**Deliverable D - Conceptual Design**

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# Introduction

This report outlines how our group used the previously obtained criteria to create new conceptual designs that are accurate, easy to use, and universal. After creating different concepts, they were compared and benchmarked. Finally, the best elements of each design were combined into one final complete design.

# Concepts

In this section, each team member will display their conceptual design that meets the criteria presented in previous deliverables and discuss the strengths and weaknesses of their concept.

## Concept 1 - Calum Avon

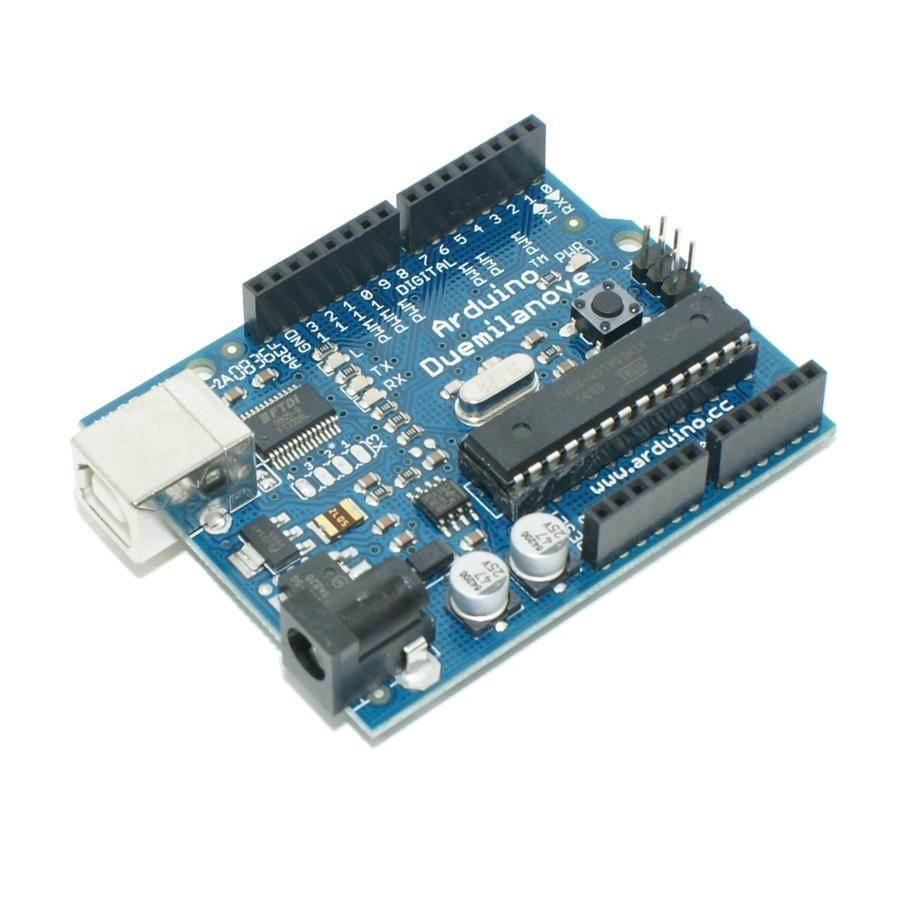
### Components:

* Arduino microcontroller
* Temperature sensor
* Radar or ultrasonic sensor
* CO sensor
* Phone application
* Wireless relay system

