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The Evaluation of Cyclistic, a Bike Route Planning Tool for Tourists in Copenhagen

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The Evaluation of *Cyclistic*, a Bike Route Planning Tool for Tourists in Copenhagen

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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Authorship

Brian Joseph

Brian has written the introduction and has also written portions of the background, including the sections about Dansk Cyklist Forbund, the Cycling Infrastructure and the Perceptions of Cycling. He has also written portions of the methods and results including gaining a better understanding of *Cyclistic.* Brian has written a majority of the conclusions and recommendations, and has co-written the cycling guide with Victoria. Brian has also created all of the progress reports. He has also conducted user testing with tourists.

Jennifer Mann

Jennifer has written portions in the background, including co-writing the Route Software section and writing the User Testing section. She has also written sections in the methodology and results including ways of promoting *Cyclistic* and identifying strengths and shortcomings of the software. Jennifer has also done a majority of the final editing and formatting of the final report to ensure fluidity throughout. She has also conducted some user testing with tourists.

Victoria Tower

Victoria has written the acknowledgements, abstract, the executive summary, and portions of the background including the Danish Tourism section and co-writing the Routing Software section with Jennifer. Victoria has also written portions of the methodology and results in understanding what tourist's motivations/deterrents to cycle in Denmark are. She has also co-written the Cycling Guide with Brian in the conclusions and recommendations section. Victoria has also analyzed all of the numerical data collected from the tourists and to create all of the tables of this data. She has also created and organized the appendixes and helped in the final formatting of the report. Victoria has also edited portions of the methodology and results, and tracked and edited by Victoria. She has also created all of the work plans for each week and organized the group so that deadlines are always met. Victoria has also conducted user testing with the tourists.

Through this project as a group, we have learned about user testing, how to conduct a usability study, and the importance of cycling to the Danish culture.

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Abstract

The Danish Cyclists Federation recently released a web-based, bike route-planning tool, *Cyclistic,* designed to facilitate cycling amongst tourists in Denmark. To test the software's usability, we compared *Cyclistic* to other route-planners, interviewed 25 tourists about their biking needs, and conducted a usability study with 16 tourists. As a result, we identified major aspects of *Cyclistic* that could be modified and additional features that could improve the usability of the software.

Executive Summary

Cycling is a primary means of transportation for the Danes. The highly developed system of bike paths provides cyclists with a fast, inexpensive, and easy means of travelling through the city. This extensive infrastructure has inspired many Danes to cycle, but unfortunately many tourists find the cycling culture intimidating due to its complexity. The Danish Cyclists' Federation (DCF) has been working to increase cycle tourism in Denmark by promoting biking as a safe means of experiencing Denmark's culture and by creating *Cyclistic*, a new form of bike route planning software for tourists. This software is unique in its ability to combine up-to-date bike path maps of Denmark with a comprehensive database of tourist attractions, enabling users to plan bike routes around their own sightseeing interests. Development of this software is ongoing and it has yet to undergo any usability studies; therefore, it still has room for improvement. The ultimate goal of this project is to evaluate *Cyclistic's* usability to develop recommendations so that it can better target tourists' needs and desires. The three methods of usability that we will test for are (1) *functionality* – how well the software works and where its glitches are, (2) *ease of use* – how intuitive the software is from a user's perspective, and (3) the users' *enjoyment* while planning and biking routes

To achieve our goal, our team developed the following objectives: (1) develop an understanding of *Cyclistic*, (2) identify ways to promote *Cyclistic* and bike-tourism, (3) understand tourists' motivations/deterrents to cycle in Denmark, (4) identify *Cyclistic's* strengths and shortcomings, and (5) recommend software modifications. To fulfill these objectives, we conducted interviews, focus groups, surveys, experience prototyping, think-aloud sessions, and field-testing with our project stakeholders. These stakeholders include the *users* – or tourists, the *facilitators* – the organizations/businesses that help interested tourists get on a bike, and the *promoters* – organizations/businesses that encourage tourists to take part in Denmark's cycling culture.

To better understand *Cyclistic*: how it works, why it was developed, and its features, limitations, and unique qualities as compared to existing routing tools, we interviewed our sponsor Michael Hammel, who is overseeing *Cyclistic's* development. To acquaint ourselves with software, we experimented with *Cyclistic* ourselves and recorded our impressions. In addition, we researched existing routing tools to compare their features with *Cyclistic's*

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capabilities and to develop ideas for how *Cyclistic* could be made a superior routing tool. Finally, to assess the feasibility of incorporating these features into *Cyclistic,* we interviewed one of its developers Lars Nielson. From him, we created an updated list of feasible-only features, which was presented to tourists and prioritized based on their approval.

To identify ways to make *Cyclistic* better known amongst tourists in Denmark and to determine how it can work with facilitators to promote biking in Denmark, we interviewed (1) a *promoter*: a representative from the tourism agency *Visit Denmark* and (2) a *facilitator*: the owner of the bike rental shop Baisikeli. From them, we acquired information on what types of tourists Denmark attracts, how tourists find information on cycling in Denmark, plans for promoting *Cyclistic*, ideas for improving *Cyclistic*, and how *Cyclistic* could work with facilitators such as Baisikeli.

In an effort to better understand what motivates and deters tourist's interest in cycling in Denmark, we conducted a focus group with WPI students who previously cycled in Denmark, surveyed 30 members of the WPI cycling team, used the software ourselves to plan and bike routes, and had 25 different tourists complete our cycling-interest survey. The most common motivating factors were that biking is (1) how you fit in with the Danes, (2) a convenient means of sightseeing, and (3) a healthy way to travel. Tourists' major deterring factors were (1) safety concerns, (2) the unfamiliar infrastructure, and (3) not knowing the proper Danish cycling etiquette/rules. Although *Cyclistic* cannot change the physical cycling environment in Copenhagen, it could offer tourists information to help them cope with some of these deterrents in the form of a cycle guide.

The main element of this project was our *Cyclistic* usability study. 16 tourists participated in the study by using the software to plan a route during a think-aloud session and then answering questions about their impressions of the site. The purpose of the think-alouds was to evaluate the intuitiveness of *Cyclistic's* interface and determine where tourists' encountered problems. Seven tourists then agreed to bike their route and answer our post-touring survey questions, which allowed us to assess how much they enjoyed their bike rides. To ensure variety in our data, we recruited tourists from several different locations to target tourists of varying ages and nationalities.

The main problems that tourists encountered with *Cyclistic* fall into the following five categories: (1) not knowing how to begin planning a route, (2) not being aware of important software features, (3) having difficulty navigating a route with *Cyclistic's* directions, (4) being inconvenienced by technical glitches, and (5) not being familiar with proper cycling etiquette/rules. To address these problems, we identified four major areas in which *Cyclistic* could be modified to improve the usability of the software. These area are (1) creating an informative cycle guide, (2) redesigning the software interface, (3) creating instructions and tips to guide users through the use of the software, and (4) developing better cycling navigation tools. The two most important features that should be added to the software are a cycling guide and instructions on how to use *Cyclistic.* These will address tourists' problems with not knowing the proper cycling etiquette/rules and not being aware of or knowing how to use major features within *Cyclistic*. The cycling guide provides tourists with a better understanding of the cycling infrastructure of Denmark and explains basic etiquette such as hand signals. The instructions explain the different ways users can plan a route and shows them what steps to take when planning a route. It also guides users to features such as the attraction bar and right-click functions to expand the usefulness of the software. Other features that should be added include a map key explaining what the differently colored paths on the map mean, a function that minimizes the number of turns in a route, and a way to integrate public transportation hubs and routes with a cycling tour. Additional features that tourists approved of include an audio navigation option, satellite view, calorie-counter, database of cycling-related events, and more attraction information.

Our two main deliverables – the cycling guide and tutorial – in conjunction with our list of software modifications and feature additions should improve *Cyclistic's* usability, making it a more useful bike routing tool for tourists. With *Cyclistic's* assistance, the hope is that tourists will not be as reluctant to bike and will choose to experience Denmark's culture the way everyone should – on a bike!

Chapter 1: Introduction

Cycling is a fundamental part of Copenhagen's culture and a primary mode of transportation for the Danes. According to Bicycle Account (2010), the primary reasons Danes choose cycling over driving or public transit are that cycling is faster, more convenient, healthier, cheaper, and more in line with environmental concerns. Each day, more than half of Copenhagen's residents use bicycles to commute to work and school and to run errands (City of Copenhagen, 2009). To make it easier for cyclists to get around, Denmark has worked to improve its cycling infrastructure by creating more bike paths and implementing various laws and regulations such as requiring taxis to provide a means of transporting bicycles. With such an extensive cycling infrastructure and culture, one might expect that many tourists in Denmark would be eager to tour the country on a bike. However, according to Marcussen & Zhang (2007), only about 11% of Danish tourists ever swing their leg over a bicycle.

Infrastructure reforms may have successfully encouraged more Danes to bike, but paradoxically, according to Marasco (2011), many tourists in Denmark choose *not* to bike because they are intimated by the complexity and sheer expansiveness of Denmark's cycling culture. These tourists also fear that they will cause traffic disturbances and stand out amongst other cyclists. Despite these concerns, the Danish Cyclists Federation (DCF)(2012) has pointed out that when tourists are reluctant to cycle, they miss the opportunity to truly get to know Denmark and experience its culture. Moreover, the DCF believes that if Denmark does nothing to promote cycling amongst tourists, then the country will miss out on opportunities to acquire more revenue and promote environmentally-friendly travel. To address these concerns and missed opportunities, the DCF has been working in collaboration with the web agency Klean to create *Cyclistic,* a new form of route planning software specifically designed to facilitate cycling among tourists in Denmark. As explained by the Minister for Transport Hans Christian Schmidt, "The idea is to have a high-quality and nationwide tool that can easily show cyclists the best routes that combine nature, accommodation, sights, and bicycle repair shops – if the bike needs a little extra love and care on the way" (Willemoes, 2011). One of *Cyclistic's* main goals is to make it easier to sightsee and navigate the country so that tourists have one less obstacle to worry about. In turn, this will allow tourists to direct more of their attention towards obeying the rules of the road, which will also help appease safety concerns.

Cyclistic is not Denmark's first attempt at promoting cycling amongst tourists. Two years ago, a team of WPI students (Tragellis, A., Lopez, K., & Ilyashenko, 2010) worked in collaboration with the DCF to condense information on Copenhagen's cycling infrastructure and culture into an online guide available to tourists, located at cycleguide.dk. The purpose of this guide is to educate new cyclists about the cycling rules and regulations that are specific to Denmark and to make them feel more at ease while cycling. In 2011, another team of WPI students (Aubin, A., Chichester, C., & Kantesaria, S. ,2011) continued where the past group left off by helping the DCF further develop its information gateway by collecting up-to-date information on bike rentals, safety, bike routes, and guided tours in Copenhagen. In addition, bike rental shops such as Baisikeli (Baisikeli.dk, 2012) and bike tour companies such as Bike with Mike (Bike with Mike website, 2012) have helped promote cycling tourism by providing bike rentals and safe, enjoyable guided bike tours through Copenhagen. The issue with guided bike tours, however, is that they hinder exploration. Tourists, who would rather explore Denmark on their own, must turn to online routing tools such as Google Maps and Cycle Copenhagen. These route planners are limited, however, in that they either have not mapped Denmark's intricate system of bike paths in enough detail to render them useful for cyclists or have not been specifically refined for tourists.

To address these issues, *Cyclistic's* developers have aimed to provide tourists with detailed routing information, while leaving room for exploration. *Cyclistic* is unlike existing routing tools because it combines an up-to-date map of the majority of the cycle paths in Denmark with an expansive database of Danish attractions, which enables users to plan bicycle routes around their own sightseeing interests. As *Cyclistic's* development is currently ongoing, there is ample opportunity to make *Cyclistic* a better guidance tool for tourists through user testing.

Accordingly, the DCF and *Cyclistic's* developers invited us to determine a means of testing and improving *Cyclistic*. The ultimate goal of this project was to evaluate *Cyclistic's* usability – its *functionality*, its *ease of use*, and users' *enjoyment*. We fulfilled this goal through interviews, focus groups, surveys, think-aloud sessions, experience prototyping, and field-testing with tourists in Denmark. Based on our findings, we developed suggestions for improving *Cyclistic* so that it better targets tourists' needs and desires. We hope that an

improved tool will make it safer and more enjoyable for tourists to experience Denmark and that the tool itself may eventually promote cycling within the tourism community.

Chapter 2: Background

The cyclists of Copenhagen are largely committed to the bicycle as a means of transportation, and extensive work has been done to promote cycling in Denmark and the culture associated with it. Many aspects of Danish cycling culture are not found anywhere else in the world. Hence, even though natives consider Denmark to be a highly bike-friendly country, few tourists in Denmark choose to cycle because the process of finding a bike, figuring out where to go, and learning the rules of the road can be an overwhelming experience. The *Cyclistic* software tool aims to alleviate some of these issues by facilitating the planning of tourists' sightseeing ventures. To evaluate *Cyclistic's* ability to attain this goal, our team needs to develop a thorough understanding of the cycling culture and infrastructure that bicycling tourists will encounter in order to recognize how the software could be improved to better target their needs and prepare them for their cycling adventures. This section presents an overview of the cycling infrastructure and culture in Copenhagen, various aspects of Danish tourism including popular tourist attractions and how tourists seek information about Denmark, the different types of existing route planning tools, including *Cyclistic*, and their unique and useful features. It also discusses fears associated with being a new cyclist in Copenhagen, how a route-planning tool such as *Cyclistic* can help address those fears, and how *Cyclistic* could be tested to ultimately increase its usability.

Figure 1: An everyday scene in Denmark (Colville-Andersen, 2010)

2.1 Dansk Cyklist Forbund

The Dansk Cyklist Forbund, or the Danish Cyclists Federation (DCF), is a non-governmental organization that has been working to strengthen the cycling culture in Denmark since 1905 (DCF, 2012). Since its establishment, the DCF has sought to promote cycling for both transportation and recreational purposes. Initially, the DCF focused its efforts on creating an environment where cars and bicycles could safely co-exist by advocating various rules, regulations, and infrastructure changes. Their main philosophy is that "Cycling should be a safe, fun, easy and obvious choice everywhere in Denmark" (ibid.).

To further promote cycling in Denmark, the DCF has employed various campaigns and projects such as the *We Cycle to Work Campaign* that rewards people for biking to work with freshly baked bread (Copenhagenize, 2012). The DCF has also sponsored a number of kid-friendly campaigns to promote cycling among Copenhagen's youth by providing biking lessons (Bicycle Account, 2010).

More recently, the DCF has directed their efforts at promoting cycling *amongst tourists* in Denmark. Since cycling is such an integral component of Danish culture, the DCF believes that the only way for tourists to truly get to know Denmark and experience its culture is via cycling. Over the past few years, the DCF – in conjunction with students at Worcester Polytechnic Institute – has aimed to educate tourists about Danish cycling culture to make it easier for them to cycle around the city. One outcome of this initiative, a blog known as Cycle Guide, contains "everything you need to know about cycling in Copenhagen and Denmark" (Cycleguide.dk, 2010). It provides tourists with useful tips, informative videos, and other handy links for those interested in cycling. To further promote cycling amongst tourists in Denmark, the DCF has been working in collaboration with the web agency Klean to create the online route planner *Cyclistic* (Cyclistic.dk, 2012). This site is unique in that it contains a comprehensive database of Danish attractions and their locations, which enables users to plan bicycle routes around their own sightseeing interests. In 2011, a beta version of *Cyclistic* was launched, and its database of attractions and features has been progressing ever since. *Cyclistic's* main ambition is to help tourists plan their tours of Denmark by providing detailed routing information and the locations of various types of attractions, while still leaving room for tourists "to improvise, explore…the unknown, and manage the unforeseen" (Cyclistic.dk, Colville-Andersen, 2010). Since

Cyclistic's development is ongoing, it still has room to improve. Accordingly, the DCF and Michael Hammel have asked us to develop suggestions for making *Cyclistic* a better routing tool for tourists. Our suggestions will be in the form of (1) modifications to the current interface and (2) new features to add, which will enhance *Cyclistic's* functionality and ease of use as well as the users' overall enjoyment throughout the process of route planning and biking in Denmark.

In addition to tourists and the DCF, other relevant stakeholders in our project include tourist agencies in Denmark such as *Visit Denmark* (VisitDenmark.com, 2006) and bike rental shops such as *Baisikeli* (Baisikeli.dk, 2012). As displayed in Figure 2, the users, or tourists, are located at the center of the stakeholder diagram. This illustrates their centralized importance in this project and emphasizes the importance of addressing their needs and desires. Surrounding the users are the facilitators – the organizations/businesses that help interested tourists get on a bike (*Baisikeli*). Since they work so closely with the tourists, facilitators serve as excellent sources of information pertaining to ways in which *Cyclistic* could be improved to better target tourists' needs. Our final stakeholders are the promoters – the organizations/businesses that encourage tourists to take part in Denmark's cycling culture (*Visit Denmark*). The promoters are located in the outer ring of the diagram because they are involved least directly with the tourists. In addition to addressing the needs and desires of the users, we will also involve the promoters and facilitators in this process to determine how *Cyclistic* can be made more well known in the tourist community as well as how it can work with the facilitators to promote cycling in Denmark.
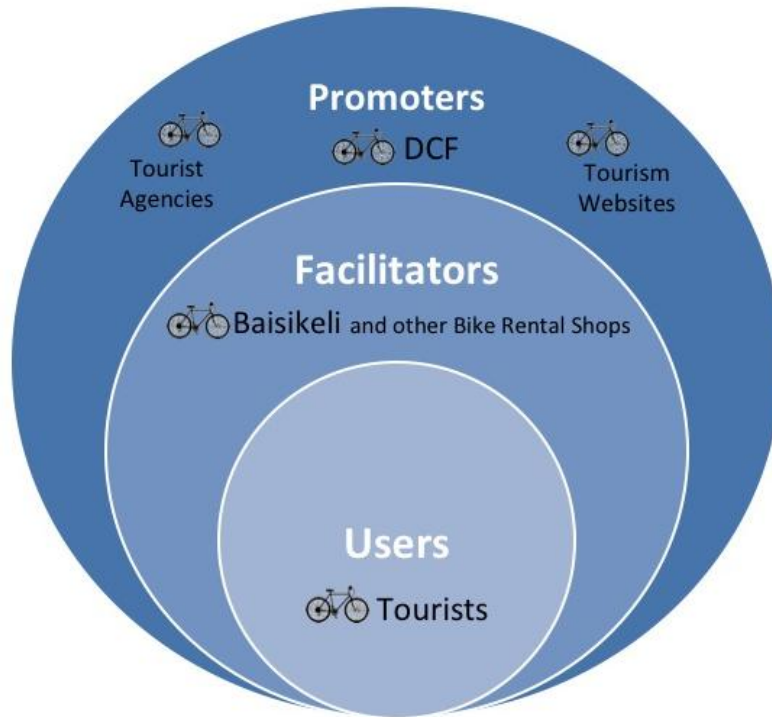
Figure 2: Project Stakeholders

2.2 Cycling Infrastructure

This section details the various aspects of Denmark's cycling infrastructure with special attention to the different types of bike paths and cycling etiquette/rules that tourists would encounter. In order to evaluate a tool that is specifically aimed at assisting people who are unfamiliar with cycling in Denmark, we need to develop a thorough understanding of this unique infrastructure so that we have a better idea of what aspects may be most intimidating to tourists.

2.2.1 Bike Paths and Bike Parking

The bike, in an urban setting, is often a swift and convenient mode of transportation. Martino, Maffii, & Raganato's *The Promotion of Cycling* (2010) is a study organized by the European Parliament that investigated ways to promote the bicycle as a sustainable form of

transportation. A key strategy they devised is creating designated bicycle routes, which channel cycling traffic away from car and pedestrian traffic for the purpose of offering the safest, most efficient routes through both urban and suburban areas. The pathways themselves vary in size and complexity based on the particular region and traffic flow. They tend to be separated into four distinct categories: (1) cycle paths or tracks, (2) cycle lanes, (3) cycle streets, and (4) cycle routes. *The Promotion of Cycling* defines a cycle path or track as a structure or pathway along the side of, but not on, a roadway. Cycle lanes vary from cycle paths since they are defined as painted lanes on a roadway. Cycle streets are simply streets where bikes have priority over vehicles and pedestrians, and finally cycle routes are constituted by a linked series of cycle paths or lanes. These bicycle routes also vary in their levels of traffic. Some routes are fairly low-traffic, while others are high-traffic and congested with commuters on bikes, which can be intimidating to first-time cyclists. According to Copenhagenzie.com (2012), a blog dedicated to the cyclists of Copenhagen, The Green Wave (Figure 3) is an example of a high-traffic bike route. The Green Wave is actually a series of cycling routes designed for mass flow, specifically to help commuters get to work as quickly as possible. The largest of these routes is along Nørrebrogade and sees upwards of 35,000 cyclists a day. The major advantage of commuting via the Green Wave is that the traffic lights are timed in such a way so that a constant 20kph rate may be maintained along the entire route. Biking along the Green Wave can be especially intimidating to first-time cyclists in Denmark because it is a highly congested route, so it is not unusual to find yourself cycling in extremely close proximity to other cyclists.

Figure 3: The Green Wave (Copenhagenize.com, 2012)

Another feature of cycling infrastructure that has made cycling in cities a fast and easy means of transportation has been the implementation of bicycle parking stands (Martino, Maffii & Raganato, 2010). Because bicycling has become such a major transportation option in many cities, bicycle parking has become an integral part of cycling infrastructure. Incorporating the locations of designated bike parking stands into its attractions database is a feature of *Cyclistic* that tourists may find useful.

2.2.2 Rules and Regulations of the Road

All bicycle-friendly cities have their own unique bicycle policies with distinct laws and regulations. A sufficient understanding of these rules is a requirement for anyone planning to cycle in Copenhagen. In some countries such as the UK and Australia, cyclists are required to wear helmets and reflective clothing, and bikes must be equipped with bells and lights (Pucher, 2007). Denmark, on the other hand, does not enforce these types of rules. Rather, their safety policy predominantly focuses on accident prevention by use of well laid-out cycling paths. Despite this relaxed approach to safety law, the City of

Copenhagen reported in their bi-annual Bicycle Account (2010) that cycling-related injuries are at an all-time low with only 92 serious injuries in 2010 despite a record high number of cyclists. According to the Ministry of Transport in the Netherlands (2009), Denmark has one of the lowest fatality rates compared to other countries in Europe, which corresponds to the inverse relationship between the amount of kilometers cycled in a country and the number of cycling-related fatalities (Figure 4).
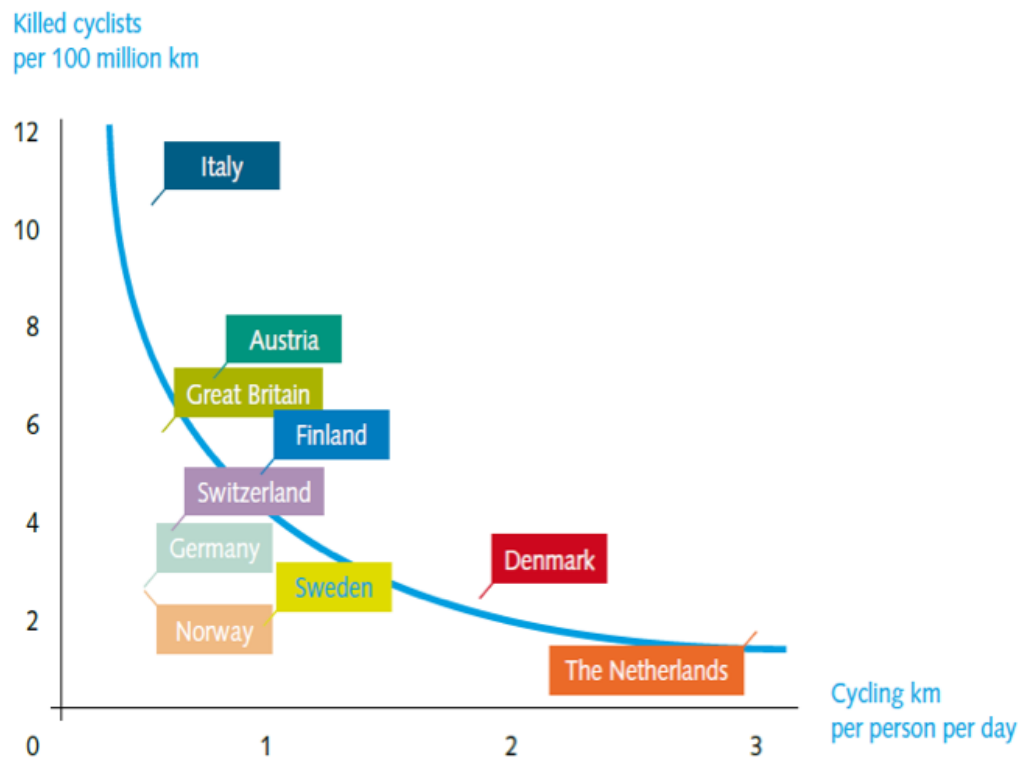
Figure 4: Relationship between amount of cycling and number of fatalities (Ministry of Transport, 2009)

In addition to well-organized cycle paths, Denmark's extensive *rules of the road* may also contribute to its relatively low cycling fatality rate. Cycle Guide (2010) is a blog specifically designed to educate tourists about cycling in Denmark, which contains a comprehensive list of these rules. It provides tourists with useful tips and informative videos on using hand signals, obeying traffic laws, and heeding cycling etiquette.

Cycle Guide points out that some rules may seem like common sense, such as keeping at least one hand on the handlebars and both feet on the pedals or keeping to the right side of the cycle paths so others may pass. Other rules are not so obvious, such as rules for turning at an intersection. As intersections are the scene of many accidents (Rosenkilde, 2011), it is important for tourists and new cyclists to understand how to safely navigate intersections in a lawful manner. A number of the busier intersections in Copenhagen have traffic signals tailored specifically to bike traffic (Figure 5). The blue light with a bicycle symbol signifies a bicycle-only path.

Figure 5: A Traffic Light Tailored for Cyclists (Copenhagenize.com, 2012)

Other rules of the road outlined in Cycle Guide that tourists may be unfamiliar with are that turning right on red is not allowed, and in order to turn left, it is recommended that cyclists perform what is known as a hook turn. The proper way to execute a hook turn (denoted by the green path in Figure 6) is by taking a slight right turn in an intersection before hooking left to line up with the traffic flow. Then, the cyclist waits for the light to turn green.
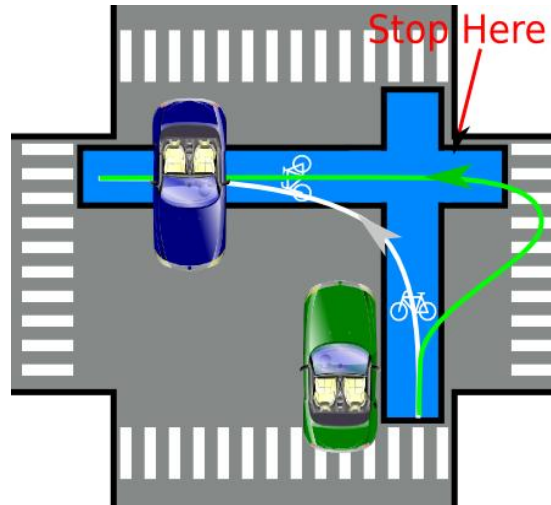
Figure 6: Performing a Hook Turn (Cycle Guide, 2010)

As mentioned in Cycle Guide, unlike a car or motorcycle, bicycles do not have brake lights or turn signals. For this reason, it is up to the cyclist to let other cyclists now their intentions, and the best way to do this is through a series of simple hand signals (Figure 7). Unfortunately for tourists, hand signals are not universal, and the signals that are used in America and other places in Europe mean different things in Denmark. For example, the signal used in America for turning right is actually the stop signal in Copenhagen. This kind of confusion could lead to serious accidents or disruption of traffic flow. According to Marasco (2011), this confusion is also one of the predominant reasons why tourists are reluctant to cycle – they fear that they may cause a disturbance or stand out. However, according to Michael Hammel, by creating an online route planner that makes it easier for users to navigate through the city, tourists will have one less obstacle to be concerned about. Ideally, *Cyclistic* will allow tourists to worry less about where to go and will direct more of their attention to obeying the proper cycling etiquette and rules.
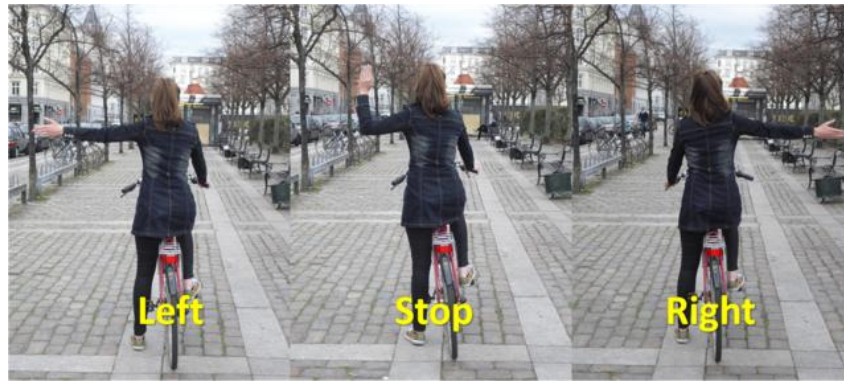
Figure 7: Proper Hand Signals in Copenhagen (Cycle Guide, 2010)

2.2.3 What is unique about Danish cycling infrastructure?

Copenhagen boasts some of the most extensive bike paths in the world. The physical infrastructure itself, described in the latest Bicycle Account (2010), released by the City of Copenhagen, is comprised of 346km of cycle paths and is constantly being updated and maintained. According to The Promotion of Cycling (Martino, Maffii & Raganato, 2010), in order for cycling to pass as a legitimate means of mass transportation, there must be a separation of pedestrians, cars, and bikes. The routes available to cyclists in Copenhagen follow this standard and range in size and complexity, from smaller, 1 meter-wide lanes differentiated by a small curb, to the Green Wave, which expands to 5m in some places (Cycle Guide, 2010).

