

January 31, 2018

Andrew H. Rawicz

School of Engineering Science

Simon Fraser University

Burnaby, British Columbia V5A 1S6

**Re: Capstone Project Proposal for *SafeLift* and *AppAid***

Dear Dr. Rawicz,

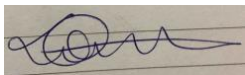
I am writing to provide a report that presents the proposal of our Capstone Project, *SafeLift* and *AppAid*. *SafeLift* is a proximity alert system that aims to improve the overall safety of workplaces that utilize powered industrial trucks such as forklifts, which poses a great hazard to both the drivers and bystanders. *AppAid* is a risk management app that compliments *SafeLift*. It is a tool that helps manage and mitigate risk before they become fatal.

This report describes the problems and steps that will be undertaken in providing the solution. It includes the project schedule, cost considerations and technical aspects of the project. We also discuss the challenges that will be faced and the market for the product once the project is completed.

Our team consists of four senior engineering students with backgrounds in electronics, software, embedded systems, hardware and mechanical design. Individual profiles can be found in the report. If you require any further information, feel free to contact me via email at [fmose@sfu.ca](mailto:fmose@sfu.ca).

Sincerely,

Fred Mose,



Chief Executive Officer  
PowerLift Safe Solutions

Enclosure: Proposal for *SafeLift* and *AppAid*



## SafeLift and AppAid

### Project Proposal

**Team:**

Daniya Zafar  
Fred Mose  
Layomi Dele-dare  
Wenhao Zhang

**Contact Person:**

Fred Mose  
[fmose@sfu.ca](mailto:fmose@sfu.ca)

**Submitted to:**

Dr. Andrew Rawicz – ENSC 440  
Steve Whitmore – ENSC 405W  
School of Engineering Science  
Simon Fraser University

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## Executive Summary

In the US alone, there are over a million PITs in operation [1]. Commonly known as forklifts or lift trucks, they are used in many industries, primarily to move heavy materials. While forklifts offer the best practical solution for material handling, they pose a significant danger to both personal safety and property. According to the US Department of Labor, OSHA estimates that 11% of forklift operations will be involved in an accident or collision every year.

Many of the risks involved in their operation are mitigated through workforce training and competency testing. However, there is still a plethora of hazards, depending on the workplace type, location and condition. For example, retail establishments face greater challenges in maintaining pedestrian safety. This report presents a practical solution that will minimize the risk of injury to operators, pedestrians, as well as avoid unnecessary property damage.

Our target market is specifically warehouses, with both lift trucks and pedestrian traffic. *SafeLift* provides the operators with improved situational awareness of pedestrians and obstacles, in and out of their field of vision, allowing them to maneuver safely. *AppAid* compliments this by providing operators with training modules, information of high risk areas, such as blind spots and pedestrian intersections. The app will keep track of track of licensed operators and provide information on forklift maintenance records. It will also be used for injury and incident reports. These reports will help management improve overall workplace safety.

Our proposed solution for *SafeLift* will employ the use of RFID tags and several ultrasonic sensors mounted on strategic positions on the forklift. These will be used to detect obstacles and bystanders in proximity of collision with the forklift. Data captured by the sensors are transmitted to a control unit that alerts the operator through a system of audio and visual warning devices. In blind spots, where operator and pedestrian are not aware of each other, this can be exceptionally useful. *AppAid* will be available on android platform for the beta stages before rolling it out onto the iOS platform.

*PowerLift Safe Solutions* consists of four very dedicated engineering students with expertise in a range of field including electronics, systems and computer systems. We all bring varying skills and experience that will allow us to design and produce a prototype in the next 11 weeks. We expect our product to be very beneficial to both; employers, by saving them thousands of dollars in property damage as well as to employees, by preventing personal injuries or worse, their deaths.

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## 1. Introduction

In this fast-paced world where everyone is racing with life, often we subconsciously forget the basic rules of safety which, in 2016, resulted in 149,554 work-related injuries costing over a billion-dollar worth of claims in British Columbia alone [2].

Forklifts are used to stack, lift and transfer loads in factories, shipping yards, freight terminals, warehouses and other workplaces. While they offer the efficiency in material handling they are amongst the most hazardous vehicle types and continue to be associated in workplace injuries and death. The following are the most common incidents involving forklifts:

- Object and pedestrian collision
- Loose loads falls
- Tipping from overloading or high-speed swerves

According to the 2016 statistics provided by WorkSafeBC, 26.2% of reported workplace fatalities occurred due to incidents involving heavy industrial vehicles including loaders, skidders and forklifts. Clearly, there is a serious need, to put in place strict protection measures and risk management systems to provide a safer workplace. Our project seeks to provide a solution to reduce the percentage of injuries and deaths caused by these powered industrial trucks.

