MAPPING HISTORIC STREETS

using gis to track historic changes through time

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CHAPTER EIGHT

While Geographic Information Systems (GIS) are ideally suited for representing location and information about locations, they are not well suited to represent concepts of time. With only a few exceptions – such as feeds from global positioning systems (GPS) – the history of a particular feature or condition is rarely represented. Under many circumstances, this makes a great deal of sense. The data sets we value most are those that tell us about the world as it is now, or as close to 'now' as we can make them. After all, we are interested in routing garbage trucks and visualizing crime hot spots in the city as it is today. However, the absence of a temporal dimension to our geographic data can also be enormously problematic.

This chapter will focus on the development of a GIS that can manage and use a map of streets that tracks both spatial and non-spatial changes through time. Doing so will provide a robust information structure from which a more complete set of data and analyses can be drawn. The goal of this effort is to create a geocoding facility (one that converts written street addresses into "mappable" point locations) that is capable of accepting both an address and a year in order to accurately locate addresses derived from historical documents.

The dataset that forms the foundation of most urban GIS databases is the humble map of street centerlines. This represents the primary passageways we use to move across the urban landscape. In a GIS, these lines also include information on street names, numeric address ranges, one-way flags, and other attributes. In many cities, the street centerline map is organized so that it can function as a connected network, thereby enabling activities such as routing and logistics. In the United States, most street centerline databases derive from a single parent: the TIGER/Line (Topologically Integrated Geographic Encoding and Referencing) database developed by the U.S. Census Bureau. The TIGER database was developed to support the decennial census required by the U.S. Constitution. In the late 1960s, the U.S. Census Bureau created a GIS database called the Dual Independent Map Encoding (DIME) in order to provide census enumerators with maps to support canvassing of neighborhoods (Tomlinson, 1991).

In order to solve problems encountered in the 1980 census, TIGER was developed and first used for the 1990 census. It included not only roads derived from U.S. Geological Survey (USGS) topographic maps but also counties, congressional districts, school districts, ZIP codes, and enumeration districts such as census tracts and blockgroups. It enabled geocoding of street addresses as well. Most importantly, TIGER was released into the public domain and became an invaluable starting point for many GIS databases.

Philadelphia's street centerline database began with TIGER street data. It is now maintained by the City of Philadelphia Streets Department, where it has been steadily improved since the mid-1990s. From the City Planning Commission to the Police Department, the centerline is used in every agency as a core component of any GIS analysis and visualization. The Streets Department now releases a new version of the street centerline at the end of each month, thereby enabling all agencies to have the most current information possible. This street centerline map is fairly sophisticated and supports display, geocoding, routing, and other functions. A system that can geocode locations is of great importance to anyone doing research related to urban geography. Most street-level data are recorded using descriptive locations such as addresses or intersections. The geocoding process translates these text descriptions into coordinates that can be displayed on a map.

The need for a temporally-enabled street centerline became clear as part of the PhillyHistory.org Project. Many of the photographs housed in the City Archives had locations associated with them, but many of those that preceded the twentieth century used street names that no longer existed or were now in a different location. As one of the oldest cities in the United States, Philadelphia has a large number of streets whose names have changed over time. These changes have been recorded in documents such as city ordinances and directories as far back as 1760. However, the name changes have never been consolidated into a single database. This poses a problem for researchers trying to find a location based upon an historic address. The problem is complex because street names can be changed in a number of ways and for a variety of reasons. In addition, not only do the names change, but their geographic locations shift, new streets are added as the city grows, and old streets are struck from the city plan.

When William Penn first planned the City of Philadelphia, he envisioned it being organized as a rectangular grid. This configuration allowed room for public squares as well as individual houses with their own plots for gardens. As the city grew, these plots were divided. Contrary to the most common street addressing schemes used today, new buildings in early Philadelphia were numbered by the order in which they were built,

rather than being based upon their physical placement along the street. This trend continued until 1785, when the first city directory was published. At that time, buildings were numbered starting on the south side and continuing up the north side of the street. Five years later when the first census was conducted, the numbering system was changed again. All of the buildings on the north or east sides of streets were given odd numbers and those on the south and west were given even numbers. In 1856, the entire city was renumbered again, with the new system beginning at the Delaware River to the east and Market Street to the north. Each block was allocated one hundred numbers (e.g. Second Street to Third Street became the 200 block). Renumbering occurred two more times in Kensington in the 1880s and in Germantown, Chestnut Hill, and Mount Airy in the 1890s.

