ENGR 110/112 - B04 #16

Final Report

Ring Road Audible Assistance and Pedestrian Crosswalk Lights

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A. Problem Definition

A.1. Need

Barrier	Description	Problem
1	**Heavy bathroom doors in older buildings**	In residential buildings across campus, we have noticed that the doors to the bathrooms are heavy. This issue creates limiting access to people who use wheelchairs and those with dexterity-related disabilities. Some washrooms on campus are not automated or hard to open for some individuals due to their weight.
2	**Lack of noise assistance and pedestrian crosswalk lights to cross between Ring Road**	We have noticed that pedestrian crosswalks have no crosswalk lights nor noise assistance for disabled individuals. Lack of crosswalk lights and noise assistance can cause many accidents and encourage disabled students to avoid campus. Furthermore, it can be hard to find and navigate the crosswalks for students with diverse needs affecting accessibility on campus.
3	**Lack of signage for disability accessibility**	Across campus, we have noticed that the signage relating to accessibility both inside and between buildings is lacking. This issue affects movement-related disable individuals getting from building to building, making it harder to maneuver exits and entrances safely and effectively. For example, in the event of a fire, unless an individual had prior knowledge of the buildings around campus, it may be difficult to exit beyond just following the crowd.

Our team has decided to choose Barrier number 2 - lack of noise assistance and pedestrian crosswalk lights on campus - for our project proposal. We believe this is something that we can enforce and adapt on campus to create a safer environment for all students and staff members. Addressing this issue, we feel that the campus would be made more inclusive for the diverse range of disabilities.

A.2. Research

This section describes some positive and negative characteristics of each research analysis.

Pedestrian Controlled Crosswalks

Intersections with stop signs or flashing green lights give priority to pedestrians and force motorized vehicles to stop.

Positive	Negative
• Pedestrian awareness and priority • Car breaking enforcement • Disability-friendly • Highly visible • Accident prevention • Signals drivers	• Signals require initiation from the user • Difficult to interpret for the visually impaired • Tactile paving can be hazardous when wet • Not long term and will need repairs

Tactile Paving

System of textured surface found on stairs, lower curbs, and subway station platforms to assist visually impaired individuals.

Positive	Negative
• Disability-friendly • Highly visible	• Not long-term • Constant repairments needed • Hazardous when wet

Audible / Visual Signals

Devices indicating when it is safe for pedestrians to cross the street using chirping sounds or visual cues.

Positive	Negative
• Impairment-friendly • Pedestrian awareness	• Hard to interpret for the visually impaired

Flashing Lights

Flashing lights are a system that indicates a pedestrian is crossing, aerting vehicles, and cyclists to desaleart to a complete stop.

Positive	Negative
• Accident prevention • Signals drivers • Pedestrian priority	• No signal for the visually impaired to activate

Questions

1. How can we define what makes an intersection safer and accessible?
2. What solutions can be implemented at a low-cost and long-term?
3. Are the solutions detrimental to other members of the community?

A.3. Objective & Constraints

The section below lists the objectives and constraints to identify the optimization and limitations of the design.

