

**Cynthia Zastudil**  
**Honors Capstone Project**  
**Journal of Progress for Creative Project**  
**Fall 2019 – Spring 2020**

## Spring 2019 & Summer 2019

### Literature Review/Application Discussion:

During the Spring 2019 semester, I focused primarily on familiarizing myself with what the field of accessibility-focused mobile applications looked like. I spent most of time reviewing the literature and drawing inspiration from some existing research projects from various places around the world. One application that was of particular interest to me was RouteCheckr, which is focused on accessible routing for mobility impaired pedestrians. RouteCheckr's focus is much broader than I intend my application to be, the developers meant for it be used by the elderly, visually and motor impaired, and blind. Due to the scope of this project, I will be focused solely on mobility impairments, be it temporary (e.g. using crutches or a scooter for a broken ankle or foot) or long-lasting. RouteCheckr was particularly interesting to me because of the way in which they determined the routes that individuals can take. They used multi-criteria routing, and something called the user's LOM-Modality. The LOM-Modality is described as a derived modality which includes the user's location, orientation, and movement. In my application, users will have the ability to indicate if there is terrain they would like to avoid, whether or not stairs can be included in the route, and if they have a preference in the overall change of elevation of the route.

Some other applications that stood out to me over the course of my literature review were VirtualLeap & VirtualWalk which were developed at the same time during the same research project. Both of these applications were created with visually impaired and blind people in mind. A prominent concern in this field of research is what the best way to enable people with visual impairments in how to create, as the authors put it, "memorable representations of the real world." While my application is geared towards mobility impaired people, the presentation of the directions that VirtualLeap & VirtualWalk use have heavily influenced my application design. VirtualLeap allows users to look at an overview of a route, including intersections, points of interest, and turn-by-turn instructions. On the other hand, VirtualWalk provides directions to its users in real-time as they are navigating the route. Both of these methods of providing route information to users is of particular interest to me, and I think I would like to include aspects of both in my application.

The world of research on this particular topic is incredibly vast, and I'm sure I've missed some incredible research topics on the issue. I will continue to review the research throughout the duration of my project.

For now, I've named my application CampusPartner, this may be subject to change, however. In my research, I've found some existing technologies that I will be leveraging in my application: Open Route Service and Open Street Maps. Open Route Service provides an API that facilitates the retrieval of directions with specific constraints in mind, such as avoiding stairs in a particular route. In my application user's will be able to create a profile to indicate their route preferences which will automatically be taken into consideration when generating a route for them. If a user encounters missing data, they will be able to access Open Street Map to indicate as such. CampusPartner will assist people in planning their routes around the JMU campus with their personal accessibility needs in mind. The motivating example I like to use for why an application like this is needed and shows that commonly used applications (i.e. Google Maps and Apple Maps) are lacking in this accessibility information is the route from ISAT/CS to UREC. If was unable to take the stairs for any reason, the route that avoids stairs entirely is significantly longer

than the most direct route. The route that people normally take is estimated to take 6 minutes and covers 0.2 miles, whereas the route without stairs nearly doubles the estimated time and doubles the distance you have to travel at 11 minutes and 0.5 miles. If I was unfamiliar with the JMU campus, or I was a new student, I could be caught seriously off-guard when walking around on campus. Not only could this take a physical toll, it could take a significant emotional toll.

### **CAPWIC Flashtalk**

In March of this year, I presented a five-minute flash talk at the Capital Area Celebration of Women in Computing. I presented on the research I had done into the existing research in the area of assistive technology and applications focused on physical accessibility as well as the concept of the application I am planning to develop. Overall, I believe that the presentation went well, and it was my first ever presentation at an academic conference and it was a great way to slowly introduce myself to it. Presenting a self-directed research project is a totally different beast than presenting a research project for a class where the professor explicitly tells you what to focus your efforts on, the format to present it in, etc. I also got the chance to watch other people's presentations. Since a lot of the students who were presenting had a similar level of experience in research as me, it was great to see the approaches of other people. To see the slide deck, I used for my presentation and the notes I used, follow this link:

<https://czastudil.github.io/campuspartner.html>

### **Submission to Assets SRC**

After the flash talk and the completion and subsequent submission of my capstone proposal to the Honors College, work on my capstone project honestly took the back burner. However, in July of this year, my capstone advisor encouraged me to submit my work in progress to the Assets Student Research Competition. ASSETS is the premier forum for presenting research on the design, evaluation, use, and education related to computing for people with disabilities and older adults. The submission to Assets consisted of an extended abstract. Unfortunately, my submission was not selected to be included in the SRC. With that being said, my status in research is junior, and I will have plenty more opportunities to present my work. A

