Interactive digital mapping as a park-planning tool in the creation of the Boucher-Forest Park in Gatineau, Quebec

by

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This thesis is dedicated to the memory of Jin-Uk Kim.
For encouraging me to go back to school.

Abstract

The study presents a design of an Interactive Digital Map with 360-video capability as a planning tool in the park-planning for the Boucher-Forest Park in Gatineau, Quebec. This thesis tested it's use with an interactive digital map in the context of planning for a park.

The study describes a usability testing method to improve the design of the map and its use by public and the park planners. The findings include an empirical analysis and demonstrates that users could learn and use the park-planning tool easily. The results show that it is an efficient and effective park-planning tool.

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Chapter 1

Introduction

I am attempting to determine whether the use of an interactive mapping tool can help improve decisions about planning of a park.The purpose of the thesis is to design and test an interactive park-planning tool.

I designed an innovative park planning tool with 360-video interaction. The targeted users are the visitors to the Boucher Forest in Gatineau, Quebec. As a part of my study I conducted a usability study for the to test park-planning tool's utility, efficiency and effectiveness.

The Boucher Forest Foundation is a charitable organization whose mission is to protect, preserve and enhance public appreciation of the Boucher Forest. It does so by purchasing parcels of land and carrying out environmental projects designed to protect its ecosystems and by educating the public about the importance of protecting the Boucher forest and ecology generally.

The Boucher Forest is the last large wild space in the Aylmer sector of Gatineau Quebec. Its large area (700+ acres) makes it a green space of considerable ecological value. Currently, half of its territory belongs to the City of Gatineau while the other half belongs to private owners. The City of Gatineau plans to make the forest a protected park, in partnership with the Boucher Forest Foundation. In 2018, a conservation plan for the forest is being developed by the Foundation, with the City and the public. This

thesis is a contribution the process creating a plan for the upcoming Boucher Forest Park.

Although some information sources on the Boucher Forest are available, they have not been combined to give a global view of the forest situation. Creating a digital map and putting all the information together, and giving the opportunity to the public to add more information on the map, will be used to collect the data for making a decision-making tool for all the stakeholders in relation to the Boucher-Forest Park.

This research has created a digital interactive map using the variety of information sources available: existing trails, land ownership, forest stands, humid zones, etc. in order to be able to cross reference and combine information and plan the park accordingly. Using this interactive map, the park-planner and visitors of the forest will identify park-planning issues: width of trails, ecological findings, signs on trails, type of trees and users will label their findings on the map to give the Boucher Forest Foundation additional information about the forest's biodiversity and threats to it.

The objective of this study is to investigate the usability of the interactive map as a decision making tool. I first had to design an interactive digital map of the forest including a 360 degree video capability along the trails. The participants were then given tasks to complete and they were observed by using a Think Aloud protocol. Finally the participants were asked to complete questionnaires to get their opinions about their experience.

Several tasks were created, and the participants were selected from Gatineau residents including the Boucher Forest Foundation, the City Council, the administration and the public.

1.1 Objective

This study is examining the use of an interactive map which can help to make decisions for park planning. Park managers' objective is the visitors to stay on formal trails.

The case study is the Boucher Forest in Gatineau Quebec. The results of the usability research were used to improve the design of the park-planning tool.

1.2 Research questions

Primary questions

1. Can the use of a interactive digital map with 360-video help to determine the planning and creation of trails in a park?
2. Can the use of an interactive digital map together with a 360-video be used effectively and efficiently?
3. Can the park-planning tool easily learned by initial users?

Other questions

- Can users explore the trails with using the interactive digital map together with a 360-video efficiently?
- Do audiovisual media act as visual and aural guide to decide about park-planning?
- Can the use of a 360-video together with an interactive digital map be effective for users prior to visiting a park?

1.3 Outline of thesis

- Chapter 1 is the introduction.
- Chapter 2 is the literature review exploring to see what has been done before.
- Chapter 3 covers the design philosophy, user-centred design process and prototype implementation.
- Chapter 4 describes the usability test in detail. It describes the research methods for empirical research to design an usability testing, including a screening process and the test setting used to conduct the usability testing.
- Chapter 5 presents the findings of the usability study and and presents the results of quantitative and qualitative methods.
- Chapter 6 concludes the thesis by answering the research questions as well as providing future recommendations for future research.

Chapter 2

Literature Review

This literature review can be grouped under the following subtopics: interactive digital maps, 360-video, and trails.

The first goal was to have a portrait of the actual situation of interactive digital mapping and determine the thin line that establishes the border between maps and 360-video. The goal was to understand the usability of digital maps and 360-video as an audiovisual element to design a park-planning tool.

The literature review is highly specific and directly related to the needs of the thesis.

2.1 A Brief History on Maps

There are many questions that need to be asked in order to have a better understanding of the definition of maps. The following questions were asked during the literature review: when did we start using and creating maps? That also raises another question; how we did we find directions before maps? There are many discussions about how we found directions without maps. Researchers assume; before maps, directions were found by using other methods, including using magnetic fields and castastic signs (Ellard, 2009).

FIGURE 2.1: A mural map of Çatalhöyük B.C. 6200

According Smith (1987) maps go back to the 7th millennium B.C. The Çatalhöyük map (See figure 2.1) was a mural map that contained a plan of a large village and the hunting trails around the village. There are many other rock engravings that were discovered from the prehistoric period but most of them were identified as rock art or pictures, and not maps, because they didn't include the six cartographic elements necessary to qualify as a map: houses, borders, paths and land use (Smith, 1987).

The signs and elements are identified similarly by map creators in our time Lynch (1960) asked participants to draw maps, and he found a significant similarity with all the participants. His findings showed that participants were sketching five main elements to understand spatial elements of a city. These were paths, landmarks, nodes, edges and districts (Kian Teck Kueh, 2007). An effective map design is a complex process that involves the relationships between these spatial elements of space.

2.1.1 Evolution of Interactive Digital Maps

Digital maps have been available for many years but the introduction of interactive digital maps using World Wide Web is a phenomenon of the last decade that is constantly growing in importance.

One of the the first interactive digital maps also was one of the first hyper-media system which was the Aspen Interactive Movie Map that allowed to experience a little city of Aspen by viewing the photos that was taken from top of a truck (*Aspen Moviemap* 2010).

In 1977, Ted Nelson thought of hypermaps as a concept as a map that could be navigated by steering and zooming around the World without any delays. While the magnification increases the user gets the choices of seeing other data such as population, climate and industry (Nelson, 1987).

The Ecodisc is an example of interactive 360 view that observe ecology and its varied habitats. The Ecodisc system allowed the user to view lake by looking at photos at different directions. The 360 view is possible with choosing between a sequence of photographs taken with a camera with a panning action. The same photos were taken from the same spot in summer and winter seasons (Nielsen, 1995).

The first examples of online maps were: In 1983, Xerox PARC included interactive digital maps as a web based educational system that had the functionality of an interactive digital map: Notecards, a hyper-text based personal knowledge system included interactive maps as a digital content. In 1984, Macintosh implemented an interactive digital

map with the FileVision system which was developed using the interactivity of HyperText links (Nelson, 1987). FileVision allowed the user to obtain information with a click on the digital map, including a photograph taken at the geo-location (Conklin, 1987). Tim Berners-Lee described HyperText in his article as an interaction method as links can point to anything that can be displayed on the screen (Berners-Lee, Fielding, and Frystyk, 1996).

In 2000, the competition of web mapping services has accelerated in popularity when America Online Inc. to acquired MapQuest and Microsoft pushed their first release of MapPoint which is known today as Bing Maps. In 2007, a large amount of computer users were already using digital maps, although the mobile maps did not exist yet. For example, MapQuest had 40 million unique visitors per month. The same year, the number of digital map users was 10 million in England (Nivala, Brewster, and Sarjakoski, 2008).

In 2005, Google Maps was launched by Google. It allowed the user to make a geo-location related search and to see the matching Google search results on a digital map. Svennerberg (2010) explained there are many methods for displaying data on an interactive digital map then just markers. A filtered search can increase the readability of a map such as clustering the results of a search depending of the zoom level of a digital map.

In 2007, when Google Maps decided to increase use of its content by adding the Wikipedia database in the search results as a strategic response to Yahoo adding Yellow Pages on Yahoo Maps. Use of online maps became more popular with the standardization of GPS mobile phones because the Internet of Things and crowd-sourcing allowed digital

maps to present more accurate data (*Wired* 2007).

Digital map composition and visualization techniques kept improving with the increasing revenues of geo services. Geo services is a name given for location-based services that uses the technology of electronic maps, satellite receivers, satellite navigation, satellite imagery with location-based search. In 2013, geo services global revenues were valued between 150-270 billion US Dollars per year, while it's output on the economy was beneficial. Geo services returned 100 billion US Dollars per year by saving us travelling time, fuel and helped the economy by creating GIS-related education and jobs, helping planning of agricultural irrigation, and saving time with emergency services (Ltd, 2013). With the use of GPS services and satellite imagery service, digital maps increased the quantity and quality of data that can be searched and ease of use for searching for them. Investors increased their revenues each year to achieve better effects on the marketing outcomes.

Streetview

Today, home users use Streetview for various purposes such using Streetview for saving time by searching for an address. This allows the user to preview the urban environment in advance.

On May 25th 2007, Google released Google Street View, a new feature of Google Maps which provided 360-degree panoramic photos of street-level views of various locations. Street View was a 360-view technique that showed a panoramic photo from a position along the streets around the world. Although it started in the United States there was still some legal issues and legal decisions given around the World. There

was still privacy concerns about Google recording the streets around the World (MacDonald, 2010). In 2013, Google map was claimed legal in Germany and the 360-view content was being updated by blurring the faces on the photos taken for Streetview (Farivar and Isenson, 2011). It drew the attention of mobile users and desktop users because Google Street View included more content from cities and rural areas worldwide (Vincent, 2007). Although its main feature was to allow computer users to visit environments virtually and to view streets in an urban area without having to be present physically it still randomly caught photos around the World of people's personal space and actions.

Streetview was created by Google as a project under the name; multi-perspective panoramas of city blocks (Roman, Garg, and Levoy, 2004). Computer users could preview a streetview of a location to have a first person viewer virtual experience. In 2008, it quickly became an important tool for viewing outdoor locations that we all use daily with increasing worldwide coverage (*Cnet* 2008). Street View data can also be used for testing accuracy of data recorded by GPS devices to the geographical visual localization (Zamir and Shah, 2010).

2.1.2 Cybercartography

Cybercartography is an evolving concept of creating interactive digital maps based on the theory that it can change the way cartographers think creatively by using the key elements of cybercartography: imagination, foresight, and effort. Cybercartography is multi-sensory in nature, which creates new challenges when creating unique designs.

Fraser Taylor and Caquard (2006) suggested that combining research process and production process allows creating unique designs and improving the cybercartographic design. Another goal of cybercartography is to make the user experience simple for the user, which is made possible by combining cartographic practise with theory. In cybercartography, the user is an integral part of the creative process. Fraser Taylor and Caquard (2006) indicated that designers should have a creative approach in terms of art and science, which allows using both quantitative and qualitative cartographic elements.

> There are seven major elements of cybercartography: Cybercartography is multi-sensory using vision, hearing, touch, and eventually, smell and taste;
> • uses multimedia formats and new telecommunications technologies, such as the World Wide Web;
> • is highly interactive and engages the user in new ways; • is applied to a wide range of topics of interest to the society, not only to location finding and the physical environment;
> • is not a stand-alone product like the traditional map, but part of an information analytical package;
> • is compiled by teams of individuals from different disciplines; and involves new research partnerships among academia, government, civil society, and the private sector (Taylor, 2003).

Taylor (2013) highlighted that the process for implementation of a cybercartographic atlas that uses multi-sensory assets is similar to designing a cybercartographic atlas with an interactive data visualization interface.

2.2 Interactive Digital Maps

ImaNote is a web-based digital map that allows sharing information among multi-users. The point of interests on the map contain multimedia resources that are displayed on a hand-drawn map of Mexico City. The idea of Díaz et al. (2011) was to display a photograph to show the history. Particularly close-up images were captured in the historical Mexico City. It was an efficient tool for visitors and educators who could also upload textual information on the map. The high-detailed photos that were used on the platform gave the user the impression to be able to touch the monuments themselves. During the design phase, this was an idea that was thought to allow the user to get close to the details of the city that he could imagine being in front of an augmented version of the image. The main design concern of the user interface was to make the navigation intuitive and to make the map elements, icons and routes visible. The elements of the interface consisted of a map, a separate area overlaying the map for displaying related images and controls for navigating the map.

Bortolaso et al. (2014) considered the effect of different view techniques on collaborative digital tabletops by using map-based tasks. He conducted a user study with participants and observed them while they were playing a turn-based military game. The users interacted with the tangible digital tabletop map by dragging a unit on determined destinations. Some of the findings of the research were that participants often have not changed the scale of the map and and participants browsed the map when the participants stopped engaging with their units and having already completed their map-based tasks.

Feibush, Gagvani, and Williams (1999)'s case study was to observe users' capabilities

by using interactive digital maps to compare color-coded textures versus high-quality graphics were tested on a military simulation map. Participants were given the choice of selecting a tank or an aircraft. Users could tap the screen to move their units on the terrain. Users who were given aircraft were satisfied with the shaded, color-coded texture. A visualization style for the aerial map was displaying the entire terrain two dimensional graphics using color-coded texture to show the elevation. The other technique was a 3-D high-resolution model of the terrain with three dimensional graphics. Users who were given tanks preferred the high-quality with 3-D graphics.

2.2.1 Interactive Digital Maps with ego-centric viewing techniques

Everyone has differences in terms of their capacity of visualizing their spatial orientation in the virtual world, depending on their previous profession, their education, and their age. Wayfinding and spatial orientation is defined as a cognitive sign assisting our imagining ability that will help to identify a position from another perspective (Kozhevnikov, Blazhenkova, and Becker, 2010). Guilford and Zimmerman (1948) tested the impact of giving the user feedback about his ego-centric position regarding the virtual world. By giving a reference of the users; he found that we can have a clearer understanding of spatial orientation and our direction on the landscape we are facing.

Everyone has different capacity of reading maps. To better analyze this, Kobayashi (2010) simplified a formula to measure map-reading ability because and compared it to our spatial recognition capability.

He named three abilities of “sense of space memorizing”, “sense of direction” and “sense of position” , Koyabashi thought those are the key abilities of human map-reading ability. The formula Kobayashi (2010) created of a formula of these key abilities to be able measure human map reading ability:

(SoM + SoD + SoP) / 3 :

• SoM (Sense of Space Memorizing): How many times does each participant need to refer to a map?

• SoD (Sense of Direction): How precise and quickly does the participant detect the direction to go?

• SoP (Sense of Positioning): If the participant made a mistake, can he or she recover the problem soon?

The parameter for error rates that Kobayashi (2010) used in his experiments were frequent referring to a map, double checking their direction at crossing points, and by using error prevention by walking back to the right path once they realized they are on the wrong path.

Ellard (2009) compared computer interaction in both physical world and virtual environments, including a gender approach. He stated that women are more likely to use landmarks and men prefer to look at directions and rather use the compass. Fujii and Sugiyama (2000) concluded that women usually use color or shape in route finding, and that men are generally stronger in remembering topology or sensing a distance (Fujii and Sugiyama, 1999).

Researchers predicted that that people’s perception and thoughts about a place can give valuable information on the environmental characteristics of the geo-locations

they visited with digital maps. Klettner and Gartne (2012) conducted a study to test a mobile application that displayed the emotional data on the navigation map. This was thought to provide a better service that included field observations, physiological recordings and reports remind the user their motives and needs for his previous experience. EmoMap integrated collected data and was used by pedestrians to test its usability.

In a traditional video, the user is locked to the angle where the camera was pointing to during the capture of the video. With 360-video recording, there are no longer these boundaries, and 360-video capturing devices are becoming more common and afford able to the general public (Neng and Chambel, 2010).