Our solution, *SafeLift*, is a sensory system that can be easily integrated into existing industrial vehicles. *SafeLift* alerts the driver when a worker or an obstacle, that might be out of sight, is in the proximity of collision. Added on to this system is a risk management app, *AppAid*, that keeps record of all injuries and helps track accident prone locations in workplace so that concerned authorities can be notified to take appropriate measures to reduce calamities, fatal or otherwise.

This proposal is a detailed document that outlines:

- The motivation behind *SafeLift* and *AppAid*
- Risks and benefits associated with the product
- Outline of the design and implementation plan
- The target market and competition analysis
- Project schedule and estimated cost of producing working prototype

### ***Motivation***

According to the Industrial Truck Association, the lift truck market in North America is at a record high in the material handling industry [3]. As more workplaces become more populated with forklifts, overall safety has become very vital. The human and financial cost of forklift-related incidents for workers, industry and the community is substantial. The 2016 WorkSafeBC statistic of workplace fatalities is evidence that the current measures to prevent lift trucks

incidents are just not enough. Our product therefore seeks to improve on the already existing measures and provide better motivation in employee safety training.

## 2. System Overview

### 2.1 Scope

Forklift related workplace incidents have a substantial human and financial cost. These incidents can be prevented with proper measures in place. SafeLift and AppAid seeks to manage this problem. The vision of *P.S.S* is to deliver a robust and reliable solution to provide the warehouse employees a safer work environment.

Our system consists of two parts. *SafeLift*, a forklift proximity alert system and *AppAid*, a risk management android app. *SafeLift* will be easily installed to new and existing forklifts providing the operator better situational awareness of obstacles and pedestrians in close vicinity of danger, that may not otherwise be visible because of a blind spot. To make it robust and reliable, we expect to test its feature in a warehouse environment. Once, these features are correctly designed and regressively tested, *SafeLift* will be a product worth depending on for providing a safe work environment.

To keep track of and manage hazardous incidents, *AppAid* will be a database that holds detailed records of all the incidents and injuries in the workplace. This data will then be represented as meaningful graphs for proactive safety planning. Other features of *AppAid* are comprehensively discussed in *Project Design* section.

### 2.2 Product Design

#### ***SafeLift - Forklift proximity alert system***

Our proposed solution will comprise of obstacle detection sensors mounted on key positions around the forklift and an RFID system. The ultrasonic sensors will be used mainly for obstacle detection and the RFID reader will specifically be for pedestrian detection or other forklifts. Pedestrians working around the forklift area will be required to always carry RFID tags. The danger zone for the sensors and RFID detection is expected to be a radius of 2 - 2.5 meters. Figure 1 below shows the proposed positioning of the control and sensory systems.

