Illuminating the McKeldin Mall: Part III

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Table of Contents

I. Project Description

The Mall is a hub for activity during the day, but is not often used at night. Insufficient lighting plays a role in the Mall's use in the evening hours; patrons do not feel safe in a dark open space, and find the area impractical to use. From our field research, our team found that three types of users frequent the mall; commuters, event-specific users, and general/multipurpose users. In response to our findings, we propose a comprehensive solution designed to improve the space's usability after dark for these groups. This solution aspires to addresses the needs of all three user groups and meet system requirements.

Design Summary:

- *Audience*: Multiple user groups
- *Space*: large open lawn
- *Design Dimensions:* Light fixtures of variable size
- *Position*: located around the perimeter of the space
- *Interaction Technology*: controlled using a mobile application

II. Requirements

System requirements are based on *group needs, efficiency, university aesthetics, and feasibility*. Through a series of surveys, interviews and observations our team found that the space is used by three major groups of users: **commuters**, who cross the mall to get to their destination, **event users**, who primarily interact with the space during organized gatherings and concerts, and **frequent and/or general users**, who use the mall as a space to play sports, eat lunch, or study. Group needs should be prioritized for users to *maximize their use of the space*.

Group needs are primarily dictated by three concerns: *safety, flexibility, and visibility.* Safety is a primary concern that affects commuters, event users, and multipurpose users. The mall needs to be lit so that users can see the space and people around them. Light placement, color and intensity will impact how easily users will be able to see, and whether they feel safe. Flexibility of use is also a primary concern. Users may need to change lighting to reflect a particular event or mood, or light different areas of the mall at different times. Additionally, users may use lights to augment inter-group visibility and share information. It is important for users to *enough* direct control over the lights to easily interact with them, but not enough to abuse the system.

Efficiency is a primary concern of the university. In 2007, the university launched a "Going for the Green" initiative, determined to become of the nation's most environmentally friendly higher education institutions (Robinson, 2007). Not only does efficient lighting create **positive environmental impact**, it may reduce overall costs, an important consideration (Energy Efficient Lighting, 2012). Lighting should be as efficient as possible while serving the needs of the users. Efficiency will be affected by the number and type of lighting fixtures, as well as the energy source. Low power consumption LEDs, for instance, may prove to be both efficient and powerful.

University aesthetics also play a significant role in our design. Since the mall is the epicenter of campus life, it must reflect the **overall brand of the university**. The lighting needs to conform to the look and feel of the buildings and structures around it. Additionally**,** preserving the **natural "campus"**

landscape of the mall is extremely important to users and to the facilities management staff. The lighting designs must not detract from or get in the way of the classic façade.

Lastly, design feasibility and practically must be considered in lighting design. The design must be easily to implement and maintain. In particular, lighting must be **durable** enough to withstand student interaction and inclement weather. The lighting design must also be **a cost-effective** solution.

III. Prototype design

General Overview

Challenges of prototyping

The goal of prototyping is to create a model that allows users and developers to understand both what the system would look like and how it would interact with users. This would be relatively simple to do with a website or one type of technology; however, lighting the McKeldin Mall required a more complex solution. As the design is complicated, modeling it proved to be especially challenging.

Initial ideas and our final approach

Initially, we considered several options that might best depict our design; at first, we envisioned creating a physical diorama of the Mall with working miniatures of the lighting fixtures, but soon scrapped this idea because it required more time and resources than we had. We then decided to create a virtual representation of the space using Second Life Virtual Worlds. While more feasible than a diorama, this also required skills and experience that we didn't have time to learn.

Rather than creating one prototype that could model all of the interactions together, we built a set of mockups and prototypes that addressed our design considerations, described below, in an evolutionary prototype (Soegaard 2010) showing a hierarchy of views– from a less detailed aerial view of the mall to more detailed 3D Google Earth and 2D static models of the light fixtures, as well a prototype of the proposed iPhone application.

Design Considerations	Issues Addressed	Prototype Solutions
Interaction between users and technology	Control	Mobile prototype, scenario
Visual representation of lighting fixtures	Size	2D mockups
Functional representation of lighting fixture	Coverage	2D mockups, charts
Composite picture of the Mall	Overall Image	Aerial view, 3D mockup

Since we are proposing seven unique lighting fixtures, we divided the lights into complex and standard lights; Complex lights, like the fiber optic light curtain, are unique and require detailed explanation, while standard lights (e.g. string lights) refer to fixtures that are common and easily visualized. We vertically prototyped the complex light fixtures to allow users to visual what they might look like; we created 3D and 2D models, and explained their function in our scenarios. Since standard lights did not require in depth explanations, we decided to prototype them horizontally; these tasks are included in the Aerial view and briefly explained.

