Milestone 2

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Project Overview

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ENGR Quad Milestone 2

Version 4

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Executive Summary

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Walking has been proven to have tremendous health benefits including, reducing dementia, the risk of heart disease and depression, and the risk of developing type two diabetes (JAMA Network). In order to promote this very favorable mode of transportation, our team has developed a project that facilitates pedestrian transportation between popular engineering buildings on UIUC's North Engineering Quad. Currently, there are 2-3 principal routes that students take to class in this area by cutting across a long and raised lawn. Not only is campus property damaged, but students experience distress and unease taking these routes, and so might give up their daily walk because of this impediment.

By recording videos of pedestrians in that area during peak hours of traffic in between classes, we mapped out the two most popular unpaved paths that students took across the quad and using IDOT's bike and pedestrian standards pedestrian density accommodations, proposed putting two 6-inch one-way paths along these two highly demanded routes. We considered safety risks students may face if they needed to commute without these pathways being available, however, discovered that is is not large enough to strongly require the installment of these paths. Nonetheless, the indirect costs students face, such as health risks discussed earlier, people reverting to motorized transportation, or even students avoiding the area, present a reasonable opportunity to augment the welfare of individuals that must access this area on a regular basis.

Introduction & Background

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UIUC's computer science and engineering program are not only front and center for a staggering 1200 students each year, the number of undergraduate Computer Science students increases by approximately 17% each year (CS @ Illinois, 2013). The North Quad is one of the most critical places on campus for the University's reputation and sustained growth. However, the unconventional design of the pathways provides a daily obstacle for students rushing to class on the unnecessarily long and winding paths. The frustration due to inefficiency and economic loss that the pathways cause is felt by many students who use the pathways, but as of yet has not been quantified. There is also a significant safety concern, as the angles of the pathways and the design of their connecting nodes have the potential to cause pedestrian-bike collisions can easily collide with bikes going in any direction. Such factors often compel students to ignore the paths and cut directly across the quad; we believe that such a disturbance is inappropriate for one of the top engineering schools in the world. This has motivated us to look for potential opportunities to improve north campus through conducting studies that specifically focus on gathering information about pedestrian activity in the area. We intend to use the results of the study to suggest improvements for the efficiency and safety of pedestrian and commuter movements while maximizing the green space. Such data may even prove useful to consider opportunities for harnessing energy through means of piezoelectric walkways and/or solar panel surfaces. Our project will initially focus on the North Campus Lawn (area directly north of the Engineering Quad, in particular, however, patterns observed in this model may possibly expand to other parts of campus.

Similar projects have been performed on the Main Quad since the early 1900's. The image below illustrates the pathways on the Main Quad in 1905. Several studies were conducted that resulted in the diagonal pathways that are present today. These paths efficiently move tens of thousands of students between campus buildings, without sacrificing the beauty, safety or integrity of space. With UIUC Engineering being the most popular and fastest growing major on campus, we hope to ensure the Engineering Quad has the same balance of utility and aesthetic value, as the demand for its access will undoubtedly increase over the years to come.

Project Objectives

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Throughout the semester, our team will conduct a numerical analysis of students that cut across the pre-existing pathways the North Campus Quad; and using this information, will quantify whether there exists an opportunity to more efficiently connecting buildings. To make sure our proposal for new pathways coincides with the demand for them, it is important to measure pedestrian density,, especially during peak hours. Using this data and IDot's pedestrian accommodations code, we intend on applying our study towards defining the problem that exists, the potential losses the university is experiencing, and ultimately specific improvements that can be implemented to the area.

By filming the quad during passing periods, we can reduce the error in our data collection process by ensuring all relevant information is captured. Professor Golparvar-fard's graduate student, Shai Tang, will process the footage using their prototype automated program to give us an understanding of traffic using different methods (including contrasting moving objects, intensity analysis of motion, and thermal analysis). This information along with our manual analysis of pedestrian density (counting and calculating pedestrians per hour) will reveal the true demands for pathways in the area, and will additionally bring forth considerations, such as pathway size, cost, type, and others we must consider. We expect to be able to propose a safer and, more efficient pathway design for the quad that will facilitate better commutes, but also ensure that it is cost effective. This can be done by comparing costs of installing new pavements, removing existing ones, maintaining grass, and also other implicit costs that might not be obvious, such as losses in efficiency and safety. Improving commute time is not our only goal, reducing possible pedestrian-bike collisions, preventing degradation of grass and dirt, reducing traffic jams and eliminating unnecessary costs (both explicit and implicit costs) are important aspects we intend on focusing on during and after we collect our data. Using our findings, we intend on determining wether there exists a significant safety concern that must be immediately tackled, and which of the previously mentioned considerations is impacted he most.

