January 25th, 2016
Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S6

Re: ENSC 305W/ENSC 440W Project Proposal for CleanLift

Dear Dr. Rawicz,

Attached is our proposal for CleanLift, a touchless elevator panel system. CleanLift is the inaugural product developed by our company, Porcupine Solutions, and aims to reduce disease and germ transmission between elevator users in high risk environments such as hospitals and cruise ships.

This proposal goes over the scope of the project, the benefits and risks, and provides an overview and analysis of the need and market for a cleaner elevator panel solution. A breakdown of our budget and timeline are also included. With this proposal we aim to show that there is need for our product as well as a many benefits for users and society.

The Porcupine solutions team comprised of Ryan Goldan, Elizabeth Durward, Lauren Jackson, and Simon Huang thanks you for your consideration of our proposal. If you have any questions, feel free to contact us.

Sincerely

Ryan Goldan
CEO, Porcupine Solutions

CleanLift

Touchless Elevator Panel

Porcupine Solutions

Project Proposal

Issue Date: January 25th 2016

Revision Number 1.0

Ryan Goldan
Lauren Jackson
Elizabeth Durward
Simon Huang

Executive Summary

The spread of infectious disease has been a central concern in modern health care since its early days, and over time there have been numerous methods introduced to battle its spread in hospitals, airports, and numerous other public spaces. Technology in particular has played a very important role for the past decade in mitigating the presence and transmission of bacteria on common surfaces. Innovations such as motion sensor activated faucets, toilets, and paper towel dispensers have greatly reduced the risk of bacterial spread in public restrooms, which have been identified as a high-risk location for disease transmission. Other innovations such as motion sensor doors and light switches have also assisted in the battle against disease causing bacteria.

While there have been many great advances to minimize the presence of bacteria on various common surfaces, there is one very common surface which has yet to be addressed. That surface is the elevator button panel. Elevator panels are one of the most frequented surfaces in any building and are generally cleaned and disinfected less frequently than restroom surfaces. A recent study showed that elevator buttons in hospitals actually have a higher rate of bacterial colonization than toilet surfaces [1], which may come as quite a surprise to most people. With this fact in mind, it is hard to believe that there has not been a viable solution to this very real problem. Until now.

In this proposal Porcupine Solutions will present CleanLift, a touchless elevator panel system. The system employs a laser grid consisting of horizontally and vertically oriented lasers projecting onto photocells on the opposing end of a panel. When a user crosses the intersection of two lasers and blocks the paths to their corresponding photocells, they have pressed a virtual button. The panel will be designed in such a way that the user will not need to touch any surfaces, thus eliminating the possibility of bacterial spread leading to illness.

We will discuss why this technology is needed and how our system will serve as a solution to the problem at hand, as well as explore the various settings in which it can be applied. We will provide background on the initial design concepts we propose for the implementation of the system, some potential challenges, risks associated with our method, and the multitude of benefits our product will bring.

Presented in this document is the projected timeline, including milestones and completion dates, as well as the estimated budget. The projected completion date is April 1st 2016, giving a development cycle of 13 weeks. We expect the budget for the development of the initial product prototype to be under $600. A more detailed breakdown of these estimates will be provided in our proposal.

Porcupine Solutions is composed of four 5th year engineering students with a range of skills including medical device development, systems engineering, software development, electro-mechanical system design, and product testing. We are very excited about the potential success of CleanLift, and we hope that you see this potential as well.

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1 Introduction

As world populations rise, disease spread in high density urban areas is becoming an ever-growing concern. Although more attention is being given to sanitation, many public spaces such as washrooms, hotels, and elevators are often neglected due to their complexity to properly clean using traditional cleaning methods. These methods do not always allow for proper sanitation procedures, especially in areas that have many small crevasses or moving parts where cleaning liquids may cause unintentional harm. Elevators are a prime example of this, as they are a high use area in many buildings and the panels often go unnoticed as locations of bacterial risk. Furthermore, elevator panels are also implemented with small moving parts that require direct contact to operate, and a lack of easily cleaned smooth surfaces. Porcupine Solutions is proposing a revolutionary product that will negate both of these issues – high user contact and poor cleaning feasibility – by designing fully touchless elevator, CleanLift.

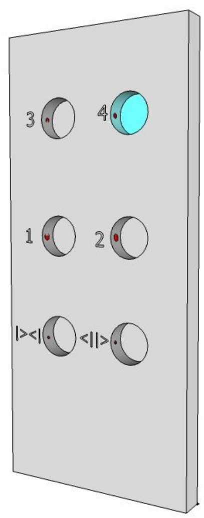

Figure 1: CleanLift panel mock up

Designed with ease of use, knowledge of human habits, and simplicity in mind, CleanLift will change how people interact with elevators. It will be designed to be intuitive for first time users as well as frequent users. This will to allow them to use it correctly and without frustration. For frequent users, such as nurses and doctors in health institutions, the panel will be easy to use and provide significant benefits by reducing direct contact with high use objects.