Complex Lights	Standard Lights
Fiber optic light curtain	Stadium lights
Embedded Lights	String Lights
Digital sundial	Light Columns
Sidewalk sensor lights	

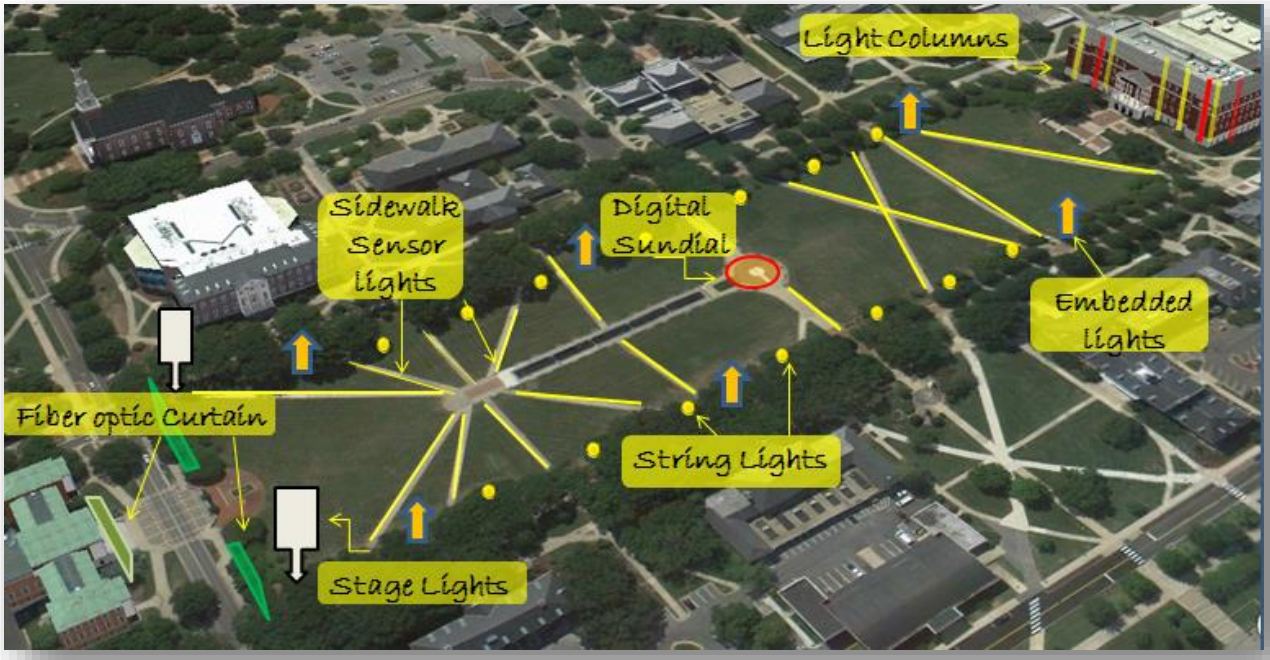
Our set of integrated prototypes allows users to more fully understand how our design solves the needs of our target population. Together, the prototypes clarify how and when our target groups would use the lights as well as delineate where the lights would be located and how they would work.

Order	Asset	Coverage	Technique	Elements shown	Limitations
1	Aerial view	High-level	Static image	✓ Area ✓ Lights location ✓ Lights name and concept	Does not provide much detail
2	3D earth model	Mid to High level	3D model with Google Sketch Up	✓ Terrain altitude ✓ Spacial location ✓ High-level positioning of lights ✓ Scaled view	The terrain has very low resolution, which is not affecting the big lights, but is not adequate for smaller lights.
3	2D static models	Details	Drawing/ PowerPoint	✓ Lights design ✓ Basic movements ✓ Interaction features	Does not specify the entire imitation and it is not as realistic as a 3D model.
4	iPhone App prototype	Very detailed. Specific to user interaction	Prototyping tool for mobile phones	✓ Interaction of lights ✓ Mall preview	It is specific for interaction, and does not provide a high-level view of other aspects of the design (e.g. location).

The prototype hierarchy allows users to understand the overarching vision of the design and obtain an in depth understanding of the system mechanics.

1. Aerial view: Complex and Standard Lights

This is a high level view of the entire mall, showing approximately where the different light fixtures would be located.