We hope to offer data-supported suggestions about the costs and benefits of installing regular pathways as well as permeable pavements along the paths we determine should be paved. And since the administration of the ECE building gave us concerns about mud and dirt in the building, we could mention how these different pathways might reduce such problems that we would not typically be aware of. UIUC is one of the country's leading engineering schools, and electrical and computer engineering are majors increasing exceptionally in popularity on campus (DMI Illinois). It is important to use this space on the north quad as systematically as possible, and maybe even demonstrate modern technologies will help inspire and motivate future students. Since engineering is one of the fastest growing majors on campus (17% annual increase) (DMI UIUC), the north campus will continue experiencing higher demand, and access to certain buildings is bound to be negatively affected if this problem is not addressed.

Project Scope

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All members of our team will use a 1080p digital camera to record the movements of students on the North Quad from room 469 of the Coordinated Science Laboratory building. Videos will be 15-20 minutes long and will be shot during passing periods (at the end of each hour), as to observe the behavior of hurrying students who cut across the paths and green space. We Will then drop off the footage as soon as we collect it to Professor Shuai so that his graduate students may analyze our footage using a prototype software that they have developed. Once all the footage has been processed, we will try to digitally represent the problem we believe exists in that area, as well as proposed solutions that take into consideration factors mentioned in out objective, such as pedestrian safety through facilitating multimodal commutes, and reducing pedestrian jams and time expended commuting, while maintaining the aesthetic component of the area by maximizing green space.

1. Our first task will be coordinating and finding the best locations for us to study the North Campus Quad by meeting with representatives from buildings encompassing our area of interest. (Oct. 30 - Nov 5)
2. Then, we will cheek out cameras from the UGL that meet the requirements given to us by D. Shuai's graduate team (Nov 1 - present)
3. After that, we will record 5-6 passing periods from room 469 of the Coordinated Science Laboratory building as to assess the information and quality of footage that can be gained from that location (Nov 2 - 3)
4. We will deliver initial footage to Shuai's graduate students as to ensure that the film can be analyzed and processed and whether changes must be made to our filming methods or location. (Nov 4 - 9)
5. Appropriate adjustments will be made to the video recording methods as recommended to us, and we will continue filming more passing periods while submitting film every week (on Thursday or Friday) as to gather a large enough data set that is representative of the movements occurring in the North Campus Quad. (Nov 11- 18)
6. Using the processed information collected, we will quantitatively map out the benefits of installing new walkways as well as suggest possible ones using the most common paths that students took on the grass. We intend on representing our end result through several visual as well as numerical representations that clearly convey the ongoing transportation hazard and the potential opportunities for the quad. (Nov 13 - 19)
7. We will then finalize the project by condensing all of our findings into a poster and powerpoint presentation while at the same time encapsulating the outcomes and solutions we have proposed from the information we gathered (Nov 15 - 20)

Alternative Solutions Under Consideration (Similar Projects)

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Of course, there exist several distinct solutions to the problem we are studying on the North Quad, and it is crucial for us to compare different options in order ensure that the one we are considering is the most advantageous.

A possible method that would accommodate all the distinct routes students and other people are taking to get to and from these buildings would be to completely pave the oval lawn on the north quad. Ostensibly, this tactic would result in the most efficient commuting of people from one point of the quad to the other, as people can always take a straight path to their destination. Travel time would be reduced for both pedestrians and bikers, and the larger space available would significantly reduce the possibility of modal conflicts and collisions. Moreover, there would be more space available if students in the future decide to engage in activities or set up booths for certain events. This model, however, h as many shortcomings associated with it, the biggest of which is that it would strip the area of its aesthetic appearance and green space. We are all familiar of the positive health benefits that green space provides for us, such as stress reduction and better brain performance, and, therefore, paving that area would present numerous, maybe subtle, harms in the long run for people who regularly spend time there. Additionally, the iconic features of the north quad (described in the introduction) would diminish as the ground would be dull pleasing for the eye to see. Of course, this would also reduce the amount of storm water absorbed by the ground and may even reach the point where flooding may be caused in certain areas mainly due to the sheer size of the area paved.

