Building History:  
Learning with Archival Photographs

Erik Jackson Blankinship  
B.A. English Literature, University of Maryland, 1997  
M.Ed. Harvard Graduate School of Education, 1998

Submitted to the Program in Media Arts and Sciences,  
School of Architecture and Planning,  
in partial fulfillment of the requirements for the degree of  
Master of Science in Media Arts and Sciences  
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Author:  
Erik Jackson Blankinship  
Program in Media Arts and Sciences  
May 22, 2000

Certified by:  
Brian K. Smith  
Assistant Professor of Media Arts and Sciences  
Thesis Supervisor

Accepted by:  
Stephen A. Benton  
Chair, Departmental Committee on Graduate Studies  
Program in Media Arts and Sciences
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abstract
In many classrooms, learning about history means memorizing facts from textbooks, films, and other media. It is rare for students to engage in authentic historical activities - analyzing multiple documents to look for similarities and variations and ultimately assembling interpretations of past events. In this thesis, I present a set of tools, called Image Maps, that allow students to conduct historical inquiry within their own communities. Rather that reading about the history of a community, students are encouraged to photograph the buildings in their neighborhoods. The cameras they use have been augmented with global positioning system (GPS) receivers and digital compasses. The metadata provided by these sensors are used to retrieve historical images of the locations that students photograph. This collection of photographs is used as evidence for hypotheses about how and why a city has changed over time. In this document, I explain how the integration of geographic information systems (GIS) and digital photography can lead to new ways of thinking about local history. I describe the hardware and software used to make historical photographs accessible for reasoning about community change. I also describe preliminary evaluations that show how sophisticated reasoning can occur when students are made to develop their own interpretations of historical photographs.
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tables of content

1. MICKEY AND GOOFY'S EXCELLENT ADVENTURE .......................... 6

2. SCENARIO: CHANGES IN HARVARD SQUARE ................................ 12

3. THEORY ........................................................................ 19

4. IMPLEMENTATION .................................................................. 25

5. EVALUATION ...................................................................... 35

6. FUTURE WORK .................................................................... 44

7. WORKS CITED .................................................................... 49
1. Mickey and Goofy's excellent adventure

Let's consider the following scenario in which Mickey and Goofy are taking photographs at the beach:

![Figure 1.1. Panels from a 1962 Mickey Mouse comic, "Lost Treasure Trackers". Mickey and Goofy discover that their camera returns photographs of the past. (Murry, 1962)](image)

The photograph returned by the camera is clearly not the one taken by Mickey, yet there are features which indicate it is a photograph of the same place: the coastline, people in bathing suits. There are also things that differ indicating that it is an image of the past: the antiquated style of the bathing suits, the presence of destroyed buildings. These observable differences support Mickey's hypothesis that the photograph is of a scene thirty years before.

Mickey and Goofy's conversation centers around specific references to the photograph, making it a conversational prop (Brinck & Gomez, 1992; Roschelle, 1992) for the discussion of historical change. It is an exceedingly apropos prop, given that Mickey and Goofy are standing at the scene of the changes. If Mickey and Goofy converse further and contemplate the reasons for the observable changes in the
archival photograph, they could articulate more specific questions. Why did they need to demolish the buildings along the beach? How have the swimsuits changed to make them appear “old fashioned”?

If Mickey and Goofy did not have this special camera returning historical photographs, it is doubtful they would have thought about the history of their environment. If somehow they did find themselves thinking about history, it would probably be through a more traditional method such as reading an historical sign or history textbook.

If Mickey and Goofy were to pass Paul Revere’s house of some other “important” historical monument, they would probably see a sign or plaque describing its cultural and social significance. Generally, some historical commission decides where these signs should be placed; for example, Boston's Freedom Trail is a designated historical site because of its role in the American Revolutionary War. It is doubtful that a beach would be considered an historical monument (unless it happened to be, say, one of the French beaches involved in the D-Day invasion during World War II). But the most ordinary beach does have a history; it does carry implicit stories about its development and growth.

The beach that Mickey and Goofy visit lacks historical markers, but they are able to see its history through their magical camera. They very fact that they were able to see history in a place that is meaningful to them may motivate them to learn more, to seek out how and why their favorite beach has changed over time. If Mickey and Goofy happened to read a conventional K-12 textbook about the area, it would probably only consist of dates, important events on those dates, and a summary of the consequences of those important events. If there were any archival photographs in the textbook, they would most likely be accompanied by captions that specify what the historian determined was important in the photographs. If, by chance, Mickey and Goofy learned about the history of the beach in one of these traditional ways, everything deemed important would have already been decided for them.

1.1 the city as laboratory

In the past decade, reform efforts in science education have suggested that students engage in authentic inquiry around scientific principles (AAAS, 1990; NRC, 1996). That is, we should be giving students conceptual and technological tools to help them develop questions and strategies for testing and evaluating hypotheses. Learning is best facilitated when students conduct self-directed inquiry. Rather than giving students “cookbook” laboratory exercises, we should help them understand how to choose interesting research problems and conduct investigations to verify their
hypotheses about these problems. These reform ideas are not unique to science learning. We can imagine students doing similar investigation tasks in the streets of their cities. For instance, Mickey and Goofy have a unique opportunity to see the past and to interpret it for themselves.

Opportunities exist for students to generate their own explanations of historical trends by engaging in “field work” in their cities by taking photographs. This fieldwork is complemented with archival photographs. Historical photographs provide a glimpse at the architectural, fashion, transport, and cultural trends of a period. Students can reflect on how these trends change and effect cities over time.

The city is a “laboratory”, a place where we can reflect on the successes and failures of architectural design and building (Jacobs, 1992). Typically, we do not think of cities as learning environments, and we certainly do not see much emphasis placed on studying the city in most formal school curricula. In this thesis, I describe a system in which students can begin exploring their communities to learn about how and why their cities have changed over time.

Consider the radical difference in how history education is being proposed. In most K-12 classrooms, history is presented through textbooks, educational films, and museums. In general, students are not given opportunities to explore historical issues in their own communities. They may take field trips to see local sites of interest, but they rarely use such journeys to investigate how and why their own communities have changed over time.

1.2 the “right” answers

Mickey and Goofy have a powerful tool, a camera that can reveal images of the past. Let’s consider how they might try to further investigate the mystery of the demolished buildings at the beach. They could take another photograph with their magic camera closer to where the demolished buildings used to stand, in the hopes of retrieving another archival photograph. With another photograph, they might be able to determine the building’s function (private residence? public showers?) and formulate a more specific hypothesis about the observable changes (the beach is now public, swimming is no longer allowed). These hypotheses might, in turn, lead to other questions about the beach community that Mickey and Goofy could investigate with their camera (where does this family live now? where do people bathe now?). Photograph after photograph would lead to more questions in a continuing process of inquiry.