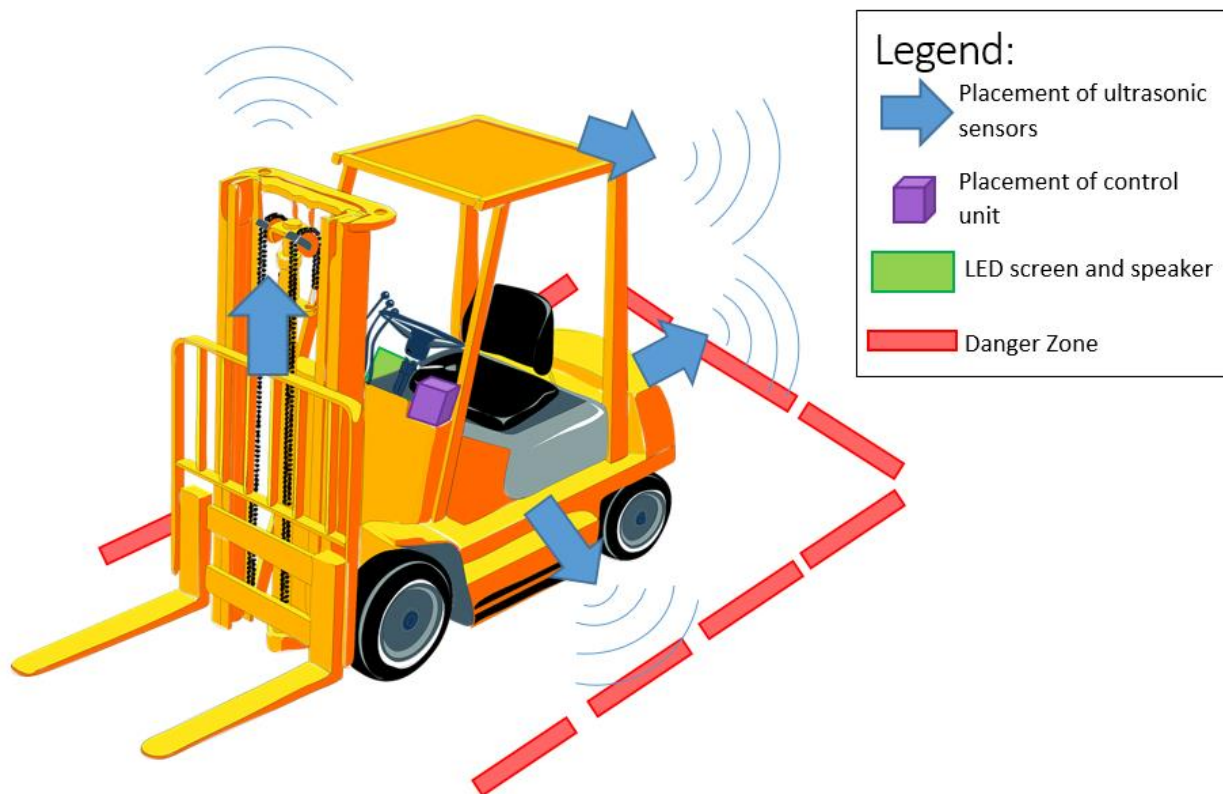


Figure 1. SafeLift control and sensory system placements

While in operation, the ultrasonic sensors and RFID reader will continuously be checking for obstacles within the danger zone and if any found, they will relay the data to a microcontroller which will trigger a warning to the forklift operator. The warning system will comprise of an audio speaker that will make an alerting sound and an LED screen that will indicate the distance and direction of the obstruction. The diagram below shows a block diagram of the system.

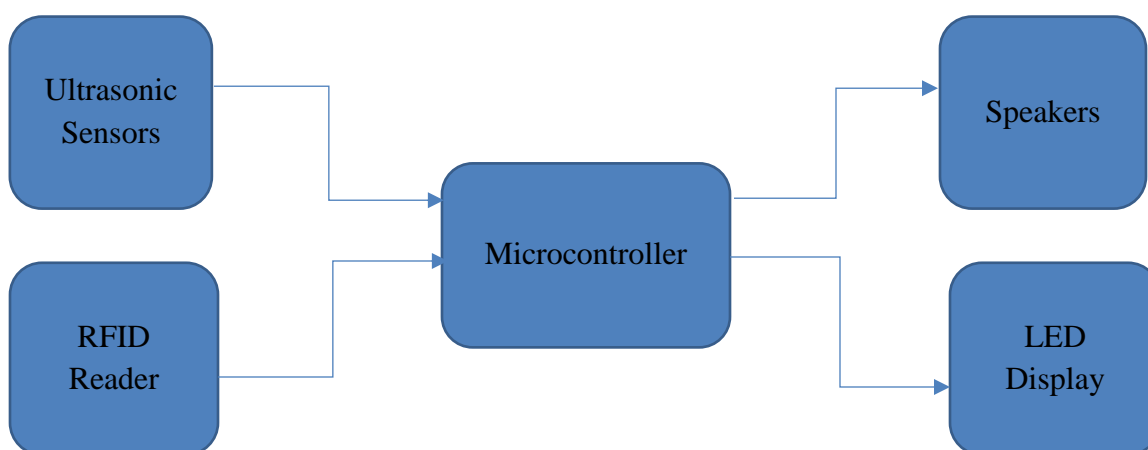


Figure 2. Block diagram of SafeLight system



### ***AppAid - Risk management Android app***

This app will be used by employers to train employees, identify and mitigate long term workplace risks by tracking and analyzing the recurrence of injuries and incidents. The following are some of the features that will be in the app:

#### *Floor Plan*

There would be an option that allows the employer to upload a general layout of the workspace that would show vital details such as fire exits, first aid stations, pedestrian high traffic areas and whatever they see fit to include. This will familiarize employees with their working environment thereby increasing efficiency and productivity.