CleanLift will be implemented by arranging a grid of laser, with each intersection acting as a virtual button. The enclosure of the CleanLift system will be designed to fit in seamlessly with existing elevators, and the simplicity of the hardware will allow for a relatively low production cost, as described further in section 4: Need, Market, and Competition. Our solution will not only have increased sanitation benefits, but will be able to be licensed to existing elevator companies at a reasonable price point.

Our proposal will further discuss the scope, risks and benefits of CleanLift as well as the market for touchless elevator panels. Project management issues are also included, namely presented in detailed budget and timeline, as well as our team members' relevant expertise.

2 Background

A recent study estimates that 15% of adults do not wash their hands after using public restrooms [2] and among those who do, the majority fail to wash for the complete recommended length of time. Hand washing is an essential part of preventing infections and diseases and improper hygiene can have serious consequences; poor hand hygiene leads to 50% of foodborne illness outbreaks [2]. Touchless systems are a way to compensate for the reality of inadequate personal hygiene, and could be used in high risk and high traffic areas such as elevators to greatly reduce the repercussions of poor personal hygiene.

Another recent study found that elevator buttons in hospitals have higher rates of bacteria colonization than toilet surfaces [1]. This is a problem, as elevators are some of the most frequented public spaces in hospitals where direct user-surface contact is mandatory for operation. Introducing a touchless solution will greatly reduce the risk of disease transmission in the form of influenza, common colds, pneumonia, and many others. These bacteria vary in lifespan, and can last anywhere from a few hours to a few months on a hard surface indoors, as demonstrated in Table 1. Influenza still accounts for a notable number of deaths in hospitals [2] due to the fact that many patients have compromised immune systems, reducing their ability to fight off illnesses. Eliminating the high risk areas for disease travel that are conventional elevator panels is one of the main problems Porcupine Solutions will aim to solve with CleanLift.

Bacteria	Cold Virus	Flu Virus	Salmonella	MRSA	Herpes	Norovirus	C. Difficile
Lifespan	7 days	1 day	4 hours	> 7 days	4 hours	> 1 week	5 months

Table 1: Lifespans of various bacteria on hard surfaces indoors [3]

In addition to hospitals, the concern of infection and disease due to bacteria transmission is present in other dense public spaces, such as cruise ships and residential high rises. Cruise ships are an area of concern for disease spread due to the enclosed environment and high density within. Many studies have shown various illnesses have accelerated rates of transmission aboard cruise ships. Diseases such as norovirus [4], diarrhoeal illness [5], and gastrointestinal illness [6], have been known to spread among passengers at a rate much greater than recorded on land. Thus, introducing touchless technology to reduce the presence of disease-causing bacteria on commonly used surfaces such as elevator buttons, would be of great benefit in not just medical environments, but on cruise ships and other similar environments as well.

3 Scope, Benefits, and Risks

The following section will cover the scope, benefits, and risks of CleanLift. The scope will include the initial proposed design of the product, as well as possible alternative solutions. The possible benefits of the product will then be discussed as it pertains to its applications in various settings such as healthcare and industry; we will look at health benefits, social benefits, and cost benefits. In the third sub-section the possible risks of our proposed design will be investigated.

3.1 Scope

We propose a multi-tiered approach to the design of CleanLift, in order to allow for the addition of features as development of the product advances. Tier 1 will be the threshold we would hope to achieve by the project's end, however the capabilities introduced in Tiers 2 and 3 are of great interest, and we intend to implement as many of them as possible by the end of the project timeline, time permitting.

TIER 1

The basis of our proposed design consists of arrays of lasers mounted onto a panel, oriented horizontally and vertically, each projecting onto a photo resistor on the opposing end of the panel (see Figure 2). A virtual button is created at each intersection of beams. As a user's finger crosses the beam of a vertical and horizontal laser (i.e. the intersection), the beam projecting onto the photo-resistor is blocked. Using signal processing and logic programmed into an Arduino microcontroller and the change in voltage across the photocell, the system senses that a virtual button has been triggered. Upon activation of one of the virtual buttons, a display LED will light up to indicate to the user that the button has been pressed, giving feedback to the user to aid them in confirming their selection. After a button selection has been made, the selection signal would be sent to the elevator controller in the same manner as the usual push button elevator panel implementation does today. We have consulted with an industry professional who mentioned that elevator buttons function with serial communication, and that translating our technology to work in an existing elevator would be fairly trivial.