Out of all six passing periods we filmed and analyzed, we only saw 2 bike-pedestrian near-misses and one person tripping on a utility box on the lawn. We, therefore, concluded that there is no significant safety risk in the area and so another solution possible could be leaving the quad as it is now. Despite our concerns, the quad has operated this way for years and nothing catastrophic has taken place so far; people can enjoy the additional green space available, decide when they must cut the path at times when the need to, and when to follow the path at other times. This gives students the most liberty though does nothing to facilitate the problem at hand. A limitation of leaving the area this way is that a substantial area of grass is damaged by people walking on it, and although that may seem insignificant, it costs $50 to prepare one cubic foot of lawn on any part of campus (Facilities and Services/ Morgan). In addition, since the lawn itself is curved, the inconvenience becomes more of a trouble and distress for students trying to reach class, and so may discourage people from choosing the healthy option of walking everyday.

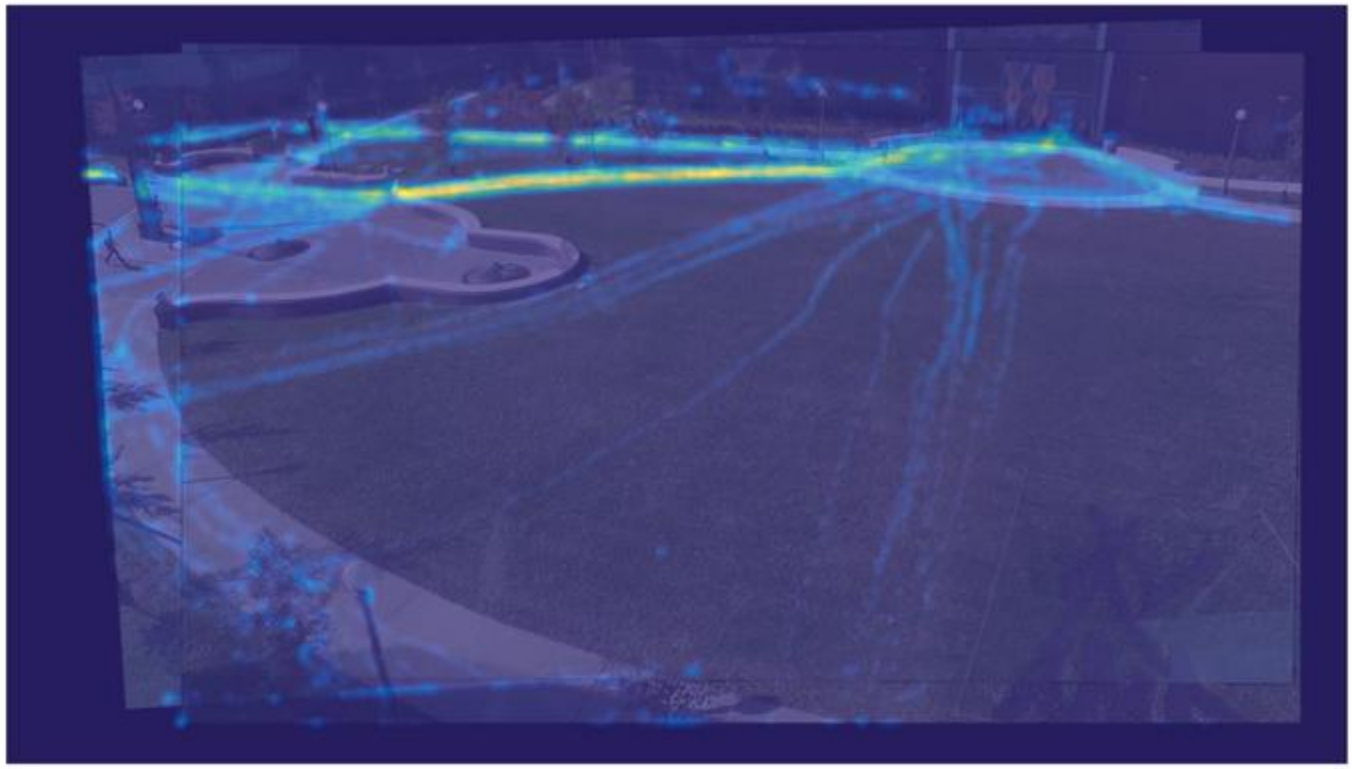
The most practical solution, other than the one we are proposing, is one that was implemented on the lawn directly in front of the Illini Union's north entrance. To prevent people from cutting across the grass, Facilities and Services can install tall bushes along the circumference of the oval quad as to force people to only utilize the paths provided. This solution is plausible as is it is one that is affordable, very effective as demonstrated at the Union, and ultimately is done not reduce the green space of the area at all. The health benefits associated with planting more foliage in the area would improve mental health and reduce stress. By forcing people to walk longer paths, they may get more exercise did throughout the day and spend more time outside in a green space and thus indirectly benefit from this inconvenience of walking more. A limitation however to this proposal is that bushes would limit the access to the green are itself if students decide to spend time/ sit down on the grass for whichever reason they may want. In our videos, we have captured several people using the space as a study area, and even for picnicking. Additionally, during harsh weathers especially in winter time, this increased the passing time that the students will be forced to cope with, might bring forth more harm than benefit through longer exposure to the cold or possible safety concerns with them walking on slippery snow or rain covered pathways.