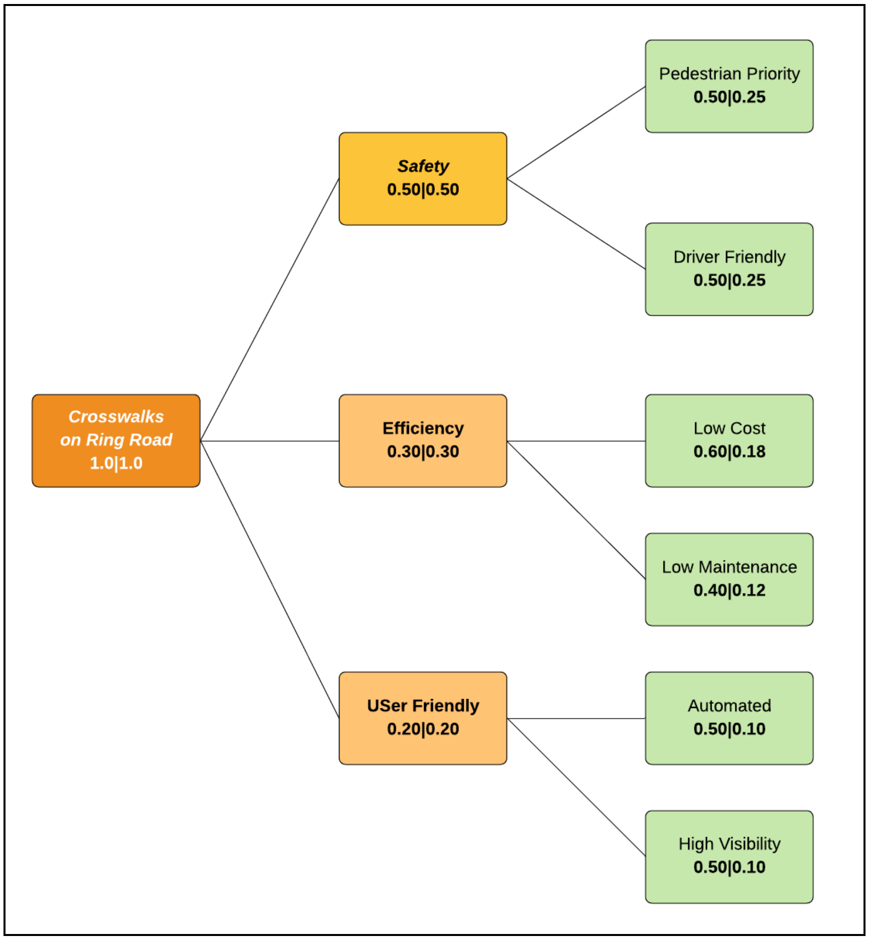
Objectives:

1. Safety improvement
    - Decrease in accidents per year on campus
2. Automated
    - Requires no initiation from user
3. Low cost
    - Industry-standard cost or less
4. Low maintenance
    - Requires minimum maintenance hours and material
5. User friendly
    - Accessible for all users
6. Pedestrians priority
    - Forces vehicles to stop when pedestrians are crossing.
7. High visibility
    - Reflective under street and headlights

Constraints:

1. Funding
    - Budget that would allow installation at main campus crosswalks
2. Implementation on main crosswalks on campus
    - SUB, McPherson Library

A.4. Weighted Criteria Tree



Pairwise Comparison

	Safety	Efficiency	User-Friendly	Total
Safety	-	1	1	2
Efficiency	0	-	1	1
User-Friendly	0	0	-	0

We decided that safety is the most important, followed by efficiency, and finally a user-friendly system. While being user-friendly is highly important to find a solution to the problem. Given that the client is the university, we found that efficiency in implementing and maintaining the solution was most important. However, safety improvements on campus were the focus of the project. The solution to making crosswalks safer creates a more welcoming and accessible environment for all students and staff members attending the university.

A.5. Problem Definition Statement

Problem Definition

There is a need for improved noise assistance and pedestrian safety in crosswalks between Ring Road and the rest of the campus. Many crosswalks around campus have limited visibility at night, which can lead to unsafe crossing. Therefore, presenting difficulties for various disability groups that make traversing Ring Road more of an obstacle. Crossing the street without proper care can result in fatal accidents by electronic transportation users such as drivers, cyclists, and skaters for pedestrians. As it stands now, there is a need for improvement in the crosswalks. It can be exceedingly difficult for a variety of groups to cross the street making attendance to the university difficult or even in some cases, a reason not to enroll in the university. To make the university more inclusive and accessible, crossing at main intersections should be safer and easier for everyone. Some key problems include poor lighting after dawn and before sunrise, and the difficulty of recognizing intersections for visually impaired pedestrians.

Goal

Make traversing crosswalks safer and less of an obstacle for all pedestrians in the university, and improve visibility for drivers.

