Group 5

Road Safe Phone Case
Project Plan

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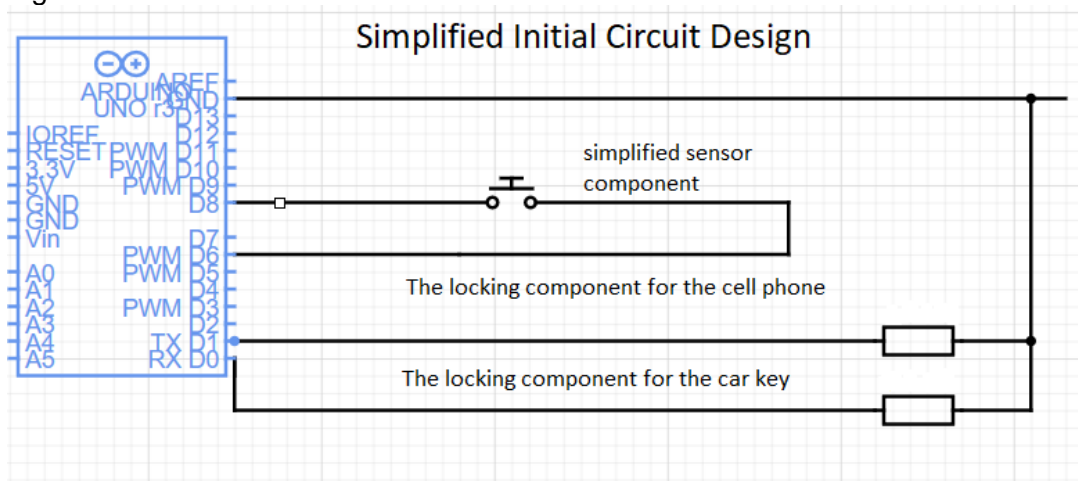Kedan Xin

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Figure 1:

Simplified Initial Circuit Design

simplified sensor component

The locking component for the cell phone

The locking component for the car key

Opeartion:
1. The sensor circuit is located inside of the phone case and it's used to sense the object that is placed inside of the phone case.
2. When the sensor is activated, the Arduino will perform a specific command accordingly to lock or unlock the one side of the case.

Introduction

Problem Statement

Phones have become an integral part of everyone's lives. Communication, entertainment, and organization are only a few of the advantages a phone offers. However, this small device can also serve as a fatal distraction. According to the Centers for Disease Control and Prevention, in the U.S. alone, approximately 9 people are killed and more than 1,000 injured in crashes involving distracted drivers daily (2017). Talking on the phone, sending a text message, using navigation systems, and more are just a few ways that drivers easily endanger themselves and others on the road.

To help make the road a safer place, the amount of distracted drivers must be reduced, which can be accomplished by removing the temptation of a phone. The approach to this problem will be to create a device that locks away the keys to car, unless the phone is swapped for the keys. Progress towards safe driving can be achieved by creating a two-sided case, in which one of the two sides always remains locked. One side will securely store the keys until the other side detects, verifies, and secures the driver's phone. Then, to reacquire the phone, the keys would need to be returned, verified, and secured in the case. In case of emergency, access to either the phone or keys will be made available, and the case can be reset to function normally and protect the drivers and the roads once again.