#### *Injury and Incident Reporting*

Here employees will enter incident and injury reports. The reports will be categorized according to location, type and cause of injury. This will easily help management to track where there is a need for safety improvement in the workplace.

#### *Training Modules*

These modules will contain up-to-date health and safety standards as well as relevant training materials for forklift operations. According to WorkSafeBC, once the forklift operators have been trained and passed a competency test, the retaining period is 2 years. This is a lengthy period in which the operators can easily forget some basic safety training, becoming a liability in the workplace. Our app will schedule and send reminders for regular review sessions to help maintain the highest level of competence.

#### *Data Summary and Analysis*

The app will offer management report summary and analysis, presented in an easy to understand way. These can be used to assess risks, identify hazards, and help develop the best traffic management plans in pedestrian and forklift shared zones.

#### *Forklift Maintenance and Condition Records*

The level of maintenance a forklift receives is a crucial factor in its performance and longevity. Our app will help the management keep track of their forklift service conditions and help schedule routine maintenance. Moreover, it will reduce the risk of accidents due to faulty lift trucks which were being presumed in acceptable working conditions. This will help maintain optimal operating condition thereby reducing the risk of accidents due to poor maintenance.

#### *List of Licensed Power Tool Operators, First Aid Attendants*

This information will ensure only trained and certified drivers operate forklifts. It will in addition, monitor the drivers involved in most incidents to ensure they receive more training. It

will also provide information on all first aid certified personnel, information that is crucial during emergencies.

### 2.3 Benefits

The success of the product depends on its robustness. The goal is simple – to alert the driver of pedestrians and objects at a distance safe enough as for him to take appropriate course of action. The most important benefit we expect our product to have is reducing the forklift incidents and injuries. Worker will be more motivated to work in a safer environment, thereby increasing efficiency and productivity.

For warehouse owners, our product will offer a couple of financial benefits. First, is the reduction in claims due to forklift injuries and second savings gained from avoided property damage will be significant.

In terms of management, our app will help identify zones that need safety improvements. This will help in avoiding disaster before it strikes. Moreover, through *AppAid*, the organization can monitor incidents caused by each driver, thereby managing the liability.

### 2.4 Risks

*SafeLift* is an aid for creating environment awareness for forklift driver. Forklifts are dangerous pieces of equipment travelling with relatively high speeds in comparatively narrow aisles. This inherently introduces risks. One significant risk would be the operator's over-dependency on the product. For example, drivers not looking back while reversing, assuming they will be alerted if there is obstruction. In such cases if the sensors fail to detect the obstacle or are slow, the result could be disastrous. To avoid such incidents, the lift truck operator will have to always obey all forklift safety rules.

Since we will be using RFID tags, there is a risk of workers forgetting or losing their tags without informing management. In addition, electromagnetic interference for example from other machines or fluorescent lights could block proper tag reading. Our system therefore connects the ultrasonic sensors and RFIDs in parallel combinations rather than series. This ensures that the failure of one component does not affect the functionality of the others.

Another risk would be complacency of forklift drivers. Even highly skilled forklift operators can become careless in their daily routines due to the repetitive nature of their jobs. Stopping distances are often significantly underestimated and with only a maximum detection of 2.5 meters, our product may be slow in alerting the driver in case they are driving too fast.

One risk we could run in developing our app is the lack of strong expertise in app development by our team members. This could slow down the process as we learn and design at the same time.

## 3. Market and Competition

Today, almost every heavy material handling facility such as warehouses owns a forklift or some other kind of lift truck. These lift trucks pose a great hazard to those around them when operated unsafely. Often when people get negligent, they tend to forget about basic safety practices ultimately leading to avoidable accidents. In 2016 in British Columbia, 49,554 work-related accidents injuries cost over a billion-dollar worth of claims [2]. With the ever-increasing number of forklifts in the material handling industry, the need for a solution in reducing the accidents due to the operation of lift trucks has become very crucial.

### 3.1 Target demographic

The main target market for our product will be material handling warehouses with plenty of lift trucks and pedestrian traffic. While forklifts are not the only type of heavy lift trucks that this system can be applied to, our initial target vehicle will be forklifts. Forklifts can be dangerous not only to those around it, but also the user if caution is not taken. Accident claims can cost an employer a substantial amount of money, so there would be a great motivation to not only prevent accidents but to also prevent the occurrence of future accidents. Our hope with *AppAid* and *SafeLift*, is to provide an easy to use, all-in-one solution to employers of warehouse workers that will not only prevent forklift accidents, but also record and track the occurrence of those accidents or any other incidents.