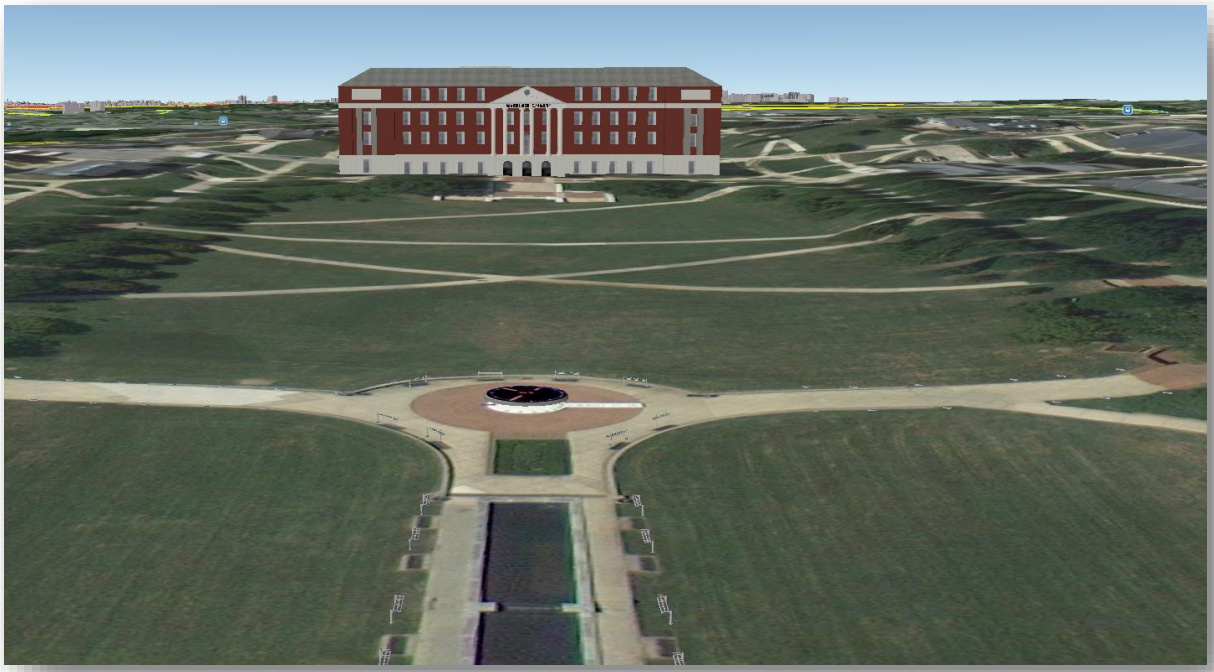


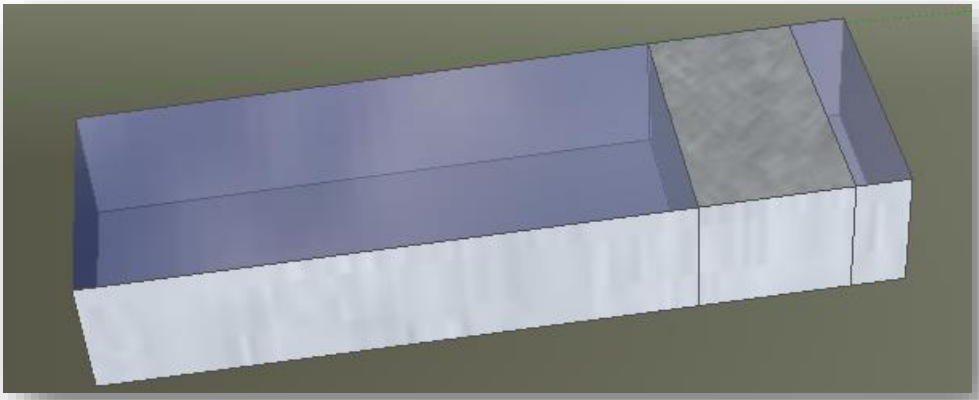
2. 3D model in action: Complex Lights

The 3D model of the complex lights demonstrates a realistic scale of the light fixtures, as well as their approximate location and surrounding terrain. The quality offered by the Google Maps satellite allows us to provide rough models of the complex lights, but is detailed enough to fully depict the smaller lights.

The 3D model can be downloaded from this location: terpconnect.umd.edu/~mnaftali/themall2.zip

Sample Screenshots:





3. Prototype elements in detail

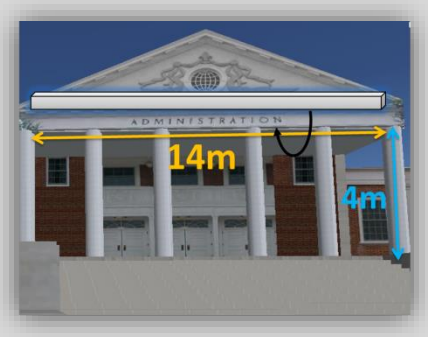
a. Fiber optics curtains

Details:

Users	**Administrators:** Facilities management and authorized staff **Requester users:** Faculty, staff
Purpose	University aesthetics – Reinforce brand identity: Bring performances, theater events and graduation ceremonies to the Mall; Advertising space.

Location

Mounted in the inner façade ceiling of the administration building, behind the columns.



Specs

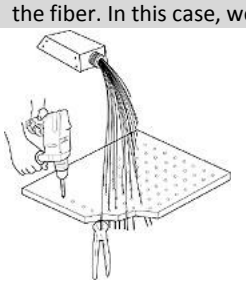
Curtain dimensions: 14m x 4m
Fiber diameter: 0.75mm-1.00mm
Type: Edge-emitting fiber
Number of bundles: 14-20
Curtain density: 40 fibers/meter
Total strides: 560-800
Colors: 8-16
Lighting system: LED

Technology overview

Fiber optic lighting uses optical fiber as a "light pipe", transmitting light from a source through the fiber to a remote location. The light may be emitted from the end of the fiber creating a small spotlight effect or emitted from the outside of the fiber along its length, looking like a neon or fluorescent tube.

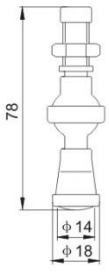
The light source consists of a bright light and often some optics to efficiently focus light into the fiber. In this case, we selected LED lighting for the high intensity and efficiency.

Installation Details



Fiber optic lighting curtains are sold by bundles, which are boxes with a specific quantity of polymer fiber strides. Each fiber is aligned in a custom matrix of holes, as it is shown in the figure. The shape or the pattern can be customized to add volume or different layers of light, but not dynamically.

Having multiple lines and redundant strides enables to show or hide several layers, and create patterns and effects.

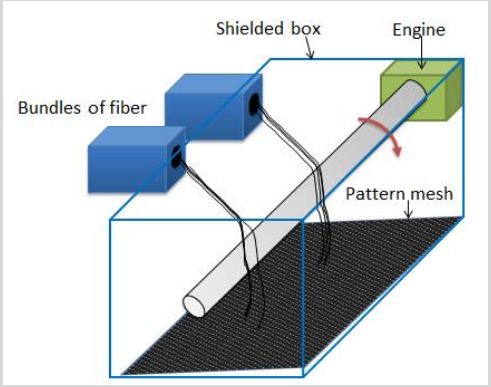


The fiber wires can have about 3-4 meters, while they can also be custom made. Each fiber has a small terminator known as 'fixture' in the end, which can have different sizes and intensity.