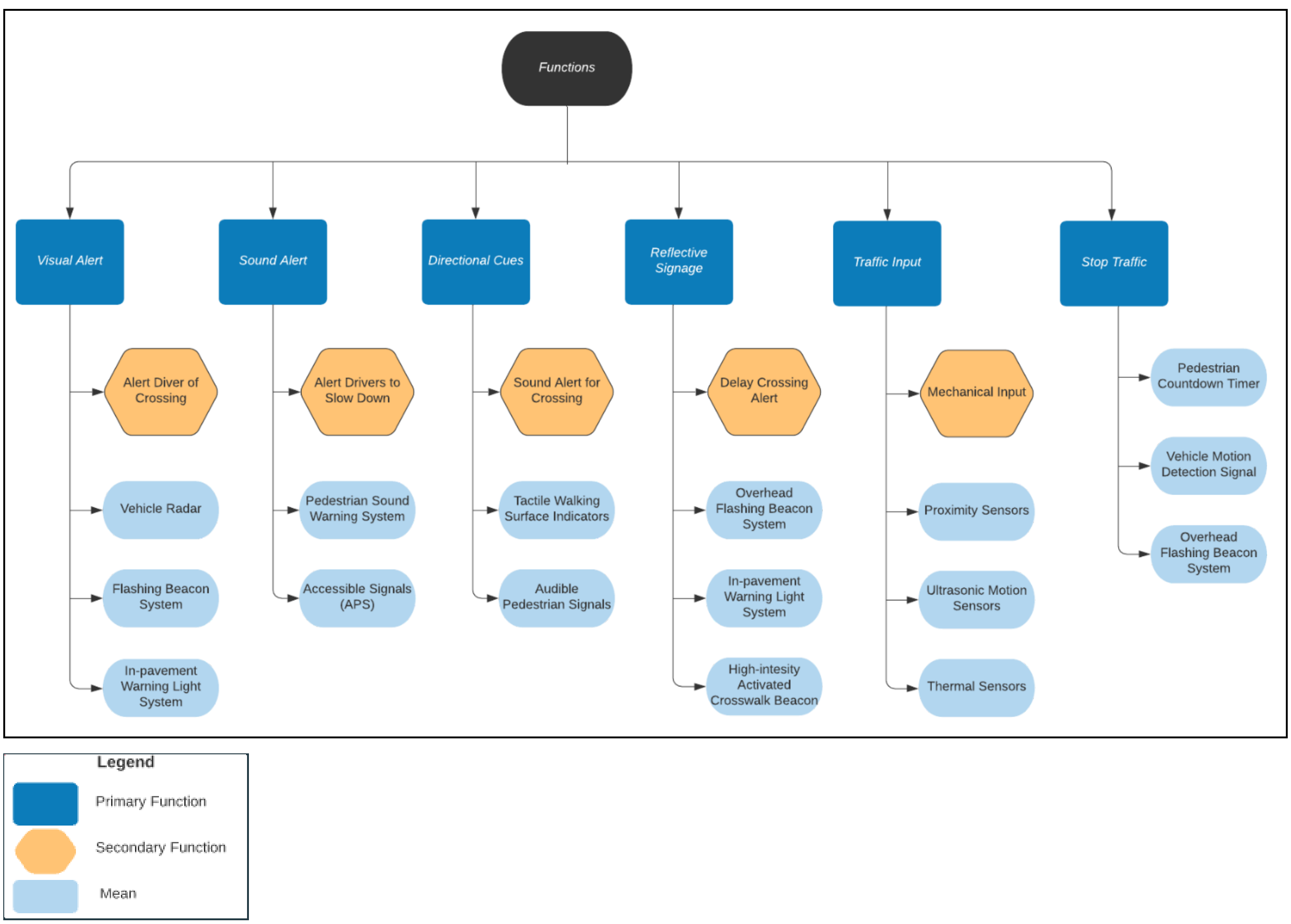
B. Conceptualization

B.1 Functions

Primary:

- **Visual Alert** - Caution drivers of intended pedestrian crossing using a specific spectrum of lights.
- **Noise Alert** - Produce noise when it is safe to cross for pedestrians.
- **Directional Cues** - Improve access for the visually impaired using some type of unique ground texture near the road.
- **Reflective Signage** - Alert drivers clearly of any upcoming crosswalks.
- **Traffic Input** - Receive input from pedestrians when they are about to cross the street.
- **Stop Traffic** - Alert drivers that it is unsafe to proceed.

B.2. Function-Means Tree



Means

Visual Alert
How will we sense a pedestrian is crossing while a vehicle is passing by?

- Vehicle Radar
- Flashing Beacon System – Alerts driver when any pedestrian is crossing the road.
- In-pavement Warning Lighting Systems

Sound Alert

How can we make the pedestrian aware of any upcoming vehicles in the road while crossing?