A second factor that altered the organization of streets in Philadelphia was consolidation of the city in 1854. By 1850, Philadelphia and its surrounding districts had experienced a population boom. The outlying districts were unable to maintain law, and their dependence on the city caused economic strain (Weigley et al 1982). This situation led to the rushed signing of the Act of Consolidation on February 2, 1854. The consolidation greatly expanded the city's borders to include all of Philadelphia County. In 1858, many city streets were renamed to standardize street names and eliminate duplicates (Alotta 1986). Another large round of changes occurred in 1895 but, due to protests from the community, a number of streets were returned to their historic names in 1897. Additional rounds of changes occurred in the early twentieth Century and, in the post-World War II era, City Council has changed the names of several sections of streets to honor individuals of local and national historical significance including Christopher Columbus, Martin Luther King, and Cecil B. Moore.

There are a large number of historical datasets that use addresses or other descriptive location devices to geographically reference events. Land records, newspaper articles, historic photographs and documents, crime records, and socioeconomic surveys all use addresses to describe locations. To analyze these data in a GIS, it is necessary to geocode them. While all of the places described still exist, they may no longer be locatable by way of their original location descriptions. For example, what most people considered Morris Street in 1858 was a north-south street in Center City between Broad and 15th Streets.

FIGURE 1
Map from 1910 Bromley Atlas showing streets (ex. Buttonwood) existing in blocks where they no longer do.
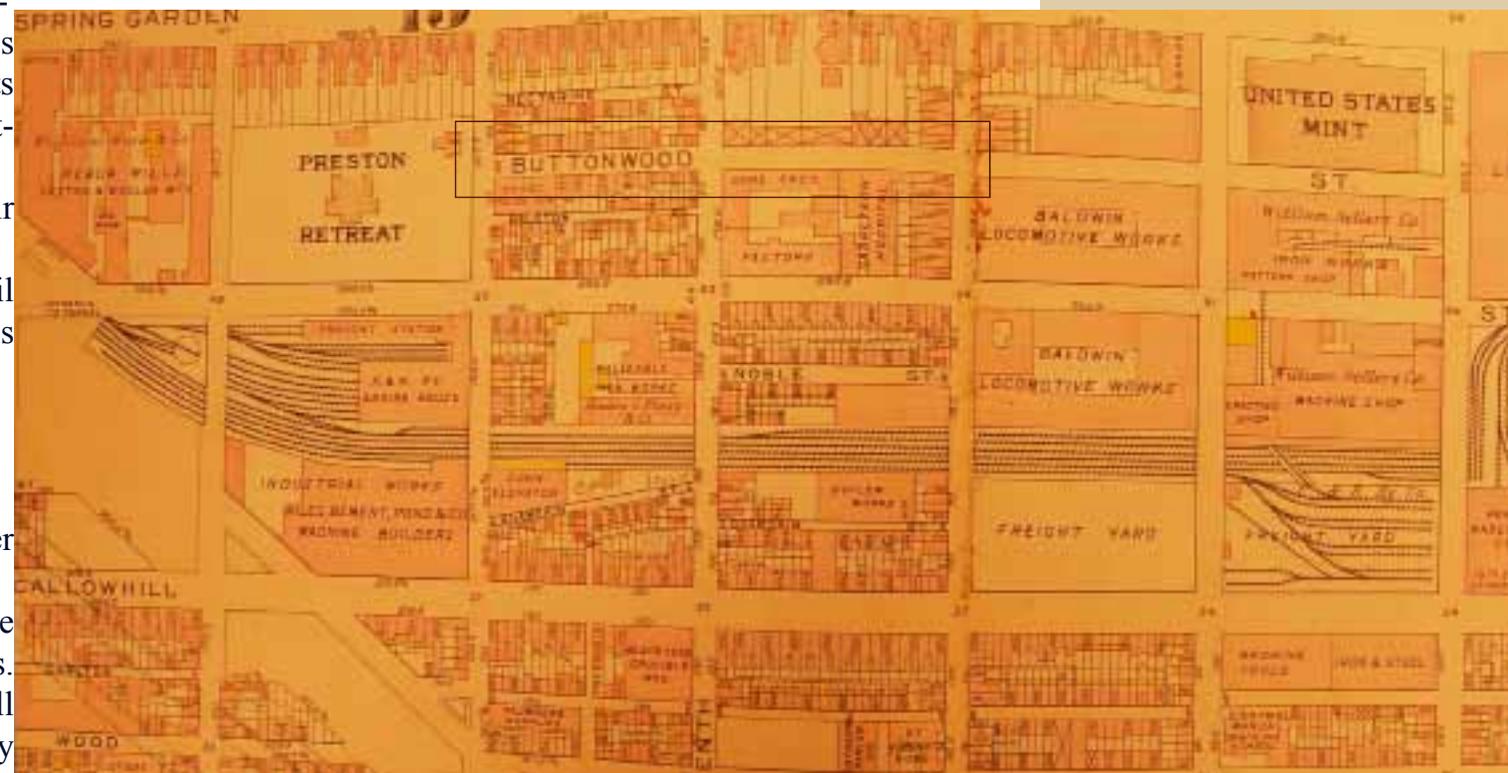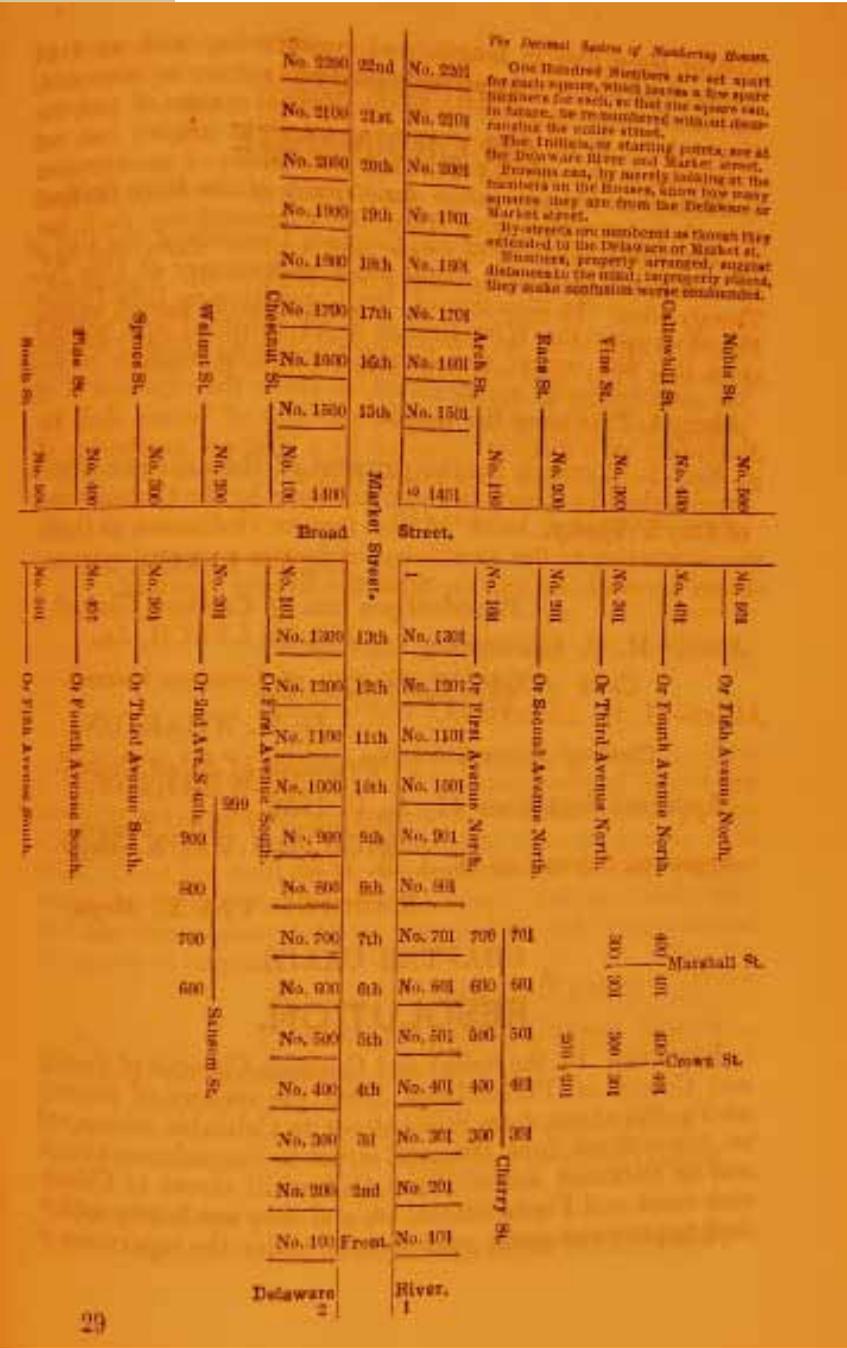
PhillydotMap