In the image we see a small fixture with a light focus on the bottom edge

Preservation and packing

Fiber optic light systems are durable, but have to be protected from extreme conditions. For that reason, **the terminators or fixtures will have a small diameter with a stop** so the curtain could be **rolled up automatically once the event is completed**.



Rolling up mechanism
The engine starts rolling the fibers into the metallic shield.
When the terminators reach the pattern mesh – slightly inclined and over the end of the box- a signal is sent to the engine to stop working and close the window at the bottom.

After that, all the fiber optic wires are protected

All the fixture edges will make contact with the mesh when the fiber is completely inside the box.

This rolling process is feasible because the strides are made from a **flexible** material.

Image of a fiber bundle with circular terminators.

Interaction highlights

- **Interaction Type:** Scheduled, On demand – Mobile App
- **Interaction details**
  Users can book the curtain, and facility management receives an alert with the starting time and the ending time of the event. Once a staff member approves, users will receive a booking confirmation.

- **Light parameters**
  - ✓ Frequency of color change (0-20s)
  - ✓ Starting time
  - ✓ Ending time
  - ✓ Drawing
    If custom, up to 3 lines
    - Line 1: Color; text or patters; intensity
    - Line 2: Color; text; intensity
    - Line 3: Color; text; intensity

    Or, a light pattern (users will choose one of the pre-programmed patterns)
    - Stars
    - Solid curtain
    - Solid curtain changing colors
    - Blinking stars

- **Permissions**
  Users: request the curtain for a specific event that is allowed to take place at the mall.
  Facility management staff: receive the request details and contact the requester (all of them are members of UMD network).

Examples:

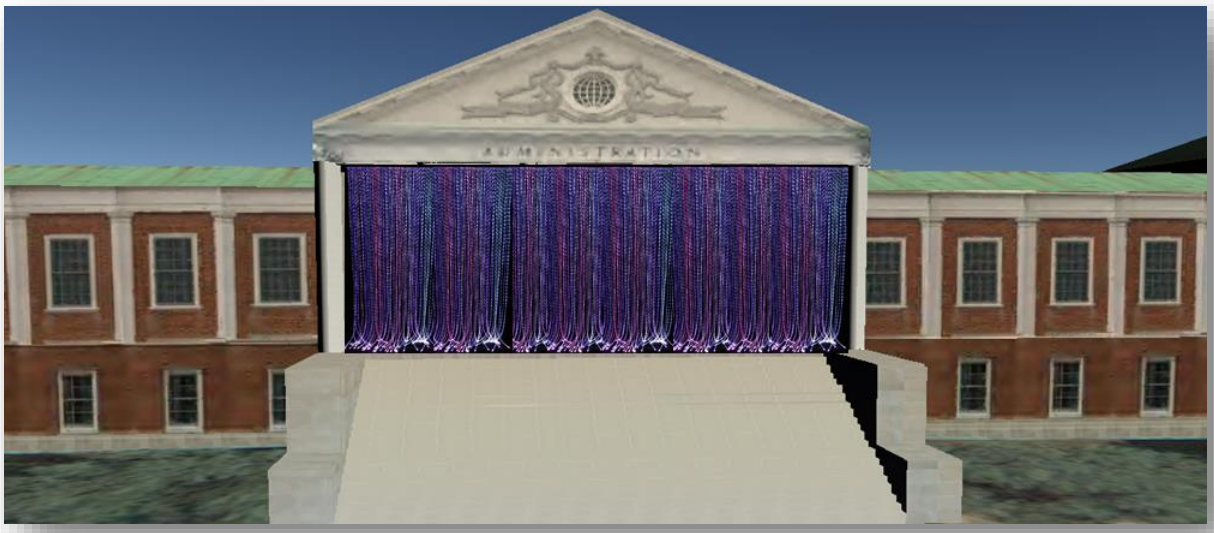


Figure 1: Using a 1-layer curtain with 4 colors

Figure 2: Using a 3-layer array of strides with UMD logo. First level belongs to red logo, second level to blue shade, and third level to star pattern.

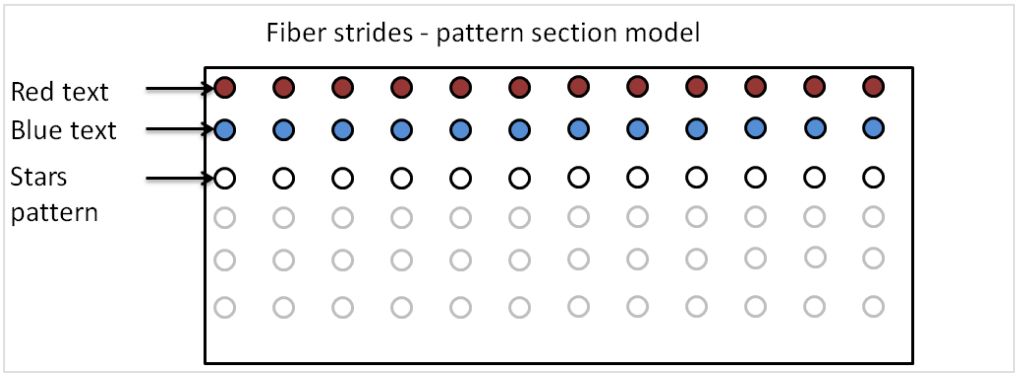
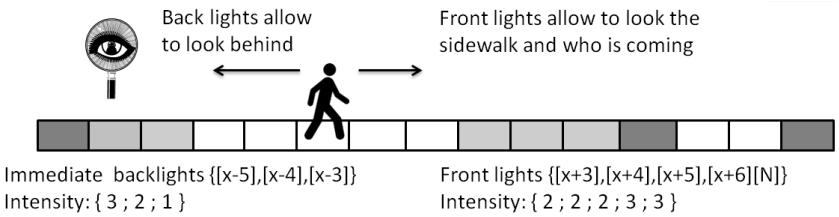