Mickey and Goofy will want to know more about the reasons for the observable changes they have identified in the photograph of their community. To answer these
questions, Mickey and Goofy visit the local library:

![Figure 1.2. Panels from a 1962 Mickey Mouse comic, "Lost Treasure Trackers". Mickey and Goofy research an historical photograph at a local library. (Murry, 1962)](image)

Getting the “right” answer to their questions (houses torn down to make place for a public beach) about the changes at the beach is a good thing, but more important is that they posed their own questions about historical change and then went on to research their own questions. Instead of being told what was important about the history of their community, Mickey and Goofy identified something of interest to them and proceeded to investigate.

1.3 taking pictures... further

1.3.1 the camera

The camera in the comic uses magic (Murry, 1962) to retrieve archival photographs, making it difficult to use in real world scenarios like classrooms. To remedy this situation, we have augmented digital cameras to offer the same functionality of the magic camera, along with additional benefits. By attaching a global positioning
system (GPS) receiver and a digital compass as additional measurement devices to the digital camera, position and orientation metadata can be embedded into the image file when photographs are taken. This location and orientation information is used to query a database of historical photographs indexed to geographic features. Using this technique, photographs taken with our camera are able to retrieve matching historical photographs from our database.

1.3.2 image maps software suite

To help students articulate and structure their observations about community change, I have developed a suite of tools called Image Maps. Students use the Image Maps software to compare their own photographs with historical photographs. Next, Image Maps requires students to create an ontology (a structured description using categories and lists) of features to annotate the image collection (e.g., street lights, parking lots, fire hydrants). As students annotate photographs, they can search through the image collection using their ontological features as search criteria, and can further constrain this search using dates and locations as additional parameters. For example, a student can search for photographs annotated “fire hydrant” and “burned down building” over a specified time interval (1910 to 1950), and also narrow the search to certain buildings (a local neighborhood). In this way, users can search for spatial and temporal patterns in the image collections.

Once features have been identified and annotated in the photograph collections, they can be assembled into visual patterns with explanatory captions provided by the students. These patterns allow students to explicitly describe interrelationships between annotated features of the photo collection. The types of relationships students define between annotated features and the resultant patterns are central issues in this thesis. An example of the process students go through appears in chapter two, and the technical details of the system are presented in chapter four.

1.4 building history

Using geographic data to retrieve relevant historical information from a certain location has been proposed (Höller, Pavlik, & Feiner, 1999; Mitchell, 1996; Spohrer, 1998, 1999; Lüsebrink & Sauter, 1997), and Image Maps is one implementation of such a system. Instead of simply presenting historical synopses or retrieved information, our tools encourage students to build explanatory models using historical data. The “answers” to history are not returned by the system; one uses the primary documents retrieved to build one’s own interpretations of historical change.
By providing a method to collect and retrieve photographic archives and tools facilitating the creation and structuring of observations about these photographs, my thesis is that students will generate hypothesis about urban environments and argue these claims. In evaluating Image Maps, I wanted to see which features of the urban environment students would chose to annotate in the image collections, and how they would choose to describe these features in relation to each other.

What follows is a description of the activities that students pursue as they use historical images to reflect on how and why their community has changed over time. I will describe the technology that enables this sort of historical inquiry, the augmented camera and the software that helps students annotate and compare photographs. I will also present results from my initial deployment with students, results that suggest future improvements but also show that proper guidance can lead to sophisticated hypotheses about how and why a city has changed over time.
2. scenario: changes in Harvard Square

To provide an example of the sort of activities I imagine occurring around the Image Maps software, I will describe a hypothetical scenario in this chapter. This scenario will describe the ways students might investigate their community with digital cameras, use the Image Maps software to annotate and describe photographs of their communities, and the resultant discoveries that might occur. The events in this hypothetical scenario are fictional, but the hardware, software, and database are real.

2.1 in the field

Most afternoons, a group of teenagers stop in Harvard Square on their way home from school. The students usually arrive in Harvard Square thirsty, and almost always stop for a drink at a local independently owned coffee shop. On one of these visits, the owner of the coffee shop informs the students that he is closing his coffee shop since business is poor. In place of the coffee shop, a developer is planning to construct a new chain bookstore.

One of the students decides that a photograph would be a good way for everyone to remember the good times they had at the coffee shop. The student has everyone pose with the owner in front of the coffee shop, and takes a picture with her digital camera. The student’s digital camera has sensors attached to it allowing it to record additional information other than the photograph. When the student presses the shutter button, her digital camera not only records the photograph of the coffee shop, but also records the camera’s geographic location using a global positioning system (GPS) receiver and the camera’s bearing using a digital compass.

2.2 pictures of the past

The next day at school, the students upload their photograph from the camera into a computer. The Image Maps software installed on the computer parses the image file to find and retrieve the embedded geographic metadata in the image file. The position and orientation metadata are used by the Image Maps software to locate where the photograph was taken on a geographic information systems (GIS) map of the buildings of Cambridge. Using the embedded orientation metadata, the Image Maps software determines which building on the GIS map was closest to the lens of the camera -- the coffee shop.

The Image Maps software then searches a remote database of archival photographs to determine if any pictures have been indexed that include the coffee shop or any past structures standing in the same place. If there are any matches, these
archival photographs are returned to the *Image Maps* application and displayed next to the student's photograph (Figure 2.1). In this way, photographs taken with the enhanced digital camera serve as a key to photographs of the past.

![Image Maps comparison interface](image)

**Figure 2.1.** *Image Maps* comparison interface. Thumbnails on the right are images taken by students. Choosing one of these displays its larger image and an array of historical thumbnails across the top. The left image is the historical photo chosen from the retrieved collection. The floating "info" window provides additional information on the selected photograph.

### 2.3 comparing photographs

The students are amazed to see the amount of change to such a small area of Harvard Square. Twenty years before the coffee shop existed, the students discover that many different pubs inhabited the same structure at different times.

Comparing their own photograph with the archival photographs, the students begin to argue about the nature of the changes to this area of their community. They note that drinking establishments have long been located at the same place, and question why this is now suddenly changing.
The students have identified a question that they want to answer by studying the photographic evidence. Instead of being given questions posed by a textbook or from a worksheet, the students have found something of interest to them and have begun wondering about the reasons for changes in their environment.

2.4 iterating on history

That afternoon, the students return to Harvard Square with their camera. Their goal for the afternoon is to photograph all of the drinking establishments in the area. By taking all of these photographs, they anticipate that it will reveal more photographic evidence about the history of the area with the Image Maps software.

By making a return trip to Harvard Square to gather more evidence, the students are engaging in fieldwork. That is, they have left the classroom and work outside in the “field” to collect data in the form of photographs. The data they are collecting will later be analyzed back in the classroom, much like data collected by scientists in the field is later analyzed back in the lab.

