

**BYU SOUTH-CAMPUS PEDESTRIAN AND MICRO-MOBILITY
TRAFFIC ANALYSIS
PROJECT ID: CEEN_CPST_004**

by

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A Capstone Project Final Report

Submitted to

**Nathan Summers
Brigham Young University Physical Facilities**

**Lt. Rich Christianson
Brigham Young University Police**

**Department of Civil and Construction Engineering
Brigham Young University**

April 11, 2022

Executive Summary

PROJECT TITLE: BYU SOUTH-CAMPUS PEDESTRIAN AND MICRO-MOBILITY TRAFFIC ANALYSIS
PROJECT ID: CEEEn_CPST_004
PROJECT SPONSOR: Nathan Summers and Lt. Rich Christianson
TEAM NAME: RHAD Traffic Consultants

With the rising popularity of hover-boards, scooters, and other forms of micro-mobility, university students have a wide variety of travel options available to them that may be more convenient than driving a car. Employees in BYU Physical Facilities wish to better understand the micro-mobility and pedestrian traffic entering the south side of campus.

The purpose of this project will be to complete an “existing conditions” analysis of the pedestrian and micro-mobility traffic at each of the main south-campus entrances that will provide the necessary data for BYU Physical Facilities and serve as a baseline for future projects to evaluate changes in pedestrian traffic.

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Introduction

BYU Physical Facilities needed pedestrian and micro-mobility counts to be performed for entrances to the south side of campus. The research team undertook developing a methodology for performing data counts and collected data for the days of January 24 through January 27, 2022. Afterwards we summarized the data using R and Microsoft Excel, and analyzed the results for possible trends. The following report details our schedule of tasks, assumptions and limitations, methodology design, results of our analyses, and recommendations for future action.

Schedule

Capstone team weekly meetings were held each Monday during Winter Semester 2022 from 4-5 pm. The dates of completion of the tasks and major events for the project are listed below.

- January 8, 2022: Submitted a revised statement of work.
- January 21, 2022: Finalized which campus entrances would be used for data collection.
- January 24-27, 2022: Footage of pedestrian and micro-mobility volumes were collected at each counting location from 7:30 am -11:30 am for Monday, January 24th, through Thursday, January 27th, continuously. Footage was recorded by BYU Security.
- February 11-23, 2022: Collected footage were counted. The counts were performed by the capstone team members as well as by volunteers from the BYU ASCE student chapter under the supervision of the capstone team.
- March 22, 2022: A Status Update was submitted to the client and the majority of the data were analyzed
- March 28, 2022: All data graphs, videos, and visual representations were completed.
- April 4, 2022: Proposed solutions based on the data and observations of feasibility were made and included in this report.
- April 11, 2022: Final Report of the project submitted.
- April 20, 2022: A meeting will take place with our faculty advisor and BYU Physical Facilities.

Assumptions & Limitations

Counts were performed using the BYU Security cameras to count pedestrians, bicycles and other micro-mobility modes. See the following section for an explanation of the data collection methodology. A few general limiting factors due to the use of cameras in recording data were user error in counting, the cameras being aligned at inconvenient angles, the view of a couple cameras being moved by the BYU Police who used them for other purposes, and the footage not being clear enough to distinguish whether someone was walking or using a skateboard or other micro-mobility mode. This yielded a small margin of error in the “other” category for active transportation, especially for counts near the Engineering Building. Another minor source of error during the busy times of the day in areas with high pedestrian traffic was that it was easy to mis-count the number of pedestrians in a crowd. However, the error from mis-counts in these areas is likely negligible due to the large volumes of pedestrians in these areas.

The scope of this study is limited to only counting pedestrians around the south end of BYU campus and only during the morning from 7:30 am to 12:30 pm on Monday through Thursday. This data is representative of the south end of BYU campus, but not to other parts of campus since the traffic patterns differ significantly and there is more student housing close to campus towards the South than there is towards the North, East, or West.

Limitations more specific to certain areas within the study include the Life Sciences Building (LSB) and Maeser Hill. The one camera close to the LSB that could be rotated to count the pedestrians entering the front doors was unavailable to use for counts so there was no data recorded for this entrance. In addition, the number of cyclists that parked close to the duck pond, west of the LSB, who most likely walked up the stairs towards the ramp of Maeser Hill were not counted at the bottom, so there are likely more cyclists entering campus through the Maser ramp than were counted.

On the southwest side of campus, it was unclear from the angle of the cameras whether the pedestrians who were entering campus by the Maeser hill stairs and ramp were going towards the Richards Building (RB) or walking to the parking lot, so the research team decided that it was best to disregard this data due to the discrepancy.

Design, Analysis & Results

To analyze pedestrian traffic patterns south of BYU campus, data were collected by counting pedestrians, bicyclists, and other active modes of transportation using footage from BYU security cameras. Since most of this area is on a steep hill, most travelers followed prescribed paths which meant we were able to thoroughly count people travelling towards the south of campus using the security cameras along these paths. Each of the approaches where data were collected are shown and described in Figure 1. Data at each of these approaches were recorded for every 15 minutes between the hours of 7:30 am to 12:30 pm from Monday through Thursday and the data were separated into three categories: pedestrian, bicycle, and other. Table 1 shows a sample of the worksheets used to record the data. A separate macro-enabled worksheet was used for counting the data by mapping key presses to functions which incremented fields on the worksheet.