### 3.2 Competition

There are many existing solutions that try to solve the problems of safety associated with forklifts. One type of prevention system that is marketed by competitors is one that uses an LED spotlight or projector to alert the pedestrian of an oncoming vehicle.

We believe such types of safety, while low cost, is not adequate to prevent injuries. It requires the pedestrians to have awareness of the situation. If someone is using their phone or carrying a box that is blocking their vision, they will not see a light or projection on the ground. These systems do not alert the driver of any pedestrian or other obstructions. This can lead the driver to assume that there is no obstruction, which can lead to unnecessary injuries.

Other companies like Claitec and Cisco-Eagle provides a system that uses RFID. These systems have an antenna that can detect in a circle around the forklift for any RFID tags that can be worn by a pedestrian or attached to another vehicle. When a pedestrian or another vehicle with a tag enters the detection zone, it sets off a visual alarm as well an audio one to alert the driver.

While RFID can tell you that something with a tag has entered the zone, there is no way to know which direction or how far the object is from the vehicle. We believe that this can be vital information for the driver. If they know where the object is, they will have better awareness of their surroundings. This can prevent the driver from missing things, as even if they take extra

precautions, being human, they can miss some details. These systems also do not tell the driver if there are any obstacles in their way if it does not have a tag. If a person forgets to wear a tag or their tag gets lost, the driver will not be notified. A box, or other obstruction can fall without notice, and if it is substantial in size, it could cause injury. A worker can forget and leave a box in aisle. If a forklift is carrying a large enough load that, their vision is blocked, they will not notice the obstruction in front of them. A forklift could hit obstacle that is hanging from the roof and these systems from the competitor cannot detect them.

With *SafeLift* we will not only have an RFID sensor but also an ultrasonic sensor system. The ultrasonic sensors can not only detect object that do not have a tag, but also provide range and location of the object. It will also provide overhead detection to prevent the forklift from hitting any overhead obstructions.

There are many competitors to *AppAid*, such as *EHSInsight* and *INTELEX*, and the traditional filing of a workplace incident form. These companies provide a typical application to manage workplace safety, risk and compliance. The solutions are provided as different modules. They include incident management, audit management, training management, and near misses, and many other modules. While these solutions are general and can be applied to many different workplaces, they may not fit the needs of a warehouse. They also tend to be expensive. Our app will be more affordable and include features that are more suited to the warehouse setting.

*AppAid* will include incident management, training management, and near misses, but also other features such as floor plan for the warehouse to show important safety details, forklift maintenance and condition tracking, and a tool for tracking all licensed power tool operators, first aid attendants. Our incident management will provide an easy reporting format that will include location, type, and cause of injury and as well as any other information required by WorkSafeBC. Once, we correctly meet the WorkSafeBC standards of incident reporting, we can easily upscale it to other provinces of Canada. For accidents involving forklifts information on the operator can be reported as well. This information will be used in our analytics module to provide graphs and other reports.

The additional features provided, we believe can be of immense value to a workplace. Our app can send reminders and help with maintenance of vehicles. This can help prevent any injuries caused by poor maintenance. Located in the app is also a list of all first aid attendants. The floor plan will show the location of all safety details. This is crucial information, and having it on hand, can help workers be more efficient during a crisis. Our app can also provide information on all certified operators. This can help workers locate someone when they need help instead of operating equipment they do not know how to use.

While *AppAid* and *SafeLift* both individually have competitors, as an integrated system, there is not any competition that can be found on the market. We believe that this will be the edge for our product. It can cost enormous amount of money and headache to integrate systems from different

vendors. By providing an integrated solution, we hope to provide a solution that is not only lower cost, but also easy to use.

## 4. Project Schedule

The Gantt Chart below is a detailed representation of our project over the span of 4 months, from 2018-01-04 – 2018-04-10.

