Active Legends

For

Interactive Cartographic Animation

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Abstract

Active legends in cartographic animation serve the dual purpose of controlling the display of a map sequence and providing necessary information about the individual frames. Legends for cartographic animations have typically been implemented in a non-interactive form as individual legends that are synchronized with the display of the map. An active legend creates a tactual/visual association between the individual maps in the animation and what they depict. The development of more interactive cartographic animations is a function of both the available technology and the operational metaphors that make the technology accessible. The Web is providing a means to distribute interactive animations. A particular interactive cartographic animation developed with JavaScript is evaluated for functionality and content.

Keywords: cartographic animation, interaction, JavaScript

I. Introduction

Interaction is now incorporated in all forms of mapping, whether with a database of a geographic information system, a multimedia atlas on a CD-ROM, or street maps on the World Wide Web. All of these forms of mapping share the characteristic that the user has control over the resultant map. Cartographic animation, on the other hand, is usually implemented in a more passive way as with a static map, often allowing the user to only view a pre-defined sequence of maps.

A variety of problems exist in the passive viewing of cartographic animations. Foremost among these is the design of the legend. The legend, usually included to explain the meaning of symbols, is also used with a cartographic animation to illustrate the progression of time or change in a non-temporal variable that is being animated. Users have difficulty viewing both the map and legend simultaneously, and thus making the relationship between the

animated maps and what they depict. In addition, the attention of the user seems to be centered on the area of the animated display where change is the greatest or the most predictable -- often the legend itself. As a result, the animated legend moves attention away from the map. Studies have examined legend design for animated maps (Kraak, et.al., 1997). Proposals seem to be directed toward the development of more active legends to direct the display of the animation.

Interactive forms of cartographic animation have existed for many years. The World Wide Web, now the major form of distribution for cartographic animations, provides a number of tools for distributing interactive animations. These tools will likely play a major role in the development of cartographic animation with the increased importance of the Web as a means of map distribution. In the future, most of the maps on the Web may actually be composed of multiple maps that can be viewed interactively as an animation.

This research examines the use and design of active legends for interactive cartographic animation. An active legend implements an interactive cartographic animation by making the legend an active element of the display. The particular implementation of an active legend is tested in a group environment to determine if users can determine the function of each active control element and whether they can identify patterns evident in the animation.

II. The Animated Map

Although many see the growth of cartographic animation related to the development of film in this century, it is reasonable to assume that animated maps are as old as maps themselves. Because movement is part of the environment, its depiction was likely a part of the illustrations of pre-historic humans. The drawings on cave walls from between 10,000 - 20,000 years ago have received much attention (Davis 1986). Drawn with charcoal, these illustrations of animals and other objects have survived until this day because of the protected environment in which they were made. Lost, of course, are those illustrations that were done on a less permanent and protected medium. Perhaps drawn with a stick in sand, an early cartographic

animation may have depicted the movement of animals or a fast-moving river.

Maps turned to *stone*, so to speak, first on clay approximately 4500 years ago in Mesopotamia and then on paper some time later. It may be argued that we are still emerging from the stone-age in cartography and a "paper-thinking" that ties us to a static form of map display (Peterson 1995, p. 17). Regardless of the medium used for modern maps, the static map has had a profound affect on the way we represent the world, and the way we think about it. The design of cartographic animations is still influenced by a paper maps, both the graphic design of the individual maps and their presentation as an animation.

Film influenced the presentation of maps as early as the 1930's. An early animation made by Disney in 1940 depicted the invasion of Poland by Germany a year earlier. Arrows, representing the movement of the German army, are shown moving towards Wausaw and then encircling the city (Figure 1). Shown as part of a newsreel during the war, these early animations were an effective means of both education and propaganda.

Figure 1. Five frames from the Disney Studios production of the invasion of Poland in 1939. Arrows, representing the German army, are shown encircling the capital of Warsaw.

The film metaphor is still an important part of cartographic animation. Many of the current cartographic animations are implemented as digital movies in either the MPEG or QuickTime formats. In this form, the cartographic animation is as non-interactive as a map on paper. While some digital video formats allow the user to access individual frames, they do not allow control over how or which frames make up the animation. It is uncommon for a current cartographic animation to include more than the VCR-type of controls (e.g., play, stop, forward, reverse) that we associate with a video cassette recorder.