The students are also in the midst of an iterative process of inquiry, refining their initial questions through further investigation. The answers they find to their questions will, in turn, probably lead them to ask more questions and continue the process of inquiry.

2.5 annotating photographs

When they return to the classroom the next day, the students use their own photographs and the Image Maps software to retrieve more historical photographs. The students are initially overwhelmed with the large number of historical photographs returned by the software.

Using the Image Maps software, the students create an ontology of pertinent features they want to identify in the image collection. They cluster features into groups, such as “places to drink”, which includes “pubs”, “coffee shops”, and “juice bars”. Another category is “places to shop” which includes “book stores”, “hardware stores”, and “toy stores”. Features within the photographs are then tagged with these labels by highlighting them (Figure 2.2).
2.5.1 finding causal relationships

As the students annotate the image collection, they also search the image collection using the features of their own ontology as search criteria. For example, one of the students searches for instances of "pub" and "streetlight" and finds an interesting pattern: over time, the number of pubs declined with the increase in the number of streetlights. He speculates that streetlights made it safer to travel at night, increasing the number of people who would travel to this part of Harvard Square, thereby creating opportunities for different types of establishments -- like the coffee shop.

When another student searches the image collection for "book store", he finds a large increase in the frequency of bookstores in recent years. The student speculates that the reason for their favorite coffee shop's drop in business is due to large chain bookstores including a coffee shop in their store. Since shoppers can get their coffee and browse for books at one location, the desirability of a specialty store like a coffee shop could be on the decline.

It is important to note that the students' speculations are not conclusions. Many factors influenced the development of Harvard Square, and students' study of photo-
graphic evidence cannot completely solve the mysteries of the past. The students have posed hypotheses and informed their hypotheses with detailed analysis of photographic evidence. It is possible that the students might generate false or unfounded hypotheses based on the photographic evidence. The co-occurrence of pubs and streetlights in the image collection might not indicate any causal relationship. Teacher guidance is a necessary component of the inquiry process in order to keep students on track. Desire for confirmation of students' hypotheses will hopefully lead to researching in a library, over the internet, conducting interviews, or other means. The important thing is that students are posing questions about factors they have identified as important.

2.5.2 describing architectural patterns

Years ago, when a bar stood in the place of the soon-to-be closed coffee shop, the windows of the building were noticeably different. The windows were just small holes in the wall, and these were filled with neon beer signs. When the coffee shop was built, the windows were restructured and widened allowing anyone passing by to see inside the coffee shop.

Students compare the look of the old bar to other bars like it still standing in Cambridge and note the architectural similarities. They also notice how many coffee shops in Cambridge all have large glass windows. The students realize they have identified architectural patterns that define the look of certain types of establishments. Much like certain architectural features make all McDonalds look the same, the students identify that there are properties other types of structures might have in common which identifies their function.

2.6 modeling observations

The students who have discovered patterns in the image collection want to share their findings with other students and the owner of the coffee shop. Using Image Maps, the students sequence annotated regions of photographs into a visual model, or graph (Suthers, 1999), to represent their findings about the urban landscape. An example of how these models look is displayed in Figure 2.3.
Figure 2.3. *Image Maps* modeling interface. Students extract regions of photographs into nodes that they create and position. The text field under each node provides space for students to add explanations. Lines connect the different nodes together into a pattern created by students.

2.7 looking for answers

Intrigued by their discoveries, the students decide to see if there is any published information to support their claims. Using the Lexis/Nexis news search engine to research bookstores in Harvard Square, they discover that Harvard Square has the moniker “bookstore capital of the world” (Imbrie, 1998). This informs the students’ finding about the dramatic increase in bookstore construction.

They also find recent news about the advent of chain stores to the Harvard Square area (Abel, 2000). These articles argue that niche shops, which have defined the unique look of Harvard Square for years, cannot compete with the advent of new chain stores. This argument resonates with the student who hypothesized that individual coffee shops cannot compete with new chain bookstores that offer in-house coffee.
2.8 the big picture

The events and students in this scenario are fictional, but the GPS enabled digital camera, *Image Maps* software, and database of digital historical photographs are real. In this chapter, students took photographs of their community to record something meaningful to them. When the students viewed their photographs with the *Image Maps* software, they were presented with historical photographs matching their own photographs. Viewing these historical photographs generated conversation amongst the students as to how their community has changed over the years and motivated them to collect more evidence in the form of photographs. By annotating features within the photographs, the students were able to identify patterns in the image collection and hypothesize about why changes have occurred in their community.
3. theory

“No true secrets are lurking in the landscape, but only undisclosed evidence, waiting for us. No true chaos is in the urban scene, but only patterns and clues waiting to be organized.” (Clay, 1980)

3.1 doing history

The premise of this research is that students can learn critical observation and interpretation skills by investigating changes in their local communities. Many authors describe the changes in urban landscapes (Hoskins, 1970; Jacobs, 1992; Kunstler, 1993) while others describe the details of developing organized arrangements for city planning (Alexander, Ishikawa, & Silverstein, 1977; Bacon, 1967; Lynch & Hack, 1996). Such texts provide ways for us to begin thinking about learning from our cities, but they do not actively engage students in conducting their own historical inquiries.

As it is now, history education normally consists of students reading books to memorize facts about past events (Paxton, 1999). For the most part, students are passive recipients of filtered historical information from textbook authors. History classes are structured to teach students to absorb historical knowledge and do not require students to actively investigate historical change themselves. There are approaches to history in which students repeat the research of a professional historian (Kahn-Leavitt & Moyer, 2000), but these programs provide students with pre-defined historical questions. The problem is that students do not engage in authentic historical inquiry in classrooms. That is, students do not decide for themselves what is important to question about the past, how to structure their investigations into the past, or how to interpret their findings. Being a skilled historian means integrating, completing, and challenging evidence conveyed through multiple knowledge sources, but these skills are not typically addressed in high school curricula (Rouet, Favart, Britt, & Perfetti, 1997; Wineburg, 1991).

In this work, I assume that students have intuitions about their own communities: how they have developed over time, how the architecture has come to serve people’s needs. So rather than instructing them in “classroom history”, the study of extraordinary events (e.g., World Wars, the European renaissance), I use rather ordinary events as the target content. However, these ordinary events have occurred in the students’ communities, potentially making them more relevant than detailed studies of world history, for instance. By creating tools that structure inquiry around the history of a community, my goal is for students to actually do history. There is much to be learned from being an active explorer of one’s city (Stilgoe, 1998), and my goal is to assist students in realizing that they can conduct investigations in their community “laboratories”.
The urban landscape is rich in history: the layout of most roads were decided on centuries ago; offices and apartment buildings of today are often reconditioned warehouses and factories; old trolley cars are permanently removed from their abandoned tracks and turned into diners. By looking closer at the world immediately around us, it becomes possible to find clues to the past and determine how the land was used.