On a relatively unrelated note to my capstone project, I recently decided that I want to go to graduate. This means that my capstone project means more than it initially did. I originally wanted to complete the capstone project because it would be a great chance to learn something outside of my classes and begin the process of lifelong learning. While I still believe that is a good enough reason as any to complete a capstone project, it will also look really good on graduate school applications, especially if I get my work published at a conference or in some other capacity. So, in addition to working on my actual project throughout the next two semesters, I will be researching opportunities to present my work at academic conference in addition to the required public presentation of my capstone in the last semester of my project.

## Fall 2019

### August 26, 2019: Proof of Concept

The first milestone I set for myself was to do a “proof of concept” of sorts in order to test the quantity and quality of the data I am working with on Open Street Maps and Open Route Service. What I initially planned on doing was finding four different routes:

1. A route where the accessibility data is lacking (e.g. missing stairs)
2. A route where the accessibility data is accurate
3. A long-distance route (e.g. across campus)
4. A short-distance route (e.g. from ISAT/CS to Festival)

Regardless of the outcomes of the proof of concept, there is unfortunately no other source that will provide the functionality I need for my application. When I first looked at the data, it looked like the proof of concept was off to a bumpy start because there is a significant lack of complete data for the JMU campus. So, my options were: manually add all of the data to Open Street Maps and wait for Open Route Service to update to test the routes or to find another location to see where the data was better for simply testing the functionality of the Open Route Service API itself. According to their support page Open Route Service has been updating their maps every 2-3 weeks, but they hope to have weekly updates soon, which is hopefully very soon, because it has the potential to significantly affect my work. I also discovered through their support page that the wheelchair functionality is only supported within Europe. Thus, I decided to work with European routes for the proof of concept because Open Route Service only supports wheelchair routing in Europe and the data is drastically better.

Fortunately for me I am pretty familiar with the area in London that I studied abroad in, so it shouldn't be too much of an issue to test with European routes in this stage of development. In the meantime, I am going to explore the different endpoints in the API and work on annotating the routes I want to use on this campus because they will be used in the final project. In the Open Route Service API, there is simple direction retrieval with a starting point and a single endpoint. There is also multi-stop directions available. You can specify the mode of transportation you will be using, such as foot-walking and wheelchair. When you request directions from the endpoint it provides a very complete JSON object with turn-by-turn directions along with distances and elevation information. This means that I will be able to use these directions to provide a “pretty” interface.

I am considering emailing the people in charge of Open Route Service to see if it's possible to include wheelchair functionality on the JMU campus. I am unaware of what this may entail, or whether or not it's even possible. If it's not, I will have to use the option to avoid stairs on the route instead. It is important to note however that mapping a wheelchair accessible route requires much more than avoiding stairs. Some other things that are important in this case are the width of the sidewalk (or whatever surface you are traveling on), the steepness of the route, among other things. It seems improbable that my application will be able to include wheelchair routing in the final project for JMU, but seeing as it would require an immense amount of data to added to Open Street Maps and Open Route Service, it looks like it may be out of the scope of this project.

In the next week, I plan to finish up the proof of concept and begin looking into iOS development. I am currently looking for a good source to learn Swift.

### **September 2, 2019: Proof of Concept Continued**

The proof of concept is now complete, and a week earlier than I scheduled in my initial semester timeline! For the routes I described above, I used some from London and some from Harrisonburg. I used London for the routes that required accurate accessibility data and Harrisonburg to show where data can be improved (which is a lot). One thing that I think is really cool is that I am getting the opportunity to contribute to help the group of people that Open Street Map and Open Route Service benefits, the same group of people I am aiming to benefit with my app. This relates to some reading I did about how assistive technology is not about independence so much as interdependence. Meaning that we should all work together to create an accessible world and accessible technology. I think that this is one of the most valuable things about my project. Sure, I am learning about mobile app development, iOS development and the Swift programming language, full-stack development and integrating with a third-party API, and various other things. While all of that is really good, I think that this is what is really making my computer science education as interdisciplinary as the Honors College aims to make it.

The next milestones I'm going to be working on are learning iOS development, sketching out some wireframe drawings for what the user interface of the application should look like (which will be included in this journal), and preparing an extended abstract for submission to the Group 2020 conference in January.