The film / video metaphor still ties us to a certain way of thinking about cartographic

animation that could be best described by the German word "ablauf." Roughy translated, the word means "an uninterrupted progression from a beginning to an end." Most people, even within cartography, still think of cartographic animation as a sequential display of a series of maps (an "ablauf") to show change over time. Just as we attempt to break loose from the paper thinking that binds cartography, we must also break free from the "ablauf" way of thinking about cartographic animation that has its roots in the film / video metaphor.

III. The Meaning of Animation

Animation holds a special place in cartography. The limitation of static maps to depict the temporal dimension is widely recognized. However, early examples on film and video could not be easily duplicated, transported, or displayed and this severely limited the distribution of cartographic animations. In addition, the making of these animations was time-consuming and expensive. The failure of cartographers to grasp the importance and necessity of cartographic animation was lamented upon by researchers in the early 1990's (Egbert & Campbell, Karl 1993). The wide availability of microcomputers and access to the Internet has spurred a renaissance of sorts for this method of mapping. However, the technique is still not widely used, with the exception of cloud movements on weather forecasts, and faces a number of conceptual and methodological hurdles.

        In its simplest form, a cartographic animation can consist of only two maps. Viewed in quick succession, these maps can depict a trend or a pattern that would not be apparent if the maps were viewed individually. Creating this "pattern in space and (animation) time" is the purpose of cartographic animation, much as the purpose of a static thematic map is to create a pattern only in space.

IV. Interactive Cartographic Animation

Interaction with an animated map can be implemented in two ways. In the first approach, a high-performance computer and specialized program makes individual maps in real-time and

displays them in a specified fashion under the control of the user. The second form of interactive animation is implemented as a stack. Here, a series of maps are pre-made and stored in the memory of the computer. The maps can then brought to the screen of the computer in a sequential-form as a movie, or they may be depicted under the control of the user as an interactive cartographic animation.

The idea of the stack was popularized by HyperCard, a program introduced by Apple Computer in latter part of the 1980's (Winkler, et al., 1994). Using an index card metaphor, the program allowed for the creation of individual cards containing text, graphics, and sound, that could be accessed in any particular way. Animation with HyperCard is implemented through a HyperTalk script that directs the display of individual frames at a specified time interval (Peterson 1995, p. 157). The script may also be written to display the series of maps in any particular way.