FIGURE 2
Scan from 1856 city ordinance

This street is now known as Carlisle. Today, the name Morris Street refers to a completely different location, an east-west street in South Philadelphia.

To geocode historic place descriptions, we need to create a GIS that understands not only where, but when. Currently, there is no system for Philadelphia that enables a user to find a location by typing in a place description and a date. Our goal is to create such a system in order to be able to produce a street map for any given time.

The first step in this process has been the development of a table of street name changes that can be referenced to a contemporary street map. The user would look up a street name, and the system would use the name change list to find the modern street that corresponds to the historic one. In 2005, the Department of Records contracted with Avencia to make such a system available to the public as a web application. The resulting software, the Historic Street Index (http://www.phillyhistory.org/HistoricStreets/) is available as resource to both researchers and to the general public. It supports text searches and, if the street is still in existence, enables the visitor to view its contemporary location.

This approach posed some fundamental problems, however. While the index included textual descriptions of the street segments that were the target of a particular change, these were not related to a particular geographic location. Nor was the index comprehensive. It was an accumulation of street name change notices culled from some documents, but it was not structured as a series of clear relationships that would enable a particular segment to be traced forward or backward in time. This creates a problem when there is a chain of name changes and one of the links is missing. In such cases, it is not only the missing link that cannot be found by the system but also any links that came before it. These historic streets cannot be linked to modern equivalents.

As our research progressed, we also encountered considerable ambiguity regarding the timing of name changes. It turns out that a street can simultaneously have different kinds of names. It can have an official name, but it may also have been popularly known by other names. For example, what is now known as Market Street was once High Street and, at consolidation, was officially renamed Market. However, the name Market, though not recorded until 1854, was commonly used before then. This is even an issue with modern streets whose names were changed more recently. For instance, Christopher

Columbus Boulevard is sometimes still referred to as Delaware Avenue. Furthermore, the 'official' name for a street is established in different ways in different times.

To truly resolve these issues, two important steps would need to be taken: develop a more comprehensive street name change database and develop a geography-centric mechanism for tracking both location and other changes over time. The effort now known as the Historic Streets Project has therefore been organized into two major activities:(1) library and archival research focused on filling in the gaps in the name change table; and (2) the development of a GIS database and software that will support tracking of the physical locations of street segments over time.

ARCHIVAL RESEARCH

Today, the official name for a street in Philadelphia is stored in a database of all Philadelphia streets. Before the Streets Department kept this information in a database, it was recorded in books. In addition, each township or governmental district may have kept its own list of official street name changes. To adequately differentiate official names from common names or aliases, it is necessary to record the different types of names separately. The system is built so that, at any given time, a street has exactly one official name, but could have any number of aliases.

The research process for the Historic Streets Index began with a spreadsheet developed by Jefferson Moak, a former employee of the City Archives later working at the National Archives and Records Administration (NARA). As part of his work with historical documents, Mr. Moak had developed his own database of street name changes. When we began the project, this was the most complete list available. It incorporated information compiled from archival sources such as city ordinances and city directories. However, as noted above, it was not

FIGURE 3
The Historic Street Index database anables researchers and the public to match current street names with historic ones and their locations in the city.

comprehensive. It suffered from gaps in both the number of change events it recorded and the extent of its descriptive information about name changes. It was an invaluable starting point, however, and Mr. Moak was kind enough to make his database available for this project.

A number of text sources exist on the topic of Philadelphia street names. The ordinances and directories that Mr. Moak used can be found at the Philadelphia City Archives. In addition, the City of Philadelphia Department of Streets maintains its own list of changes. By comparing these documents to the Moak database, we were able to identify changes that he had missed and add additional information to the records.