Group is a conference primarily focusing on things such as civic participation, collaborative prototyping, collaborative work in organization, and other things of that nature. My project relates to this in that Open Route Service and Open Street Maps are both open source technologies intended for people to contribute to, and I will allow users to contribute to these technologies through my application. If possible, it would be great to do some user studies when I have a prototype of the application working. This would probably happen in the Spring semester and would require IRB approval which is something I should probably start considering now.

### **September 9, 2019: Planning**

To be completely transparent, this past week I've slacked a little bit on working on my capstone project. Although I'm only enrolled in 12 credits this semester, the course load is a difficult one, and I've been working to get myself into a functioning routine for this semester. This early into the development it's hard to tell what significant roadblocks may be, but I anticipate that this may be one of them. Currently, I don't have a way to keep myself accountable to, well, myself, so I'm finding that I'm pushing off the work I need to do on my capstone in favor of doing work for other classes that have strict deadlines. So, this week, I'm going to bring this up with my advisor to see if there is a way I can adjust my milestones laid out in my proposal to be broken down into more digestible and measurable subtasks. The larger milestones and general plan for the semester have stayed pretty much the same fortunately. I ended up finishing the proof of

concept earlier than anticipated, which is great so I can focus on the front-end of my project until the end of October, when the back-end development will begin.

### **September 16, 2019: iOS Development & Mock-Ups**

This week, I met with my capstone advisor to figure out a way to break down larger milestones into smaller and more achievable sounding goals. We decided that it would be beneficial to have another 30-minute meeting per week. That means that our meetings are now on Mondays at 11 and at Thursday at 1:30. This week, the things I have to do are:

- Have an iOS app running on my device from XCode (even if it's just a blank screen)
- Paper sketches of the front-end
  - o Launch state/initial empty get ready to search
  - o Search result screen
  - o Navigating screen
- Outline/rough draft of the extended abstract for poster submission to Group 2020

Some more stretch tasks are:

- Work through some basic iOS development examples
- After that, start a tutorial with some mapping
  - o Possibly something with MapBox

We also started discussing how to integrate users and reporting missing data with my app. One potential solution we discussed was using Open Street Map OAuth to identify users. This way, users could launch the Open Street Map editor in response to a user encountering bad data. This would mean that we would have to incorporate a small sever. This part of the project is of relevance to my submission to Group 2020. If we do host a server, we will almost certainly not hit the API limit.

Relevant links:

[OSM iOS Integration](#)

[OSM OAuth](#)

[ORS API Information](#)

[Hosting App Ourselves](#)

### **Tapia Conference 2019**

This week, I attended the Richard Tapia Celebration of Diversity in Computing in San Diego. Unfortunately, there wasn't a ton of relevant posters or conference sessions to my capstone project, but it was a valuable networking opportunity. My department head was having a conversation with someone from the University of Washington Computer Science department who is also doing research in accessibility and stuff similar to what I'm doing with my capstone project. She gave her card to Dr. Simmons and told her to have me email her about my work because they are very interested in hearing about. They are interested in seeing if there is anything that they can do to help support my project or if they have anything resources I can use. Not only is this an incredible opportunity if it pans out, it's a great networking opportunity and experience for graduate school applications. I'm glad I had the opportunity to go and see the potential research pathways I can go, even if it's not within the realm of assistive technology. I'm considering submitting my work to Tapia 2020, which would be in September of next year,

which is no longer related to my capstone project but more of an opportunity for academic and professional development.

## **September 23, 2019**

Goal: Extended abstract for Group 2020 & application mockups

In the next coming weeks, I intend to dedicate a lot of my allocated work time to compiling an extended abstract for a poster submission to Group 2020. Group is the shortened name for the ACM International Conference on Supporting Group Work. The research presented at Group is focused on:

- Computer Supported Collaborative Work
- Human Computer Interaction (HCI)
- Computer Supported Collaborative Learning
- Socio-technical studies

My capstone project generally falls under the categories of computer supported collaborative work and HCI. In terms of collaborative work, the people who use my application are able to actively improve the data source which informs the service they are using. The act of navigating using my application is collaborative in the sense that all users are essentially working together to improve the application through continued use and data updates. This application clearly falls under the umbrella of HCI, because as indicated by the name of the research area the topics included have a wide breadth. In terms of socio-technical studies, this project would fall into this category with future work. What I am developing is only a prototype and is not intended for immediate use by the population it is intended for. This is because there have not been any user-studies done, and there will not be as it not within the scope of this project.