Preliminary Results and Discussion 2

We recorded a total of five videos during peak traffic times around the Oval Allee: weekday passing periods around noon. These videos were approximately 10 minutes long each, recording the final 10 minutes of the hour. These videos were shot from 469 of the Coordinated Science Laboratory. Shuai Tang (a Civil Engineering Ph.D. student) used matlab to perform background subtraction and a Kalman filter in order to create heat maps from the static video. Shuai's processed footage of select clips resulted in the images you see below. As you can see, in addition to using the paved walkways, there are two unmarked pathways that appeared repeatedly over multiple trials. These are the true routes students use when commuting around the Oval Allee.

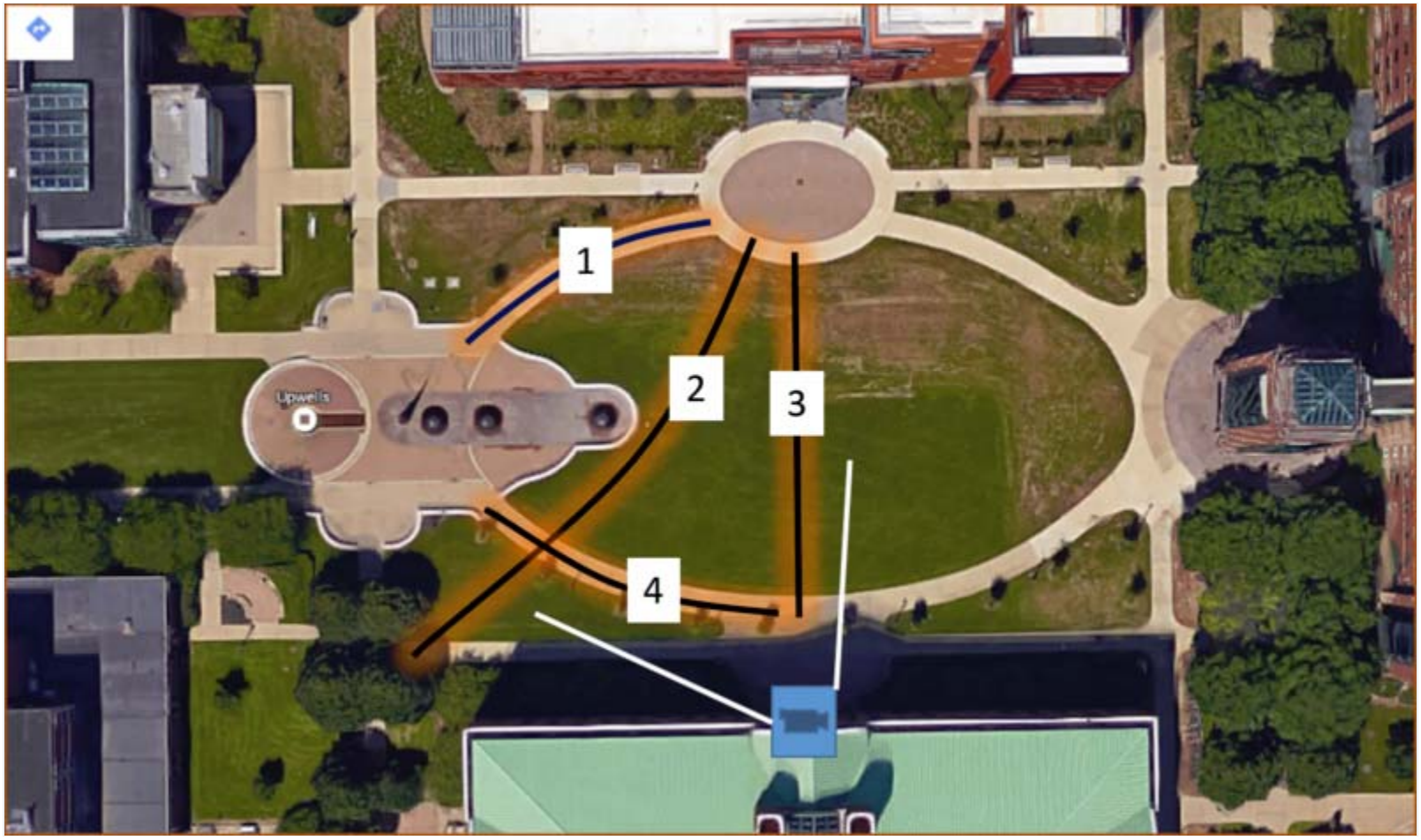
Tuesday November 3rd 12:50-1:00pm

Monday, November 2nd 10:50-11:00am



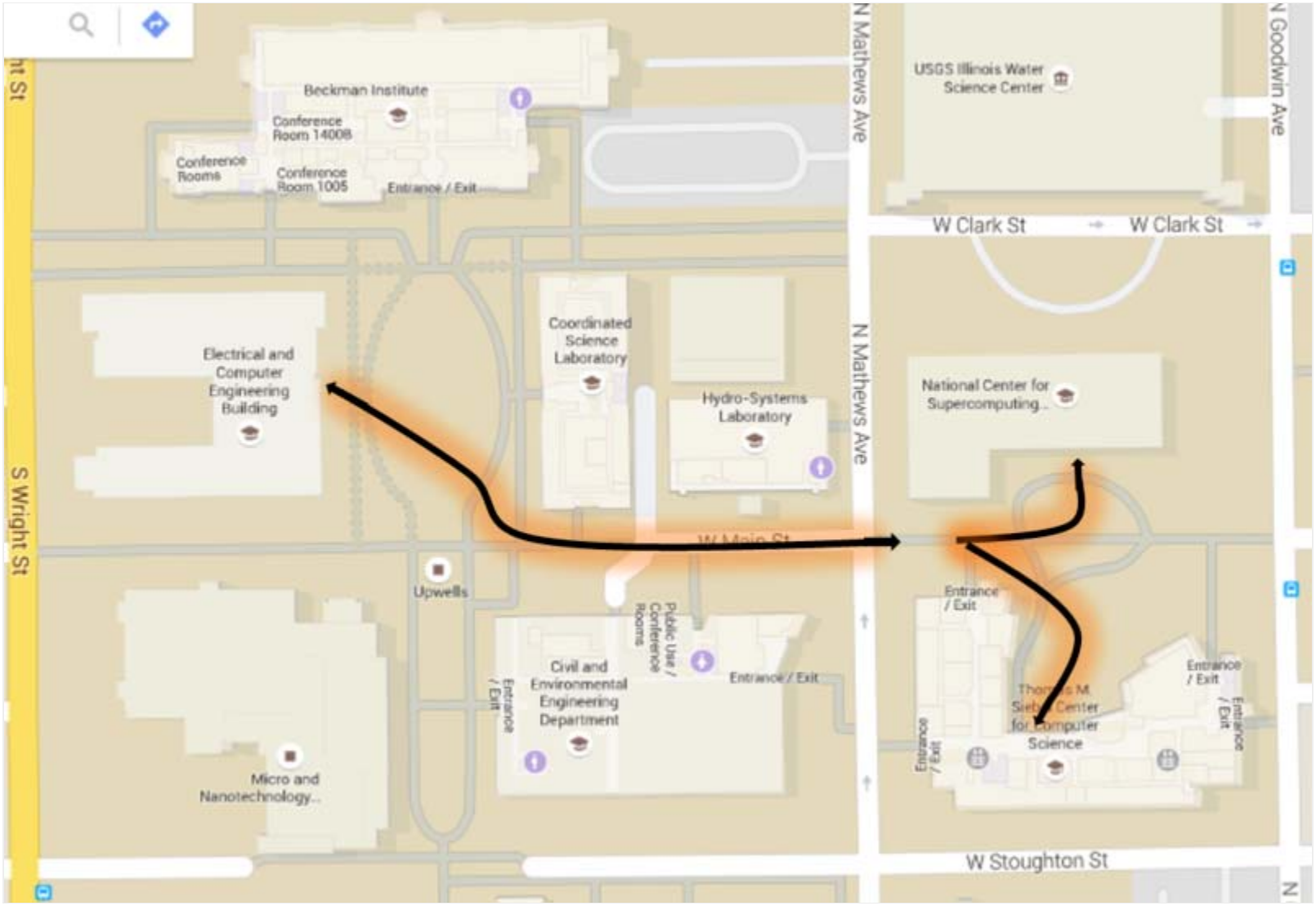
Heat Map from Selected Clip

These visuals directly identify the alternative routes that students are using when commuting across the quad. To further quantify results, we counted total volume of pedestrians crossing most critical four critical paths to our study.



Four key paths identified on satellite map, as well as location and orientation of the camera. (North is to the right)

Pedestrians cut across the pathway between the ECE Building and the Coordinated Science Laboratory. They also cut across diagonally, and it would be logical to presume that many students are traveling between the ECE building and Siebel Center or the National Center for Supercomputing.