One unique aspect of Danish cycling infrastructure is its use of bike barometers to promote cycling. These barometers count the number of bicycles using a certain path and proudly display the number to those passing by. "It is a way to favor cyclists – to show that they count" (Kristiansen, Koors & Martinez, 2010).

In an effort to ensure that cycling works *with* the public transit system, rather than against it, The Danish Cycling Embassy (2010) has also worked to make buses and trains more bike-friendly. For instance, the S-train, which services much of the area in and around Copenhagen, now allows cyclists to bring their bikes on the train free-of-charge and store them in specially designed bicycle compartments (Figure 8). These compartments, which

were remodeled in 2010, now provide twice as much space for bicycles and allow for one-way traffic to make it easier for cyclists to enter and exit the train (Rosenkilde, 2011).

Developing an understanding of the unique aspects of Copenhagen's cycling infrastructure is critical in evaluating *Cyclistic's* ability to make navigating through this unfamiliar city more manageable for tourists.

Figure 8: S-train bike compartment (Cycling-Embassy.dk, 2010)

2.2.4 Baisikeli and other Bike Rental Shops

Because most tourists are incapable of transporting their own bikes to Denmark, bike rental shops have become prominent businesses for tourists. There are many shops that rent, sell, or repair bicycles in Copenhagen, such as Baisikeli (Baisikeli.com, 2012), which will be our main *Cyclistic* testing site. This shop is named after the Swahili word for bicycle and was founded by Henrik Smedegaard Mortensen and Niels Bonefeld. Baisikeli is unique compared to other bike rental shops because they rent out second-hand bicycles. They refurbish bikes that have been thrown out or donated, and the proceeds are used to provide bicycles to less fortunate people in third-world countries such as Tanzania, Sierra

Leone, and Ghana. They believe bikes to be "one of the simplest and most effective ways of creating better lives for the poor population of the world."

Figure 9: Baisikeli shop in Copenhagen (Peter Stanners, 2011)

As mentioned in Section 2.1, we have classified Baisikeli and other bike rental shops as facilitators, defined in this context as organizations that help interested tourists get on a bike. For this reason, Baisikeli will serve as an excellent source of information pertaining to ways in which *Cyclistic* could be improved to better target tourists needs. In addition, since Baisikeli and the DCF share the goal of promoting bicycling in Denmark, it is worth looking into a possible collaboration on *Cyclistic* between the two groups.

2.3 Perceptions of Cycling

Copenhagen is a city designed for cyclists, and in order to understand why few visitors choose to cycle, we need to understand what influences their decisions. This section explores the psychological aspects of cycling with particular focus on why cycling can be a desirable form of transportation and the fears and stigmas that prevent it from being an enjoyable experience for tourists.

2.3.1 The Cycling States of Mind

In most countries, people are either recreational cyclists or vehicular cyclists (Cycling in Cities, 2012). In the case of recreational cycling, bicycles are regarded as a sporting contraption to be used by enthusiasts only. This is alienating to new cyclists who feel they cannot meet the high athletic expectations characteristic of cycling for sport. Vehicular cycling was pioneered by cyclists such as John Forrester (Forrester, 2010), who classifies vehicular cyclists as those that share roads with automobiles, hence the vehicular connotation. John Forrester believes that "cyclists should be seen as equal road users to automobiles, and the expansion of bike routes and lanes just alienates cyclists who deserve the same rights to the road as drivers." Unfortunately, vehicular cycling can pose significant dangers to new cyclists who are unfamiliar with road customs or traffic flow. Tourists from countries where people are either recreational cyclists or vehicular cyclists, are less likely to show interest in cycling in Denmark since they either view cycling as something that is only for cycling enthusiasts or is too dangerous to attempt in an unfamiliar setting.

In *Mobility in Everyday Copenhagen* (2011)*,* Matteo Marasco analyzes the state of mind of cyclists in Copenhagen. Marasco classifies cycling in Copenhagen as utilitarian cycling, where the bike can be used for any purpose that another transportation medium could accomplish. This means that the bike is just as capable of picking children up from school and commuting to work as driving, walking, and public transit would be. The concept of utilitarian cycling works well in a city like Copenhagen, especially when a bike can take the most direct route along bike paths and lanes, while avoiding traffic and maintaining a speed of roughly 15kph. Marasco also maintains that new cyclists and tourists are often more willing to embrace an environment where utilitarian cycling reigns over recreation

and vehicular cycling because traffic flows are separated between other modes of transportation, and slow cycling is accepted, if not the norm, in most areas.

2.3.2 What are the motivators and deterrents to cycling?

According to Copenhageners, the main reasons for cycling, in descending order, are that it is fast, convenient, healthy, cheap, a good way to start the day, the shortest route to work, and in line with environmental concerns (Bicycle Account, 2010). Bicycles are simple machines with numerous capabilities. There are bikes for just about any ability or purpose, from race bikes to bikes that can transport children or groceries. In addition, bicycles are relatively inexpensive, require little maintenance, and are a sustainable form of transportation (Martino, Maffii & Raganato, 2010).

Despite the numerous benefits of cycling, tourists in Denmark are still reluctant to give it a try. Dave Horton's *Fear of Cycling,* in Paul Rosen's *Cycling and Society* (Rosen, 2007), addresses the factors that prevent people from cycling. These factors break down into perception of risk versus actual risk and factors that make cycling strange to someone new to cycling. Horton explains that being new to any culture can be intimidating, but in the case of cycling, prior misconceptions or fears over safety can lead to immediate avoidance. The main concerns tourists have are causing disturbances and getting lost in a foreign place. In addition, many tourists believe that cycling is a dangerous activity, when in reality very few people are seriously injured on a bicycle each year when compared to other forms of transport as discussed in Section 2.2.2. Understanding these concerns and how to potentially mitigate fear through the use of educational tools within *Cyclistic* is something that we will consider as this project moves forward.

Cycling in Cities (2012) – a research program based out of the University of British Columbia – has studied factors that motivate and deter people from cycling in an urban environment. The motivation to take a bike may be different for different people, but according to their 2011 opinion survey of 1,402 current and potential cyclists, cyclists are more motivated to cycle when they have a list of route preferences to select from (Cycling in Cities, 2012). This study in particular shows that people are more motivated to bike along cycle routes that are low-traffic and not plagued with noise or air pollution. A complete list

of motivating/deterring factors from this study is presented in Figure 11. From examining the chart, these factors can be broken down into the following categories: safety, aesthetics, cycling difficulty, and convenience. Safety factors include separation from road traffic and well-maintained routes. Aesthetics involve factors such as pleasant scenery or low traffic noise. Cycling difficulty includes route complexity and elevation changes. Finally, the convenience category is comprised of factors that involve how long it takes to get to a destination and route accuracy. In promoting interest in cycling among tourists in Denmark, we can conduct a similar study to determine what specific factors would motivate or deter Danish tourists from cycling. We can also use the results from this study to develop ways to incorporate these motivating factors into *Cyclistic*.

FACTOR	INFLUENCE
The route is away from traffic noise & air pollution	0.79
The route has beautiful scenery	0.70
The route has bicycle paths separated from traffic for the entire distance	0.69
The route is flat	0.61
Cycling to the destination takes less time than traveling by other modes	0.59
The distance to your destination is less than 5 km	0.53
You can make the trip in daylight hours	0.50
You can take your bike on the SkyTrain at any time	0.50
A 2-way off-street bike path has a reflective centre line for night & poor weather cycling	0.49
The destination has secure indoor bike storage	0.49
The route has bike signage, pavement markings & bike activated signals on residential streets	0.47
The destination has covered bike racks, to protect from rain	0.47
Information about cycling routes to the destination is available	0.46
The bus has racks that carry bikes	0.45
A web-based trip-planning tool is available	0.45
The destination has outdoor bike racks	0.42
There is a consistent type of bike lane marking throughout the greater Vancouver area	0.41
There are secure bike lockers at transit stations	0.41
The route is wide enough for cyclists to ride side-by-side	0.40
The destination has a place to store a change of clothing	0.38
The route has on-road bicycle lanes on major roads for the entire distance	0.36
Traffic calming on designated bike routes reduces the number of cars using the route	0.36
The destination has a place to dry your cycling gear	0.36
The bike lane has a different colour pavement than the road	0.35
You would be eligible to receive prizes or discounts such as savings on bike gear	0.35
There are shops, banks, & grocery stores along the route	0.34
The destination has showers	0.34
The route has push-button-activated traffic signals for cyclists & pedestrians only	0.30
There are bike racks at transit stations	0.30
Inexpensive or free short courses are available to help you learn how to fix your bike	0.30
A bicycle is stenciled every 75 m (250 ft) along the route	0.28
The destination has bike repair facilities	0.28
The destination has rental bike lockers	0.27
A solid white line is painted on both sides of the lane separating it from moving cars & from parked cars	0.26
Inexpensive or free short courses are available to help you improve your cycling skills	0.24
You are making the trip with other people	0.18
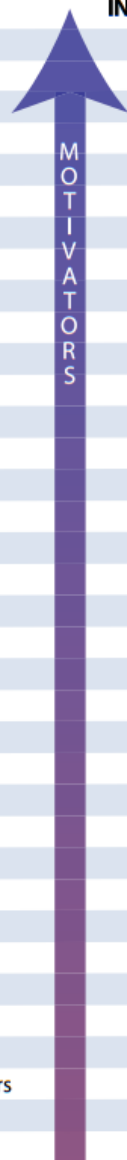
Figure 10: Motivating and Deterring Factors to Cycling (Cycling in Cities, 2012)

(continued on next page)

The bike lane has one solid white line painted between moving cars & the bike lane	0.16
The distance to your destination is 5 to 10 km	0.14
Cycling helmets are required	0.14
Lights are required for cycling after dark	0.13
The street is wide enough for motorists to safely pass cyclists	0.10
The route has a few small hills	0.02
The route has regular traffic signals for all traffic (cyclists, pedestrians, cars & trucks)	0.01
Cycling side-by-side on roads is not allowed	-0.05
Many intersections on the route have traffic circles	-0.12
Bike lane markings end just before intersections	-0.13
The route has rail crossings	-0.13
The weather is hot & humid	-0.16
Cycling on sidewalks is not allowed	-0.22
You need to buy groceries	-0.23
The route surface is gravel or dirt	-0.25
The route has speed bumps	-0.25
The route has lots of fallen leaves	-0.29
Designated bike routes on residential streets are used by cars because there are fewer stop signs	-0.31
There are bridges along the route where cyclists must share a narrow sidewalk	-0.34
The distance to your destination is 10 to 20 km	-0.37
The risk from cyclists who don't know how to ride safely	-0.37
Cyclists have to stop at many stop signs on the route	-0.37
The street has on-street parking	-0.43
The route has long steep sections	-0.50
The risk of violent crime when cycling	-0.55
The route has potholes or uneven paving	-0.55
The risk of bicycle theft	-0.56
You need to carry bulky or heavy items	-0.57
The route is not well lit after dark	-0.59
The route has surfaces that can be slick when wet or icy when cold	-0.59
It is raining	-0.63
The risk of injury from car-bike collisions	-0.67
The risk from motorists who don't know how to drive safely near bicycles	-0.73
Vehicles drive faster than 50 km/hr	-0.76
The route has glass or debris	-0.76
The street has a lot of car, bus, & truck traffic	-0.83
The route is icy or snowy	-0.86

Figure 11: Motivating and Deterring Factors to Cycling (Cycling in Cities, 2012)

2.4 Danish Tourism

According to an annual study completed by the Denmark National Tourism Organization and Statistics Denmark (2009), approximately 4.7 million tourists visit Denmark each year. Interestingly, Statistics Denmark has found that while the number of day trips to Demark has been steadily increasing, the number of overnight trips has been steadily decreasing. Cycling tourists who are only looking to spend a day in Denmark are especially in need of a bike routing tool such as *Cyclistic* because they have little time to research cycling routes and attractions on their own.

Even with the decrease in overnight tourists, tourism in Denmark is still a growing industry – with an overall percent increase of tourists per year of approximately 1.4% (Euromonitor International, 2012). The DCF has been focusing on expanding means for tourists to sightsee via bicycling to accommodate this increasing numbers of tourists.

In evaluating the *Cyclistic* software tool, we will need to understand tourists' sightseeing interests and how they seek information about touring. This will allow us to make educated decisions about how to promote the tool to make it more accessible for tourists. This section discusses the attractions in Denmark that tourists visit most often, how tourists find information on those attractions, and the various bike tours that Copenhagen has to offer.

2.4.1 Danish Attractions

Denmark has a variety of attractions for tourists, providing them with the opportunity to experience the past with the present. In the context of our project, we define an attraction as a desired point along a route. Attractions can be any place that appeals to someone's interests and desires such as a restaurant, museum, park, or architecture. Attractions are not the same as destinations because a route can only have one destination – but can have multiple attractions. Table 1 presents a summary of some popular tourist attractions organized by the type of attraction. Figure 12 displays the relative locations of a selection of these attractions, and as shown, a number of these popular attractions are within biking distance of one another.

Table 1: Summary of Popular Tourist Attractions in Denmark (*VisitDenmark*, 2006)

Historical/Museums	Parks/Recreation	Restaurants/Bars	Architecture/ Modern Art
The National Museum	Tivoli Gardens (Figure 14)	Andersen's Danish Bakery	AROS Aarhus Art Museum
Round Tower	Legoland	Noma Restaurant	Louisiana Museum of Art
Rosenborg Castle	Copenhagen Zoo	Carlsberg Brewery	Danish Film Institute
Little Mermaid Statue (Figure 13)	Dyrehavsbakken	Peder Oxe's Restaurant	Ørestad
Viking Ship Museum	Sommerland	Gitte Kik (Slotskaelderne)	Royal Danish Playhouse
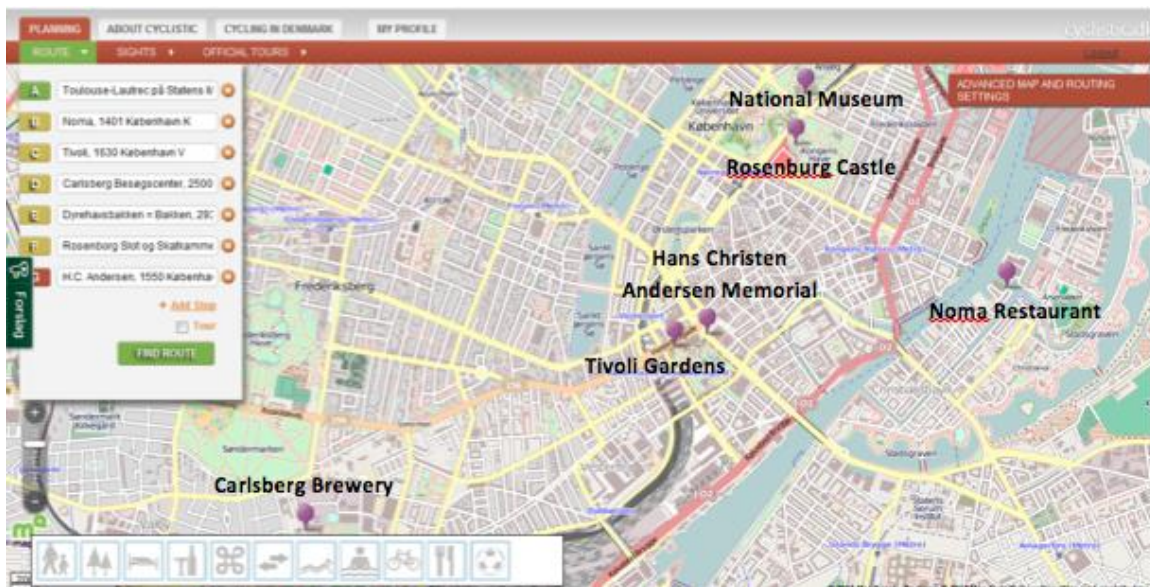
Figure 12: Locations of various Danish attractions (Cyclistic.dk, 2012)

Figure 13: Little Mermaid Statue (PlanetWare, 2012)

Figure 14: Tivoli Gardens (European City Parks, 2007)

2.4.2 How do tourists seek information about Denmark?

Most tourists seek information about Denmark either through tourist agencies or by word of mouth from others who have previously visited the country (Mansfeldt, Vastager & Iversen, 2008). According to Donna Sandahl Sørensen, a representative from VisitDenmark.com (2006), the majority of tourists in Denmark come from local countries such as Germany, Holland, Sweden and Norway. Most of these tourists travel to Denmark for the purpose of going on cycling holidays. Conversely, tourists from other parts of the world tend not to cycle during their stay in Denmark.

In order to better attract tourists to Denmark and entice them to sightsee via cycling, Michael Hammel and Baisikeli have been working with various Danish tourist agencies. As mentioned in Section 2.1, tourist agencies are cycling promoters, along with the DCF. The main tourism website in Denmark is VisitDenmark.com (2006), which provides information on the most visited attractions in Denmark and ways to tour Copenhagen, including via cycling. *Visit Denmark* supports smaller tourist companies and sites such as *Cyclistic*, but in order to make the routing tool more accessible to tourists, our team will need to work closely with this promoter to ensure that tourists are well aware of the tool and its capabilities.

2.4.3 Bike Tours in Copenhagen

In addition to bike rental shops such as Baisikeli, there are a number of bike tour companies that also share the desire to promote cycling amongst tourists in Denmark. Many tourists opt to take these guided bicycle tours as a less overwhelming means of experiencing Danish culture. Guided bicycle tours offer tourists the ability to tour the country along a safe, pre-planned route with experienced cyclists.

Presently, there are three major companies that provide guided bike tours through Copenhagen: *Bike with Mike* (Bike Copenhagen with Mike website, 2012), *Copenhagen Tours* (Copenhagen Tours website, 2012), and *Copenhagen X* (Copenhagen X website, 2012). All of these guided tour companies allow tourists to choose between tours focused on different aspects of Danish culture such as its history, architecture, and famous restaurants and bars. Copenhagen X's guided tours focus more on providing a view of the modern aspects of

Denmark such as its modern architecture, art, and sculptures. These tours are available as guided biking or walking tours.

The negative aspect to touring a city via a guided tour is that tourists do not have the freedom to visit the sites that most interest them. Tourists must stay with the group and cannot travel beyond their predetermined attractions. Guided tours hamper inspiration, unlike route planning sites such as *Cyclistic*, which leave room for exploration

2.5 Routing Software

Route-planning software such as Google Maps (Google Maps website, 2012) and MapQuest (MapQuest website, 2012) are programs that can design routes to connect different locations of interest. Google Maps, MapQuest, and most other existing route-planning software were originally designed for motor vehicles and offer turn-by-turn directions via streets and highways. Google Maps also has a "search nearby" feature, which allows users to search for various types of attractions along their routes.

Although Google Maps and MapQuest are two highly utilized and well-known routing websites, they are not especially useful for bicyclists. MapQuest, for instance, lacks the ability to incorporate vital cycling-specific constraints such as avoiding highways, and both sites lack a comprehensive database of all bike lanes and bike-only paths. Further, as discussed in Section 2.2.2, bicycling has its own set of traffic rules and regulations that most routing tools do not address. All of these issues prompt the need for cycling-specific routing tools, such as *Cyclistic*.

2.5.1 What are the goals of *Cyclistic*?

The primary ambition of *Cyclistic* is to promote cycling amongst sightseeing tourists in Denmark. To address most tourists' reluctance towards cycling in Denmark, the creators of *Cyclistic* want to make it easier for tourists to navigate to their attractions of interest so that they have one less obstacle to worry about. To achieve this ambition, *Cyclistic's* developers aim to exceed other routing tools by better targeting users' needs and desires. No tool like *Cyclistic* currently exists, and as Michael Hammel explained, "*Cyclistic* is

currently being developed as something that nobody has asked for because many didn't know it was possible."

In addition to providing tourists with a means of finding bicycle-friendly routes along their points of interest, the developers want to educate tourists about the country of Denmark and inspire them to immerse themselves in its culture. According to Michael Hammel, the creators of *Cyclistic* would also like to see an increase in the number of tourists cycling in the countryside and hope that this tool will encourage tourists to explore everything that Denmark has to offer. In essence, the creators of *Cyclistic* want to make routing a bi-product of tourists' own research and interests.

In order to achieve all of the developers' goals and create a superior guidance tool for sightseeing tourists, we need to develop an understanding of what types of features an ideal bicycle routing tool would possess. Thus, it is advantageous to look at existing bicycle routing tools to study both their flaws and desirable features.

2.5.2 What features do existing bicycle routing tools offer?

There are a number of route planning applications and websites currently available for cyclists. A few of the most popular websites among cyclists include MapMyRIDE.com (MapMyRIDE website, 2011), Bikely.com (Bikely website, 2010), Cyclevancouver.ubc.ca (Cycle Vancouver website, 2007), and Cyclecopenhagen.dk (Cycle Copenhagen website, 2012). These routing tools have become well known among cycling communities because of their unique and useful features (**Table 2**), which are discussed later in this section. Some of these features include: attractions, amenities, eliminatory constraints, route attributes, and attribute weights. As previously stated, attractions are desired points of interest along a route. Amenities, such as public restrooms, water fountains, and bike repair shops, are points of interests that can accommodate the immediate, pressing needs of the cyclists. Eliminatory constraints are factors that can restrict routes by only showing bicycle-friendly paths and intersections or excluding roads prohibited from cycling. Route attributes are desirable route characteristics such as "safest," "shortest," "most vegetated," and "least pollution." Finally, weights are numerical values that users can apply to given attributes to prioritize their *preferred* route attributes. Examining existing bike routing tools' desirable

features will help us establish how *Cyclistic* fits into the realm of routing software and make recommendations for its improvement.

Table 2: Routing Tools and their Features

Routing Tool	Specific for Cyclists?	Routing Tool Features					
		Route Descriptions	Attractions	Amenities	Eliminatory Constraints	Route Attributes	Attribute Weights
Google Maps		✓	✓	✓			
MapQuest		✓	✓	✓			
MapMyRIDE	✓	✓			✓		
Bikely	✓	✓			✓	✓	
CycleVancouver	✓	✓		some	✓	✓	
CycleCopenhagen	✓	✓			✓	✓	
Cyclistic (CURRENTLY)	✓	✓	✓	some	✓		
Cyclistic (IDEAL)	✓	✓	✓	✓	✓	✓	✓

MapMyRIDE (2011) is a social health-oriented website owned by MapMyFITNESS, Inc. that attracts a number of fitness enthusiasts and avid cyclists around the world. As presented in Figure 15, MapMyRIDE offers an easy-to-use interface that allows users to create routes, share routes, and search for pre-mapped routes. It is an outlet for like-minded and similarly skilled cyclists to connect and share their training plans. The site provides detailed route descriptions from the distance traveled to the estimated duration, pace, and elevation. A drawing tool even allows users to add pit stops for water and bathroom breaks along their routes; however the software does not provide the locations of these amenities – the user must input them instead. MapMyRIDE is also equipped with a number of other useful features such as nutrition tracking, route comparisons, a calorie counter, and an expansive database of cycling events, races, and results. In addition, the application works on various mobile devices such as iPhone, BlackBerry, and Android, and the routes can be exported as GPX files and transferred to GPS devices. Even though MapMyRIDE is esteemed among the cycling community, it does have a few undesirable features such as: (1) it does not allow users to input route preference data such as "shortest route" or "most scenic

route," (2) map printing costs money and requires a membership, and (3) the site is plagued with distracting advertisements that can only be removed through premium membership.
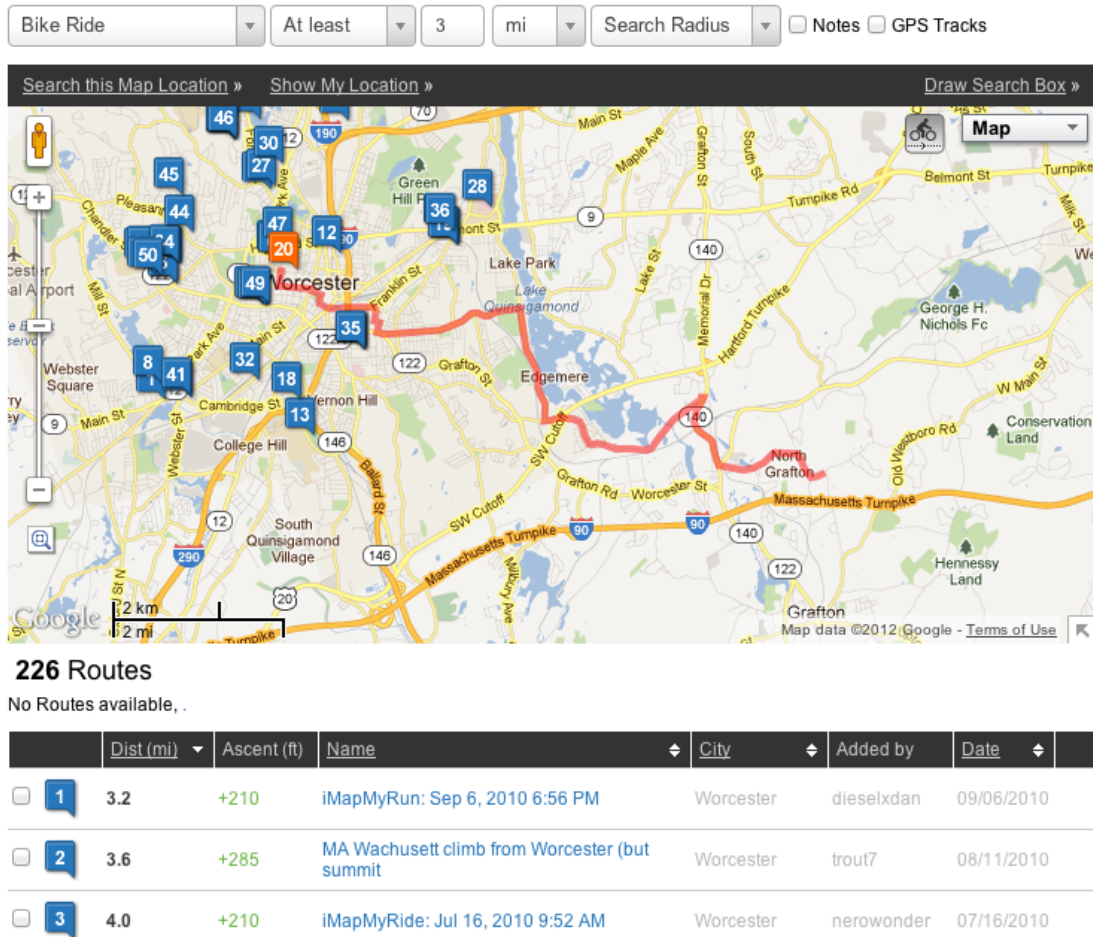
Figure 15: Screenshot of MapMyRIDE user-interface (MapMyRIDE.com, 2011)

Bikely (2010) is another popular global routing tool used among cyclists. It was designed by cyclists for cyclists and is a completely free site that allows users to map and share routes. Currently, it has over 170,000 pre-planned routes, which grows every day. Bikely offers a few unique and useful features such as: (1) users can search for pre-mapped routes that have been tagged with certain attributes such as *scenic* or *low traffic* (Figure 16) and (2) users can upload photos from their favorite routes to give others a preview of the routes' highlights and attractions. Like MapMyRIDE, Bikely is also equipped with the capability of exporting routes to GPS devices.