The general outline as it stands right now is the following:

- I. Abstract
- II. Introduction
- III. Review of Prior Work
- IV. Description of the Application
- V. A discussion about the collaborative emphasis of the application
- VI. Conclusion

In compiling this abstract I hope to come up with a more creative name other than “my application.” An updated name is coming soon. Other than the extended abstract for Group, I’ve been working on some application mock-ups. I will continue to work on more in the next week.

After I complete the mockups, I will begin working on creating the front-end of my application. This will not include any functionality in a strict sense. The focus of this portion of the development of my project will be primarily design based. I think that this emphasis on design is essential to developing an accessible and actually helpful app. Even if the functionality works great, it doesn’t matter if the user interface is completely unusable and inaccessible.

## September 30, 2019

Goal: Extended abstract for Group 2020 & application mockups

This week I primarily focused on finishing up my extended abstract submission for Group 2020. One kind of large roadblock I faced was that the abstract was limited to two pages, including references. This was unexpected, I believe because they changed the page length requirement to include references in the length of the abstract. This meant that I, along with my advisor, had to trim down a significant portion of my abstract in order to meet the length requirement. My hope is that we've managed to trim it down in a such a way that the content and meaning of the project is still portrayed in a good way and that we'll have a good chance of getting accepted to the conference.

I also continued working on mockups for the application, which we have (possibly temporarily) named CampusPartner (CP for short). The overall flow of the application is the following:

- The user will open up the application (a screen with a nice loading screen will appear)
- If this is the first time a user has opened up the application on this device, they will be prompted to log-in with their Open Street Maps login (this will make it easier to correct data later on) & they will also be prompted to create their profile with their routing preferences
- Once the user is logged in (or if they have previously logged in) they will see tabbed user interface with the following options: Navigation, View Favorites, and More
- The Navigation tab is pretty self-explanatory, this is where the user will begin routing from using the routes generated from Open Route Service
- Once a user has generated a route, they will have the option to save the route to their favorites, which is the second tab in the interface. In this tab, users will be able to see the routes they have favorited, and if they click on them, they will have the option to either remove the route from their favorites or begin navigation.
- The More tab includes the ability for a user to view and edit their profile and also to see the static help page

In other news related to my capstone project, I was accepted to be a student volunteer at the ASSETS 2019 conference. This is a super exciting opportunity because even though I wasn't accepted to present my capstone work in the student research competition, I will be able to attend the conference and see research that is relevant to my project. ASSETS focuses on presenting research about design, evaluation, use, and education related to computing for people with disabilities and older adults. Should I continue research into assistive technology or with this project, this conference would be one of the ultimate goals for submission. There are a good number of papers being presented about navigational tools for people with disabilities and I'm really excited to travel up to Pittsburgh for the conference at the end of October.

The goal by the end of October is to have the front-end of the application completed. However, with student volunteering at ASSETS and a busy month ahead of me, I can see that deadline being extended a bit into the month of November, but that shouldn't greatly affect the overall development of my project.

## October 28, 2019

Goal: Student volunteer at ASSETS 2019

This week, I attended ASSETS 2019 as a student volunteer from Sunday to Wednesday. As such, I didn't get too much time to dedicate directly to my capstone due to the fact that I was volunteering all day and trying to stay up to date on the classes that I was missing. However, I did get to have a ton of valuable discussion with academics in the field of assistive technology and get some new ideas for my project. Additionally, I also got an idea of what the reflective essay is going to look like:

- I. Extensive literature review
- II. The potential impact an application would have on campus
- III. Detailed discussion of how the application is going to work
- IV. Appendix with screen shots from the applications
- V. Some discussion of future work

In addition to this essay, I will also have the website describing the work, where a screen recording of a demonstration of the app will reside. This journal is also considered a deliverable for this project.

Overall, attending ASSETS was a great opportunity for me in terms of educating myself about the assistive technology "world" and how to effectively develop these technologies for disabled people. I know now that what I am making is more of a prototype and cannot be considered done without user studies, which are unfortunately outside the scope of this project due to time constraints. If work on this project is to be continued, it would be awesome to have these user studies done and to also be able to include some interview from people from the Office of Disability Services. All of these things require a great amount dedicated time to complete well and unfortunately, I don't have that right now.

I also got to meet with the other reader for my project for the first time, Dr. Erin Brady. It was really nice to meet her in person. Actually, just meeting with a bunch of people in this field was really helpful in determining the trajectory of my project and where I want to go in the future (i.e. whether or not grad school is for me). I think that (this is outside of my project now), grad school is definitely in the cards for me, but just not immediately after the end of my undergraduate career. I think I need the break. Although I haven't been the best at keeping on top of my capstone project this semester, I'll be able to pull it off, and I think that the experiences I have had and the experiences that I'm going to have are well worth the time and effort of the capstone project. I am worried that I haven't been the best at managing my time this semester, I definitely believe that is true, but based on my schedule next semester, my class load should be easier and I will be able to dedicate more time to my capstone and creating something that I'm proud of.