Findings of Mulloni et al.'s (2012) research presents the results of using 360-view for testing the efficiency of location-based services. Researchers tested the 360-video usability with mental rotation. Participants were tested to see if they are rotating their body when they were aligning themselves with the directions that was matching with the virtual environment corresponding to the 360-video. The user study scenario was that users had to find objects in virtual environments using egocentric directions; front, back, left,right. They found out that, when the users aligned themselves with their egocentric directions; it decreased the time until they completed a task exploring an object. The interface included a directional element that allowed users aligning themselves with geocentric directions; north, south, east, west. The users used only geocentric directions when there was no other panoramic image loaded on the screen.

Researchers highlighted the advantages of using the egocentric perspective of the world

when users are using maps to find their ways by using location-based services. Chittaro and Burigat (2005) presented an mobile navigation system testing the usability of interactive digital maps as user switched between an egocentric perspective of the world to a geocentric perspective of the map. The navigation system was showing three different layouts; the map or the photographs of the area that are clearing showing the direction, or the arrows as three separate layouts. They found that users preferred using the map view only when they were planning to visit a place. And they made the most errors when they were using the map view individually. The results of the study found the photograph view was the most useful view perceived when testers were walking.

Previous studies show that spatial abilities can differ between genders when playing computer games. In a virtual environment spatial orientation and skills are used more effectively by males when they are playing computer games. Feng, Spence, and Pratt (2007) tested users after getting a training of 10 hours of action video games and they found that 6 males had better results than 14 females.

Google Maps was previously tested as an evaluation system for managing the traffic signs on highways. U.S. traffic signs were managed by detecting them, classifying them, and mapping them on a new system that was used as an inventory with Google Map's functionality of Streetview, Aerial/Satellite photography and adding recorded GPS data of the vehicle traffic. It was proposed because it was a cost-effective method that can automate data collection for ESRI ArcView GIS databases (Balali, Rad, and Golparvar-Fard, 2015). Boonsuk, Gilbert, and Kelly (2012) conducted a user study to evaluate the effectiveness of 360-view in this context. In their study, they compared three user interfaces that had three different layouts of a 360-degree videos. The first

one was a full display of 360-video, the second layout was two separated views of 180-degrees videos displaying on top of each other and the last one was a four separate 90 degrees of front, left, right and rear. He found that non-seamless interfaces with visual boundaries support spatial visualization and egocentric were not correlated with allocentric visualization. According to *Allocentric vs. Egocentric Spatial Processing* spatial coding system can be thought of tranformations of egocentric visualization; when the users are referencing their location to other objects to find out the distance. Allocentric visualization is a reference to the transformation of the objects considering by the distance with other objects.

As reported by (Kozhevnikov and Hegarty, 2001) spatial visualization and object visualization abilities have differences relating to spatial allocentric and egocentric abilities. They are correlated but also have different relationships to real-world performance. The result of Kozhevnikov and Hegarty (2001)'s study illustrated that participants used spatial orientation as a common strategy when they rotated themselves with the virtual environment, and rotating the view more than 90 degrees.

On the opposite viewpoint, video games limit the narrative structure which can carry a plot. The experience can be interactive while the gamer is given choices such as playing with scenes, staging the characters and cameras positions placed in 3D World (Porteous et al., 2011).

According to Boonsuk, Gilbert, and Kelly (2012) spatial understanding of users shows that a cognitive map is considered as a mental representation of exocentric directions.

They tested 360-videos and conducted a research with computer gamers and with non-gamers. Participants who played 3 hours of video games per week had reduced number of errors compared to others who did not play games. However, they did not find any affects that have created difference in performance time.

2.3 Trails

The number of visitors changes the quality of the natural environments and therefore it changes the quality of visitor experiences as well (Hockett and Clark, 2011) .

Klettner et al. (2013) specify that people do not simply decide for the shortest route, but that decisions related to the walking distance from one location to another location are influenced by various characteristics of the environment, including parks, slopes, trees, front gardens, or shops.

Consequently, Borst et al. (2009) note that, to understand route choices, we need to use findings about people's perception of space and that it makes it more feasible to support a user-oriented way.

Trails are a core component of park infrastructures to provide access to natural areas. Well-designed trails play a role of protection natural areas by maintaining visitor activity on the trails (Marion and Leung, 2001).

Formal trails are drawn on a map as the principle trails of a protected area or a park. Thurston and Reader (2001) illustrated the influence of Visitors to the the trail network by creating informal trails. He acknowledged that formal trails must be planned of taking in account travel patterns for visitors. His requirements to design a park with

trails were oriented about visitor's goals, and he thought that visitors will want to go off the trail and start walking on the forest, to create a new paths. A well-designed park will provide access to natural areas and satisfy visitors' experience at the same time. Informal trails are also called visitor-created trails and they might be used for a long time and eventually become formal trails (Roovers et al., 2005). When formal trails do not have markings on the trails, informal trails are recognized as formal trails by visitors and this can cause more visitors to begin creating informal trails (Brooks and Titre, 2003).

Wimpey and Marion (2011) suggest a method of differentiating formal from informal trails. They concluded that an average width of informal trails is 0.86 meters, while common formal trails' width is 2.41 meters. Relying on Wimpey and Marion (2011)'s previous observations, formal trails often receive a group of people, while informal trails get visited by individuals or small groups. In his article "A Spatial Exploration of Informal Trails Within Great Parks, VA", it is suggested that, when deciding on informal and formal trails, visitors should have a role in creating the trails.

Wimpey and Marion (2011) acknowledged that all visitors visit the forests with their own intentions and motives and that they will decide their own path in the forest,if they are not following trail blazes and signs. He considered visitor behaviours and motives when travelling on trails and developed a typology of visitor motives and behaviours:

1. Access-visitors leave the formal trail network to access park areas not reached by formal trails,

2. Avoidance-visitors leave formal trails due to undesirable conditions on the trail (e.g., mud, erosion, crowding/conflicts, difficult terrain),
3. Exploration - visitors are drawn off formal trails to investigate unknown areas,
4. Accidental - visitors follow an informal trail due to poor formal trail marking or inattentiveness,
5. Shortcuts - visitors leave a formal trail to reduce hiking time,
6. Attraction - visitors leave a formal trail to see, study, or photograph interesting wildlife, plants, vistas, or to investigate interesting sounds or an inviting informal trail's destination, and
7. Activities - visitors leave informal trails to engage in off-trail dependent recreational activities, e.g., orienteering and geocaching (Wimpey and Marion, 2011).

When exploring environmentally friendly projects under a human-computer interaction view point Piccolo and Smith (2015) suggested to promote volunteer participation when conducting user studies. They claim that a volunteer approach allows the participants to feel comfortable when evaluating. Contrarily, offering participants a compensation often makes them feel guilty and do not feel an emotional engagement through commitment (Petkov et al., 2012).

A research study that was conducted by the Virginia Polytecnic Institute and State University College of Natural Resources Forestry, Recreation Resources Management showed that public and visitors can benefit from a map that includes informal trails.

Hockett and Clark (2011) found that a good application to identify trails is categorizing them with visitor's motives and to use this information for the park planning decision-making process. He suggested that when making decisions regarding the planning of the trails in a forest , it is preferred to engage dialogue with the public in the design process.

Marion (2008) constructed a problem analysis for improving trail management for a more efficient park management. Potential strategies and actions that were outlined were considering visitor behaviour, educating visitors and relocating campsites and facilities. He suggested that visitors should stay on formal trails and he specified that visitors should be able to differentiate formal and informal trails. To improve the management of formal trails, he suggested to place signs and trail blazes on formal trails by park management. Steinholtz and Vachowski (2001) determined that planning trails and other infrastructures have an important impact on park management.

Marion, Wimpey, and Park (2011) developed trail surveys to assist in park planning and managing trail systems :

- A trail attribute inventory that uses GPS units to observe trail system characteristics, providing accurate geographic information systems (GIS) trail layers for mapping, planning, analytical, and decision-making functions. Common trail attribute data or use type can be cultural/historical features, attraction features, hiking difficulty and accessibility, maintenance features (e.g., signs, gates/barriers, bridges, culverts/water bars), and sustainability attributes (e.g., trail grade, slope alignment angle, slope ratio, trail substrates). Inventories of informal

trail networks provide data on their spatial distribution and aggregate lineal and areal extent.

- Trail condition assessment: A problem assessment survey provides census data by recording every occurrence of predefined impact problems, monitoring continuous trail attributes (trail width) or common impacts (trail incision/soil loss)
- Trail prescriptive management assessment: Sustainability analyzes can be conducted with data from walking surveys, or when available by condition of or work needed on existing trail features, or the need for new features, including gates/barriers, bridges, signs, and tread drainage features (Marion, Wimpey, and Park, 2011).

Identification and evaluation of a park planning process depends on the causes and influential factors of the park problems. If there is research to be done, researchers should consider adding use related factors, environmental factors and managerial factors to their results. Park managers goal is reducing off-trailing behaviour and finding out the impacts of off-trail hiking (Hockett and Clark, 2011).

Chapter 3

Design and implementation

In this chapter, the design aspects and documents related to the process will be outlined, including the initial sketches.

This section also includes information about the prototype and the interactive 360-video. The product created within this study is an interactive digital map with 360-video functionality that helps planning trails or visits in forests and parks.

3.1 Description of the Project - Park Planning Tool

The project's goal is to address the challenges to design a planning tool for trails in a park, using an interactive digital map with a 360-video functionality in order to understand the relationship between the egocentric view and aerial map view. The case study was the future Boucher-Forest Park in Gatineau as a support to the current park-planning process, including the formal trails. The tool that was created also aims to be used by the visitors to Boucher-Forest, by uploading new videos and photos as a multimedia content to the interactive map. The park planers' role will be to analyze the new trails, and the associated videos, and to measure GPS accuracy with recorded video on a trail.

Online map editors, such as MapBox, allow us to create custom maps using a computer. Interactive digital maps were created to be accessed from home and on mobile devices,

basically from anywhere at anytime. The Boucher Forest Foundation wanted to create a map to be used as a planning tool in the process of creating the Boucher-Forest Park. With the ongoing process of content creation from the public and the City of Gatineau, and the government growing attention to the data collection by using professional and personal applications, the goal was to expand interactive digital map capabilities with a focus on park-planning.

This thesis considers three main areas of research: a User Centered Design for planning a park, an interactive digital map with 360-video functionality and usability research of the tool that was created.

3.2 Design Philosophy

The understanding of the design philosophy behind the park-planning tool is constructed with the development method that is suggested in creating cybercartographic atlases. There are two phases in cybercartographic design: theory, which is an iterative design to improve the user interface and theory and practise, and user study, which is demonstrating the usability of the prototype. Cybercartography includes multi-sensory elements, including audiovisual, to create maps (Taylor, 2013). The User Centered Design of this prototype's implementation includes three phases: gathering and combining all the layers that are important to the creation of the custom map, including geographical layers, filming a 360-video and recording trails' GPS data in the Boucher-Forest park, and designing an interactive map using these multimedia assets.

As mentioned in chapter 2, a majority of the world population have been using digital maps for about a decade now and our ability to transfer knowledge of reading maps has been developing for centuries. Naturally, humans are good with spatial orientation for finding ways, but the user interface has to be simple and intuitive. The initial learnability of the designed prototype was considered a challenge since we knew that using the prototype for planning a park required interdisciplinary studies.

3.2.1 User Centered Design

The main approach used in this study was to improve user interface design within the User Centered Design life cycle. This included designing the conceptual planning of the user experience design process (e.g. user personas and storyboards, etc.).

User Centred Design is the critical part of this thesis because the the interactive digital map's design was is driven and refined by user centered evaluation. The design process of the park-planning tool required creating a User Centered Design.

User Centered Design is explained by Constantine and Lockwood (1999) as a design process that requires an analysis of users. Abstract use cases or user scenarios were employed with an explicit understanding of the user interacting with the system to create a design for the product. The use cases were written with respect to users' goals, roles, tasks.

This planning tool was set to create a contextual interaction using a geographical map layer, an interactive trail, and an 360-video. To test this the user was given scenarios based on some tasks to accomplish.

Nelson (1987) says, "computers are not everything, they are just an aspect of everything." The park-planning tool is innovative because it is being tested for a new aspect of park-planning goal with the aid of a 360-video and interactive digital map interaction. These are two multimedia elements that allowed the creation of park-planning tool, which stand differently for their multi-discipline functionality:an interactive digital map that has 360 video capability to be used as an audiovisual element. The goal is to research interactive digital maps and explore their effects with 360-video viewing techniques.

As a first step, user scenarios were written and personas were created to outline a user experience. A persona is a definition of a user group who share the common goals and needs for using the product. “A scenario is a concise description of a persona using a product to achieve a goal” (Cooper, Reimann, and Cronin, 2007). A process of designing a park had be analyzed to create a design. After analyzing the context, a sketch of a user journey of the park-planning tool was drawn.

During the design of the prototype the elements of the User journey sketch allowed the creation process to take form. (see 3.1) To begin designing the prototype, a user journey helped visualizing and the process of following a User Centered Design; a scenario, a persona, a task analysis and it helped making selections when creating a style; a palette, and icons to guide the design of the park-planning tool.

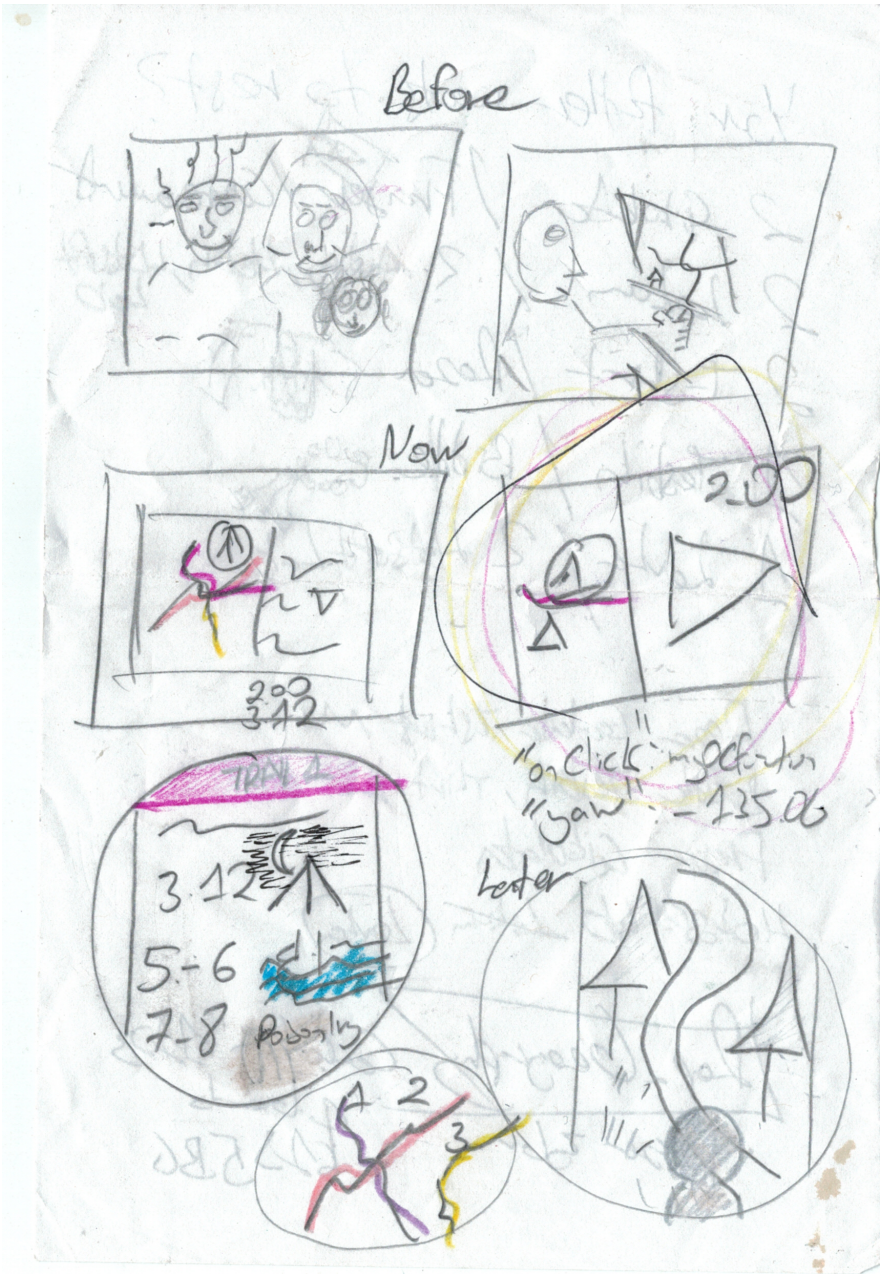

FIGURE 3.1: User journey of the park-planner tool

3.3 Designing the Park-Planning Tool

There is a demand for a park-planning tool, and therefore, it needs to be investigated with using a User Centered Design approach starting with usability goals and then defining its primary users and secondary users.