Figure 16: Screenshot of Bikely's Unique Route-Searching Feature (Bikely, 2010)

Cycle Copenhagen (2011) is a website that allows users to plan routes based on their own personal preferences, and as its name would suggest its mapping is centralized around Copenhagen. As shown in Figure 17, Cycle Copenhagen allows users to choose among the following route attributes: shortest, "copenhagenized," safer, green, and quiet.

Figure 17 displays how the same route can be mapped multiple ways depending if the user prefers the (blue) shortest route, (orange) "copenhagenized" route, (red) safest route, (green) green route, or (pink) quiet route. The *shortest* route will direct users from point A to B in the least amount of time possible, the "copenhagenized" route will steer users along bike lanes whenever feasible, the *safer* route will design a path along roads that are less traveled, the *green* route will navigate users through more scenic and vegetated paths, and the *quiet* route will direct users through areas with less noise pollution. With these unique features, Cycle Copenhagen is a useful tool for the utilitarian biker, but it is not especially helpful for tourists who are unsure of where to go and what sites are nearby.

Figure 17: Screenshot of Cycle Copenhagen (Cycle Copenhagen, 2011)

CycleVancouver (2007) is another routing tool that allows users to map routes based on their personal preferences. It was developed for cyclists and would-be cyclists in Vancouver to facilitate cycling in the city by the Cycling in Cities project team at the University of British Columbia, previously mentioned in Section 2.3.2. As displayed in Figure 18, users can choose among an array of route attributes such as shortest, most vegetated, least elevation gain, least traffic pollution, and restricted maximum slope. Figure 18 displays how the same route can be mapped multiple ways depending if the user prefers the (A) shortest route, (B) most vegetated route, (C) route with least elevation gain, or (D) route with restricted maximum slope. In addition, CycleVancouver possesses eliminatory constraints that can plan bicycle-friendly routes by excluding roads prohibited from cycling and by using only designated cycling paths and cyclist-controlled road crossings. Another key feature of CycleVancouver is its ability to display the locations of amenities such as water fountains and SkyTrain stations.
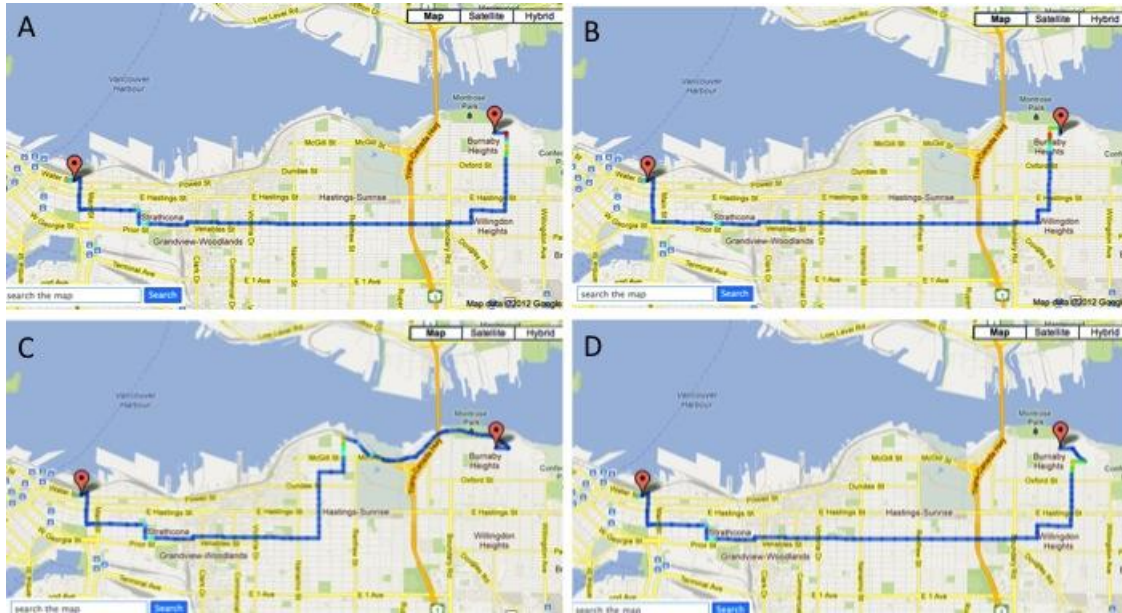
Figure 18: Screenshot of CycleVancouver (Cycle Vancouver, 2007)

There is no doubt that CycleVancouver is a useful routing website. Nevertheless, developers plan to make future modifications designed to make it a *superior* routing tool. According to Su, Winters, Nunes, and Brauer (2010), experts in the fields of Public and Environmental Health, the majority of existing route planners "provide only very limited functionality" and only have "single attribute optimization function[s]" (p.496). This means that users can only choose one route attribute preference, such as "safe." The authors argue that a more useful routing tool would provide users with the capability of choosing more than one route attribute, such as "safe *and* scenic." A further means of increasing usefulness would be allowing users to apply weights to their different selections. For example, users may desire a route that is both safe and scenic but would prefer safety slightly over scenery. Incorporating multiple route attribute selection and attribute weighting may allow tools such as CycleVancouver, and possibly *Cyclistic,* to more closely target each user's specific needs and desires, thereby rendering them superior guidance tools.

2.5.3 How is *Cyclistic* unique?

Cyclistic is a routing tool that has been specifically developed to promote cycling among tourists in Denmark by the DCF and the Klean web agency. Table 3 displays a summary of the different types of features that the previously described routing tools possess. The table is organized based on what features *Cyclistic* has and does not have. The features that *Cyclistic* currently possess are denoted by a checkmark, while features highlighted in yellow are features not yet incorporated into the software, but if integrated, could be potentially useful for tourists.

When compared to other routing tools, *Cyclistic* is unique because it incorporates comprehensive, up-to-date maps of the majority of bike paths in Denmark with bike-specific eliminatory constraints and an expansive database of Danish attractions. *Cyclistic* provides useful routing information, while leaving room for inspiration and exploration, enabling users to plan bicycle routes around their own sightseeing interests. Users can choose from an array of different attractions related to culture, food, sports, children, accommodations, the city, the waterfront, nature, relaxation, and transportation. Figure 19 displays a route in which the user has selected nature and child-related attractions. In Figure 20, the user has clicked on one of the nature icons to display its contact information and a brief description – yet another useful feature of *Cyclistic*. Figure 21 displays turn-by-turn directions that the user can print free-of-charge, and **Error! Reference source not found.**Figure 22 shows how long it will take to traverse the route based on the user's inputted speed as well as the elevation changes throughout the course of the route.

According to Michael Hammel, the attractions built into *Cyclistic* are downloaded from a database that contains over 18,000 points of interest, which is continuously updated. To our knowledge, the incorporation of sightseeing into bike route planning is a feature that no other existing bicycle routing software possesses.

Table 3: Summary of Routing Tool Features

Route Descriptions	Attractions	Eliminatory Constraints	Amenities	Route Attributes	Other features
✓ Turn-by-turn directions ✓ Distance traveled ✓ Estimated trip duration ✓ Elevation change	✓ Historical sites ✓ Parks ✓ Kid-friendly places ✓ Recreational sites ✓ Restaurants/ ✓ Bars ✓ Accommodations ✓ Nature-related sites ✓ Culture-related sites ✓ Sports-related sites	✓ Bicycle paths only ✓ Exclude roads that prohibit cycling ✓ Only use cyclist-controlled road crossings o ==Restrict maximum elevation change==	✓ Bike repair shops ✓ Public transit stations ✓ Public restrooms ✓ Water fountains ✓ Bike stands/ parking ✓ Picnic tables	o ==Safe== o ==Short== o ==Vegetated/ green== o ==Scenic== o ==Low traffic== o ==Small== ==elevation gain== o ==Quiet==	✓ Multilingual ✓ GPS compatible o ==Mobile App== o ==Nutrition tracking== o ==Route comparing== o ==Route sharing== o ==Pre-mapped routes== o ==Cycling-related events database== o ==Photo uploading== o ==Attraction pricing information== o ==Guide to information on cycling in Denmark== o ==Attribute weighting== o ==Link to Google Street View==

> ✓ = feature that *Cyclistic* currently has
> == == = feature that *Cyclistic* does NOT currently have that tourists may find useful (highlighted)
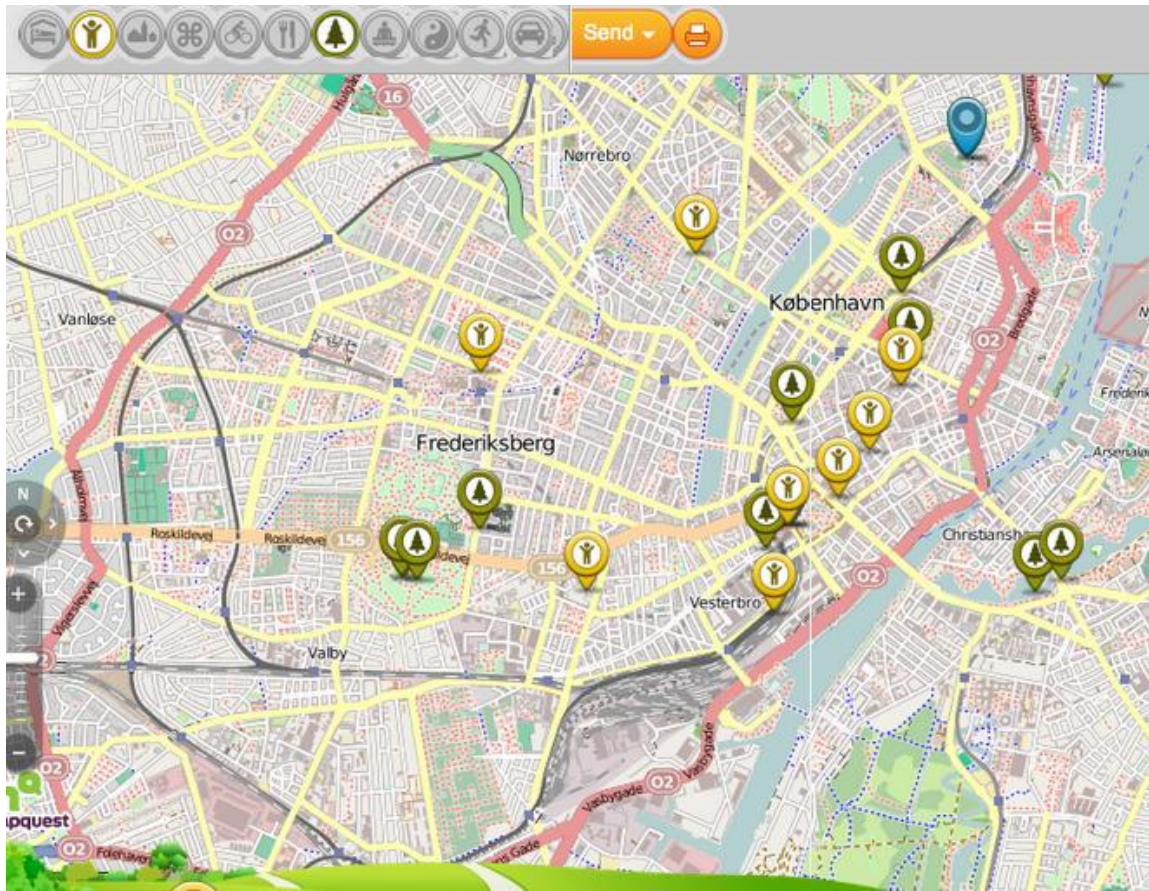
Figure 19: Screenshot of *Cyclistic* (Cyclistic.dk, 2012)

Figure 20: *Cyclistic's* Attraction Information (Cyclistic.dk, 2012)

Figure 21: Sample *Cyclistic* Route Description (Cyclistic.dk, 2012)
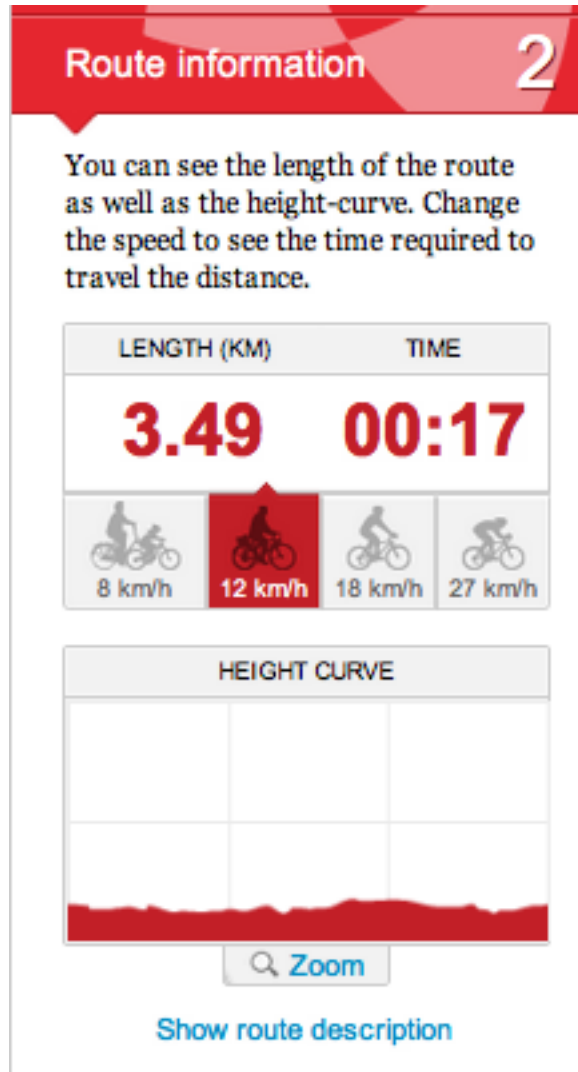
Figure 22: *Cyclistic's* "Estimated Time" Feature (Cyclistic.dk, 2012)

Another unique feature built into *Cyclistic* is its bicycle routing capabilities. As reported by Michael Hammel, *Cyclistic* was interfaced with MapQuest in developing the mapping portion of the software; however, modifications were made to exclude roads that prohibit cycling and to include paths designated only for bicycles. To help design routes that would be suitable for tourists, the movements of 80 different Danish cyclists, equipped with GPS receivers, were tracked and recorded. Presently, 50% of Denmark is routed in more detail than ever before. *Cyclistic's* bicycling-specific routing capabilities easily surpass those of Google Maps, MapQuest, or any other general mapping tool.

2.5.4 Improving *Cyclistic*

As outlined in this section, there are a number of routing tools currently available for cyclists that possess a variety of valuable functions and features. *Cyclistic's* ability to combine comprehensive levels of bicycle route mapping with the locations of attractions in Denmark place *Cyclistic* on its own unique level of bicycle mapping tools. All the same, as was displayed in Table 3, there is still opportunity for improvement. The ideal *Cyclistic* route planner could allow users to optimize their routes based on their preferred route attributes, apply weights to those preferences to prioritize them, and compare and share routes. *Cyclistic* could also include information on how much different attractions cost, cycling etiquette, and rules as well as a database of pre-mapped routes tagged with themes such as "parks & leisure," "night life," or "modern architecture." No existing routing tools possess all of these capabilities. Thus, in order to make *Cyclistic* a superior routing tool that better targets its users' needs, we will determine which features are most useful through a comprehensive usability study that will include field-testing the software with actual tourists.

2.6 User Testing

As the *Cyclistic* website was only recently launched in 2011, it is still currently under development. Thus, there is still a large margin for improvement. In order to make *Cyclistic* a superior guidance tool, the usability of its interface will need to be assessed. According to Michael Hammel, *Cyclistic* has not yet undergone any such usability studies. The following sections discuss what usability means, how a product can be designed with usability in mind, and finally how to test that product's usability.

2.6.1 What is Usability?

According to the International Organization for Standardization (ISO, Ergonomics of Human-System Interaction, 1998), usability is defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context" (ISO 9241-11). In general terms, usability is how easy something is to use. Joseph Dumas and Janice Redish, a psychologist and linguist, respectively, both with extensive experience within the domain of usability engineering,

have explored many aspects of this field in *A Practical Guide to Usability Testing* (Dumas & Redish, 1999). According to Dumas and Redish, product usability resides on four fundamental points: (1) in order to design a usable product, the needs and desires of the users must be thoroughly understood, (2) users are busy individuals who are trying to accomplish tasks as efficiently as possible, (3) people connect usability with productivity, and (4) users, not the designers, decide when a product is helpful and straightforward to use.

These authors also assert that historically, people choose the easiest, quickest route to accomplish a task. In regards to testing the usability of the *Cyclistic* software tool, tourists will want to be able to plan their sightseeing trips as quickly as possible so that they have more time to actually hop on their bikes and explore Denmark. According to Michael Hammel, most tourists who visit Denmark only spend 2-3 days in each city, so they have a limited amount of time to experience the culture. If *Cyclistic* or any other product is not straightforward to use or cannot be quickly learned without specific training, then consumers will search for another product to meet their needs. Therefore, even though usability is just one of the many aspects that must be addressed in developing a successful product, it is one of the most critical elements of product design.

2.6.2 What are the key principles in designing for usability?

Dumas and Redish (1999) emphasize that usability is not something that can simply be added to a product after it has been developed. Rather, usability must be incorporated and built into the product at the onset of the design phase. In their usability guide, Dumas and Redish note the key principles in designing for usability, which include: (1) involving users throughout the design process, (2) understanding the needs and desires of the users rather than merely identifying them, (3) testing the product with potential users after each design iteration, and (4) basing design decisions off of usability and the users' needs. In our case, our team will incorporate sightseeing tourists into the process as much as possible – we will need to garner an in-depth understanding of what would motivate them to sightsee via cycling and what sort of capabilities an ideal routing tool would possess. Ideally, every time a design alteration is made to *Cyclistic*, we will field-test the software to assess both the

users' opinions of and associated experiences with each modification. This will allow our team to determine which features actually increase *Cyclistic's* usability.

In *Designing Pleasurable Products: An Introduction to the New Human Factors* (Jordan, 2000), P.W. Jordan, an expert in the field of design and marketing, looks beyond the realm of usability to human elements and considerations. In the book, Jordan develops a three-step hierarchy of user needs, based on Maslow's Hierarchy of Needs. Jordan contends that the most basic need of a user is for the product to work. Once the users are satisfied with the product's functionality, they will expect the product to be easy to use. Finally, once the users are confident that the product is easily learnable without any specific training, they will expect that their experience using the product will be enjoyable. Functionality, ease of use, and enjoyment are the three metrics that we will evaluate in our study of *Cyclistic*.

If possible, we will incorporate *experience testing* into our usability study by observing users' actions and behaviors during their self-guided cycling tours. In the article, *The triumph of users* (Sun, 2006), Sun, a Communications Professor at the University of Washington Tacoma, maintains that even if a product is functional and fulfills the needs of the users, if the users have unpleasant experiences with the product, they will not want to use it again. Sun asserts that designing is an "open-ended process…that reaches beyond the design stage to the use and consumption stage" (p. 476). She also stresses the importance of users and designers working together to co-construct a product because in all actuality, "who better understands the local use situation than users themselves?" (p. 477).

2.6.3 How do we test for usability?

Although usability testing can vary considerably from product to product, Dumas and Redish (1999) assert that the following three guidelines are characteristic of most successful usability tests: (1) for each test conducted, establish a specific goal and articulate the reasoning for performing each test, (2) always use potential users as test participants when possible, and (3) keep track of all the test participants' relevant actions and remarks. The reason why it is important to establish explicit goals for every test is so you can determine whether or not the product has passed or failed a certain assessment.

In addition to testing how straightforward *Cyclistic* is to use, we will also be evaluating the users' experiences with the software. According to Arhippainen and Tähti (2003), professors at the University of Oulu in Finland, "user experience refers to the experience that a person gets when he/she interacts with a product in particular conditions" (p. 27). As they point out, capturing these experiences can be challenging because there are a number of different factors such as emotions and prior experiences that can influence the interaction between a product and its user. In order to accurately assess a user's experience, these factors must be clarified, and in order to simplify the assessment, specific test goals should be established so that only the pertinent information is documented. At the same time, however, the tester cannot always predict what information will end up being relevant, so testers must use their own judgment and realize that experience testing is an open-ended and adaptable process.

Arhippainen and Tähti explain that there are a number of different methods to gauge user experience such as interviewing/think-aloud session, observing, surveying, storytelling, and experience prototyping. Each method possesses its own unique benefits; thus in order to successfully assess a user's experience, several of these methods must be employed.

Arhippainen and Tähti (2003) discuss a study in which the previously mentioned testing methods were used for user experience evaluation of a personal digital assistant (PDA). The authors found interviewing or think-aloud sessions useful means of gauging experience because they offered a relaxed environment to chat about the product and allowed the interviewers to acquire relevant information about the users' backgrounds such as their expectations for the device and their past experiences with similar products. Arhippainen and Tähti note that when conducting an interview it is important not to directly ask the users about their experiences, but rather ask, "Can you tell us something about this test situation? How did you feel about it?" (p. 29). For the purposes of our project, we will mostly be interviewing Danish tourists about their cycling experiences and conducting think-aloud sessions with tourists using *Cyclistic*. The think-aloud sessions will allow us to evaluate the intuitiveness of *Cyclistic's* interface because we will be able to take notice of any instances where the users get lost or confused.

Observation is another useful technique in user experience evaluation that was employed during the testing of the PDA device. The authors found that observing offers a means to acquire information about the users' emotions and experiences that they either may not be cognizant of or capable of describing verbally. Observation is a task that requires a painstaking and continuous inspection of a user's facial expressions, body gestures, and overall behavior and demeanor. Arhippainen and Tähti recommend videotaping observation sessions because it is impossible to detect every behavioral cue and mannerism, and videotaping allows sessions to be reviewed again later. In evaluating *Cyclistic*, we will observe tourists during think-aloud sessions to determine if and when they get frustrated with the software.

In addition to interviewing and observing, surveying and storytelling are useful tools because they allow users to communicate their own opinions and experiences by writing them down. In the case of storytelling, users can write these experiences in their own words. These methods are useful for obtaining information from users who may have difficulty expressing themselves verbally. Arhippainen and Tähti note that it is important to conduct all of these tests in a natural and comfortable environment so that the emotions and experiences documented are authentic. In regards to our project, we will mostly be surveying tourists – both before and after field-testing *Cyclistic* – to acquire an understanding of their expectations and opinions of the software.

Experience prototyping is a technique that places the designers in the shoes of the users. In essence, the designers become the users, and the designers can then acquire a first-hand, user perspective of the product. This method for assessing user experience has been developed by Buchenau and Fulton Suri (2000), Interaction Designers at IDEO San Francisco – a design and innovation consulting firm. In regards to our project, we will easily be able to employ this final approach because we are all effectively first-time cyclists and tourists in Denmark.

It is also sometimes worthwhile to organize a focus group to gauge usability. In *The Use and Misuse of Focus Groups*, Jakob Nielsen (1997) discusses how focus groups can be implemented to develop an understanding of user needs and desires. Nielsen makes it clear

that focus groups are useful tools, but should not be the only tool that testers use. The benefit to conducting focus groups is that the dynamics within the group can trigger spontaneous reactions or ideas that may prove useful or informative. The downside to group environments, however, is that what people say does not always reflect what they do. Within the scope of this project, we will be conducting focus groups with students who previously traveled to Denmark to gauge an understanding of the types of issues they encountered while being first-time cyclists in Copenhagen.

The methodologies discussed by the case studies in this section represent a successful manifestation of the key characteristics of usability testing, and a similar methodological approach will be applied to the testing of *Cyclistic's* usability.

Chapter 3: Methodology

The ultimate goal of this project was to evaluate *Cyclistic's* usability – its *functionality*, its *ease of use*, and users' *enjoyment* to develop suggestions for improving the software so that it better targets tourists' needs and desires. To achieve this goal, our team:

- Developed an understanding of *Cyclistic*
- Identified ways to promote *Cyclistic* and facilitate bike tourism
- Developed an understanding of tourists' motivations/deterrents to cycling in Denmark
- Identified *Cyclistic's* strengths and shortcomings
- Compiled list of recommended software modifications/additions

Our overall methodology is outlined in Figure 23:
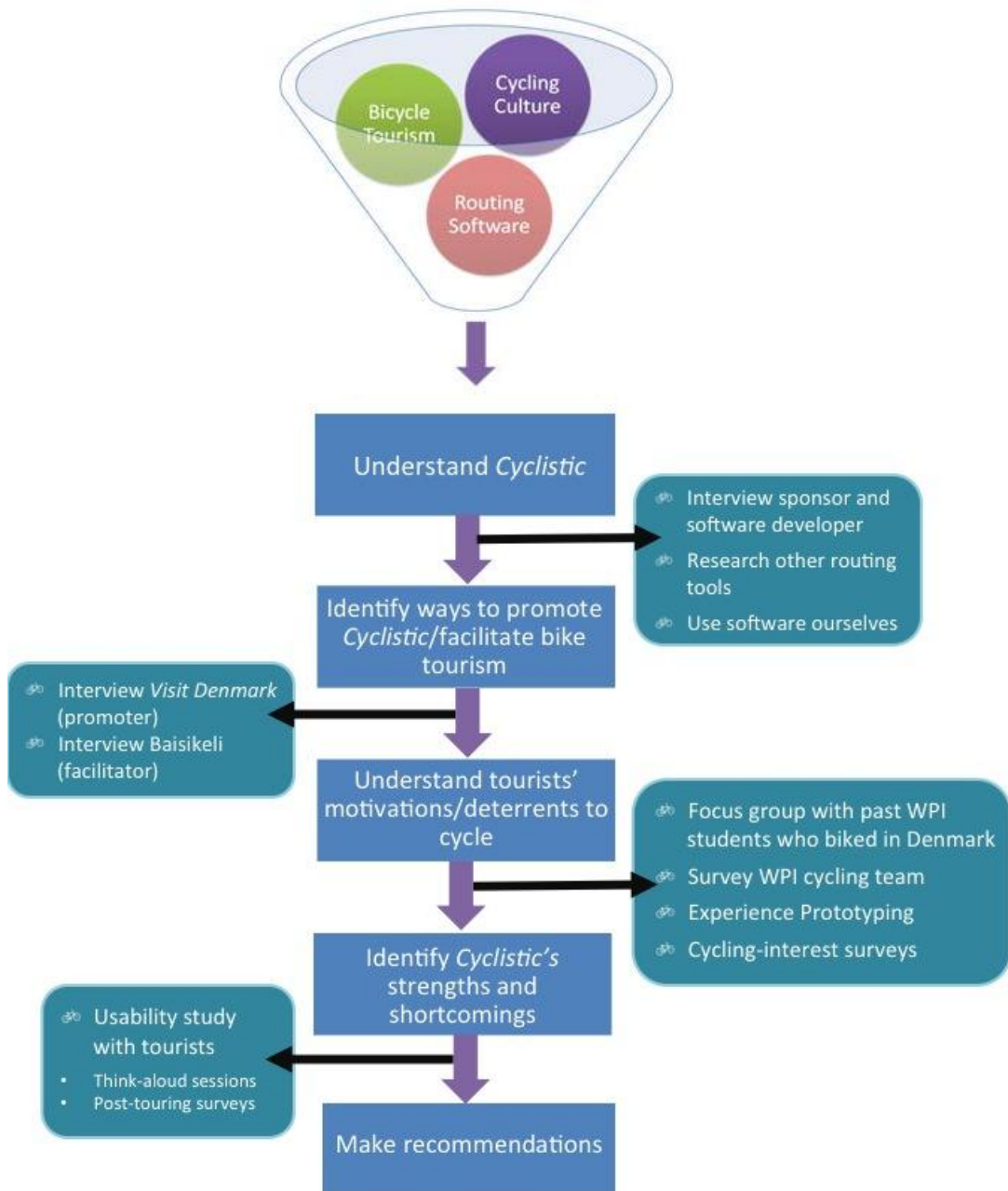
Figure 23: Project Methodology

3.1 Understand *Cyclistic*

During the first 7 weeks of this project, we gathered background information on the cycling infrastructure and culture in Copenhagen, various aspects of Danish tourism, and different types of route planning tools' unique and useful features. As represented in Figure 23, these topics embody the scope of our project, and each funnels into our project objectives. Our first objective was to develop an understanding of *Cyclistic:* how it works, why it was developed, and its features, limitations, and unique qualities as compared to existing routing tools.