Journaling doesn't always seem the most beneficial to me, to be completely honest. I feel like I've been able to see where I'm not keeping track of my time and prioritizing different things correctly. This semester has been really difficult academically, but I can see where I went wrong and begin to readjust. I don't anticipate that this semester will be able to change in any meaningful way, but certainly next semester will.

## **Weeks of Oct. 7, 14, 21 & Nov. 4, 2019**

Goal: Work on the front-end of the application

Throughout the months of October and November, I dedicated the majority of my capstone work time to creating the front-end skeleton of the application. I will include some screenshots of my current progress in this journal, and as the front-end nears completion, I will include more updated screenshots. At this moment in time, there is not much to write about. No significant roadblocks have been encountered and development has been pretty smooth because of Apple's storyboard method of app development. I'm sure I will encounter more roadblocks when it comes to back-end development seeing as I will be in totally foreign waters at that time. Updates to come.

In other news, I received really exciting news regarding my poster submission to GROUP 2020 on Oct. 14th! I was accepting to present a poster at GROUP in January 2020. This is super exciting to be me, since this will be my first poster presentation at an academic conference, and my first presentation at a conference not held at JMU. Technically, including the flash talk I gave at CAPWIC in March, this will be my second time being published at a conference, and I feel incredibly proud of this achievement. Not only is it providing me with invaluable experience, it will look really good on graduate school applications. Again, this is a part of my capstone project that is not directly related to the actual development of my application, but I find it to be an incredibly side effect of it. I'm grateful to have such a supportive advisor who helps me find these opportunities. Not only will this be a more in-depth presentation of my project than the flash talk, it'll be a great "practice run" before presenting my final project at the end of the spring semester at the honors symposium.

## **November 11, 2019**

Goal: Discuss how users will be interacting with the data updates via GoMap

This week we primarily talked about different editing ideas when users are interacting with the app. For the prototype that I am making right now, it's likely that users would just find an inaccuracy on the map and then navigate to the GoMap application and fix the data independently of my application. However, this is clearly not the easiest solution. Some options that would be cool are using Twitter or some other social media to tweet out where data needs to be fixed so that the user isn't solely responsible for fixing anything inaccurate he/she sees. This would include creating some way of telling where the user was when they reported the data and then tweeting it at some account, likely a CampusPartner account used solely for collecting data to fix tasks, and then someone having to fix it behind the scenes. Another more plausible solution would be to have a button that generates a link that opens GoMap and immediately puts the user where they currently are. This solution is the next clear step from the prototype solution, but it still has some significant drawbacks. The largest being that if a user found missing or inaccurate data, they would have to immediately stop to fix it or return to the site of the inaccurate data, both of which can become an undue burden on people navigating with the app.

These are important things to take into consideration when making an assistive technology. We want to actually *help* the people we are developing for, not add an additional burden to their lives.

Another thing we discussed this week was where we will be hosting the static website. Currently, the thought is to use the departmentally hosted website that is provided for all students. The only problem with this is that it will not exist once I have graduated.

## **November 18, 2019**

Goal: Discuss lack of data updates with ORS

In researching how to implement the backend of my application, which unfortunately is behind in terms of development, we (me and my advisor) have hit a somewhat expected roadblock. Unfortunately, Open Route Service has not been updating which the frequency with which we are expecting. This means that development will become slightly harder, using test locations, such as London, England, to test the backend as well as potentially figuring out a way to host Open Route Service ourselves. The latter is not the preferred option because it will increase the workload of this project, but if I cannot get good data for JMU, it will most likely have to be done. This app is intended to be a proof of concept of something that could have a much larger scale and encountering these data-related problems is part of the task of creating this proof of concept.