3.3.1 Usability goals

The interactive digital map is a tool that was created to be used as a planning tool to decide Boucher Forest's formal trails in the creation process of the Boucher Forest park. Boucher Forest currently has about 10 kilometers of trails. These informal trails were initially created with visitor's behaviours and motives. Every park has different objectives depending on the goals of the park's management, Boucher Forest's goal is to maintain safe access to the trails while protecting the environment.

The goal was to give the park planner a satisfying and efficient experience of a park-planning tool with the aid of a 360-video with audio feedback. Visitors were also tested when exploring the forest with the interactive map. The user could take the role of the park visitor/organizer and experience a trail trekking at his desk, or wherever he or she is using a computer. The interactive digital map of Boucher Forest was created with the help of the community in Gatineau. The City of Gatineau was contacted to send some of the layers(humid zones, tree types, land ownerships, roads and highways) and volunteers from the Boucher Forest Foundation walked all the trails inside Boucher Forest to create the GPS data to be used as trails and draw the other elements that we did not have.

The primary users of the park-planning tool are park planners. Park planners will use the interactive digital map that contains the recorded trails inside. Park planners need to find an item along the trail, for which the visual and auditory feedback from the 360-video will be used. The user will see the trails on the map but it might be more efficient to identify the item using the video. We wish to use a linear video which can also limit the user with a constrain with dragging the marker only along the selected trail linearly. The park-planning tool is aimed to be easily to learned by depending on the fact we know about using digital maps, but we do not know if a 360-video that is recorded from a egocentric angle will make it easier for the manager to define the problems related to park-planning.

The secondary users are visitors; a visitor might be familiar with the Boucher Forest map but may not all the trails. The interactive map's secondary users are the visitors who plan an activity or to access the park. They are providing updates and all of the discovery in the forest such as trails, problems on the trails, dangers, living things, garbage, etc. Secondary users have a role in planning Boucher Forest as an accessible, safe and enjoyable park, as they are the ones who will benefit from the park once it's created.

- The first goal of the tool was to determine if the trails are accessible or recognizable(usable).
- The second goal of the tool was to find out how to categorize the trails, depending on the influential reasons or causes for creating alternate trails
- The third goal was to determine if trails or surroundings need maintenance.

For visitors park-planning tool can be used to observe the vegetation that is growing

on the trail can give an idea of the trail accessibility. A park-planner can use map's layers to find out if the trails are intersecting with wetlands. A visitor might use the park-planning tool to have an idea of what to bring with him for his next visit. By uploading multimedia such as 360-videos and 360-photos Visitors will use this tool to contribute to the trails and their management inside the Boucher Forest. Park-planning tool will connect primary and secondary users, and it will do so by helping finding visitor behaviors and motives, what is the reasons visiting the forest in the first place by looking at the existing information. The observation will be done by identifying the alternate trails to find underlying causes and influential factors of their creating in the first place. Use-related problems will be analyzed along with managerial issues and environmental factors.

3.3.2 Primary functions

The primary functions of park-planning tool have to be tested to provide an efficient and effective usage. The interactive maps' primary objective is to support the decision-making process for planning the park adequately for its future visitors, with regards to existing trails that are passing through sensitive habitats, such as checking if the trees provide enough shade for living things or if any other potential infrastructures that will be built on humid zones including bridges, etc...

It is designed to be a decision tool for park planning with regards to trail maintenance(See section about trails in Chapter 1). Decisions that are made during a park planning process depend on the park management objectives. Every park has different

objectives. Boucher-Forest Park's objectives are safe access to facilities, and protecting the environment.

The map's main functions are:

- Wayfinding,
- Learn about Forest,
- Help to identify plants,
- Maintain paths,
- Maintain vegetation,
- Learn visitor's motive and influence.

3.3.3 Secondary functions

The map also serves a variety of complementary functions, that have to be separated from those actual requirements of primary operating functions. These functions include: discovering nature stories, year by year analysis, planting trees, help to spot animals, spatial analysis, seasonal planning, measurement tools.

3.3.4 Hierarchical Task analysis

HTA - Primary User: Park planner

- Select/Find alternate trails.
- Change the layers from terrains and trails.
- Drag the marker on the trail.
- Watch the 360-video for looking at trail errors in the park.
- Identify potential problems that are given in each task.
- Record the time the problem by taking a screen-shot.

HTA - Secondary User: Visitor

- Look at the map for camping icon.
- Click on the map where it is close to the camping icon.
- Drag the marker along the trail to the desired position.
- Look at 360-video and use arrow keys to explore the forest along the trail.
- Look if there is a good camping spot.

3.4 Implementing the park-planning tool

This section is about the implementation of the Interactive Digital Map with 360-video capability and explains why it was chosen to create the park-planning tool. To design a prototype first we need to understand the capabilities and the of the interactive tools we will use to create the prototype.

A prototype was created using an interactive digital map and an integrated 360-video. The interaction between the map and the 360-video allows the user to find his location, using map navigation and spatial orientation together. Although it uses a 360-video, and not 360-photographs, the 360-view is similar to the Google StreetView experience because they are both recorded with egocentric perspectives.

The interactive prototype that is designed is a digital park-planning tool. The intended users and designers require that the tool be accessible in the forest to upload pictures and videos to the map, which is possible by developing with web mapping techniques.

Web mapping is an increasingly popular method of presenting interactive spatial content on the Internet. The main difference between interactive digital mapping and traditional mapping, besides the obvious difference in terms of accessibility and technology, is the content. Either traditional or digital, the goal of every map can be different. Designers must think of issues of usability and user experience, by creating a tool that works with human-computer interaction.

Digital maps that use location-based services helps users to get somewhere quickly and the digital map is being measured with a usability criterion of efficiency and effectiveness. However, satisfaction can also help as a usability element by using user

interface elements. For example, when the goal of the user to find the icon, the icon should be how user would describe the icon to himself or herself.

3.4.1 MapBox Capabilities

MapBox Studio

MapBox is a map design tool that allowed the creation of interactive digital map for Boucher Forest. MapBox Studio lets you brows through examples and modify map styles, and add other visual elements such as; landmarks, lines, areas, fonts, and icons. Mapbox studio has capability of importing vector tiles from other design tools such as Adobe Illustrator. The Scalable Vector Graphics (SVG) format between vector files allows creating interaction with the vector tiles that are named conventionally named. Mapbox allows to change the presentation of the digital map. MapBox allows designers to create custom maps by playing with map elements' appearance to increase the usability of interactive digital maps.

MapBox GL JS

Mapbox can be integrated into web pages using HTML, CSS and Javascript, which made possible the creation of an interaction on top of a customized map. MapBox maps can be integrated into HTML to create interactive maps and using custom interaction. One of the advantage of online maps that they can be accessed on web browsers that also supported by mobile phones.

An interactive digital map was developed with MapBox GL JS by following open source examples and tutorials. First I read MapBox (2016)'s tutorial that showed how to create interactive digital map with a capability of showing Trekker Icon's position and movement. His open source code allowed the marker's position is synchronized with video's time.

Finally I followed an Denelius (2016)'s tutorial and used his modifications to the precedent MapBox opensource code, where he added functionality of dragging and rotating of an icon on a digital map. I integrated the digital map of Boucher Forest that was created with MapBox studio. During the creation process of the park-planning tool, a prototype was created and was iteratively changed along the study project.

The map is running on an external server and was accessed using HTTP protocol using computers.

Panellum

Panellum is a plug-in with capabilities of displaying 360-photos and 360-videos as in equirectangular, partial, cubic, and multi-resolution panoramas. Panellum also has WebGL and CSS 3D based renderers that can use hot spots for interactive tours and compass headings. 360-video is a spherical video format where a view of every direction is viewable in the same time. It is currently in daily use for a wide variety of topics. A 360-video player was produced completing three production steps: a 360-camera recording the trails, a GPS logger recording the trails and integrating Panellum plug-in as an HTML5 video player that also has the ability to play 360-videos. I added

the functionality of the 360-video by using the plug-in Panellum to the park-planning tool.

Recording of 360-video

By recording the trails on a video by trekking the trails in the forest, allowed to explore the same video with the same context of trekking on a trail. This will add to the realistic value of virtually created environments which can get compared to the real world experience. Google uses Trekker technology which is a 360-angle camera that has 15 lenses and 22kgs. This is heavy to carry around when you are recording trails. The production of 360-photography for Google Streetview is a long production time, because the 360-angle views created by stitching millions of photographs together.

A 360 video can be recorded using an omnidirectional camera. The camera is very small and lightweight. During playback, the viewer has control of the viewing direction by dragging the 360-video. The 360-video that was produced while recording the trails in the Boucher Forest was produced with a Safari 360 camera that was mounted on a selfie stick. The trails were recorded by a volunteer also carried a tablet on his other hand that helped him to preview what is being recorded. The Safari 360 camera has dual 220 degree lenses and creates a 360-video by attaching these over lapping video files. The video can be recorded at a frame rate of 30 fps. The *Safari 360* can record audio. The battery life allowed recording around 30 minutes of continuous trekking.

FIGURE 3.2: Safari 360-video camera with two ultra-wide lenses

Recording of trails

With the help of volunteers willing to create an interactive map for the forest, all of these trails were recorded via GPS loggers and the data was integrated as different layers into the interactive prototype. Global positioning system (GPS) devices are commonly used for surveying trails. GPS data and map inventory data allow to find problems effectively. GPS data collection is vectoral lightweight data that can be easily collected. GPS data as gollected as Keyhole Markup Language (KML) and converted to Extensible Markup Language (XML). I added the XML data as an array to draw the trail on the map and the panoramic video plugin. I will explain how they can work together.

3.4.2 Description of the prototype

The designed prototype is an interactive map tool that helps to explore the forest from the perspective of a first person who is trekking on the trails of Boucher Forest.

Interactive digital maps are designed by different people for different purposes. Every map is designed depending its own goal or use case for its target audience. Custom maps can be easily created using online maps. Web mapping is an online process of interactive mapping that is combining geographic information systems and other geographic data to be on one map project. On the map, there are three layers: blue areas are the wetlands, a yellow line for informal and a red line for formal trails, borders and land ownership of the forest. With visitor's collaboration all the trails that exist in the forest are being recorded as street-view videos. At the moment, there is only one alternate trail and the corresponding trail video.

To view the prototype, a 360-video is needed, along with a MapBox account to obtain an access token, web space to load content that can use JavaScript, a computer that runs Java and an HTML editing application. Mapbox Studio works online it can be reached from www.mapbox.com site.

The three assets of the interactive map vector data and streaming video, allow to connect time and distance with a linear connection checking every second of the video when displaying time-codes on the trail map.

The map uses an aerial view of the Boucher Forest in Gatineau as a background. There are also other layers on the map such as the wetlands, the land ownership and the trails, in order to provide more information on the environment. The map interacts by

allowing the user to toggle on and off these layers and by dragging the Trekker icon to rewind/forward video preview. The 360-video preview is recorded at the geo-location can be selected by clicking on the trail. This will allow the user to match the real world preview with the existing trails.

To display the park's planning tool effectively, HTML rendering capabilities were used and with the integration MapBox Studio capabilities were used to change the maps characteristics, including the color of a geographical layers and elements; trails, wetlands, trees, land ownerships . The designer chose the theme with an expectation of visitors knowing certain standards to use maps and they can dedicate colors to unique elements.

A custom interactive digital map was developed with complete three production steps: Trails were recorded with a GPS logger, and custom map was created for the park with Mapbox GL JS (an open source JavaScript library) and the interactive trail that allows to replay the 360-video.

The main functionality of the tool is viewing 360-playbacks of the trails. Planners can use the tool for planning parks and they can get use of larger screens, while, on the other hand, visitors can be trekking on the trail and navigating using this tool in the same time.

User Interface Elements

During the implementation phase, all of the alternate trails were logged with GPS and the one of the trails were recorded with using a Safari 360 camera recorder. The 360-video was implemented and the interaction with the interactive map is functioning.

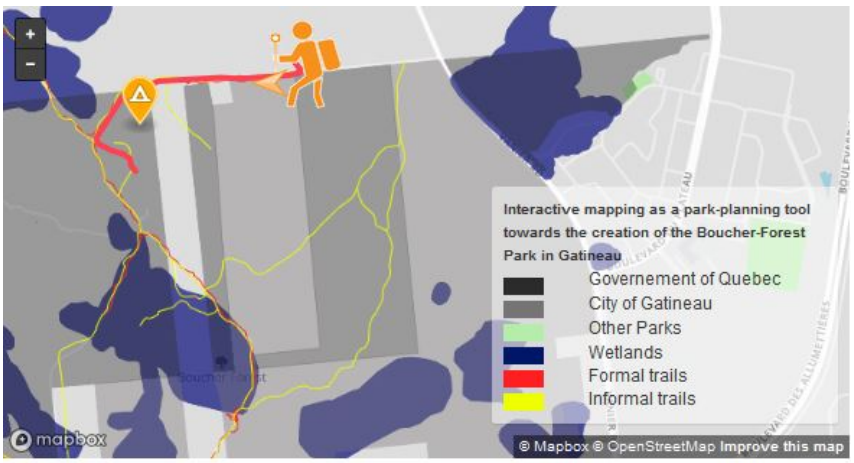

FIGURE 3.3: User interface of the map

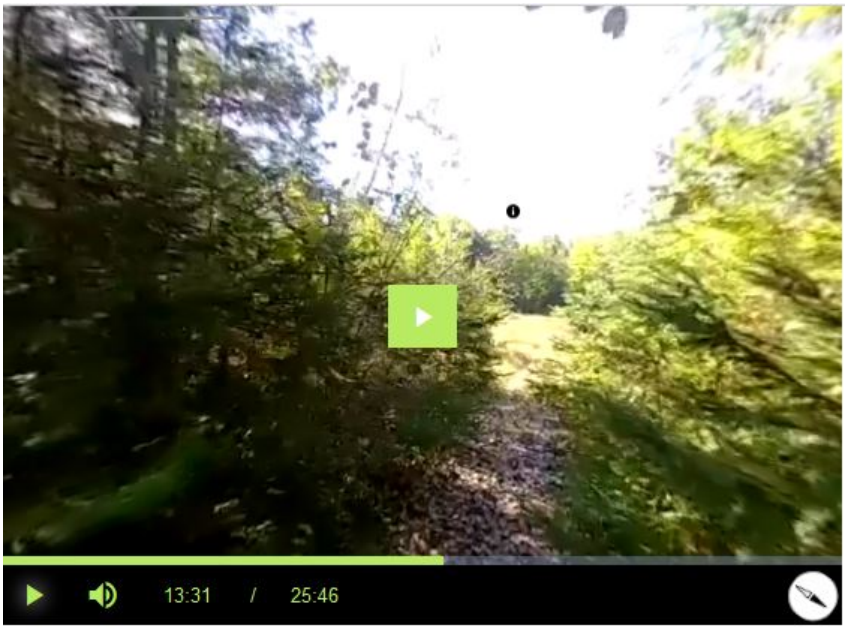

FIGURE 3.4: User interface of the video

Thus, the park-planning tool is combined of two panels:

The 360-video window plays the recorded trail in the Boucher-Forest following the trail and by dragging the marker on the mini-map. 360-video has a recorded audio track user can mute the volume and control volume. Users can use audio feedback to explore in the forest. The 360-video capabilities allow the user to the viewing the from desired angles when the 360-video is playing. Users can mark information on the map to share their findings and put a hotspot on the video that also displays on the interactive digital map.

Interactive Digital Map UI: (See figure 3.3)

- Satellite view: A button was placed on the top-left to give the user an option to switch map style. This button changes the map's background layer from the designed MapBox style to OpenStreet satellite imagery map.
- Labels: Map elements and colors are identified with labels. The user may be familiar with the forest but may not know the design of the digital map,
- Interactive Trail: The interactive trail is selectable and interacts with playing the corresponding time of the 360-video.