We plan to use an Arduino Mega microcontroller to implement our signal processing and signal conditioning, as our focus is on creating a robust and adaptive control system. Using a programmable microcontroller allows us to easily test and change our signal processing algorithms to work in varied environments and ultimately create a complex and versatile system. We plan on using an Arduino Mega over other, smaller, microcontrollers because it allows for a large number of I/O pins which we require to interface with the various photocells and LEDs. It will also allow enough pins to add more features which will be discussed in Tiers 2 and 3.

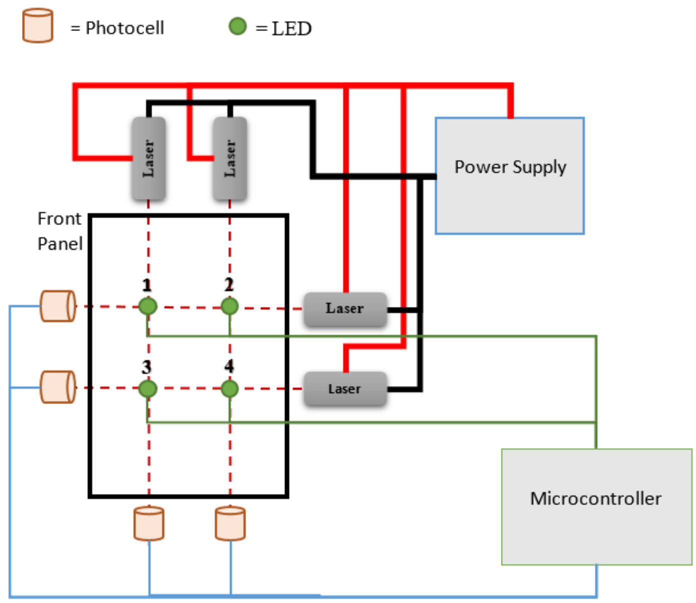

Figure 2: Schematic of system organization for a 4 button system

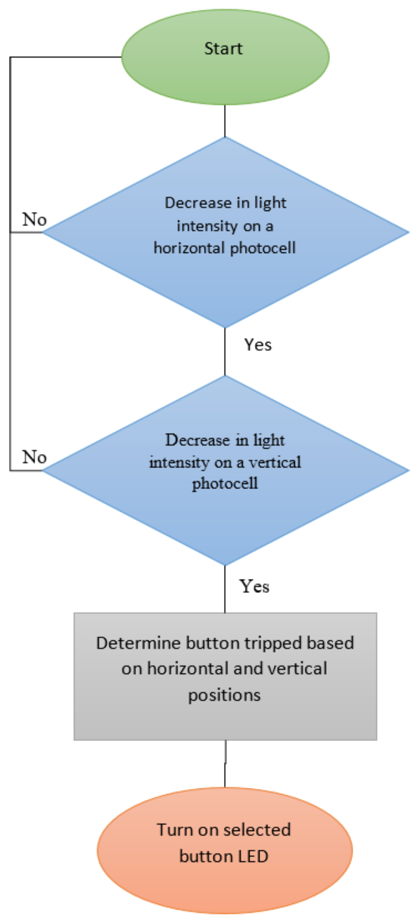

Figure 3: Flowchart for the selection of a button

One of the biggest challenges for the design of CleanLift will be making it user friendly and intuitive. First time users should be able to look at the panel and know how to operate it without touching the surface; if a user touches the panel because of poor design, then it defeats the purpose of creating the product in the first place. To address this, we intend to design and manufacture a panel with recessed areas at the button positions. The thought behind this design is that a user will see this recess which extends past the flat surface of the panel, and begin to approach their finger towards it. The depth of the recess along with the positioning of the laser beams will allow for enough time for the system to give the user feedback before they touch the end of the recessed portion of the panel. The recesses in the final product should be smooth and bowl shaped in order to allow for easy cleaning. Figure 4 shows an initial design model for the CleanLift panel's laser placement and enclosure.