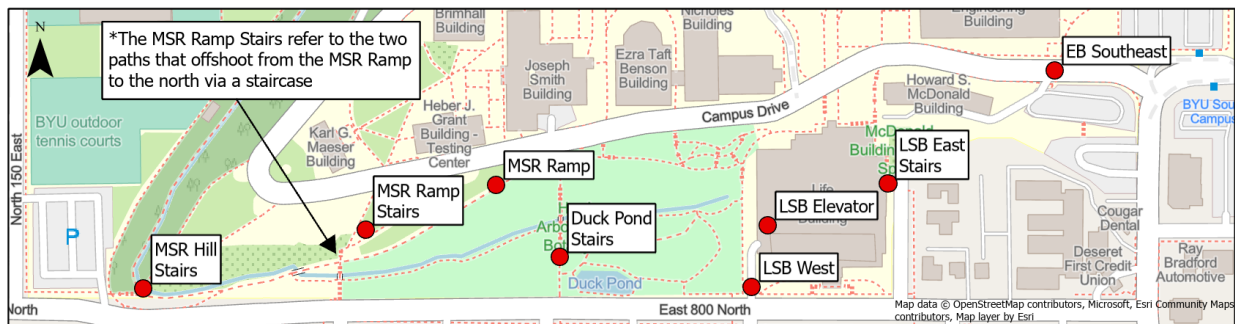


Figure 1: Map of data collection locations

Table 1: Count Record Sheet (Sample)

Monday, 1/24/22	Name of Counter	Ped	Bike	Other	Ped	Bike	Other	Ped	Bike	Other	Ped	Bike	Other	Total Ped	Total Bike	Total Other	Total per Hour (by half-hour)
Time of Day	Name	:00-15			:15-30			:30-45			:45-00			:30-:30			
7:00 - 8:00 AM								33	0	0	123	0	0	221	0	0	221
8:00 - 9:00 AM	Sam Runyan	32	0	0	33	0	0	27	0	0	139	0	0	243	0	0	243
9:00 - 10:00 AM	Josh Hart	34	0	0	43	0	0	32	0	0	69	0	0	133	0	0	133
10:00 - 11:00 AM	Lucky B.	20	0	0	12	0	0	18	0	0	69	0	0	112	0	0	112
11:00 AM - 12:00 PM	Lucky B.	16	0	0	9	0	0	5	0	0	33	0	0	60	0	0	60
12:00 - 1:00 PM	Matthew D.	8	0	0	14	0	0							Total for the Day			769

The “other” category included chosen modes of transportation such as skateboards and scooters as well as “captive” modes of transportation such as wheelchairs and strollers. Figure 2 shows an estimated distribution of mode choices in the “other” category, which was determined by counting specific modes of transportation at the Southwest Stairs, Maeser Ramp, LSB West, LSB Breezeway, and EB Southeast locations