A program that both created the individual frames for a cartographic animation and made the resultant animations interactive was MacChoro II. The program, limited to choropleth mapping, allowed the user to select the maps that would make up the animation through two dialogs. The first dialog controlled which variables were to be mapped and second dialog was used to select the methods of data classification (Figure 2). Following this, the individual maps were created and stored in memory. The speed at which the individual maps were constructed and stored varied with the number of polygons in the map but averaged about one map per second using late 1980's technology (Macintosh SE/30). Following this, a pop-up control palette could be used to change the speed of the animation, forward and backward movement, and other aspects of the display (Figure 3). The animation could also be saved to disk and viewed at a later time. MacChoro was an early example of an interactive form of cartographic animation. Examples of these choropleth animations have been converted to QuickTime for distribution and are available through the Web (maps.unomaha.edu/books/IACart/book.html).
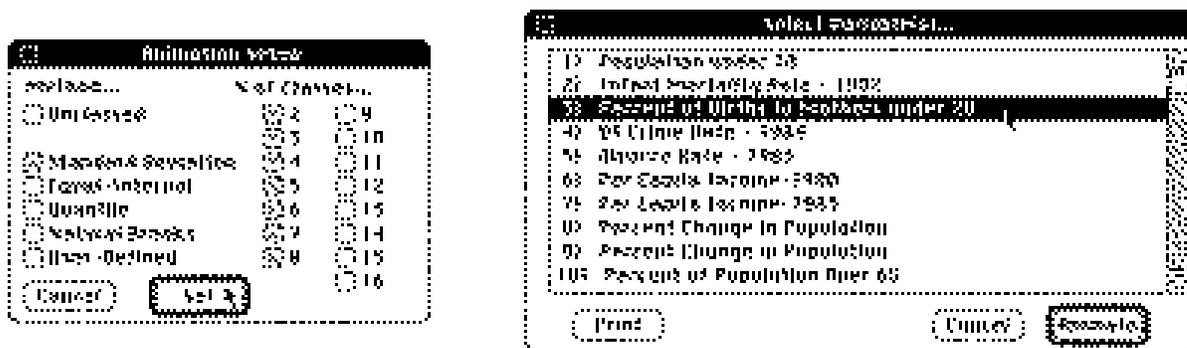
Figure 2. Dialogs used to specify the creation of an animation with MacChoro II. The dialog on the left controls the method of classification. The dialog on the right is used to select the variable to map. Multiple methods of data classification and multiple variables can be chosen.
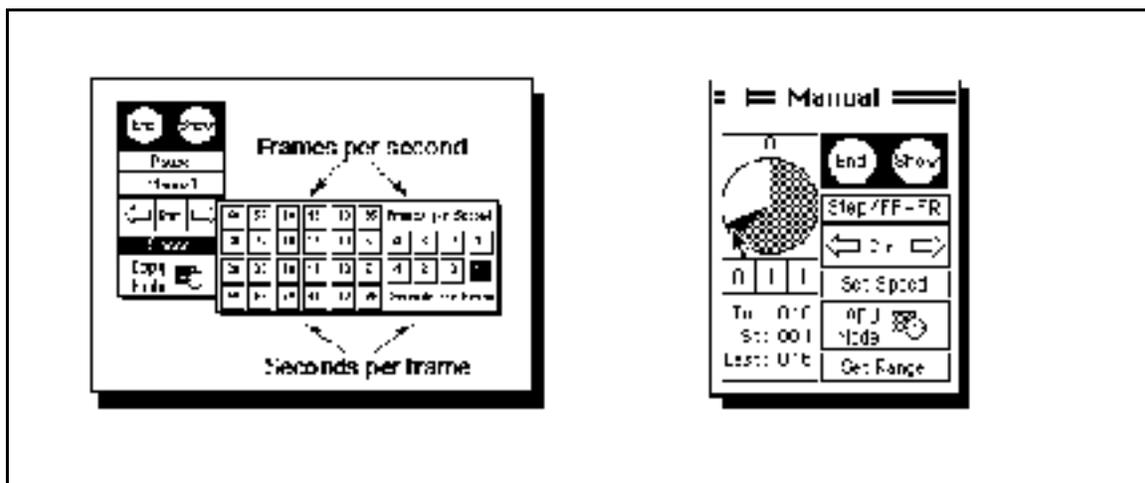

Figure 3. Pop-up palettes used to control the display of the animation with MacChoro II. The palette on the left controls the speed while the palette on the right includes controls to stop, reverse, or interactively control the display of the animation.

V. Interactive Cartographic Animation on the World Wide Web

The World Wide Web offers a number of tools for implementing interactive cartographic

animation. The advantage of the web is that it makes the display of the animation possible on

virtually any computer, anywhere. Although this may appear to be a minor consideration, the

distribution of maps is probably the most important factor in their use. The slow acceptance of

cartographic animation in the decades preceding 1990 had much to do with difficulties

associated with their distribution.

A common form of animation is the animated GIF file. This format, an extension of the popular GIF format for the distribution of pictures, can be viewed using any of the major web browsers. Animated GIFs are created by assembling individual GIF or JPEG files using shareware programs like *GIF Construction Set* (ftp://www.boxtopsoft.com/pub/GIFmation2.0b-PPC.sit.hqx) for the PC and *GifBuilder for the Mac* (http://www.mindworkshop.com/alchemy/gifcon.html). The playback of animated GIFs is done automatically by the browser and is not accompanied by any controls that could be used to adjust the display. However, it would be possible to provide VCR-type controls for an animated GIF file that would work independently of the web browser.

More advanced forms of web-based animation through the web are accomplished through a variety of specialized plug-ins that display files stored in a proprietary format. An example of this is Macromedia's Shockwave (URL). The plug-in makes it possible to display a Macromedia Director file through a web page after it has been converted with the company's Afterburner product.

On the opposite end of the spectrum is Java. Java applets, downloaded and executed on the client computer, could be implemented in a number of ways to support interactive animation. It could be used to display a series of pre-existing maps that are downloaded with the Java applet or in combination with a database of both maps and data to create and display animations in real-time.

A further option is JavaScript (also referred to as JScript). JavaScript is an interpreted language that executes through the web browser (Reynolds 1998). The object-oriented language shares some structural similarities with Java but it is a separate programming language. It was designed primarily to control graphic elements on the web page. Swanson (1997) describes how a series of maps can be displayed interactively with JavaScript in a technique called "mouse-over mapping." The method involves creating "hot spots" on the screen that control the display of the individual maps that have been stored in memory. Moving the mouse over the hot spot changes the map that is currently visible.