Hypothesis for pedestrian travel nodes. (North is up)

To further quantify our results we counted pedestrians crossing the 4 pathways identified above.

Day/Time	Duration	Path 1	Path 2	Path 3	Path 4

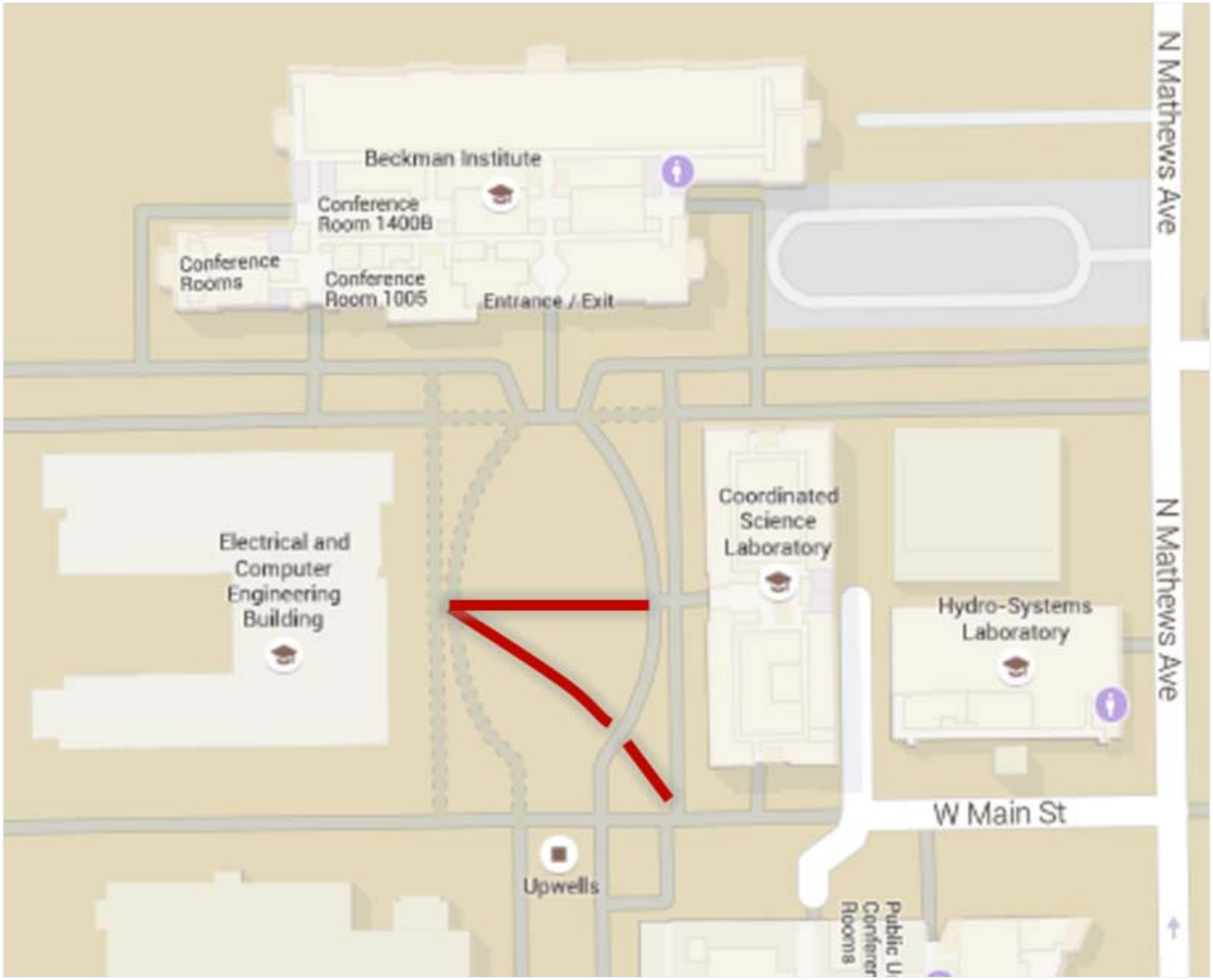
		(peds)	(peds)	(peds)	(peds)
10/29/15 10:50-11:00am	868 s = 14.47 min	126	6	26	23
11/2/15 11:50-12:00pm	929 s = 15.48 min	152	10	3	30
11/2/15 12:50-1:00pm	812 s = 13.53 min	104	3	6	31
11/2/15 1:50-2:00pm	658 s = 10.96 min	86	7	6	26
11/5/15 12:50-1:00 pm	600 s = 10.00 min	130	20	12	30
Average	773 s = 12.89 min	119.6	8.2	10.6	28
Extrapolated to entire hour (Avg. X .7757 X 2)=Ped/hr	3600 s = 60 min	185.6	12.7	16.4	43.4