Case Diagram

Road Safe Phone Case
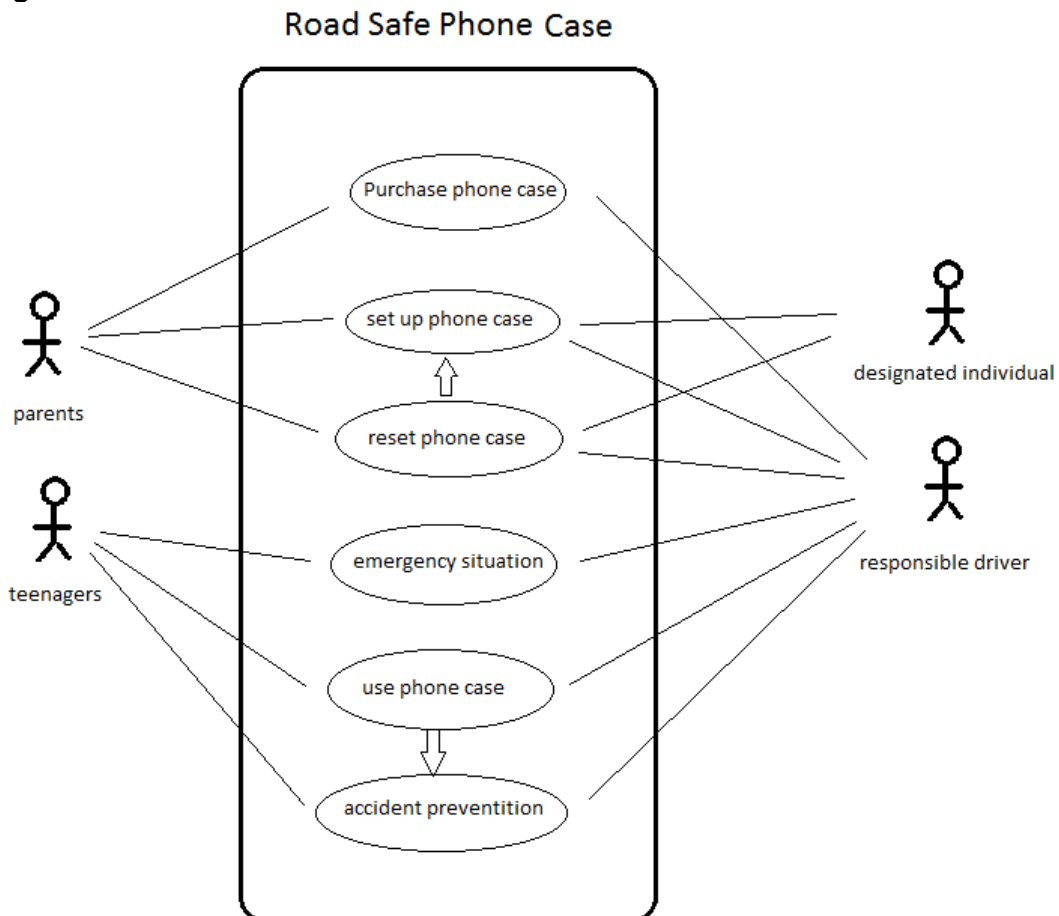
Operating Environment
The road safe case will mostly operate in a car, which should endure various temperatures. The case will need to be able to withstand normal and hazardous weather conditions inside a car, whether it be extreme cold or heat. The case should also fit in a spot within the car so that it remains stationary while in a mobile vehicle. The interior of a car also often gathers dust and at times trash, though this does not pose a threat to the case unless there was direct interaction with the case. Other potential environments are inside a home, because the case will portable and may be moved to other locations if the user needs to take the case to a parent to reset it or for other reasons. However, the case does not have functions that primarily relate to being outside of the car environment.

Intended Users and Intended Uses
The intended use of the road safe phone case is as its name implies. To keep the roads and drivers safe, especially drivers that are easily distracted by their phones. The case restricts the driver's ability to access their cell-phone while driving, which will increase the safety of driving for themselves and others significantly. More specifically, the road safe case not only locks away the driver's phone, but their car keys as well. In order to access one item, the other must be locked in the case. Audio capabilities such as GPS or music can still be utilized while the phone is in the case; however, the screen will not be visible.

Studies have shown that compared to adults, teenage drivers are four times more likely to get into car crashes or near-crashes when talking or texting on a cell-phone, with approximately 21% of fatal teenage driving accidents resulting from cell-phone distractions (Edgar Snyder and Associates, 2016). As a result of these trends in distracted driving, the road safe case will primarily be used by teenagers. However, an AAA poll that showed while 94% of teen drivers acknowledge the dangers of texting and driving, 35% admitted to still doing it anyway (Edgar Snyder and Associates, 2016). This demonstrates that many teenagers would not impose phone restrictions on themselves. Thus, the case will be marketed to parents who have to the ability to oversee their children, and choose to enforce safer driving for them.

Distracted driving due to cell-phones is not only abundant in teens, but especially in drivers in age groups above 20 years-old as well (National Highway Traffic Safety Administration, 2012). Thus, the road safe case may also attract responsible drivers that choose to limit their distractions on their own, unlike a young teenager whose parents may buy the product for them.