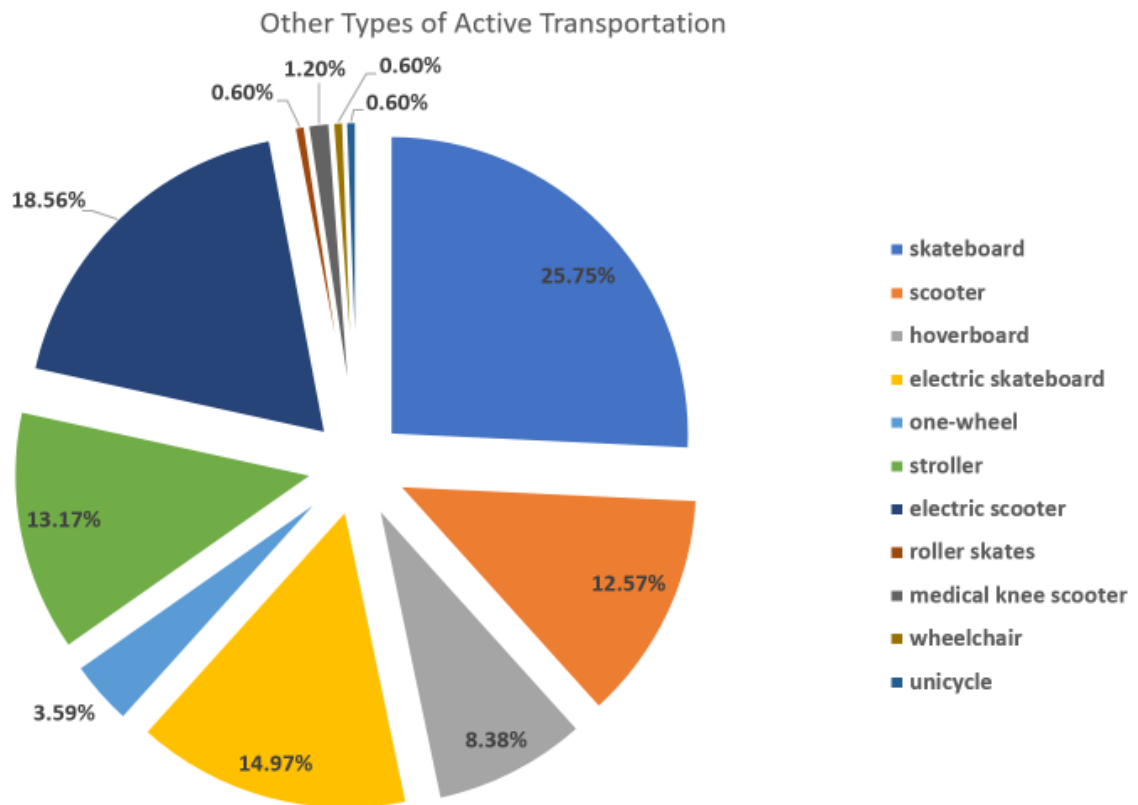


Figure 2: Distribution of other modes of active transportation

The data were transferred to a new table with columns for location, mode, time, and counts allowing for analysis to be performed using R script. The Figures 2 through 5 were generated using R and Microsoft Excel to represent the data obtained through this process.

Table 2: General Mode Choice Summary

Mode	January 2022				Average/Day	Total	Percent
	24th	25th	26th	27th			
Ped	6,977	6,467	6,955	6,304	6676	26,703	96.67%
Bike	178	148	157	157	160	640	2.32%
Other	78	56	81	66	70	281	1.02%
Total	7,233	6,671	7,193	6,527	6,906	27,624	

