ROBOTEX

Dr. Robert Dony, PhD, P.Eng.
University of Guelph
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Dear Dr. Robert Dony,

COVID-19 is a widely and rapidly spreading disease caused by a newly discovered virus known as coronavirus. Governments and health professionals are working together to defeat the virus. Currently, people are required to wear face covering and a routine check of their temperature and any related symptoms at the entrance of stores, clinics and other public places have been made mandatory. It was brought to our attention that the workers responsible for checking all the people entering the building are highly exposed to the virus, which puts their and other lives in greater danger.

ROBOTEX is interested in reducing the spread of COVID-19 by reducing people's exposure to the virus—hence, the front- line workers. We also want to ensure that the required safety measures, including wearing a mask, regular temperature checks and the allowed number of people, are accurately done to limit the spread.

ROBOTEX plans on approaching the problem by implementing a device that can be placed at the front door of any public building. Its role is to measure the customer's temperature, check for appropriate face covering and keep a count of the people currently within the building.

Altogether, ROBOTEX's goal is to stop the spread of COVID-19 through a safe and efficient approach. Your support and guidance are highly appreciated.

Sincerely,

Aarthi Christina Aruliah

Layal Alzaydi

Lina Shaabo

Nasiba Alchach

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ENGG*3100 – Engineering and Design III - W21

Design Proposal – Automated COVID Screening Entrance Device

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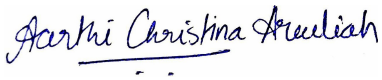
In signing this report, I certify that I have been an active member of the team and provided approximately equal contribution to the work. I take shared credit and responsibility for the content of this report. I understand that taking credit for work that is not my own is a form of academic misconduct and will be treated as such.

___ **Aarthi Aruliah** ____ 

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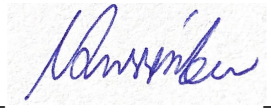
Team Member Three Name Team Member Three Signature

___ **Nasiba Alchach** ____ ____  _____

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Team Member Five Name Team Member Five Signature

___ **February 5^{th}2021** ___

Date

Executive Summary

The recent coronavirus pandemic has been an eye-opener to the world and has brought our everyday hygienic practices to attention as the mode of transmission of this disease is through infected respiratory droplets. Different world governments have enforced many restrictions and health measures to control the spread and safeguard society. Some of the standard measures taken include wearing a mask at public places, maintaining social distance, sanitizing hands, and checking body temperature when entering. This screening test at store entrances has been assigned to essential frontline workers. Due to such exposure, this poses a threat to both these workers and the customers as well.

To resolve this issue, the team of engineers at ROBOTEX proposes a design of an automated machine that will perform the screening test without the need for a worker to be there. This product will test for temperature and a mask and keep a count of the number of people currently within that building. This number will be checked, and a barrier would be put up if the number reaches the allowed maximum number of people. This will ensure a safe operating environment for store owners and customers. Moreover, customers can either view the current number on the shop windows or in an app connected to the product used.

Before seeking the solution's specifics, this proposal explains the problem and criteria and constraints that must be met. Furthermore, the plan for approaching the solution's design and the appropriate tasks and goals with their respective time frames are determined. This sets the stage for developing such a revolutionary product that will play its part in saving lives.

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1.0 Problem Definition

1.1 Problem Description

COVID-19 is a respiratory disease caused by the SARS-CoV2 virus (Huang et. al, 2019). It provides flu-like symptoms to those who have it, such as a cough, sneeze, or fever (CDC, 2020a). The main form of transmission is respiratory particles in the form of droplets that can be released from an infected person if they talk, sneeze, or cough (CDC, 2020b). This disease has caused a pandemic within the last year and has sent many countries into a harsh lockdown, where everyone who could work from home doing so (Financial Times, 2021). However, the exemption of this was with essential workers, who remained working to maintain the key aspects that society needed to function. These included those working in lower-wage areas, such as grocery stores, fast food, and more (Government of Canada, 2021). Unfortunately, these lower-wage jobs were the ones who were more impacted by the economic crash that COVID caused (Statistics Canada, 2020).

With the essential workers continuing to work and interact with customers daily, this places them at a higher risk of contracting the disease. Even as the months went by and screening technology became implemented, those who worked with direct customer exposure were five times more likely to become infected (Lan et. al, 2020). This poses a risk not just to employees but also to the large traffic of customers they interact with daily from a health and safety perspective. Considering that in the US, 50% of these workers are unable to receive paid sick leave(BLS, 2018), along with the fact that unemployment rates doubled since quarantine started (Statistics Canada, 2020), many would still feel pressured to show up to their job even if they feel ill or anxious about the pandemic (Bhattarai, 2020). The government recommended certain protocols to put into place to increase health safety, such as wearing a mask when leaving the house, as it has proven to be an effective control measure (Greenhalgh et al., 2020).