Assumptions
1. The phone case will only need to detect if an object placed inside is a phone and a key.
2. The phone case will only detect if the phone placed inside belongs to the individual whose phone is required to be not in use when driving.
3. The default setting of the phone case will be that only one user's phone is allowed to be placed inside, but it can be adjusted if the driver changes their phone.
4. The phone case can be opened in emergency situations by clicking on a special button (i.e., panic button). Every time the panic button is pressed, a designated person will be notified and the driver must reset their phone case by the person.

 Limitations
1. Shape and size of the phone case should fit comfortably in a car, at a size where it does not take up a seat and restrict passenger seating.
2. Because the phone case will need to fit a phone, a car key, a PCB board, and other parts, the size of the phone case might be too big to be easily carried.

3. The cost of making the phone case itself and the operating system within it might exceed the $500 budget.
4. The road safe case functions as a two-person system, so that if one individual uses the emergency access to open it, another different individual will have the "password" to reset it.
5. End cost of the product should be relatively inexpensive because this product will be made available to other potential consumers.
6. The system must be able to operate from a battery supply because it is portable.

Expected End Product and Other Deliverables
The entire design of the road safe case will be completed by the end of April, possibly with a prototype as well so that some of the parts can be tested before constructing the end product in the fall. The final, fully-functioning product should meet all the criteria that discussed between the team and the client by the end of December.
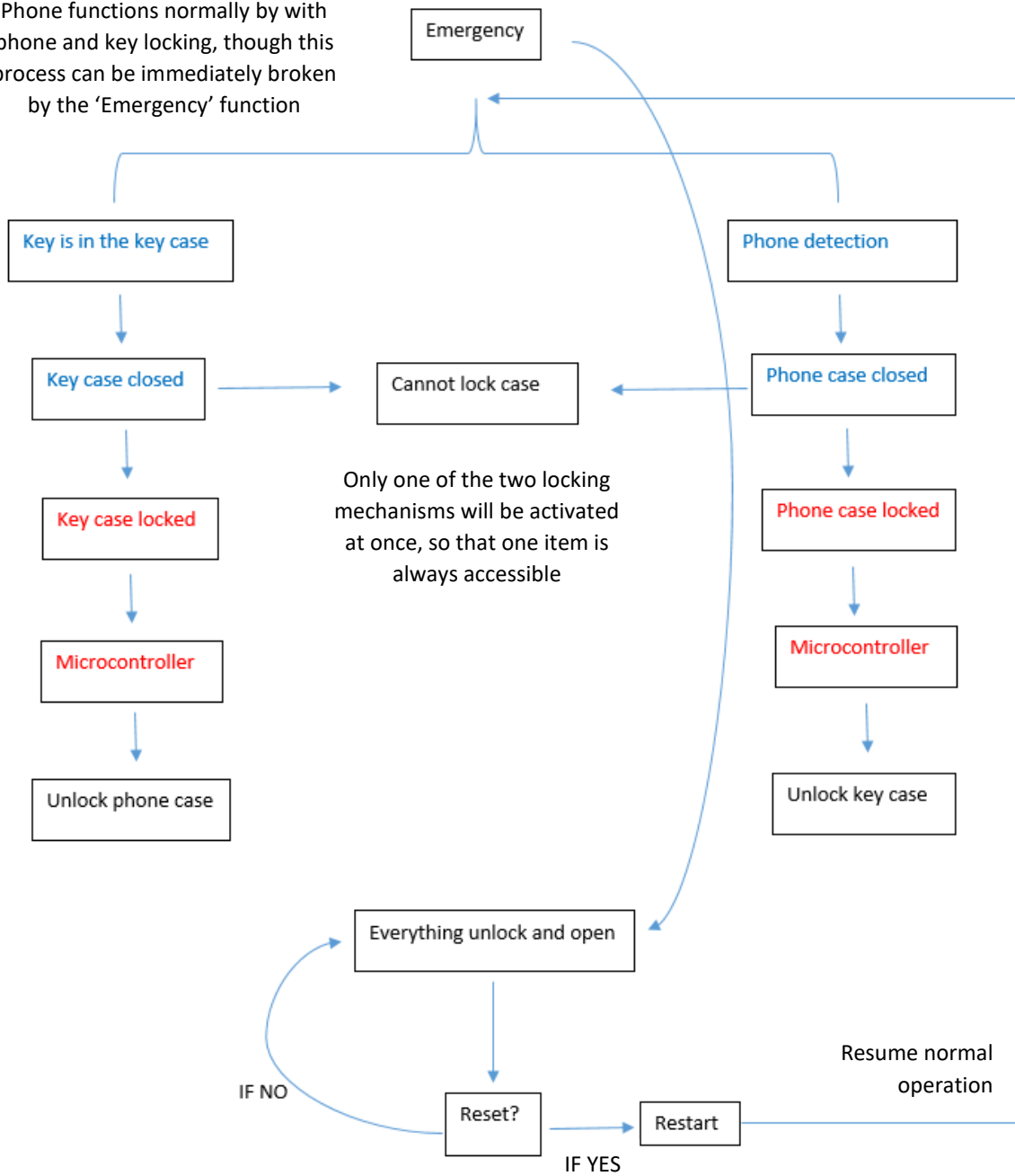
Related Works / Literature Review
There is a product that was proposed in 2017 by Michael Maguire to create a "The Shellback Smartphone Safe". The idea was to create a case for the phone that does not lock, instead it can be zipped closed to keep drivers from accessing their phone while driving. However, if a driver wishes to access their phone, they can easily unzip the case and use it. Because the phone has been accessed while driving, the product will send a message to a designated person to inform them that the driver accessed their phone while driving. Due to lack of funding, this project never left the idea phase and was never marketed.