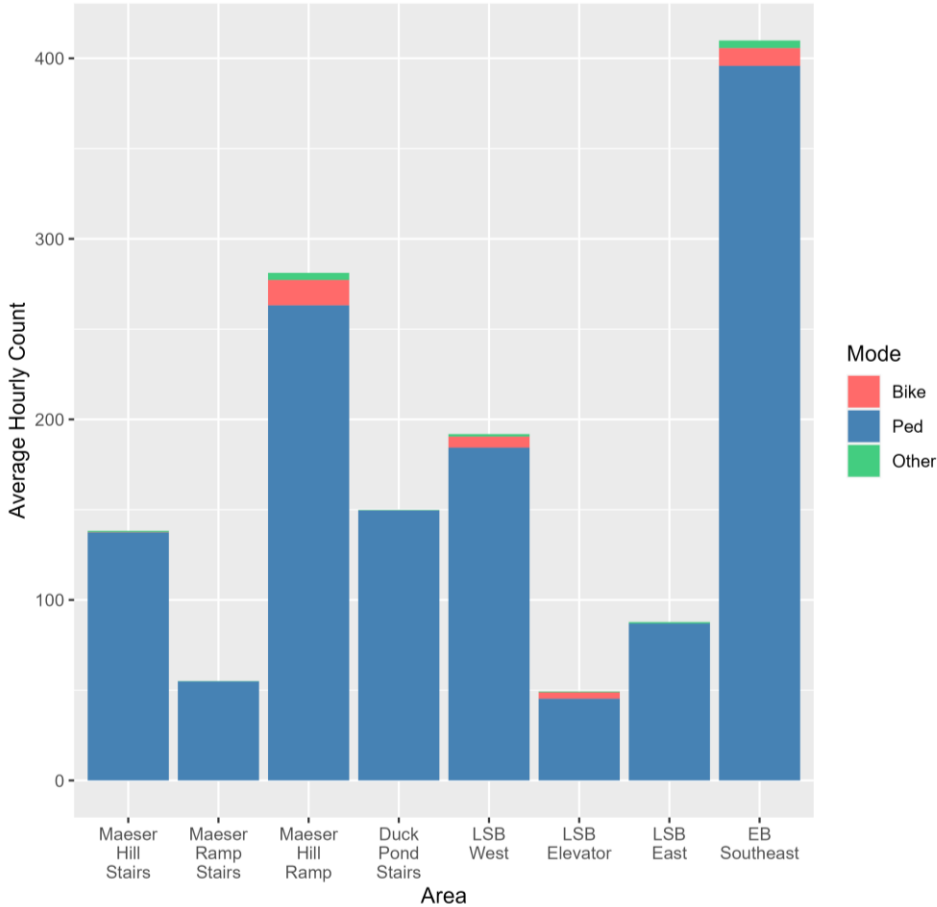


Figure 3: Average hourly micro-mobility volumes at each location

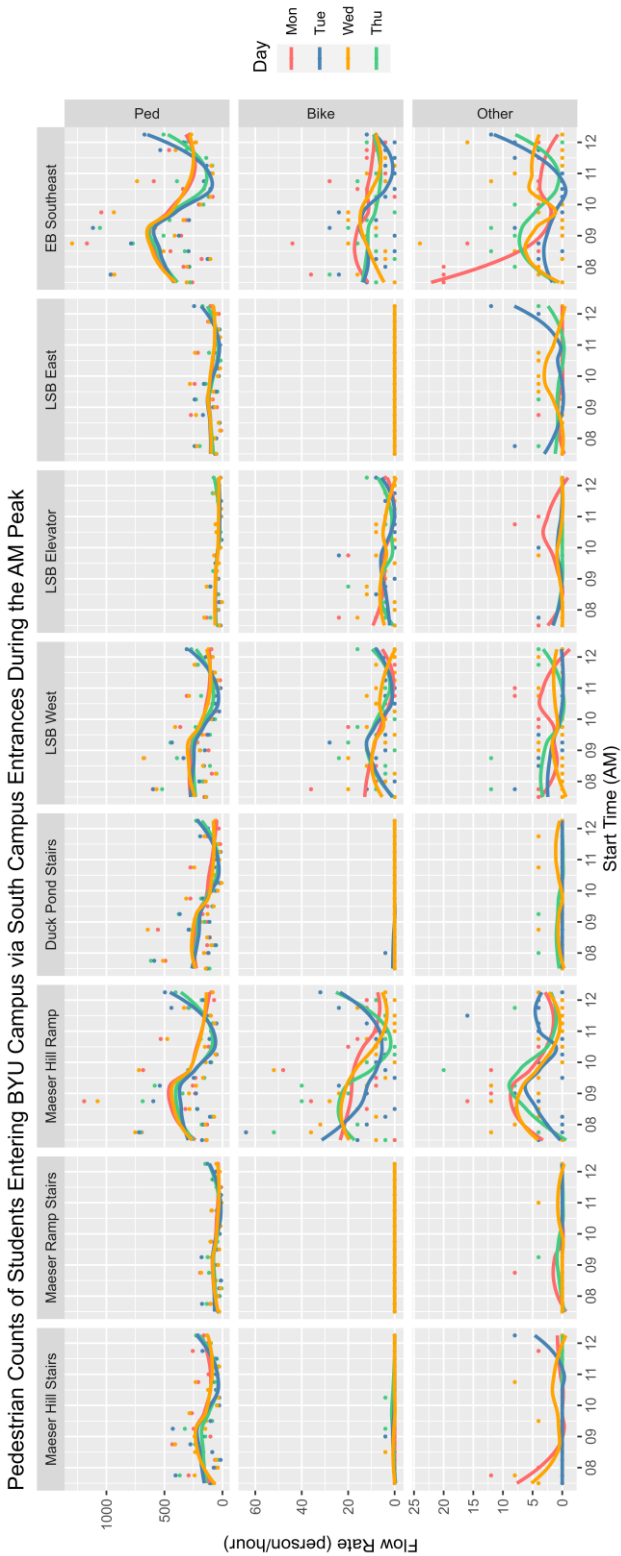


Figure 4: Hourly micro-mobility flow rate over time in each location

In addition to R script, the 3D Maps feature of Microsoft Excel was used to generate a map showing changes in pedestrian traffic over time. A screenshot of this map is shown in Figure 5.

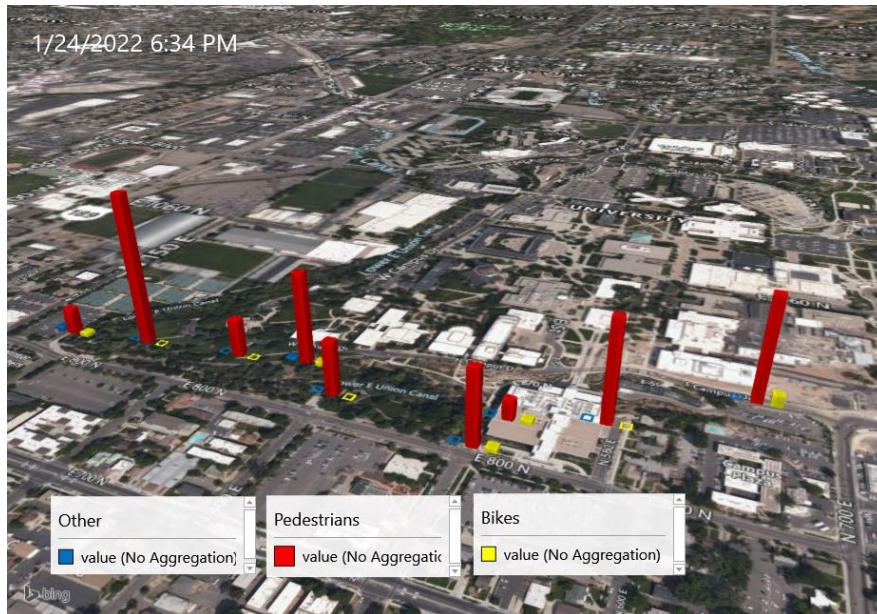


Figure 5: Microsoft Excel 3D Maps time lapse of micro-mobility data

A consistent trend of a 9 AM peak period for pedestrians each day was evident when the data was visualized in R, as shown in Figure 4. However, the limited amount of data makes it harder to see these trends for bicycles and other active transportation. Additionally, there were little to no bicycles or other modes reported at the Duck Pond Stairs, the LSB East stairs, or the Southwest Stairs. Unfortunately, the footage of the Duck Pond Stairs did not show people parking their bikes at the foot of the stairs, so that data is missing from the analysis. Even with this missing data, our data shows that people are more likely to ride their bike to the top of the hill than park it at the bottom because most of the bicycle counts occur at the Maeser Ramp and EB Southeast locations.