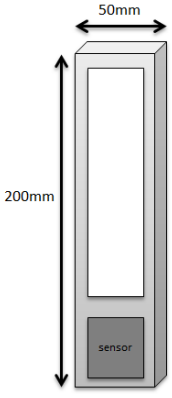
Figure 3: Pattern alignment of the strides to show UMD in red with blue shadow and stars background

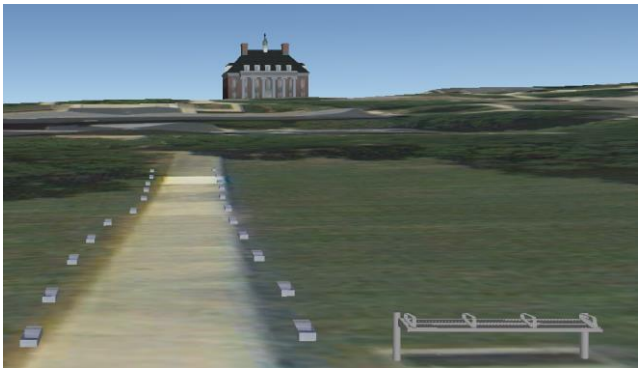
b. Sidewalk sensor lights

Details:

Users	Commuters
Purpose	Safety, general purpose
Location	Embedded in the sides of the sidewalk (not in the grass)
Technology	Motion sensor lights for exteriors Using LED technology Plastic shielded bar containing a light and a motion sensor
Specs	**Dimensions:** 50 x 200mm **Power:** 1W **Material:** Plastic box for exteriors containing the sensor and the LED **Separation:** 180mm
Details	When users walk along the sidewalk, their motion is detected and the lights turn on in pattern that **allows users to look around**. The lights are divided into custom segments blocks that increase energy efficiency. The maximum distance between the user and the light blocks it is determined by the motion sensor technology. 
Maintenance/ preservation	The lights are waterproof and specific for exteriors and highways. About the electricity concern, all of them will be plugged to a shielded wire path to make sure that rain will not affect.
Interaction	• **Interaction type:** immediate, on *close* motion detected • When users walk in a sideway, the lights turn on and off depending on the user position. The motion sensor triggered lights turn on and off when users are within a certain proximity.

Details:





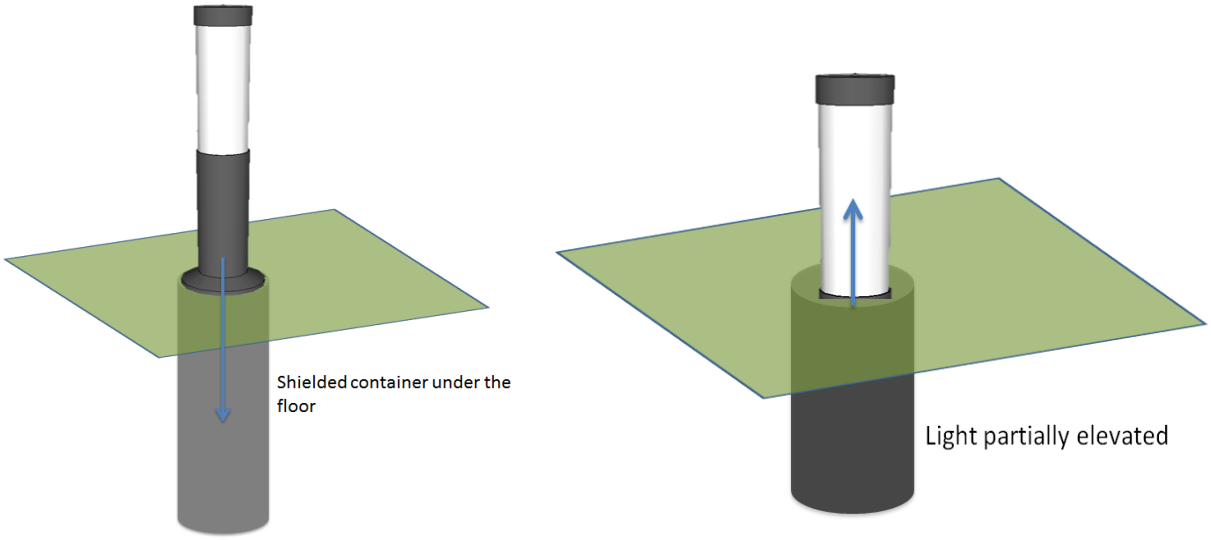
c. Embedded lights

Details:

Users	Event users; Frequent users
Purpose	To light specific sections of the Mall after sunset
Location	Around the Mall perimeter
Technology	These lights are LED-based tubes for exteriors embedded in the ground, with configurable height, intensity, color and duration. The envelope is shielded to prevent water damage. The lights will have a timer, and also a blocking system to turn the lights on when a bad use is detected (E.g. users changing the height randomly and fast)
Specs	**Lighting type:** White LED, 3W **Material:** Metal and plastic
Preservation	The lights "sleep" under the ground unless a user requests the lights to be on. For that reason, the columns are not visible and are also preserved from the environmental conditions.
Details	

Interaction	• **Type:** immediate or by demand via Direct control – Mobile app.
	• **Interaction details:** Users can immediately request a light, or plan ahead and select a light configuration for a certain moment.
	• **Light parameters:**
	  ○ Color
	  ○ Intensity
	  ○ Start time
	  ○ End time
	  ○ Height
	• **Permissions:**
	  ○ **Students and faculty, general staff:** request a light, plan a light configuration
	  ○ **Facility management staff (admin):** reset a light block (not available through mobile apps) and request/plan a light configuration.
	• **Duration:** Default time is set to 30min. Otherwise, either until sunrise or the time specified.

Examples



d. Digital sundial

Details:

Users	Event users;
Location	On top of the sundial
Purpose	University aesthetics – Reinforce brand and group identity
Technology	LED lights with different colors on each number position A digital thermometer at the center of the clock
Specs	
Preservation/ maintenance	N/A
Interaction	• **Light parameters** ✓ Show/hide temperature ✓ Start time ✓ End time ✓ Odd number colors ✓ Even number colors ✓ Color of the hours/minutes/seconds • **Permissions:** ○ **UMD Staff/ faculty users:** schedule an event and program the sundial to follow a specific color configuration according to the event ○ **Facility management:** reset the sundial and turn it on/off (not available in the Mobile App) • **Duration** Either an end time is specified, or the clock is turned off by maintenance employers when the event ends.

Examples:

Figure 1: Standard sundial in red and blue

Figure 3: The “Go Terps” classic version in white, yellow and red

4. iPhone Application prototype

This iPhone app prototype shows the entire interaction flow between users and lights. After users interact with the lights, they can get a preview.

The iPhone app can be accessed from this location:

Screenshots

5. User scenarios

Scenario A: Staff Use

The university has decided to host an Alumni donor dinner on the mall. The dinner will take place from 7 to 10 PM. The event organizers have decided to use the light curtains and string light for this event. A few weeks before the event, the facilities management staff reserve the light curtains using the iPhone application. They choose a wave pattern to project onto the curtains, with the words "UMD" written in yellow, red, and white colors, and set the lights to start projecting at 8 pm. They program this setting into the iPhone application, which sends the information to a database.

On the evening of the event, a staff member turns the string lights on and turns the sidewalk sensor lights off, since directly from their system since neither of these lights is controlled in the iPhone application. When guests begin to arrive, they enjoy the causal beauty of the string lights adorning the trees. As the awards ceremony begins at 8 pm, the fiber optic curtains turns on and the donors marvel at the innovation and creativity of the university.

Scenario B: Student Use

Sarah, Mike, and Jack are meeting under a tree at 10 PM on the mall to discuss their final project. Sarah arrives first, and immediately notices that is too dark to see around her. She sees that there is an embedded light within 10 feet of their meeting place, and decides to use it. She takes out her iPhone and signs into the mobile application. She clicks on the light and selects a high intensity yellow light. Once she clicks submit, the embedded light is activated. It slowly appears from out the ground to light her way. When Mike and Jack arrive they see Sarah, and the three team members successfully complete the project together.

IV. Initial Evaluation

Evaluation techniques

i. Evaluation objectives

- **Primary:**
  - Detect elements in the UI that could **prevent** users from executing their task.
  - Detect elements that could cause a **misuse** of the technology (e.g., prevent users from 'playing' with the lights, or damaging the order of the place).
- **Secondary:**
  - Find ways to improve how information is displayed on the iPhone application to enhance usability and efficiency.

ii. Evaluation Method

As the idea for a first iteration is to get the "big issues" of our design, the evaluation we performed adapted three different techniques to our objective. Each technique was applied to a different part of the prototype:

a. User survey

b. Usability Evaluation with iPhone application

c. Heuristic Evaluation of the iPhone application

a. User survey

Objectives: To gather ideas about the prototype and opinions.

Technique: 5-10 minutes survey. After taking basic demographic data (see appendix I), we showed each participant the high-level prototype and some screenshots about the interaction.

Interview Questionnaire	
Baseline Questions	Age/education/nationality Affiliation with the University of Maryland/length of time *Use of the Mall:* Do you use the mall? When? At what times? How often? *Technology:* How familiar are you with mobile or computer technology? *Main concerns about the Mall:* ask interviewees to select from security, privacy, population, location, lack of activities, terrain, others)
General Reactions	Which lights did you like? Which lights didn't you like? Why?
Function	Do you think it would be easy or difficult to use this lighting system? Why? What would be the most difficult thing to use?
Perception/Image	What do you currently think of the Mall? How would your opinion change if this system were to be introduced? How might the image of the mall change? Would you identify with it more or less? Do you have any concern about how users might use the interface? Do you think that the beautiful landscape of the mall, and its private environment, would be damaged?
Project Personal Use	If this system is applied would you feel safer at night? Would you use the mall more time? Would you plan your organization/class/department activities or events at the mall?

