Deliverable D - Conceptual Design

GNG 1103 - Engineering Design

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1.0 Introduction

This project deliverable presents the solutions and systems that will be used in the final product to meet the client's needs and solve the problem at hand while still satisfying all the design criteria. The deliverable is separated into multiple sections. The first section separates the product into all of its subsystems in order to isolate each specific function of the device. Each of the group members will provide their own concept of each subsystem, with the purpose of providing further explanations and developing each concept to its full potential. Benchmarking will also be conducted to verify the viability or the usefulness of certain concepts. With the results, the team will collectively read over the results with the others in order to separate the good ideas and to compare them with the overall design criteria to verify if they meet expectations. Once all the best results are gathered, the group will collectively create a final concept of the product that will be used for the rest of the project as a baseline for the final prototype.

2.0 Subsystem Definition and Concepts

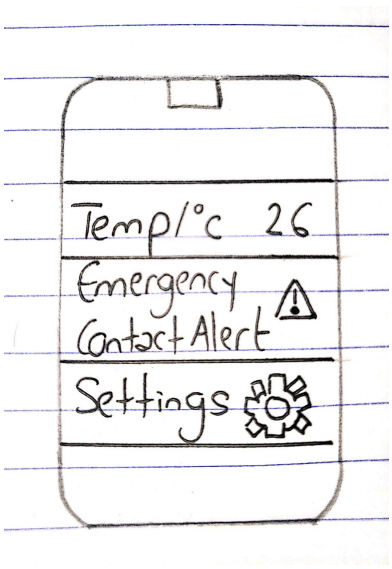
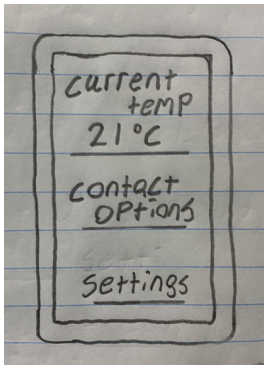
The final device will include the following subsystems: (a) User Interface; (b) Detection; (c) Notification; (d) Pet and Child Safety and; (e) Implementation. These subsystems will be used for the Individual Group Member Concepts, which will later be benchmarked; using the technical benchmarking from Deliverable C.

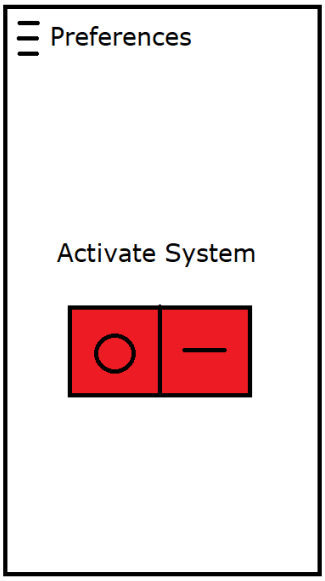
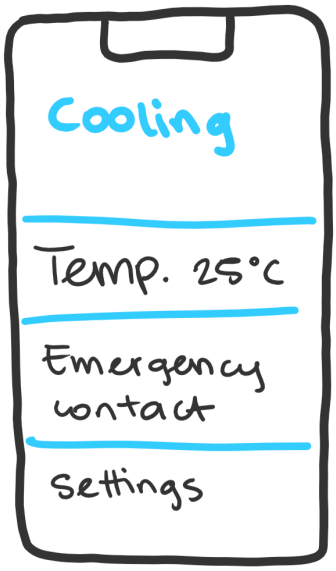
Table 1: Subsystems for Final Product

Subsystem	Definition
User Interface	How the user will interact with the device.
Detection	A method that will detect whether a pet or child is in a hot vehicle
Notification	A feature that will allow users to be notified if a pet or child is left unattended in a hot vehicle.
Pet and Child Safety	The system that will keep the pet or child will be cool in a hot car, and how the child will stay occupied until a guardian comes back
Implementation	How the device will be installed in the vehicle (car, bus, etc.)