The following are some notes from meetings with my advisor about this: found this section [https://wiki.openstreetmap.org/wiki/Planet.osm#Country\\_and\\_area\\_extracts](https://wiki.openstreetmap.org/wiki/Planet.osm#Country_and_area_extracts) and randomly chose 1 provider to investigate below

<https://protomaps.com/extracts/>

POST to <https://protomaps.com/extracts/>  
with some region like this

HEADERS:

Host: protomaps.com  
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10.15; rv:71.0) Gecko/20100101  
Firefox/71.0  
Accept: \*/\*  
Accept-Language: en-US,en;q=0.5  
Accept-Encoding: gzip, deflate, br  
Referer: <https://protomaps.com/extracts/>  
Content-Type: application/json; charset=utf-8  
X-CSRFToken:  
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Origin: <https://protomaps.com>  
Content-Length: 282  
DNT: 1

Connection: keep-alive

Cookie:

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Pragma: no-cache

Cache-Control: no-cache

BODY:

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### **November 25, 2019: Thanksgiving Break**

### **December 9, 2019: Finals Week (no capstone work done)**

### **December 2, 2019 & December 16, 2019**

Goal: Make poster to bring to Group

The primary focus of my project towards the end of the semester has shifted from development to preparing for my poster presentation at GROUP in January. This includes actually creating the poster (linked <https://czastudil.github.io/campuspartner.html>) that I will be presenting. This poster will contain a description of the problem I am attempting to solve and a proposal for the application to solve this problem. I intend to have a good number of visuals on the poster, including the route comparisons I used in my CAPWIC flash talk, as well as system and dataflow diagrams. Considering I have not gotten as much development done as I would've liked this semester, the poster will not have any screenshots from the application or any demonstrative materials. This is okay, however, because the posters at GROUP are intended to be projects that are conceptual in nature or in the early stages of development (my project being the latter).

This will be my first time ever creating a research poster for an academic conference and I'm equal parts excited and anxious about it. I am excited to share my ideas and progress with people to get constructive feedback and ideas about my project. On the other hand, I am feeling uncertain because I feel like I haven't done as much work as I could've up to this point. This is primarily due to poor planning on my part I believe, because I scheduled such an intense semester for the fall semester and didn't really take into consideration the significant time commitment I would need for this project. Honestly, one of the biggest roadblocks I have faced is that I want to be able to change the credit hour schedule to fit my course schedule better. If this coming spring semester was able to be my 3-credit hour semester, it would fit much better. As I cannot change any of this now, I will simply make up for the work I didn't accomplish this semester in the coming semester.

The sections of my poster will be the following:

- Problem
- Solution
- Collaborative Emphasis
- Future Work
- Any visuals relevant to the project as space allows

This poster draws significant direction from the ThoughtSwap poster shared with me by my advisor and it takes the traditional approach to research posters. The draft and final version of the poster will be completed after finals week, at the beginning of the winter break. In addition to creating the poster, I will be linking a website which will contain the extended abstract and the poster for anyone who wishes to view the materials in an online format. I think this is a good way to share my materials and it also allows for people who may not be able to view my poster at the poster session due to accessibility issues to view it online via a screen reader or other assistive technology.

## Spring 2020

### Semester Goals:

- Polish the frontend of the application, making sure that it complies with accessibility standards for mobile applications
- Complete the backend of the application
- Write the reflective essay required of this project
- Complete the static website and video demonstration of the application functionality
- Prepare for the final, public presentation of my work at the Honors symposium

## **Presenting at GROUP 2020 (January 6 – 8, 2020)**

Before the semester began, I went down to Sanibel Island, FL with my capstone advisor and another honors student to present my capstone project in the form of a poster. I still intend to present my work at the Honors Symposium in April of the upcoming semester; however, I believe that this opportunity to present will prove itself incredibly valuable. This is mostly due to what GROUP focuses on. There is a heavy emphasis about participatory design and crowdsourcing data in my project and GROUP is focused on “group work”, which is an umbrella term for crowdsourcing, collaborative design, participatory design, and other similar disciplines.

The poster session was during the evening session of the first full day of the conference. As this was my first time presenting my work in poster form since elementary school science fairs, I was pretty nervous about the whole thing. With that being said, my experience was overwhelmingly positive. Since this was a poster session for students, both undergraduate and graduate, the environment was very welcoming and was mostly for peers and professionals in the field (both in academia and industry) to provide constructive criticism, share their ideas, and give any insight they might have about the projects and research being presented.

I heard a lot of great feedback about my project, ranging from how I can make it more accessible to the best routing algorithms/services to use. I also heard about some relevant work in this field and was able to meet some people who are working in related or the same fields. I am very grateful to have had this opportunity, and thankful for my advisor and the Computer Science department for encouraging me to apply and funding the trip.