Once these text sources were exhausted, the next step was to move to the use of atlases. Atlas publication in the eighteenth and nineteenth centuries was an active and competitive business, and Philadelphia had several companies that specialized in their creation and distribution. Among the atlases created by these companies were the following:

- Hexamer & Locher Atlas, 1860
- Hexamer General Surveys, 1866-1895
- Hopkins Atlas, 1875
- G.W. Bromley Atlas, 1885
- G.W. Bromley Atlas, 1895
- Hexamer Insurance Maps, 1880-1920
- Manufacturer's Mutual Fire Insurance Company Surveys, 1895-1954
- Rand McNally and Company, 1897
- Sanborn Fire Insurance maps, 1916-present
- G.W. Bromley Atlas, 1927

While the City Archives house some of these atlases, the Map Collection of the Philadelphia Free Library has also been an invaluable resource. Even these map atlases, however, proved to be difficult sources from which to cull information. Because many of the records in the database listed only the street names and not the location of the street or the section for which the name was changed, it was often difficult to locate them in an atlas. This was especially true when the atlases did not include indexes. To alleviate this problem, it was sometimes helpful to work backwards by first locating the streets on current maps and then going to the historic atlases. The historic atlases were used to narrow down the specific segments of streets whose names changed. They could also be used to determine the year in which the change occurred, as well as the ward and the districts in which the streets were located at the time. If the dates or wards were known, streets could be found in maps of specific wards from that year. Otherwise, two atlases would be used to compare an old street name from an older atlas to its newer name in a newer atlas. The segment of the street that was renamed could be found and its location recorded with an approximate date of the name change. When comparing atlases, it has also proven immensely helpful to use two atlases by the same publisher. This way, the plate numbers in each atlas match, allowing the researcher to be certain that the areas being viewed are indeed the same part of the city.

During our research, we encountered several additional problems that made the work challenging. With the creation of new buildings and roads, other roads were often vacated. If we were not careful, we sometimes ended up searching not for a street with a new name but for a street that simply no longer existed. In addition, as the city expanded, ward boundaries shifted, causing streets to be in different wards at different times. This was especially problematic when using historic atlases, as many of those volumes are based upon wards.

The publisher and quality of atlases available for this research also varied from volume to volume. As noted above, publishers divided the city into plates. In order to prevent copying by competitors, however, each publisher used its own scheme for assigning plates, thus making it difficult to compare atlases from different publishers. Many publishers also add fake 'trap streets' to further protect against copyright infringement issues (Mathieson 2006). So whenever we noted an anomalous street, we had to consider the possibility that it might never have actually existed.

Furthermore, an atlas published in a given year may not always include up-to-date street name changes, so our dating for some streets may not be very precise. Finally, while the Philadelphia Free Library, City Archives and other institutions have some of the finest map collections in the world, some of their atlases have decayed beyond the point of being useful. While the atlases have certainly been helpful to the project, their use has also proven to be particularly tedious and time consuming.

SOFTWARE AND DATABASE DESIGN

Our second major activity has been the design and development of software tools and the creation of the geographic database. This development work is not yet complete, but the overall design of the system has now been established.

An important design decision was made early in the process, as it became clear that this database would have to separate the physical existence of a street segment from its textual description. In this way, information pertaining to a street (where it is, when it was created, and - possibly - when it was destroyed) can then be represented without the street's name(s). All related data about that street, such as its various names and address ranges would