From qualitative observation, the crossing at 800 North and 300 East appears relatively unsafe because cars are more likely to drive quickly through the intersection. Also, the Maeser Ramp stairs are degrading and pose potential tripping hazards. Our team also noticed desire lines, or cow trails, at some locations, most predominantly at the amphitheater by the Duck Pond. Action could be taken to either prevent travel in this area or provide additional routes.

Related Issues

The impact of this study in surveying the current state of pedestrian traffic and micro-mobility on the south side of BYU campus will have minor impacts on the public health, culture, and environmental state of the BYU campus as well as the safety of pedestrians. The public health of campus is affected by the pedestrian and cyclist infrastructure in place and expansions in cyclist infrastructure will attract more bicycle traffic to decrease the time spent commuting for students who choose to take this mode and allow them to have greater flexibility in where they can park their bikes. Added cyclist traffic allows for the public to get more physical exercise and have fun which has positive impacts on physical, mental, and emotional health.

The culture of BYU has long been one of a small suburban town where driving to campus is preferable if not necessary for those who do not live close to campus. Additional bicycle infrastructure that is aesthetically pleasing and signage to make it clear to students that infrastructure will be an incentive for more students to choose riding a bicycle or other vehicle to campus making cycling as well as riding other vehicles more popular and incorporate itself into student culture. This will also be a benefit to the campus environment with the increased traffic around campus due to the rising population in Provo and the change in housing policy which will likely increase the number of students commuting further from campus.

While the environmental effects of more students choosing ecofriendly modes and the number of students who drove versus taking transit is not within the scope of this study, the better experiences that pedestrians, cyclists, and other vehicle users have while approaching campus, the more likely that they are to continue to use eco-friendly modes of transportation to commute to campus.

Assessing traffic patterns has allowed the research team to make recommendations to improve the safety and aesthetics of paths south of campus to avoid cars hitting pedestrians around 800 North. Additional lighting should also be provided on the stairs by the duck pond above 400 East where only the ends of the paths are lit at night.

Lessons Learned

The largest challenge we overcame as a team was building the methodology from the ground up. When starting the project, we assumed that finding the camera angles and deciding how to count the students would be simple, but we hit more roadblocks than we anticipated. When choosing which entrances to use, we discovered that there were different ways that we could approach the question. We could count students as they arrived to the top of the hill at Campus Dr, as they were choosing their path up to campus from 800 North, or a combination of both. We had a lot of discussion for a few weeks about the benefits of each and disagreed between team members. Eventually, we had a discussion about each individual entrance and came to the conclusion that each entrance should be treated differently based on the most accurate method available. This method eventually expanded to also include which camera angles were available and how each approach was counted. There were also many disagreements on how each approach should be counted. Each team member had a different opinion about what was most important. When making final decisions about our methods, we compromised between individual opinions and planned for not only what would be best for each approach, but what could be done systemwide by using all of the cameras together. By working together, we created a methodology that we felt answered the question we were presented with and provided a robust way to cover the majority of entrances to the south side of BYU Campus.

Determining exactly how to count the traffic observed in each camera also presented a challenge. Appendix B includes snapshots of each campus entrance in our study marked with lines indicating the precise location students had to cross in order to be counted. These locations were determined through trial and error as we gained experience counting traffic. In the future, we recommend creating these charts or something similar beforehand so that all counts are consistent.

Conclusions

Of the three modes considered in this study, the data suggests that walking was the primary mode of transportation for students entering the south side of BYU campus. Only 3 percent of students traveled by bike or pedalcycle during the observed time period.

The micro-mobility infrastructure around Maeser Hill meets the needs of BYU students well, and the campus has been certified by the League of American Bicyclists as “bicycle friendly”, but our team believes this infrastructure can be improved upon. The data shows that bicycle riders commuting to south BYU campus prefer to park their bikes at the top of the hill, closer to the buildings on campus, but there are only two places south of campus where students can ride their bikes up the hill. Incorporating another way for students to bring their bikes up the hill may encourage bicycle riding, giving students and faculty more options for commuting to campus.

Recommendations

RHAD traffic engineers recommend the following improvements be made at the south of BYU campus to encourage active transportation and improve safety.

- A bicycle service station and bicycle racks should be provided near the LSB East stairs to encourage bicyclists in this area. In addition, signs could be posted outside the LSB breezeway near the LSB West stairs to inform bicyclists of the bicycle parking in the breezeway.
- Additional lighting on the Duck Pond Stairs should be provided to improve early morning and late-night commuter experience and safety.
- Pedestrian traffic can be improved and made safer on the Maeser Hill Ramp Stairs by improving the staircase condition and adding a High Intensity Activated Crosswalk (HAWK) at the 800 North and 300 East intersection for increasing pedestrian visibility.
- The addition of bike ruts along the EB stairs, (west of the EB at the top of the hill,) Maeser Hill Ramp stairs, or LSB West Stairs may increase availability for the large number of cyclists in these areas. This will allow more cyclists and other vehicles to approach campus from more locations than just the Maeser Hill ramp.
- Our team also recommends that a follow up study be performed during the fall semester and after the BYU housing policy change is implemented. It will be particularly useful to see how the policy change affects active transportation south of campus.