There are also phone applications that can be installed for minimal fees that will restricted a driver's access to the phone while driving at a certain speed. For example, an app called Drive Smart will allow users to direct incoming calls to voicemail, mute incoming texts and send an automatic response that he/she is currently unavailable (P, 2017). However, the biggest problem with an app such as this is that instead of avoiding people from using the phone, it tries to change certain functionalities of the phone such as muting the text and directing incoming calls without doing so in the most efficiency way, which is ultimately to prevent the driver from reaching their phone during driving. Therefore, the case became a more desirable potential solution for removing the distraction of dangerously using a phone while driving.

Proposed Approach

High-level Block Diagram of System

Phone functions normally by with phone and key locking, though this process can be immediately broken by the 'Emergency' function

Emergency

Key is in the key case

Phone detection

Key case closed

Cannot lock case

Phone case closed

Key case locked

Only one of the two locking mechanisms will be activated at once, so that one item is always accessible

Phone case locked

Microcontroller

Microcontroller

Unlock phone case

Unlock key case

Everything unlock and open

IF NO

Reset?

Restart

Resume normal operation

IF YES

Functional Requirements
The potential consumer group are parents who have children that currently (or are learning to) drive. The road safe case needs to be restrictive on the cell-phone use while the user is driving with no exception. In case of an emergency, the phone case holder should be able to immediately access either the phone or key. To ensure normal, safe-driving operations, the case then needs to have some form of a "passcode" from a parent or designated person to reset the normal operations of the case.

Constraints Considerations
The timeline for this project is within two school semesters, with a small possibility of the work being done over the summer because team members have other responsibilities that must be tended to during break. This is a relatively small amount of time to create a fully functioning project especially if unexpected events, such as a broken part or faulty design are discovered when the product is being constructed during the fall. As for the parts themselves, it can be difficult to find components that fulfill to perform the desired functionalities. Thus, compromises must be reached. Another constraint to searching for parts is cost as well, with a limit of $500 to spend on resources.

Technology Considerations
1. Lack of professional level of equipment to perform mechanical parts production.
2. Cell-phone recognition technology is hard to achieve because the product should not allow other people to use another device and make the case falsely believe that the detected object is the user's phone.
3. Sophisticated parts may be able to improve the functionality of certain components; however, more capabilities warrant a higher cost.

Technical Approach Considerations
One component that may be used is an Arduino or another microcontroller that must coordinate with multiple sensor switches to the perform interlock operation. Also, a chip may be used to detect the input device is a phone (Android or IOS). Compatibility of all components must be considered carefully to ensure the project can be completed within the timeline.

Testing Requirements Considerations
Testing requires that the mechanical linkage operates in a precise manner to have correct input and output signals to electrical components. The road safe case will need to operate in different cars and with different phones and keys. A variety of objects and environments must be accommodated for.