2.1 Team Member Concepts for Each Subsystem

Table 2: Concepts for User Interface

Team Member	Sketch	Concept
Hans Rao Ladkoo	 Figure 1.	A smartphone app for both IOS and Android will allow the user to interact with the system. The user will set up his own contact information and that of his emergency contacts (Name, phone number and email), and will receive live data from the sensors onboard when he checks in the app. The user will also set up his emergency notification message that his emergency contacts and he will receive by text message and email when the temperature is above the limit that the user chooses (28 °C in our case)
Benjamin McConnell	 Figure 2.	The device should be compatible with an app for IOS and Android, should be very easy to follow/use. Somewhere to input the user's contact info including extra spaces for emergency contacts, somewhere to input weight so the sensors do not activate at an inappropriate time. Lastly the app should have a display of the temperature inside and outside the car.

Kobe Belanger	 Figure 3.	The device should include some interface on the front panel, but the majority of the interface would be on an app. On the device itself, it would be advantageous to have quick and easy access to a power button in case you put a box or shopping bag on the seat and don't want the device to trigger. On the app, the user will be able to set lines of contact for emergencies, the approximate age and weight of the child, and other preferences. The user will also input the model and colour of the vehicle for the purpose of contacting authorities.
Steven Wilson	 Figure 4.	The user will interact with the system through an app. The user will set up the emergency contacts, child weight, and receive live data from the sensors onboard.

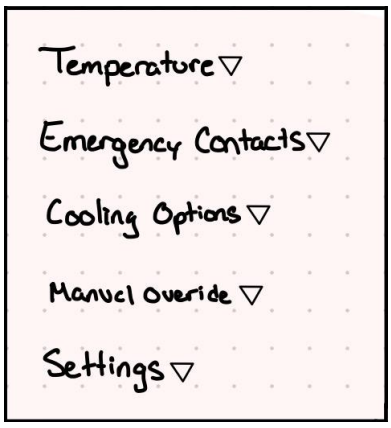
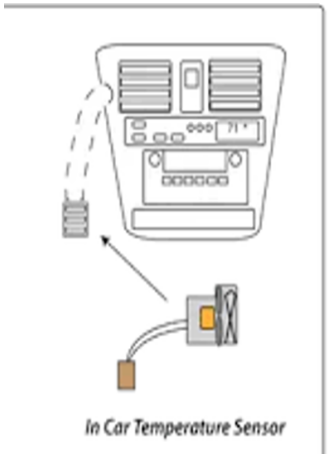
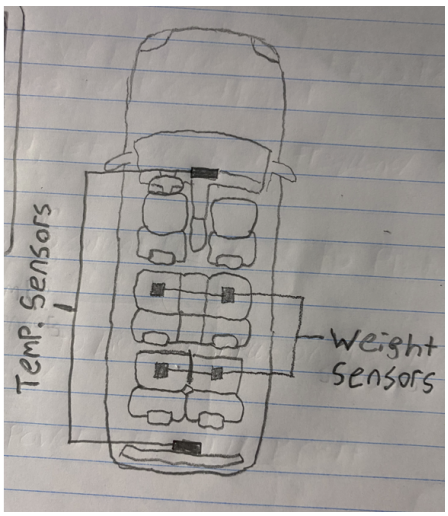
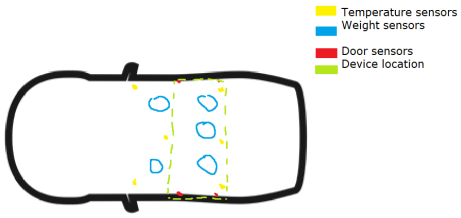
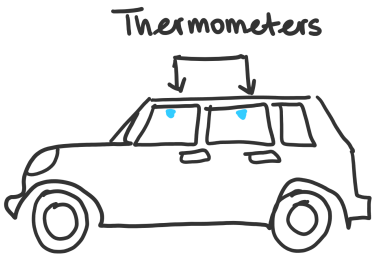
Kaitlynn Sampel	 Figure 5.	This system will include an app and device. The user will interact with the device via an app (that will work on IOS and Android). The user will input the guardian's contact plus an extra three contacts who will receive a notification if a child or pet is left unattended in a vehicle. These notifications will be sent via text message (using OneMessage, a satellite messaging app) and email.