360-video UI (See figure 3.4)

- Play/Pause: Interactive digital map allows seeing the geo-location of the trekker while the video is playing continuously, user can pause the video with a button.
- Volume: allows to mute, increase and decrease the volume.

- Timecode screen: displays the time of the video; the total time and the time elapsed.
- Digital compass: using the digital compass on the video screen users can follow cardinal directions.
- Hotspots: allow to mark the video on x and y axis.
- Full Screen button: toggles the video between full screen and small screen.

The interface of the interactive prototype combines two interactive elements in one layout. The interactive digital map panel is displayed on the right side. The 360-video of the trail is showed on the left side, as shown in 3.5. To explore the trails in the forest, users can interact with the the map to view the 360-video. To change the viewing angles of the 360-video directions that can be used are; up, down, left, right. The user also can change the viewing angles with the mouse by dragging the 360-video to change the viewing angle.

Interaction techniques

Exploring the forest: The park-planning tool allows interaction when the user is exploring the forest with 360-videos of trails. The user interacts with the trail-video on the map in two ways;

- Dragging the Trekker icon: The users' interaction happen when dragging and dropping the Trekker icon on the trail. When the user drags the Trekker icon to a further geographical location on the trail, the video will play at the corresponding

FIGURE 3.5: User selects the satellite view.

FIGURE 3.6: User selects Trail 1 as a start point.

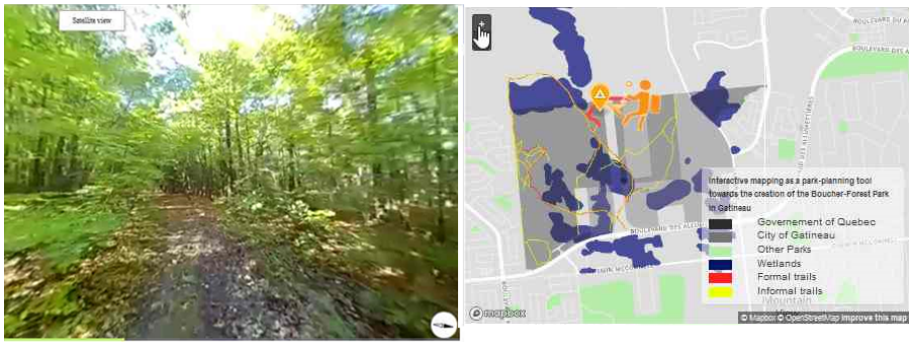

FIGURE 3.7: User zooms on the map by clicking the zoom in button.

FIGURE 3.8: User drags the trekker icon close to the camping icon

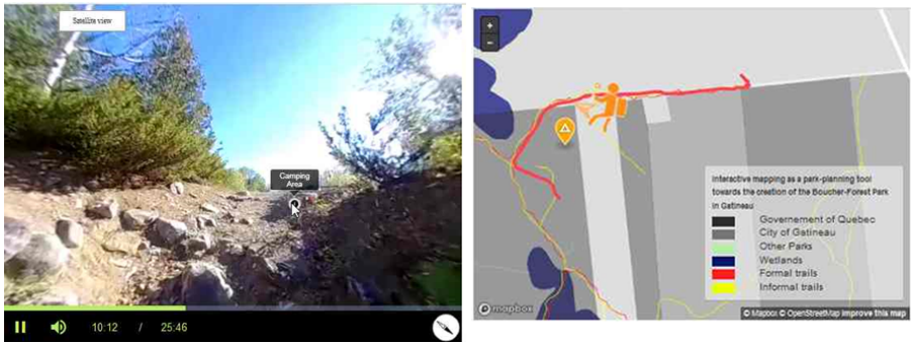

FIGURE 3.9: User is dragging and viewing the 360-video at the direction of camping area.

FIGURE 3.10: User can pause and view the 360-video to find a good spot camping.

geographical location. The Trekker icon and the trail is also linked to the scroll bar on the video player's timeline.

- Video player's timeline: Video timeline is linked with the Trekker icon's position on the trail. Two choices for this interaction were given on the user interface; the 360-video player controls or by dropping the Trekker icon on the map. Users can control also control the 360-video with the video player's timeline.
- Adding/removing markers: Users can register their finding by putting new markers on the map corresponding the time on the 360-video.
- Zoom in/out: Zooming is a technique that allows the user to view a grand format on a small space.
- Panning: Panning is used for scrolling larger areas. By using one complete scroll, either vertical or horizontal slider only, a user has reference to the portion of the content in relation to the total content of the page.

Viewing the 360-video: This is not an interaction but the main functionality of 360-video to view every direction in the same time. Dragging the 360-video with the mouse or the keyboard will allow viewing other angles in the 360-video.

Dragging the marker on the map forwards/rewinds the video to the relative second when and where it has been recorded. The marker was designed as a Trekker symbol (See figure 3.11) This allows the user to get a panoramic video of the trail at that exact geo-location. The interactive digital map created is centered at the geo-location of Boucher Forest (See figure 3.3). The required action to seek the 360-video is to drag the Trekker icon using the interactive digital map or dropping the Trekker icon back on the

FIGURE 3.11: Trekker icon

trail. Alternatively, user could replay the 360-video using the video player's progress timeline bar. Technically, this tool is similar to Google's StreetView, with the exception that Google is using photographs that were processed to create 360-field views, and the park planning tool is an interactive digital map which works with video files.

Custom maps can be designed but with user's feedback, for example limiting the interaction of functionality, removing/adding navigation buttons on the prototype can make the content more available and appealing. The computer knowledge of users and how well we the user knows using digital maps and using 360-videos can help exploring a familiar place.

3.4.3 Design challenges

- The user sees the map but might not be efficient to identify the problem by just looking at the map and its layers: The user needs to find a geo-location related problem along the trail, for which visual auditory feedback is effective. The preview can use less space than the map and it should be sufficiently good for identifying the trail. A path should be identified altogether with the trail video.
- The user is looking for an geo-location and marks it on the map with a point: The user can access the forest map from his computer to consult the information

that is made available. The video preview can be an efficient tool, as it allows to interact instantly with the map in order to see how an exact geo-location in the forest looks in the real-world.

- The user wants to use the tool efficiently when completing tasks but he or she can make errors: The user might want to preview other areas in the forest that are not recorded in the video: constrains the user by locking the marker along the trail path on the interactive digital map.
- The User Interface elements were too small for a standard HTML video player tag to use with mouse interaction: The timeline progress bar and video control buttons (Play, Pause and Video Time feature) were scaled twice as bigger.

For all the issues listed aboved, the researcher made the appropriate design changes and designed the park-planning tool again by following an iterative design process. An iterative design process helped design choices of the park-planning tool's design, and the interactivity depending on the comments and choices of participants.

Chapter 4

Methodology

This section presents the methodology that was used in planning the user study.

4.1 A Review of Usability Evaluation Methods

A user study was needed to determine if the interactive digital map with a 360-video functionality could be a useful park-planning tool. To address this issue, the commonly used methodologies in user studies were analyzed. There are three typical measurement methods that can be applied with the collaboration of users and evaluators: Think Aloud (TA), Heuristic Evaluation (HA) and Cognitive Walkthrough (CW). TA is the a method used with users in laboratory environment, HE is used by specialists to identify the obvious and specific usability problems and CW helps understand the user's and designer's conceptualization of a task.

When a user experience specialist conducts a user study, his or her approach is to identify the problems when the users are testing the prototype. A usability evaluation performance that is measured by the estimate of discovery rate is widely used as a measurement rate. (Virzi, 1992) Nielsen and Molich (1990) reported that, at the early stages of a user study, the optimal number of evaluators is five, as five evaluators found the 67 percent of the usability problems. Virzi (1992) and Nielsen (1994)'s conclusion was a sample size of 4+1 can find out 80 percent of the usability problems.

(Caulton, 2001) questioned that Nielsen (1994)'s "magic number" *4+1*, stating that it can only be true if all participants have the same probability of getting all usability problems. This is also known as homogeneity assumption.

Hwang and Salvendy (2010) analyzed fifteen years of usability data and have found that the sample size 10 ±2 was more likely to success with an 80 percent discovery rate. Hwang and Salvendy (2010) suggested that mixing of research methods or adding individual research method will perform an even better discovery rate. Thematic Analysis and Think Aloud protocols were chosen among all the usability test methodologies that were studied while preparing the phase of the project.

4.1.1 Think Aloud Protocol

The Think Aloud method is a verbal protocol to understand the user's thoughts when asked to solve the user study tasks. Hollingsed and Novick (2007) suggested that the think-aloud method can identify almost all of the problems within a user study. They examined 65 user studies and concluded that 60 percent of the errors using a dialogue approach. By using the verbal protocol, they could identify usability problems in all severity levels. Furthermore, concurrent Think Aloud protocols may change how the users react because they are asked questions. (McDonald, Edwards, and Zhao, 2012)

During a think-aloud user study, the participants are asked to comment aloud on what they are doing and the results that they achieve. The validity of protocol analysis rests on the assumption that if 7 plus or minus items are found from a participant's Short Term Memory (STM) during a solution of a problem, it is a significant amount about their problem solving process. (Miller, 1956)

Kuusela and Pallab (2000) defined Concurrent Think Aloud approach (CTA) as observing the participant and while asking them speak loud all their thoughts and arguments aloud verbally while they are solving tasks and making decisions.

McDonald and Petrie (2013) found that ETA was more efficient while finding problems but it did not affect task success or time on task. Gerjets, Kammerer, and Werner (2011) found that ETA found a better quality of qualitative results when users following the Think Aloud protocol.

I used Explicit Think Aloud within this study, giving the participants the following explicit instruction: "I would like you to think aloud. I would like you to tell me the things that you like the things that you dislike or find confusing about the park-planning tool."

When analyzing the results of the user study, using a think-aloud protocol, Thematic Analysis can be used for analyzing qualitative results. A researcher can start searching for themes when he or she is transcribing the recorded audio to verbal data. (Braun and Clarke, 2006) It is a flexible approach and it allows the researcher to understand the data during the research and to group the findings in order to draw conclusions. It is used for transforming qualitative data into meaningful patterns, classifying results and users' comments of a user study. (Boyatzis, 1998)

The Thematic Data Analysis method consists of six phases; Transcribing the verbal data from the Think Aloud, adding the open-ended question answers to the qualitative data, find the most repeated terms in the qualitative data, edit and group the qualitative data under these titles, review and produce a report.

System Usability Scale [SUS] analysis methodology

SUS is a universal scale that is used to measure a system's usability to be able to compare with other system's effectiveness, efficiency and learnability. But it isn't one-size-fits-all and sometimes need to be changed. In the SUS questionnaire the questions 1,2,3,5,6,7,8,9 were used to scale usability, since they are questions related to easy of use of the tool. The answers to questions 4 and 10 were used to evaluate learnability. When we were analyzing the Likert Scale scores, the numeric values of the results of even numbered questions in the questionnaire were reversed and then changed from a 1-5 scale to a normalized 1-4 scale, as a result an average score of percentages were calculated. (See figure 5.1)

This standard SUS test asks the odd numbered questions in the SUS questionnaire are asked in a negative tone and asks the even numbered questions are asked in a positive tone. In our version we used the standard version of the negative and positive order although we changed the questions to have a clearer meaning for the use of an interactive digital map and a 360-video together as a park-planning tool. (See Table 4.1 to see the questions of the SUS test)

4.2 Data collection method

This section describes a test plan for conducting empirical research about the interactive map's use with a park-planning objective. User study is a critical step in the overall user experience design. The general approach is to divide the usability evaluation and the testing techniques into two major categories: Empirical Testing, a user

study method that requires the direct involvement of users by observing them. Think Aloud testing allows the examiner to observe the participant with a recorded media that was taken during the test.

The usability test conducted within this study used two different methods to get qualitative results. A usability test with a Think Aloud protocol was ran it was analyzed with Thematic Analysis.

The empirical data collection was run with participants using the park-planning tool during a 45 minutes usability study. This study collected new information by observing and recording the participant's interaction with a digital map interface. The user study gathered data by observing participants by following Explicit Think Aloud protocol, followed by a questionnaire and semi-structured interview. Users were also timed with of the duration of the tasks they have completed.

4.2.1 Qualitative data collection

A semi-structured interview was run during this study in order to gather qualitative results regarding the usability of the tool and its other multimedia components. The interview(Appendix G) is an open-ended questionnaire to find out severe problems of the park-planning tool.

4.2.2 Quantitative data collection

Within the usability study, the participants were asked to accomplish four different tasks to answer pre-test and post-test questionnaires. These tasks are designed to measure the efficiency of the interactive-map and the 360-video as a park-planning tool. The quantitative data collection is the time that participants take to complete usability tasks. We also asked participants to fill in SUS questionnaires to measure effectiveness, efficiency and learnability.

4.3 Usability objectives and measurements

The researcher created questions based on the System Usability Scale (SUS) and followed a Thematic Analysis method to analyze the findings following the participants' interaction with the map. Participants' on-screen actions and all the spoken audio was coded and interpreted into quantitative and qualitative data.

4.3.1 Test objectives

The usability test evaluated three usability criterion: learnability, efficiency, and effectiveness. A questionnaire was created based on the System Usability Scale, a test that measures the ease of use and learnability of the park-planning tool. (See table 4.1) With the User Centered Design process, the focus was to analyze the concerns of primary users. The results are analyzed in the next chapter; using statistics of the usability testing.

Timing users solving tasks The methodology that for the usability test and scenario is driven by a Task Analysis followed by structured Thematic Analysis design. Complementary techniques were thought by van der Veer and van Welie (2000) to create tasks:

- Define a clear process,
- Define the models and representations including semantics,
- Support the methods and models with tools .

The tasks test the prototype usage and measure efficiency. A usability test scenario for timing users on tasks was designed (Appendix C) to obtain quantitative and qualitative results of an empirical research. The tasks are defined as follows:

Task 1 This task intends to make the user familiar with the environment and the computer while completing a exploration of the park-planning tool's user interface and viewing the 360-video. This task aims to understand the effect of initial learnability of following a trail on a forest map. Researcher asked the participants to take a screenshot when they though it it interesting. Success was measured by whether the participant was able to take a screenshot.

Task 2 The participant is asked follow a scenario and access a specific location on the forest map, entering information about the trail. There are four sub-tasks included Task 2; these are **2A, 2B, 2C, 2D**. (See Appendix C) Success is measured by the ability of the participant to entering the information. Efficiency was measured by measuring the time taken by a user to complete the task. Users were timed when using the interactive

map and completing a task. Success was measured by whether the participant was able to answer the question with the right information. The qualitative findings of this task can help the park organizer to analyze visitors' behaviours and motives.

Task 3 The third task intended to discover the visitor's classifications. (e.g., if the location is ok for camping) This task was was aimed at discovering the reasons how the visitor's find a camping spot with the help of icons and landmarks placed on the digital map. Success was measured by whether the participant was able to find his or her ideal camping location. One of the goals was to verify it they would be tempted to find other alternative spots for camping. These answers can enlighten the forest's uses and user can label them on the map. (e.g. Access to facilities, looking for short-cut, exploring, etc.)

4.4 Usability Testing

The following phases of the usability testing are developed in this section: planning, setup and execution.

4.4.1 Study Goal and Benefits

The purpose of this test was to detect the most severe usability problems, by using the right sample size of participants. In the previous chapter, it is explained that the right sample size for a mixed method is 10 ±2 (Hwang and Salvendy, 2010), and the

researcher started the research with a the usability testing with recruiting at least 10 participants.

The outcome of the usability research is to identify the user interface's usability issues with the final objective of proving its effectiveness, efficiency and learnability. The feedback given by the participants led the researcher to make design changes throughout the user testing phase, by using the park-planners and visitors ideas and comments. Another benefit is to know if the interactive mapping can contribute to identifying problems in the forest park using a 360-video.

4.4.2 Running the Usability Test

Tools

The test took place in the office of the Boucher Forest Foundation. The participant used the park-planning tool on an internet browser launched on a notebook computer. He or she used the interactive digital map operating with a keyboard and a mouse. The participants were observed while following the explicit Think Aloud protocol using the interactive map park-planning tool. The Active Listening questions were also asked.