3.2 urban planners and the past

The workplace of urban planners is the real world landscape in which most of us live day to day. Planners encounter the unknown or overlooked history of our communities and must interpret this history to do their job. For example, information about past and current transportation systems can inform future designs. A city like Los Angeles, for instance, once had vast rail services that linked the suburbs to the city center (Kunstler, 1993). Today, these rail lines can only be seen in pre-World War II photographs. Studying urban history informs the planner about what has worked in the urban landscape and what has not.

Planners use historical imagery to study the aesthetics and functionality of city environments (Bacon, 1967; Whyte, 1984). Patterns of urban change can be difficult to explain or justify without using qualitative data such as photographs. Time lapse photography and documentation of changes with sequences of photographs are two techniques that allow for analysis of city transformations and communicating hypotheses (Bacon, 1967; Whyte, 1984).

If students approached history using techniques similar to urban planners, students could tackle interesting problems relevant to their immediate environments. What is needed is to find an activity of the urban planner appropriate for students to participate in.

3.2.1 introduction to patterns

Planners have looked for ways to structure their observations of the urban landscape. In the 1970s, Christopher Alexander and his colleagues introduced the concept of pattern languages to the architectural community (Alexander et al., 1977). The elements of the pattern language are schemata describing frequently occurring problems in man-made environments and solutions addressing those problems. In the original notation, each pattern begins with a photograph displaying a prototypical example of the problem. Accompanying the image is a full description of the problem and evidence for it being a pattern that frequently occurs in architecture. A series of instructions to correct the problem accompanies the pattern, as seen in this description.
from the “Six-Foot Balcony” pattern:

Balconies and porches which are less than six feet deep are hardly ever used…Therefore, whenever you build a balcony, a porch, a gallery, or a terrace, make it at least six feet deep. If possible, recess at least part of it into the building so that it is cantilevered out and separated from the building by a simple line, and enclose it partially (Alexander et al., 1977 pp. 781).

The features which constitute an effective balcony are: six foot depth, recession of half of the balcony, and partial enclosure. Alexander links different patterns by providing descriptions of how juxtaposed architectural features fit together to create urban environments. For example, Alexander recommends builders of the “Six-Foot Balcony” pattern to “Enclose the balcony with a low wall -- SITTING WALL (243), heavy columns -- COLUMN SPACES (226), and half-open walls or screens -- HALF-OPEN WALL (193)” (Alexander et al., 1977), wherein each number refers to another pattern.

Students can define similar patterns in their own communities. This would require them to travel through their communities looking for examples of architectural features. To help record their findings, students use a camera to take photographs of architectural features. Photographs provide a means for students to later study their findings and help students to communicate their findings to others. The camera we created retrieves historical photographs matching the view of those taken by students. These archival photographs provide students with an opportunity to compare the architectural features of today with those of the past and note how they have changed. In this way, students exploring historical photographs can identify changes in the architectural patterns of their communities.

3.3 multimedia supports for inquiry

To describe their own patterns, students annotate images with relevant features that form the basis for describing relationships. For example, we can imagine a student creating their own balcony pattern by describing the features of photographs of balconies in their own communities (Figure 3.1).
Photographs are excellent props to use for the task of annotating architectural features. Instead of being provided with captions explaining what is important about a photograph, students must describe relevant architectural features in photographs themselves. This is good because through this process students are using primary sources to build an argument. In this case, the argument is a description of which features define an architectural pattern in a neighborhood.

Repeating the feature annotation process in multiple photographs provides students with an opportunity to look for regularity and variation in their patterns. This is good because it challenges students' definitions of their own patterns and forces them to possibly redefine their definitions. When historical photographs of architectural features are compared with photographs of the present, students' definitions of patterns are challenged once again. The architectural features of the past might be so different that students' patterns of the present might not apply. Students must then determine which features have changed in their patterns and hypothesize about the historical change.

3.3.1 modeling the process

Learning how to structure an argument through the annotation of photographic evidence is a good skill, and learning to refine that argument through the comparison of multiple photographs hones this ability. However, the process of using photographs

Figure 3.1. An annotated photograph of a balcony. The annotations demonstrate how a student could define an architectural feature (a balcony) by describing its components ("railing", "built in seat", "sliding glass window", "lawn chairs and table", "stick out at least six feet").
as evidence for arguments is not obvious and can benefit from structuring the inquiry process. Students need to understand how to assemble photographs into explanatory models. The following structure defines four steps that assist in building models from casual observations of still and moving images (Smith & Blankinship, to appear):

1 Decompose. Complex processes consist of many constituent, related actions. The changes in a city's major modes of transport may progress from horses to trains to automobiles. Identifying these components provides the building blocks for the remaining strategic steps.

2 Compare. It is not enough to analyze a single film or photograph of a complex process. Our students investigate libraries of video and images and compare them to look for similar events. By looking for variations in a routine or across time, students can identify patterns that may prove critical to explaining the process.

3 Identify factors. Once variations are detected through comparison, students need to perform additional analyses to determine the factors influencing the variance. For example, one might observe that antennas on houses are disappearing over time in a collection of urban photographs. To explain why this is the case, it is necessary to look deeper at the images, to identify additional factors that may account for the disappearance (e.g., the number of satellite dishes are increasing). The identification of related factors does not necessarily lead to accurate causal relationships, but provides evidence for the structuring of hypotheses around these factors.

4 Model. With variations and influencing factors identified, students can generalize causal models that explain the phenomenon under investigation. The modeling step creates an explanatory framework that can be used to predict and design future configurations of the problem space.

3.4 summary

I want students to engage in authentic historical inquiry by learning how to decide for themselves what is important to question about the past, how to structure their investigations into the past, and how to interpret their findings. Right now, this is not the current way history is being taught in schools.

Urban planners examine the history of our communities to learn how they have functioned in the past and apply this knowledge to their design tasks. To help analyze the urban environment, planners have devised ways of describing urban features as patterns.

Students can define their own patterns found in the urban landscape by analyz-
ing photographs of their communities and using them as evidence. By comparing photographs, students can look for regularity and variance in their patterns. The introduction of historical photographs forces students to question if their patterns existed in the past and why and how these patterns have changed. In a sense, students become urban planners, actively investigating their cities and developing theories about their construction.
4. implementation

In this chapter, I discuss the design of Image Maps hardware and software and how these tools support inquiry around historical images. The first part of the chapter describes the digital camera used to retrieve historical photographs. The second part of the chapter presents the workings of the Image Maps software and how it supports students inquiry around historical images.