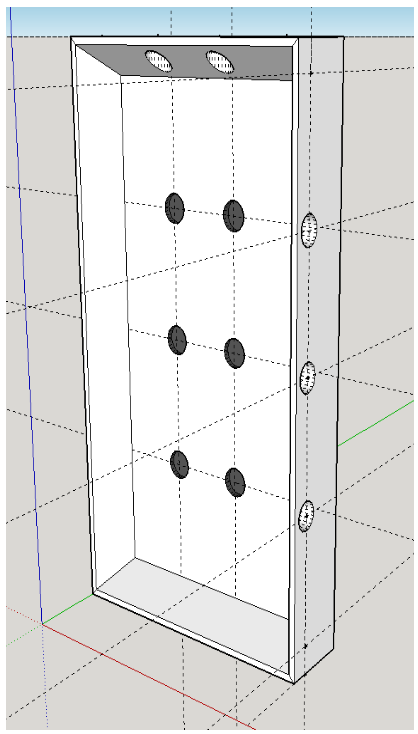

Figure 4: Laser placement and enclosure

TIER 2

In the second tier of the design we aim to add further feedback methods to alert the user that they have triggered the virtual button in addition to the LEDs. One of these methods would be a subtle audible tone, similar to that of dialing a telephone button. We would ensure that the tone is obvious enough that it gives sufficient feedback to the user of their action, while taking into account the fact that audible noises in systems can quickly become irritating and negatively affect user experience. The completion of tier two would also come with improved user experience and aesthetic design. Again, we are ever conscious that physical feedback may startle first time users if it is too forceful, and that implementation it will be a challenge to ensure that it is noticeable yet subtle.

TIER 3

The third tier of the design will aim to address the challenge of making the panel touchless to all users, including those who are visually impaired. Currently, elevator panels have braille to allow visually impaired individuals to physically feel which button is for which floor, and this is congruent with standards of accessibility for this demographic. Of course, touching the panel is what we are trying to avoid, so there needs to be an alternative. That alternative is voice recognition software. With voice recognition implemented in our system, visually impaired users or any other users with accessibility limitations can indicate vocally which floor they wish to press rather than physically reaching for the button.

In addition to this, we would like to implement a design upgrade of using a bundle of lasers at each array site, positioned closely together and acting in parallel. this will create multiple beam crossings close to one another at each virtual button, increasing the probability that the user will successfully trip at least one of these intersections. With only one intersection of two lasers in our Tier 1 design, users may miss the point they are meant to cross, and fail to press the button. This is where our desire to bundle multiple lasers together stems from.

Lastly, another form of haptic feedback would be explored in tier three. Air-puffs as tactile feedback for users would help give resistance against forward movement and possible contact between the user and the back panel of the system.

The figure below describes the need for smart feedback and processing.

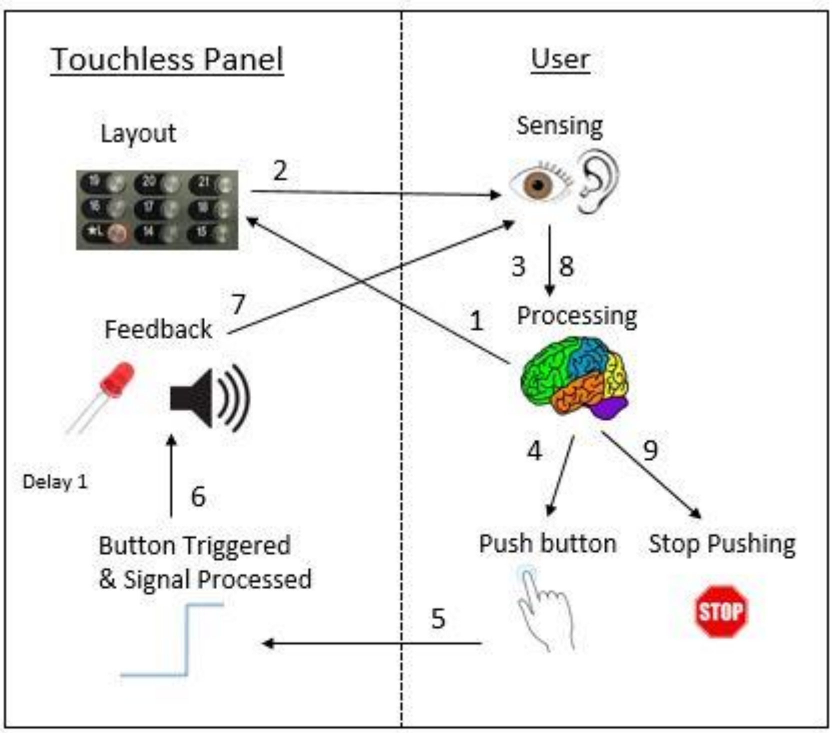

Figure 5: Panel-User interactions

Once the user has start the triggering action (Steps 1-6) the user must be given adequate feedback (Step 7) to ensure they stop the motion prior to touching any part of the panel (Steps 8 &9).