VI. A JavaScript Interactive Animation

        For this experiment, eight choropleth maps of the state of Nebraska by county depicting

mortality data for 1996 were used for the JavaScript animation. The data used included those

on the mortality of cancer, heart disease, cerebular vascular disease, and chronic lung disease.

The data were mapped using two different data classifications: standard deviation with five

classes and an unclassed procedure (Tobler 1973; Peterson 1993). The unclassed choropleth

mapping technique assigns a unique shading to each individual data value. There are as many

different shadings as there are different values in the map (see Figure 4). The maps were

constructed with Adobe Illustrator and converted to a GIF format using Adobe Photoshop.

(The maps are used here to examine alternative forms of cartographic animation. While

patterns are evident in the maps, the data only represent values for a single year. In addition,

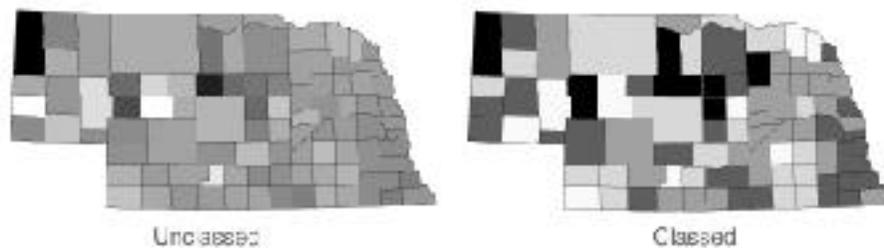some counties have very low populations that tend to skew the percentage data.)

Figure 4. Examples of an unclassed and classed choropleth map used for the JavaScript animation.

        In addition to the static legend that depicts the associated data values for each shading,

three active-legend items were added to the display. These active legends control the display of

the maps (see Figure 5). The control boxes in Figure 5a are used to control the classed maps.

The boxes in Figure 5b control the display of the unclassed maps, while the boxes in Figure 5c

switch between the class and unclassed maps for each of the four mapped distributions.

The active legend boxes make it possible to create different types of animations, with a variety of different combinations of maps. The boxes were constructed in such a way that any of the 2 x 2 pair-wise comparisons between the eight maps could be easily viewed. An animation of the maps results by moving the mouse in a rapid fashion over the active legend in a back-and-forth or circular motion (Figure 6).
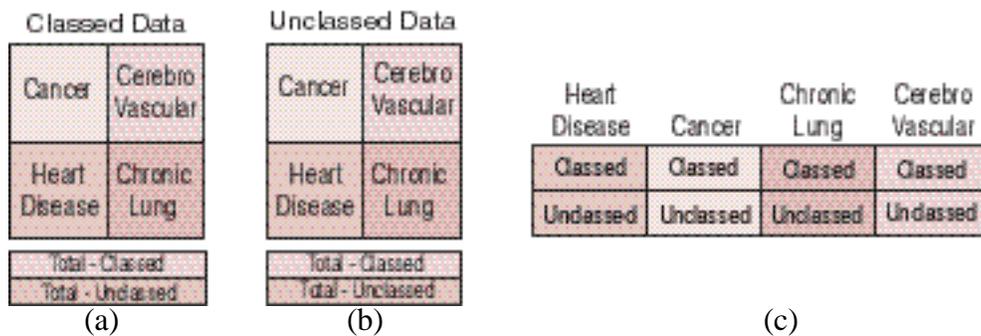

(a)   (b)   (c)

Figure 5. Active legend elements used with the cartographic animation.   A particular map is display by placing the mouse over the box.

Figure 6. Possible mouse movements with active legend to create a cartographic animation.

Among the patterns evident between the maps is a difference in the location of cancer and heart disease. In general, the percentage of deaths caused by heart disease is highest in the eastern part of the state while higher rates of cancer deaths are evident in the western counties. Differences in the spatial patterns caused by the classification of the data are also apparent.

VII. The Test

In order to test the functionality of the active legend elements and the ability of users to see patterns in the animated displays, ten subjects in a 300-level geography course were asked to participate in an evaluation of the mapping method. The subjects were tested on a series of Macintosh computers using Netscape Navigator 4.04. All subjects were given the same set of instructions and questions.