Table 3: Concepts for Detection

Team Member	Sketch	Concept
Hans Rao Ladkoo	[1]  Figure 6.	The temperature inside the vehicle will be detected using 2 temperature sensors, that will measure the temperature inside and outside of the car and the output temperature will be the difference between these 2 values If the temperature is above 28 degrees celsius, the user and his emergency contacts will be instantly notified, because 28 degrees celsius is the cut-off that has been decided as being too hot for the child.

Benjamin McConnell	 Figure 7.	The design will feature thermometers installed into the car (one at the front and back) and a weight sensor on the seat. If the weight sensor is activated(a child/pet is in the car), the thermometers will track the temperature if they read above 28 C° the user will receive notifications until shut off on the device inside the car.
Kobe Belanger	 Figure 8.	Temperature sensors will be put in different areas of the vehicles to make sure it has even heating/cooling. The temperature sensors will also be used to determine when the cooling or heating needs to be turned on. A weight sensor will be installed in the car seat to detect when a child is present. Door sensors will also be used to verify whether a driver or passenger is present in the vehicle.
Steven Wilson	 Figure 9.	The temperature inside the vehicle will be detected using two thermometers. The thermometers will be placed near the driver and child's seats. If the measured temperature is above 28 °C it will be determined that the child is hot inside the vehicle. The vehicle will also be equipped with a hazardous gases sensor.

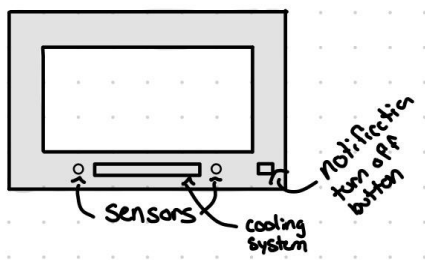
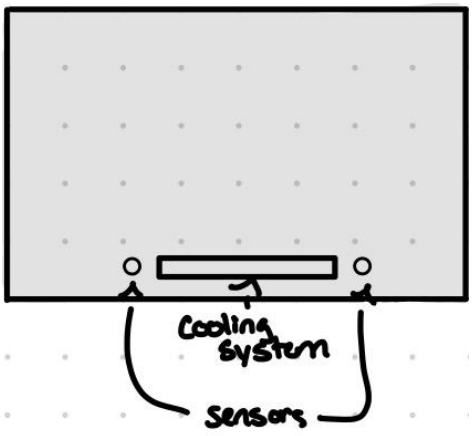
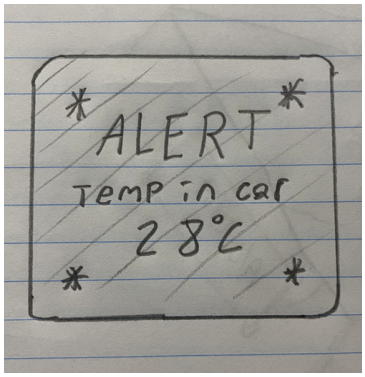
Kaitlynn Sampel	 Figure 10.  Figure 11.	The design will use a temperature gauge that will detect if the temperature of the car is above 28°C. Then a heat sensor (thermocouple) will be used to detect if there is a child or pet left unattended in a hot vehicle.

Table 4: Concepts for Notification

Team Member	Sketch	Concept
Hans Rao Ladkoo	 Figure 13.	The product will have a Passive Infrared sensor, that will constantly monitor heat levels inside the car. The heat level change will be detected by the sensor and converted into an electrical signal to the Arduino. If a change in heat levels is detected within a specified time interval of 3 minutes, an alarm will be triggered to alert people in the vicinity as well as a text message and email sent to the driver and emergency contacts.
Benjamin McConnell	 Figure 14.	The device will be able to tell if a child/pet has been left unattended, if the device picks up that a child/pet is left unattended, the user will receive notifications every 10 minutes or if the temperature increases. An alarm should also go off to attract attention to the car, until physically shut off from inside the car.
Kobe Belanger		Once the system detects that a child is left unattended and that action is required, the device will send messages to the users mobile device. If action is not taken in a certain amount of time, a phone call will be attempted. If there are still no results, the device will set off an alarm for pedestrians to hear, and the device will contact a third party, so they can call authorities. A GPS sensor should also be included to provide an exact location.