Security Considerations
All design drawings and instructions will be stored in the designated personal laptops with restrictive access.

Safety Considerations
The project may involve circuit soldering which introduces a risk of burns to users, and in worst cases, it is a potential fire hazard. The assembly of the road safe case itself may involve nails, screws, and bigger tools if deemed necessary later on, which must be handled with care to avoid injury to users as well. Thus, a two-person team principle is a requirement for all project designs to ensure safety.

Possible Risks and Risk Management
This project design has limited funding support. The goal is to optimize the operational capability of the phone case to accomplish the desired functionalities with minimal parts expenses. For every step of the technical proposal, the team will attempt to borrow parts from an on-campus electronics store for testing the feasibility of the different approaches. Purchases will be decision-based, considering the testing results to avoid the unnecessary waste of resources.

Safety is also an essential aspect of risk management. The project involved a lot of hands-on mechanical work — activities like cutting, soldering, and installation. Wearing proper PPE (Personal Protective Equipment) is a requirement for all engineering design processes.

Project Proposed Milestones and Evaluation Criteria
Throughout the months, the team will work on the major overarching tasks listed in the Statement of Work section. These tasks will be used in both the design portion of the project in the spring and the construction portion in the fall as the proposed project milestones.

By the end of April, the team should have a design for each component and potentially a rough prototype with the major functionalities. The evaluation criteria should be the interlocking operation, sensor performance, and parts mechanical performance. By the end of November, the team should have the end-product with full functionalities. The evaluation criteria should be the functionalities testing in real time situation.

Project Tracking Procedures
The team will rely on the Gantt Charts, which can be found in the Project Timeline section, and will also work to divide the whole project into different aspects for individual or subsets of the team to focus on. Each team member will rely on themselves and especially one another to enforce and strictly follow this time table. Also, by dividing the team into different working branches depending on individual member's own field of study, it will be easier to concentrate and accomplish small tasks that will build the project. The team leader will decide the due date for each individual component for further testing and development. Other external project trackers are the advisor and the client, who will be updated on the team's progress on a weekly basis.

Statement of Work

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1. **Task:** Object Detection
Objective: To successfully detect whether the object in the case is strictly a phone or a car key.
Approach: Using a charging port to detect the input and recognize the owner's phone. Another sensor can be used to verify the phone and key as well, such as a proximity sensor or a form of machine learning with a camera if that is affordable and compatible with other parts.
Expected Results: If the driver is to put in the wrong object to attempt to access the phone while they are driving, the case will not unlock because the object is incorrect.

2. **Task:** Locking Mechanism
Objective: To create a circuit with two locks in which only side remains locked at a time
Approach: A circuit will be built on a breadboard to send the correct signals to activate or deactivate one of the two locks, based on the output from the object detection sensors. The control for the circuit will be coded using a microcontroller.
Expected Results: The circuit will operate on the output of the sensors properly and will only lock one side at once.

3. **Task:** Emergency Access, Alert, and Reset
Objective: To successfully resolve the situation when the driver encounters a car accident, and need to use the phone for help, and the case should automatically open. The case will then need a way to be reset to function normally again.
Approach: An emergency button will be placed on the case that will break the circuit and normal operations until being reset. The team is considering adding an alert to notify an external person, but research regarding implementation is still in progress. As for the reset, the team is considering using a scanner that can only be accessed by the parent or a designated person.
Expected Results: The case will always function normally unless in the case of an emergency, in which a designate person will be notified, who can then easily reset it.

4. **Task:** Physical Case
Objective: To successfully make the physical case with pre-designed space to integrate the circuit components as well as the phone and car key..
Approach: Record measurements of circuit parts, locking tools, various phones and car keys, and other materials to design a case layout. Then use 3D software to create the layout of the case and a 3D-Printer to supply the materials and make the physical case.
Expected Results: A solid and good-looking case with the space for circuits components.

5. **Task:** Testing Product
Objective: To make sure that all components work together after implementation.
Approach: The team will test individual components first to make to confirm they work separately. After combining all the components all together, then the final product will be tested as a whole and make sure all the functionalities are still functional and meet the requirements from the client.
Expected Results: To produce a fully functional and reliable road safe case which meets all the demands from the client.