ALTERNATIVE DESIGNS

In our initial concept discussions, we explored the possibility of multiple types of proximity sensors to use before we decided to use lasers and photo-resistors as our sensing method. Mainly, we considered capacitive sensors since they are relatively common in electronics and had the range we were looking for. However, we were not convinced that the sensors would have the sensitivity to sense a finger through a few centimeters of glass or plastic before the user touches the surface. In addition to this, there is the problem of users trying to use the system while wearing gloves or using other parts of their bodies which are clothed to trigger the buttons, which would not work with a capacitive sensor (e.g. using a touch-screen phone with cotton gloves). Scalability would also be an issue with this method especially in comparison to our laser method, in that for every additional button we want to add to the panel we require another sensor; whereas a single laser can act as the signal source for multiple buttons.

We explored the possibility of having a completely flat panel in order to make cleaning of the system easy, however it was realized that this approach would give no indication to the user that the buttons are not intended to be touched, and therefore would not only create more of a learning curve for using the product, but also cause more users to touch the surface, defeating the purpose once again.

Another approach is to use existing infrared touchless frames, which employ several hundred infrared sensors positioned around a frame projecting parallel to a flat surface. These frames provide resolution in the order of millimeters and are easy to interface with by using built-in USB communication. Using such a frame would be interesting for a commercial system, since it allows the manufacturer to customize the number of buttons and their orientation in a multitude of orientations using the same frame. However, the cost of the system ranges from $100-$400 USD depending on the size and resolution desired. We do see the possible uses for such high resolution in our current design, but cannot justify the significantly higher cost it poses for what we believe to be marginal performance improvement. When thinking about scaling the design to much larger systems, this may be a viable solution to move forward with, once the cost of individual components approaches that of a frame.

3.2 Benefits

The main benefit CleanLift provides is reducing disease transmission in public spaces. Elevators in public spaces such as hospitals have been shown to be a significant source for bacteria colonization [1]. Introducing a touchless system will greatly reduce the risk of disease transmission of influenza, common colds, pneumonia, and many others. The benefits provided by CleanLift will be of particular importance to hospitals due an increased number of users with possibly contagious diseases as well as a high proportion of users with compromised immune systems. Another application that will see significant benefits from this technology is cruise ships as they often have disease outbreaks, and eliminating a source for disease spread will slow the transmission rate and lower the number of people infected before the end of the trip. High rises will also benefit from CleanLift as having a touchless panel will reduce anxiety for germ conscious users. Industrial settings can also benefit from a touchless system, as it will prevent users with contaminants or dirt on their hands from transferring it to the button surface.

The benefits as described above can be achieved at a cost which is reasonable in comparison to the current button panels implemented in elevators. This in itself will be a benefit for elevator companies which could use this technology in their products. The cost of lasers and photocells has become very low in the last decade; it costs about $10/unit for each component, and this cost can be further reduced with high volumes of manufacturing or purchasing. While this price is greater than a simple physical button, the margins which could be achieved by selling a state-of-the art technology with real benefits for healthcare and industrial institutions make it a worthwhile investment for elevator manufacturers. Healthcare institutions in particular are willing to make investments in products which will better the quality of care they provide to patients, and will actually reduce their own costs in the long run. Reducing the rate of hospital borne illness is something which institutions are always looking to do, and thus CleanLift will be of great interest to them.

3.3 Risks

The first risk that comes to mind for most people when it comes to the use of lasers, is possibility of eye damage as a result of their exposure to the retina. Obviously, the system must make it nearly impossible for the user's eye to ever cross paths with the beam of the laser, even if they deliberately tried to do so. For example, a child could attempt to look into the opening where the lasers are positioned out of curiosity. One common misconception with lasers is that they are visible in free space, however the light only becomes visible when the beam reflects against a surface.

Another risk associated with our system is that it adds a level of complexity which is greater than that of current mechanical button panels in elevators. With the use of lasers, photocells, and software to control the button operation, there is an increased risk of failure of the system as a result of the failure of one of these components. The reliability of these components is essential, and therefore high quality lasers and photocells must be used. In addition to the quality of the components, redundancy must be built into the product to ensure that it still functions in the event that one of the system components fails. This requirement is met in the Tier 3 design, where we employ multiple lasers in a bundle along the same path. In this arrangement, if one of the lasers or photocells fails, the other remaining functioning parts of the bundle will allow the system to continue proper operation.

4 Need, Market, and Competition

Population growth rates in the past decade are the highest that they have been in all of human history. High growth rates combined with population flow into cities are creating urban areas of high density - ideal breeding ground for viruses and the spread of diseases. The World Health Organization reports that in the past 20 years, more than 30 new diseases have been recognized [7]. Many of these and less recent diseases do not have cures and are contagious through contact; treatment for preventable diseases such as these is expensive and add unneeded stress to medical systems. Based on the information presented here and in previous sections, the cost of a CleanLift unit can be justified on the economic and societal benefits to our health care systems.