To this end, we interviewed our liaison Michael Hammel, who is overseeing Cyclistic's development. We chose interviewing over the other data collection methods discussed in Section 2.6.3 because interviewing allows for the acquisition of specific information, while providing the freedom to change or expand topics and pursue unexpected, yet valuable conversations.

To develop an initial understanding of *Cyclistic*, we asked Michael Hammel various questions such as:

1. How will *Cyclistic* address tourists' reluctance to cycle?
2. What special features does *Cyclistic* possess?
3. How is *Cyclistic* different from Google Maps or MapQuest?
4. How do you foresee tourists using *Cyclistic*?
5. What are your future goals for the software?
6. What information do you expect us to deliver at the end of the project?
7. Has *Cyclistic* undergone any previous field-testing studies?

Though this was a preliminary interview, we gleaned a significant amount of useful information – a full summary of all our interviews can be found in the appendix. To get our project underway in a timely manner, we made sure to speak with Michael Hammel as soon as possible so as to immediately dive into our background research.

In addition, through using the software ourselves and planning routes, we acquainted ourselves with the software and gauged how easy its interface is to use. A list of our positive and negative comments can be found in the Results section.

We also researched other routing tools and compared their features with *Cyclistic's* capabilities. As outlined in Section 2.5.2, there are a number of diverse bike routing tools used by cyclists. The reason these tools are so popular is because they possess certain features or capabilities that cyclists find useful. By exploring the most popular features, we developed a list of ideas to make *Cyclistic* a more useful routing tool (Table 3).

To become more knowledgeable about how *Cyclistic* works and determine if our initial list of potential features (Table 3) is in line with what is considered technically feasible, we asked Lars Nielson the following questions:

1. Are there any features in our list that you can immediately say would *not* be feasible to add to the software? If so, which ones and why?
2. Which of our proposed features seem most feasible?
3. Are there any features that you initially programmed into the software and then scrapped?
4. What current developments are occurring within the software?

3.2 Identify ways to promote *Cyclistic* and Bike-Tourism

To find ways to make *Cyclistic* better known amongst tourists in Denmark, we interviewed a representative from the tourist agency *Visit Denmark* (VisitDenmark.dk, 2006). Through this interview, we acquired useful information on how *Visit Denmark* provides tourists with cycling-related information, their plans for marketing *Cyclistic*, and what types of tourists Denmark attracts.

Some questions asked include:

1. For tourists who want to cycle in Denmark, what kind of information, if any, do you provide about cycling?
2. How many tourists come to Denmark looking to experience the cycling culture?
3. Are you familiar with the *Cyclistic* software tool, and if so is this something that you would potentially market as a way for tourists to access Copenhagen by bicycle?

Since we needed to find tourists for our usability study of *Cyclistic* and mid March – beginning of April is not a highly popular tourist season, we also asked them where we could find tourists this time of year.

Another stakeholder we spoke to was a facilitator – Baisikeli. The main purpose of this interview was to determine if *Cyclistic* would be able to assist Baisikeli in any way and if they would in turn, be willing to be a promoter of *Cyclistic*.

Some questions asked include:

1. Do most tourists that come into the shop already know where they would like to visit in Denmark?
2. Do people typically tend to book bike rentals ahead or do they walk in?
3. Would you be willing to collaborate with the Danish Cyclists' Federation?

Since Baisikeli works closely with cycling-interested tourists on a daily basis, we also asked them if they had any ideas on how to improve *Cyclistic* so that it better meets tourists' needs. In addition, we asked if we could conduct part of our usability study with the tourists who come to their shop and what days/times tourists tend to come in.

3.3 Understand tourists' motivations/deterrents to cycle in Denmark

By understanding what motivates and deters tourist to cycle in Denmark, we can determine what they need in order to feel comfortable while cycling and how *Cyclistic* can help address some of their deterrents. In our background research, we reviewed literature on what tourists should know about cycling in Denmark and what motivates/deters them from cycling. We compared these findings with our own data from (1) a focus group with WPI students who previously cycled in Denmark, (2) a survey of the WPI cycling team, (3) experience prototyping, and (4) tourist cycling-interest surveys. Triangulation of these methods provided us with useful insight into what users need and desire from routing software. When collecting this data, we took ethical considerations into mind such as ensuring informed consent of subjects, excluding sensitive or personal questions, being respectful of people who did not wish to partake in our tests, not taking responses out of context, ensuring that all information, both good and bad, was recorded, and providing a comfortable setting for people to share their thoughts.

Focus Group

To understand the problems that first-time cyclists in Denmark encounter, we directed a focus group with WPI students who traveled to Denmark last year to complete their IQP. Since these students were effectively tourists cycling in Denmark for the first time, it was interesting to hear about their initial impressions of cycling and how those opinions changed with time. The reason we chose to organize a focus group rather than an interview or survey is because a focus group allowed us – the mediators – to speak with a number of different informants at once and was logistically easier to arrange. A focus group is also open-ended, which was ideal for acquiring general information about cycling experiences in Denmark. During the focus group, we encouraged the students to speak freely and express their opinions as much as possible. Questions included:

Q1: How often did you bike?

Q2: Where did you usually bike?

Q3: What was your first impression of cycling in Denmark?

Q4: What kinds of problems, if any, did you encounter while cycling?

Q5: What did you enjoy about cycling in Denmark?

Q6: Would you recommend cycling to others?

Q7: How did you figure out how to get places? What route planning tools did you use?

Q8: Did you feel safe while cycling around Copenhagen?

Q9: Would you have found *Cyclistic* useful for planning bike routes?

WPI Cycling Team Survey

We chose to utilize cycling enthusiasts, such as the WPI cycling team, as key informants because they have extensive cycling experience, are familiar with modern cycling culture, and are familiar with route-planning software. By surveying WPI's cycling team we gained an understanding of:

i.   the desirable features in existing routing tools

ii. what types of features their ideal routing software would possess

iii. the flaws in existing routing tools

The advantage to an informal survey is that it can reach a large number of people without extensive effort and does not demand a significant amount of time or effort from the respondent. By emailing a survey to the WPI cycling team alias, we acquired 30 different responses from cycling enthusiasts. Questions included:

Q1: Do you use a bike route planning software?

Q2: What bike routing software do you use?

Q3: What software features do you find useful in a route planning tool?

Q4: Does the route planning software you currently use have any of these desired features?

Q5: What would you improve about bike routing software? / What kinds of features would you find useful?

Q6: Have you ever considered biking in another country with a strong cycling culture, such as Denmark?

Even though members of the WPI cycling team do not necessarily use route planning tools for the same reason that tourists do – to sightsee and find attractions – their input provided us with valuable insight into what routing features experienced bikers like and what users of *Cyclistic* might desire.

Experience Prototyping

Another resource we had available to us was our own experiences. Upon arriving in Copenhagen we immediately became tourists, eager to explore the city. Accordingly, we employed experience prototyping as a means to identify issues that first-time cyclists in Denmark may encounter and to develop ideas for how to make *Cyclistic* a more useful routing tool. We planned three different routes using *Cyclistic*: (1) a long, urban route with several different types of tourist attractions, (2) a short, kid-friendly, urban route with family-oriented attractions, (3) a long route outside of the main city through the countryside. We printed out maps and turn-by-turn directions of these routes from *Cyclistic*. While biking, we made sure to keep track of any problems or complications associated with navigating the city on a bicycle, reading the directions/map, or getting lost. Through our experiences, we created a condensed list of comments, which can be found in the *Initial Impressions of Cycling* section of our Results (Table 9). In addition, each of us completed a cycling-interest survey (before using *Cyclistic*), think-aloud session (while using *Cyclistic*), and post-touring survey (after biking our route) – which are expounded upon below and in Section 3.3.

Cycling-Interest Surveys

To gauge general interest in cycling, we asked tourists to complete a cycling-interest survey. From these surveys, we also determined what motivates and deters their interest in cycling and what specific features a software tool could possess to better accommodate their needs and encourage them to cycle. Many of these tourists later participated in our usability study of *Cyclistic*. A description of the study and how we located these tourists is discussed in Section 3.3.

Cycling-interest survey questions:

Q1: How interested are you in cycling while in Denmark?

- ☐ 1 – definitely not interested
- ☐ 2 – slightly interested
- ☐ 3 – indifferent
- ☐ 4 – interested
- ☐ 5 – very interested

Q2: What would you say your bicycling experience level is?

- ☐ 1 – beginner
- ☐ 2 – novice
- ☐ 3 – intermediate
- ☐ 4 – advanced
- ☐ 5 – expert

Q3: How knowledgeable would you say you are in terms of Danish cycling laws and etiquette?

- ☐ 1 - none
- ☐ 2 - limited
- ☐ 3 - basic
- ☐ 4 - advanced
- ☐ 5 – expert

Q4: What motivates you to cycle in Denmark?

Q5: What deters you from cycling in Denmark?

Q6: How would you find information on how to cycle in Denmark?

Q7: How do you plan to find your way around the city?

Q8: What kind of information would you want from a bike routing tool?

3.4 Identify *Cyclistic's* strengths and shortcomings

Arguably the most important step in our methodology was identifying strengths and shortcomings in *Cyclistic*. To identify the software's positive attributes and "black-spots," we conducted a usability study of *Cyclistic*, which included think-aloud sessions with tourists as they used the software, think-aloud debriefs, and post-touring surveys. This combination of methods allowed us to evaluate *Cyclistic's* three metrics of usability: its *functionality*, its *ease of use*, and users' *enjoyment*.

Think-Aloud Sessions

Think-aloud sessions with tourists as they planned routes using *Cyclistic* specifically allowed us to evaluate the intuitiveness of its interface and determine where users encountered problems. After the think-aloud sessions, test-subjects who were willing used the route they planned to go on a self-guided tour through Copenhagen. We accompanied some tourists (those who did not mind our company) on their rides, which allowed us to observe our test-subjects' reactions and any problems that they encountered first-hand. When our subjects returned from their tour, we asked them questions regarding their reactions, suggestions for improvement, and overall experiences cycling through Copenhagen. The purpose of attaining their feedback post-ride was to evaluate how enjoyable their cycling experiences were as well as develop ideas for how the software could be modified to make touring the city an even more pleasurable, non-stressful experience.

In order to acquire a wide-range of data, we recruited tourists from several different locations to target tourists of varying ages and nationalities. Because tourists are busy people eager to explore Denmark, we anticipated that many tourists would not be willing to waste their vacation time speaking with us. To complicate matters, we needed test-subjects who also spoke English and were interested in cycling. Thus, we spoke with Baisikeli to determine their busiest days and chose Thursdays, Fridays, and Saturdays from 11:00 – 14:00 as times to recruit these tourists. A representative from *Visit Denmark* suggested The Royal Library (*Det Kongelige Bibliotek)* as an additional location because it is a tourist hotspot with free Wi-Fi, which is needed to use *Cyclistic*. By attaining test-subjects at both of

these locations as well as from our own IQP group, we ensured variety in both the ages and demographics of our users.

We introduced ourselves and explained/asked the following to tourists we recruited:

*"Would you be interested in answering a few questions about cycling in Denmark? Would you also like some help planning your trip around Copenhagen today? The Danish Cyclists Federation has developed a new bike route-planning tool called Cyclistic. Cyclistic allows you to plan your route based on your own sightseeing interests and is specifically designed for tourists in Denmark. It is currently in its development phase, and we are looking for cycling-interested tourists to field-test the tool and provide us with feedback on how it could be improved. Use of the software is completely free. In testing out Cyclistic, we simply ask that you do three things: take 5-10 minutes to answer our survey (**cycling-interest survey**), use the software to plan your bike route – we'll set it up for you, and then answer a few questions about your experience cycling (**post-touring survey**). You can either give us your email and we will send you the survey, or you can pick up a hard copy of the survey [here]. While planning your route, we ask that you talk us through your exploration of the site so that we can get an idea of how you are using it (**think-aloud session**). We can help you if you get stuck; however we would like to see how you navigate the site on your own. We would greatly appreciate your feedback. Our overall goal is to make it easier for tourists to cycle in Denmark, and your responses will help us develop recommendations for improving Cyclistic so that the software can better meet the needs and desires of tourists in Denmark."*

To ensure continuity between **think-aloud sessions**, we used the following procedure to conduct each session:

1. Showed tourists to computer and had them navigate to http://cyclistic.dk/da.

2. Started timer to record how long it took tourists to plan their routes.

3. One member of our team – the session leader – sat beside tourists and introduced the software and the think-aloud process:

   "Hello, this is the Cyclistic software tool that we're developing with the Danish Cycling Federation. I'd like you to plan a cycling route while we note how you use the software.

Explain what you are thinking and doing and if you get stuck or confused just talk out loud about it so we can see what is going through your mind. Please also communicate to us any major comments or concerns that you have."

4. During the process, the session leader interacted with the tourists while they used the software:

   "*What types of destinations are you interested in? How long do you plan on biking?*"

   "*Tell us what you are doing when you plan your route. Let us know what you're looking for, what information you're entering, and where you click and why.*"

5. If the tourists encountered any major problems while planning their routes, they could direct their questions towards the session leader. However, in order to best identify shortcomings in *Cyclistic's* interface, the session leader intervened as little as possible.

6. Another member of our team – the note-taker – recorded all of the tourists' comments, questions, and actions in a think-aloud data sheet (Appendix H). The note-taker also made sure to record their own observations on problems the users encountered, instances where the users seemed to get confused or frustrated, and users' demeanor changes.

7. Once tourists finished mapping their routes, the session leader asked the following questions about the process (Think-Aloud Debrief):

Think-aloud debrief:

Q1: Overall, how intuitive was the software's interface on a scale of 1-5?

☐ 1 – too complicate to use
☐ 2 – somewhat complicated
☐ 3 – somewhat intuitive
☐ 4 – mostly intuitive
☐ 5 – highly intuitive

Q2: What did you like about using *Cyclistic* to plan your route?

Q3: Was there anything about the interface that was difficult to use or understand?

Q4: Were you able to find attractions you were interested in? (yes/no)

Q5: Were you able to successfully plan a route? (yes/no)

Q6: How happy are you with the route you have planned?

☐   1 – very unhappy
☐   2 – unhappy
☐   3 – indifferent
☐   4 – happy
☐   5 – very happy

    i.   Is there something you expected from the software that was missing? Are there any other features that you would find useful that *Cyclistic* does not currently possess?

For tourists who agreed to go on a bike ride to test out their route after their think-aloud session, we also completed steps 8 – 10:

8. Prior to leaving for their tour, tourists were given the option to either print their route or email it to their smart phone. Whichever option they chose was recorded.
9. The session leader then gave the tourists a condensed list of cycling guidelines to help them safely and enjoyably navigate the streets of Copenhagen:

    i.   Stay to the right of the bike lane.
    ii.   Check over left shoulder before passing someone.
    iii.   Signal when turning and stopping.
    iv.   Do not assume that other cyclists are obeying the rules of the road.

10. When the tourists returned from their tour, we asked them questions from our **post-touring survey:**

Q1: What was your first impression of touring via cycling in Denmark?
Q2: What kinds of problems, if any, did you encounter? Please elaborate.
Q3: Did you have any memorable experiences, either good or bad? Please elaborate.
Q4: Were you able to locate all of your attractions and navigate to them easily? If not, please elaborate.
Q5: How did you use your map?
Q6: How comfortable, physically and emotionally, were you riding around Copenhagen?

☐   1 – highly uncomfortable
☐   2 – mildly uncomfortable
☐   3 – neutral
☐   4 – somewhat comfortable

☐ 5 – very comfortable

Q7: How enjoyable was your touring experience?

☐ 1 – very unpleasant
☐ 2 – somewhat unpleasant
☐ 3 – neutral
☐ 4 – fairly enjoyable
☐ 5 – highly enjoyable

Q8: Here is a list of features that could potentially be added to the *Cyclistic* software. Please check off which ones you think would have been <u>most</u> useful in planning your route and touring Copenhagen:

☐ **Route documenting and sharing** – being able to upload photos and write brief descriptions about your favorite routes to document your memories and share your cycling experiences with others
☐ **Route tagging** – being able to tag your own routes as "scenic," "green," "low-traffic," or "quiet," etc. so that other *Cyclistic* users can search for routes with certain attributes
☐ **Mobile App**
☐ **Audio option** – being able to *listen* to turn-by-turn directions via head phones; the audio could also alert users when they pass attractions along their routes
☐ **More attraction information** (i.e. cost of attraction, hours of operation)
☐ **Cycling Guide** – a condensed list of everything you need to know about cycling in Denmark
☐ **Satellite view** – being able to view your route on your computer on a street-by-street level before tackling the route yourself
☐ **Database of cycling-related events**
☐ **Nutrition tracking/Calorie counting**
☐ *Cyclistic* **Tutorial**
☐ **Restricting maximum elevation change**
☐ **Minimizing the number of turns in your route**
☐ Any other information that would have been useful to know?/Any features that would have been helpful to have prior to going on your self-guided tour?

In addition to spending several days at Baisikeli, we also spent some time at The Royal Library. Most tourists here were willing to complete both our cycling-interest survey and think-aloud session, while some were only willing to complete the cycling-interest

survey. None of these tourists used the route they planned to go on a bike ride, so none of them completed a post-touring survey. To attain test-subjects at the Royal Library, we approached English-speaking tourists and implemented the following script:

1. **Us**: "Hello, would you like a cycling sticker? We are students working in collaboration with the Danish Cycling Federation to evaluate a new bike-route planning tool called *Cyclistic. Cyclistic* is a website specifically designed for tourists in Denmark that allows users to plan routes based off their own sightseeing interests. It is currently in its development phase, and we are looking for cycling-interested tourists to try the tool and see how it works for them. Are you interested in touring Denmark on a bicycle?"
2. **Tourist**: "Yes" → proceed to #4
3. **Tourist**: "No" → proceed to #12
4. **Us**: "Do you mind taking 5-10 minutes to answer a few brief questions about cycling in Denmark?"
5. **Tourist**: "No, I do not mind." → proceed to #7
6. **Tourist**: "I do not want to answer any questions right now." → proceed to #15
7. *Ask the tourist the pre-touring survey questions.*
8. **Us**: "Thank you for taking the time to answer our survey questions. Would you be interested in planning a bike route yourself using *Cyclistic*? It should only take 10-15 minutes, and use of the software is completely free. All we ask is that you talk us through your exploration of the site so that we can get an idea of how the site works for you."
9. **Tourist**: "Yes" → proceed to #11
10. **Tourist**: "No" → proceed to #15
11. **Us**: "Great! Your responses will help us develop recommendations for improving *Cyclistic* so that the software better meets tourists' needs.
    Begin think-aloud session (only go up to step #7). **(END OF SCRIPT)**
12. **Us**: "Is there any particular reason why you have chosen *not* to cycle during your stay here in Denmark?"
13. *Tourist responds.*
14. **Us**: "That is understandable. Have a nice day." **(END OF SCRIPT)**
15. **Us**: "Ok. Thanks for taking the time to talk to us. Have a nice day!" **(END OF SCRIPT)**

Through our survey questions and think-aloud sessions with various potential users, we were able to acquire a comprehensive understanding of *Cyclistic's* strengths and shortcomings. From here, we consolidated *Cyclistic's* flaws and organized them into distinct categories, which is further explained in the Results section.

3.5 Recommend software modifications

After gathering and analyzing the results from our focus group, surveys, interviews, experience prototyping logs, think-aloud sessions, and field-tests we addressed the following questions:

i. How could *Cyclistic* be promoted to reach more tourists?
ii. What user needs has *Cyclistic* not addressed?
iii. What could be <u>modified</u> to improve *Cyclistic's* functionality, ease of use, and users' enjoyment?
iv. What features could be <u>added</u> to the software to improve *Cyclistic's* functionality, ease of use, and users' enjoyment?

From here, we developed suggestions for *Cyclistic's* improvement and presented these recommendations to our liaison and the other software developers.

Chapter 4: Results

4.1 Understanding *Cyclistic*

To better understand Cyclistic, we interviewed our liaison Michael Hammel, researched other routing tools, interviewed software developer Lars Nielson, and experimented with the software ourselves.

Michael Hammel Interview

As mentioned in Sections 2.5.1 and 2.5.3, Michael Hammel shared why *Cyclistic* was developed, how it is unique, and what his future goals are for it:

1. *Cyclistic* makes routing a by-product of users' own research, desires, and interests in hopes of inspiring them to cycle.
2. *Cyclistic* is unique because it was designed by cyclists, for cyclists; it utilizes *Openstreetmap* to incorporate the majority of bike paths and bike-friendly routes in Denmark.
3. The developers' future goals are to determine what features could be enhanced or changed to better target users' needs and desires, which is why we conducted a usability study of *Cyclistic* with actual tourists.

In addition, we analyzed existing routing tools' features and compared them with *Cyclistic's* capabilities, developing a list of potential features summarized in Table 3. We later presented this list of features to one of *Cyclistic's* developers to determine which ones would be more and less feasible from both technical and business standpoints. Before acquiring tourists' input on these potential features, we wanted to weed out the unrealistic ones.

Lars Nielson Interview

Lars Nielson, one of the software developers at Klean, explained the physical architecture of the software and the feasibility of incorporating our preliminary list of features. From him, we learned:

1. *Cyclistic* does not take the most direct route between two points; instead it preferences a route that covers a larger area to help tourists experience more. As a result, the routes that *Cyclistic* plans tend to have many turns. During user-testing, many tourists complained that their turn-by-turn directions were too complicated to follow while biking.
2. *Cyclistic* can only show a limited amount of on-screen real estate. Developers will only consider adding the most critical features since new features take up space, and they want to make the map as large as possible as it is the main component. Therefore, we prioritized the features to add based on users' preferences.

In discussing the feasibility of incorporating additional features, Lars indicated that:

1. Integrating route attributes such as "scenic" and "quiet" and allowing users to weight the importance of these attributes is not feasible because the entire structure of the site would have to be altered and information on the attributes of the different regions of Denmark would have to be gathered – *Cyclistic* does not currently have a budget for attaining this kind of information.
2. Route-tagging and sharing is possible, but not necessarily desirable by the developers, who prefer that the route database only include the official routes of Denmark. They worry that allowing users to share their own routes will hamper the legitimacy of the site.
3. Incorporating satellite-view is possible, but expensive.
4. *Cyclistic's* attraction information is only as good as *Visit Denmark's* database, which is where the software's attractions are drawn. However, if we found any missing or inaccurate information, the developers could inform *Visit Denmark*.

Table 4 summarizes our proposed features and highlights those that are feasible based on this interview.

Table 4: Feasibility of Potential Features

Feature	How Feasible?
Route Attributes	0
Attribute Weighting	0
More Attraction Info	0
Route Tagging	1
Photo Uploading and Sharing	1
Satellite View	1
Cycling Guide	2
Database of Cycling-Related Events	2
Nutrition Tracking/ Calorie-Counting	2
Side-by-Side Route Comparisons	2
Restrict Maximum Elevation Change	2

0 – not feasible

1 – somewhat feasible/not necessarily desirable

2 – feasible

Discussing the technical feasibility of our proposed features allowed us to create an updated list of features (Table 5) to present to tourists in our post-touring survey. Tourists' interest in adding these features to *Cyclistic* is assessed in Section 4.4.

Table 5: *Cyclistic's* Potential Features

- **Route tagging** – being able to tag your own routes as "hilly," "scenic," or "quiet," etc. and also being able to search for routes tagged with these attributes
- **Audio navigation** – being able to *listen* to turn-by-turn directions via head phones; the audio could also alert users when they pass attractions along their routes
- **Photo uploading and sharing** – being able to add photos from your favorite routes so that others can see what the route looks like
- *Cyclistic* **Tutorial** – being given the option to walk through a tutorial of how to plan a route using *Cyclistic* when you visit the website for the first time
- **Cycling Guide** – a condensed list of everything you need to know about cycling in Denmark
- **Satellite View** – being able to view your route on your computer on a street-by-street level before tackling the route yourself
- **Mobile App**
- **Database of cycling-related events**
- **Nutrition tracking/ Calorie counting**
- **Restricting maximum elevation change**
- **Minimizing the number of turns along your route**

Experimenting with *Cyclistic*

In experimenting with the software ourselves, we each planned routes and recorded both our positive and negative impressions of the software. This can be seen in **Table 6** and **Table 7**.

Table 6: Our Positive Impressions of *Cyclistic*

Useful Features	Route information (length, duration, elevation change)
	The color-coded attraction markers that show up on the map help distinguish the different types of attractions (Figure 24).
	The attraction database is extensive and has a wide variety of interesting attractions as well as amenities (Figure 25).
	The attraction *information* is useful and specific for tourists.
	Creating an account allows users to save their routes.
	There are various ways to export your route.
Intuitive Interface	The different steps of the route-planning process are numbered, which makes navigating the site more straightforward (Figure 26).
	The site is visually appealing.