For many large retail stores such as Walmart, there are rules in place saying that face masks are required for entry- however, there have been contradictions to that as well. Employees have reported that even though stores say this, there is no way to enforce it. Out of concern for their staff safety, stores have told employees that they should not refuse entry or even confront a customer who comes in maskless (Corkery, 2020; Meyersohn 2020). It has also been observed

that around 4% of customers also refuse to wear a mask or wear them ineffectively (Haischer et al., 2020). This raises concerns about their policies' efficiency then since it still exposes those inside to the same amount of risk. Besides, for stores like Walmart, no system set up would account for those who do have COVID from coming into the store, should they be wearing a face mask or not (Walmart, 2020).

The economic impacts of this can be huge, especially considering pre-existing losses that were experienced last March. Should a potential employee test positive, the Public Health Agency of Canada strongly advises a thorough disinfection process of the store to ensure that potential transmission is minimalized (Region of Peel, n.d.). Doing so can mean closing the store for a day- which loses a day's worth of revenue. For smaller, local stores that are already struggling, this only causes further damage. One of the social impacts that play into the problem is that employees are experiencing an increase in anxiety and depression (De Boni, 2020). This may be due to the high exposure they're forced to endure for their job, but it can also be linked to the high amounts of aggression and violence since the pandemic came, especially if they're a minority (Statistics Canada, 2020). The anxiety is felt by customers as well- 60% of people in the US have said that since the virus hit, they've felt anxious going into a grocery store (C+R, 2020).

While there are little to no environmental impacts on this issue, it still poses a threat to store owners due to the other aspects mentioned. Even though policies and systems have been implemented, there still poses a need to develop a system that would allow customers to enjoy a safer shopping space and reduce the spread of COVID-19.

1.2 Background Information and Literature Review

With many forms of PPE being implemented into stores, such as mandating facial masks, sanitizing hands, and social distancing, those factors alone are difficult to facilitate, especially to stores that receive heavy traffic forms every day.

It becomes difficult to regulate what counts as an “effective” face mask as many people may wear them incorrectly, rendering the PPE useless (Haischer et al., 2020). In addition to that, there is a large percentage of people who fail to follow WHO’s recommendations for appropriate mask measures (Machida et al., 2020).

A company that has offered a potential solution is Category 5, a Canadian business that has developed an effective screening technology that monitors the temperature, proper mask usage, and more. This is done by using a thermographic camera that can detect temperatures with high accuracy within 1-2 seconds. The pros of this technology are that it allows group scanning, making it faster to allow entryway into and out of the store. Should a high temperature be detected, it will notify employees (Category 5, n.d.). In addition to that, another company called PredictMedix has implemented a similar screening technology. It also keeps an eye out for other COVID-like symptoms, such as coughing or a heavy breathing rate, while only requiring a bandwidth of 25 Mbps to operate (Predict Medix, n.d.). However, the problem with these existing designs is that there are no ways of controlling whether the infected individual is allowed to enter the store or not. Current designs say that they leave it up to the business owner to determine what will happen when they are notified and say that they can approach the customer and politely ask them to leave. This means direct exposure, and since they were alerted in the first place that the customer has a high chance of COVID, this provides a high chance for the employee to contract the virus.

Thus, to ensure that customers are wearing their masks correctly and that they are screened for COVID in a non-contact like manner, some system would need to be implemented that is purely technological. This prevents employees from being directly exposed to customers and allows for a safer and friendlier approach to confront those who are wearing their masks improperly. Doing so can reduce anxious feelings within employees, as well as other customers. The store can also continue operations smoothly, and these features can be used as a selling point to attract customers due to the increased level of safety provided that other stores lack. Also, finding a method to analyze other symptoms of COVID can be another design aspect to prevent those who have it from entering the store and potentially spreading the disease even more.

1.3 Scope of Project

The problem dealt with in this project, in short, is to reduce the spread of COVID-19 in public frequented places like retail stores and grocery shops by maintaining public health measures and restrictions that are being enforced. The project aims to ensure that the checking of temperature, mask, and the number of people in a store is done effectively and efficiently without a front-line worker being exposed to all the customers entering the store. Working on this aim, this project's scope is to create an engineering solution that would help store owners operate in a safer environment and provide a sense of security to the customers by verifying that the protocol for entering the store is followed. The solution's design and specifications must be finalized before and submitted on the 2nd of April 2021. The design will include a control system with sensors that measure temperature, detect a mask, and update the count. In the case of the count reaching the allowed maximum capacity, a mechanism would create a barrier to prevent from entering.