## **January 12 – 17, 2020**

Goal: Work on completing the front-end of the application & explore alternative data source/routing options

The primary focus of this week is working on finishing up the strictly front-end portion of app. I haven't started on any functionality yet because I want to focus on the look and feel of it. When thinking about how I want this application to work, I find myself equating it with Google Maps and Apple Maps. This is not necessarily in terms of the overall quality and functionality of these apps, because they have been developed over many years with large teams of people working on them. I will have worked on this app for about two semesters by myself, with only the help of my advisor and many Google searches, so it would be unfair to myself to hold myself to that standard. However, I want this app to model the ease of use of these kinds of apps, so making sure the user interface is intuitive to use is very important.

A roadblock I have run into is one I have likely discussed before. Open Route Service has not been updating their data from Open Street Map nearly as often as I would prefer. It seems as if they are updating only every couple of weeks, and that just doesn't really work with my development timeline. In a meeting with Dr. Stewart, we discussed this issue, and we decided to reach out to someone I met at GROUP and who Dr. Stewart has met before who works in this area of industry. He suggested using GraphHopper for the routing. GraphHopper is also developed in Germany and it seems to provide nearly all of the functionality that Open Route

Service does, but it updates its data significantly more. Next week, I will be looking more deeply into it as a replacement for Open Route Service. The only thing it doesn't seem to have is wheelchair accessible routing, however that doesn't matter a whole lot for this project because that functionality from Open Route Service isn't available in the U.S. anyways.

### **January 20 – 24, 2020**

Goal: Continue making progress on the front-end and explore GraphHopper

There is not much to report from this week, I primarily worked on finishing up the front-end of the app, same as last week. This week I had to figure out how to customize tab bar icons for the navigation within the app. All things considered, this capstone has done a great job exposing me to iOS development if nothing else.

I also worked on exploring the GraphHopper Routing API and overall, I'm pretty impressed and it seems to have all of the functionality I need for CampusPartner. After discussion with Dr. Stewart, we've decided to replace Open Route Service with GraphHopper.

### **January 27 – 31, 2020**

Goal: Finish the front-end (finally) and integrate the services I am using in the app

This week, the front-end was finished (finally).

In other news, I am running into a seemingly unending stream of problems integrating the third-party services I am using in this app, specifically Mapbox. This is probably because I am new to iOS development, but also because the instructions and tutorials I'm following have not been too intuitive and clearly written (good documentation is important). Not a ton of progress has been made with the actual functionality of my app because progress can't really be made until I get these problems worked out. My capstone meetings have really been dedicated to troubleshooting these problems since my advisor is much more familiar than me with iOS development.

### **February 3 – 7, 2020**

Goal: Fix the constant problems

This week is pretty much the same as the last, but probably more frustrating. I honestly get super disheartened every time a build fails because of a problem with the third-party app. I feel like I'm falling behind in my work and it's not entirely my fault.

### **February 10 – 14, 2020**

Goal: Figure out the best way to store user profile data

This week, we worked on figuring out the best way to store user profile data. We decided pretty early on that we didn't need to have the user log-in to Open Street Map, because they will do that

through GoMap when they are editing Open Street Map. We also decided that we don't need a fully-fledged database using a language like SQL because we aren't storing that much data and the data we are storing isn't very complex. In addition, we also removed the log-in idea because realistically, only one user is going to be using this application, and if they uninstall it, it will clear all of the data and that's good enough for this app.

We looked into different services provided by Apple, and we found two primary options: Core Data and User Defaults. We decided on user defaults because it's very lightweight and easy to set up (because there is virtually no set up) and access the data. Modifying the data is also easy, which is useful because the user could potentially want to go back and modify their information later on.

### **February 17 – 21, 2020**

Goal: Work on communication between the front-end and back-end of the app

This week I primarily worked on figuring out how to communicate information from the front-end of the application to the backend of the app. For example, when a user enters the profile information, what's the best way to indicate that, upon pressing a save button, that the user's information should be saved and that the app should segue from the profile creation to the navigation view. Since I decided to base the majority of the user interface of my app off of the storyboard in Xcode, it was pretty simple to add variables into the backend code to access the values of text boxes and perform some actions whenever a button is pressed because you can also register UI elements to do things when certain events happen. This is the point where I'm seeing trade-offs between totally programming the entire app and separating the code and the UI. Although I'm not totally in love with either option, I think I'm glad I chose the storyboard option because creating and showing UI items via Swift code is not very intuitive to me.

### **February 24 – 28, 2020**

Goal: Work on getting the user's location and desired source and destination and retrieving a route from GraphHopper

This week I worked on figuring out how to determine the user's location, constantly update it, and use it in determining routes. The default source location for a search is the user's current location, so I constantly update a variable that stores the user's current location so that if that's the option they choose, I already have all of the information I need. I am also working on figuring out exactly how to use the GraphHopper API to retrieve routes and I'm doing that via a Postman project, so I don't have to build and run the app every time I want to test something. So far so good.