- Pedestrian Sound Warning System – Alerts pedestrians when a vehicle is approaching from a distance.
- Accessible Pedestrian Signals (APS) –Provides auditory, visual and tactile information so that a person with vision and/or hearing loss will know when it's safe to cross at a set of traffic signals.

Traffic Input

How can the pedestrian use the system?

- Proximity Sensors –Detect the presence of any nearby individual who has crossed the sidewalk and is about to use the pedestrian crosswalk.
- Ultrasonic Motion Sensors
- Thermal Sensors

Reflective Signage

How do we let the incoming drivers be aware of any individuals about to cross the Ring Road?

- Overhead Flashing Beacon System
- In-pavement Warning Lighting Systems
- High-intensity Activated crossWalK beacons (HAWK)

Stop Traffic

How do we improve traffic within the campus at peak hours?

- Pedestrian Countdown Timer at SUB crosswalk
- Vehicle Motion Detection Signal – Alerts when a vehicle is crossing a speed limit of 30 km/hr.
- Overhead Flashing Beacon System at SUB crosswalk

Directional Alert

How can we help alert visually impaired individuals in giving directions when to cross the road and/or when to use the crosswalk?

- Tactile Walking Surface Indicators (TWSI)
- Audible pedestrian signals

B.3. Morphological Chart

Means / Functions	1	2	3
Visual Alert	Vehicle Radar	Flashing Beacon System	In-pavement Warning Light System
Sound Alert	Pedestrian Sound Warning System	Accessible Pedestrian Signals	
Directional Cues	Tactile Walking Surface Indicators	Audible Pedestrian Signals	
Reflective Signage	Overhead Flashing Beacon System	In-pavement Warning Light System	High-intensity Activated crossWalK Beacon (HAWK)
Traffic Input	Proximity Sensors	Ultrasonic Motion Sensors	Thermal Sensors
Stop Traffic	Pedestrian Countdown Timer	Vehicle Motion Detection Signal	Overhead Flashing Beacon System

B.4. Performance Specifications

- The overall timer for pedestrians to cross must be a minimum of 20 seconds.
- The system must be installed at all crosswalks in Ring Road.
- The system must be equally accessible and friendly to all individuals.
- The system must help signal incoming vehicles when individuals with disabilities are about to use / using the crosswalk(s).
- The system must ensure the safety of pedestrians with disabilities when crossing the road during dark hours / night times.
- The system must detect when vehicle(s) cross a speed of 30 km/hr around any crosswalk.
- The system must be able to properly inform the drivers through audio-visual signals when it’s crossing the speed limit or when a pedestrian is using the crosswalk.
- The system must be able to effectively function throughout the day and during power outage and/or load shedding.

C. Preliminary Design

C.1. Metrics

Visual Alert

Quantitative Description	Scale
Lights are very effective at alerting pedestrians	1.0
Effective when indicating to cross the street	0.8
Alerts pedestrian when to cross the street	0.5
Has difficulty alerting pedestrians	0.2
Does not give any visual alert when it is safe to cross	0

Audible Alert

Quantitative Description	Scale
Very effective audible alert for pedestrians	1.0
Good audible alert for pedestrians	0.8
Moderate audible alert	0.5
Audible alert is usually not effective	0.2
Audible alert is not effective	0

Directional Cues

Quantitative Description	Scale
Tactile paving is very effective indicating the crosswalk	1.0
Tactile paving is good at indicating the crosswalk	0.90
Tactile paving usually alerts a pedestrian of the crosswalk	0.50
Tactile paving has difficulty alerting a pedestrian	0.10
Tactile paving does not alert pedestrians	0

Reflective Signage

Quantitative Description	Scale
Very effective at alerting drivers of the crosswalk	1.0
Effective at alerting drivers of the crosswalk	0.8
Drivers can see the reflective signage	0.5
Signage is present but minimally reflective	0.2
Drivers cannot see reflective signage	0

Traffic Input

Quantitative Description	Scale
Sensors are very effective at taking input from pedestrians	1.0
Sensors are good at taking input from pedestrians	0.75
Sensors can take input from pedestrians	0.50
Sensors have difficulty taking input	0.25
Sensors do not take input	0

Stop Traffic

Quantitative Description	Scale
Very effective	1.0
Effective	0.8
Average	0.5
Below Average	0.2
Ineffective	0

Low Cost

Quantitative Description	Scale
Very Expensive >$132.5k	0
Expensive $90K - $132.5K	0.2
Average $70K - $90K	0.5
Below Average $27.9K - $70K	0.8
Inexpensive <$27.9K	1.0

Budget Breakdown

Below is the budget breakdown for each proposed solution design.