Along with this, including a sanitization station for customers when entering would prove to be beneficial and will maintain hygiene. As design engineers, we aspire to optimize this process, keeping in mind the government and community safety regulations. Another main focus to apprise shoppers would be identifying a way to incorporate useful information such as the number of people currently in the store displayed on an electronic display board/screen and an app that the public can access.

There are many cases where temperature screening to detect coronavirus disease has proven ineffective as infected individuals can also either be asymptomatic or in incubation period (W.H.O., 2020). In this case it lies outside the scope of this project. Additionally, this project does not extend to ensure that people within the store are wearing their masks the entire time as it depends on the type of cameras being used within the store, angle and range of detection, and access to data. Ultimately, this project's main scope is to create an automated machine that can be used at the entrance of stores in place of a front-line worker to reduce the risk of COVID-19 transmission.

1.4 Constraints and Criteria

Our constraints and criteria are dedicated to protecting front-line workers, the environment, and everyone in the community. To make the device highly accessible, the team promotes the device by making it safe, accurate, and cost-effective. ***Tables 1*** and ***2*** below demonstrate the constraints and criteria of the design solution set to design a successful device that helps with the detection of COVID-19. The assumptions that the team has made in regard to defining the problem are all listed below.

Table 1. Constraints of the Design Solution

#	Constraint	Explanation
1	The materials used to construct the design solution should minimize environmental impact.	This helps promote the device as the design solution ensures to keep the environment safe regardless of the location.
2	The design solution must have the ability to extend itself accordingly or be accessible to all demographics.	This ensures that the device is accessible to people of different heights.
3	The design solution must be safe and easy to use.	This helps promote the device as the design solution will require less training and will therefore be more widely used.
4	The design solution must serve as an effective alternative compared to pre-existing measures.	The ability to detect for masks and measure temperature.
5	The design solution must serve as a worry-free alternative.	The ability to function efficiently in order to replace front-line workers and therefore improves mental health.

6	The device must be able to use face detection.	This ensures that public health measures and restrictions are followed by everyone entering the public space.
7	The device must have a spill-free container that can function automatically.	This gives the user the accessibility to safely add alcohol-free hand sanitizers at their entrance.

Table 2. Criteria of the Design Solution

#	Criteria	Explanation
1	Minimize cost of the design.	If the cost is unreasonable, the device will not be able to be implemented or may not be widely used regardless of its effectiveness.
2	Minimize size of structure.	This ensures that the device is accessible to various stores and clinics since it is easier to carry and move around.
3	Maximize accuracy of mask detector.	This ensures that the design solution protects the front-line workers by being an effective alternative.
4	Maximize the accuracy of the thermometer.	In order to achieve satisfying results, the thermometer would need to be used correctly in order for them to be as accurate as other thermometers, such as oral and rectal thermometers.
5	Minimize the complexity of design.	Complex designs are more expensive and require high maintenance.

6	Maximize accuracy of the collection of COVID-19 data.	False data is a concern to the government, the health professionals and everyone in the community.
7	Maximize rate of detection.	The design should allow for fast detection or multiple detections at once to allow for a smooth process and prevent any delays.

2.0 Plan for Information Gathering and Approach to Design

2.1 Overview of Proposed Approach to Solving Problem

When solving a complex problem, the design process is highly essential in designing an achievable solution. The design process consists of steps that must be pursued to establish an efficient result. The main steps in the design process involve defining the problem, gathering information, determining the contains and criteria, developing possible solutions and creating a decision matrix to enable choosing the best solution and developing it, and finally communicating the results.

The first and one of the most important steps in the design process is to define the problem. The particular problem existed because of the recent pandemic of COVID-19 as the front-line workers are assigned at the entrance of the stores to check if customers are following the restrictions and measures taken to prevent the transmission of the disease including wearing a mask, regular temperature check and making sure that the allowed number of customer are in the store. Thus, the situation puts the workers at a higher risk of exposure to the disease. The proposed solution is to design an efficient, accurate, and cost-effective automated device that performs all tasks done by the workers to eliminate the risk which yields to the stated constraints and criteria to solve the identified problem. The next move is to conduct a thorough background research about how the COVID-19 virus is transmitted through the air, the temperature range that is associated with the COVID symptoms, and if there are any existing older versions of the product to find out about any current defects and drawbacks to avoid similar problems. Primary research shows that the previous solution by Category 5 (Category 5, n.d.) and Predict Medix

(Predict Medix, n.d.) does not detect if the customer is wearing a mask, restrict the entrance of customers who are detected for symptoms, and does not have a mobile application that displays the live capacity of the stores to minimize the waiting time of the customer outside the store. The following step would be to meet the constraints and criteria which were developed from the conducted primary research. Multiple trials of improvements on the design and re-evaluating the design will be constantly conducted as part of the design process which will lead to a feasible solution.