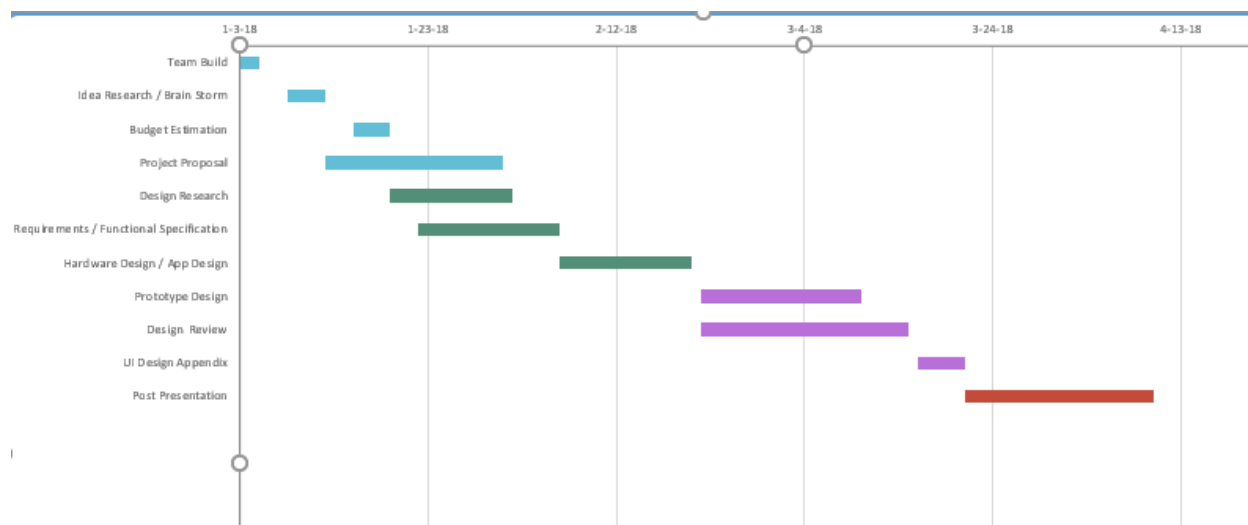


Figure 3. Gantt Chart for first 4 months

The Gantt Chart below is a detailed representation of our project over the span of 4 months, from 2018-05-07 – 2018-08-3.