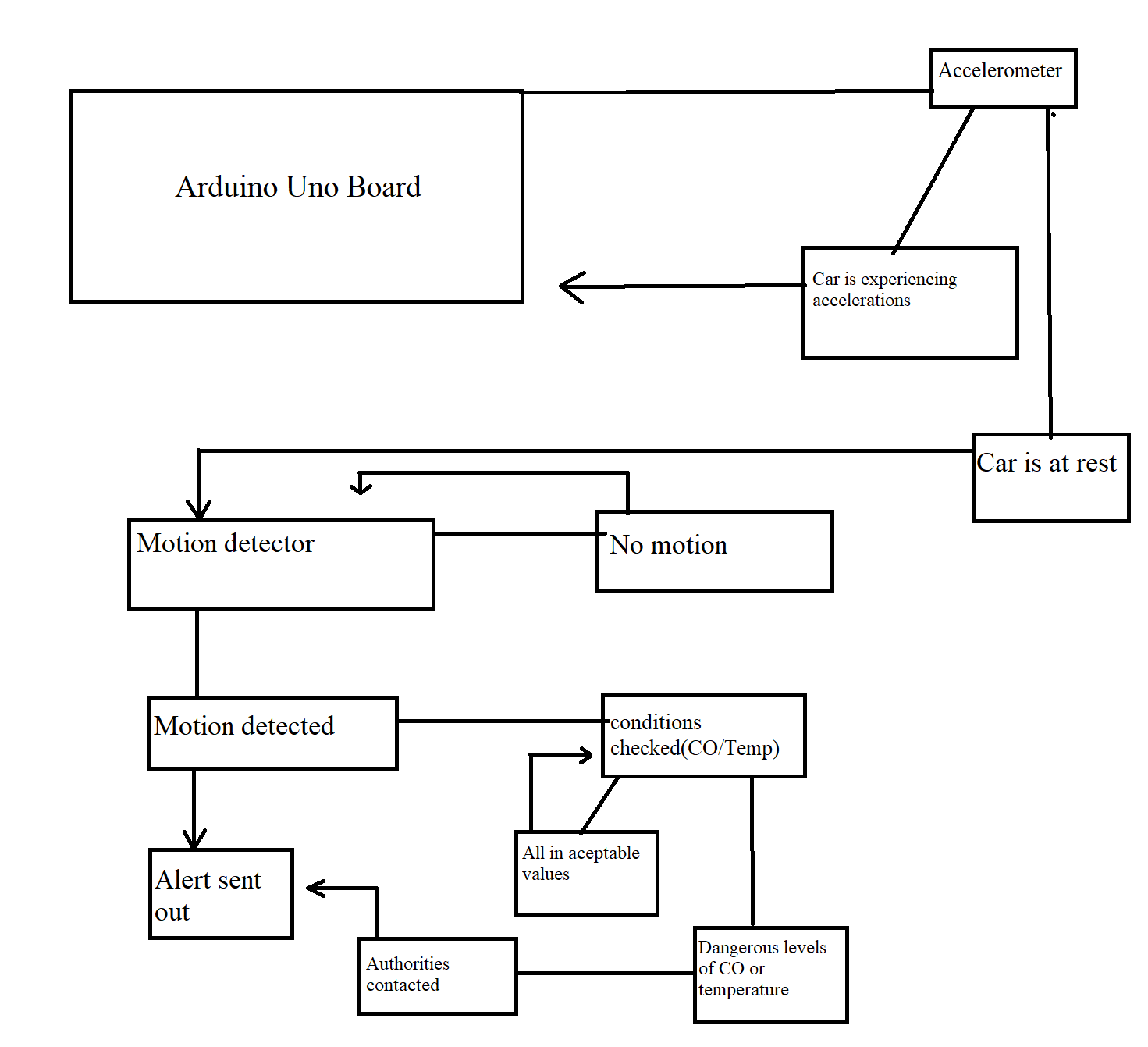
### Description:

This system will feature an Arduino board, an app, and an array of sensors. The sensors include an accelerometer, a movement sensor, a CO and temperature sensor. To begin the function of the system, the accelerometer will detect when the vehicle has come to a rest for a time greater than 2 minutes; once this happens, the rest of the system will become active. Once the system is active, it will continually check the air quality and temperature and determine if there is movement in the vehicle. If there is significant movement detected, an alert will be sent to the owner's phone. If there is no response from the owner or there is still movement detected more alerts will be sent. If these alerts fail and the conditions are becoming unsuitable in terms of temperature and CO levels authorities may be contacted as well as other emergency contacts, the location and situation will be reported. Additionally, a relay could be installed to have the car perform an action to alert others of the emergency. But this would be modifying the car.

The system will have the option of resting underneath the rear headrest, the roof, or the door. These locations will give the sensors the best chance to get accurate information and make the install relatively simple. It will receive power from the car, either through a 12V socket or some other means.