Estimated Resources

| Personnel effort requirements	Other resource requirements	Financial requirements
6-8 hours a week per team member work individually to find new technical approaches for current project issues. - Weekly meetings with the advisor and client to update the project status and optimize the functionalities of the project. - Work together on weekends to test and implement the new method.	(Potentially) access to a 3D printer to - Ask some professor for help if necessary - If the mechanical device does not function in the desired manner, team members may need to order the part from the outside of the school.	- Funds to purchase parts - Operation fee for using 3D Printer, soldering device, PPE (personal protective device)

Project Timeline

The project team was assembled at the end of January, and February has marked the start of the design portion of the project. The initial schedule for the major research and design tasks are represent in the Spring 2019 Gantt Chart below.

Spring 2019 Gantt Chart:
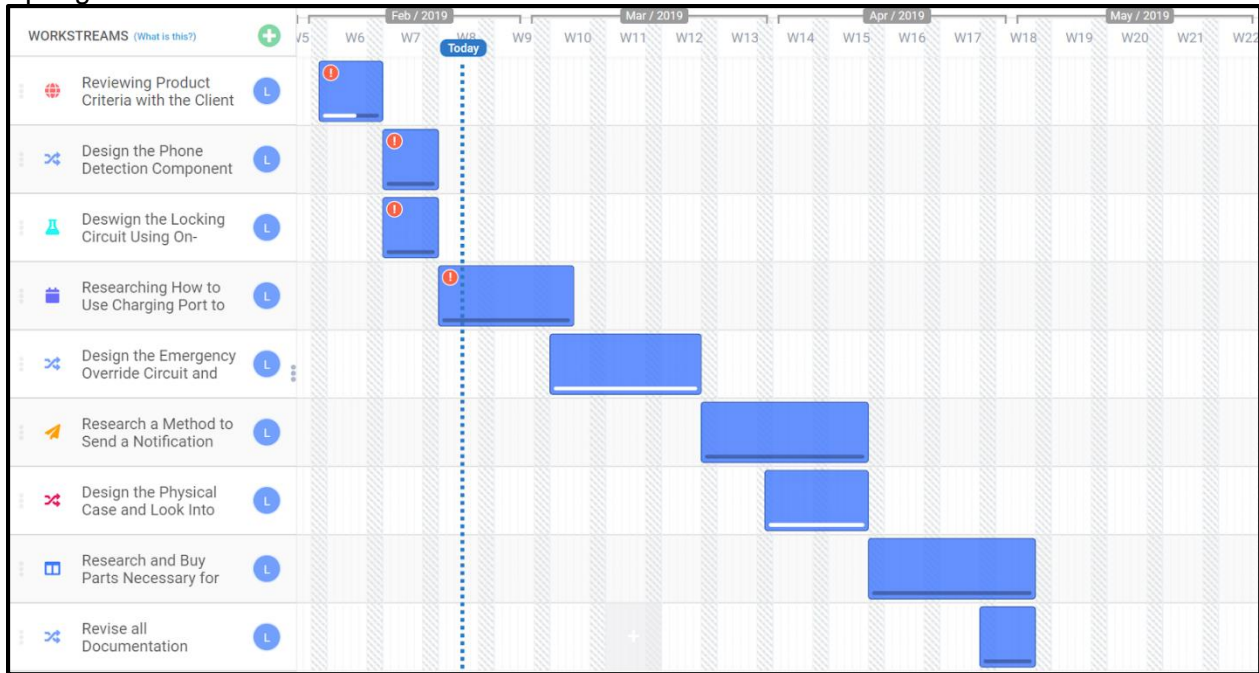
An explanation of the tasks in chronological order:
1. Review product criteria with the client to ensure the design meets their needs.
2. Design and research object proximity or recognition sensors for the case.
3. Design the locking circuit and test using on-campus resources.
4. Research how to use charging port to detect the phone belongs to the driver.
5. Design the emergency override circuit and reset for normal functioning component.
6. Research a method to send a notification from the case to alert emergency access.
7. Design the physical case and look into materials to build it.
8. Determine the most ideal parts that are essential for the circuits.
9. Revise all documentation needed for the project construction during the fall.

After summer break, the project will resume with the construction portion. The team's initial schedule for building each of the main components are represented in the Fall 2019 Gantt Chart below.