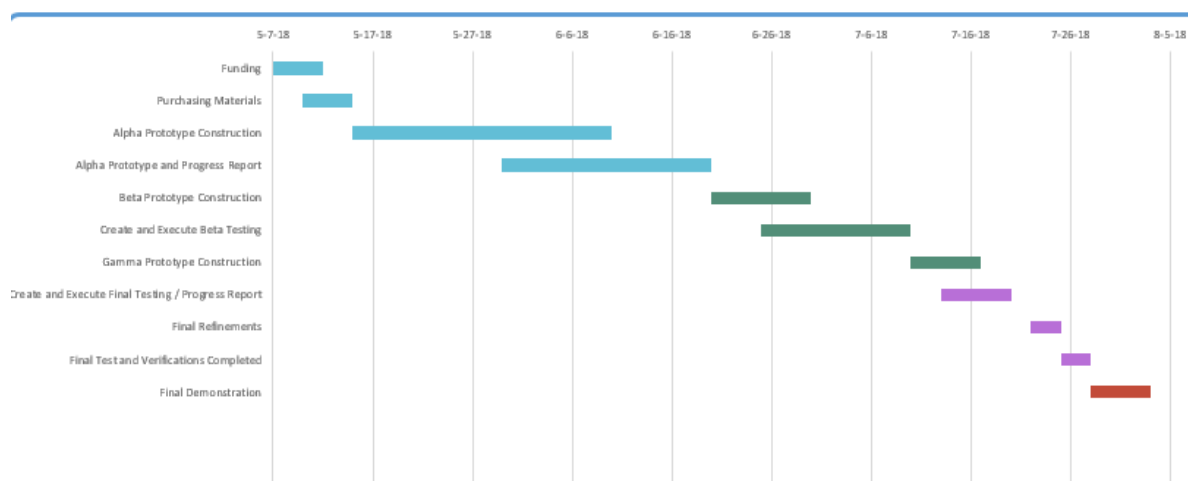


Figure 4. Gantt Chart for first 4 months

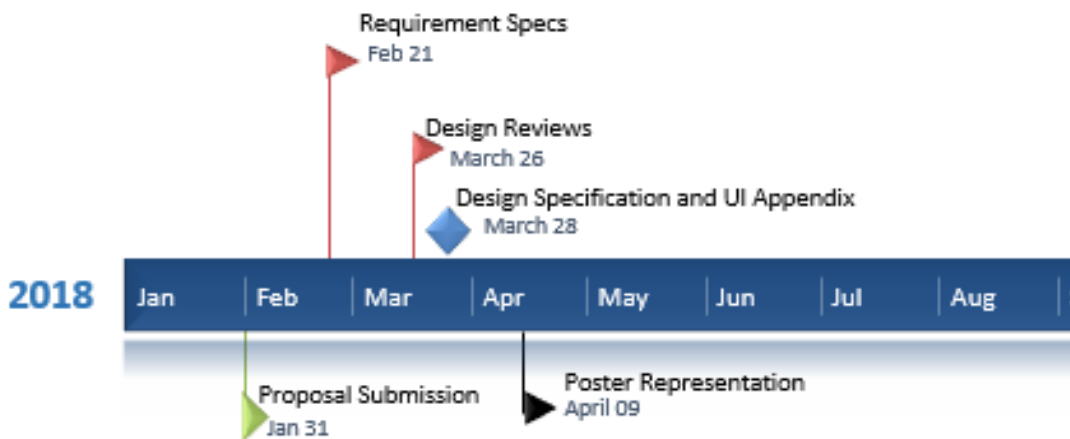


Figure 5. Milestone timeline

Table 1. Milestone table

Task Name	Start Date	End Date	Duration
Team Build	1/3/2018	1/5/2018	2
Idea Research / Brain Storm	1/8/2018	1/12/2018	4
Budget Estimation	1/15/2018	1/19/2018	4
Project Proposal	1/12/2018	1/31/2018	19
Design Research	1/19/2018	2/1/2018	13
Requirements / Functional Specification	1/22/2018	2/6/2018	15
Hardware Design / App Design	2/6/2018	2/20/2018	14
Prototype Design	2/21/2018	3/10/2018	17
Design Review	2/21/2018	3/15/2018	22
UI Design Appendix	3/16/2018	3/21/2018	5
Post Presentation	3/21/2018	4/10/2018	20

## 5. Cost Estimation

### 5.1 Projected cost

The table below breaks down the cost estimation required in completing the prototype of our products

*Table 2. Estimated cost of project*

<b>Component</b>	<b>Description</b>	<b>Cost \$</b>
Arduino /Raspberry pi	Microcontroller	75
Ultrasonic Sensors	There will be five different sensors attached to the forklift	200
RFID Reader/ tags	The RFID tags will be placed with a badge that is worn by pedestrians and placed in other forklifts. The reader will be placed in forklifts.	50
LED Screen	For displaying location and direction of obstructions reported by ultrasonic sensors. Also displays a warning for when a pedestrian is near.	200
Audio Speaker	These are used to give a audio queue to alert the operator of pedestrians that are near the forklift.	100
Miscellaneous	Wires, Resistors, Op amp, batteries	100
Subtotal		725
Contingency (15%)		108.75
<b>Total</b>		<b>833.75</b>

### 5.2 Funding

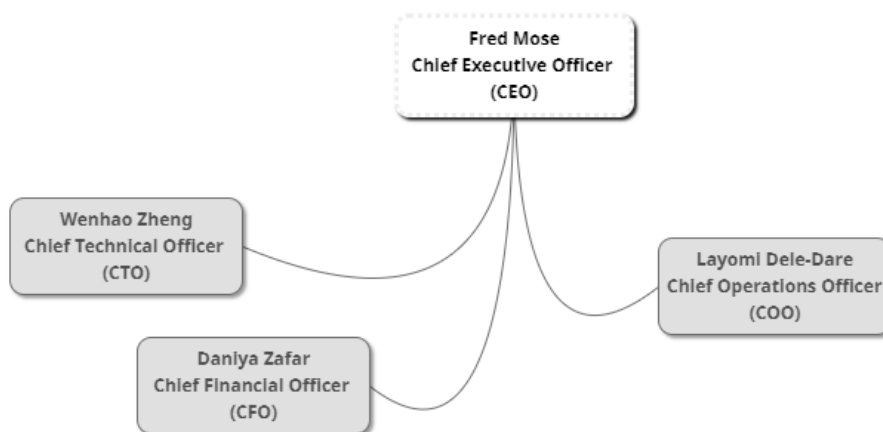
We have a couple of possible funding sources. One would be the Wighton Engineering Development Fund, whose application deadline is in March 2018 and the Engineering Science Student Endowment Fund offered by the ESSS, whose application deadline is May 2018. Both of these funding are offered on a competitive basis which we believe our project has an upper edge. If by any chance we miss any of the funding, our team is prepared to share the cost equally and mitigate some of it through loans of some components from the ESSS library.