*Figure 1: Arduino Uno Board*

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*Figure 2: proposed action path*

### Pros:

* Relatively simple install
* Multiple sensors to gather lots of information
* App to receive notifications

### Cons:

* High cost
* Complicated system
* Low redundancy

## Concept 2 - Ashley Larocque

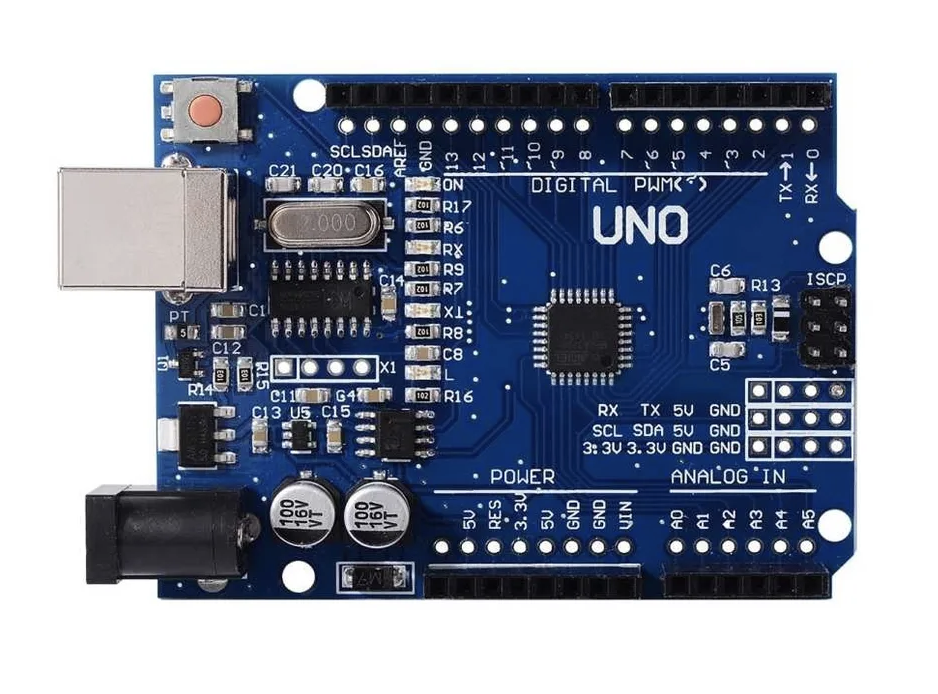
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### Parts of the system:

* Arduino Board.
* TMP36 – temperature sensor.
* HC-SR501 – PIR motion sensor.
* MQ-7 carbon monoxide gas sensor.
* Phone application to send a notification to the driver’s device.
* ESP32 BLE

### Description:

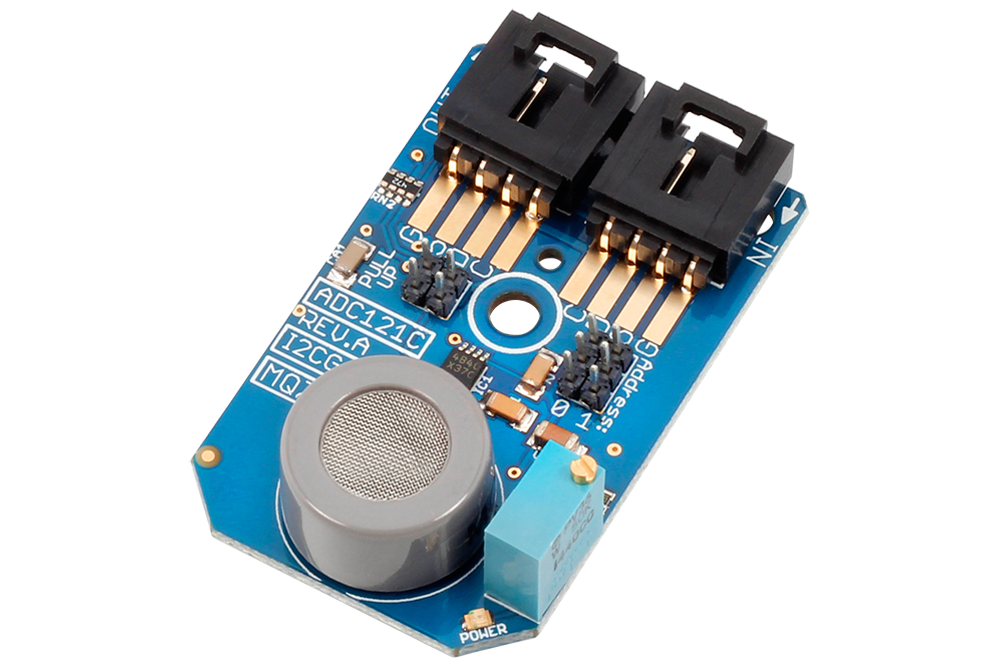
The system would be composed of three subsystems, the Arduino board (*Figure 3*), a system of sensors, and a phone application to send notifications to the driver’s device. An HC-SR501 PIR motion sensor (*Figure 4*) will be connected to the arduino board to detect the presence of a child in the car. If movement is detected, a notification gets sent to the driver’s phone. A TMP36 temperature sensor (*Figure 6*), will connect to the Arduino board, which measures temperatures between -45°C to +125°C to detect if the car is at a safe temperature for an occupant. If movement is detected and the temperature is not within a safe range, a notification gets sent to the driver’s phone. The third type of sensor used is an MQ-7 carbon monoxide gas sensor (*Figure 5*). This sensor detects the concentration of carbon monoxide in the car from anywhere between 10-50ppm. If an occupant is detected and the concentration of carbon monoxide is not within a safe range, a notification will get sent to the driver’s phone. The Arduino will be connected to the ESP32 (*Figure 7*) via Bluetooth to send notifications to the driver’s phone. This connection will also allow sensor readings to be viewed from the application as well. This device can be installed under the driver’s or the front passenger seat, and it connects to the car’s 12V power socket.