Test Schedule

- 0-5 minutes: Consent Form
- 5-10 minutes: Demographics survey
- 10-30 minutes: Performance on 5 tasks
- 30-40 minutes: Post-test questionnaire

- 40-50 minutes: Post-test survey

4.4.3 Setting

The prototype used in this study was displayed on a computer screen. (See 4.1 & 4.2) Participants were tested using a computer, a microphone and a speaker. Researcher recorded participants' on-screen interactions with the interactive map's user interface and mouse cursor pointing on the user interface. The researcher recorded the audio when the participants were solving the tasks.

Screen recording

The sessions were recorded to capture the users' interaction with the screen and their audio was recorded to be transcribed for qualitative analysis.

The process

The researcher asked the participant to read the briefing on paper (Appendix A). The researcher asked the participant to review and sign a consent form and then to fill out out a demographics questionnaire on paper (Appendix B) After the participant had an understanding of the main purpose of the digital map tool, the researcher provided the scenario script on paper (Appendix C). The participants started using the prototype on the internet browser of a notebook computer. Participants were asked to solve

FIGURE 4.1: The study took place in a private and convenient office setting

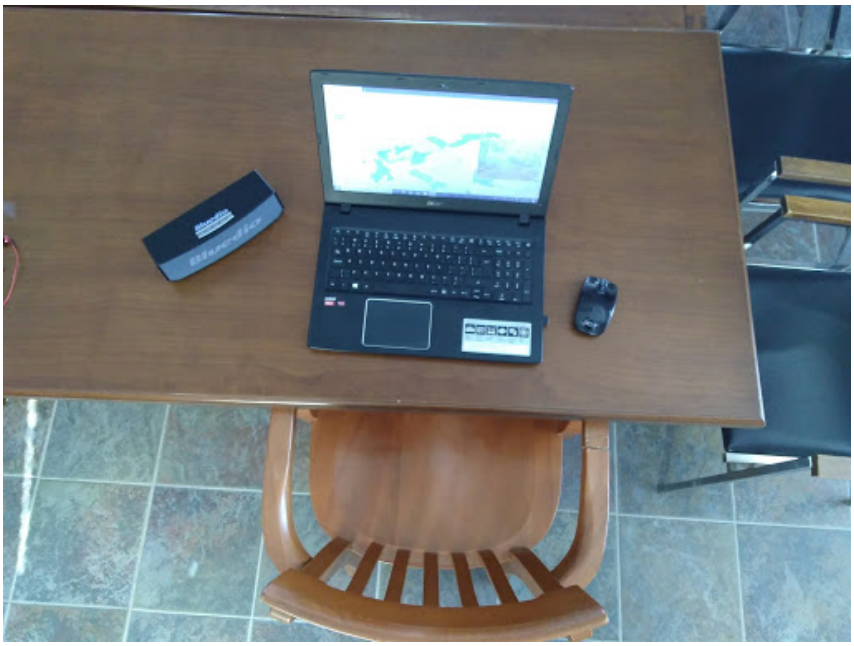

FIGURE 4.2: Computer system: A notebook computer, a wireless mouse and a speaker/microphone

the tasks. The researcher observed the interaction between the participant and the interactive digital map and took notes of the user interacting with the tool by using the Explicit Think Aloud(ETA) protocol.

In order to understand the user learn of use an ease of use better, the participants were asked if they have used digital maps or if they have experience with planning parks before, to aid the researcher understanding the effects of the user interface better. During the test, the researcher asked the Active Listening questions to the participants when they were completing the tasks.

At the end of the usability test, the researcher asked the participants to fill out questionnaires that included Likert scales (Appendix E,D,F) and a semi-structured interview (Appendix G) was conducted to determine if an interactive map was helpful in taking decisions for park-planning in relation to existing trails in the Boucher Forest. These questionnaires provided the researcher as quantitative and qualitative findings and statistical data that was collected from participants' insights.

TABLE 4.1: System Usability Scale [SUS] Questionnaire

Question #	Original question	Custom question
1	I think that I would like to use this system frequently.	I would like to use the interactive digital map with 360-view more frequently
2	I found the system unnecessarily complex	There was too much information on the map
3	I found it easy to use the interactive digital map with 360-video capability	I found it difficult to use the interactive digital map with 360-video capability
4	I think that I would need the support of a technical person to be able to use this system.	When I was using the park-planning tool I might have got stuck without help being provided
5	I found the various functions in this system were well integrated.	The 360-video and the interactive map working together helped me solving the tasks about the trail
6	I thought there was too much inconsistency in this system.	The user interface was confusing and it was hard to find the information
7	I would imagine that most people would learn to use this system very quickly	I think the interactive map can be learned quickly
8	I found the system very cumbersome to use	It was complicated to use the video and the interactive map together
9	I felt very confident using the system.	I am confident to use the interactive digital map for another time
10	I needed to learn a lot of things before I could get going with this system.	I need to learn a lot of things before you start using the park-planning tool

Chapter 5

Usability Testing Results and Discussion

The previous chapter discussed the planning and implementation phases of the usability test. This section presents the empirical research results of the usability test and the outcomes of the overall user study.

5.1 Results

The first section of this chapter presents the participants who took part in this research. It beings with a descriptive of the participants.

The participants were asked to fill pre-test forms to obtain the demographic information cited above. Participants ranked their familiarity and usage of digital maps technology, computer games and camping by using Likert scales from 1-5.

The second section is the qualitative results were that were analyzed with a Thematic Analysis approach which was used to present the observations elicited from the participants' comments and answers to open-ended questions (Appendix G).

The last section, quantitative results is giving the results of the usability testing. There results includes following two results; a System Usability Measurement (SUS) based test in Likert Scale (1-4) and Time on Task in seconds.

TABLE 5.1: Likert scale: Pre-test screening results

Variables	N	Mean	Std. Deviation
Age	12	37.5	10.0
Plays computer games	12	2.7	0.7
Uses digital maps	12	3.6	1.1
Familiarity with Boucher Forest	12	3	1.5
Knowledgeable about Camping	12	2.7	1.1

5.1.1 Descriptive of the participants

This section shows the statistics of the data that was collected was collected by asking them to fill in a demographics survey (Appendix A). 13 participants were in contact with the researcher but only 12 of them participated in the study. 12 of them completed the demographics survey. Participants were recruited through an online posting and through an e-mail sent to the Forest Boucher Foundation's Board members. Participation was voluntary and there was no compensation offered to the participant. Only Gatineau residents were recruited.

The participants' ages ranged between 21 and 65, the mean age being 37.5 (std. dev. 38.4). On a gender perspective, 6 of the participants were female. (See 5.1 for the results of demographic survey)

12 participants proved to have an expertise level of an average of 3.58/5 Likert Scale (1-5) for understanding and using digital maps. 7 of them used digital maps at least one a week, 72% of them used digital maps once a month. Participants who used digital maps once a week were names as mappers, who used digital maps less then once a week were named non-mappers.

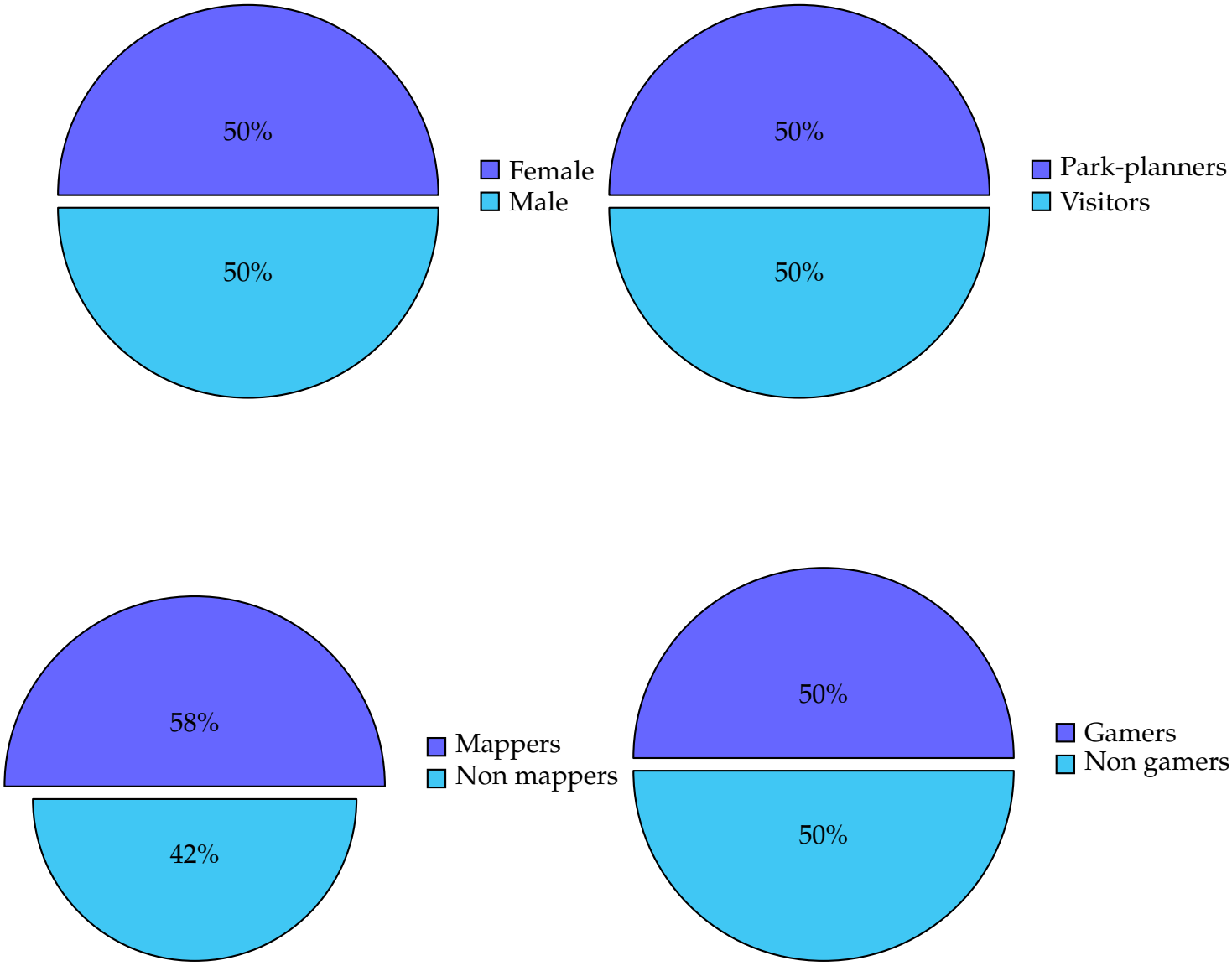

FIGURE 5.1: Pie chart presentations of demographics

6 of these participants took roles as a specialist to plan parks and forests, 6 of the participants have visited Boucher Forest twice in the last year.(See 5.1) javascript:void(0); Half of the participants played computer games regularly half of them haven't played computer games a couple of times their life. The other 6 participants played computer games regularly before and they have played three-dimensional games with egocentric view angles at least once in their life. Participants who had experience with playing computer games regularly were grouped as gamers, and the people who haven tplayed computer games regularly before were grouped as non-gamers.

7 participants had previously camped in a forest at least twice previously, although this was not a requirement to be a participant in this study. Since these participants had a better idea about camping settings, they were called campers and the other 5 participants who have camped less then twice were called non-campers.

All participants reported having visited the Boucher Forest at least once in the pre-test questionnaire (Appendix B). Except one of the participants, all of the participants were familiar with the use of digital maps and were using them at least once a week.

The primary users were the people involved in planning the Boucher-Forest Park and everyone interested in visiting the Boucher Forest. It was also a requirement for the participants to speak English fluently and to be aged above eighteen.

From the 12 participants lived in the Gatineau area, 6 of them have visited Boucher Forest more than once a year. The 6 participants who had visited the Boucher Forest less then once this year declared having little knowledge about the trails in the Boucher Forest but were familiar with Gatineau area therefor they knew where exactly Boucher Forest covers on the map.

5.1.2 Qualitative results

The goal was to collect qualitative feedback about the park-planning tool and find potential user interface problems when the user was testing it's user interface.

Thematic Analysis

The main idea of this research is that what viewers are imagining or thinking when they were using the interactive digital map with the trekker icon, dragging it on the trail to view the 360-video that was shot from an egocentric view angle. A Thematic Analysis was created using an analysis of two qualitative methods: Think Aloud method and the answers to a semi-structured interview. It was used to present the observations elicited from the participants' verbal comments and written answers. As a result of Thematic Analysis, eight themes were obtained that was emerged from the comments and interviews of the participants. Moreover, we received substantial feedback from the participants in the study regarding the semi-structured interviews that had open-ended questions.

Users expressed their feelings and thoughts when they were performing the usability tasks.

Theme 1 : Being there

Half of the participants described their experience with the wording "being there". One participant declared having a "real feeling of walking in the forest, it increases satisfaction. It felt different I was there and walking". Another participant said that the

360-video gave an experience similar to a walker's experience in the forest: "I felt like I was actuallythere,the sound of the walking steps in the 360-video felt real, I felt that it was me who was walking". Another participant declared "Oh yeah I know this place I have been there". A participant talked with his familiarity about Boucher Forest in these words: "I have been in the forest many times, I know the forest so my perception of familiarity even increases more".

Theme 2 : Exploration

Half of the participants were exploring to find new things in the forest when solving the tasks. A participant said : "I would watch just video to get to know the park". Another said: "Wow a fountain! Who knows what's in there." Another participant mentioned that it was enjoyable just to watch the video and commented: "It is nice that there is a trail that you can follow". A participant continuously used the interactive digital map and kept dragging the Trekker icon to explore the forest and asked: "Can I drop the Trekker Icon anywhere inside the forest?". Another participant mentioned the forest borders and said: "The trail follows the fences all way along narrow path makes you to want explore more". One participant took longer time to solve task 1 and mentioned enjoying the exploration of the forest in those words: "I got a sense of the attractiveness in the forest, it increases my interest".

Theme 3 : Preparing

One third of the participants mentioned the park-planning tool's usefulness for preparing a visit to the Boucher Forest. Some participants mentioned the park-planning tool's

importance when deciding what to bring for a visit, by knowing the geography of the forest. A participant spotted poison ivy when solving task 2 and said: "I can prepare at home and bring boots for my visit to the forest". A participant mentioned that a measuring tool would increase the park-planning tool's effectiveness and said: "For hiker or mountain biker, elevation is important". Another mentioned the length of the trails would be good and commented: "If you are going there for exercise, this map would be useful." Another participant declared: "It would be nice to have information about each trail as information such as if its good for one hour walk, has a picnic table on the route, etc.". One participant said : "This tool is nice to check before and then you can go and discover".

Theme 4 Planning

All of the participants thought that the prototype has a good functionality as a park planning tool. One participant mentioned that the 360-video would help to know the tree types and articulated that this was especially important to identify the potential animal habitat. The same participant commented: "There are deers in forest that want to hide using the shades of trees, I noticed some trails had shade, some did not. Trees create green walls each side of the trail". Another participant said: "It would be good for restriction of dogs, then people would know where to stop them". One participant said: "For planning better parks, we need more of these trail videos recorded". Another participant said: "When I saw a dog, it raised my attention that I should be careful about unleashed dogs in certain areas". A participant commented that an informal

trail should be a formal trail and said: "People can get lost without signs. The path needs signs".

Theme 5 : Angle of View

25% of the participants criticized their angle of views, such as the zoom level of the digital map, the same participants mentioned the zoom levels while they were using the interactive digital map, and some of participants had their concerns related to the egocentric view angles of the 360- video. One participant complained about the shaking happened while recording the video. Another participant talked about the the shake of the recording and said: " The shaking makes me feel that I am walking step by step" and the same participant said: "This is very close to real world experience". However none of the participants complained about the shaking of the camera was a problem related to see the problems along the trail when they were viewing the 360-video.

Theme 6 : User Interface

67% of the participants gave feedback about the usability of the user interface. One participant asked about the controls: "How do I drag the Trekker Icon?". Another participant suggested adding additional controls to the video, especially if it was related to a linear video. The same participant commented: "Arrows on the video to show directions would be handy especially". Another participant said: "Labels on the map are not necessary". One participant asked: "Am I dropping the Trekker icon exactly on a the camping icon?".