## 6. Company Profile

P.S.S is a venture start-up comprised of the following senior-level engineering students. They are Layomi Dele-Dare, Fred Mose, Wenhao Zheng and Daniya Zafar. Through their experiences in the Engineering program as well as their experiences obtained through their CO-OP placements, they bring a diverse range of specializations and skills to the team. To ensure that there is consistent progress and forward progress, we have assigned two mandatory weekly meetings. During meetings, Layomi Dele-Dare will be recording minutes and task assigned. SFU Vault is being utilized as the document sharing platform for the project.

Due to the wide range of specifications. P.S.S will be structured as shown below. Team members are expected to take responsibility to ensure that their work is done correctly and on time. It is also of immense importance that they collaborate well with other team members to ensure an effective team dynamic and successful completion of the projection.

### 6.1 Team Profile



*Figure 6. Team dynamics*

Fred Mose, CEO oversees the overall project and making final decisions. Layomi Dele-Dare, COO oversees day to day operations and reports directly to the CEO. Daniya Zafar, the CFO, is responsible for product marketing as well as the financial budget and reports. Wenhao Zhang, the CTO, oversees technical issues and supports and is also the lead in the software development of the project.



***Fred Mose – Chief Executive Officer***

Fred Mose is 5<sup>th</sup> year Systems engineering student with a passion for robotics and systems designs. He has a wide range of experience from his co-op as a Research assistant for Menrva Research Labs and a Software Test Engineering for Sierra Wireless. His technical skills in wireless and communication systems in addition to his outstanding decision making and management ability makes him fit to lead this company. As the CEO his main contribution will be on the hardware design and ensuring effective communication between team members.

***Layomi Dele-Dare – Chief Operations Officer***

Layomi Dele-Dare is a 5<sup>th</sup> year engineering student who majors in Computer Engineering. Due to his experience in CO-OP as well as his academic career, he has extensive knowledge in both software and hardware design. This makes Layomi Dele-Dare a strong leader who will be responsible for the day to day operations. Layomi has done multiple technical projects in both individual and team-based settings. Layomi has also trained individuals to be part of team. This was done on his CO-OP term at IBM. This demonstrates leadership skills, critical thinking as well as his ability to pay great attention to details.

***Daniya Zafar – Chief Financial Officer***

Daniya is 5th year electronic engineering student with an inclination towards finance. She also has a business background which includes academic courses such as organizational behavior, management information systems and financial accounting. In addition to it, her two-year role as VP Internal Relations Officer of student body club PSA, has well-polished her administrative, financial and risk management skills. Daniya also has extensive quality assurance skills gained because of her one-year co-op experience with FDM, where, along with performing quality assurance analysis, she also learnt the financial responsibilities required during the initial stage of software development.

***Wenhao Zhang – Chief Technical Officer***

Wenhao is a 5<sup>th</sup> year electronics engineering student with an interest in the embedded system and software design. Through his work experience at SAP Canada Inc. and Sierra Wireless, he has gained valuable experience in firmware and software testing and development. He has knowledge of various programming languages such as Java, Python, C#, and C/C++. Wenhao has complete various personal projects using Raspberry PI and developed apps for the Android platform. His knowledge of Raspberry PI and android development makes him the perfect leading the design of the mobile app and hardware systems of SafeLift.

## 7. Conclusion

Safelift, in combination with AppAid is a robust and powerful system for reducing forklift injuries. Safelift provides operators improved situational awareness of pedestrians and obstacles. AppAid complements Safelift by providing workers with training modules, information on forklift maintenance records and keeps track of licensed operators. The data obtained from AppAid will also help management to prevent workplace injuries and improve overall safety outcomes.

Although many similar solutions solve the problem, SafeLift and AppAid, are the only products that offers a low cost, efficient solution that combines a physical product with an application to form a practical and comprehensive solution. The integration of SafeLift and AppAid will be a workplace environmental solution that is unlike any.

*With PowerLift Safe Solution, you don't have to be a statistic*

## 8. Glossary

RFID – Radio frequency identification

OSHA – Occupational Safety and Health Administration

CEO – Chief Executive Officer

CTO – Chief Technical Officer

COO – Chief Operations Officer

CFO – Chief Financial Officer

P.S.S – PowerLift Safe Solution

LED – Light Emitting Diode

PITs – Powered Industrial Trucks

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