*Figure 3: Arduino Board*



*Figure 4: HC-SR501 – PIR motion sensor*



*Figure 5: MQ-7 carbon monoxide gas sensor*

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*Figure 6: TMP36 temperature sensor*

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*Figure 7: ESP32 BLE*

## Concept 3 - Poula Rezkalla

### Components:

1 - motion detection lenses

2 - support case for the lenses

3 - temperature sensor

4 - App ( Alert ) for the parents

5- Arduino board

6- wires

### Description:

A movement detector will be installed in its support case just above the rearview mirror of the car to maximize the area of movement detection. The movement detector will be wired to the main Arduino board. Besides the movement detector, there will be a temperature sensor installed, that will be also wired to the main Arduino board. If the motion detector sensor detects a movement inside the car, while the temperature inside the vehicle passes the 39-degree celsius or goes under -20-degree celsius, Arduino will send a signal to HC-05 Bluetooth to send multiple alerts to the parents until the motion detector can’t detect any motion.

# Conceptual Design Benchmarking

Concepts will be ranked from 1-3, 3 being best, 1 being worst to determine each concept's strengths over the others.

| Concept / Subsystem | Sensors | Notification System | Install |
| --- | --- | --- | --- |
| Ashley Larocque | 2 | 3 | 3 |
| Poula Rezkalla | 2 | 2 | 3 |
| Calum Avon | 3 | 2 | 3 |

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# Final Design Concept

The best attributes from each concept are combined to create the best overall solution to the client’s problem.

## Sensors

Subsystem one had the best array of sensors marginally with the inclusion of an accelerometer to trigger the rest of the sensors to make the system as autonomous as possible. The addition of a weight sensor could eliminate the issue of a child being asleep or not moving enough to be sensed. The combination of carbon monoxide and temperature sensors to ensure that the vehicle is a suitable environment for an occupant and a movement sensor will be more than sufficient to ensure as little redundancy as possible.

## Notification

Subsystem 2 had the best notification system, as it is the most thoroughly planned. If possible, it would be good to add an alarm system to alert those nearby to the car. This can be done using relays or speakers. Additionally, it would be good to have a system with a further range than a standard BlueTooth connection.