Fall 2019 Gantt Chart:
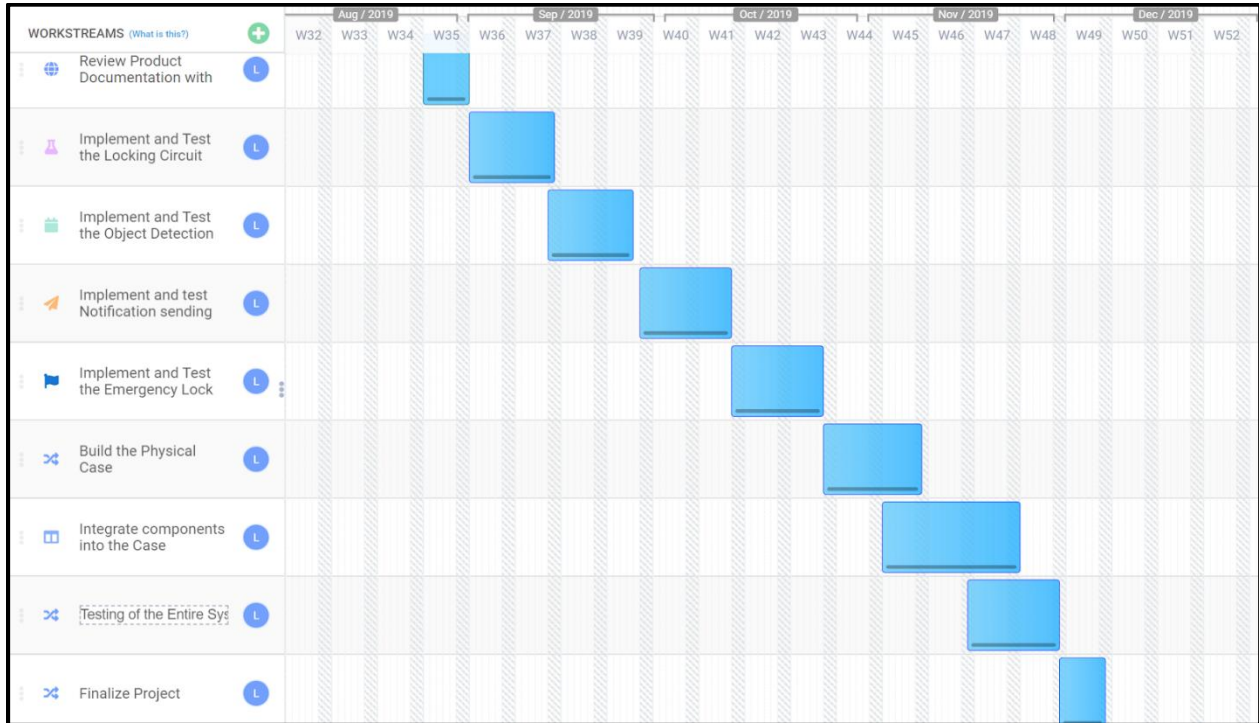
An explanation of the tasks in chronological order:
1. Review product documentation with client and team as a refresher.
2. Implement and test the locking circuit and verify it works with object detection.
3. Implement, test, and integrate the emergency override circuit into the system.
4. Implement and test the emergency notification sending and reset.
5. Verify that all components work together.
6. Build the physical case to fit all parts.
7. Integration of the circuit components into the physical case.
8. Testing of the all the components as a whole.
9. Finalize documentation and the physical project itself.

Conclusion

Summary
The undeniable fact is that cell-phone usage while driving is highly dangerous for both the driver and other individuals on the road. A lot of worry surrounds the safety of young drivers, especially as they have been shown to have the highest rates of phone usage while driving as compared to individuals 25-years-old and above. To increase safety on the road, the amount of distractions must decrease which can be achieved by removing the temptation of a phone through the Road Safe Phone Case. By a locking mechanism that will store either the driver's car keys or cell-phone at all times along with sensors to detect the correct objects, access to distractions will be restricted. The case will also accommodate for emergency situations and allow important phone functionalities such as GPS and Bluetooth to still be utilized through audio. With team members' engineering knowledge, assistance from an advisor, and adherence to project plans and timeline, the road safe case will be successfully designed, constructed, and tested within the year. Not only will the case help parents feel relief while their children are out on the road by themselves or give responsible drivers an ease of mind, but it will also save lives.

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