2.2 Required Information and Tools

To assure that the designed product is suitable for most of the clients, some information might be required depending on the selected design solution. Different stores might have to provide the dimensions of their entrance doors which would assist to produce a better, suitable, and dynamic design for clients. This information can be obtained from megastores, pharmacies, malls, etc. Clients will be able to input the maximum capacity of customers depending on their given area and COVID measures. Moreover, in regard to the mobile application, clients are requested to sign an agreement contract that allows the device to send data to the ROBOTEX database in order to update the mobile application for customers to view the live capacity of the stores.

Various tools are required in modeling and designing the product to prepare an effective and feasible design solution:

1. SolidWorks

SolidWorks will be used for planning, modeling the system and components, prototyping, and visualizing by creating a 3D model of the product and its components (CAD MicroSolutions Inc).

2. EAGLE

Easily Applicable Graphical Layout Editor is a scriptable electronic design automation (EDA) application software will be used to connect electrical schematic diagrams with printed

circuit boards (*EAGLE: PCB design and Electrical SCHEMATIC SOFTWARE*).

3. Integrated Development Environments, Code Editors, and Virtual Environments

IDES, Code editors, and Virtual Environments will be used to create, edit, compile and execute codes. It will be used to create the mobile app. Virtual Environments will be used to install the required packages and execute the scripts.

The product needs to be approved by Health Canada under COVID-19 medical devices. (Canada, 2021).

3.0 Schedule and Fee Estimate for Design

3.1 Tasks and timelines

Working with others consists of solving unexpected challenges and learning from mistakes along the way. For our team to accomplish the ultimate goal for the project, a Gantt Chart (**Appendix A**) and a reference table with the critical deadlines (***Table 3***) were constructed to outline the tasks that the team members had to accomplish.

Table 3. Critical Deadlines

#	Assessment	Start Date	Due Date
1	**Design Process**	18/01/2021	12/04/2021
2	**Team and Project Selection**	22/01/2021	24/01/2021
3	**Design Proposal**	24/01/2021	5/02/2021
4	**Interim Design Report**	5/02/2021	26/02/2021
5	**Technical Memo**	26/02/2021	12/03/2021
6	**Design Presentation**	12/03/2021	19/03/2021
7	**Final Design Report**	26/03/2021	02/04/2021

3.2 Key milestones and deliverables

Table 4. Key Milestones and Deliverables

#	Deliverables	Key Milestones Working time per weeks
1	**Team and Project Selection**	**1**
	Start the process, form a group, and plan ideas.	
2	**Design proposal**	**2**
	Identify the problem, brainstorm to find a solution, estimate timeline, and fees.	
3	**Interim Design Report**	**2**
	Highlight the details for different solutions and explain the design based on the constraints and criteria.	
4	**Technical Memo**	**3**
	Explain in depth the calculations, and show evidence of the safety and functionality of the design	
5	**Design Presentation**	**1**
	Present the designed solution to the problem.	
6	**Final Design Report**	**3**
	Report the designed solution to the problem.	
	Total	**12**

3.3 Roles and responsibilities of team members

To avoid unbalanced workloads and conflicts, tasks were divided equally between the team members. The following table (**Table 5**) demonstrates the responsibilities of each member depending on their areas of study and specific interests.

Table 5. Roles and Responsibilities of Team Members

#	Name	Role	Responsibilities
1	**Aarthi Aruliah**	Manufacturing and Controls Engineer	●Researches the most appropriate types of equipment for the project according to their efficiency and availability. ●Ensures that the workers' safety is a priority to everyone on the team by researching and writing a detailed instruction manual that enforces safety rules. ●Ensure that high-quality products are designed and manufactured for the design solution. This must be done by researching current technologies and techniques. ●Responsible for designing and building the design solution using engineering computer programs, such as SOLIDWORKS.
2	**Layal Alzaydi**	Technical Developer and Process Control Engineer	●Analyzes the customers' needs by testing and developing software accordingly. ●Responsible for the storage and manipulation of the team's data required for the project. ●Ensures that the mask detector and the thermometer are appropriately functioning and works towards ultimate accuracy. This must be done by investigating different software applications and tracking new software upgrades. ●Responsible for writing and testing the codes needed to implement the design solution.