Theme 7: Directions

One third of the participants had comments regarding minor and major concerns for finding directions by using the park-planning tool. One participant got overwhelmed with changing viewing angles of the 360-video and said: "The video should always face front unless if you are clicking". One participant declared that the map helps for finding directions and said: "The icon helps for first user to find the camping spots". Another participant said: "It is close to my house, I think I can access the forest from here. I can see where to access". One participant said: "To have both timelines is good, at least to have feedback of location". Another participant commented finding a location on the interactive digital map when viewing the 360-video by saying: "The interactive digital map is good because you want to know where you are in the Forest".

Theme 8: Entertainment

50 % of the participants mentioned the fun factor when using the park-planning tool. One participant said he really found it entertaining and especially liked the audio and the 360-video. The same participant said: "I wanted to find out more about the narrative elements in the video". Another participant mentioned the entertaining aspect of the map by saying: "I felt I was in a computer game world." One participant said "The map is entertaining because of the use of multimedia layers".

5.1.3 Quantitative Results

Two methods were used to collect quantitative data during the study: The first method was Likert Scale questions to calculate a usability measurement scale was used to evaluate the learnability of the prototype.

The second method was the time taken by participants to complete the tasks during the usability test. To analyze the quantitative results of the usability testing the measurement scale was revised from the universal System Usability Scale (SUS) measurement system.(see Table 4.1)

Since the number of participants was only 12, the difference between groups is not statistically tested with parametric or non-parametric tests when comparing users the efficiency and effectiveness with the park-planning tool. If the number of participants were a bigger number then 20 participants then a statistical analysis would be reasonable.

System Usability Scale Score

TABLE 5.2: Scores based on System Usability Scale(SUS) scores in percentages

	Overall	Usability	Learnability
Avg	73.3%	75%	66.6%

The average score of usability and learnability is based on the universal System Usability Scale (SUS). All the participants of the study were first-time users of the park-planning tool. When the average SUS scores were calculated, using the Likert system, the compilation of the 10 questions, on a scale from 0 to 4, usability scores gave a

global average score of 2.9 out of 4. The questions 4 and 10 were asked to learn if the park-planning tool is easy to learn and the average score on Likert Scale was 2.6 out of 4. When the results were normalized using the SUS score, the average score of learnability was 66% (see 5.2) and 5.2 for results). The questions that were asked to scale usability had a Likert Scale score 3 out of 4. The average score based on SUS for the the planning-tool's usability was 75%. Learnability was scaled with an average scores of 12 participants. (see 5.2) The results showed that an interactive digital map including a 360-video functionality had an average System Usability Scale(SUS) score of 73.3% as an average of easy of use and learnability of the park-planning tool.

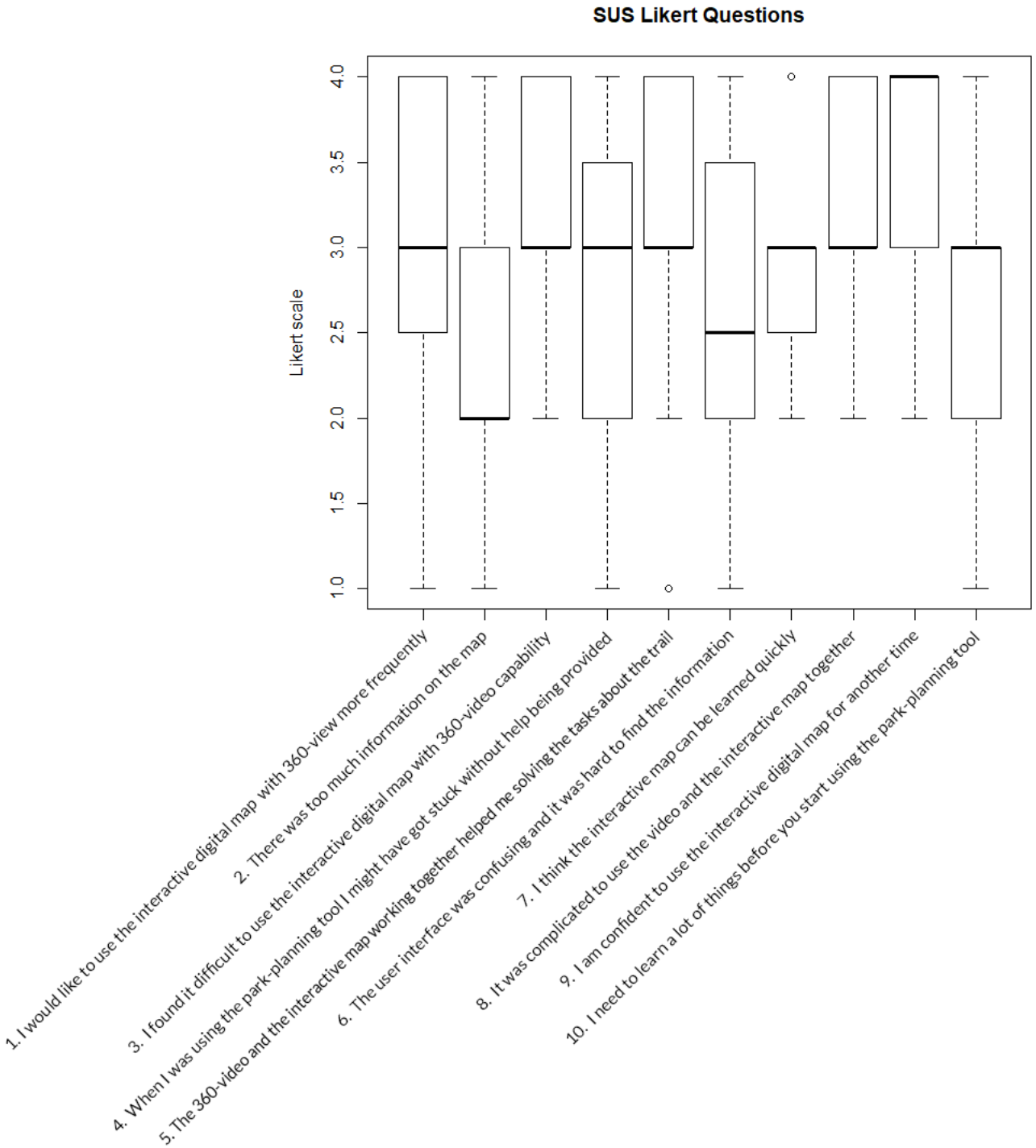

FIGURE 5.2: System Usability Scale [SUS] questionnaire boxplot

Time on Task results

There were six tasks that were given to the participants were timed. Only five of these tasks were used statistically. Task 1 was only used to allow the initial users to explore the interface. Task 2 (2A, 2B, 2C, 2D) required the use of only the 360-video. Task 2 was timed when participants were using interactive map together with the 360-video. Task 3 included goal that requires to find a camping icon on the map and then find a camping location viewing the 360-video. The general goal was to define the efficiency of the park-planning tool while timing them on 5 different tasks. (Task 2A, 2B, 2C, 2D, 3)

Notched box plots apply a "notch" or narrowing of the box around the median. Notches are useful in offering a rough guide to significance of difference of medians; if the notches of two boxes do not overlap, this offers evidence of a statistically significant difference between the medians. (McGill, Tukey, and Larsen, 1978) If these two notches do not overlap it can demonstrate a strong evidence that their confidence interval of the medians differ. This indicates they have the same or similar averages. Notched box plots can also be useful to compare the notches of two variables to see if their data samples are identically distributed. If the notches look similar this means that the data samples have the same distribution.

Time on task results show that the notches of tasks 2A, 2B, 2C, 2D are meaningfully overlapping and this shows that 12 participants when solving tasks 2A, 2B, 2C, 2D had similar averages (20 ±seconds).(see 5.3) All of the tasks median level were around the same except the task 3. This shows that using the interactive digital map together with the 360-video was slightly more difficult then the other tasks that required only the use

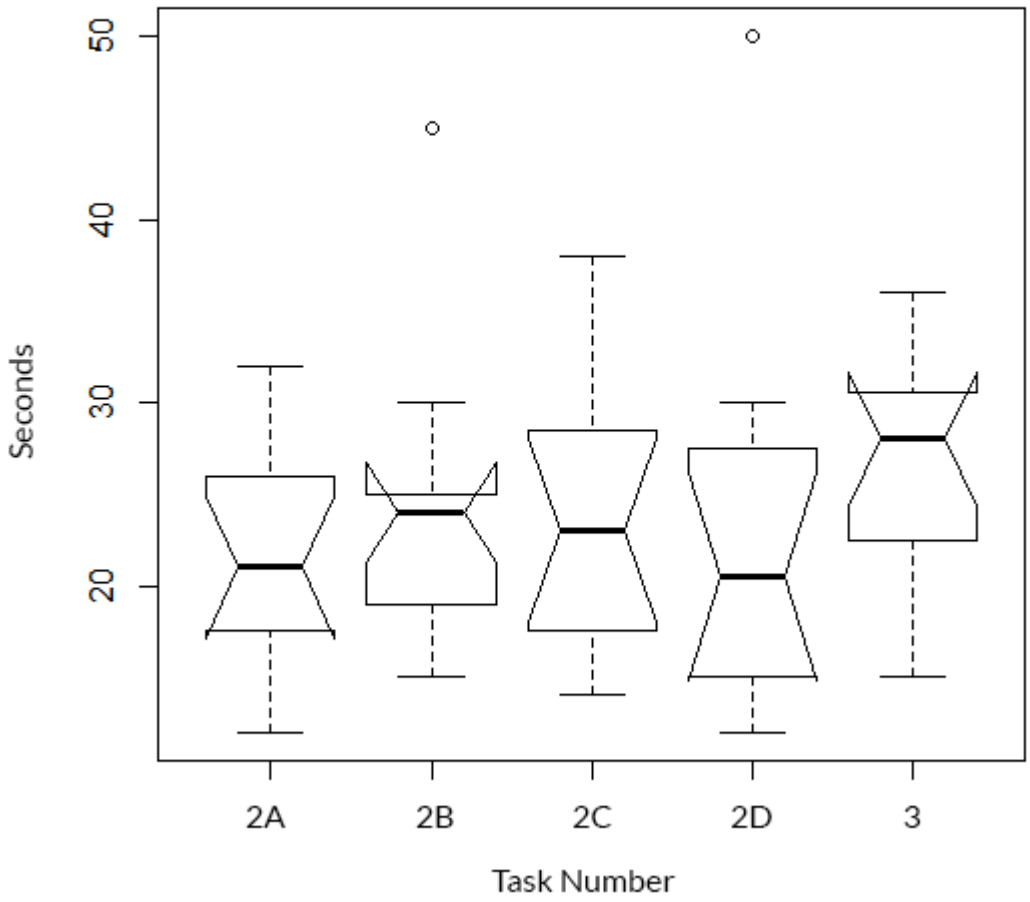

FIGURE 5.3: Completion time of tasks in seconds

of 360-video.

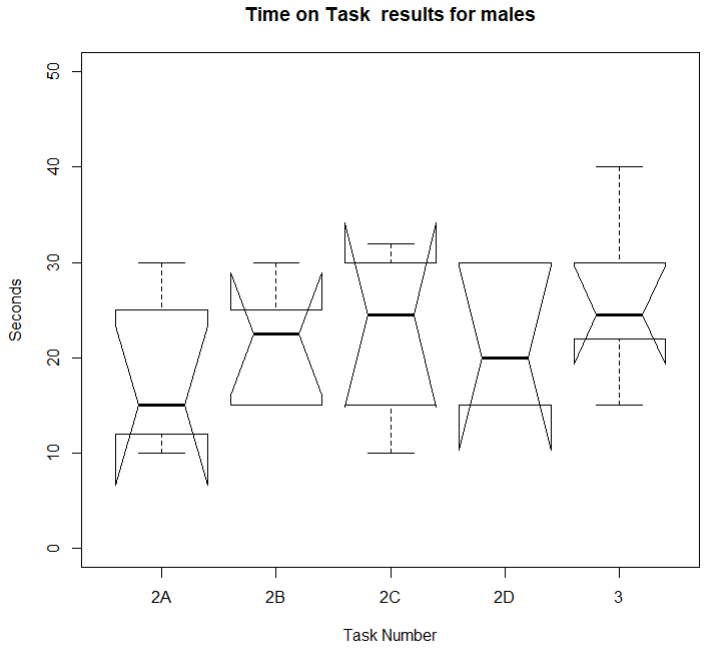

FIGURE 5.4: Time on task results for male participants

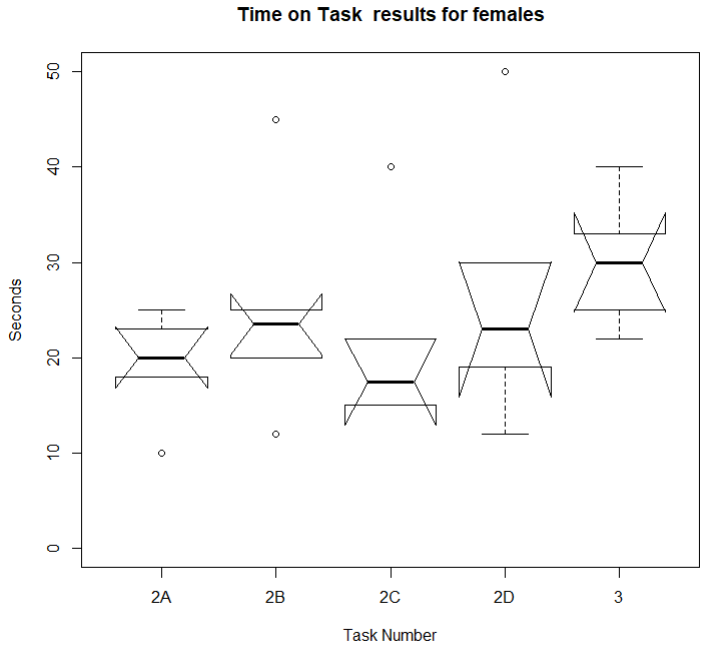

FIGURE 5.5: Time on task results for female participants

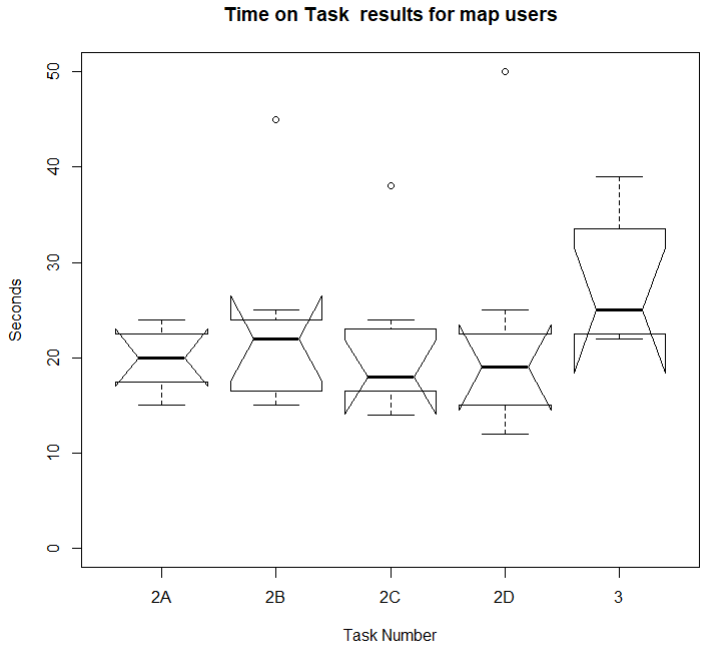

FIGURE 5.6: Time on task results for participants who uses digital maps weekly

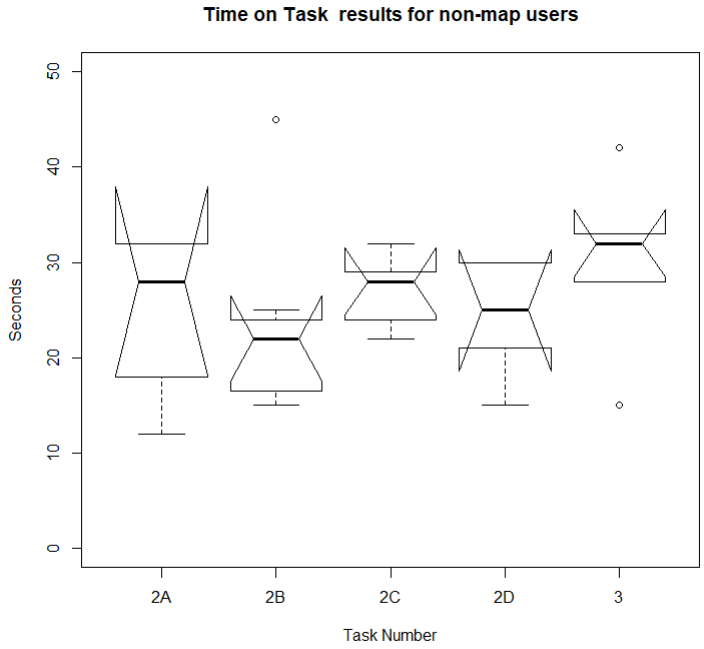

FIGURE 5.7: Time on task results for participants who uses digital maps less then weekly