Appendix A

Shannon Andersen

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- EDUCATION** **Bachelor of Science, Civil Engineering, Brigham Young University**
Provo, UT, December 2022
- GPA 3.9
 - Brigham Young Scholarship
 - NASA Idaho Space Grant Consortium Scholarship
 - KIWANIS Service Scholarship
- WORK EXPERIENCE** **Research Assistant, Brigham Young University**
Provo, UT, April 2021 – Present
- Analyze over 74 million observations using RStudio as part of the V2X Data Sharing Research Activity sponsored by UDOT and Panasonic
 - Apply leading-edge speed limit setting techniques to 45 corridors in Utah
- CCE 112 Teaching Assistant, Brigham Young University**
Provo, UT, January 2020 – Present
- Coach 35 to 80 students each semester in the use of AutoCAD and Revit
 - Train 1 to 4 new TAs each semester
 - Create tutorial videos to instruct students on the use of AutoCAD
 - Evaluate and provide feedback on assignments for 35 to 80 students
- Landscape Architect Intern, FFKR Architects**
Salt Lake City, UT, April 2020 – August 2020
- Compiled architectural plans from three teams to create realistic 3D models of complex landscape designs in Revit, Lumion, and Sketchup
 - Presented 3D models to a team of architects and engineers as part of the design process for three temples for The Church of Jesus Christ of Latter-day Saints
 - Collaborated with a team of seven individuals over Skype and Microsoft Teams to meet weekly deadlines while following local health and safety regulations
- REL C 200 Eternal Families Teaching Assistant, Brigham Young University**
Provo, UT September 2020 – August 2021
- Evaluated and graded essays for 60 students each semester
 - Reviewed weekly feedback from students and forwarded pertinent information to the professor to aid course improvement
- OTHER EXPERIENCE AND INTERESTS** **Miscellaneous**
- Tau Beta Pi member; Golden Key Society member (top 15% of graduating class); ASCE member; substitute math teacher at Ivy Hall Academy; BYU Accessibility Center volunteer; BYU New Student Orientation Group Leader; volunteer representative for The Church of Jesus Christ of Latter-day Saints; research and development team member at BYU-I; self-employed piano teacher; BYU University Chorale and Idaho Allstate Honor Choir member; Personal Progress Award recipient; amateur artist; avid reader and movie-watcher

Matthew Davis

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EDUCATION

BS, Civil and Environmental Engineering **April 2022**
Brigham Young University *Provo, UT*

- 3.71 GPA
- Institute of Transportation Engineers – Student Coordinator
- Joseph Layne Black Full Tuition Scholarship Recipient
- Relevant Coursework: Urban Transportation Planning, Technical Writing, Engineering Applications of GIS, Introduction to Transportation Engineering

SKILLS/INTERESTS

- ArcGIS Pro
- AutoCAD Civil 3D
- Programming: R and VBA
- GitHub
- Qualtrics survey building
- ITE Traffic Bowl Competition 2021
- Civil Engineering Study Abroad to Italy, France, and the Netherlands
- BYU Basketball Pep Band 2016, 2020, 2021
- Eagle Scout

ENGINEERING-RELATED EXPERIENCE

Transportation Research Assistant **January 2021-Present**
Brigham Young University *Provo, UT*

- Assist PhD candidate by finding 10+ relevant articles for literature review
- Construct and edit literature review drafts iteratively
- Research ATSPM and its uses in Utah for publication

Civil Engineering Intern **April 2019-June 2021**
BYU Physical Facilities *Provo, UT*

- Surveyed over 2,000 points with GPS and total station equipment to maintain accurate campus maps
- Evaluated and meticulously revised drawing set for 500 storm drains in AutoCAD Civil 3D
- Audited 90+ ADA ramps for compliance to increase equity in accessibility
- Automated Excel workbook using VBA to generate 80-page ADA ramp report from raw data

ADDITIONAL WORK & VOLUNTEER EXPERIENCE

Catering Crew Member **September 2019-May 2020**
Marvellous Catering *Provo, UT*

- Transported equipment after four weeks of employment with 100% on-time record
- Facilitated adherence to all food and personal safety requirements and procedures
- Trusted by employer to provide consistent, quality customer service through attention to detail and reliability

Full-time Volunteer Representative **June 2016 – June 2018**
The Church of Jesus Christ of Latter-day Saints *Boston, MA*

- Directed intensive 12-week training for two volunteer representatives to ensure quality of service
- Planned and presented weekly trainings for six volunteers to improve morale and productivity
- Delegated assignments and relayed information to inspire personal growth
- Watched over physical, emotional and mental well-being of 12 volunteers

Samuel Runyan

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EDUCATION AND SKILLS

Brigham Young University, Fulton College of Engineering Dec 2022
Bachelor of Science: Civil Engineering GPA 3.85/4.00 Provo, UT

- Classes: Capstone, Structural Analysis, GIS, Data Science
- ITE BYU Student Chapter Officer for over 30 students
- Skilled with MS Office, ArcGIS Pro, Typing: 50-60 wpm
- Moderate with Python, R Script, AutoCAD

ENGINEERING PROJECTS

UDOT Highway Safety Improvement May 2021 – Present
BYU Transportation Research Lab Provo, UT

- Develop model to analyze safety of the entire Utah state route network.
- In-depth use of Highway Safety Manual and statistical analysis in R.