3	**Lina Shaabo**	Process and Cost Engineer	●Budget, plan and monitor the costs of the project to ensure the costs are reasonable and works towards a cost-effective design solution. ●Responsible for cost forecasting, investment appraisal and risk analysis. ●Applies science principles and techniques to problems of estimation. ●Trains all team members as the implementations are completed and ensures a smooth transition for current payroll. ●Develops and implements Project/AFE cost work breakdown structure (WBS) metrics and tools, tracking data, analyzing and reporting.
4	**Nasiba Alchach**	Project Manager and Design Engineer	●Responsible for formatting the report and outlining critical deadlines. ●Ensures tasks are equally distributed between the team members. ●Responsible for the overall design of the device. This must be done by conducting brainstorming sessions to ensure that the design alternatives and suggestions by all team members are taken into account and outlined in the interim report. ●Researches and develops ideas for a creative product and works towards ultimate simplicity. ●Defines the systems that need to be used to create prototypes, such as CAD and CAE software.
5	**Whitney Trinh**	Environmental Health Manager	●Researches and examines different materials to find which one meets design criteria while also having the lowest environmental damage.

			●Helps minimize the negative effects on the environment caused by production and transportation. This must be done by conducting a life cycle analysis and optimizing distribution methods. ●Develops detailed design drawings that can be used to showcase functionality.

3.4 Fee estimate for design and required deliverables

As demonstrated by the table in **Appendix B**, the total amount of time spent in the project is scheduled to be 279 hours. Since the average cost for a junior engineer in training is $40 per hour based on talent.com, our design's approximate cost would be $11440, excluding the other tools and resources used during the design phase.

4.0 Next Step

The main step soon after the proposal is to come up with conceptual designs and decide as a team on which one is optimal. This will be done through research, analyzing backgrounds comparing materials, calculations and feasibility. Code editing and 3D design tools, sketches will also be used for projecting ideas and for better understanding for various designs. The next main focus in the project design would be how to integrate different components such as the temperature sensor, mask detector, the counter, the barrier. Moreover, a method for incorporating the data from the counter into an app will also be looked into. The process of the design selection will be detailed in the interim design report that is due on the 26th of February 2021.

5.0 References

Bhattarai, A. (2020, April 12). *'It feels like a war zone': As more of them die, grocery workers increasingly fear showing up at work.* The Washington Post. https://www.washingtonpost.com/business/2020/04/12/grocery-worker-fear-death-coronavirus/

BLS. (2018, March). *Employee Benefits Survey.* U.S. Bureau of Labour Statistics. https://www.bls.gov/ncs/ebs/benefits/2018/ownership/civilian/table32a.htm

C+R. (2020). *Changes in Grocery Shopping Habits during COVID-19.* C+R Research. https://www.crresearch.com/coronavirus-shopping-habits

Category 5. (n.d). *Thermal Imaging Camera Integration.* Category 5 COVID-19 Solutions.https://www.category5.ca/thermal-covid-19

Canada, H. (2021, January 28). Government of Canada. Retrieved February 06, 2021, from https://www.canada.ca/en/health-canada/services/drugs-health-products/covid19-industry/medical-devices/non-contact-infrared-thermometers.html

CDC. (2020, Dec 22). *Symptoms of coronavirus*. Centers for Disease Control and Prevention. https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

Corkery, M. (2020, July 29). *A Wrinkle in Stores' Mask Policies: Enforcement.* The New York Times. https://www.nytimes.com/2020/07/29/business/coronavirus-masks-stores-walmart.html

CAD MicroSolutions Inc. (n.d.). SOLIDWORKS 3D CAD. Retrieved February 06, 2021, from https://www.cadmicro.com/solidworks/3dcad?gclid=CjwKCAiA9vOABhBfEiwATCi7GOtETKmAH9VQ17sQkg5vy6dh8zvBB0c4yO3D-eqWZ1Pgx6lcTXjx1hoCHC4QAvD_BwE

De Boni, R. B., Balanzá-Martínez, V., Mota J. C., Cardoso, T. D. A., Ballester, P., Atienza-Carbonell, B., Bastos, F. I., Kapczinski, F. (2020). Depression, Anxiety, and Lifestyle Among Essential Workers: A Web Survey From Brazil and Spain During the COVID-19 Pandemic. *J Med Internet Res*. 22(*10*). doi: 10.2196/22835. https://www.jmir.org/2020/10/e22835