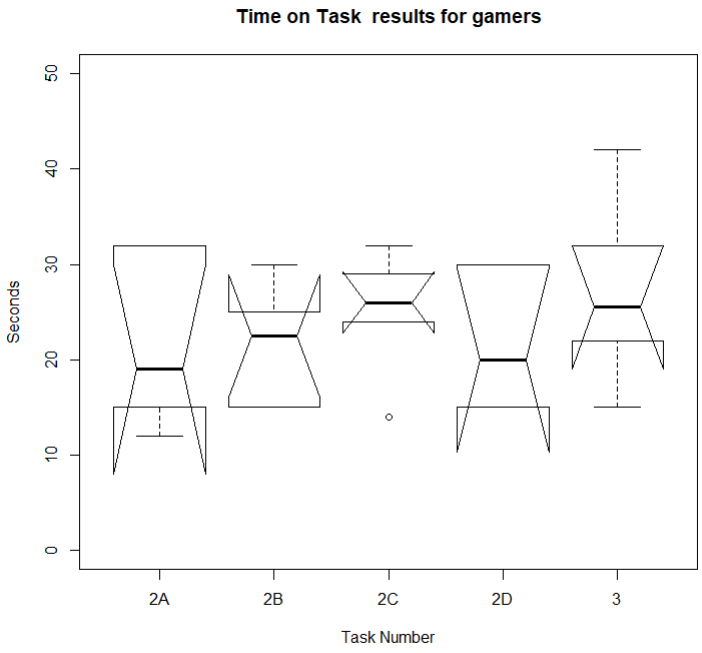

FIGURE 5.8: Time on task results for participants who play computer games

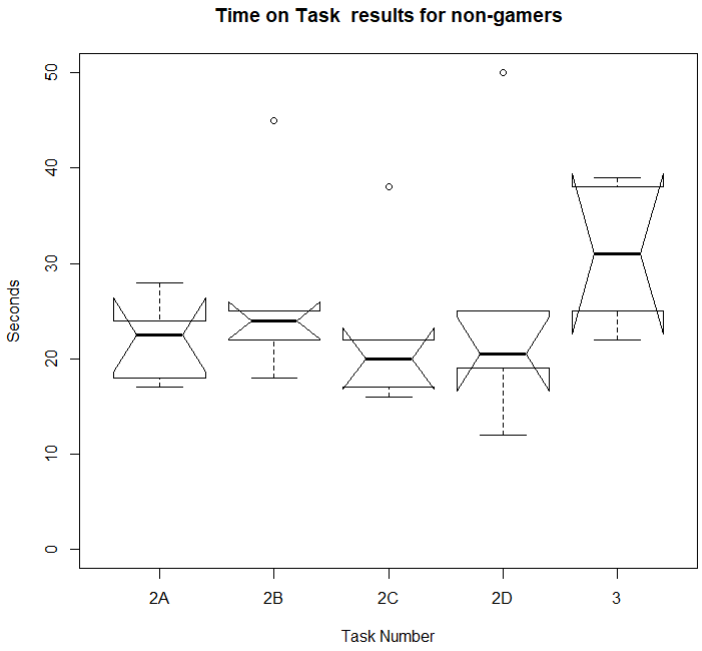

FIGURE 5.9: Time on task results for participants who does not play computer games regularly

TABLE 5.3: Time on task performances of five tasks in seconds

Participant	Age	Gender	Task 1	Task 2A	Task 2B	Task 2C	Task2D	Task3
#1	21	M	146	12	25	30	30	30
#2	41	M	149	15	15	15	15	25
#3	37	M	165	10	20	25	30	15
#4	31	F	145	20	20	45	40	50
#5	41	M	151	30	30	32	25	40
#6	38	F	149	20	25	15	25	40
#7	36	F	171	10	23	30	20	30
#8	63	M	149	20	15	10	15	22
#9	35	F	160	18	12	20	19	25
#10	32	F	155	23	22	15	12	22
#11	44	M	165	38	25	24	15	24
#12	34	F	133	25	25	22	21	33

5.2 Discussion

The main objective of the thesis was to determine if the use of interactive digital map with a 360-video was an effective and efficient tool for planning and managing the existing trails in a park. The second goal of this thesis was to evaluate if an interactive digital map with a 360-video functionality could be learned easily. A usability test was designed evaluate the park-planning tool's effectiveness, efficiency and learnability and was tested by park-planners and visitors. The tool usability was measured through a System Usability Scale (SUS) method and the results have shown that the participants found the interactive map easy to use(See 5.2). The findings demonstrate that the use of an interactive digital map with a 360-video functionality was effective as a park-planning tool. A high-fidelity prototype was tested with a scale of measurement based on the System Usability Scale (SUS) method and the results for the usability score were 75%, which confirmed the tool's effectiveness and efficiency and he learnability had specifically was 66%.

As this study was testing an innovative tool with a unique design and unique functionalities, it is possible to identify some aspects that would need to be improved for future similar projects. It was noted that the park-planning tool can be complicated to use with both the interactive digital map and the 360- video capability, but it also proved to have effective and efficient results once the user was more familiar with its use.

All of the participants who took part in the study focused on planning of the trails and were able to formulate suggestions about park-planning. Females were more careful with the interactive digital map, with landmarks referred problems in the park regarding trails, while men were more in focused on the 360-video. As it was discussed in chapter 2, the theory states that women are more likely to use landmarks and men preferring looking at directions. (Fujii and Sugiyama, 1999).

In the present study, females were more efficient with the task completion times then males. The medians of the boxplot shows that, except for task 5, males took more time to complete the other tasks (Task 1,Task 2,Task 3,Task 4) (see 5.3 compared to 5.4). (See 5.4 and 5.5)

Between the digital map users group and the non digital map users group, there was an average of 5 seconds difference. Except fo task 5, all of the tasks kept the same median level. The average time for completing task 5 was longer then the rest of the tasks. The box-plot graphs shows that task 5 was more difficult to use for both map users and non digital map users 5.6 and 5.7)

Gamers were tested by Boonsuk, Gilbert, and Kelly (2012) when conducting research about user using a 360-video without the use of an interaction with a digital map. Their

research showed that participants who played computer games made fewer errors than others. In the present research, the participants viewed the 360-video through an ego-centric view on an interactive digital map, and the finds were that interactive digital maps with 360-views proved to be difficult to use for more experienced gamers (See 5.8). On the other hand, the participants who do not play computer games regularly took less time then gamers (See 5.9).

The study also aimed at evaluation if skills could be transferred by using digital maps everyday and by playing computers. It was tested by using similar interfaces to digital maps interfaces and similar 360-degree ego-centric views that are used in first person shooters games. The results showed that it is efficient for maps (5.6) but not for computers gamers (5.8)

After the usability test, a questionnaire(Appendix E) was given to participants to be able to rate the difficulty of tasks from 1-5. The participants thought that Task 2 including the sub-tasks was the hardest. (Mean:4.16 , Std Dev:1.19) Task 1 was the easiest.(Mean:3.83 Std Dev:1.19) And 12 participants rated that Task 1's difficulty was 4 out of 5.

Half of the users only used the 360-video and the other half used only the interactive digital map when completing task 1. While completing task 1, users warmed up to the user interface: the researcher allowed the users to view the map for two minutes and asked them to take a screenshot. They were interested and all of them took screenshots of attractive trails with autumn leaves fell on, an unleash dog following trekker for a while, a water spring and a prehistoric place. Allowing the participants to explore increased their interest to use the park-planning tool. Si, Pisan, and Tan (2016) stated

that exploration is a discovery-oriented user activity and it motivates users. When the participants tested the prototype the researcher asked users to explore the user interface when solving task 1, and learn how to use the interactive elements of the park-planning tool; and get familiar with the labels of the interactive digital map and asked the participants to use it freely and view the 360-video for at least two minutes.

After completing task 1, researcher asked to the participants to solve the res of the tasks successfully. When completing task 2A, 2B, 2C and 2D, none the participants did not use the interactive digital map, they only used the 360-video. One user asked to view the video in full-screen when completing task 2A, and eliminated the use the interaction of map menu. When completing task 3, all users used both the interactive digital map and the 360-video. Task 3 required to find a camping spot which required the use of interactive digital map and the 360-video that connecting the two features. During the process, one participant could not find his directions when viewing the 360-video commented that it was hard to control and view the 360-video while it was playing and that it would preferable to have photos, like in Google Streetview.

It was noted that participants were able to add points, area, trails (lines), edit, correct feature types, correct attributes, adding the name of the trail.

Another issue was with the Trekker icon and to move it to an exact location in the forest (e.g. in an attempt to access the camping area and it would only show the trail close the camping area). It was noted that this particular error was mostly encountered by users who do not us digital maps regularly.

While completing all the tasks, it was noted several times that participants did not use the linear video capabilities of the 360-video, i.e. they did not pause the video

and they let it play at all times. This happened either because they did not know the functionality of pausing a linear 360-video or because they were used to Street View and the still photo format so they were not familiar with the video functions such as pause and play. Half of the participants had problems using the trail with the Trekker icon on the map, i.e. either they dragged the Trekker icon but they did not know where exactly they had to drop it. They moved the mouse while pressing the mouse button down, which resulted with participants wondering where and when to release the mouse button.

One of the participants found it difficult to interact with the 360-video because the video control user interface elements were considered very small. The participant added that it was difficult to change the time of the video by dragging the video's seek bar. Some of the participants found the video control buttons very small, although these buttons were HTML5 video element's native buttons.

Another participant commented about the color choice for the trails, arguing that the use of the blue color might bring confusion with rivers or streams. The primarily selected colors for trails were blue and yellow and, because of that, the participant thought they were not trails. As it was discussed in Chapter 2, this research also analyzed Fujii and Sugiyama (2000)'s theory about men are stronger in remembering topology.

In conclusion, besides the minor errors that were gathered from users' feedback and users' mistakes while interacting with the map, the users commented that the park-planning tool was easy to learn and easy to use.

5.2.1 Usability outcomes of Interactive Digital Map

The user interface of the interactive map needed to be intuitive in order to meet its goal. The plain digital map interface might be difficult in an initial learning phase, but the learning curve can be eased and new usability can be achieved for extended learnability. Interactive digital maps with no context or with just enough context can be a challenge when a user does not know how to search for the context, where to find the context, or is not familiar with the geo-location or area. The trail is created with constraints by limiting functionality for the user which does not allow him or her to choose and view a location other than the trail. The issues faced by users when using the parking-tool during the usability testing are reported in the this section.

5.2.2 Usability outcomes of 360-video

The purpose of this research was to find out the use of 360-video a digital interactive map together can be effective and efficient for park-planning. The results and analysis from the data answered the question to find out the efficiency of the multi-tasking these two tools. The medians of the tasks show that the tasks which did not require the use of interactive digital map(Task 1,Task 2,Task 3,Task 4) were solved more efficiently then the one used the 360-video and an interactive map together(Task 5). Task 5 was the only task that included a functionality of 360-video and the interactive map together. Participants took approximately 5 seconds more to solve this task then the other tasks. The use of a 360-video with an interactive digital map to plan a park can be difficult to use, and hard to learn. (See 5.3)

Chapter 6

Conclusion and Future Study

6.1 Overview

Chapter 1 introduced the design challenge and outlined the usability questions of this study: can the use 360 video help determine the planning and creation of trails in a park? Can an interactive digital map including a 360 video be used effectively by visitors who are planning to visit a park?

Chapter 2 explored the evolution of maps, from traditional to digital maps. The theory of cybercartography (Taylor, 2003)) was explained and the interaction between design process and research process was highlighted. The use of art and science, with supporting audiovisual elements, was encouraged. Secondly a research was conducted about interactive digital maps with an emphasis on 360-video and related usability studies were provided. Finally, I conducted a short review about park and trail management and the technologies that are being used to evaluate them. We found that there are no usability studies that tested usability of 360-videos for planning parks, therefor park-planning tool is new and yet the usability of it has not been studied.

Chapter 3 outlined the design philosophy with initial ideas and sketches. A prototype of an interactive digital map with 360 video was produced and presented in details.

Chapter 4 explained the methodology of the study in order to test the tool, using an iterative process to im prove its usability. The usability test methods, including Think

Aloud and Thematic Analysis, were explained in order analyze the findings and draw conclusions.

Chapter 5 reported the usability testing results. The usability test was conducted as an iterative part of the design process. This process helped improving the interactive digital map throughout the thesis project in order to be used as a park planning tool with the Boucher-Forest Park, in Gatineau. The results show that it the interactive park-planning tool was an efficient tool for park-planners.

6.2 Summary

With the use of digital phones, 360-videos can be recorded quite easily. Accessibility to digital maps opens doors to new avenues using immersive solutions and information technologies. Although using maps for viewing an urban area is common, the technology for viewing a forest or other non-urban areas is rare, because of the lack of content creation. Google Streetview camera with heavy equipment that allows to view egocentric view angles of urban streets with high-quality photographs takes time to produce and it is expensive. There are advantages of multimedia to give the user the option of multiple views of a parallel time, in a context or for an instant recall of a point in time on the map. What motivates the viewer for searching a map is not to find out what is not there, therefore the audience motive would be the empathy to the environment, world, and the story, or to what he sees or brings himself from to the point of view of the person walking in the forest.

This thesis makes three contributions:

1. An interactive digital map prototype to be used in the planning of a park is designed.
2. A methodology to test the interactive digital map was created.
3. A user study was conducted with the visitors to Boucher-Forest park is conducted and tested the usability of this tool and inspired improvements.

6.3 Future Work

The park planning tool, beyond being an innovative digital map with 360-video capabilities, is also a cost-efficient way of creating maps with audiovisual content. Customizing map elements is easy using MapBox and this allows the creation of digital maps with 360-view capabilities efficiently. This is an opportunity to create high-fidelity prototypes with decreased production costs and to test them for various use cases. This approach can contribute to the development of cybercartographic atlases using art and science together. 360-video capabilities should be tested with virtual reality systems such as head mounts. Virtual head-mounted displays could be tested for future work. 360-video on full-screen with the map showing as a mini-map screen could be a good example to study with this park-planning tool.

The usability test can be tested for efficiency by comparing different inputs such as keyboard and mouse. This thesis only explored the desktop version of the final product. To be able to analyze the complete user experience, the usability of mobile version of the user interface should be evaluated.

With the time limits on this study, the prototype was only created for the primary users of this study, the park planners. The secondary functionality of the tool to record 360-videos when they are walking and upload themselves on the interactive digital map as not been tested. A high-fidelity prototype was developed. The web-based prototype is a responsive design and has the capacity of displaying on every device correctly was created for this project, making it usable for the both primary users and secondary users for future studies. By changing the angle and how the 360-video recorded can extend the interactive digital map capabilities can by creating a new user centered design for variety of topics such as skateboarding in a city or biking in a forest.

For a better understanding, the overall design of the park-planning tool and the difficulties for the usability of an interactive map on a mobile should be tested. Participants are willing to add more content with increasing interest of different needs and motives to visit the forest.

Appendix A

Introductory speech

Thank you for participating in this study and welcome to the office of Boucher Forest foundation. I am a Master of Art's student at the Human Computer Interaction program with the Computer Science department at Carleton University. I programmed an interactive map with the collaboration from volunteers from the public, the city and the Boucher Forest Foundation, it's visitors and its neighbours.