Suggestions	Do you have any suggestions for this design? Anything that you would like us to add or remove from the design?

User Feedback

This user feedback primarily focused on the actual design of the Mall. Evaluations were made using the prototypes created and shown previously.

User Feedback	Description
Safety	The majority of our participants indicated that they **would feel safer** on the Mall at night with this design. The few who indicated they would not feel safe reported that they *hardly ever use the Mall and would most likely not go there anyways*. Therefore, they would neither feel more or less safe.
Use of the Mall	Almost all participants indicated that this design **would promote use of the Mall at night**. Many said they would come out at least once to see what the lights look like. They indicated that **simply having the ability to control the lights** would probably promote them to visit the Mall.
Personality of the Mall	The majority of participants reported that this design **fits well with the personality of both the campus at the Mall** itself. It allowed students the ability to contribute and control.
Design Additions	*Stair Lights* Some participants suggested re-including the stair lights in the design. The felt this was beneficial in the safety of the users, as well as added to the overall feel of the Mall. *Lights in Fountain* Many participants felt it would be "romantic" to add lights in the fountain as well as around it. These lights should be subtle, yet bright enough to show that they exist. This would bring the overall design together and create unity.
Design Eliminations	*Light Curtains* Many participants felt that the light curtains would take away from the park-like feel of the Mall. One participant reported that it looked "tacky" and that it didn't make sense to include them. Many also thought that it would be problematic to allow users to write text on the curtains as it may promote students to write inappropriate words or phrases.
Designs to Keep	*Motion Sensing Sidewalk Lights* Participants enjoyed the idea of having the motion sensing sidewalk lights light up a few feet ahead and behind the user as they are walking on the Mall. This ensures that the user can easily see where they are walking and who may be near them. *Sundial LED Clock* Several users indicated that the LED clock was a very nice, subtle addition to the Mall. It added to the personality of the campus and added a use of the sundial at night.

b. Usability Evaluation

This study was primarily for our iPhone application. We evaluated the app with the participants to understand what we should change in the next iteration of the project. The following table lists our results:

Feedback	Description	Type of Change
Ability to control text on curtains	Participants indicated that in addition to controlling the light on the curtains, they would also like to control the text that is written on them. This is slightly tricky as the students may write inappropriate things. A solution would be to approve what they write before it is posted.	Addition

Odd/Even numbers unclear on clock color settings	Students are able to control the minute and hour colors on the clock. These were previously described as odd and even numbers. This wording confused all of our participants. All suggested we change this wording.	Update
Tabs for LED Clock confusing	The tabs indicating whether the user should change all numbers on the clock confused participants. Again, this was a problem with the wording used in the app.	Update
Show if one is allowed to edit lights	Participants suggested that the app should show users whether or not the user is permitted to edit a certain light. Several suggested that we give users the option to choose the time slot they have reserved to be able to edit it ahead of time.	Addition
Include templates	Many participants indicated that template styles for the lights may be of benefit for users who are unfamiliar with the system or do not have time to create one of their own.	Addition
Color layout	All participants reported that they enjoyed the color layout and that it does not look “messy”. They all suggested we keep the layout in its current state.	No change
Sign up for 1 hour at a time	Several participants suggested that we only let students sign up for 1 hour at a time for each light. This will prevent students from reserving an entire day when others may need it as well.	Addition

c. Heuristic Evaluation

In addition to usability testing, we conducted an informal heuristic evaluation of the mobile application, which can provide a valuable perspective on software usability (Nielsen, 1994b). In a heuristic evaluation, a system a system is evaluated against a set of general usability principles, called “heuristics” (Nielsen & Molich, 1990). We used the findings and framework from this expert review, to organize the usability evaluation comments.

Nielsen’s Heuristics

We used the following heuristics from Nielsen (1994b) to organize the evaluation.

Visibility of System Status

"The system should always keep users informed about what is going on, through appropriate feedback within reasonable time."

Match Between System and the Real World

"The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order."

User Control and Freedom

"Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo."

Consistency and Standards

"Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions."

Error Prevention

"Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action."

Recognition Rather than Recall

"Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate."

Flexibility and Efficiency of Use

"Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions."

Aesthetic and Minimalist Design

"Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility."

Help Users Recognize, Diagnose, and Recover from Errors

"Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution."

Help and Documentation

"Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large."

The team conducted a heuristic evaluation by comparing the prototype of the iPhone application to Nielson's heuristics. Notable violations include the *visibility of system status* and *error prevention* heuristics, detailed in numbers 1, 3 and 4 of the heuristic violations chart. Not being able to see real-time availabilities or the status of requested items may cause multiple users to put in requests for one type of light, or cause one user to put in multiple requests. These problems would need to be addressed if the application was to be implemented.

iPhone Application for the McKeldin Mall Lighting System

	Noted Problem	Violated Heuristic
1.	**Users are unable to see the status of previously requested items**	Visibility of System Status(#1)
2.	**Dates and time slot reservations appear on different pages**	Consistency and Standards(#4), Error Prevention (#5)
3.	**No request verification**	Error Prevention (#5)
4.	**The system does not show which dates and/or times are unavailable**	Error Prevention (#5)
5.	**System does not identify which lights need special permissions to access**	Match Between System and Real World (#2)
6.	**The system does not have a help screen**	Help and Documentation (#10)
7.	**System does not allow users to save frequent settings**	Flexibility and Efficiency of Use(#7)

Changes implemented

Mall Design Changes

Stair Lights

Stair lights

We believe the addition of stair lights would be of benefit to the safety of the students. Additionally, it would balance out the amount of light on the Mall. Since we added these non-interactive lights to the design to balance out the amount of light and safety on the Mall, we feel that this addition will fit well with the issues of safety and use of space on the Mall that we have previously addressed.