4.1 the camera

We created a specialized digital camera for students to use when out photographing architectural features in their communities. This camera was designed so that when a photograph is taken, the camera also collects additional geographic information that will be used as a key to access a database of geo-referenced historical photographs. In this way, a photograph taken with our camera retrieves photographs of the past.

Flashpoint Technology’s Digita operating environment (Flashpoint Technology, 1998) provides a scripting language that runs on a number of commercial digital cameras. Digita allows user written scripts to execute tasks like the generating specialized watermarks for pictures, creating HTML indexes within the camera, or controlling the lens and aperture. Tasks more commonly associated with computers than consumer snapshot cameras are facilitated by the Digita scripting language.

Digita can communicate with and control external digital sensors through a camera’s serial port. In this way, a digital camera can collect data of various types from input devices other than the lens. This additional metadata, coming either from external sensors or from the camera’s settings (aperture, focus setting), can be embedded into an image file whenever a photograph is taken.

For the Image Maps system, a Kodak DC260 digital camera has been augmented with a Trimble Lassen-SK8 global positioning system (GPS) and a Precision Navigation TCM2-80 digital compass (Figure 4.1). These external sensor devices communicate with the digital camera through the camera’s serial port in the manner described above. An iRX microcontroller (Poor, 1999) handles the timing and packaging of the different sensors’ inputs before sending their values back to the camera.
Figure 4.1. An "out of the box" view of the camera hardware. A Kodak DC260 digital camera is attached to a Trimble Lassen SK-8 GPS and a Precision Navigation TCM-80 digital compass. This hardware configuration allows recording of position and orientation information into a JPEG image.

The digital compass sensor attached to our camera records the orientation of the camera’s lens (e.g. North or 0G). The digital compass also records tilt information which will eventually be used to disambiguate target buildings (e.g., photographs of tall buildings with smaller ones in the foreground).

A Digita script collects the readings from the GPS and digital compass, along with the date and time from the camera’s internal clock, and embed these data into the image file (Figure 4.2).
1 # Only when the data is read does the camera make the actual exposure
2 WaitForShutter("Go...")
3 # send 'C' to poll compass. Will return a string like:
4 # "Sc359.9p-90.0r-90.0e01*76...l0"
5 # padded with '.'s to make 25 char length + null
6 # where
7 # c:359-0 = orientation in degrees
8 #
9 uError = SerialSendReceive(1, 25, "C", TCM2DataWord)
10 # send 'G' to poll GPS. Will return a string:
11 # "bbb.cccc:dddd.eeee:g\0"
12 # where
13 # bbb.cccc = latitude in degrees (hex string)
14 # dddd.eeee = longitude in degrees (hex string)
15 # g = valid? (2 = fresh, 1 = old, 0 = unreliable)
16 uError = SerialSendReceive(1, 21, "G", GPSDataWord)
17 # write TCM and GPS data to present image file
18 SetUserFileTag(sPath, nFilename, "ust1", TCM2DataWord)
19 SetUserFileTag(sPath, nFilename, "ust2", GPSDataWord)

Figure 4.2. This Digita script allowing a digital camera to collect geographic data from an attached GPS receiver and digital compass. Line 3-16 show where the camera reads from the serial port, sending a "C" character to poll for compass data and a "G" character to poll for GPS data. The iRX board attached to the serial port (see Figure 4.1) manages these requests for data by transferring the requests to the appropriate sensor. Lines 17-19 show where the data returned to the camera is embedded into the image file as hexadecimal values.

4.2 retrieval engine

After taking photographs with the digital camera in the field, students upload them into the Image Maps software. This application parses the image file for embedded GPS and compass metadata and uses them to access a spatial map of Cambridge, Massachusetts stored in ESRI Inc.'s ArcView GIS. Since civilian GPS receivers can sometimes receive degraded GPS signals, the position of the unit might have an error of ±25 meters (Trimble Navigation Limited, 1997). To correct these potential errors, students can use graphical tools to adjust the position of where their camera was located when a photograph was taken (Figure 4.3).
Camera repositioning tool. This tool allows users to reposition the location of their camera on a spatial map to account for degraded GPS signals and resultant positioning errors. By moving the graphical camera, one can relocate the position of the camera on the spatial map to an accurate location of where the photograph was taken. The user's photograph is displayed above the map to help the user in the positioning of the graphical camera on the map.

To search for archival photographs, we start at the camera's origin (the point of image acquisition) and trace the orientation vector until we intersect a building or other landmark (Tsui, 1998) on the GIS map. This ray tracing routine approximates line of
sight to return the building ID number from the nearest landmark to the camera lens (Figure 4.4).

You are here
(x, y) = (latitude, longitude)

Camera line of sight
\theta = orientation

Figure 4.4. A segment of the ArcView GIS map for Cambridge, Massachusetts. The dot shows the current camera position at a GPS coordinate. Orientation is used to trace a vector from the camera origin along its line of sight. The current algorithm simply returns the first building that intersects the line of sight vector.

A separate database associates each building ID with a set of historical photographs. Each of these images has been hand-indexed with approximations of the position and orientation of where it was taken (Figure 4.5). Dates of each historical photograph are also hand-indexed into this database.

The database was written in Java so that it could be easily run on any desktop computer capable of running a Java virtual machine and connected to the Internet. In addition to serving up archival photographs from its database, the database software also serves as an integrated graphical indexing tool for historical photographs added to the database.
A retrieval engine selects and displays images that closely match the view of the target image. A query is made to the database for hand-indexed photographs with a building ID matching that of the target image. From this collection, images hand-indexed to a bearing within $45^\circ$ of the target image are returned to the Image Maps client. We currently test our retrieval algorithms with 434 hand-indexed images between Harvard Square and MIT. Because most of Harvard Square and MIT's buildings have remained in the same places over the past century, I did not have to position historical photographs containing destroyed buildings. For future iterations of Image Maps, tools will need to be developed to allow the indexing of photographs to latitude and longitude coordinates when GIS maps do not provide accurate positions.

### 4.3 Image Maps software suite

In order to make the theory described in chapter three explicit, I have designed the Image Maps software to model an inquiry process which leads to the description of design patterns.

<table>
<thead>
<tr>
<th>Photo Name</th>
<th>from yd. corner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1913</td>
</tr>
<tr>
<td>Orientation</td>
<td>124</td>
</tr>
<tr>
<td>Building IDs</td>
<td>9948, 9799, 9928, 9429</td>
</tr>
<tr>
<td>Mass. State Lon</td>
<td>2361442 21</td>
</tr>
<tr>
<td>Mass. State Lat</td>
<td>759160 01</td>
</tr>
</tbody>
</table>

**Figure 4.5.** Hand indexed data associated with an archival photograph in the database. The "Orientation" field is in radians and represents the direction the camera was facing when the photograph was taken. The "Building IDs" field contains building ID numbers of buildings in the photograph. "Mass. State Lon" and "Mass. State Lat" are map coordinates of the hand-positioned the location where a user approximated the camera was located when the picture was taken.
4.3.1 comparison

When users launch the *Image Maps* software, they compare their photographs with the retrieved archival photographs (Figure 4.7). This comparison task allows users to identify components (e.g., street lights, fire escapes) in the photographs for later tasks. The comparison interface structures this activity by requiring the user to compare their photograph with archival photographs. That is, *Image Maps* makes it easy to note differences between photographs of the past and present. These differences are the elements users will annotate in the photographs.