<u>Design 1</u>

Overhead Flashing Beacon System	$13,000-$77,000 CAD
Pedestrian Audible Signal System	$900-$1,500 CAD

Design 1 Min/Max: $13,900/$78,500 CAD

<u>Design 2</u>

Overhead Flashing Beacon System	$13,000-$77,000 CAD
In-Pavement Warning Light System	$14,000 - $54,000 CAD
Pedestrian Audible Signal System	$900-$1,500 CAD

Design 2 Min/Max: $27,900/$132,500 CAD

<u>Design 3</u>

Overhead Flashing Beacon System	$13,000-$77,000 CAD
Pedestrian Countdown Timer	$1,000-$2,500 CAD
Pedestrian Audible Signal System	$900-$1,500 CAD

Design 3 Min/Max: $14,680/$81,000 CAD

<u>Design 4</u>

Flashing Beacon System	$460-$75,400 CAD
Tactile Walking Surface Indicators (TWSI)	$231.25 CAD (cost per square meter)
Accessible Pedestrian System (APS)	$700-$2,470 CAD

Design 4 Min/Max: $1,241.25/$77,561 CAD

<u>Design 5</u>

High-intensity Activated crossWalK Beacon	$27,370-$164,240 CAD
In-pavement Warning Light System	$14,000 - $54,000 CAD
Pedestrian Countdown Timer	$1,000-$2,500 CAD

Design 5 Min/Max: $42,370/$220,740 CAD

C.2. Numerical Evaluation Matrix

Concepts Function	Weight	Design 1	Design 2	Design 3	Design 4	Design 5
Visual Alert	20%	0.8 | 20% (16%)	1.0 | 20% (20%)	0.8 | 20% (16%)	0.8 | 20% (16%)	1.0 | 20% (20%)
Audible Alert	15%	0.8 | 15% (12%)	0.8 | 15% (12%)	1.0 | 15% (15%)	0.8 | 15% (12%)	0.8 | 15% (12%)
Directional Cues	10%	0 | 10% (0%)	0 | 10% (0%)	0 | 10% (0%)	1.0 | 10% (10%)	0 | 10% (0%)
Reflective Signage	20%	0.2 | 20% (4%)	1.0 | 20% (20%)	0.2 | 20% (4%)	0.2 | 20% (4%)	1.0 | 20% (20%)
Traffic Input	10%	1.0 | 10% (10%)	1.0 | 10% (10%)	1.0 | 10% (10%)	1.0 | 10% (10%)	1.0 | 10% (10%)
Low Cost	10%	0.5 | 10% (5%)	0.5 | 10% (5%)	0.5 | 10% (5%)	1.0 | 10% (10%)	0.0 | 10% (0%)
Stop Traffic	15%	0.5 | 15% (7.5%)	0.5 | 15% (7.5%)	0.5 | 15% (7.5%)	0.5 | 15% (7.5%)	0.5 | 15% (7.5%)
Total	100%	54.5%	74.5%	57.5%	69.5%	69.5%

C.3. Design Description

The final design we chose involved an in-pavement warning system, a pedestrian audible signal, and overhead flashing beacon system (Design 2). The in-pavement warning system consists of lights in the pavement that turn on after sundown and stay on until sunrise. This attracts the view of oncoming traffic when it is harder to see pedestrians, lights up the dark crosswalk to improve driver and pedestrian visibility, and requires no user activation, making it very accessible for all users. The pedestrian audible signal is user activated with a button and makes noise after a short delay to notify users that the third component, the overhead flashing beacon is turned on. Ideally, at peak times of day, this would allow for a safer crossing for those with visual impairments when others activate the system. On a similar note, the flashing beacon would stop traffic and provide another alert to drivers. This design fully meets our criteria of traffic input, visual and sound alerts, reflective signage, and directional cues, and is somewhat effective in stopping traffic. This gave this design the highest rating according to our design functions and has a maximum cost of production of $132,500 CAD. Compared to our second highest ranked design according to our Numerical Evaluation Matrix, the cost is much lower, and while cheaper options are out there, they are not as effective in making the campus more accessible.