EAGLE: PCB design and Electrical SCHEMATIC SOFTWARE. (n.d.). Retrieved February 06, 2021, from https://www.autodesk.ca/en/products/eagle/overview?plc=F360&term=1-YEAR&support=ADVANCED&quantity=1

Financial Times. (2021, Feb 3). *Lockdowns compared: tracking governments' coronavirus responses*. Financial Times. https://ig.ft.com/coronavirus-lockdowns/

Government of Canada. (2021, Jan 15). *Guidance on Essential Services and Functions in Canada During the COVID-19 Pandemic.* Public Safety Canada. https://www.publicsafety.gc.ca/cnt/ntnl-scrt/crtcl-nfrstrctr/esf-sfe-en.aspx

Greenhalgh T., Schmid M. B., Czypionka T., Bassler D., Gruer L. (2020). Face masks for the public during the covid-19 crisis. *BMJ. 369*. https://doi.org/10.1136/bmj.m1435

Haischer M. H., Beilfuss R., Hart M. R., Opielinski L., Wrucke D., Zirgaitis, G., Uhrich, T. D., Hunter, S. K . (2020) Who is wearing a mask? Gender-, age-, and location-related differences during the COVID-19 pandemic*. PLOS ONE* 15(*10*). https://doi.org/10.1371/journal.pone.0240785

He, X., Lau, E.H.Y., Wu, P., Deng, X., Wang, J., Hao, X., Lau, Y. C., Wong, J., Guan, Y., Tan, X., Mo, X., Chen, Y., Liao, B., Chen, W., Hu, F., Zhang, Q., Zhong, M., Wu, Y., Zhao, L., Zhan, F., Cowling, B. J., Li, F., Leung, G. M. (2020). Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nat Med 26*, 672–675 . https://doi.org/10.1038/s41591-020-0869-5

Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zhang, L., Fan, G., Xu, J., Gu, X., Cheng, Z., Yu, T., Xia, J., Wei, Y., Wu, W., Xie, X., Yin, W., Li, H., Liu, M., Xiao, Y., Gao, H., Guo, L., Xie, J., Wang, G., Jiang, R., Gao, Z., Jin, Q., Wang, J., Cao, B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet (London, England)*, *395*(10223), 497–506. https://doi.org/10.1016/S0140-6736(20)30183-5

Lan F., Suharlim, C., Kales S.N., Yang, J. (2020) Association between SARS-CoV-2 infection, exposure risk and mental health among a cohort of essential retail workers in the USA. *Occupational and Environmental Medicine.* doi: 10.1136/oemed-2020-106774

Machida, M., Nakamura, I., Saito, R., Nakaya, T., Hanibuchi, T., Takamiya, T., Odagiri, Y., Fukushima, N., Kikuchi, H., Amagasa, S., Kojima, T., Watanabe, H., & Inoue, S. (2020). Incorrect Use of Face Masks during the Current COVID-19 Pandemic among the General Public in Japan. *International journal of environmental research and public health*, 17(*18*), 6484. https://doi.org/10.3390/ijerph17186484

Meyersohn, N. (2020, July 26). *Walmart and others will still serve customers who refuse to wear masks, despite new rules.* CNN Business. https://www.cnn.com/2020/07/24/business/masks-walmart-home-depot-lowes-cvs/index.html

Predict Medix. (n.d). *Infectious Diseases Screening Solutions.* Predict Medix. https://predictmedix.com/infectious-disease-screening-solution/

Region of Peel. (n.d). *Update on the Novel Coronavirus in Peel*. Peel Region.

https://www.peelregion.ca/coronavirus/business/pdf/COVID-19-positive-case-workplace.pdf

Statistics Canada. (2020, Oct 20). *The health impacts of COVID-19 go beyond the effects of the virus.* Statistics Canada. https://www150.statcan.gc.ca/n1/pub/11-631-x/2020004/conclusions-eng.htm

W.H.O. (2020, February 29). Updated who recommendations for international traffic in relation To COVID-19 outbreak. https://www.who.int/news-room/articles-detail/updated-who-recommendations-for-international-traffic-in-relation-to-covid-19-outbreak

Walmart. (2020, Nov 23). *Important Store Info*. Walmart Co. https://corporate.walmart.com/important-store-info

Junior+engineer salary in Canada - average salary. (n.d.). Retrieved February 06, 2021, from https://ca.talent.com/salary?job=junior%2Bengineer#:~:text=The%20average%20junior%20engineer%20salary%20in%20Canada%20is,year%20or%20%2428.21%20per%20hour.