![Image Maps comparison interface](image.png)

*Figure 4.6. Image Maps' comparison interface. Thumbnails on the right are images taken by students. Choosing one of these displays its larger image and an array of historical thumbnails across the top. The left image is the historical photo chosen from the retrieved collection. The floating window provides additional information on the selected photograph. Users must compare each of their own images with the archival images individually.*
4.3.2 annotation of architectural features

Using the *Image Maps* annotation tools (Figure 4.8), students tag architectural features identified by comparing photographs, making them available for describing architectural patterns. They begin the annotation task by entering their observational criteria into an ontology. A tree structure structures the creation of this ontology by grouping observations into different categories (e.g., the category “Road Surfaces” contains elements “dirt”, “paved”, “wooden planks”). This sample category “Road Surfaces” are initial ontological elements to show how elements can be clustered. Users can add and delete as many features and categories as they want on the tree structure. This categorization helps users cluster and thereby organize their observations of the image collection.

To annotate features in the images, users drag their mouse forming a bounding box over regions of the photograph they want to annotate and select criteria from a pop up menu mirroring the tree structure (Figure 4.8). I decided that by limiting the annotation mechanism to a bounding box, students would focus their attention on the task of identifying salient features instead of spending countless time tracing “perfect” outlines of features in photographs.

As students mark up more features on a given photograph, it can become difficult to see all of the annotations, especially if there are overlapping regions between features. To make the annotation interface more legible, the display of specific annotations can be toggled on and off by selecting/deselecting a “visibility” check box next to each criteria on the tree structure.
4.3.3 modeling

Once students have annotated features in the image collection, they can assemble these features into models representing their observations from the image collection. This process is structured by the *Image Maps*’ modeling tools (Figure 4.9) which provide an arc/node representation for models. That is, students can position graphical nodes on the screen and connect these nodes with arcs representing relationships between the nodes. The goal is to facilitate the linking of interrelated features from the urban landscape, so as to describe how these features form an architectural pattern (Alexander et al., 1977). For example, a student could cluster together nodes annotated “look out tower”, “fire pole”, and “siren” and link these clusters together to define a “fire station” pattern.

The modeling tools, as they are currently designed, frequently lead to the creation
of models with a temporal bias. That is, only being able to connect nodes with lines leads to the construction of models that invariably look like time lines. These issues are discussed in the next chapter that evaluates users’ experiences with the Image Maps system.

**Figure 4.8.** *Image Maps* modeling interface. A handful of empty nodes are provided by default when a student launches the application. Students drag annotated elements from the annotation interface into this screen. Dragged features are dropped into nodes that have text fields in which students can write explanatory captions of their models. Students can draw arrows between nodes by dragging between nodes with the right mouse button held down.
5. evaluation

The description for MIT course MAS 123: Tools for Thought advertises that the course “Examines how technological tools support new ways of thinking and learning.” One of the tools examined in the Spring 2000 course was the Image Maps software suite. The class consisted of 16 undergraduate and graduate students from MIT and the Harvard Graduate School of Education. I was the teaching assistant for the course and spent the semester working closely with the students on various projects, including this one.

Image Maps was introduced as an assignment for the students to complete as a class requirement. This was the first deployment of the system. The task was purposefully left open ended so that we could learn how people would interact with our tools. We did not specify how they should take pictures in the field or how they should use the Image Maps tool in the classroom.

When they were done, students were required to post their comments and reflections of their experience working with Image Maps. Many of the observations and insights introduced in this chapter were interpreted from these assignments. These write ups revealed how students developed theories and how students managed to work with the tools provided.

It should be noted that we placed the students in this course under conditions we would never expect in a classroom. In school, there would be opportunities for discussion with a teacher around the inquiry task. Because of time restrictions, we did not get to provide this scaffolding, and, as a result, one of the largest complaints was this assignment’s lack of structure.

5.1 in the field

Students felt the freedom to shoot pictures in the field was the best part of the Image Maps experience. The immediacy of taking a photograph and seeing the archival photographs in the same day was very popular. Being able to remember the photographed environment from earlier in the day made it easier to identify features in the photographs.

Students took different approaches to how they chose to photograph the city. Some did studies on a particular area, like Harvard Square, documenting buildings, streetlights, street performers. One group chose to focus almost exclusively on one building, an old firehouse. Other groups just walked, or drove, from one end of the designated region to the other end. Each group took an average of 50 photographs during the session.
5.2 finding meaning in the archive

I observed students having conversations about architectural features in the image data. Many students actively debated the nature of changes to the Harvard Square subway stop. Other groups discussed changing traffic patterns in Harvard Square and speculated about why traffic has changed. Conversations were informed by pointing to features within photographs such as crosswalks, trolley tracks, and pedestrians.

The manner in which I tried to get students to preserve their dialogue around the historical photographs doesn’t seem to work very well. Students went from being outdoors exploring their communities on foot (fun), to having engaging conversations about observable changes (fun), and then had to revert to “school tasks” of writing things down (boring). This suggests that the task and the Image Maps software might need to be restructured to provide a better purpose for students’ labor with the photographs. Ideas around this theme are presented in the final chapter.

Two case studies present how, with some guidance, Image Maps worked and students were able to identify patterns in the urban fabric.

5.2.1 the fire station

One student, while out in the field, became intrigued by an old fire station in Kendall Square. He took multiple photographs of the fire station from different perspectives, getting up close to document features inside the building. After photographing the old firehouse, the student remembered an active fire station down the road in Central Square and walked to this other fire station to photograph it for comparison.

When the student’s photographs were uploaded into Image Maps, no historical photographs were retrieved of the first fire station and only one historical photograph was retrieved of the second fire station. Without much to work with from the archive, the student decided to identify patterns within his own photographs of the fire stations. The student compared his two case studies of the fire stations and identified features shared between them.

- Door - big (to quickly and safely get the big trucks in and out of the building)
- Sliding pole (to get firefighters down from the residence to the trucks quickly)
- Tower - (for fire observation and/or traffic control, and to mount alarm bells)
- Windows - second floor - residential windows
- Fire hydrant - safety feature to ensure canine (presumably Dalmatian) hydraulic pressure relief

He entered these and other criteria into the ontological tree structure. He then pro-
ceeded to annotate these features within the two different photographs using his ontological features (Figure 5.1).