Folsom Dam Raise, Dike 8 May 2020 – Aug 2020
U.S. Army Corps of Engineers Folsom, CA

- Managed contract files and wrote daily reports of onsite work performed
- Reported work performed to professional engineers to ensure the project met specifications

EXPERIENCE

BYU Transportation Research Lab May 2020 – Present
Research Assistant Provo, UT

- Optimize 4 data models for more effective highway safety analysis
- Filter data from almost 300,000 crashes over 5 years to identify top 10 to 20 sites with potential for safety improvement

Fulton College of Engineering, Civil Engineering Department Aug 2019 – Present
Teaching Assistant – Introduction to Transportation Engineering / Computational Methods Provo, UT

- Tutor over 40 students to understand traffic engineering concepts
- Demonstrated and taught practical applications of MS Excel and VBA

U.S. Army Corps of Engineers, Sacramento District May 2020 – Jan 2021
Student Intern – Construction Division Folsom, CA

- Performed Quality Assurance on 3 USACE funded dam and levee projects
- Created and presented workflows for contractual and safety related processes

Church of Jesus Christ of Latter-Day Saints Nov 2016 – Nov 2018
Full-Time Volunteer Portsmouth, VA

- Assessed key indicators to help 5 other volunteers improve missionary service
- Coached 2 new volunteers to improve time management and communication skills

INTERESTS AND AWARDS

- First place in the ASCE Rocky Mountain Conference Pre-Design Competition
- Student officer for the ITE BYU Chapter
- Community involvement: Habitat for Humanity, Student Mentor, Voice for Good
- Eagle Scout Award

Joel Hyer

(385) 312-9135 | joelhyer@gmail.com | LinkedIn Profile: www.linkedin.com/in/joel-hyer

Education

BS CIVIL ENGINEERING, BRIGHAM YOUNG UNIVERSITY

- Expected Graduation: April 2022
- 3.42 GPA. Has passed all Engineering core classes within the A and B ranges
- Courses that will be completed by January 2022
 - Highway Design
 - Bridge Design
 - Reinforced Concrete Design
 - Seismic Steel Design
 - Urban Transportation Planning
 - Soil Mechanics
 - Eng. Drafting

Work Experience

VECTOR ENGINEERS: SOLAR PROJECT MANAGER | MAY 2021 - PRESENT

- Analyzes roofs of residential structures to approve the installation of solar panels.
- Performs point-load-analyses on rafters and trusses using RISA-3D to demonstrate structural stability.

BYU: TRANSPORTATION RESEARCH ASSISTANT | JANUARY 2020 – JULY 2021

- Quantified the economic benefits and performance measures of Incident Management teams in the State of Utah as part of Traffic Incident Management (TIM) research project for UDOT.
- Developed Excel VBA code to extract and analyze data.

HALES ENGINEERING: TRANSPORTATION INTERN | NOVEMBER 2020 - FEBRUARY 2021

- Completed Traffic Impact Studies using Synchro to analyze intersections at new developments.
- Completed Trip Generation Studies using the ITE Trip Generation Manual.

Professional Skills

TECHNICAL/ ORGANIZATIONAL

- Familiar with Risa-3D, AutoCAD, Micro Station, SAP2000, Revit, Synchro, and ArcGIS.
- Coded in VBA to loop through files, extract data, and automate database functions.
- Managed the design and fabrication of a model steel bridge (20'x3'x3') as BYU Steel Bridge Team captain.
- Created website content, organized documents and storerooms, and sourced products.
- Organized the building of a 500 ft boardwalk in a National Wildlife Refuge as a service project.
- Worked in Drywall Construction and understands the general processes of building projects.

LANGUAGE AND COMMUNICATION

- Speaks and interprets three languages fluently: English, Spanish, and Mandarin Chinese.
- Worked in China in Global Supply Chain management, translated technical documents into Mandarin Chinese, and taught English to non-native speakers.
- Plays French Horn and has toured internationally with the BYU Wind Symphony.

Appendix B

These are the methods the team used to count each approach through the lenses of BYU Security Cameras.

Maeser Hill Stairs: “MSR Hill South West Stair 4cam – South West” was used to capture the number of students entering BYU Campus via the staircase near the corner of 800 North and 200 East, or geographically, the Maeser Hill. Students were counted as they crossed the red line. While this camera was eventually used for the counts, “MSR Hill South West Stair 4cam – NorthEast” was also an available angle for this count. The team struggled to decide which camera to use, since both essentially captured the same counts.

The “South West” camera captured students as they were entering the stair case and provided a more count friendly approach with more time to notice and count the students accurately. It also provided a view of students traveling north towards the Richards Building (RB) and was the only camera between this street corner and the RB that captured the corridor. The camera did not capture, though, if the students traveling up the stairs continued going up the stairs after the landing or if they branched off to the paver trail. The main concern with using this angle was that if students branched off to the trail, they might continue to the Maeser Hill Ramp and be captured once on the Maeser Hill Stairs approach and again on the Maeser Hill Ramp approach.

On the other hand, the “NorthEast” camera captures if students continue up the staircase, which brings them directly to the BYU campus, but provides a more difficult counting experience, due to the more limited camera angle.