Design Concepts

Design 1
Overhead Flashing Beacon System
Pedestrian Audible Signal System

Design 2
Overhead Flashing Beacon System
In-Pavement Warning Light System
Pedestrian Audible Signal System

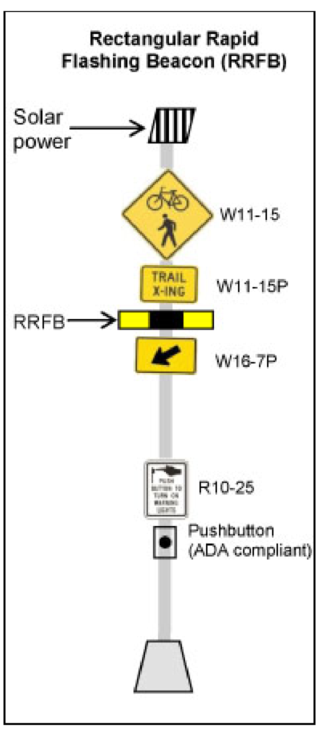
Design 3
Overhead Flashing Beacon System
Pedestrian Countdown Timer
Pedestrian Audible Signal System

Design 4
Flashing Beacon System
Tactile Walking Surface Indicators (TWSI)
Accessible Pedestrian System (APS)

Design 5
High-intensity Activated crossWalK Beacon
In-pavement Warning Light System
Pedestrian Countdown Timer

1
In-pavement Warning System
Visible at all speeds, even when drivers' peripheral vision narrows with speed

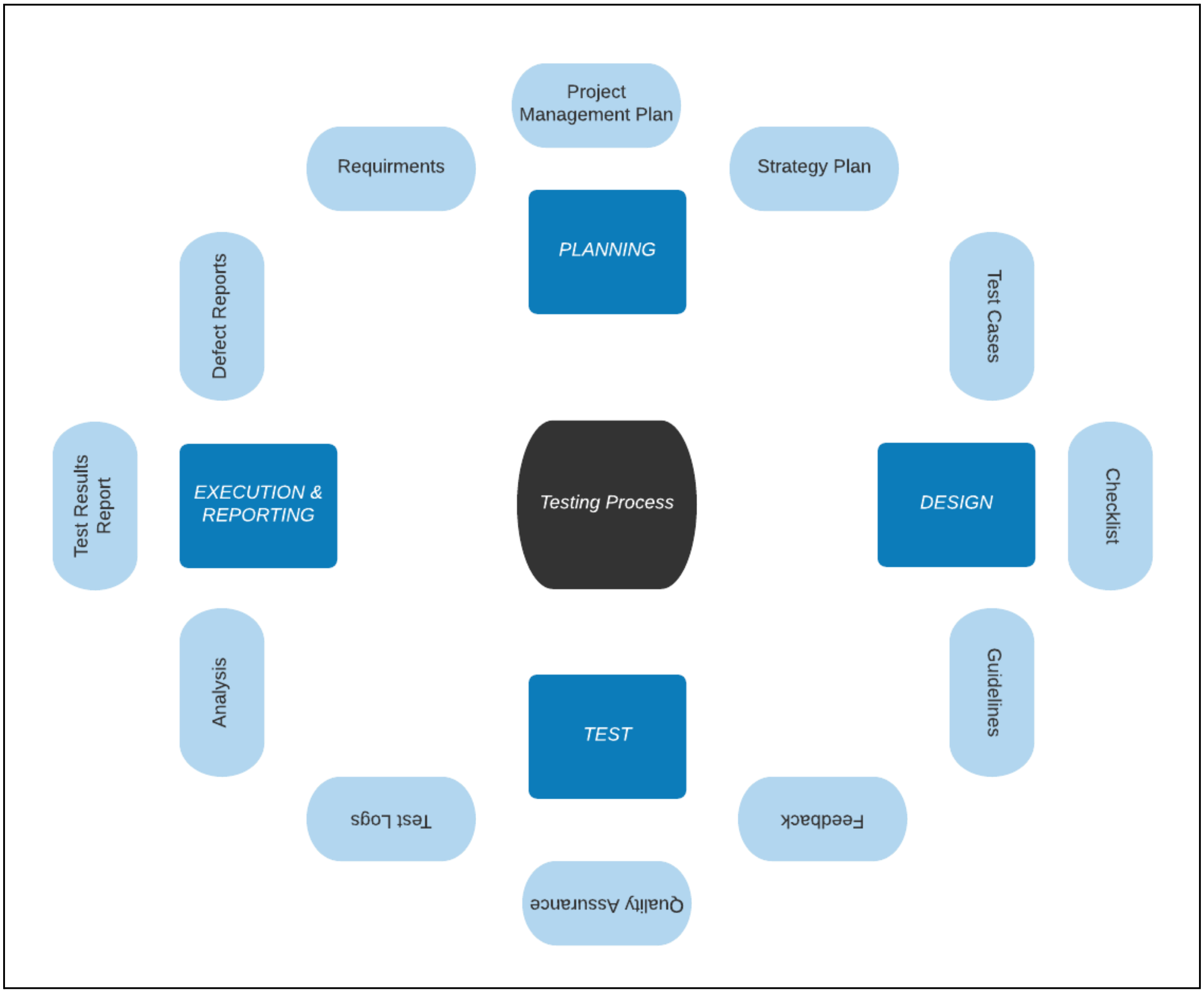
2
Pedestrian Audible Signal System
Provides auditory assistance to notify pedestrians when the beacons are on