The instructions emphasized the importance of maps as an analytical tool and the need to devise new methods of data analysis to understand mapped distributions, including the presentation of maps in the form of animations. The instructions also explained the differences between the classed and unclassed methods of choropleth mapping. Previous experience had shown that this difference was the most difficult concept to grasp.

In evaluating the interface, subjects were allowed to interact with the display for three minutes. After this, they were asked to explain the function of each of the active legend boxes. To evaluate content, subjects were asked to view specific sequences of maps and respond to questions concerning any patterns that were evident between the maps. Patterns were to be described with words using directional terms such as north, south, east, and west.

VIII. Results

Of the ten people who examined the JavaScript animation, all were able to navigate the interface and explain the function of each active legend box after the three-minute trial. From observation, it was noted that all subjects determined the active nature of the legend boxes within 10-15 seconds after they were instructed to move the mouse over the legend boxes. The difference between the classed and unclassed maps caused some confusion. Subjects generally preferred viewing the classed maps but this may have been because this active legend box was on above the active legend box for the unclassed maps.

The interface was also effective in making patterns evident between the maps. All of the subjects were able to identify the major east-west difference between the heart/cancer death

rates. The follow-up group discussion indicated that subjects were able to identify a variety of other patterns in the process of examining the interactive animations. They were then asked to re-create the pattern that they found to others in the group. The discovery of spatial patterns between maps was accompanied by a considerable excitement among the participants in the group setting.

Is it animation? This question was asked in the follow-up group discussion. Most of the subjects initially thought that it was <u>not</u> animation. Animation, some argued, had to have a start and an end. The response was not surprising given the metaphors that we use when thinking about animation. I proceeded to demonstrate that an important part of animation is what happens between the frames. I also showed how a start-end type of animation could be created with particular movements of the mouse. After asking the question again, everyone agreed that it could be viewed as an animation.

IX. Conclusion

Cartographic animation has been limited by both the medium of cartography and a continued fixation on other forms of mapping, including both the static map and film/video-based forms of animation and their computer descendents (MPEG and QuickTime). The computer is not only making it possible to incorporate interaction in cartographic animation but also to distribute these animations through the web.

Testing of the JavaScript-based interactive cartographic animation showed that users were able to determine the function of each active legend box by trial-and-error. In addition, they were able to identify a major pattern in the maps through animating a particular sequence of maps. Follow-up focus group analysis indicated that users were able to identify a number of other patterns through the interactive animation process.

Viewing static maps without interaction or animation is of limited value, particularly in the process of searching for spatio-temporal patterns. The "stack" approach to cartographic

animation may provide a useful and more easily distributable form of map presentation. Active

legends are an important means of adding interactivity to this type of cartographic animation.

The legend, implemented as explanatory boxes, provides a way to both control the animation

and determine its meaning. JavaScript seems especially suited to make such animations

available through the World Wide Web.

REFERENCES

Campbell, C. S. and Egbert, E. L. (1990). Animated Cartography: 30 Years of Scratching the Surface. Cartographica. 27: 2, 24-46.

Davis, W. (1986). The Origins of Image Making. Current Anthopology. 27: 3, 193-216.

Dransch, D. (=Karl, D.) (1992). Cartographic Animation: Potential and Research Issues. Cartographic Perspectives. 13, 3-9.

Kraak, M.J., Edsall, R & MacEachren, A. E. (1997). Cartographic Animation and Legends for Temporal Maps: Exploration and or Interaction. In: Proceedings of the International Cartographic Association 1997, Vol. 1, Stockholm.

Peterson, M.P. (1995). Interactive and Animated Cartography. Englewood Cliffs, NJ: Prentice Hall.

Peterson, M.P. (1993). Interactive Cartographic Animation. Cartography and Geographic Information Systems, 20:1, 40-44.

Peterson, M.P. (1992). Creating Unclassed Choropleth Maps with Postscript. Cartographic Perspectives, 12: 4-6.

Reynolds, M. (1997). Using JScript. Indianapolis, IN: Que Corporation.

Swanson, J. M. (1997). Mouseover Mapping. Cartographic Perspectives, 26: 46-47.

Tobler, W. (1973). Choropleth Maps Without Class Intervals? Geographical Analysis, 3, 262-265.

Winkler, D., Kamins, S. and DeVoto, J. (1994). HyperTalk 2.2: The Book. New York, NY: Random House.