Cartographic Challenges in Animated Mapping

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ABSTRACT
Animated maps are becoming more prevalent today. They are found across the web on social media and traditional media sites. With technological changes, how these maps are developed and viewed has changed for both the designer and the map reader, with new tools available to the designer and a endless amount of new devices available to the user. However, there are still many questions to be answered about how to design map animations with the user in mind as well as how to deal with the ever-changing state of technology. This position paper outlines a few of the challenges in cartographic research on map animation.

Author Keywords
Animation, Map, Research Challenges, Cartography, Change Blindness, Cognition, Cognitive Limits

INTRODUCTION
This position paper outlines some of the challenges in cartographic research on map animation. The advent of the geospatial revolution has extended beyond simply an increase in using maps and locations; maps now have also become a point of fascination. Within traditional and social media outlets, maps, especially maps that move, i.e. animated maps, are shared endlessly across the web. These maps are featured on informal blogs as well as well-known news media outlets. While technology improves and evolves to allow designers to more easily create compelling and beautiful map animations, what are some of the cognitive, data, and technology implications for how we design these types of maps? Building on previous research agendas within cartography [3,9], some of the implications of data design, technology changes, and cognitive and meta-cognitive limits are mentioned here with questions on what research might aim to answer in the future.

DATA LIMITS TO THE DESIGN OF MAP ANIMATION
Map animations are special, because unlike traditional animators, such as Walt Disney, cartographers are inherently tied to geographic data, meaning we cannot simply change the story to improve the visualization. Lasseter in 1987 [8] wrote how animators needed to slow down or speed up or design the animation in specific ways to allow the movie watcher to have the best experience. However, cartographers are limited by the data they display. We can adjust certain parameters but cartographers will never have *full* control of how the animations will look. For example, if a cartographer chooses to animate traffic in a city over the course of the day, many of the changes within the visual display will occur during a small amount of time, rush hour, and will probably be concentrated within the city center and on freeways, while very little will change during the middle of the night and might be limited to local roads. Some have mentioned adjusting the rate of change within an animation [5], however, there are potential cognitive issues associated with removing the congruence to the real world phenomena.

- Are there better ways to visualize our data through animation that limits the problems caused by the inherent nature of spatio-temporal data?

CHANGING TECHNOLOGY OF ANIMATED MAPS
Much research has surrounded the issues of human cognition and animated maps. "When it comes to designing animated maps, the bottleneck is no longer the hardware, the software, or the data – it is the limited visual and cognitive processing capabilities of the map reader" [7, p.269]. The tools may be changing, but the challenges to the human cognitive system continue. Technology for developing animated maps has changed dramatically from Adobe Flash to the ArcGIS Time Slider to new tools and code libraries such as Torque by CartoDB and D3 for JavaScript, to list a few. The changing technology offers increased challenges to understanding how different animation designs might influence a map reader.

- How does new technology change how we can design animated maps?
- In what ways can researchers remain relevant when studying animated maps as the technology changes so rapidly?

To the same degree, new technology has changed how map readers interact with animation. Today, we view animations on the web in an interactive environment that extends far beyond simply viewing the animation. In this way, we have achieved one of the goals mentioned in the 2001 research agenda [9]. New technology has allowed cartographers to move beyond animated maps as movies to exploratory interactive devices available across the web across multitudes of different devices.

- What challenges do different devices and viewing platforms cause for animated map readers and designers?

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- What is the best way to design interactivity into map animations?

GOAL OF MAP ANIMATION

There are many tasks associated with spatio-temporal data retrieval [1], however, animation is better at certain tasks over others. Similarly, there have been several studies [e.g. 2,6] evaluating how and when small multiples are better or worse than animation for spatio-temporal data. In many ways we know what tasks are best accomplished with animation versus small multiples, but this brings to mind the following:

- How can we better guide research to improve animated map design within realistic tasks?
- Should we attempt to study animated maps through more qualitative research methods as opposed to the traditional quantitative cartographic experiment?

COGNITIVE AND META-COGNITIVE LIMITS OF ANIMATED MAPS

There is no doubt map animations offer significant challenges to map readers' cognitive limits. Harrower [7] and Fish et al. [4] are just a few researchers who have spoken to some of these problems. Cognitive Load Theory, split attention effects, inattention blindness, and change blindness are some of the potential cognitive problems with animated maps. However, and perhaps more importantly, many researchers [e.g. 2,7] have stated interactivity can help to reduce or even eliminate some of these problems. However, previous research has shown the meta-cognitive problem called "change blindness blindness", or the overestimation of one's own change detection abilities, to be a problem in animated map reading [4]. Change blindness blindness could have immense implications towards map users actual usage of interactivity within an animation. If a map user fails to realize they missed something in an animation will the map user use a button to replay the animation? While we have made great progress in better understanding how to develop interactions within map displays, little has been done to understand whether map readers use interactive buttons on animations.

- How do meta-cognitive problems such as change blindness blindness affect how users interact with interactive animated maps?
- How can we study how effective interactivity is for map animation without prompting users to do something they would not naturally use as a result of change blindness blindness?

CONCLUSION

Despite a continual questioning of the effectiveness of animated maps, these dynamic displays continue to pop-up across the web shared widely across social media outlets and international media sources made for both mobile and desktop devices. In addition, the technology available to designers and developers continues to improve to allow for more customizable options for the development of incredibly compelling and fascinating dynamic graphics. Additionally the cost of developing a map animation continues to drop with the increase in free and open sourced tools and libraries. Understanding the technological changes, the goals of animation, the limits of spatio-temporal data, and the cognitive and meta-cogintive limits to reading animated maps is vital to improving these types of maps as they become more prevalent. Answering questions posed here will help us to create even more compelling animated maps.

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