Eventually, the team decided to go with the “South West” angle because of the “count friendly” view and the potential for capturing students traveling towards the RB.

To capture students going to the RB, team members and volunteers counted students going in the direction of the RB as they crossed the orange line in Figure 6, but it became clear that understanding the students’ intended destination was very difficult. With Lot 34 due west of this corner, students passing the orange line could be going to their car rather than the RB, but the camera angle did not allow for that interpolation. Though the counts were completed for students going to the RB, it was decided to not include them in the

final report due to lack of understanding of the students' final destination. The inclusion of the counts may have provided inaccurate information about students entering campus.



Figure 6: Approaches for the Maeser Hill Southwest Stairs location

Duck Pond Stairs: “MSR Hill Stairs 4cam East” was used for the Duck Pond Stairs approach. Students coming up the stairs were counted as they passed the yellow line in Figure 7, or stepped onto the top step. This was because it was the most visible location for counters to identify. If students came up the stairs and did not continue up the stairs, but turned onto the South Campus Stream and Trail, they were not counted. If students were walking on the South Campus Stream and Trail and entered the staircase going upwards to campus, they were counted as they crossed the red line in Figure 7. In hindsight, it would be more consistent to count all students as they crossed the red line. Most students did continue up the stairs, which simplified the process, but in the future, counting all students as they crossed the red line would simplify the process.



Figure 7: Approaches for the Duck Pond Stairs location

Maeser Hill Ramp: "MSR Ramp East 4cam West-Downhill" was used for the Maeser Hill Ramp approach. This camera was chosen because it provided the most count friendly option for the approach. Students are very easy to see and anticipate with the long camera view and can be more accurately counted during busy peak times of the day. Students on this approach were counted as they crossed the red line in Figure 8.



Figure 8: Approach for the Maeser Hill Ramp location

LSB West: "LSB EXT SouthWest Pole PTZ" was used for the LSB West approach. Students were counted when crossing the red line in Figure 9. Counts were also completed for

students headed from the 800 North crosswalk to the south entrance to the LSB via the ADA ramp as they passed the orange line in Figure 9. Eventually, it was decided not to include the counts of students passing the orange line due to only having data on the one approach to the south entrance of the LSB.



Figure 9: Approach for the LSB West location

LSB Elevator: “LSB EXT Breeze Way West West” was used for the LSB Elevator approach. This approach was focused on capturing students entering the LSB garage from the west who took the elevator instead of walking up the exterior staircase. The red line is marked on Figure 10 as the approximate delineation for where volunteers and team members counted students, unless the students parked their bike on the last row visible on the bottom of the image. At that point, when the student finished locking up their bike and went out of the bottom of camera view, the student was counted. The general principle with this angle was that if they were a pedestrian, they were counted as they crossed the red line and if they were riding a bicycle, scooter, longboard, or other micro-mobility mode, they were counted either after they had locked up their vehicle or as they crossed the red line if it appeared they were taking it on the elevator.

Initially, the team had also hoped to capture students entering from the east side of the garage as well using the “LSB EXT Breeze Way West East” camera, but after discussion with faculty members familiar with the LSB Garage, it was determined that many of the people entering the breezeway through the walkway visible on this additional camera were coming from parking their vehicles. Counting these individuals would have tainted

the counts, so the additional camera angle was not used. In the future, if a camera angle is available that covered the east car entrance to the LSB Garage, the team felt this would be a good location to capture students entering the garage who have the intention to take the elevator. This camera angle could be put side by side with the “LSB EXT Breeze Way West East” view on the Genetec Security Camera Client to compare which pedestrians coming to the breezeway entered on foot through the garage.



Figure 10: Approach for the LSB Elevator location

LSB East: “LSB Ext East North” was used for the LSB East Approach. This approach covered students going up the staircase on the east side of the LSB to BYU Campus. As the students passed the red line in Figure 11, they were counted. This camera captured exactly what was necessary and provided a very count friendly view.



Figure 11: Approach for the LSB East location

EB Southeast: “EB EXT Southeast Roof PTZ” and “EB EXT SouthEast Roof 4cam-Camera-01” were used to capture students entering BYU Campus near the Engineering Building (EB). The counts were broken into two camera views for ease of viewing students and for accuracy. While the “EB EXT SouthEast Roof 4cam-Camera-01” can see the entire counting area, “EB EXT Southeast Roof PTZ” was able to provide a more zoomed in view of the area of interest.

“EB EXT Southeast Roof PTZ” was used to count students entering near Campus Drive. Students on the sidewalks were counted as they left the camera view, or close to where the red lines are drawn in Figure 12. Students on bicycles or modes that can be put in the “Other” category were counted as they passed the red line on the roadway.

“EB EXT SouthEast Roof 4cam-Camera-01” was used to capture students walking north on the sidewalk of 700 N who chose to cut through Lot 31 as well as students entering

Lot 31 through the gate connecting to Campus Plaza Apartments. Students were counted as they passed the red lines marked in Figure 13.



Figure 12: Approach for the EB Southeast location via “EB EXT Southeast Roof PTZ”



Figure 13: Approach for the EB Southeast location via “EB EXT SouthEast Roof 4cam-Camera-01”