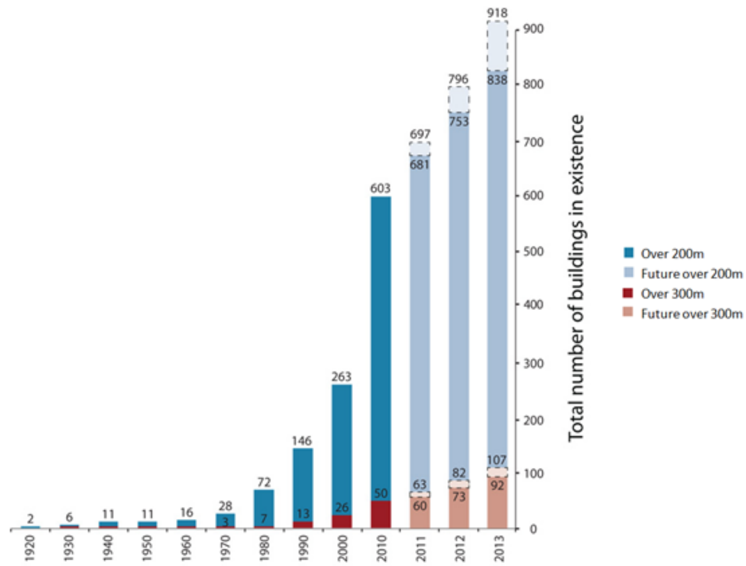

Figure 6: Number of skyscrapers around the world in 2010

The obvious hospital and medical buildings are not the only places where a CleanLift system would be beneficial. There are currently 425 high-rises above 50 meters [8] alongside the ten hospital or health institutions [9] in Vancouver, each with multiple elevators. As described above in section 2, isolated environments such as cruise ships are also possible markets for CleanLift. Another, secondary market, is industries where the main concern regarding common use items is not germs, but grease or dirt. Many manufacturing and factory environments have elevators, which can quickly get dirtied by workers' gloves or hands. Having a touchless system that works without needing the removal of gloves and other equipment would help create a cleaner and therefore safer environment.

The demand for elevators is exponentially increasing as shown by Figure 6, and each one could implement a CleanLift panel system. A major aspect of the design of CleanLift is ensuring that it is capable of being installed onto existing elevator panels, as well as being incorporated into new elevator. For a price comparison, SFU Bennet Library recently renovated one of the four elevators with new elevator button panels for both interior and exterior. After surveying a SFU facilities services staff, an exact cost from the contractors was not provided due to confidentiality but was said to be "thousands, close to ten, I believe". The library has only 6 stories, with one main panel for the interior and 6 exterior panels with only up and down buttons.

CleanLift's mechanical aspects will be relatively simple to manufacture, and mass production and bulk ordering of parts could easily cut down the per-unit price considerably. Setting CleanLift us as either a design licence or with Porcupine Solutions acting as an ODM would allow for this mass production and lowering of costs to occur more readily for a global market. Our estimated cost for an example elevator system as described above would cost closer to $800 – $1500, a tenth of what was described to us.

CleanLift provides unique benefits for consumers as the first of its kind. As populations continue to increase and urban centers become more densely inhabited, the necessity and importance such innovation will be a part of everyday living.

5 Budget

5.1 Parts Required

Throughout CleanLift's design and implementation process emphasis will be placed on prototyping and testing designs. All prototypes will be based off of a modular design intending to keep things easily modifiable and to also keep costs low. The three main aspects are the design are the panel enclosure, laser grid, and control & feedback module.

PANEL ENCLOSURE

This section requires plywood and paint for the initial mock-ups, and opaque plastic and plexiglass for the final prototype. We will also need to get screws and brackets for building the enclosure. Tools and equipment are not an issue as we will use the machine shop at SFU or borrow tools from family and friends to construct the enclosure.

LASER GRID

We aim to prototype a 9 button panel (7 floors and Door Open/Close), which requires 6 lasers and holders along with 6 photocells.

CONTROL &FEEDBACK

The project will use an Arduino Mega for control. For feedback we will use LEDs and sound if needed, which will be accomplished using a small buzzer.