![Image of a fire station with annotations]

**Figure 5.1.** Student's annotations of a photograph of a fire station. Features from the student's ontology include: "Door - Big", "Sliding Pole", "Tower", "Windows", and "Fire hydrant".

The student defined architectural patterns by clustering together certain annotated features of the two fire stations (Figure 5.2). The patterns defined by the students include:

- Fire Station vehicles (annotated features: Hose Engine #2, Chief's car, big door)
- Fire Station traffic warning/observation devices (annotated features: lanterns, tower)
- Municipal traffic control or safety devices (annotated features: divider, stop light, street light)
- Potential traffic hazards (annotated features: car, truck, bipedal carbon unit)
Figure 5.2. Student's model of architectural patterns of a fire station. The student clustered the features of each pattern into small constellations. The patterns include: “Fire Station Vehicles”, “Fire Station traffic warning/observation devices”, “Municipal traffic control or safety devices”, “Potential traffic hazards”.

What is promising about this is that a student used the software for the definition of architectural patterns using annotated features. Even more impressive is that the student explicitly presented these small patterns together to demonstrate how when combined they define a larger fire station pattern (traffic control).

The student also tried to argue that fire stations contain a unique sub culture, a group with “commitment to values such as discipline and maintenance of order”. Using annotated photographs as evidence for this argument (Figure 5.3), the student annotated these features:

- American flag (also seen in the newer Cambridge St. Station)
- Lantern for “Hose Company #2”
- Lantern for “Ladder Company #8”
- Small station wagon for Company leader (I annotated it as “chief”, but that may not be true)
Figure 5.3. Student’s model arguing that fire stations contain a subculture with “commitment to values such as discipline and maintenance of order”. The student annotated features such as: “American Flag”, “Lantern for ‘Hose Company #2’”, “Lantern for ‘Ladder Company #8’”, “Small station wagon for Company Leader”.

To inform his argument, the student even interviewed firemen at the fire station. What is interesting about the “sub culture” pattern is that it explicitly sets out to argue a student’s hypothesis about the fire station’s culture.

5.2.2 history of Harvard Square

Another student decided to photograph Harvard Square and retrieved many matching historical photographs with the Image Maps software. Like many of the students, she was overwhelmed at first, but she took the time to carefully compare the historical photographs and began to notice changes in the architecture of Harvard Square. She classified different types of change in Harvard Square into categories: transportation, traffic patterns, pedestrian paths, use of buildings. Here are the descriptions of the changing features in her category “traffic patterns”:

- Horse and buggies didn’t seem to follow a standard route, they drove every which way.
- In some early photos, cars were parked in every direction around the island.
After 1945, the T station was rectangular, but there was a deep, round sidewalk surrounding it which seemed to function as both a place for people to walk and a rotary for the traffic to move about. Cars were able to drive both ways on both sides of what we now call Mass. Ave. The sidewalk was extended to form more of a triangle where traffic no longer flowed on one side. We saw a picture of this in 1965.

The student described a pattern (“traffic patterns”) and described the features that defined this pattern over the years (“Horse and buggies”, “cars”, “deep, round sidewalk”). This is evidence that a student can identify changes in urban patterns over time. What is important is that she identified instances of variance and regularity by comparing features in the photo collection.

The student did not use the Image Maps’ modeling tools to describe her findings, but instead documented her discoveries through conversation and writing a final paper. This indicates that the modeling tools need to be redesigned to better support students’ description of historical changes. In future versions of Image Maps, students will be able to use their ontological features to access the historical data and look for patterns (e.g., historical traffic patterns with similar or different features).

5.3 the archive

Sparse data on geographical locations invariably led to sparse reports. If there were no historical photographs available for a given location, then students had a difficult (if not impossible) task of describing historical changes in that location. Another problem were the archival photographs themselves. Our archival photograph collection came from the Cambridge Historical Commission and consisted of many architectural surveys of just buildings, many with no people. This led many users of the software to remark that Cambridge seemed to be an uninhabited ghost town.

This isn’t a criticism of the Image Maps software, but it is a problem that needs to be addressed. The source of our image archive, the Cambridge Historical Commission, offered us architectural surveys for the project as that happens to be their collection of the city’s visual history. I believe that some of the best photographs of the city might not be in the Historical Commission, but rather in the shoeboxes and photo albums of regular people. In the next chapter, I propose ways to access these images and also address the scaling of the database.
5.4 interface evaluation

5.4.1 search tools evaluation

Students wanted tools to search the image collection using features from their ontologies. In addition to searching the image collection by specific features, they also wanted to search on categories of features as well. For example, students wanted searches on the category “Building Stuff” to return any instances of features like “Door - Big”, “Flagpole”, “Window”, “Door”.

5.4.2 image comparison tools evaluation

Students found it difficult to discern how some historical photographs matched their own photographs. The amount of change in some areas left students baffled as to how some photographs even related to each other. The situation was worse when there were large temporal gaps in the archive.

Many students suggested a feature that would allow them to stack photographs on top of each other to look for differences in buildings. Positions of the buildings within the foregrounds of the photographs were not indexed, making it difficult to stack photographs this way.

5.4.3 modeling tools evaluation

Students complained that the modeling tools led them to create models with a temporal bias. Nearly every model made by the students looked like a time line and students commented that the arc/node representation suggested the creation of chronological arguments. This was not the intention of the modeling tools, and I address ways to structure this differently in the final chapter.

Students wanted the ability to cluster images into large nodes so they could describe visible properties of a group. With the current tools, they had to copy their observations about similar features into every node. Students also complained that it became difficult to manage the modeling task as the number of individual nodes increased. When modeling time lines, students wanted the ability to annotate spans of time for which there was no photographic data.

Students requested the ability to have the software automatically organize the annotated nodes into multiple representations. For example, they wanted the software to automatically generate time lines for them or to automatically cluster similarly annotated features. Some students requested the software facilitate the creation of Venn diagrams based on different criteria. For example, by selecting two different patterns
such as “fire station” and “police station”, you could see which features were shared between the two patterns.

5.5 you take the picture, you do the rest

Many students ultimately turned to outside sources for additional information about their community. For example, using World Wide Web search engines students brought up web sites documenting the history of the “T” subway system. Other groups used the Lexis/Nexis news search engine to research student riots in Harvard Square. A number of students requested that hyperlinks to this sort of information be embedded directly into the photographs.

Motivating students to research questions about the photo collection is a very positive result. Photographs seem to be very good at raising questions, and Image Maps’ interface helped to structure the posing of questions. A book on fire stations might otherwise never be taken off the library shelf until a student studied variations between fire stations in their own communities and inquired about the differences.