6.0 Appendices

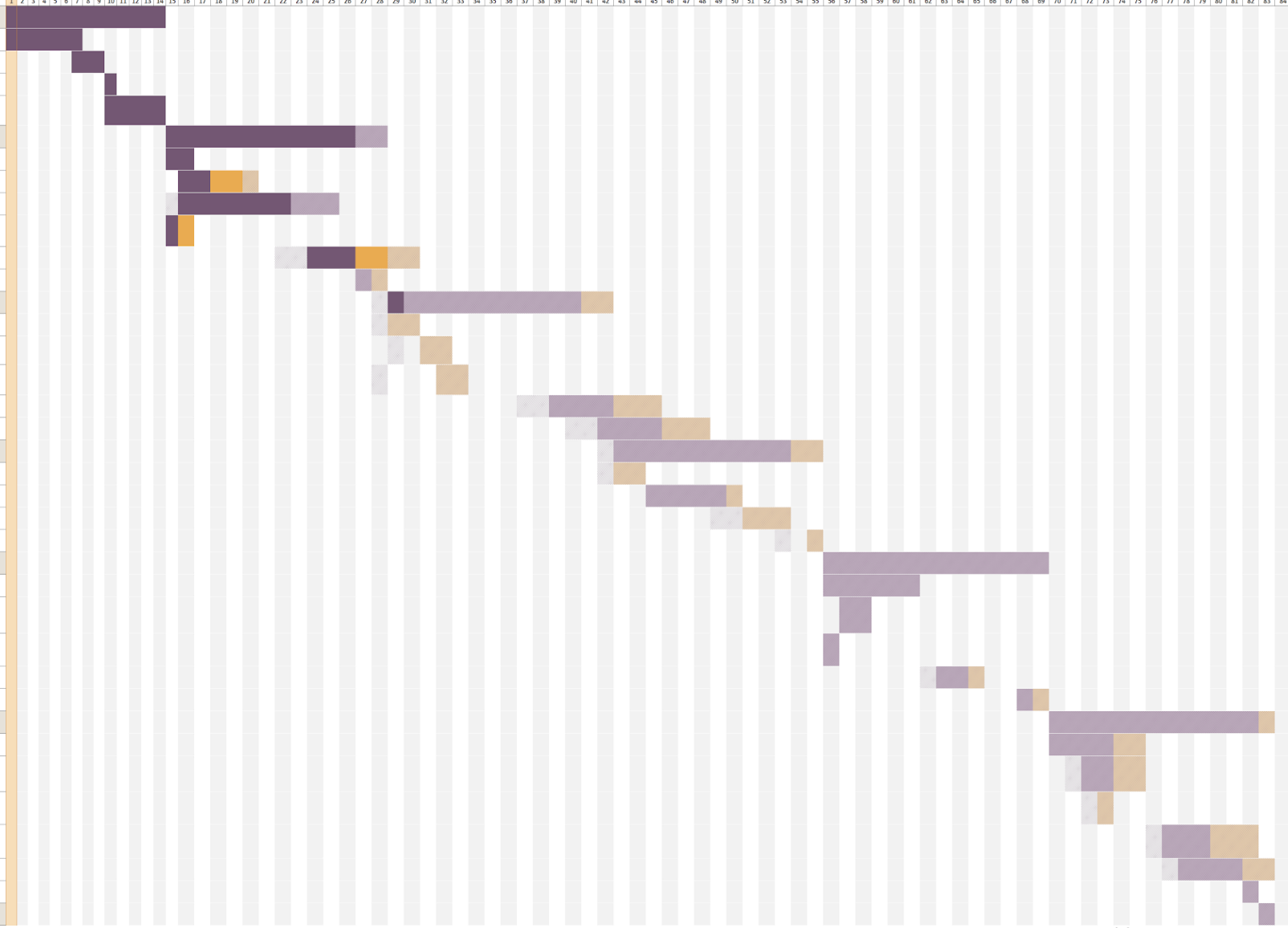
6.1 Appendix A: Gantt Chart

GANTT CHART

Passion. Purpose. Progress.