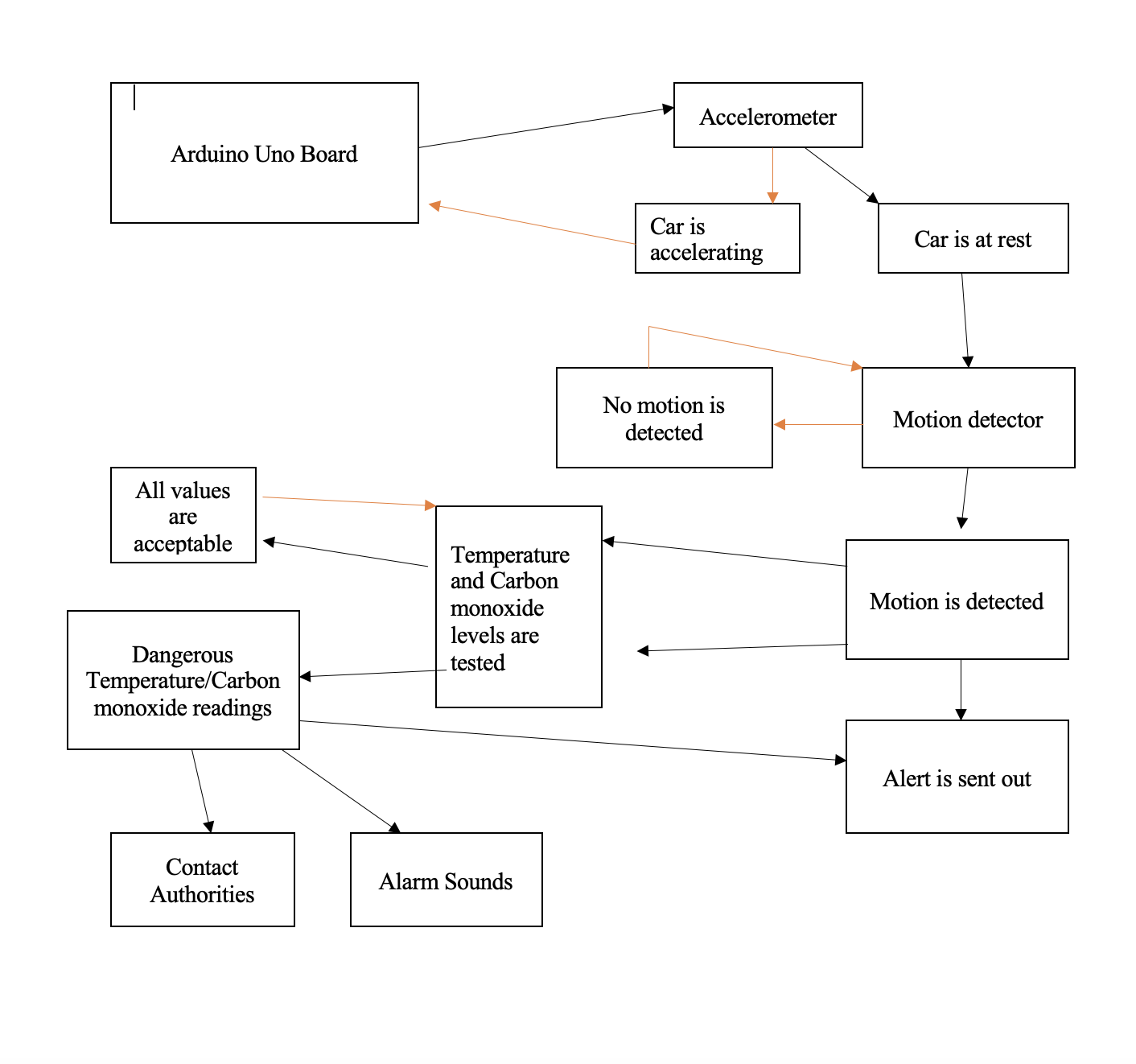
## Installation

For installation, all concepts had unique advantages and disadvantages. For the final product, it would be ideal to have multiple possible locations to accommodate all types of cars. This can be done by considering all the installation methods proposed and exploring more. The mentioned install methods all have varying levels of complexity and success in placing sensors to collect reliable data. Placement of the device is important since temperature and carbon monoxide levels can vary throughout a car, and movement can be undetectable if it isn’t visible to the sensors.

## Final Design

Parts of the system:

* Arduino Board
* Accelerometer
* Temperature sensor (TMP36)
* Motion sensor (HC-SR501)
* Carbon monoxide sensor (MQ-7)
* ESP32 BLE
* Speaker
* Phone application
* JD1912 Automotive Relay 4-Pin
* GSM module



*Figure 8: Path of Action*

# Conclusion

Using the criteria obtained in previous deliverables, we created unique conceptual designs of our systems to discuss and compare them as a group. The group conducted benchmarking to evaluate each system’s strengths and weaknesses.

The final system will consist of an Arduino board that will connect to an accelerometer. Once the car has been at rest for longer than two minutes, the motion detectors will be activated. If movement is detected, the application we will be creating will send persistent notifications to the driver’s phone. Additionally, the system will use a carbon monoxide and a temperature sensor to assess the conditions of the car. If the conditions in the vehicle are not within a safe range for an occupant, the system will sound an alarm to notify passers-by of the emergency and call the authorities.