Table 7: Our Negative Impressions of *Cyclistic*

Getting Started	The first address a user enters is the location that they want to find; however this is not useful for users who do not know where they want to go.
Planning Route	There is no easy way to clear a route without reloading the website.
	If the user is typing in an address that includes one of the three unique Danish characters (æ, ø, å) but cannot access such characters on a keyboard, *Cyclistic* will not recognize the address.
	There is no key on the website that explains what the different colored dotted lines on the map mean (Figure 27).
Technical Problems	The *Official Route* page is in Danish.
	Some of the English translations are not accurate (See Appendix M).
	Growlers (pop-ups) are distracting and block the map (Figure 28).
	If you navigate away from the map/homepage, you lose your route data.
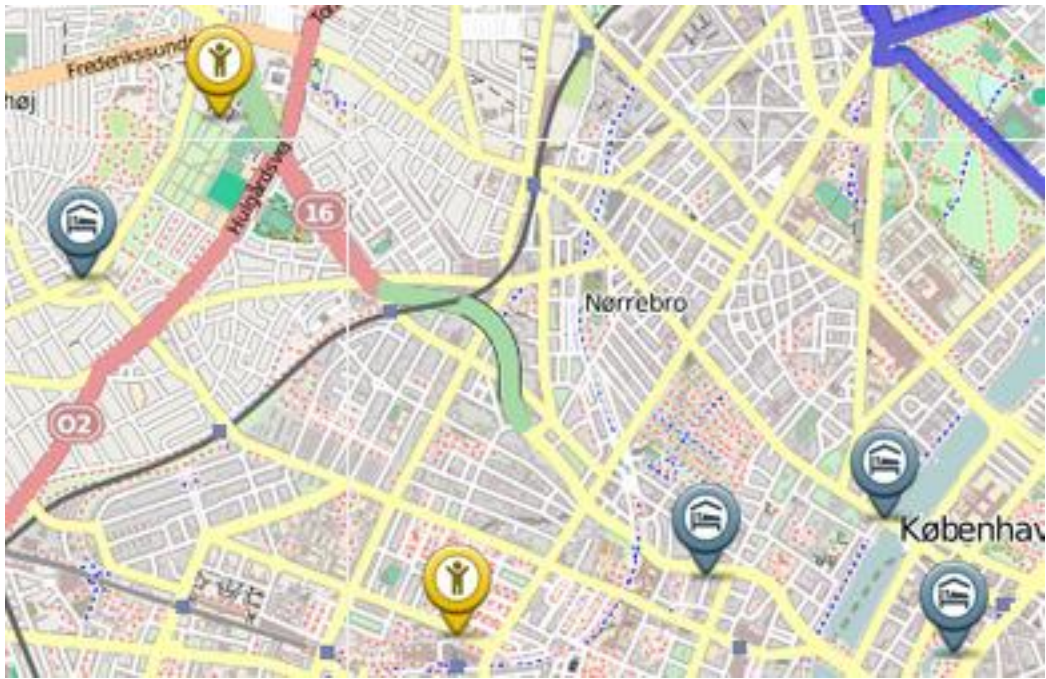
Figure 24: Attraction markers are color-coded

Figure 25: Wide variety of different types of attractions and amenities
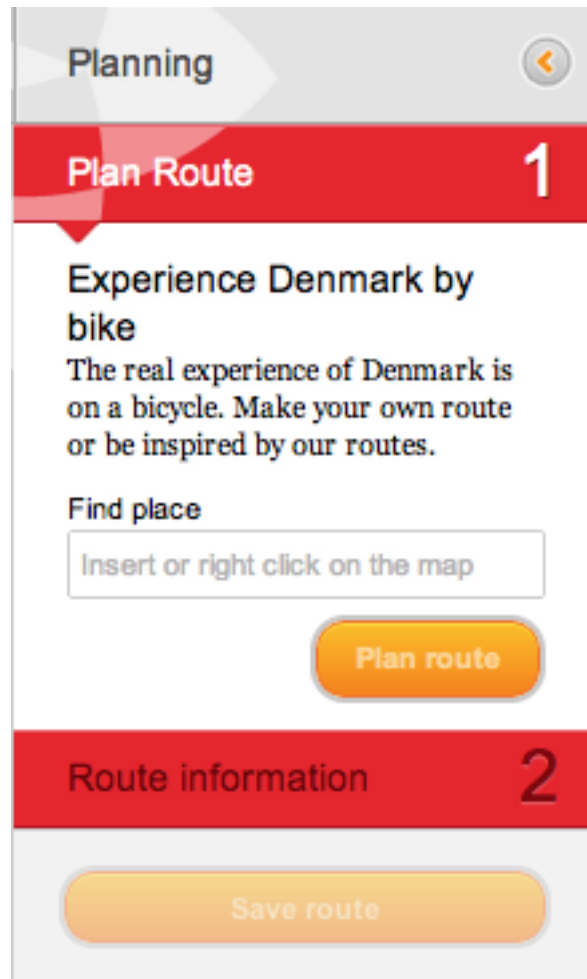
Figure 26: Different sections of the site are numbered to facilitate the route-planning process
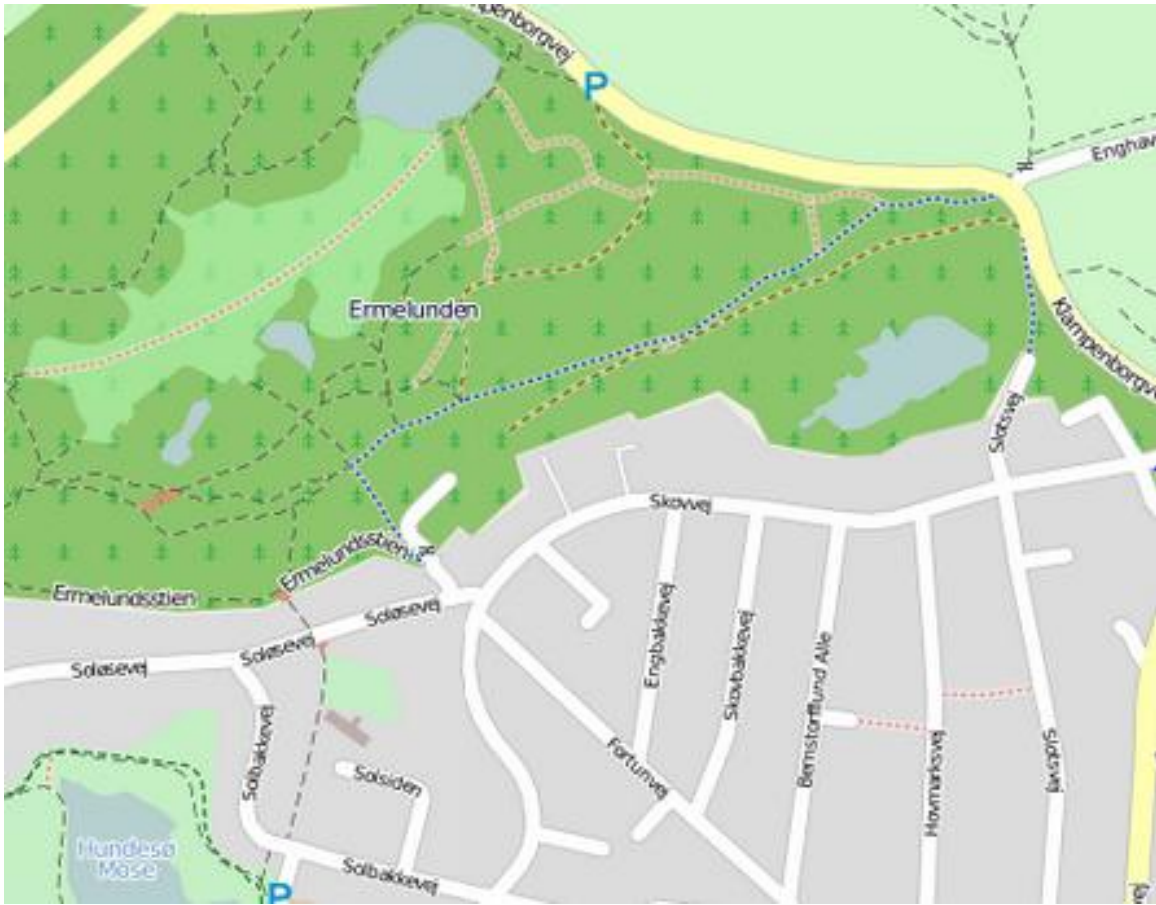
Figure 27: Different colored dotted lines are unexplained
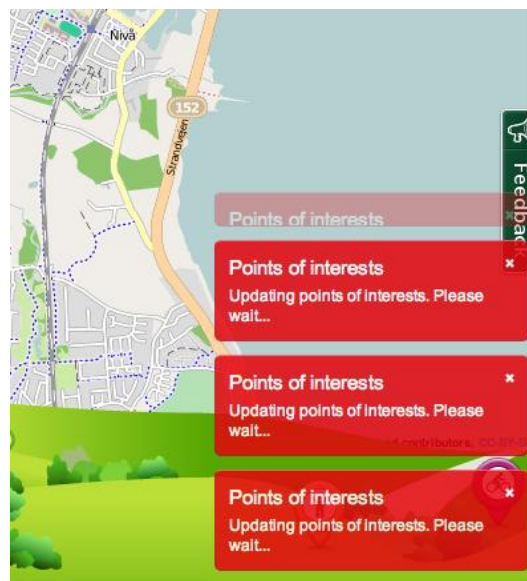
Figure 28: Growlers – distracting and obtrusive

4.2 Promoting *Cyclistic* and Bike-Tourism

To develop ideas for how to promote *Cyclistic* and bike-tourism in general, we interviewed Donna Sørensen, a representative from the tourist agency *Visit Denmark* and the owners of Baisikeli. We learned:

The majority of tourists in Denmark come from Germany, Holland, Norway, and Sweden, so we made sure to involve Northern European tourists in our usability study. Currently, *Cyclistic* is only translated for Germans and English-speakers. To reach more tourists, it should be translated for users from these other countries. *Visit Denmark* is currently working to restructure their website. The new site will have a more extensive attractions database that *Cyclistic* can draw from as well as a link to *Cyclistic*.

About 50% of the tourists that come into Baisikeli know where they want to go. The other 50% are undecided and looking for guidance. Baisikeli's staff spends a significant amount of time helping those tourists. *Cyclistic* could help alleviate this problem by providing them with route-planning guidance instead. For this reason, Baisikeli would be willing to promote *Cyclistic*. Since Baisikeli and the DCF share the same goal of promoting cycling in Denmark, this would be beneficial to both parties as well as the field of bike-tourism.

4.3 What motivates/deters tourists to cycle in Denmark?

Potential users' motivations and deterrents were determined through: (1) a focus group with WPI students who had previously cycled in Denmark, (2) a WPI cycling team survey, (3) experience prototyping, and (4) tourist cycling-interest surveys.

Focus Group

The focus group helped us understand the WPI group's previous cycling experience in Copenhagen. The group consisted of 2 college-aged students and their advisor, all of whom cycled frequently during their stay in Denmark. The discussion lasted approximately thirty minutes. A summary of the three participants' responses follows (Table 8).

Table 8: Summary of Focus Group

Question:	Responses:
Q1: How often did you bike?	• Every day
Q2: Where did you usually bike?	• To work, grocery stores, coffee shops, bars, gym, tourist attractions
Q3: What was your first impression of cycling in Denmark?	• Biking was a cheap, quick, and easy way to get around • The frequent, poor weather conditions made biking less enjoyable
Q4: What kinds of problems, if any, did you encounter while cycling?	• Not aware of other cyclists • Learning the biking rules of the road → learned rules through experience over time • Cobblestones are difficult to bike over • Turning can be difficult if there are many people in a bike plane • Rush hour is an intimidating time to be biking; must learn to move quickly at lights because other cyclists start pedaling when light turns yellow • Strong, frequent winds make it difficult, sometimes impossible, to bike
Q5: What did you enjoy about cycling in Denmark?	• Copenhagen is a bike-friendly city • The flat terrain made it easy to bike places • Bike paths made it easy to traverse the city quickly • Ample bike parking made biking even more convenient • Can take bikes on S-trains

Q6: Would you recommend cycling in Copenhagen to others?	• 100% yes • Biking is an easy way to get around, and it makes you feel like you fit in with the other Danes
Q7: How did you figure out how to get places? What route planning tools did you use?	• Printed maps that included bike paths • Google Maps
Q8: Did you feel safe while cycling around Copenhagen?	• Felt safe because most bike lanes are separated from roads • Cars respect cyclists and are very aware of them • Bikes also have the right of way
Q9: Would you have found *Cyclistic* useful for planning bike routes?	• 100% Yes → Google Maps database does not include all bike paths; would have been nice to have a map specific for cyclists

This focus group reinforced that biking is a convenient way to get around Copenhagen and provided us with an initial list of problems that first-time cyclists in Denmark might encounter. The group's response to Q9 also suggested that they would have found *Cyclistic* useful during their stay suggesting other first-time cyclists may as well. However, because the group used bikes for utilitarian purposes, they are not representative tourists. Therefore, we later conducted our usability study of *Cyclistic* with actual tourists in Denmark.

For the most part, the group's motivations and deterrents were all in-line with what was discussed in our literature review. Cycling deterrents that we were not originally aware of are the poor weather conditions and cobblestone streets.

WPI Cycling Team Survey

Surveying the WPI cycling team helped us understand what software features experienced cyclists find beneficial for bike route planning. The survey group consisted of 30 anonymous responses. These experienced cyclists noted that they used a variety of route planning tools such as GoogleMaps, MapMyRIDE, MapQuest, and Strava. The software features that these cyclists find most useful are:

1. Route constraints
2. Route attributes

3. Bike-friendly routes option
4. Amenity locations
5. Smart phone application

Only 16.7% of the respondents said that the route planner they currently use has all of these desirable features (Q4), showing room for improvement. A full summary of the cycling team's survey can be found in Appendix G.

Experience Prototyping

As first-time cyclists in Denmark, we toured Copenhagen on bikes and recorded our initial impressions of cycling in the city. We separated our impressions into five categories (Table 9).

Table 9: Initial Impressions of Cycling

Initial Impressions of Cycling in Copenhagen	
Turning	Difficult to turn left, don't always know where you can turn left
	Cannot turn left at certain intersections
	Always use turn signals!
	Use "Hook Turns" when making a left hand turn
Traffic	Heaviest from 8am-9am, around noon, and between 3pm-5pm
	At some intersections, you have to weave in and out of cars
	Bike-specific traffic lights make navigating intersections easier
Bike Paths	Cargo bikes take up a lot space on the paths →difficult to pass
	Lanes are sometimes very narrow
	Bike lanes sometimes disappear →have to bike onto the road
	Not all bike paths/lanes are marked; can be difficult to know where to bike
Other Cyclists	Not all cyclists follow the rules of the road →don't follow their example
	Faster cyclists will pass you without warning
	Bike at your own pace, don't try to keep up with everyone else
	Cyclists start going on yellow, so be ready to move
Environment	The wind is extremely strong, very difficult to bike into wind
	Wear gloves to keep hands warm
	You feel close to the environment while biking
	You feel like you fit in with the Danes
	Cobblestones are difficult to bike over
	Curbs can be tricky to bike over
	Bike seats are uncomfortable at first
	You can park anywhere; lock your wheel and move bike out of the way

All these problems are beyond the software's immediate control. However, they suggest where the stress associated with cycling in a foreign environment emanates from. If tourists had advice on how to manage some of these difficulties, then they may be more inclined to cycle.

In addition to creating a list of cycling impressions, we each completed our own cycling-interest surveys, think-aloud sessions, and post-touring surveys. This data was combined with the surveys and think-aloud session data acquired from our test-subjects in Section 4.4.

Cycling-Interest Surveys

We recruited 25 tourist groups at Baisikeli, at The Royal Library, and within our own IQP student group to complete a cycling-interest survey and explain their interest in cycling, motivators/deterrents for cycling in Denmark, and expectations of route planning software. Some, but not all of these tourists, later used *Cyclistic* to plan a route during a think-aloud session. Since *Cyclistic* aims to cater to a diversity of tourists, we conducted our usability study with a variety of test-subjects. Our users included 9 of our fellow IQP students (mostly college-aged; from the USA and Venezuela), and 16 tourist groups from Germany, Finland, United States, Switzerland and Norway. A breakdown of the ages and nationalities of our test-subjects follows (Table 10).

Table 10: Breakdown of Test-Subjects

Age	# of tourists
Under 25	9
25-35	6
35-50	6
50+	4

Nationality	# of tourists
American	11
Venezuelan	1
German	1
Swiss	1
Norwegian	1
Finland	10

Using a 1-5 scale, on average, these tourists described themselves as having *interest* in cycling in Denmark (4/5) (Q1), an *intermediate* cycling experience level (3/5) (Q2), and *limited* knowledge of Denmark's cycling etiquette/rules (2/5) (Q3). Fittingly, these are the types of tourists that *Cyclistic's* developers aim to target. Responses from Q4 and Q5 and the data from our *Initial Impressions of Cycling* allowed us to break down and categorize short-term tourists' motivating and deterring factors for cycling in Denmark.

The most commonly mentioned motivating factor was "wanting to fit in with the Danes." Ten out of 25 tourists who completed the cycling-interest survey said they wanted to bike so that they could "blend in" with the Danes. Five out of 25 said their motivation was that biking is "a convenient means of sightseeing." These tourists liked how biking is a cheap and easy way to navigate the city. The next most common motivating factor was fitness (4/25). According to one tourist, "Biking around the city just feels healthy and more active than riding a bus." Another motivator mentioned was the well-developed cycling infrastructure in Denmark. Three out of 25 tourists wanted to bike to take advantage of Denmark's extensive system of bike paths and parking. The final 3 tourists said their motivation resided in their own fondness for biking.

Even though all tourists listed at least one reason why they wanted to cycle in Denmark, 4 different categories of cycling deterrents were also named. The most commonly mentioned deterrent was safety. Eight out of 25 tourists were concerned about getting hit by cars or colliding with other cyclists. "Rush hour is an intimidating time to be biking." Another user explained, "You have to learn to move quickly at lights because other cyclists start pedaling when the light turns yellow." This deterrent follows along with the cycling discouragements explained in Dave Horton's *Fear of Cycling*, mentioned in Section 2.3.2. The next most common deterrent was Denmark's unfamiliar cycling infrastructure. Interestingly, this was also named a motivating factor. Seven out of 25 tourists expressed anxiety over immersing themselves in this highly developed infrastructure for fear of causing a disturbance on a bike path or embarrassing themselves. As one tourist explained, "Everything is so developed, and everyone knows what they are doing. I don't want to stand out." This deterrent is also in-line with Dave Horton's *Fear of Cycling*. Another cycling deterrent mentioned was not knowing Danish cycling etiquette/rules. Six out of 25 tourists expressed concern over this, specifically not knowing how to signal or navigate

intersections on a bike. A final deterrent was Denmark's weather. Four out of 25 stated they would not want to bike in the cold, rain, and wind.

Although *Cyclistic* cannot change the physical cycling environment in Copenhagen, it can offer tourists information to help them cope with some of these deterrents so that cycling is a more enjoyable experience. A summary of the rest of the tourists' responses to our cycling-interest survey follows (Table 11).

Table 11: Summary of Responses from Cycling-Interest Surveys

Question:	Responses:
Q6: How would you find information on how to cycle in Denmark?	• Bike shop (55%) • Google (32%) • Hotel (9%) • Tourist agency (5%)
Q7: How do you plan to find your way around the city?	• Google Maps (74%) • Use a paper map (16%) • "Wing it" (5%) • MapQuest (5%)
Q8: What kind of information would you want from a bike route-planning tool?	• Location of tourist attractions (24%) • Pre-mapped routes (16%) • Where the low-traffic roads are (12%) • Where the bike-friendly paths are located (12%) • Cycling guide on the rules/etiquette of the road (12%) • Multiple Route Options (12%) • Route Difficulties (8%) • Printed maps/directions (4%) • Length of Route (4%)

Q6 and Q7 provided us with statistics on how tourists currently find information on how and where to bike around Denmark. Q8 provided us with further feedback on what types of features a bike-route planner should have. *Cyclistic* already has several of these features: locations of tourist attractions, route difficulty (elevation change), locations of bike-friendly paths, pre-mapped routes, and printed maps/directions. One feature that *Cyclistic* does not currently have is a cycling guide – this was added to the list of tourist-approved features in Figure 33. The need for a Cycling Guide is also further supported by the previously mentioned cycling deterrent – not knowing Danish cycling etiquette/rules.

4.4 What are *Cyclistic's* strengths and shortcomings?

As already indicated, tourists affirmed that many of *Cyclistic's* features are desirable. However, to identify additional strengths as well as areas of weakness in the software, we conducted a usability study with actual tourists, which included think-aloud sessions, think-aloud debriefs, and post-touring surveys. This combination of techniques allowed us to evaluate all three usability metrics (*functionality*, *ease of use*, *enjoyment*) from the route planning process to the bike ride.

Sixteen of the tourists who competed a cycling-interest survey agreed to complete a think-aloud session, and of those 16 users, 7 agreed to actually bike the route they planned to complete our post-touring survey. The reason why a much smaller population of tourists completed our post-touring survey is because many tourists had predetermined plans for where they were going cycling, so they did not actually use the new route they planned with *Cyclistic*.

Think-Aloud Sessions

During the think-alouds, which generally took between 10-15 minutes, tourists planned bike routes using *Cyclistic* and their actions, comments, and questions were recorded. In analyzing the think-aloud data, we created a list of all the problems the tourists encountered and the frequency with which they appeared. Some problems were later removed from this list because they were either issues that the developers already addressed or temporary glitches in the software. Next, we grouped similar problems together and further categorized them based on when they occurred during the route-planning process, either while (1) getting started, (2) planning the route, or (3) reviewing/exporting the route.

1. Getting Started

The first stage of the route-planning process requires the user to find a place. To do so, users can either enter a destination in the "Find place" box or they can locate where they want to go/start from on the map by zooming in on their region of interest, right-clicking a point, and selecting either "Route from here" or "Route to here" (Figure 29).
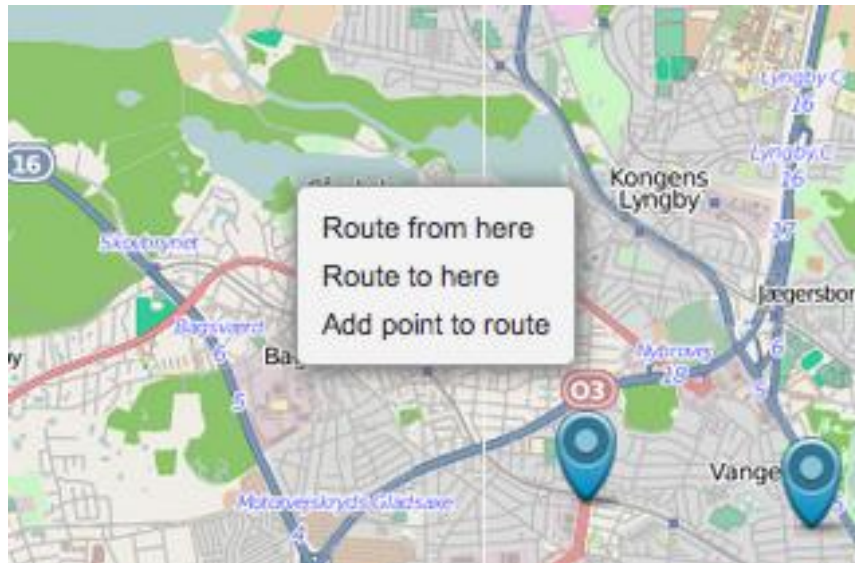
Figure 29: Right-click functions
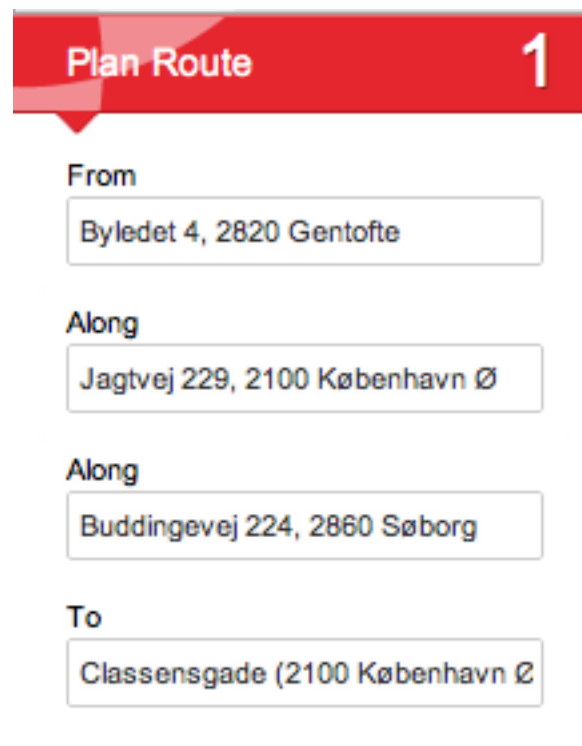
For users who chose to get started by entering a location in the "Find place" box, 6/16 of them were looking to enter their starting location rather than their destination since they did not know where they wanted to bike yet. One user commented, "What do I do if I don't know where to go?" This suggests that the developers assumed that all users already have a specific attraction in mind. It seems that *Cyclistic's* users fall into two categories: (1) those who already know where they're going and (2) those who want to explore and are looking for inspiration. In order to meet all users' needs, *Cyclisitic* could give users the option of how they want to start the route planning process.

Only 9 of our test-subjects tried zooming in on their location, and of those 9, only 2 figured out how to use the right-click functions to enter an address into the route planning boxes. An instruction guide or tutorial could alleviate this issue by making users aware of this helpful feature.

2. Planning the Route

The next stage of the route-planning process is to plan the rest of the route by clicking the *Plan Route* button. From here, users can enter a starting location in the "From" box and add points of interest in the "Along" boxes (Figure 30). This can be done through using the right-click functions, typing in the address of an attraction, or using the attraction buttons above the map. If using the right-click functions, the user can click a point on the

map and then select "Add point to route" (Figure 29). The attraction buttons above the map (Figure 25) are useful for finding points of interest around Denmark. For example, if users are interested in seeing museums or monuments, they can click on the culture icon and markers for those attractions will appear on the map. Users can then click on these markers to see what they are and find out more information about them. Thus, the attractions buttons are helpful for users who do not know where to go as well as for users who want to see what attractions are along their routes.

Figure 30: *Plan Route* Section

Seven out of 16 of our test-subjects were not immediately aware of the *Plan Route* button and had to be prompted to click it. If we had not told them to click it, they would have wasted a significant amount of time trying to figure out what to do next. One user mentioned that she wished the *Plan Route* button was bigger or more noticeable. Designing a more intuitive layout could also address this problem.

Thirteen out of 16 of our test-subjects did not initially notice the attraction buttons either. In all of these cases, the session-leader had to point out this feature so that users

could proceed with their route planning. One of these users said, "It is not immediately evident what the [attractions buttons] are and how they should be incorporated into the route planning." Two reasons why the attraction buttons could have gone unnoticed is because they are located above the map outside of the *Plan Route* section, and are grayed out, which makes them look un-clickable. Designing a more intuitive layout and creating an instruction guide/tutorial could help fix this issue.

Eight of our test-subjects discovered problems with Danish-English translations while planning their routes. Three of them complained that the site changes back into Danish after navigating away from the map/homepage, and 6 discovered minor translation-related issues as shown in Appendix M.

Four users' routes were mistakenly deleted when they navigated away from the map/homepage. These users left the homepage out of curiosity to explore other sections of the site such as the *Official Routes* or *Cycling in Denmark* pages. When they returned to the map, their route data was gone, and they had to re-plan their route. Several users' commented that this was "frustrating." To get around this problem, *Cyclistic* could save inputted data and only clear data when the user asks it to.

Four users explored the *Official Routes* page, which is designed for users looking for inspiration. This page includes a database of popular routes in Denmark and allows users to search for routes of varying lengths and difficulties in different regions. The users who explored the *Official Routes* section navigated back to the main map after realizing that the page was in Danish and only had one official route available.

While planning a route and searching for attractions, growlers (pop-ups) will appear to inform the user that *Cyclistic* is processing the users' actions. For example, when the user selects attractions from the attraction buttons, a growler that says "Updating points of interest" will emerge. Although they are just temporary, if the user moves the map another growler will appear and they will pile up on one another and block the map (Figure 28). Four users complained about this. "Too many pop-ups show up when I click on something. It's distracting and hard to see the map." To fix this issue, the developers could program *Cyclistic* to only show one growler at a time.

Three users complained that the "Along" label in the *Plan Route* section is not intuitive for adding attractions to a route (Figure 30). "Along" implies that the point is just a means of getting from one place to the next. Instead, it could say "Intermediate Stop."

Only 2 test-subjects figured out the right-click functions (Figure 29). Others were either told to use them or did not use them at all. Those who did not use the right-click functions searched for the addresses of attractions in Google or used the attraction buttons. Again, an instruction guide or tutorial could help alleviate this problem.

Two users wondered what the different-colored dotted trail lines on the map were (Figure 27). A key could explain what types of paths they are, which would give users more routing options.

3. Reviewing/Exporting the Route

The final stage in the routing process requires the user to first click on the "Calculate Route" button, which generates a route connecting the user's points of interest. Next, the user clicks the *Route Information* tab, which includes information such as the length of the route, how long it takes to bike the route, and the elevation change along the route (Figure 20). Finally, the user clicks "Show Route Description" and can either print or export their route via Facebook, Twitter, a link, or a GPX file.

Seven out of 16 of our test-subjects were not immediately aware of the *Route Information* section and had to be told to click on the link. These users could not figure out how to see how long their route was or how to get directions. The reason why the *Route Information* tab went unnoticed by so many users is because it looks different from all the other buttons. Making the buttons for all of the major steps of the routing process look the same could help fix this issue.

Four out of 11 English-speaking users did not like that the distance traveled is in kilometers and that the estimated bike speed is in km/h. To meet these users' needs, *Cyclistic* could allow users to choose between kilometers and miles.

Three users complained that the route descriptions *Cyclistic* generates are too complicated to follow. One user commented, "There are so many turns. Is there any way to make a feature that would reduce the number of turns and make a more direct route?" We later found in our post-touring surveys that users who printed out their maps and directions did in fact have difficulty following them while biking.

Two users realized they could not save their route without first setting up an account. However after creating an account, all route data gets deleted, so users should create an account first and then map their route. To solve this problem, *Cyclistic* could inform users that they have the option of creating an account upon entering the site.