Lights in Fountain

After showing this image to the participants, many reported that they would like this addition to the fountain. Similar to the stair lights, participants felt that this addition would add to the overall use of the Mall. Several participants suggested that these lights should also be controllable by the user. Therefore, this is an addition we would make to both the Mall design and the app to allow users to control the colors of the lights in the fountain.

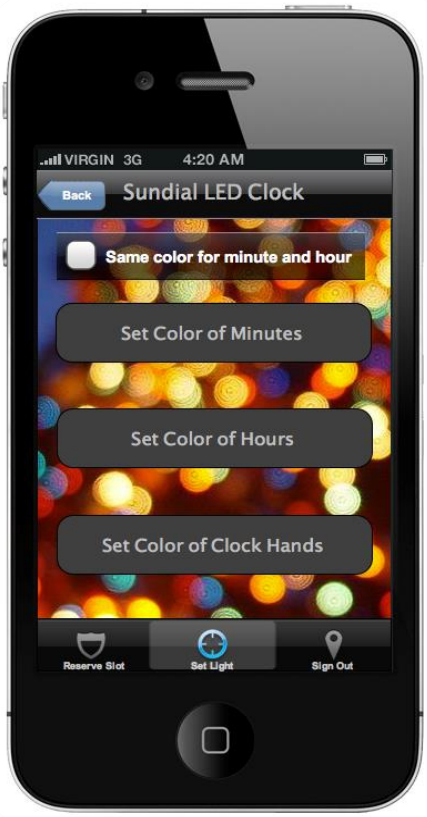
Light Curtains

There was much concern behind the light curtain design as many felt giving the ability to students to write phrases would cause them to use is inappropriately. In order to address this concern, our next iteration of the design would include a reviewing process of the text that students submit to be posted on the curtains. This reviewing process would ensure that any inappropriate words or phrases will not cause the university any problems.

App Changes

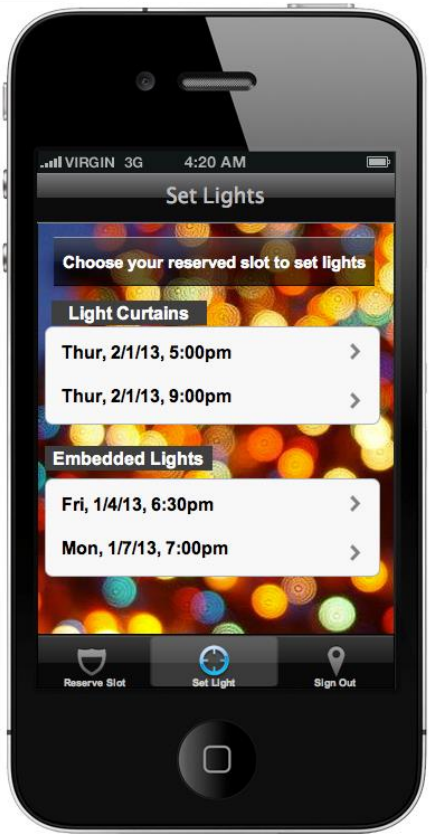
Tab removal and Change of Wording

Since all of the participants reported that the wording in this section of the app was confusing, we decided to change it slightly. Instead of "Set odd/even numbers", we used "Set hours/minutes". Participants indicated that this would make more sense. Additionally, instead of checkmarks, we previously had tabs with slightly confusing wording as to how to control the hours and minutes on the clock. Some participants even said they did not see the tab at all. To avoid this confusion, we replaced the tabs with checkmarks. The default is set to "Same color for minute and hour". When the box is unchecked, more customization of colors is shown to the user.



Setting Lights based on Slot Reservation

As participants indicated it would not make sense to simply choose a light to control when a reservation system exists, we changed this design to allow the user to first choose the time slot in which they reserved, then make the setting changes. This suggested change was accepted by the participants.



Future changes

Based on the usability study, user feedback, and heuristic evaluation, we propose a list of future changes to implement. Most concern the iPhone application, which is the central interaction tool for the light fixtures. In particular, users wanted to not only customize the lights, but to have templates to work from. Customizing light fixtures may be a new experience for users, so templates are essential to include. Other changes include adding musical synchronization to the fiber optic curtain, modifying the area illuminated by the sidewalk sensor lights, and adding controllable lights to the fountain. Although we originally decided not to include fountain lights, user feedback suggested that it was necessary.

	Proposed Change	Suggested by…	Type
iPhone Application	Fix heuristic violations	Team	Functional
iPhone Application	Create templates/examples and allow users to share patterns with each other	Feedback	Functional
iPhone Application	Real time information with current usage	Feedback	Functional
iPhone Application	Improve terminology and explanation of Sundial Clock.	Feedback	Aesthetic
Fiber optic Curtain	Synchronize the curtain with music	Feedback	Functional
Sidewalk sensor lights	Decrease the area that that lights up in front/behind the user	Feedback	Functional
Fountain	Add controllable lights to the fountain	Feedback	Functional

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