FIGURE 4
LEFT Map from 1895 Bromley Atlas and RIGHT Map from 1910 Bromley Atlas

PhillydotMap
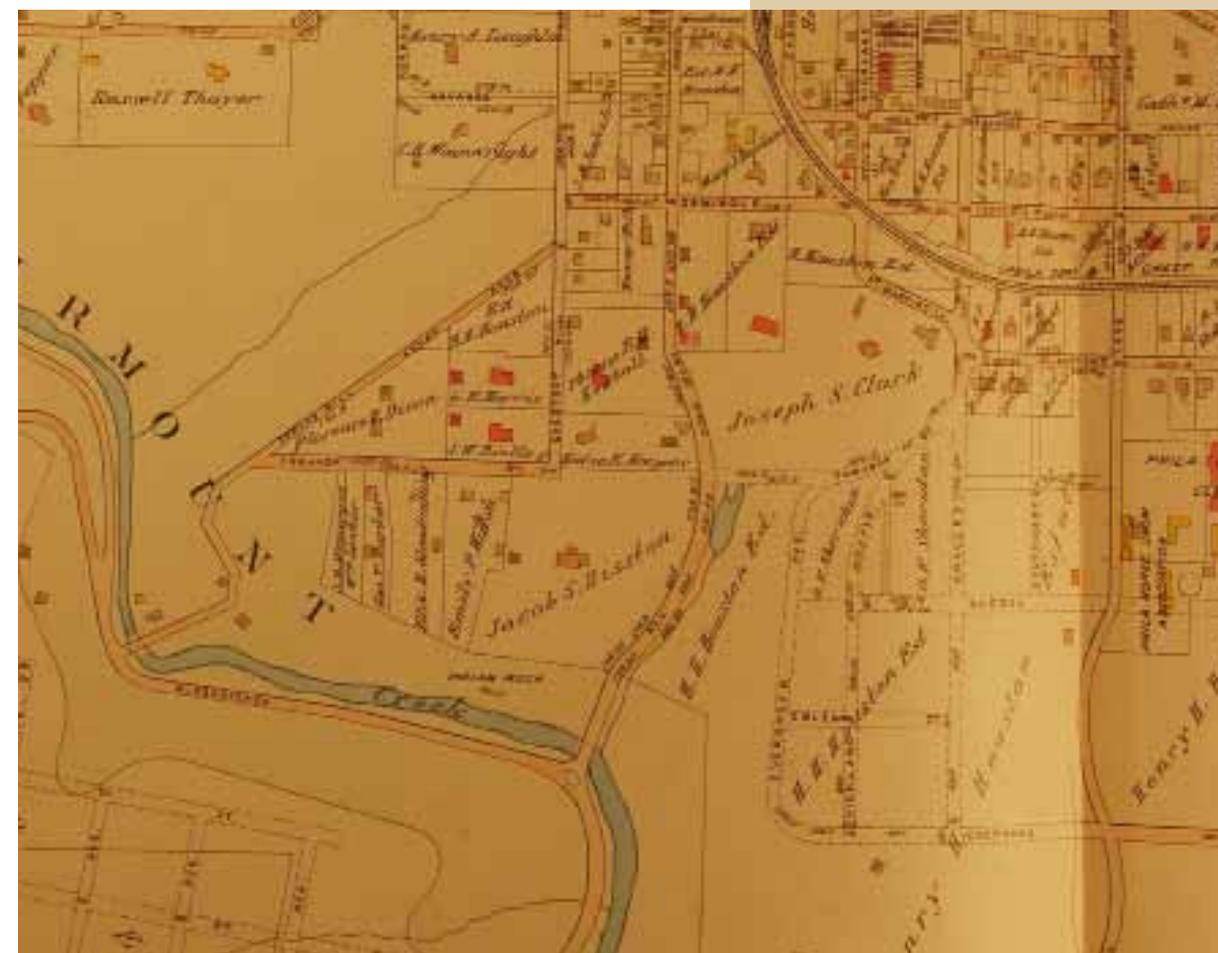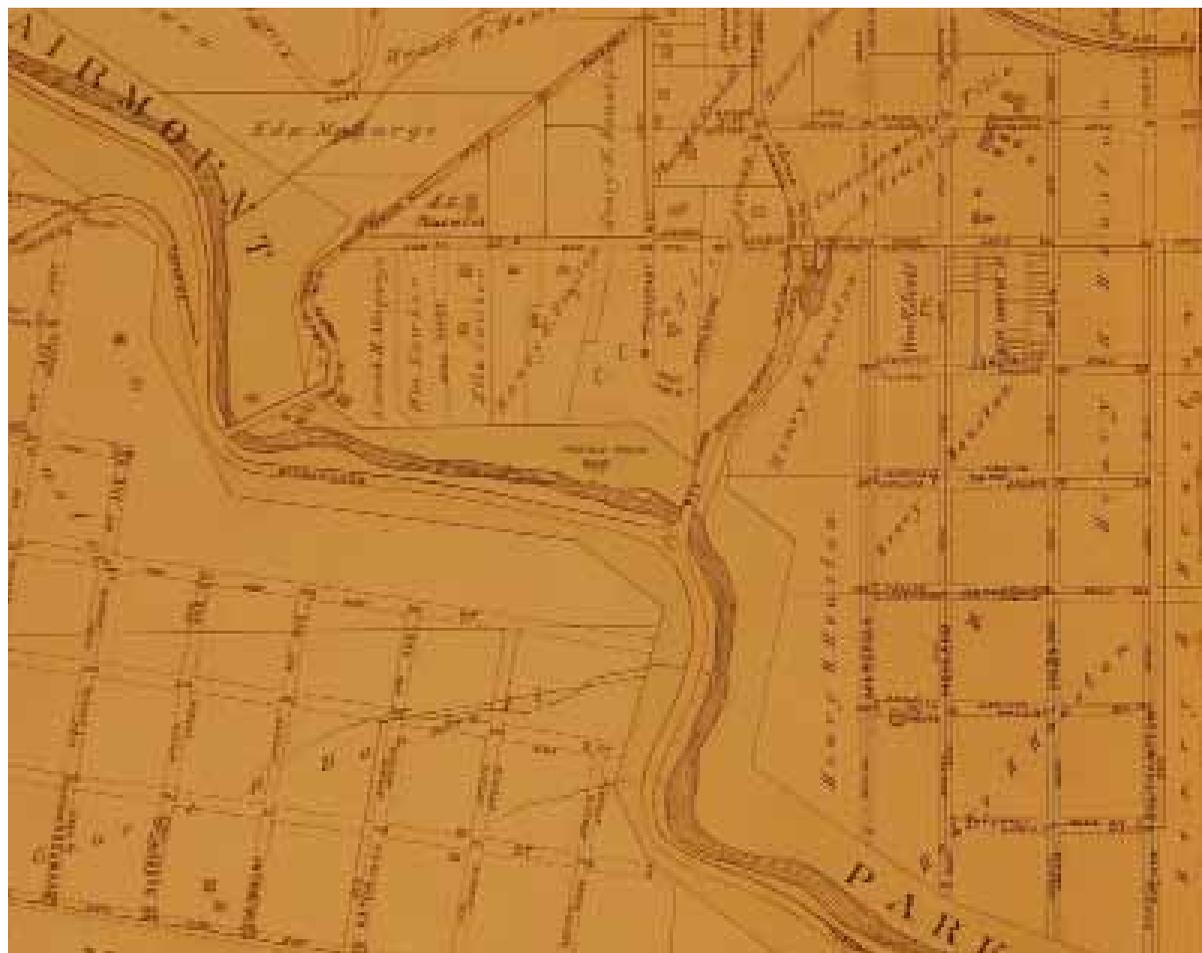
be tracked and stored separately from the street's geographic location. While this results in a far more complex database and calls for more sophisticated software, it also affords much-needed flexibility.