Additional models of traffic volume give us further insight into how to design these paths. Knowing the total number of pedestrians per hour allows us to assess the allotted width that each path should have. Using this chart from the Illinois Department of Transportation, we can say that since no path has more than 300 users per peak hour, and all pathways are two-way, they should be 10 feet wide.

Anticipated Volume	One-Way	Two-Way
< 300 Users per Peak Hour	6 ft (1.8m)	10 ft (3.0 m)
> 300 Users per Peak Hour	7 ft (2.1 m)	12 ft (3.6m)

(IDot Ch.7 2013).

Our suggested additions to the Oval Allee quad follow the pathways that were naturally taken by students and visualized graphically above.


Beckman Institute
Conference Room 1400B
Conference Rooms
Conference Room 1005
Entrance / Exit
N Mathews Ave
Electrical and Computer Engineering Building
Coordinated Science Laboratory
Hydro-Systems Laboratory
N Mathews Ave
W Main St
Upwells

We estimate the total length of pathway would be approximately 330 feet: 140 feet for each of the longer segments, and 50 feet for the shorter segment. With each pathway a width of 10 feet, this is 3,300 square feet of pathway to install. According to the Federal Highway Administration, paving a concrete sidewalk costs on average $32 per square foot (Max A. Bushell, Bryan W. Poole, Charles V. Zegeer, Daniel A. Rodriguez, UNC Highway Safety Research Center). That is a $105,600 project.

Compare that $32 square footage cost to the cost of repairing grass fields due to trampling or weather: $50 per square foot (Facilities and Services 2014). The cost of repairing the same square footage of grass is $165,000, which would likely be an annual cost to the school. Continuing to repair the pathways year after year is significantly more costly than installing sturdy pathways once. In one year the savings would amount to roughly $60,000. In addition, the cost of students tracking mud into the surrounding buildings should not be overlooked. During harsh weather, janitorial staff spend a great deal of time cleaning up tracked mud. Which is at additional cost to the university.

Students will continue to take these pathways regardless of whether the paths are there, and if installed, many more students will use these efficient corridors than currenlty do, which will increase the efficiency of students' commute, and their feelings about being on this campus.

As a result, it is safe to say that installing the suggested pathways will immediately reduce costs associated with grass maintenance, building maintenance, relive traffic and congestion in the area, and create an overall more prosperous environment for the UIUC students who use this space everyday.

Schedule Update

Below is a program generated schedule that was made for our project. The first page of the pdf is a table of start and end dates of certain tasks. The following page is a Gantt chart showing a calendar view.

CEE_20Schedule.pdf

Reference Page

Reference Page

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