3
Overhead Flashing Beacon System,
Rectangular Rapid Flashing Beacon (RRFB)
Most commonly used rapid flashing beacon

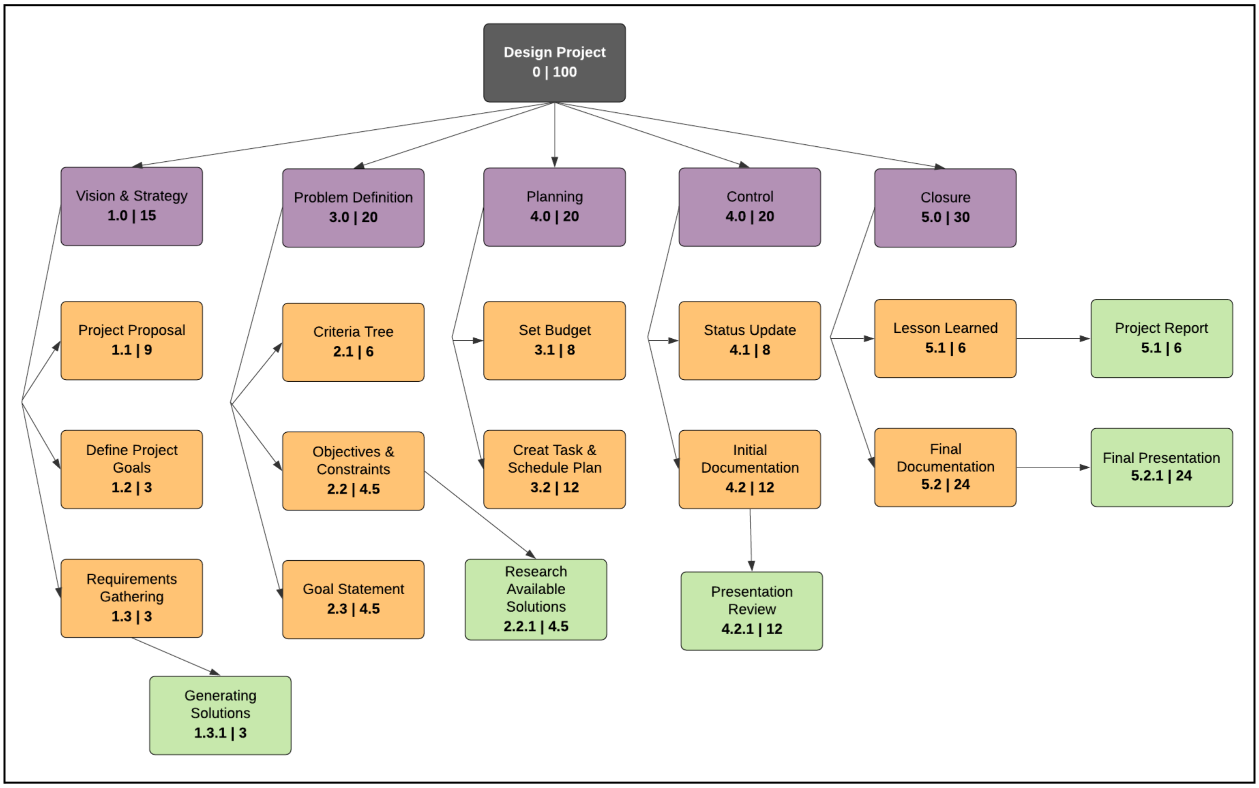
Testing Proposal

The Testing Process has four stages in order: Planning, Design, Test, Execution and Reporting.



D. Project Management

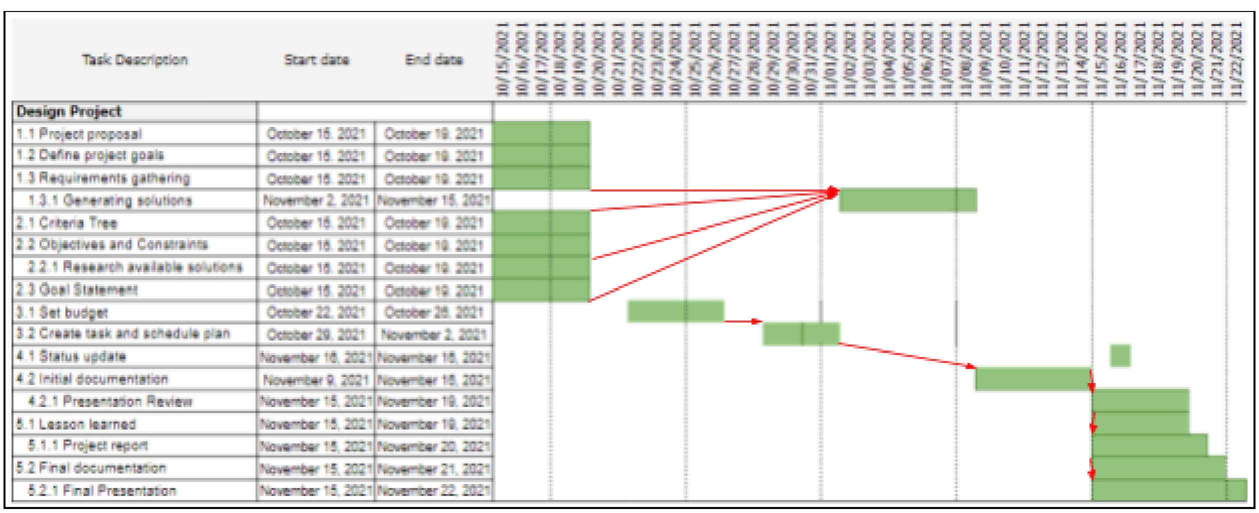
D.1. Work Breakdown Structure (WBS)



D.2. Linear Responsibility Chart (LRC)

TASKS	Mayte Solis	Sam Nelson	Hiwot	Oshen	Arfaz	Everyone
1.0 Vision & Strategy	1	1				
1.1 Project proposal	1	1	2	2	2	4
1.2 Define project goals	1	1	1	1	1	4
1.3 Requirements gathering	1	1	1	1	1	4
1.3.1 Generating solutions (Initial Presentation)	4	3	3	1	2	
2.0 Problem Definition	1	1				
2.1 Criteria Tree	3	3	1	2	2	
2.2 Objectives and Constraints	1	1	1	1	1	4
2.2.1 Research available solutions	1	1	1	1	1	4
2.3 Goal Statement	1	1	2	2	2	
3.0 Planning	1	1			2	
3.1 Set budget	3	4		2	1	
3.2 Create task and schedule plan	1	1				
4.0 Control			2	1		
4.1 Status update						1
4.2 Initial documentation	4	3	2	1	1	
4.2.1 Presentation Review						1
5.0 Closure	4	1				
5.1 Lesson learned						1
5.1.1 Project report	1	1	2	2	3	4
5.2 Final documentation	1	1	2	3	2	4
5.2.1 Final Presentation	1	1	1	1	1	4

D.3. Gantt Chart



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