Think-Aloud Debrief

After each think-aloud session, tourists completed a think-aloud debrief, which allowed tourists to look back and comment on their route planning experience. 94% of the tourists said they were happy with the attractions they found using the attraction buttons or search box (Q4), implying that the attraction database is a desirable feature of the software. Using a 1-5 scale, on average, tourists also said they were *happy* (4/5) with the route they planned (Q6). Conversely, 13% of users were unable to successfully plan a route (Q5), and on average, using a 1-5 scale, tourists said the software was *somewhat intuitive* (3/5) (Q1), implying that the software's usability still has room to improve. A summary of the rest of tourists' responses follows (**Table 12**):

Table 12: Results of Think-Aloud Debriefs

Question:	Responses:
Q2: What did you like about using *Cyclistic* to plan your route?	• Variety of attractions to choose from (75%) • Route information (44%) • Right-click features (31%) • Adjusting route via dragging (31%) • Site is visually appealing (25%) • Color-coded attractions (25%)

	• Dragging/sorting attraction (13%) • Round-trip feature (13%) • Size of map (13%) • "Add to Route" button (6%)
Q3: Was there anything about the software that was difficult to use or understand?	• Not aware of certain features (94%) • Language translation issues (44%) • Search bar problems (38%) • Not sure where/how to start (31%) • Some software glitches (31%) • Pop-ups are annoying (25%)

Responses to Q3 also suggest that *Cyclistic*'s interface has room for improvement. From Q2 and Table 6 we created a Master List of *Cyclistic's Positive Attributes* (Figure 31):

• The route information (route length, time, and elevation change) is very useful. • The attraction flags that pop-up on the map are color-coded, which makes finding certain attractions easier. • There are a wide variety of attractions to meet every user's needs. • The attraction information is useful and specific for tourists. • There are various ways to export a route such as via Facebook or Twitter, as a URL or GPX file, or printed as a hardcopy. • The site is visually appealing. • The right-click functions are an easy way to add points to a route. • The ability to drag and sort attractions is an easy way to redesign your route. • The round trip feature takes care of one extra step for the user. • The "Add to Route" button is an easy way to add attractions to a route. • The ability to drag your route on the map is an easy way to adjust your route. • The map is large, easy-to-read, and color-coded.

Figure 31: *Cyclistic's* Positive Attributes

Post-Touring Surveys

Test-subjects who agreed to use the route they planned with *Cyclistic* completed post-touring surveys. The purpose of these surveys was to evaluate the end product of the software – the map and directions. We did this by gauging how happy tourists were with their bike rides and determining what types of problems, if any, they encountered while biking.

All of our users chose to print out their maps and route descriptions and 4/7 of the users had to stop frequently to look at them (Q5). Even though they all eventually found their attractions, 6/7 of them got lost using *Cyclistic's* route, and 1 decided not to fully observe its directions (Q2). Two out of 7 users mentioned that *Cyclistic's* map and route description were not very helpful (Q2). Route descriptions tended to be long and complicated with many turns, while the maps did not include all of the street names. Based on these responses, Q3 from the think-aloud debriefs, the think-aloud sessions, focus group, *Initial Impressions of Cyclistic*, and our experience prototyping, we created a condensed list of problems that users encountered, categorized according to the *type* of problem (**Figure 32**):

Tourists were…

1. not sure how to begin planning a route

2. not aware of important software features, such as:

    a. attraction buttons
    b. route information
    c. right-click functions
    d. dotted trail lines

3. having difficulty navigating a route with *Cyclistic's* directions due to:
    a. complicated route descriptions
    b. printed maps' lack of street names

4. inconvenienced by:
    a. inaccurate/missing language translations
    b. routes mistakenly deleted
    c. pop-ups obscuring the map
    d. Official Routes page still under development

5. unfamiliar with proper cycling etiquette/rules

Figure 32: Users' Problems with *Cyclistic*

The post-touring surveys also provided us with feedback on potential features tourists might find useful. Tourists were presented with the list of potential features to add in Table 5 and asked to check off the ones they would find most useful. A summary of how tourists ranked these top 12 features follows (Figure 33):
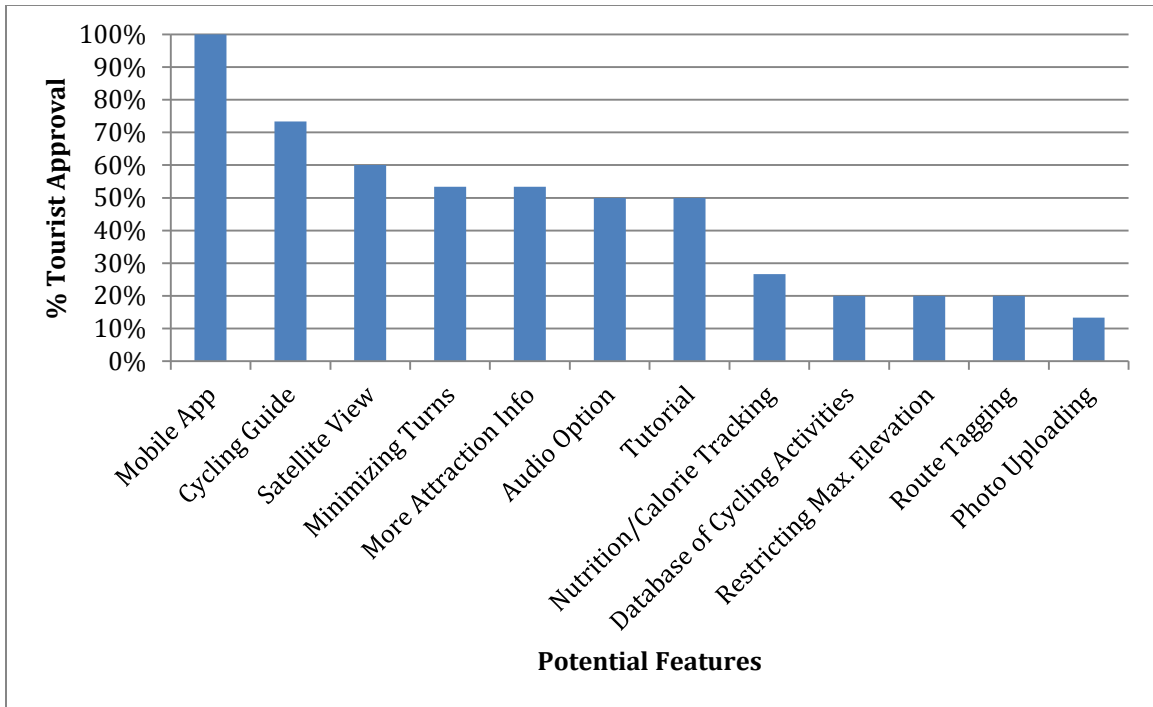
Figure 33: Tourists' Approval of Potential Features

The **mobile app** was a popular feature because the majority of tourists who completed the post-touring survey complained of having to stop biking to look at their map. One tourist commented, "It would be nice if there was a way to read the map on a smart phone instead of using a paper one. Eleven out of 15 tourists also wanted a **Cycling Guide**. As determined in our cycling-interest surveys, many tourists ranked themselves low with respect to knowledge of Danish cycling etiquette/rules. Including a brief list of things that new cyclists in Denmark should know could help alleviate this issue. In addition, 6/10 tourists said they would have liked to have a **satellite viewing option** while planning their routes. This would have allowed them to virtually view their bike routes on a street-by-street level and made them more familiar and comfortable with their routes. 5/10 test-subjects said they liked the idea of being able to *listen* to turn-by-turn directions via head phones while biking. Since 4/7 tourists complained of having to stop and look at their map while biking, an **audio navigation** option could address this issue. Furthermore, 5/10 tourists wished they had access to a **tutorial** on how to use *Cyclistic* while planning their routes. The need for one is supported by our think-aloud sessions, which shows that the non-intuitive layout could be addressed by simply providing some instruction ahead of time. A tutorial would have addressed many of the problems mentioned in the think-aloud

sessions such as not knowing how to incorporate the attraction buttons and not being aware of the right-click functions. Eight out of 15 tourists also wanted to **minimize the number of turns** in their route because the route descriptions that *Cyclistic* generated were too complicated. A complete list of tourists' desired features as well their recommendations can be found in Appendix L.

Chapter 5: Conclusions and Recommendations

The goals of our study were to understand *Cyclistic*, understand tourists' needs, and identify both the strengths and short-comings of the software. We achieved these goals by conducting a usability study involving tourists and students as outlined in the methods and results chapters. From this study we were able to develop the recommendations for additions and changes to *Cyclistic.*

In our results, it was discovered that *Cyclistic* falls short in addressing users' needs for a cycling routing tool. Users did not have an understanding of cycling rules and etiquette in Denmark and the directions provided by the software were inadequate for navigating. Furthermore, our think aloud sessions revealed that most users required significant assistance using the software, revealing that the interface itself needs redesign and users need some preliminary guidance.

Our key recommendations for improving C*yclistic* are:

1. Include a Cycling Guide
2. Make Interface Changes
3. Include User Instructions and Tips
4. Develop Better Route Navigation Tools

5.1 Include a Cycling Guide for Tourists

Our surveys indicated that tourists rarely have, but desire, knowledge of the cycling rules and etiquette of Denmark. Without it they may not have the confidence to cycle in Denmark, even with a useful directional tool like *Cyclistic.* Presented with an altogether new cycling culture tourists can become stressed and confused. To alleviate this concern, we recommend including the following cycling guidelines within the site, under the *Cycling in Denmark* page. There should also be some kind of permanent link under the *Inspiration* tab. The guide was compiled from a combination of personal experience while cycling around Denmark and the 2010 cycling IQP's guide posted on-line (Cycleguide.dk, 2010). The recommended guide is presented on the following page.

Cycling Guide

The bicycling infrastructure in Denmark can be intimidating at first glance, but here are eight useful tips that can make your cycling experience more enjoyable:

1. **Navigating Bike Paths**

   Bike routes vary in size and shape throughout the city, but there are four typical types as seen below. It should be kept in mind that cars and buses often stop or park on the left side of bike paths, so be aware that pedestrians may cross the bike path to exit or enter these vehicles. While cyclists do have the right of way, it is recommended to slow down or stop to allow pedestrians to cross, especially if entering or exiting a bus.

Cycle path with median between bicycle lane and auto/bus lanes

Cycle path separated from moving auto lanes by a raised curb, which may or may not be to the right of parked cars

Painted cycle lanes between sidewalk and traffic lanes

Streets with no cycle lanes or paths

In more rural areas, cycle routes are sometimes off from the main roads entirely. In places like Bornholm, some paths may be unpaved and hilly, so it may be preferable to just bike along the main roads. Be aware that cycling conditions can change suddenly outside the city and plan your route accordingly. Always walk your bike along the sidewalks and through cross-walks.

2. **Always use hand signals**

When turning and stopping it is important to use the correct hand signals so autos, pedestrians, and other cyclists know what to expect. Bike lanes are busy, and if you neglect to use turn signals you risk another cyclist crashing into you. Denmark uses only the signals shown below.
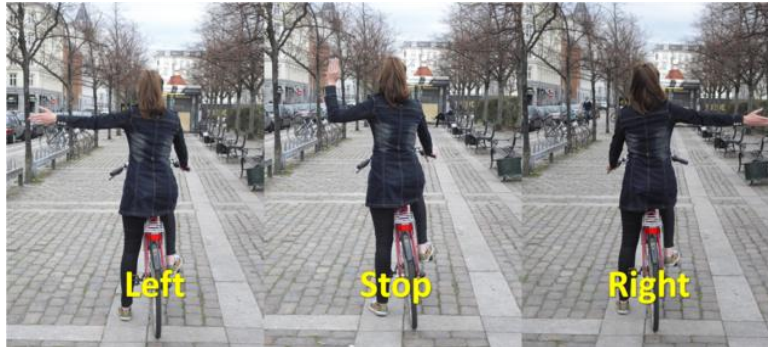
Diagram of hand signals from cycleguide.dk

3. **Stay to the right**

When biking in a designated bike path or the road, stay to the right so faster bicyclists or cars can pass. If passing another cyclist you should check over your left shoulder for other cyclists before moving to overtake.

4. **Obey traffic lights**

Many intersections along busy cycle routes have traffic lights dedicated for cyclists which are smaller than standard lights and are differentiated by a blue circle with a white bike in it as seen below.

Example of bicycle traffic light

Bike traffic lights take precedence over car traffic lights, but in the case that a bike traffic light does not exist, one must follow the car signals. Note that the signals in Denmark follow a four step sequence seen below. From left to right is stop, prepare to go, go, and prepare to stop.

Danish traffic light system from http://simple.wikipedia.org/wiki/Traffic_light

It is illegal to cross an intersection or turn right on a red light. Doing so could result in a large fine.

5. **Be aware of weather conditions**

Denmark has many windy and rainy days. Wind gusts can unsettle new cyclists, but stay calm and shift down a gear to maintain some speed into the wind. Bike seats can get wet if left outside in a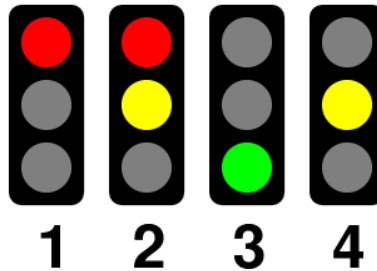 storm. To prevent this move your bike under cover or put a plastic bag over your seat if rain is in the forecast. Many people in Denmark bike rain or shine, so it shouldn't be a deterrent to your cycling adventure.

6. **Making Left –Hand Turns**

At four way intersections it is necessary to make what is known as a hook-turn. When you wish to make a left-hand turn you signal that you are going to stop and then move to the right and then turn left to make a stop in the direction you wish to travel as shown by the green line below. Then wait for the light to turn green to cross the intersection. While it is legal to take the path shown in white, it is only safe to do so at a three way intersection or if there are no cars.
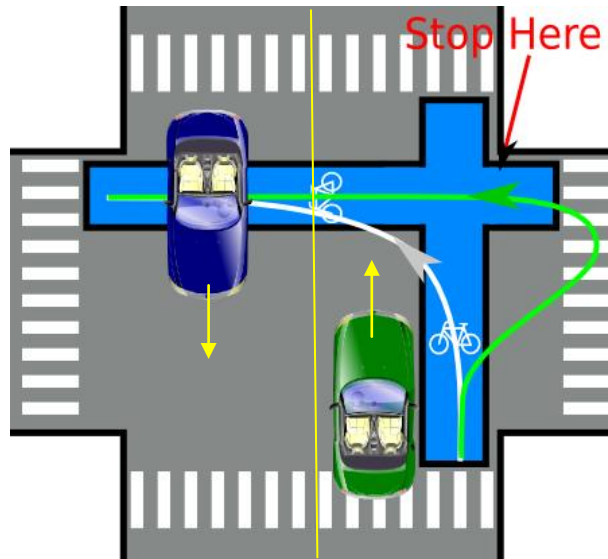
Diagram of Left-Hand Turn, Cars in street, yellow arrows showing their direction of movement across intersection, blue paths represent bikes paths, green arrows show correct bicycle movement.

7. Avoid cobblestones

Cobblestone streets are bumpy and can be a source of uneasiness on a bike. Being an old, European city, Copenhagen has an abundance of short cobblestone streets, though it is possible to avoid them for the most part. Alternatively, you can always signal to stop anywhere and walk your bike along the sidewalk.

8. Lock your bike

Try to park your bike in designated bike racks, but if not possible just make sure the bike is out of the way of pedestrians. Always lock your bike's rear wheel to prevent it being carried away and stolen.

5.2 Redesigning the Interface

Besides the instructions, a number of edits should be made to the software interface to increase the usability. The redesigned main page can be seen below with the six major changes referenced and explained below.
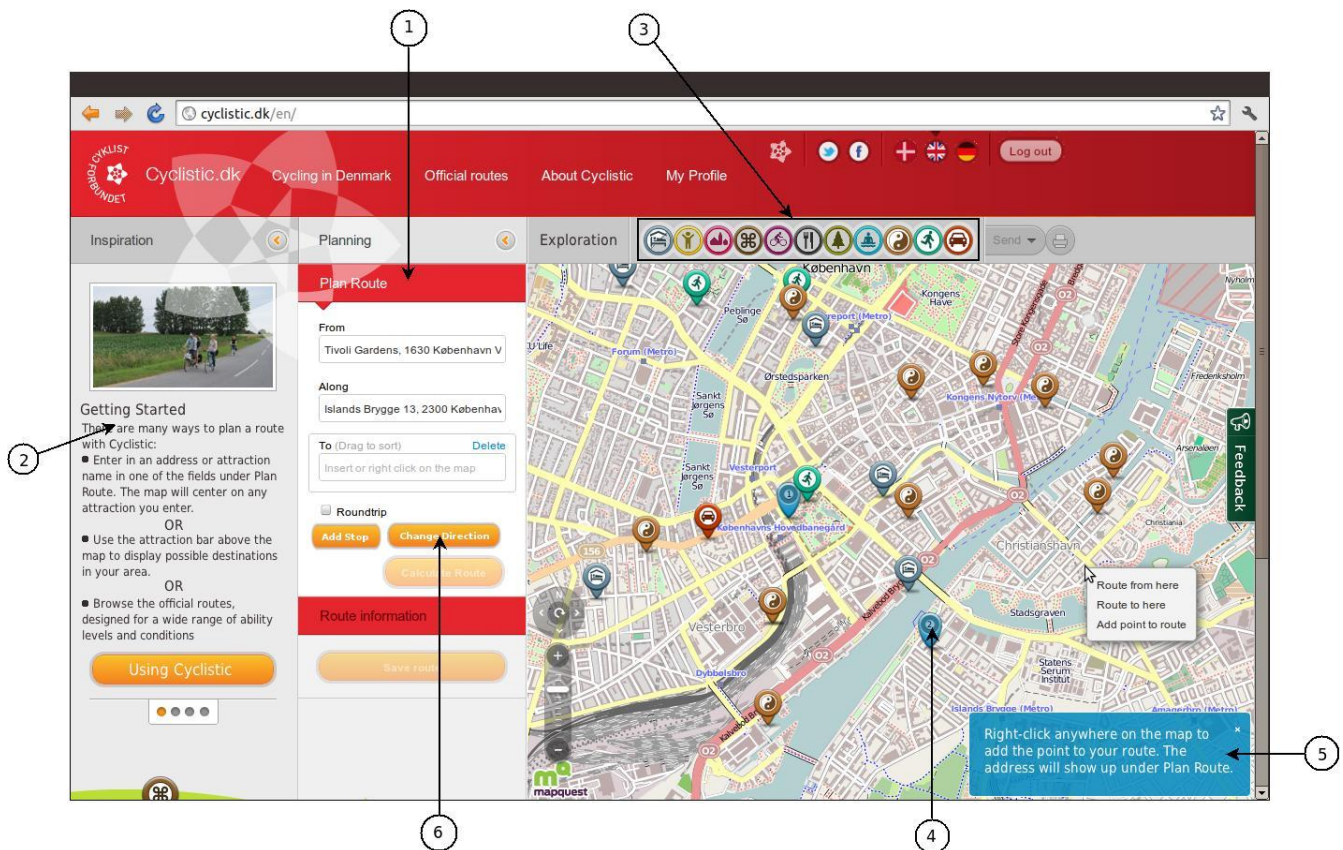
Figure 34: Redesigned Interface for *Cyclistic*

1. The first suggestion is to eliminate the opening step to find a place in the *Plan Route* tab. The extra step confuses users and often they had to be told to click the *Plan Route* button before they could do anything with an actual route. It would clean up the process if users could start planning a route from the beginning. A list of regions or a search bar by the attractions would replace the functionality of being able to find a place while still reducing the number of steps.

2. Currently, the *Inspiration* tab on the left side of the page is poorly utilized and could be the starting point for users looking for some general information about

Cyclistic and cycling in general . We suggest the opening page in *Inspiration* with the *Getting Started* message as displayed. This gives a brief explanation of how to use the site and links to the more detailed instructions in the *About Cyclistic* section.

3. The *Attraction Bar* should have colored in buttons as shown. The buttons should not be grayed-out as this implies that the buttons cannot be used.

4. Each new attraction icon that is added to the route should be numbered to correspond to the order in the *Plan Route* tab. A close-up of this is shown below.

Figure 35: Example of numbered attraction icon

5. The growlers (pop-ups) should be used to display hints such as the one that is shown explaining the right-click feature.

6. The *Add Stop* and *Change Direction* buttons should be clearly identifiable as buttons, so we recommend changing all the buttons to a single standard so it's obvious to users what they can click. This also applies to accessing the directions through the *Route Information* as seen below.
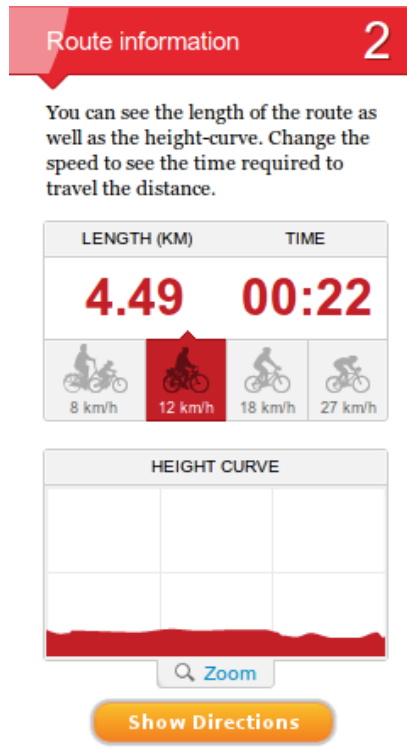
Figure 36: Example of new Route Information design

In addition to the change in visual design, the *Route Information* tab should be displayed once the user calculates a route instead of being accessible but hidden. More users will access the tab this way and it does not compromise the user's ability to change their route.

5.2.1 Additional Considerations

The following is a list of changes and features that could improve the experience of using *Cyclistic*.

Hiding Attractions

To free up the screen and make attractions easier to sort and select, specific attractions should be able to be hidden from the map by the user if they are not what the user is looking for. This could be done by giving the user the option to hide an attraction after they click on a flag. Reloading the page or resetting which attractions are displayed would show any hidden attractions.

Map Key

Create a key showing that different-colored lines indicate different path and road types as they appear on the map along with any other cycling specific symbols available through *OpenStreetMap*. Most importantly, this should address bike only paths. Giving the user this information makes it easier to make an informed decision to change the route path manually.

Transport Integration

Suggest the use of transport and provide links in the case of a user specifying a route that requires a ferry, train, or bus ride. Also allow the option to show any transport stops and hubs so users can plan a route from a train stop in the country or a ferry port.

Opening Page

On navigating to the site, a user should be prompted to select a language and log-in or create an account if desired. This could be displayed as a pop-up upon entering the *Cyclistic* main page. This page could include information for new users and link to a tutorial for the site.

Satellite View

Having the option to look at a satellite view while planning the route gives users an enhanced level of detail not available with the standard map layout. It is easier to see what attractions look like and can be used to understand what a route will look before riding. It is especially useful for selecting green and scenic routes.

5.2.2 Translation Problems

We recorded instances when parts of the software were not translated from Danish to English properly which could result in a significant amount of confusion to new users. The major issues were buttons or address bars switching to Danish as a result of a certain sequence of events and the filters used to search for routes within the *Official Routes* page are also in Danish. A full list of these problems can be found in appendix M including screen-shots and the conditions that lead to the problem and possible rewordings if necessary.

5.3 Provide Instruction for Users

As discussed in the results, it was difficult for many users to understand how to use *Cyclistic* and its varied features. Addressing this issue can be done in two ways:

1. Include instructions located in the *About Cyclistic* page detailing how to use all the features.
2. Include on-screen tips and/or a visual tutorial to direct users through the various steps and features

The software has a specific path for users to follow to create a route. The users themselves either will go into the software looking for a specific route that they have predetermined, or will look to the software for direction and inspiration. The software can address both of these users' needs well by offering a different routing experience to each. The flow-chart seen below was created to help visualize the progression through the software a user may take.
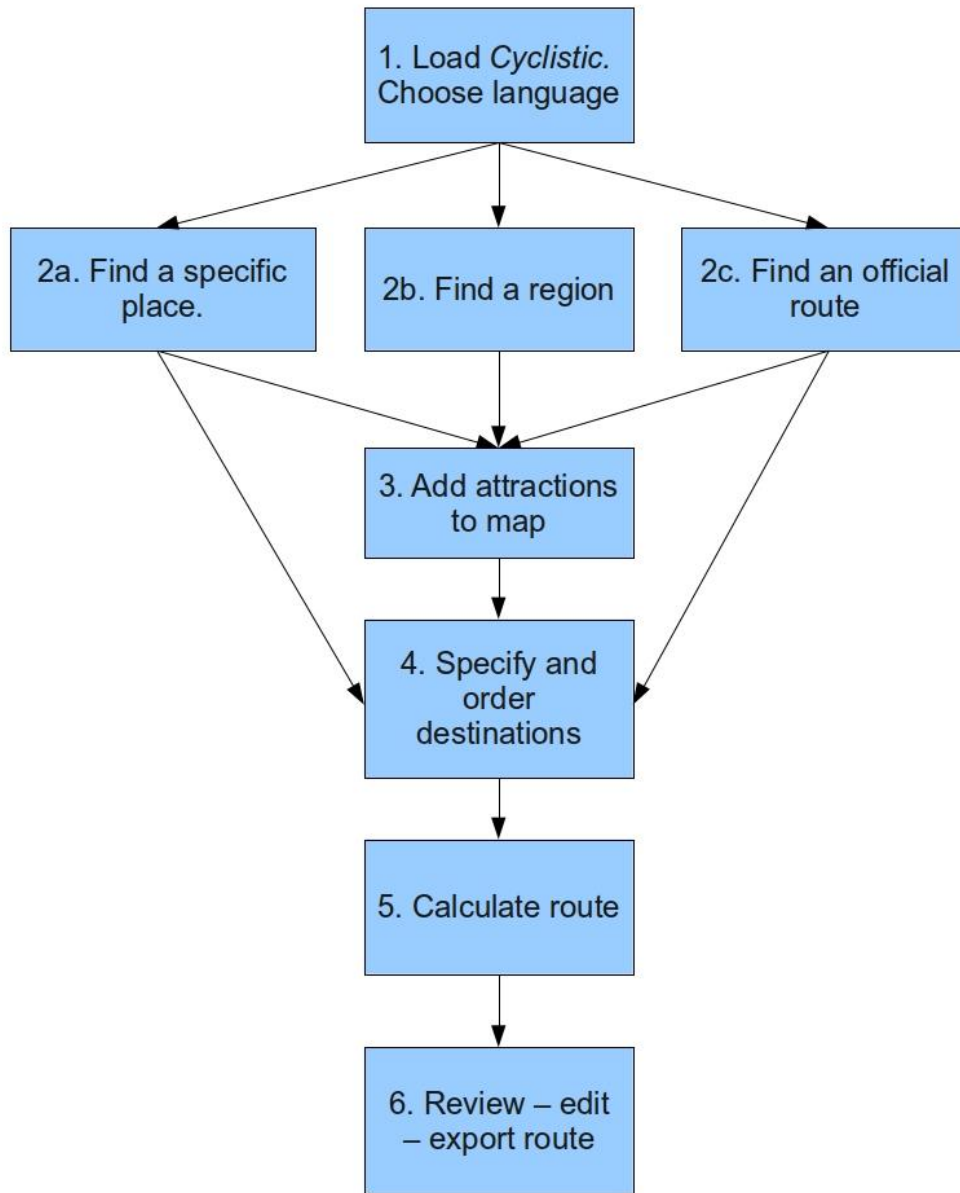
Figure 37: Flow-Chart of standard software progression

It is clear to see that there are many different ways to use the software to find attractions, but the rest of the process of creating the route is the same regardless of user desires. Those users that know where to go will immediately go to planning a route and want to enter in location names or addresses. At that point they will either continue to

finding attractions and amenities along their chosen route or continue to finalize and export their route. Users that are not so sure where they want to go can further be categorized into those that are exploratory in nature and those that want more inspiration and structure. Those who want to explore, are likely to begin with a general region and use the attraction filters to find interesting places to go. Others will start browsing through the official routes for inspiration and either use those as a starting point or chose to edit one to their own preferences.

Any of these users could benefit from guidance through these steps in the form of instructions which are laid out below. These should be included in the *About Cyclistic* page with a link in the *Inspiration* tab.