Period Highlight: 1 | Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Team and Project Selection	1	14	1	14	100%
Define individual interests	1	7	1	7	100%
Team selection	7	3	7	3	100%
Coordination Meeting	10	1	10	1	100%
Final project selection and submission	10	5	10	5	100%
Design Proposal	15	14	15	14	90%
Coordination meeting	15	2	15	2	100%
Problem Definition	16	2	16	5	90%
Research and information Gathering	15	11	16	10	75%
Divide tasks and reponsibilities among team members	15	1	15	2	100%
Write and format the proposal	22	5	24	7	80%
Final edits and submission	27	1	27	2	0%
Interim Report	28	13	29	14	10%
Coordination Meeting	28	1	29	2	0%
Discuss, review and reflect on design proposal	29	1	31	2	0%
Divide tasks and reponsibilities among team members	28	1	32	2	0%
Write and format the proposal	37	6	39	7	0%
Final edits and submission	40	6	42	7	0%
Technical Memo	42	12	43	13	0%
Coordination Meeting	42	1	43	2	0%
Generation of the technical draft memo	45	5	45	6	0%
Review and edit	49	2	51	3	0%
Final edits and submission	53	0.5	55	1	0%
Design Presentation	56	14	56	14	0%
Coordination Meeting	56	6	56	6	0%
Discuss, review and reflect on previous reports	57	2	57	2	0%
Divide tasks and reponsibilities among team members	56	1	56	1	0%
Generation of the draft presentation	62	3	63	3	0%
Final edits and submission	68	1	68	2	0%
Final Design Report	70	13	70	14	0%
Coordination Meeting	70	4	70	6	0%
Discuss, review and reflect on all previous reports	71	3	72	4	0%
Divide tasks and reponsibilities among team members	72	1	73	1	0%
Finalize the detailed constraints, criteria and design	76	4	77	6	0%
Write and format the report	77	5	78	6	0%
Final review, edits and submission	82	0.2	82	1	0%
Celebrate	83	1	83	1	0%



6.2 Appendix B: Fee estimate for design and required deliverables

#	Deliverable		Activity	Team Member					total	
				Layal 40$/H	Tina 40$/H	Lina 40$/H	Whitney 40$/H	Nasiba 40$/H	time (H)	cost ($)
1	**Team and Project Selection**									
		1.1	Group formation	0.5	0.5	0.5	0.5	0.5	2.5	100
		1.2	Coordination meeting	0.5	0.5	0.5	0.5	0.5	2.5	100
		1.3	Determine the field of interest	0.5	0.5	0.5	0.5	0.5	2.5	100
		1.4	Problem definition and data collection	2	2	2	2	2	10	400
		1.5	Decide on the design,criteria and constrains	1.5	1.5	1.5	1.5	1.5	7.5	300
		1.6	Final selection and submission	1	1	1	1	1	5	200
			Sub.Total							**1200**
2	**Design Proposal**									
		2.1	Coordinating meeting	0.5	0.5	0.5	0.5	0.5	2.5	100
		2.2	Gather more information about the design	2	1	1	1	1	6	240
		2.3	Review the process with more research	1	1	1	1	1	5	200
		2.4	Discuse and write the proposal	2	2	2	2	2	10	400
		2.5	Final reviwe and submission	0.5	0.5	0.5	1	0.5	3	120
			Sub.Total							**1060**
3	**Interim Design Report**									
		3.1	Coordination meeting	2	2	2	2	2	10	400
		3.2	Initial ideas about each section of the report	3	4	4	3	4	18	720
		3.3	Discuss and edit the draft report	1	1	1	1	1	5	200
		3.4	Write, edit and format the report	3	1	1	2	3	10	400
		3.5	Final revision and submission	1	1	1	1	1	5	200
			Sub.Total							**1920**
4	**Technical Memo**									
		4.1	Coordination meeting	1	1	1	1	1	5	200
		4.2	Creat the first Memo draft	2	2	2	2	2	10	400
		4.3	Review the process	2	1	1	3	2	9	360
		4.4	Write, edit and demonstrate the required format	2	2	2	2	2	10	400
		4.5	Final revision and submission	1	2	1	1	2	7	280
			Sub.Total							**1640**
5	**Design Presentation**									
		5.1	Coordination meeting	1	1	1	1	1	5	200
		5.2	Edit, review and format draft presentation	2	2	2	2	1	9	360
		5.3	Add pictures, digrams and videos	1	1	1	1	1	5	200
		5.4	Record the presentation on the slides	3	3	3	3	3	15	600
		5.5	Final revision and submission	0.5	0.5	0.5	0.5	0.5	2.5	100
			Sub.Total							**1460**
6	**Final Design Report**									
		6.1	Coordination meeting	2	2	3	3	2	12	480
		6.2	Generate draft report	5	4	5	4	5	23	920
		6.3	Write, edit and format the report	4	4	4	4	3	19	760
		6.4	Review and edit the final report	5	5	5	5	5	25	1000
		6.5	Final revision and submission	5	5	5	5	5	25	1000
			Sub.Total							**4160**
			Grand Total						**279**	**11440**