The conditions in which these students used Image Maps is not indicative of the conditions in which it would ever be used in classrooms. The Image Maps tools are meant to be embedded in a larger social context of a classroom with teacher guidance. With a teacher leading a class conversation, some students’ feelings of lack of completion could be alleviated. Teachers can help students search for additional information about the patterns they are describing. They can also help students interpret this new information in light of questions they are pursuing around the photographs.

5.6 summary

It is evident that there are many steps needed to make Image Maps a successful learning environment. For this experiment, students were given an unstructured task with which to use Image Maps and this led to a lot of confusion and frustration on behalf of the students. The results of the initial user study indicate that a new approach to the task is required. Allowing students to describe urban design patterns is still an appropriate goal, but the structure of Image Maps activity is currently stilted and awkward.

The annotation of the photographs was considered a good exercise, and students did examine the photographs more critically. One student’s annotation of a fire station’s architectural features led to the creation of patterns describing how these structures manage traffic flow. Another student’s observations led to a detailed analysis of architectural changes in Harvard Square. These two cases suggest that students
can engage in complex problem solving around images given structure and guidance. In future work, I will use these cases to develop structured curricular activities for classroom settings.
6. future work

Our initial evaluation of *Image Maps* revealed that students can engage in complex problem solving around images. Students studied the image archive, asked questions about features they identified in the photographs, and many students researched to find answers to their questions. In a real classroom, students would create their models and present them in some sort of debate.

In this chapter, I first propose a new direction for the *Image Maps* software that would facilitate debate between users. In the second half of this chapter, I present some ideas on how to collect larger image archives from different communities.

6.1 future direction: students create their own card games

The Sim City collectable card game by Mayfair Games, based on the Sim City video game by Maxis, puts players in charge of developing their own city over the course of the game. In the card game, players lay out playing cards representing city blocks, and points are rewarded for placing certain cards adjacent to each other. For example, a player can earn points for adding more residences to established residential neighborhoods, or for adding churches to these neighborhoods (Figure 6.1). Cards like “Grocery Store” require a number of residence cards to be in play before they can be added to the game. Other players could block the development of these neighborhoods by placing cards like “Coal-Burning Power Plant” in the way of the neighborhood’s growth.
Figure 6.1. Sim City Collectible Card Game arrangement. When playing the game, players place the cards into configurations like the one above. Players can get points by building "complexes" like the residential complex shown (made of cards "4046 N. Campbell", "Duplex", "Colonial Home", "Condo"). Cards like "Grocery Store" require a number of residence cards to be in play before they can be added to the game.

Points are awarded for developing the city through different phases of growth, eventually leading the creation of a large metropolis. This can require replacing cards already in play ("Stream") with another card that develops the original card ("Hydro-Electric Power Plant").
Inherent in the game are certain assumptions about how cities operate, much like the assumptions made by the Sim City video game designers (Starr, 1994). I propose that students construct their own card games wherein they explicitly describe the rules that define their interpretation of the visual structure of their community. Some fans of the published card game went so far as to describe which cards from the published decks could be used to build a city which closely resembled their own (Ingram, 1996). Figure 6.2 is an e-mail to a discussion list on the Sim City collectable card game wherein a player of the game lists the cards that could best define his wife’s family’s home town. The author makes special mention of how the history of the area influenced his card selection.

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Date: Wed, 27 Sep 1995 16:20:32 -0600
From: Randy Bohn <rbohn@novell.com>
To: starfish@u.washington.edu
Subject: SimCity TCG Deck Idea
X-Status:
Status: RO

Thanks for publishing your web page...it is a valuable resource. My wife’s family live in Petrolia Texas. We went there last year on vacation, and it is the inspiration for this deck. Petrolia is just north-west of Wichita Falls (Near Dallas). It was an oil boomtown in the '20's. Today it is a mix of dairy farms and oil wells.

The Petrolia Deck:
Any 3 river cards
1 Bridge card (This is the Red River which forms the Tx-Ok border).
12 residential cards, try to stay away from anything urban looking.
1 Fire Station (It’s a volunteer fire department)
1 Grocery store
2 church cards (the Lutheran card has the proper look)
18 farm complex cards, try for at least 8 dairy cards
All the oil complex cards you can find. Put the oil cards near the farm cards.
Add whatever else seems apropriate for a small town. Remember: No mountains!

---

Figure 6.2. An e-mail listing the Sim City collectible card game cards which best define the author’s wife’s family’s home town. The author describes the history of the town and how to best represent it with the playing cards. (Ingram, 1996).

I imagine a system in which students annotate image archives of their own communities and define the rules for these cards in play.

By having students develop their own rules for the development of their own communities, I hope to see students become explicit about their assumptions about their city’s development. When students play their cards against other student’s cards in the development of their city, I imagine debate will ensue about the different assumptions the card maker’s have made about their communities.
6.2 scalability

One of my current concerns is the scalability of the project. Hand-indexing and registering historical images geographically consumes large amounts of effort. The best way to bring photographs into the system may be to allow our students to assist us in the indexing task. To do this, we created a web-based indexing tool (Figure 6.3) to allow users to contribute photographs to our database. Contributors select regions of the city that they want to add to and position a camera on screen to represent where the picture was taken and the approximate angle of view seen in the photograph. Our applet uses this information to create geographical metadata that can be used to retrieve the image in future searches, and the photo itself is added to our database.

![Figure 6.3. Auto-indexing images into the Image Maps database. Contributors align the graphical camera on the ArcView map at the position where a photograph was taken and adjust the "aperture" setting to show the area covered in the image. The applet uses this information to generate the geo-referenced metadata that accompanies the submitted image so future users of the system can retrieve it.](image)

It is quite possible that the best historical, image archives are hidden in the photo albums.
of ordinary citizens, and that this tool might help to make these images available to
learning communities. Just recently, the City of Cambridge’s home page was asking
visitors to contribute photographs of their community to the web site! Using my online
tool would require a little more effort, but would result in a rich resource for learners.

We worked with the Cambridge Historical Commission to build our initial photo-

graph archive. There were complaints from the users of our system that many of the
photographs in the archive were devoid of people, and just architectural surveys. To
document communities not well archived by an Historical Commission, the community
might help to build the image archive. By bringing a vehicle with computers and scan-
ners into these communities, we might be able to mobilize communities to contribute to
an archive they might otherwise never be assembled. Residents of these communities
probably have personal anecdotes about their own photographs that could be recorded
along with the photograph itself, and added into the database.

6.3 endings and beginnings

The ability for students to retrieve photographs of the past with digital cameras is
a powerful tool for bringing history into the classroom. Students' identified architectural
patterns using photographs as evidence demonstrating that this approach to historical
inquiry holds great promise. Students were intrigued by changes they identified in the
image collection and researched their community's history. Ahead lies the job of making
tools which excite students to argue and debate their findings.
7. works cited