### **March 2 – 6, 2020**

Goal: Fix problems I've been having with retrieving and using the user's location

I've been running into some issues recently where I have nil where I should have the user's location, and it seems to be because I'm not using Apple's location manager entirely correctly. I spent most of this week researching and figuring out exactly where I've gone wrong, by the end of the week I got it working. Not a ton of functionality got worked on this week because this problem kind of stalled everything else, but we should be good to go after spring break.

**Spring Break (March 9 – 13, 2020):** No work completed over spring break

**Extended Spring Break (March 16 – 20, 2020):** Due to unforeseen circumstances caused by the outbreak of COVID-19, no work was able to be completed during this week either. Although work was not able to be done, I have revised my semester plan according to the changed deadlines/requirements from the Honors College.

Revised semester plan:

- Submission of my project and all associated deliverables will be done on April 30 (the last day of classes).
- Meetings with my advisor will take place on a weekly basis with the potential for more meetings to be added as needed.
- I will no longer be presenting my work at the Honors Symposium as that has been cancelled and the presentation requirement removed from this year's submissions.
- I will also no longer be presenting work at CAPWIC 2020 since that was cancelled due to COVID-19.
- The remainder of the semester will be dedicated to completion of the application and all other deliverables, including my contextual essay.

**March 23 – 27, 2020**

Goal: Retrieve route, process it, draw it on the map, and show source and destination annotations

Well, things changed. Due to the COVID-19 pandemic I am now working entirely from home for all of my classes, included capstone project development. The deadline to submit my project got pushed back to April 30<sup>th</sup>, and I think that this is kind of a blessing in disguise because it means I have more time to work on functionality and my contextual essay. This week I focused really heavily on getting the route from GraphHopper and figuring out how to draw on it on the Mapbox map. This proved to be more difficult than I initially thought because Mapbox uses a different form of response for their Routes and I could not just throw the GraphHopper response into their navigation framework. This means I have to abandon the idea of providing a turn-by-turn routing interface because it isn't really realistic given the time constraints. This is unfortunate because it gives my app a significantly different feel than Apple or Google Maps. I did figure out a way however to extract the coordinate list and adapt the draw route method from Mapbox to work with GraphHopper. Once the route is drawn, I can easily drop a source and destination pin to mark the beginning of the route.

**March 30 – April 3, 2020**

Goal: Make sure a user can edit and immediately view their updated profile

This week was relatively light in terms of work, I just figured out that I hadn't implemented profile editing yet and spent most of my time implementing that functionality. I made it so that if a user updates their profile the screen will automatically update and show the changes made.

### **April 6 – 10, 2020**

Goal: Show the user a step-by-step list of instructions in a tabular format and let them select a specific route step

This week I had to figure out how to create a custom table view cell in order to show the user a list of instructions to follow. I did this all programmatically because I couldn't figure out how to put a view that only shows up on top of existing views conditionally in the storyboard. This proved a little more difficult than I was anticipating but I didn't have a ton problems with it. More of the problems arose when I was trying to program what should happen when a user selects a cell. I just had some problems with making the view show up and being able to see the route drawn on the map.

### **April 13 – 17, 2020**

Goal: Allow a user to bookmark and load a route later

This week I finished up the last major piece of functionality, which is bookmarking a route and loading it again later. I had to create a custom table cell, similar to what I had to do for the route instructions. However, this was actually easier because I could do a lot of it via the storyboard which handles a lot of the work for you. I also worked on an outline for the rough draft of my contextual essay.

### **April 20 – 24, 2020**

Goal: Fix navigation instruction bug and write and send out rough draft to readers and advisor

I found a small bug in the navigation instructions. It was a problem in how I was determining what instructions were referring to. I thought the instructions were referring a single coordinate pair, when in reality it was referring to an interval of coordinates in the returned coordinate list. That was a relatively easy fix. Other than that, I wrote a rough draft of my essay and got it sent out to my advisor and readers for edits.

### **April 27 – 30, 2020**

Goal: Finish any final touches on the app and submit the project!

This week I finished up some final touches: making the profile default to avoid stairs and having the map open up to a view of Harrisonburg. The rest of time was spent updating my website, creating the video demo, putting the code in a public GitHub repository, and editing my contextual essay. Then I got the project submitted!! 😊