We are going to determine whether or not an interactive map would be helpful in the park planning process (decision making). Interactive mapping can contribute to park planning with respect to the maintenance of existing trails in the Boucher Forest. It is an important issue for Gatineau citizens to protect and provide access to green space in the city. Therefore, a digital interactive map represents an integral asset in decision making with regards to identifying trails, land information, and multimedia, etc. within the boundaries of Boucher Forest.

When you complete the tasks, please fill out the questionnaires. There are no right or wrong answers, so please be honest with your choices and opinions. Your responses may provide solutions toward achieving a better user interface design.

Before we begin, I will ask you to take a moment to review and sign the consent form. If you agree to participate in this study, you may proceed. If you have any questions during the study please ask.

Appendix B

Demographics survey

Participant No (1-20):

Researcher: Mahmut Erdemli

About the Demographics Survey

The following questions are given in the form of statements regarding your demographics, knowledge about the field and familiarity with Boucher Forest.

- **Your Age:**
- **Your Gender:** ☐ F ☐ M ☐ I prefer not to answer
- **Are you a Gatineau resident?**

  ☐ Yes ☐ No
- **How often have you visited the Boucher Forest?**

  ☐ Never ☐ I've heard of it ☐ Once a year ☐ More than once a year ☐ Several times every year ☐ More than once a month
- **What is your main activity when you are visiting Boucher Forest?**

  ☐ Walking my dog ☐ Exploration ☐ Activities ☐ Biking ☐ Trekking ☐ Other(precise):
- **Have you played computer games ?**

  ☐ Never ☐ A couple of times ☐ Many times ☐ Every weekend ☐ Everyday

- **How many times a year do you go camping per year?**

  ☐ None ☐ Once ☐ Twice ☐ Three times ☐ More than three times

- **Do you use Digital Maps? (e.g. Google Maps)**

  ☐ Never ☐ Once a year ☐ Once a month ☐ Once a week ☐ Once a day

Appendix C

Scenario script

When you are interacting with the interactive map I want you to think aloud. I would like you to tell me the things that you like the things that you dislike or find confusing. Please do this as much as you feel comfortable with it. I am not testing you I am testing the product and I want to know more about the user interface design of the interactive map. Please do not hesitate to ask if you have any questions.

At the beginning our session, I will launch the interactive map on a browser window. The interactive map will be tested by using an internet explorer window. [Facilitator launches the Application on Internet Explorer]

Now we can initiate the scenario. You are planning to go to Boucher Forest for your favourite activity, you want to plan and prepare for your route. You will do so by exploring the trails inside the Boucher Forest by using the interactive map on a computer. We are asking you to decide about the informal trails in Boucher Forest. Our analyses may require collaboration of your findings to find more about using this interactive map as a park planning tool. Consideration of a range of visitor motives and behaviours and classifications (e.g., avoidable, unavoidable) in light of park management objectives(safe access, and protecting the environment) by zone can help to inform management for decision-making. Finally, the other layers (trails, wetlands, satellite view and land ownerships) are other data-sets that will provide information about informal trail management decisions.

I will ask you to accomplish the tasks from 1-4 with the help of the interactive map.

Tasks

Task 1 You want start playing around with the map and start exploring inside and see the video player that includes a video that was shot along a trail inside the Boucher Forest.

If you see any obstacles in the forest that could create a conflict in order to be avoided in real life such as mud, erosion and difficult terrains. Please take a screen shot. If you see anything beautiful or attractive (plants, animals) please take a screen shot, this will allow us to place the input on the interactive map.

Task 2 Go to 0.00 of the video. What does the traffic sign say?

Go to 1.00 of the video. Do you think this path is wide enough to pass? Yes/No

Go to 2.00 of the video. Do you think the vegetation here needs maintenance? Yes/No

Go to 3.32 of the video. Do you think the difficulty of accessibility of this path is rather Easy/Hard Would you take an alternative path? Yes/No

Task 3 We marked a few locations as icons on the interactive map.

Look for a camping spot by using the interactive map.

Have you found a good spot for camping? Yes/No

Please explain why the surrounding and this area is a good choice?

Task 4 Look at the image handed to you, it is a printed version of this map that contains a plain map without the other data layers, just the Boucher Forest satellite imagery as a geographical layer.

Customize the user interface on a blank map and draw anything that you like to be added or removed from/to the user interface, add two User Interface element of your choice to the map. (e.g. button, iocns, lines, menu, search bar, close button[x])

Appendix D

Post Test Questionnaire

About the Questionnaire

The following questions are given in the form are statements regarding the interactive map tool to be used for park planning. We would like you to give your level of agreement with each statement on a scale going from 1 to 5.

The park-planning tool...	−−	−	−/+	+	++	
I would like to use the interactive digital map with 360-view more frequently	☐	☐	☐	☐	☐	I would like to use the interactive digital map with 360-view less frequently
There was too much information on the interactive digital map	☐	☐	☐	☐	☐	The interactive map was simple and didn't need anymore information
I found it easy to use the interactive digital map with 360-video capability	☐	☐	☐	☐	☐	I found it difficult to use the interactive digital map with 360-video capability
When I was using the park-planning tool I would have got stuck without help being provided	☐	☐	☐	☐	☐	When I was using the park-planning tool I could solve all the tasks without help being provided
The 360-video and the interactive map working together did not help making decisions related to trails in the park	☐	☐	☐	☐	☐	The 360-video and the interactive map working together helped me making decisions related to trails in the park
The user interface was confusing and it was hard to find the information	☐	☐	☐	☐	☐	The labelling was clear and I hard a hard time find the information
I think the park-planning tool could be learned quickly	☐	☐	☐	☐	☐	It could take a long time to learn the park-planning tool
It was complicated to use the video and the interac-	☐	☐	☐	☐	☐	It was simple to use the video and the interactive

Appendix E

Post Test Questionnaire

Next time, I think I can remember to use the interactive map	☐	☐	☐	☐	☐	I am note sure if I can remember hot use interactive digital map next time
I need to learn a lot before you start using the park-planning tool	☐	☐	☐	☐	☐	I found it practical to start using the park-planing tool without needing to learn anything
When I was using the park-planning tool	−−	−	−/+	+	++	
Was difficult to use the 360-video	☐	☐	☐	☐	☐	It was easy to use
Was easy to see the problems relating to trails using the interactive digital map	☐	☐	☐	☐	☐	It was hard to see identify the problems relating to trails
Task 1 was easy	☐	☐	☐	☐	☐	difficult to accomplish
Task 2 was easy	☐	☐	☐	☐	☐	difficult to accomplish
Task 3 was easy	☐	☐	☐	☐	☐	difficult to accomplish
Task 4 was easy	☐	☐	☐	☐	☐	difficult to accomplish

Appendix F

Post Test Questionnaire

With the use of 360-video tool...	−−	−	−/+	+	++	
It was difficult to use the 360-video	☐	☐	☐	☐	☐	It was easy to use
It was easy to see the problemMs relating to trails using the map	☐	☐	☐	☐	☐	It was hard to see identify the problems relating to trails
I preferred dragging the marker on the trail	☐	☐	☐	☐	☐	I preferred dragging the timeline on the video player

What tool allowed you to find results effectively? 360-video / Interactive Digital Map Please explain:

What tool allowed you to find results effectively? 360-video / Interactive Digital Map Please explain:

What tool allowed you to find results with satisfaction? 360-video / Interactive Digital Map Please explain:

Appendix G

Semi-structured interview

How do you feel you have performed in the test?

Which task did you find most difficult, why?

Did you find it easy to use to interactive map navigation? Please explain: Did you find it easy to use to 360-video? Please explain:

Did the interactive map improve your knowledge about the park-planning? Please explain:

Did the interactive map improve your knowledge about the Forest? Please explain:

When you use the interactive map what motivates you to plan the trails in the park?

When you use the interactive map what motivates you to explore the forest?

How did you like the look/feel of the interactive map altogether?

In the future, would you like to use and contribute to the Boucher Forest interactive map?

Appendix H

Oral script

Hi there!

I am a Master of Art's student Human Computer Interaction program with the Computer Science department at Carleton University.

I am making a study about the usability of an interactive map as a possible park planning tool. This study is taking place at Boucher Forest in Gatineau. This study involves a set of questionnaires and a semi-structured interview about the usability of the interactive park-planning tool that will last approximately sixty minutes. The participation to this study will be on a volunteer basis and no compensation will be given for participating to this research.

This study's objective is to determine if an interactive map can help making decisions for park planning, in relation to existing trails that are passing through humid zones and infrastructures that are built to protect them such as bridges or walkways etc.. Your interaction with the digital map will be audio recorded and your on-screen actions will be recorded so the researcher can evaluate the usability of the interface by determining your thoughts interacting with the park-planning tool of Boucher Forest.

If you would like to participate, or if you have any questions please let me know. You can contact me by writing an email at mahmut.erdemli@carleton.ca.

Thanks, Mahmut

Appendix I

Twitter advertisement

YOU ARE INVITED TO PARTICIPATE TO A USABILITY STUDY evaluating the use of an interactive map as a park-planning tool, taking the Boucher Forest in Gatineau as a case study. To join, you must be a resident of Gatineau, you must speak English fluently and be at least eigh-teen years old. This study will take 60 minutes to complete and it will collect new information by a user study that includes using an interactive map. During the study you will be asked questions about your experience with the interactive map. After he study is done you will be asked to fill-in questionnaries. The study has been reviewed and cleared by Carleton University Ethics Board CUREB-B Clearance #108088 If you have any ethical concerns with the study, please contact Dr. Andy Adler, Chair, Carleton University Research Ethics Board-B (by phone at 613-520-2600 ext. 4085 or via email at ethics@carleton.ca). To get more information, please email the lead researcher of this study mahmut.erdemli@carleton.ca. The participation to this study will be on a volunteer basis and no compensation will be given for participating to this research.

Fondation
Forêt Boucher

Carleton
UNIVERSITY

Appendix J

Consent Form

Carleton UNIVERSITY
Canada's Capital University

CUREB-B Clearance #108088

Consent Form

Title: Interactive mapping as a park planning tool towards the creation of the Boucher-Forest Park in Gatineau

Date of ethics clearance: To be determined by the REB (as indicated on the clearance form)

Ethics Clearance for the Collection of Data Expires: To be determined by the REB (as indicated on the clearance form)

I _____, choose to participate in a study on "Interactive mapping as a park planning tool towards the creation of the Boucher-Forest Park in Gatineau." This study's objective is to determine if an interactive map can help making decisions for park planning, in relation to existing trails that are passing through humid zones and infrastructures that are built to protect them such as bridges or walkways etc. The researcher for this study is Mahmut Erdemli in the department of Human Computer Interaction working under the supervision of Dr. Fraser Taylor at Carleton University.

To participate in this study, you must to be comfortable speaking in English. This study involves a demographics questionnaire, a semi-structured interview with using the computer interactive map lasting approximately 60 minutes. After completing the tasks by using the interactive map, you will go through questionnaires/semi-structured interview to share your opinions about the usability of interactive mapping as a park planning tool towards the creation of the Boucher-Forest Park in Gatineau. You will not be compensated for your participation in this research.

With your consent, I will record your on-screen actions and your audio using a software (QuickTime). Your audio recording will be necessary to analyze a think-a-loud protocol to better understand your thoughts while interacting with the park-planning tool and to learn what determine your actions. Once the recorded audio has been transcribed, the recorded audio will be destroyed. The transcribed data will be saved on a USB and on also a password-protected computer in an anonymously named and password protected folder. Audio-recording is optional and if you do not wish to be audio-recorded the researcher will take notes.

You have the right to end your participation at any time for any reason. During the testing session, you can withdraw by verbally telling the researcher. Before or after the testing session, You can withdraw by phoning or emailing the researcher or the research supervisor. You cannot withdraw from the study after March 30th 2018, as

this is when data analysis begins. If you withdraw from the study, all information you have provided will be immediately destroyed.

All research data, including audio-recordings and any notes will be encrypted. Consent forms and questionnaires will be immediately scanned and shredded. Audio-recordings and questionnaries will be deleted from the USB key when data has been transcribed and verified. Transcribed text will be saved in an encrypted USB and shredded. USB key will be kept in a locked cabinet at Carleton University. Research data will only be accessible by the researcher and the research supervisor. Research data will be anonymized by participant number.

If you need to take a break please ask anytime. You can also ask to withdraw from this study until the end of the testing session.

The reports and the presentations will include interesting qualitative comments of anonymized data only. Once the project is completed, scanned consent forms will be deleted, the data from audio-recording and the questionnaire forms will be kept securely for two years and potentially used for other research projects on this same topic. At the end of two years, all research data will be securely destroyed. (Electronic data will be erased)

If you would like a copy of the finished research project, you are invited to contact the researcher to request an electronic copy which will be provided to you.

The ethics protocol for this project was reviewed by the Carleton University Research Ethics Board, which provided clearance to carry out the research. If you have any ethical concerns with the study, please contact Dr. Andy Adler, Chair, Carleton University Research Ethics Board-A (by phone at 613-520-2600 ext. 2517 or via email at ethics@carleton.ca). [Use the contact information for CUREB-B – see instructions – if appropriate.]

Researcher contact information:	**Supervisor contact information:**
Mahmut Erdemli	Dr. Fraser Taylor
Human-Computer Interaction	Computer Interaction Geography and Environmental Studies
Carleton University	Carleton University
Tel: 613-520-2600x8232	Tel: 613-520-2600
Email: mahmut.erdemli@carleton.ca	Email: fraser.taylor@carleton.ca

Do you agree to be audio-recorded: ___Yes ___No

This document has been printed on both sides of a single sheet of paper.
Please retain a copy of this document for your records.

_____ _____

Signature of participant Date

_____ _____

Signature of researcher Date

This document has been printed on both sides of a single sheet of paper.
Please retain a copy of this document for your records.

Appendix K

Invitation Letter

Carleton UNIVERSITY
Canada's Capital University

CUREB-B Clearance #108088

Letter of Invitation

Title: Interactive mapping as a park planning tool towards the creation of the Boucher-Forest Park in Gatineau

Date of ethics clearance: To be determined by the REB (as indicated on the clearance form)

Ethics Clearance for the Collection of Data Expires: To be determined by the REB (as indicated on the clearance form)

Dear Sir or Madam,

My name is Mahmut Erdemli and I am a Master's student in the Human Computer Interaction department at Carleton University. I am working on a research project under the supervision of Prof. Fraser Taylor.

I am writing to you today to invite you to participate in a study on the Interactive mapping as a park planning tool towards the creation of the Boucher-Forest Park in Gatineau. This study's objective is to determine if an interactive map can help making decisions for park planning, in relation to existing trails that are passing through humid zones and infrastructures that are built to protect them such as bridges or walkways etc.

To participate in this study, you must to be comfortable speaking in English. This study involves a pre-test questionnaire a walkthrough scenario 60 minutes interview that will take place in a mutually convenient, safe location. With your consent, your on-screen actions will be recorded using a software called QuickTime. I will also record your audio to analyse what is users' thoughts by think-aloud protocol while using an user interface. At the end of the usability test, the researcher will conduct an interview with a questionnaire to assess the usability of the interactive map as a park planning tool.

These recordings will only be accessible by me and my supervisor. No identifying information is captured other than your voice, and the rest of the data will be collected and kept anonymously and stored securely. Once the recording has been transcribed, the audio-recording will be destroyed. Once the written forms have been transcribed the hard copies of written paper forms will be shredded.

You will have the right to end your participation in the study at any time, for any

reason, up until March 30th, 2018. You cannot withdraw from the study after March 30th 2018, as this is when data analysis begins. If you choose to withdraw, all the information you have provided will be destroyed. You will be not be compensated for your participation in this research.

This ethics protocol for this project was reviewed by the Carleton University Research Ethics Board, which provided clearance to carry out the research. Should you have questions or concerns related to your involvement in this research, please contact:

CUREB-B:

If you have any ethical concerns with the study, please contact Dr. Andy Adler, Chair, Carleton University Research Ethics Board-B (by phone at 613-520-2600 ext. 4085 or via email at ethics@carleton.ca).

If you have any questions or would like to participate please do not hesitate to contact the research team. (by phone at 613-520-2600 ext. 8232 via email at mahmut.erdemli@carleton.ca).

Sincerely,

Mahmut Erdemli

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