5.2 Cost Breakdown

Table 2: Budget cost breakdown

Item	Cost per unit (CAD$)	Number	Cost	Tax	Total Cost	Product Information
Plexiglass	$5.00	2	$10.00	$1.20	$11.20	Plaskolite Model # 1S08104A
Opaque Plastic	$10.00	7	$70.00	$8.40	$78.40	Approx. size 8.5"*11"
Plywood	$18.46	1	$18.46	$2.22	$20.68	Home Depot cost for 4ft by 8ft
Screws					$20.00	
Paint					$20.00	
Lasers	$8.33	6	$49.98	$6.00	$55.98	Adafruit 5mW 650nm ID# 1054
Laser holder	$6.93	6	$41.58	$4.99	$46.57	Adafruit ID # 1094
Photo cell	$14.00	6	$84.00	$10.08	$94.08	Specific part not determined
Arduino Mega	$64.33	1	$64.33	$7.72	$72.05	Cost from Adafruit
LEDs	$1.00	9	$9.00	$1.08	$10.08	No specific part decided
Buzzer	$4.83	2	$9.66	$1.16	$10.82	Adafruit Piezo Buzzer - PS1240
Assorted Electronics					$10.00	
Sub Total					$449.86	
Shipping					$30.00	
Contingency (20%)					$88.97	
Total					$569.83	

Research was done to determine the approximate cost of the items required for our project. In certain cases, such as with the Arduino Mega, we have already selected a specific product we would like to use. For other items a specific product has not yet been selected, so for the purpose of creating a budget we compared several of the options on the market to determine a reasonable estimate to put in our budget.

5.3 Funding

Our main source of funding is the ESSEF, from which we have received $399. We are also planning on making use of the ESSEF Parts Library to source the Arduino Mega for our project, reducing our total remaining cost from $569.83 to $497.78 (keeping contingency and shipping costs constant). With current ESSEF funding our remaining expenses are $98.78, which be split equally between members, or we will apply for reimbursement from the Wighton Fund later on in the development process.

6 Time Schedule

The projected schedule for CleanLift has been broken up into two main sections: ENSC 305W deliverables and Design/Prototyping, as described below in Table 3. To ensure project completion before our ENSC 440W demo, all goals and deliverables are scheduled to complete by or before April 1st, 2016.

Table 3: CleanLift goals and deliverables

Section	Task	Complete By
Design/Prototyping	Research	February 1st, 2016
	Single Button Prototype	January 25th, 2016
	Plywood Prototype	March 14th, 2016
	Plastic Prototype	March 21st, 2016
	Usability Testing/Debugging	March 30th, 2016
	Additional Features	March 30th, 2016
	Demo Preparation	April 1st, 2016
Deliverables	Project Proposal	January 25th, 2016
	Functional Specification	February 15th, 2016
	Design Review	February 19th, 2016
	Design Specification	March 7th, 2016
	Progress Report	March 28th, 2016
	Test Plan	April 1st, 2016
	Post Mortem	April 1st, 2016
	Demo	April 1st, 2016

The timeline for these goals are further broken down by Figure 7, which is a Gantt chart describing the duration (in weeks) of each task and the projected completion timeframe. Figure 8 takes the major goals of the project and lines them up by completion date on a Milestone chart, with the height of each marker detailing the effort required.