As the research progressed, it also became clear that this database would likely be completed by multiple researchers over a long period of time. This would require that edits be validated and corrected by others before they are published. More importantly, we felt that the people who would perform this work would generally not be people with GIS training. For that reason, the software used to edit this database should not assume such knowledge.

This software has been organized into three major components: a database; a data main-
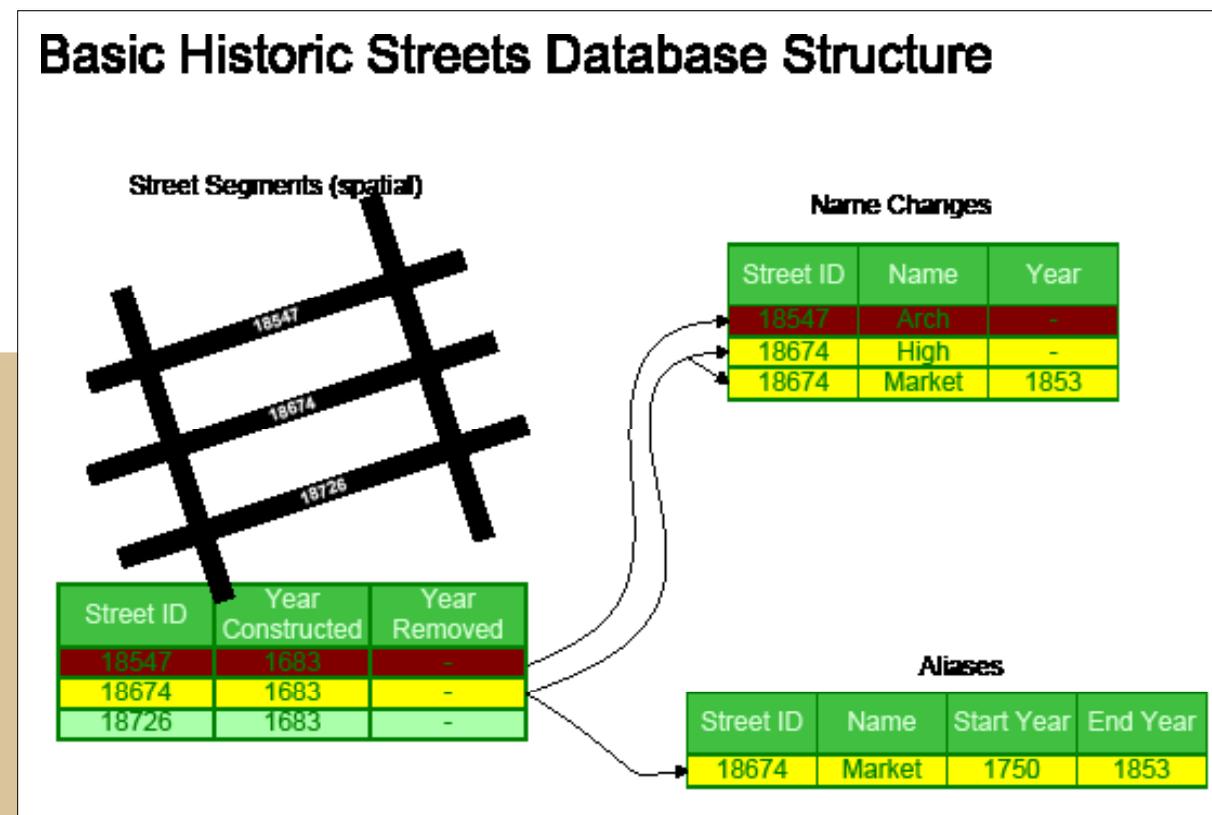
tenance module targeted at archivists and historians; and an historic address geocoder that can be incorporated into software such as the PhillyHistory.org database of historic photographs. The database design work has largely been completed. The data maintenance module includes a number of user-friendly features. First, the entire system is run via web access, eliminating the need for GIS-specific software by end-users. Second, the data entry component is task-driven. Instead of having users interact directly with the database and geographic data, tasks in the application correspond to how data will be researched and found in the real world, and abstracted from the underlying data model. For example, if a researcher finds a name of a street that was previously unrecorded, he or she will use the 'Add street name' task. This task will guide the researcher through as he/she chooses a street and enters its name by date and type (official or common). When adding a street, the user will define it geographically, using a base map of the other contemporaneous streets, and entering the dates of its physical existence. The user will then be asked to fill in available name information for the street.

The system will also allow users to leave some fields blank and query for inconsistencies. For example, suppose a researcher discovers that a street with a given name was removed in a certain year but has not been entered into the system. The researcher also does not know when the street was created. Instead of requiring the researcher to enter all information about a street, the system allows fields to be left blank. Later users can then query the system for instances where incomplete information was entered and supplement that information with their own research results.

The Historic Geocoder module will be available in two different forms. First, the existing Historic Street Index web site will be extended to support entry of any address with a time period and return a ranked list of likely locations. Since official name changes sometimes take decades to fall from common use, each response will need to be ranked with a likelihood score that will reflect this concurrent usage of both official and vernacular versions. The Historic Geocoder will also be available as a web service, a data-processing capability accessible online. This web service will enable projects like the PhillyHistory.org photo database (http://www.phillyhistory.org/) or the Philadelphia Architects and Buildings project (http://www.philadelphiabuildings.org/) to add historic geocoding capabilities to their web sites without having to develop that functionality themselves.

FIGURE 5

Diagram showing the Historic Streets Index database scheme.

GIS provides a unique opportunity to combine technology and historical research. Most historical location information is recorded as location-descriptions (i.e. addresses). The GIS cannot understand this description on its own. Geocoding translates the address into information the GIS can understand (i.e. x y coordinates). Adding the element of time to the geocoder through a database of street name changes will enable the GIS to map historic locations on a current map, making historical research based upon location much simpler. The Historic Streets Project will provide the opportunity for researchers to collaborate using technology to reconstruct the historic geography of Philadelphia.

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For more information on trap streets, see:
"Copyright Easter Eggs." 2 January 2007. http://wiki.openstreetmap.org/index.php?title=Copyright_Easter_Eggs&printable=yes (accessed 15 February 2007).