Cyclistic Tutorial

Step #1: Overview of Features
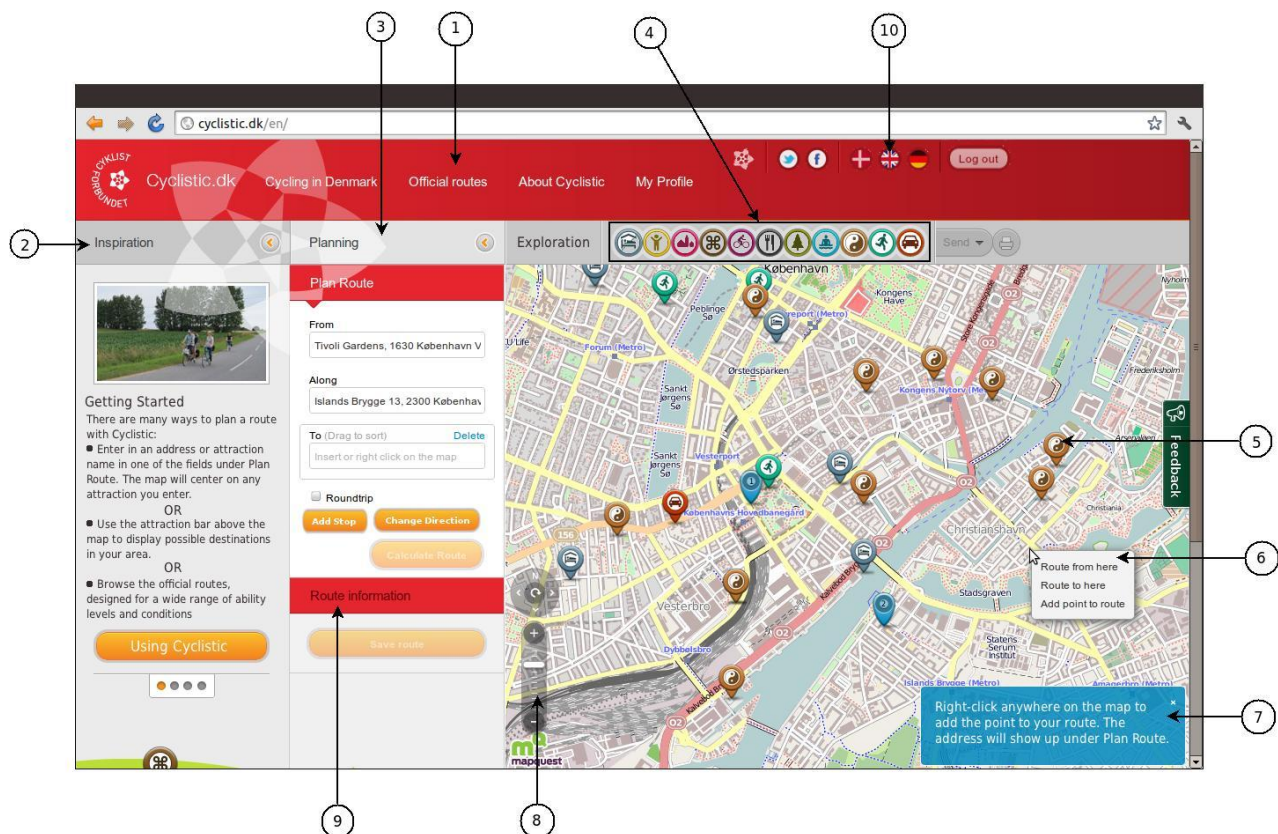
Screenshot of re-designed interface of *Cyclistic*

1. **Menu Bar** – links to the different pages available within the *Cyclistic* site.
2. **Inspiration Tab** – General help using the site and useful information for tourists new to cycling in Denmark.
3. **Planning Tab –** Where you can enter your current location and the addresses/locations of the stops and final destination for your trip.
4. **Attraction Bar** – Contains a list of different types of attractions under eleven different categories including accommodation, children, city, culture, cycling, food, nature, waterfront, relaxation, sports, and transportation. If you select a category, related attractions in the area will show up on your map allowing you to select types of attractions to view on the map
5. **Attraction Flag** – Shows where attractions are located and the kind of attraction based on the symbol. Hover over the flag to see the name of the attraction and then click to see a description of the attraction with more information.
6. **Right-Click** – Right-click on the map to select any location and add it to the route.
7. **Pop-Up** – Pop-ups display hints and useful information along with letting the user know when the software is searching, calculating, or has run into an error.
8. **Navigation Pane** – Move around the map using the directional arrows and adjust the zoom level with the slider.
9. **Route Information** – Once you enter your current location and destinations, you will hit calculate and a new box, *Route Information*, will appear showing information including length, completion time, and elevation change.
10. **Language** – Options for Danish, English, and German.

Step #2: Getting Started

Three Ways to Use Cyclistic

You can use *Cyclistic* in 3 different ways, depending on whether you know where you want to go or whether you want to explore a region or whether you would like to browse suggested routes in a particular area.

1. Know where you want to go?

Enter in a *From* and *To* location along with any intermediate (*Along*) destinations in the *Plan Route tab.* You can type in either the addresses or the names of attractions and the form will auto-complete. Addresses are only available in Danish. Many of the attraction names are in both Danish and English.
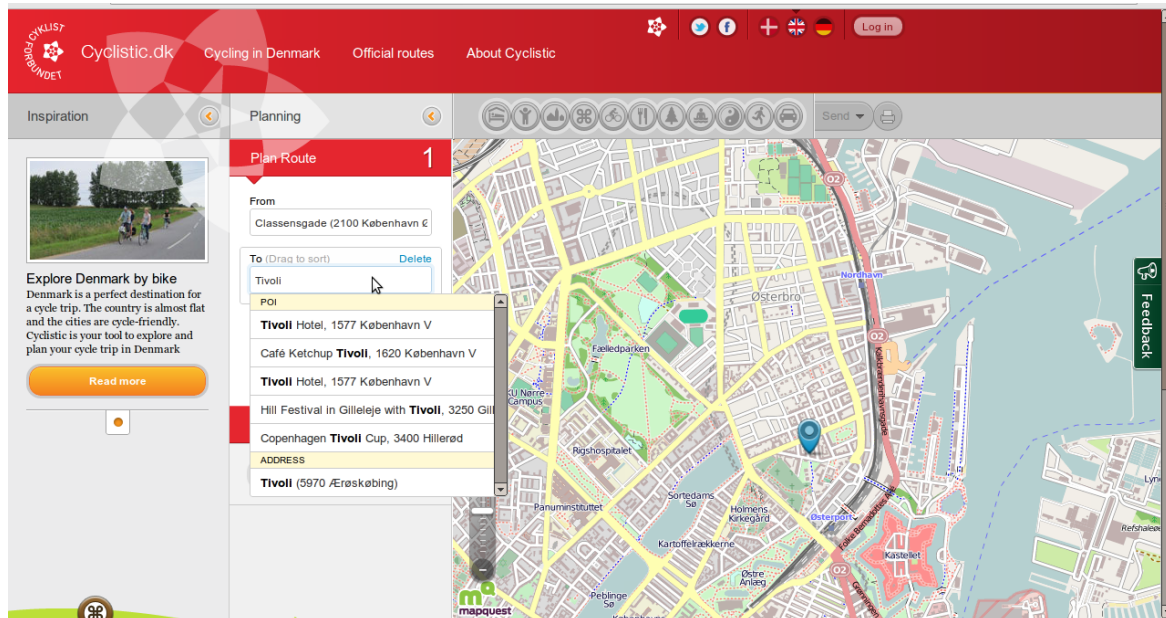
Screenshot of search bar

2. Looking for inspiration?

Cyclistic can suggest popular routes throughout the different regions of Denmark. Click on the *Official Route* link on the message bar. Select the region of interest on the left side of the page. Change the selection criteria to match the desired route. Specify the difficulty, type of route, and desired length in the search box and browse the related routes. Once you select a route you will be shown a description of the route and can choose to import the route to the map. The route will appear on the map with the destinations in the *Planning* tab.
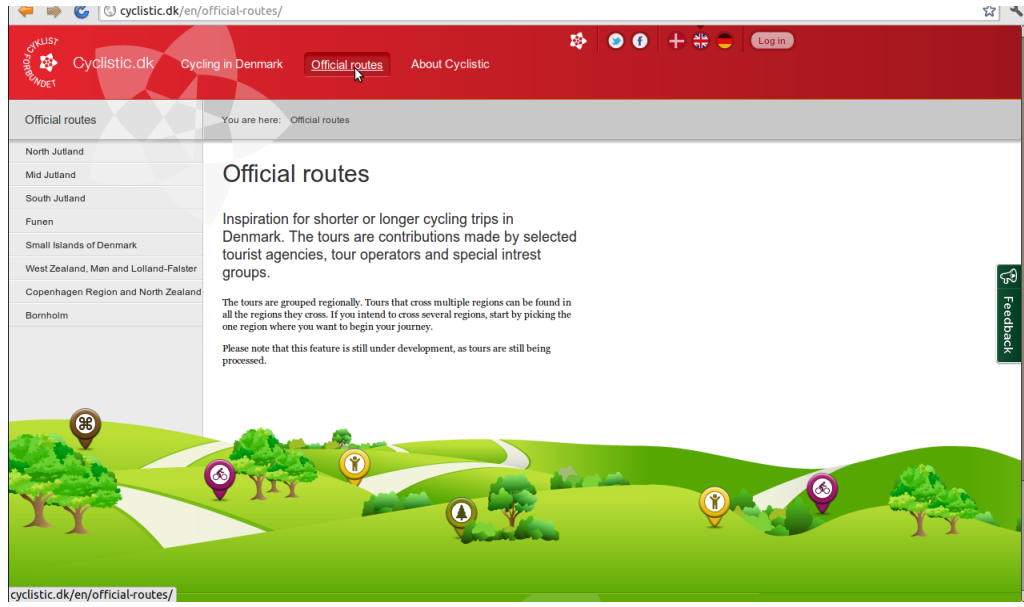
Screenshot of Official Routes page

3. **Want to explore a region?**

Move around and zoom in on the the map of Denmark to locate a region that looks interesting. Browse attractions by using the using the *Attractions Bar* located above the map as is explained below.

Step #3: Planning a Route

Accessing attractions

Cyclistic includes information on various attractions within Denmark. To access these destinations, you can either use the *Attractions Bar* found above the map or search for specific attractions. The *Attractions Bar* can be used to display specific types of attractions on the map. Anything from restaurants to water fountains and amusement parks can be specified and these attractions are broken down into 11 categories, each containing sub-categories.
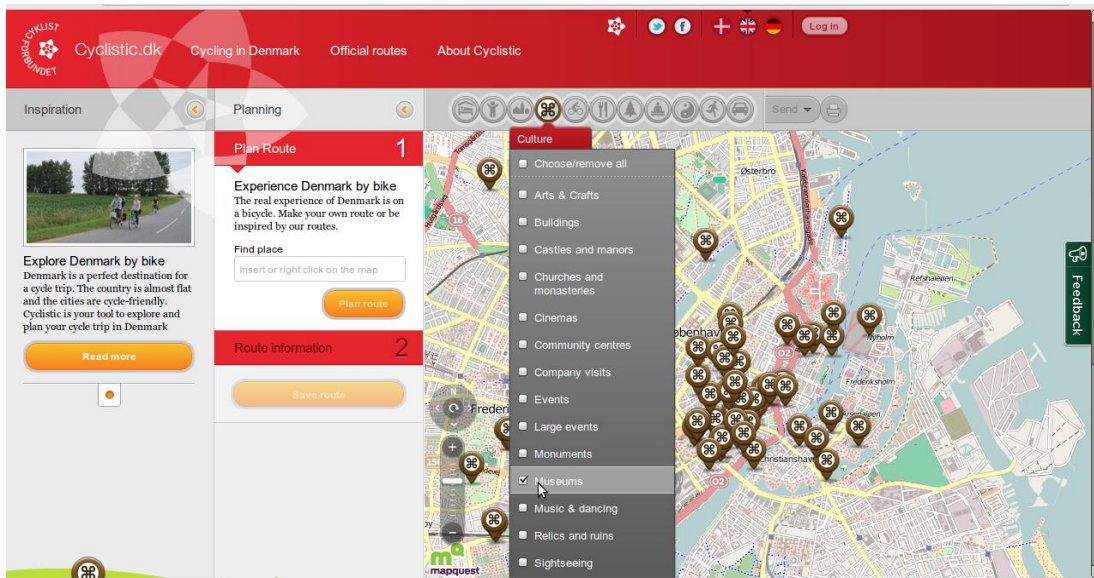
Screenshot of attractions bar

Ordering Destinations

Clicking the *Add Stop* button will add another address box to the list and any extra addresses can be deleted by hovering over the address box and pressing *Delete.* Addresses can also be reordered by clicking and dragging the address box. Right-clicking anywhere on the map summons a dialogue box at the address selected prompting to either add the location as a start, finish, or intermediate point. The *Round-Trip* button will set the final location to the same as the first. Once you are happy with your route, click *Calculate Route* and the path will appear on the map.
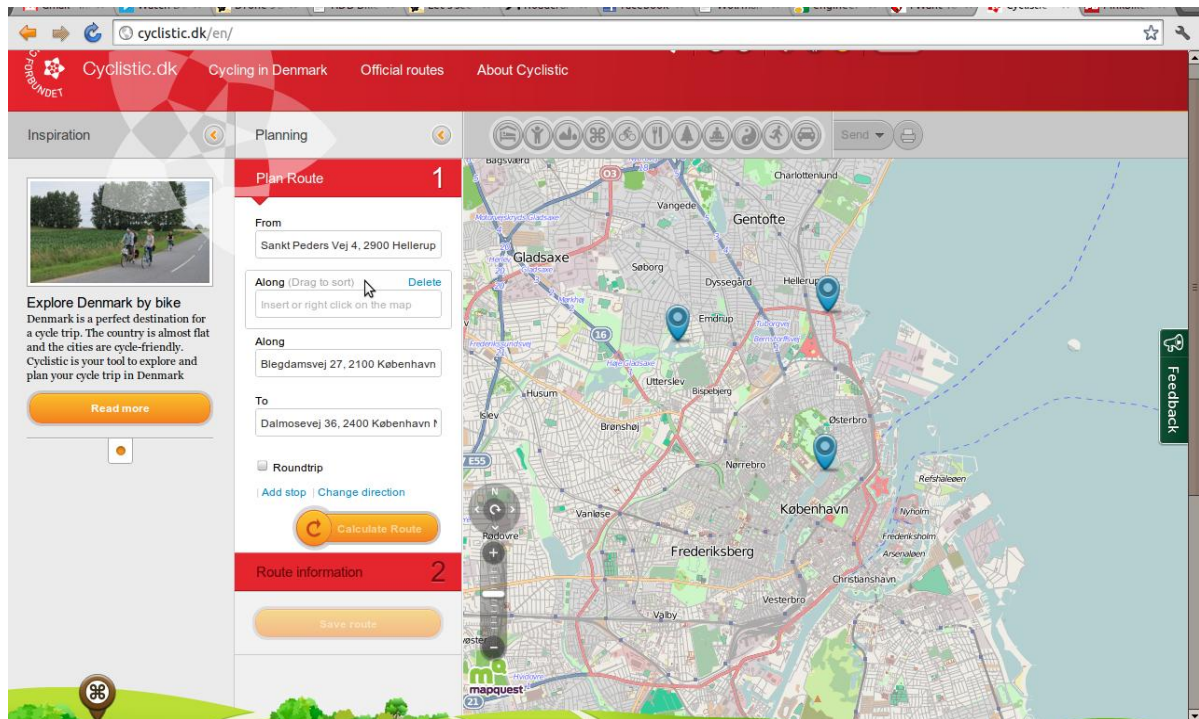
Screenshot showing the reordering feature

Reviewing and editing the route

Upon calculating a route, the R*oute Information* field will become viewable. *Route Information* includes route length, duration depending on user-selected speed and an elevation chart. The directions can also be accessed from *Route Information* and displayed in a printable pop-up. The route can be changed and recalculated at this point based on user preference. The path of the route itself can also be changed by clicking and dragging any point on the route to a new location. The path will automatically adjust to this change and recalculate. Dragging the route allows the user to preference certain paths or make personal adjustments to pre-made routes.

Step #4: Exporting and Saving the Route

Exporting the route

   Users have the option of exporting the route in the following ways by using the *Send* or *Print* buttons:

   1. Printing out a direction and map sheet

   2. Exporting the route as a file or direct link

   3. Posting the route to Facebook or Twitter

Creating a user profile and saving routes.

   Users have the option of creating their own profile within the site. This allows users to save their routes and access them at a later date or on a mobile device. All that is required is an e-mail address and then the user sets their name and password. Once logged in, the *My Profile* button will appear. From there the user can access saved routes.

Quick Tips

   Users looking for quick direction on how to use the software should be provided with a few simple steps depending on if they (1) know where they want to go, (2) are looking for guidance, or (3) are interesting in exploring an area. It's important that users have tips like this since many would not be willing to read through a fully developed list of features or instructions. These tips could be displayed on an opening page for new users, or cycle through the *Inspiration* tab to provide guidance to new users.

Quick tips for New Users

Know where to go	Looking for guidance	Exploring an area
1. Enter in the starting address under the *Plan Route* tab. The address will auto-complete. Upon select an address, the map will center and zoom in on the location. 2. Enter the destination(s) in the same way. 3. Once all the addresses are entered, select *Calculate Route.* The path will appear on the map. 4. The *Route Information* tab will open and the directions can be viewed from there. 5. On the right side, above the map are options to send or print the route directions. The route can be exported to a GPS, posted on facebook and twitter, and sent as a direct link.	1. Click on the *Official Route* link on the message bar. 2. Select the region of interest on the left side of the page. 3. Change the selection criteria to match the desired route. Select difficulty, type of route, and desired length. 4. Once you select a route you will be shown a description of the route and can choose to import the route to the map. 5. The route will appear on the map and the R*oute Information* tab will open. From there you can view the directions. 6. On the right side, above the map are options to send or print the route directions. The route can be exported to a GPS, posted on facebook and twitter, and sent as a direct link.	1. Drag and zoom in on the map to center on a region of interest. 2. Filter the types of attractions you'd like to see on the map by clicking on icons from the *Attraction Bar* located in the *Exploration* tab. 3. Attraction flags will appear on the map. Hover over the flags to display the name and then click to view more information about the selected attraction and to add the attraction to the route. 4. Once all the addresses are entered, select *Calculate Route.* The path will appear on the map. 5. The *Route Information* tab will open and the directions can be viewed from there. 6. On the right side, above the map are options to send or print the route directions. The route can be exported to a GPS, posted on facebook and twitter, and sent as a direct link.

5.4 Cycling Navigation Issues

An issue we noticed in our post -touring reviews was that using the exported map and directions when cycling was a source of difficulty among users. There are two issues at work here:

1. The map is too small
2. There are often many turns in the step-by-step directions, so users must constantly pull over check the map.

The map issue can be solved in a couple ways. More maps could be incorporated in the directions, one for each attraction selected, one for the general route, and one for the finish unless round-trip is used. This would enhance the resolution of the maps, even if the attraction maps are relatively small. The other way to solve this issue is if the map itself could be cached on a mobile phone with just the area of the route and the route itself. This would offer a very high resolution as the user could zoom in to the street level and see names and distances easily. Of course this solution only works for users with mobile devices, but a more traditional map and directions could be supplied in parallel.

The issue with the directions is harder to address, and would be aided by having a map with a high resolution as detailed above. One way to reduce the number of directions is to make the route simpler. A route with fewer turns would reduce the stress of missing a turn and getting lost. To do this, a routing algorithm would have to be found that reduces the number of turns for the majority of routes. This unfortunately is not as simple as just taking the shortest route as that could have more turns. Instead of addressing the complications of the route, there is also the option of presenting the directions in a different manner to reduce the stress of having to stop and search for street-signs. An audio option could be implemented, again on a mobile device, which would guide the user along a route. *Cyclistic* currently exports .GPX files for those who are inclined to use a GPS, but it would be nice to see other file types offered and instructions for those not familiar with uploading the files to a GPS enabled device.

Another addition that was mentioned as being useful by users is having the estimated time to a destination included in the directions for the given speed along with the

elevation at destinations. This would link in the route information with the actual route and give a higher level of detail.

5.5 Promoting *Cyclistic*

Promotion of the software is most effective through both *VisitDenmark* and bike rental shops including, specifically, *Baisikeli*. While this could begin as a link on their respective websites, directing tourists to the site, there is more that can be done to increase the number of users. There are two ways that we think there could be major gains made in accessibility.

- Include a link directly from attraction pages on the updated *VisitDenmark* site to the actual attraction location in *Cyclistic.*
- Set up terminals at bike shops for users to access *Cyclistic* and export routes.

Within the *VisitDenmark* site there are attraction pages with information on specific destinations including their location in a small map frame. It would facilitate the use of *Cyclistic* if there was the option to bike to the destination that would either replace the current *Google* map with the *Cyclistic* equivalent or link to the *Cyclistic* page with the attraction selected and added to a route. A sample attraction page of Tivoli is shown below in Figure 38.
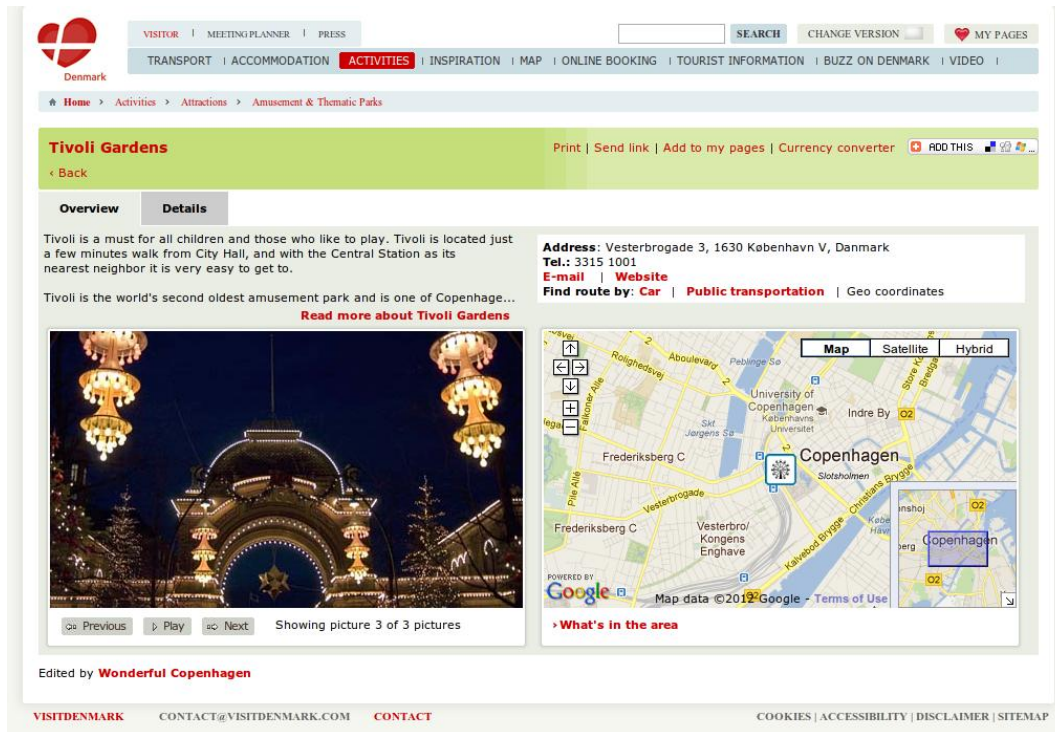
Figure 38: Sample attraction page from *VisitDenmark* website

A *Cyclistic* could replace the Google map that is currently shown or there could be a cycling icon routing tourists to a *Cyclistic* map and any pre-planned routes that include the destination chosen.

Setting up a computer terminal in bike shops would help the 50% of tourist who do not know where to go. It provides an interactive experience that can increase the enjoyment of cycling and would help the bike shops themselves as it would both save bike shop employees time explaining routes and be more accurate, as well as be a selling point to going to a specific bike shop. The terminal could be very basic and set up to just run *Cyclistic* and print or export to a mobile device. Overall the expense would be low for the experience it would provide. *Cyclistic* could also in turn promote the bike shops to tourists who find the site by other means.

5.6 Conclusions of the Study

Throughout this project, the focus has been on increasing usability and promotion of *Cyclistic*. By doing so, we hope to increase the enjoyment of using the software and create a unique user experience. The addition of a cycling guide will give an educational aspect to the software and provide users with the information they need to feel comfortable cycling in Denmark. The inclusion of user instructions and a redesigned interface will make it easier and more enjoyable to use *Cyclistic*. Developing tools for navigating routes besides the basic map and directions would alleviate concerns about getting lost and increase enjoyment on the bike. In order for these usability considerations to affect a large group of users, it is important to promote the software through both tourist and cycling related organizations. Beyond these considerations, we have recommendations in ways this study can continue in the future along with the limitations of our study and its overall implications.

5.6.1 Future Study

It would be interesting to further explore the possibilities for a mobile application of *Cyclistic* either with a simple map reader or something more complicated as part of a software suite as is found on-line. It would have been useful to experiment with alternate navigation options using mobile devices or GPS's. Further research would have to be done to see if this is money well spent for the improvement in navigation that may result.

Another area for further study is in the promotion of *Cyclistic* and its impact on promoting cycling tourism in general. There is more work to be done to help make *Cyclistic* part of a cohesive holiday experience including rental, planning, and touring.

5.6.2 Limitations of the Study

This study was conducted in the tourism off-season, so the results could have been more thorough had there been a more diverse range of tourists. As such, our study focuses primarily on the English portion of *Cyclistic*. Though many of the interface suggestions are relevant to other language versions of *Cyclistic*, the guides we suggested adding would have to be translated to be useful.

There was no testing of the instructions with tourists, so it is unclear if they will need to be developed further. It is especially difficult with instructions, since they demand their own usability study, but the combination of a simplified and clearer interface along with the general hints and instructions should go a long way to increasing usability on their own.

During our study, the *VisitDenmark* database was going through a major restructuring so many of the problems encountered were database problems that may or may not be fixed in the changes. It would have been useful to re-run the testing after the database was fully implemented as many of the problems users had may be addressed and the new database should allow for more attractions and information.

5.6.3 Implications of this Study

Cyclistic has the potential to become a portal for cycling tourism in Denmark. All the pieces are there for it so succeed and become a promoting tool as well as a routing tool. In becoming a better routing tool, it will both promote the experience of cycling in Denmark and its culture, but also add to the experience itself by guiding users to plan a trip they can call their own. *Cyclistic's* main strength is that it approaches the idea of a bike specific routing tool in a very focused way. It only caters to cyclists traveling in Denmark and as a result is very information dense on exactly the topic of cycling in Denmark. This is a fairly new direction for routing tools as most of the bigger names in routing are far more generalized and utility based. *Cyclistic* can focus on the experience of planning a cycling tour and learning about the cycling culture in Denmark, which boosts the enjoyability of using the software and in turn of cycling a created route. The focus should be on the user and creating a unique experience centered around cycling.

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Appendix A: Interview with Michael Hammel

Interviewers: Jenn Mann, Victoria Tower, Brian Joseph

Interviewee: Michael Hammel, Danish Cycling Federation

January 27th, 2012

5:00 AM-U.S. Time/ 11:00 Am-D.K. Time

Q: What was your inspiration for the *Cyclistic* software?

- Saw that there was a threshold of people who wanted to recreationally cycle but didn't know where to go or which routes to travel
- How to get to/from attractions
- SAFETY!
- Even people who were used to cycling weren't cycling in Denmark because it's a different country
- Possibly because they were not sure of what to do in the region (tourist perspective)
- Cycling is such a key component in Danish culture that they want tourists to have the ability to experience it
    o Not difficult to delve into
- People (tourists) fear the myths of biking (100 mile routes, dangerous, inhospitable environment)
- *Cyclistic* is designed to configure smaller, shorter trips that are ideal for tourists
    o Can depart from different points (hotels, rental homes) and view attractions in desired proximity
- **Overall goal of *Cyclistic*: create more possibilities for cycling tourists (give them safe routes)**

Q: How will *Cyclistic* address tourists' reluctance to cycle?