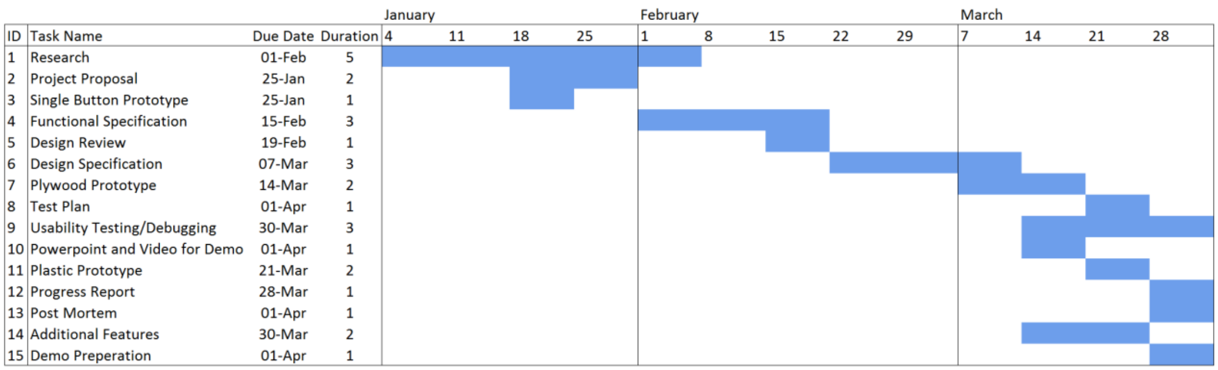

Figure 7: CleanLift Gantt chart

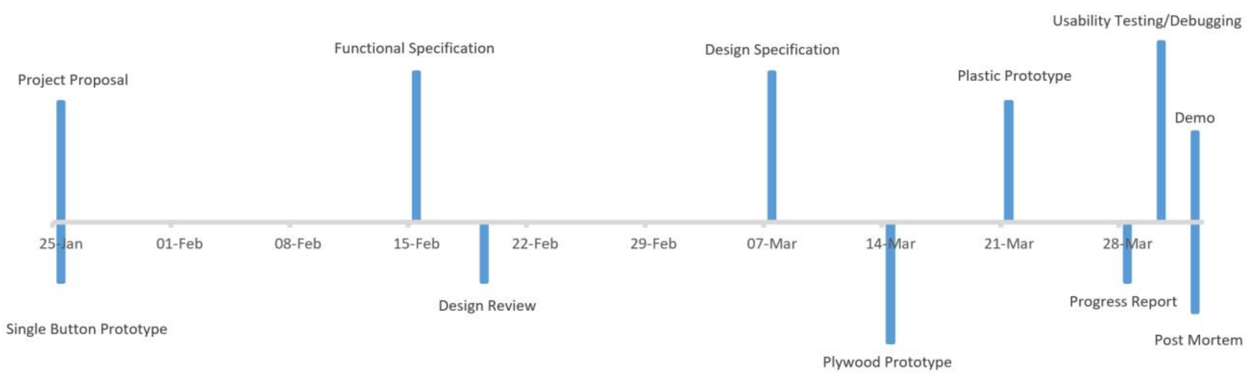

Figure 8: CleanLift Milestone chart

7 Team

CEO – Ryan Goldan

Ryan is a fifth year Biomedical Engineering student with a focus in medical image acquisition and processing. He has experience with designing electro-mechanical system prototypes and testing devices from his time at Motion Metrics International Corporation, where he spearheaded two projects to develop demo models of products developed by the product engineering team. He is excited about the potential of Porcupine Solutions, and believes that CleanLift will be a useful and revolutionary product.

CTO – Elizabeth Durward

Elizabeth is a fifth year Systems Engineering student. She gained experience with product design and initial prototyping while working as part of a team developing smart sensors. Elizabeth also has experience with Accelerated Lifetime Testing and empirical modeling and plans to put her statistical knowledge to use in this project during the testing phase. She is excited to put her skills to work developing CleanLift.

CCO – Lauren Jackson

Lauren is a fifth year Systems Engineering student with an interest in computer-human interactions, explored through her minor in Computer Science. Her experience working with and helping manage a small team at Sierra Wireless, together with her time on the executive of two different conferences has given her practice in project management that she is excited to apply during the development of CleanLift and the growth of Porcupine Solutions.

CFO – Simon Huang

Simon is a fifth year Systems Engineering student with a passion in innovative tech.His time with Nav Canada as a systems engineer providing specification design proposals and instrument purchasing came along with experiences for tight budgeting and analysis of alternative solutions. He is also team lead on an ongoing mobile application project with a heavy focus on user interface and experience. He is thrilled to apply his experience to perfecting CleanLift for potential markets.

8 Conclusion

Porcupine solutions is designing and prototyping CleanLift – a touchless elevator panel – to replace the conventional button style elevator panels. Implementation will be straightforward, with a laser grid creating a set of intersections, each acting as a virtual button. Extensive brainstorming and testing will be completed to ensure an excellent user experience and to create designs that are intuitive and easy for first time users, while being reliable and consistent for frequent users. To ensure that users do not touch the display, feedback methods such as light, sound and tactile air-puffs will be considered.

Our touchless elevator system will decrease disease spread in high risk locations, such as hospitals, by removing bacterial spread from elevator buttons which have been shown to have surprisingly high levels of bacteria [1]. Hospitals are a crucial market because they have high traffic rates of users that may be ill or have weakened immune systems. Another application of this technology is on cruise ships as they often have rapid virus outbreaks; CleanLift will help minimize the risk of bacterial transmission and slow down outbreak rate. High-rise apartment buildings are another market that would benefit from touchless elevator panels, however the benefits are less critical in a residential setting, thus the price would need to be comparable to conventional button systems in order to be competitive in this market. We foresee this to be possible with large scale manufacturing of panels. The system also has applications in industrial settings where users may have dirty hands or gloves; having touchless controls will prevent users from having to remove their gloves or clean their hands to avoid getting the buttons dirty. As demonstrated, CleanLift has the ability to reach several large markets with its many applications.

CleanLift will change the landscape of hygienic technology and act as a catalyst for further innovations in the field.

9 References

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10 Glossary

Term	Description
CCO	Chief Communications Officer
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CTO	Chief Technical Officer
ESSEF	Engineering Science Student Endowment Fund
I/O	Input/Output
LEDs	Light Emitting Diodes
ODM	Original Design Manufacturer: a company that designs and manufactures a product to be specified and branded by another firm for sale
SFU	Simon Fraser University
USB	Universal Serial Bus
USD	US Dollars