- They looked at the number and demographics of cycling tourists to see what types of tourists are cycling and which ones would be interested in cycling but have not yet tried
- 50% of tourists said they come to Denmark to bike; but only 10% actually end up cycling
- This is a problem that can be easily leveraged with a tool; by not making it a challenge of equipment, then perhaps tourists will be more willing to cycle

◎ Q: Where does the stigma of danger come from?

- People (tourists) would rather drive because they perceive cars as protection because they are larger, and people are more accustomed to driving
- Lack experience in cycling
- The idea of cycling as a primary transportation mode is foreign to most people because most countries do not have such a prominent cycling culture
- If you are not accustomed to cycling as the primary means of transportation that you do not necessarily see it as safer than driving; this is unfortunate because bikes are much safer than cars
- In Denmark:
  - People start biking at young age
  - Cars=expensive
  - Only used for great distances like in the countryside

◎ Q: What are the key components in the software design?

- Prototyping Route
  - Giving people opportunity to plan a route that they can choose
- The present design has been prototyping the mapping
- Central Concept: Everything that you could possibly want to do in Copenhagen has a geographical position, and the tool can get you there
- Have considered adding information to the map to make it a central guidebook (educational aspect?)
- Have also considered adding public toilets, water fountains, and cycle rental places along the map
- The database they have access to has 18,000 points of interest, and more are constantly being added
- **They want to put tourists into the map and provide them with as many points of interest as possible!**

◎ Q: How is *Cyclistic* different from Google Maps or MapQuest?

- *Cyclistic* works in collaboration with the Danish tourist organization
- The map-planning bit of the software was developed by MapQuest to follow cyclists' movements
  - Roads where bikes are not permitted were excluded; paths that are only open to bikes *are* included
  - **The software was developed by cyclists, for cyclists!**
- Although the routing was initially developed by/similar to MapQuest, *Cyclistic* provides additional information to cyclists:
  - More attractions
  - Roads they are encouraged to ride on (bike paths)
  - Roads that are unsafe (highways)
- **Cyclists is also unique because it lets users plan their own route, draw their own sight-seeing map**
- Google Maps is not designed for cyclists but rather for motor vehicles
  - Lacks information which is evident when travelling within city

- o Google Maps was designed for drivers by drivers
- **Bikes have their own traffic rules and regulations that other software tools do not touch upon**
- Looked at possibility of simply adding bike routing to Google Maps but they weren't interested at first…now they are.
- 80 cyclists were trained in using street maps and were equipped with GPS receivers so that their routes could be followed and recorded; this helped design routes that would be suitable for tourists to follow
- 50% of Denmark is now routed in more detail than any other maps
- This software possesses routing-capabilities well-beyond that of other software tools
- **They want to make routing a bi-product of tourists' own research, desires, and interests**
- **The best way to plan a trip is to leave space for exploration and improvisation**
- The online website provides guidelines for cycling in Denmark, but from there they hope that cyclists get inspired to further explore the city
- **Focusing on facilitating inspiration**
- A possible mobile app will have the same capabilities of the website

⊛ Q: How do you foresee tourists using *Cyclistic* and finding out about the software?

- Users get to *Cyclistic* via tourist websites and touring agencies
- Mike Hammel's company is in agreement with tourist companies that whenever tourists discuss biking, the companies will direct potential users to the *Cyclistic* website
- Tourist companies also share the goal of inspiring tourists to bike, so they will encourage them to use the software

⊛ Q: How involved are tourist agencies with *Cyclistic*?

- They are very close to the project; tourism agency = marketing agency
- It's been difficult to get the government to invest in tourism because the only national funding you can currently get is for Health
  - o Instead they have to use regional funding (takes longer)

⊛ Q: Future goals of software?

- They want the software to be more user friendly and compatible; they want to better target users 'needs
- *Cyclistic* **is currently being developed as something that nobody has asked for because many didn't know it was possible**
- **They want to perfect the ability of the software to make routes but also want to provide for route inspiration**
- Main ambition: provide tourists with a better view of the possibilities and opportunities available for sight-seeing

- Would like to see an increase in the number of tourists cycling in the countryside, not just within Copenhagen
- **Want to find a way to make routes interesting so that tourists will see certain sites as places they would like to visit (even sites that are not as popular)**
- Fewer attractions in countryside = difficulty drawing people in
- Tourists only have 2-3 days to explore the city on average
  - Less time to experience cycling culture
  - Must learn rules QUICKLY!

🚲 Q: What is your overall goal for us?

- **Get feedback from tourists about the software; figure out how tourists perceive it**
- Start by using ourselves as the informants and make initial recommendations
- **Determine what features could be enhanced or changed to better aid the users**
- Make more tourist agencies more aware of *Cyclistic*
  - Be the fly on the wall at tourists agencies; see what tourist agencies actually do and not just what they say they do
- Find out what the tool enables and does not enable
- Figure out what can be done to make the tool better into the environment of tourism
- Figure out how we can make the tool more convenient for *Basikeli*
- Figure out how to make *Cyclistic* a better guidance tool
- Look at other challenges (i.e. why won't avid cycling tourists visit Denmark? Is it because there is no challenge with no hills?; could ask fellow students who are avid bikers what they perceive as challenges)
- Possibly make new routes based on our interests
- Want to use us as informants as we examine tourists' needs

🚲 Q: Expected results from our efforts?

- Depends upon how we want to work with the tourists
- Direct suggestions for improvement (i.e. menu structure)
- Listen to tourists and observe them and how they interact with software and Copenhagen.
  - Observe them and their reactions to Danish culture and cycling

🚲 Q: Is it possible to make modifications to the software while we are there? How long would these changes generally take?

- Depends on how substantial changes are (but usually changes are made every 2 weeks)
- They will make changes if it is critical but changes take time
- Focus on exploring area for our own interests rather than following route
- March 5th—User testing begins

⚙ Q: Has any previous testing occurred?

- Not for this kind of user testing
- There might not be enough data sources to cover everything that the users want or have an interest in
- How can tourists get the most out of their visits?
  - Best tourism planning leaves exploration as a possibility so that tourists are free to follow interests

⚙ Q: Who are we primarily working with? Where?

- Base (Headquarters) = DCF
- Primary work = field work at Baisikeli
- Want us to be tourists at first and just explore the city
- Some desk research looking further into *Cyclistic*—DCF

Appendix B: Interview with *Cyclistic* Developer

Interviewers: Jenn Mann, Victoria Tower, Brian Joseph

Interviewee: Lars Nielsen, software developer at Klean

March 27th, 2012

5:00 PM-D.K. Time

🚲 **Q: Are there any features in our list that would not be feasible to add to the software? If so, which ones and why?**

- **Route Attributes:**
  - Adding route attributes is a challenge because routing information is based off of old street maps that have little information on the attributes of the region
  - Klean talked to the creators of "Cycle Copenhagen" because they were able to add attributes to their software through a series of 4-5 different *layers*
    - There is a green layer, quiet layer, etc.
    - Layers are based on observation
    - *Cyclistic* would have to have the data for these layers for the whole country and not just Copenhagen – huge challenge
    - *Cyclistic's* developers would have to either further develop their own search engines or utilize software that has already been developed
  - *Cyclistic* gets its routing information from MapQuest
    - Allows users to drag routes
    - Offers two different route options, fastest and least hilly
    - **"Safest" is a dangerous attribute to use** because the DCF could be held accountable if something happened to a cyclist
    - Currently, software takes scenery and ease of biking into consideration; for example, if there is a more scenic route or better cycle path to take, then the software will re-direct the route even if it is longer; sometimes scenery > fast

- **Route Tagging and Sharing:**
  - Possible, but not necessarily desirable
  - The developers want to provide "official" routes for tourists since Cyclistic will be one of the official sites of Denmark; other users' routes would not be "official"
  - Tourist agencies make official routes

- These routes are easily searchable and have some attributes such as child-friendly or hilly
- They also have an image and a description

- **Google Street view**:
  - Not possible since they use MapQuest
  - **Satellite view — possible, haven't looked into it yet**

- **More attraction information**:
  - Would have to talk to VisitDenmark because all attraction information originates from their database
    - Their database does not recognize the English translations of Danish names
    - They are currently updating their website with a new database
    - *Cyclistic* can only be as good as their database
  - There is also limited "real estate" on *Cyclistic's* website
    - Want map to be as big as possible so that limits the number of things that can be offered on the site
    - Don't want website to be cluttered with features

🚲 Q: Which of our proposed features seem most feasible?

- **Tutorial for users:**
  - Creating a tutorial for first-time users of *Cyclistic*; the website could detect when a new user is visiting → pop-ups (or light bulbs) could appear, and they could walk the user through the steps involved in planning a route
- **GPS/Smartphone App:**
  - Ability to download a GPX file is already available and has been tested
- **Database of cycling events:**
  - Would be easy to add to the site if the information was already compiled and available from another source
- **Nutrition tracking:**
  - Could create simple algorithm based on length of route and speed
  - Denmark is very windy, so wind and elevation vary in different regions and could effect the number of calories burned
  - Might be able to factor in elevation changes throughout route

🚲 Q: Are there any features that you initially programmed into the software and then scrapped?

- **Attribute Weighting** is a feature that the Navicki Project is currently looking at…
  - Navicki project → ghost behind *Cyclistic*
  - Cycle routing plan being designed for all of Europe
  - Potential engine to use instead of MapQuest
  - Went forward with MapQuest because the Navicki database was not finished yet

🚲 Q: What current developments are occurring within the software?

- Building more menus to route from or to a desired point
- Adding more options to the "right click" function
- They would like feedback on software, especially the English-Danish translations that do not make sense

🚲 Q: How often do you make modifications to the software?

- *Cyclistic* version 1.0 should be finished right before Easter; after Easter, no more major changes will be made for a month
- They may be able to make minor changes

Appendix C: Interview with *VisitDenmark*

Interviewers: Jenn Mann, Victoria Tower, Brian Joseph

Interviewee: Donna Sørensen, *VisitDenmark* representative

March 23th, 2012

7:00 AM-U.S. Time/ 1:00 PM-D.K. Time

🚲 **Q: For tourists who want to cycle in Denmark, what kind of information, if any, do you provide about cycling?**

- Cycling is a key part of Denmark, so we try to promote it as much as possible
- The goal is to increase the number of foreign tourists
- They market Denmark to three target groups:
    - Cycling Enthusiasts
    - Families
    - Culturally-minded tourists
- Currently developing new website for Visit Denmark which will be released in June
    - Incorporating biking link on the homepage
    - The biking page, "Biking Denmark", includes things such as:
        - 10 great reasons to get on a bike
        - Child-friendly cycling holidays
        - Where you can go to buy or rent a bike

🚲 **Q: How many tourists come to Denmark looking to experience the cycling culture? How many tourists actually cycle?**

- Most of the tourists that come to Denmark to bike are from Norway, Sweden, Germany and Holland
- American tourists and other tourists from further distances do not really come to Denmark to cycle

🚲 **Q: Are you familiar with the *Cyclistic* software tool, and if so is this something that you would potentially market as a way for tourists to access Copenhagen?**

- Yes, they have included a link to *Cyclistic* on the new website

🚲 **Q: What are the major hotspots for English-speaking tourists?**

- Tivoli, Royal Palace, Little Mermaid

- Cycling-interested tourists are typically already on bikes, so they are more difficult to find
    - Bike rental shops would be good to talk to because tourists come in to get their bikes, and they would have a better idea of major cycling tourist locations

🚲 Q: Are many tourists around this time of year?

- Unfortunately this isn't the high cycling/tourist time, it's still early
- May is when a majority of tourists come to visit

Appendix D: Interview with Baisikeli

Interviewers: Jenn Mann & Victoria Tower

Interviewee: Henrik Smedegaard Mortensen, founder of Baisikeli

April 11th, 2012

4:30 AM U.S. Time/10:30 AM-D.K. Time

Q: What ideas do you have to improve the *Cyclistic* software?

- I-frame of *Cyclistic* maps on the Baisikeli website in order to make tourists more aware of *Cyclistic* and what it has to offer
- Mobile App
  - Makes it easier for tourists to take the software with them
  - Audio feature:
    - Tells you where to turn and alerts tourist of upcoming attractions on route
    - Relatively safe option so that tourists aren't constantly stopping to check their maps

Q: What days/times are most popular for tourists to visit Baisikeli?

- Fridays and Saturdays are the busiest days by far and peak hours are from 11-1pm

Q: Do most tourists that come into the shop already know where they would like to visit in Denmark?

- About 50% know where they want to go and 50% are undecided and looking for guidance
- They spend a lot of time giving people information on attractions
  - *Cyclistic* could alleviate this problem

Q: Do people typically tend to book bike rentals ahead or do they walk in?

- About 90% of the tourists they get in the shop are walk-ins
- The remaining 10% are typically larger groups that already have a planned route

Q: Would you be willing to collaborate with the DCF?

- Yes, we'd be willing to help promote each other, it would meet our needs and be beneficial to both parties

Appendix E: Initial Impressions of *Cyclistic*

Negative Impressions:

- ☐ There is no easy way to clear a route without reloading the website
- ☐ The Official Route page is in Danish and not easy to understand
- ☐ Some of the English translations are grammatically incorrect and difficult to read
- ☐ The first address that a user enters is the location that they want to find; however this is not useful for users who do not necessarily know where they want to go.
- ☐ If the user is typing in a address that includes one of the three unique Danish characters (æ, ø, å) and does not type in that character, then *Cyclistic* will not recognize the address
- ☐ Pop-ups are distracting
- ☐ It would be helpful if Cyclistic could place attractions in a logical order along a route; instead the user has to specify the order, which can be difficult is you are not familiar with the city
- ☐ If you navigate away from the mapping homepage, you lose your route
- ☐ There should be a key somewhere on the website that explains the markings on the map such as the dotted lines

Positive Impressions:

- ☐ The attraction database is quite extensive; it has a wide variety of interesting attractions
- ☐ Having numbered steps makes planning a route straightforward and logical
- ☐ When you click on an attraction, you can see a brief summary of the attraction as well the attraction's contact information
- ☐ If you log in and create an account, you can save routes
- ☐ You can print and email routes
- ☐ When you plan a route, *Cyclistic* will tell you the length of the route and the estimated duration. It will also show you the elevation change along your route.

Appendix F: Initial Impressions of Cycling

🚲 Difficult to turn left/don't know where to turn left

🚲 At certain intersections you cannot turn left

🚲 Never cross any traffic flow; must make sure to stay on the correct side of the road

🚲 Should get off bikes and walk through crosswalks

🚲 Cyclists start going on yellow

🚲 Cyclists make illegal right hand turns

🚲 Not everyone follows all of the rules of the road

🚲 At some intersections we must weave in and out of cars, which can make crossing those intersections intimidating and difficult

🚲 The cargo bikes take up a lot of room on the bike paths; they are difficult to pass

🚲 The lanes narrow some times

🚲 Some times the bike lanes disappear and you don't know whether its ok to get in the road

🚲 Cobblestones are difficult to bike over

🚲 The curbs can be difficult to bike over

🚲 Faster cyclists will pass you without warning

🚲 Bike at your own pace; don't try to keep up with everyone else

🚲 Traffic is heaviest in the morning between 8am and 9am, around noon, and between 3pm and 5pm

🚲 Not all bike paths/lanes are marked; it can be difficult to know where to bike

🚲 Seats are uncomfortable!

🚲 The wind is extremely strong here; it can be difficult to bike into the wind; wear gloves to keep hands warm!

🚲 Cycling is fast and easy; more time- and cost-efficient than taking the train or bus

🚲 The bike-specific traffic lights make navigating intersections easy

🚲 You can park anywhere; just lock your wheel and put your bike somewhere out of the way

🚲 You feel like you fit in

🚲 You feel close to the environment

Appendix G: WPI Cycling Team Survey Results

Q1: Do you use a bike route planning software?		
Yes	19	63.30%
No	11	36.70%
Q2: What bike route planning software do you use?		
Google Maps	24	80.00%
May My Ride	10	33.30%
MapQuest	5	16.67%
Other (Strava)	5	16.67%
Bikely	0	0.00%
Q4: Does the route planning software you currently use have any of these desired route features?		
All of them	5	16.67%
Some of them	21	70.00%
None	4	13.30%
Don't use one	3	10.00%
Q5: What would you improve about bike route planning software/What kind of features would you find useful?		
Easy to use	6	20.00%
Route constraints	6	20.00%
Route attributes	6	20.00%
Bike friendly routes	5	16.67%
Amenities	2	6.67%
Smartphone App	2	6.67%
Attractions	1	3.33%
Elevations	1	3.33%
Print out Map	1	3.33%
Q6: Have you ever considered biking in another country, such as Denmark?		
Yes, and I have	4	13.30%
Yes, I would like to	11	36.70%
Possibly	15	50.00%
No	0	0.00%

Appendix H: Think-Aloud Session Data Sheet Example

Test Subject's Actions	Test Subject's Questions/Comments	Note-taker's observations
1. Changes language to English		
2. Tried typing in "Cinemaxx" for location		Cinemaxx not in attractions database
3. Zooms in on map and manually looks for Cinemaxx	Knows region of desired location so realizes *Cyclistic* is missing info on attraction	
4. Uses attractions bar to find "Culture"		Session leader had to instruct tourist to use attractions bar
5. Selects "Music & Dancing" and picks a location	Zooming in closer provides more attractions, but there still isn't information on some attractions	
6. Selects "Plan a Route" button	Did not know what the *Add to Route* button was because it was in Danish	Session leader had to instruct for the "Plan a Route" feature
7. Enters home address		Session leader had to instruct for the "Round Trip" feature
8. Uses attractions bar to add another stop for ice cream	"Why are there so many pop-ups? What do they mean?" (Pop-ups still in Danish)	
9. Calculates route		
10. Rearranges attractions in a more logical order (dragging)		Liked the ability to rearrange attractions by dragging them
11. Recalculates and reviews route		
12. Looks at Route Information		Session leader had to instruct for the "Route Information" feature
13. "Prints" route information		

Appendix I: Think-Aloud Debrief Example

1. **Overall, how intuitive was the interface on a scale of 1 to 5? (5 being very intuitive)**

    3.5

2. **What did you like about using *Cyclistic* to plan your route?**

    - Attractions bar
    - Attraction Information

3. **Was there anything about the software that was difficult to use or understand?**

    - Sections not translated into English
    - Adding attractions to route was not straightforward
    - Pop-ups were annoying

4. **Were you able to find attractions you were interested in?**

    ☐   Yes

    ☐   No

5. **Were you able to successfully plan a route?**

    ☐   Yes

    ☐   No

6. **How happy are you with the route you have planned on a scale of 1 to 5? (5 being very happy)**

    4.5

7. **Is there something you expected from the software that was missing? Are there any other features that you would find useful that *Cyclistic* does not currently possess?**

    - More attraction information
    - Better search feature, one that works in English

Appendix J: Post-Touring Survey Example

1. **What was your first impression of touring via cycling in Denmark?**

   - Quick and easy way to get around
   - Liked the Infrastructure

2. **What kind of problems, if any, did you encounter? Please elaborate.**

   Took two wrong turns, had to keep stopping to look at directions

3. **Did you have any memorable experiences, either good or bad? Please elaborate.**

   Had trouble turning at one intersection because I was on the wrong side of the bike path

4. **Were you able to locate all of your attractions and navigate to them easily? If not, please elaborate.**

   Yes

5. **How did you use your map?**

   Didn't look at map, looked at route description and made simpler instructions

6. **How comfortable, physically or emotionally, were you riding around Copenhagen?**

   - ☐ 1-Highly Uncomfortable
   - ☐ 2-Mildly Uncomfortable
   - ☐ 3-Neutral
   - ☐ 4-Somewhat Comfortable
   - ☐ 5-Very Comfortable

7. **How enjoyable was your touring experience?**

   - ☐ 1-Very Unpleasant
   - ☐ 2-Somewhat Unpleasant
   - ☐ 3-Neutral
   - ☐ 4-Somewhat Enjoyable
   - ☐ 5-Highly Enjoyable

Here is a list of features that could potentially be added to the *Cyclistic* software. Please check off which ones would have been useful for planning your route and touring Copenhagen on a bike.

- ☐ **Route tagging** – being able to tag your own routes as "hilly," "scenic," or "quiet," etc. and also being able to search for routes tagged with these attributes
- ☐ <mark>**Mobile App**</mark>
- ☐ <mark>**Audio Option for directions**</mark>
- ☐ **Photo uploading and sharing** – being able to add photos from your favorite routes so that others can see what the route looks like
- ☐ **More attraction information** (i.e. cost of attraction, hours of operation)
- ☐ <mark>**Cycling Guide**</mark> – a condensed list of everything you need to know about cycling in Denmark
- ☐ **Satellite View** – being able to view your route on your computer on a street-by-street level before tackling the route yourself
- ☐ **Database of cycling-related events**
- ☐ <mark>**Nutrition tracking/ Calorie counting**</mark>
- ☐ **Side-by-side route comparisons**
- ☐ **Restricting maximum elevation change**
- ☐ <mark>**Minimizing the number of turns along your route**</mark>
- ☐ <mark>***Cyclistic* Tutorial**</mark> – being given the option to walk through a tutorial of how to plan a route using *Cyclistic* when you visit the website for the first time
- ☐ Any other information that would have been useful to know?/Any features that would have been helpful to have prior to going on your self-guided tour?

Appendix K: Post-Touring Survey Results

Q1: What was your first impression of touring via cycling in Denmark		
Fast and Easy to get around	3	42.9%
Fun	3	42.9%
Confusing to navigate	2	28.6%
Infrastructure was convenient	1	14.3%
Roads less busy at certain times	1	14.3%
Q2: What kind of problems, if any, did you encounter? Please elaborate.		
Missed turns/ got lost	5	71.4%
Map not usable	2	28.6%
Lots of stops to look at directions	2	28.6%
Difficulties making turns	1	14.3%
Q3: Did you have any memorable experiences, either good or bad? Please elaborate.		
Confusion over route	3	42.9%
Broke the rules	2	28.6%
Difficulties traveling as a group	1	14.3%
Q4: Were you able to locate all of your attractions and navigate to them easily? If not, please elaborate.		
Successfully arrived	7	100.0%
Took a wrong turn	6	85.7%
Consciously took a different route	1	14.3%
Q5: How did you use your map?		
Looked at it at stops	4	57.1%
Simplified Written Instructions	2	28.6%
Written directions useless	1	14.3%
Memorized landmarks	1	14.3%

Q6: How comfortable, physically or emotionally, were you riding around Copenhagen? (scale of 1-5)		
1	Highly uncomfortable	0	
2	Mildly uncomfortable	0	
3	Neutral	0	
4	Somewhat comfortable	6	
5	Very comfortable	1	
	Average	**4.14**	

| Q7: How enjoyable was your touring experience? (scale of 1-5)			
1	Very Unpleasant	0	
2	Somewhat Unpleasant	0	
3	Neutral	0	
4	Somewhat Enjoyable	4	
5	Highly Enjoyable	3	
	Average		4.43

Appendix L: Master List of Potential Features/Tourists' Recommendations

Potential Feature/Tourist's Recommendations	# of users who wanted/asked for feature	% Approval
Route attributes (traffic, scenic route, fastest route)	21	84%
Mobile application	16	64%
More attraction information	14	56%
Cycling guide	12	48%
Minimize # of turns in a route	10	40%
Cyclistic Tutorial	7	28%
Restrict maximum elevation change	7	28%
Satellite view	7	28%
Audio navigation option	5	20%
Calorie-counting	4	16%
Pre-mapped routes (official routes)	4	16%
Ability to search for a region rather than an address	3	12%
Database of cycling activities	3	12%
Key explaining what the different colored dotted lines on the map are	3	12%
Option to directly email route to self	3	12%
Route tagging	3	12%
Attribute weighting	2	8%
Ability to specify desired route length before planning the route	2	8%
Clipboard on bike to hold map	2	8%
Photo uploading	2	8%
Using the wording "stop" instead of "along" in the *Plan Route* section	2	8%
Calculate route as stops are added	1	4%

Appendix M: Screenshots of Translation Issues
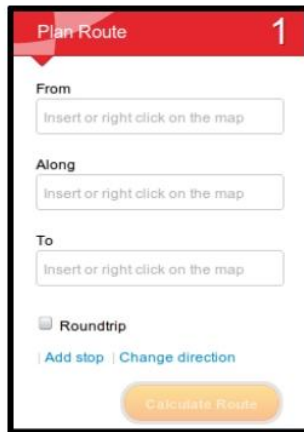
Upon deleting the *Along* address box, *From* and *To* revert to Danish:
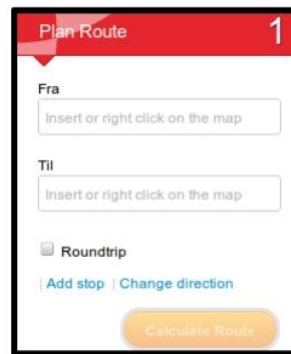
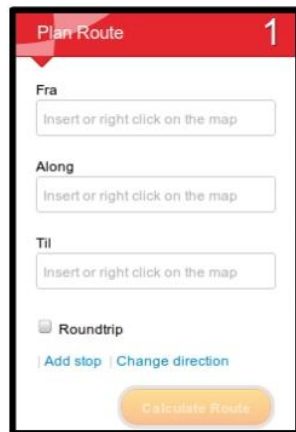If *Add Stop* is clicked, a new address box is added with the English heading:

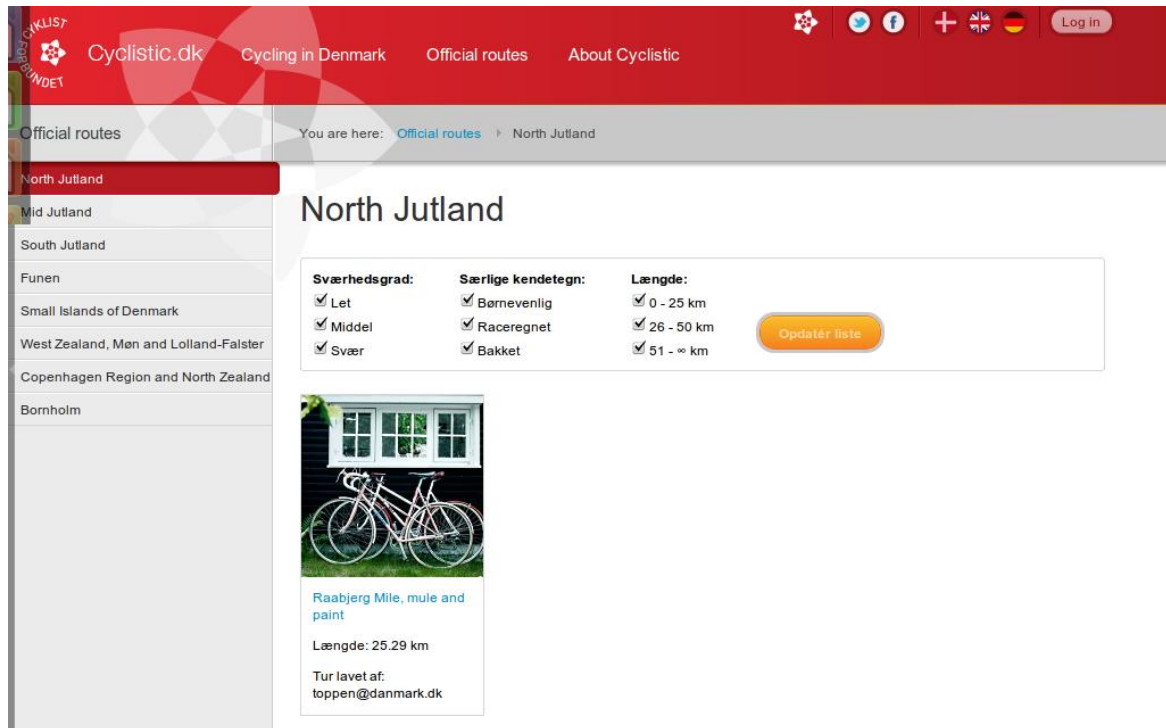**Figure 39:** Screenshots of "Plan Route" language problems from *Cyclistic*

Figure 40: Screenshot from of Official Route language problems from *Cyclistic*

The frame should read:

Level of Difficulty:	Type of Ride:	Length:
Easy	Family-friendly	0-25 km (0-16 miles)
Medium	Race-ready	26-50 km (16-32 miles)
Tough	Hilly	>51 km (>32 miles)