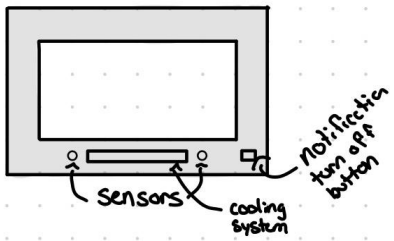
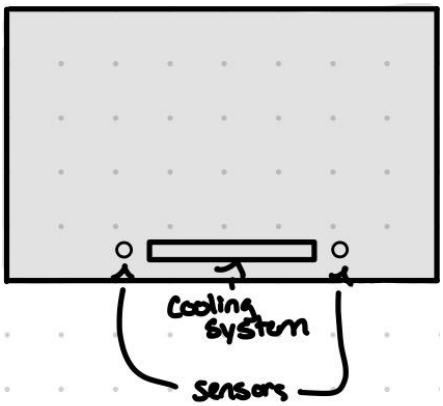
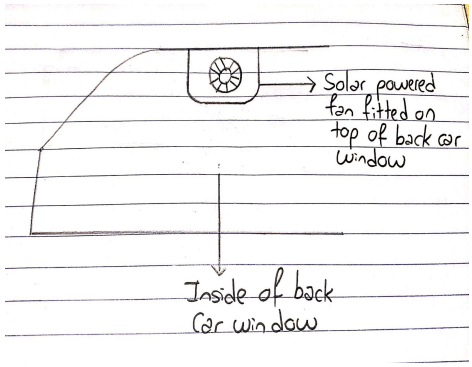
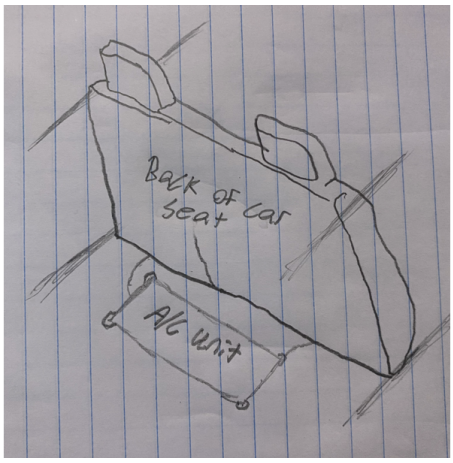
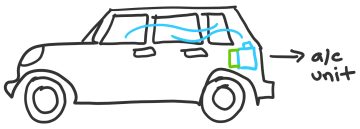
Steven Wilson	 Figure 15.	The product will have motion and pressure sensors for detecting if a pet/child is in the vehicle unattended. The motion sensor will be placed pointing toward the child's seat and another one pointing to the driver's seat. The pressure sensors will be placed under the driver and child's seats. It will be defined that a child is unattended if motion/pressure is detected from the child's seat and no motion/pressure from the driver's in a 5-minute time frame. The emergency contacts will be notified and if the child is still unattended for another 5 minutes an alarm will alert people in close proximity.
Kaitlynn Sampel	 Figure 16.  Figure 17.	The device will have a heat sensor, one on the back of the device to detect passengers in the front seat and a sensor on the front which will detect people in the back seats.

Table 5: Concepts for Pet and Child Safety

Team Member	Sketch	Concept
Hans Rao Ladkoo	 Figure 18.	The vehicle will be equipped with a solar-powered fan, fitted on a window, that will keep the air circulating and keep the car cool at all times, regardless of the actual temperature inside the car.
Benjamin McConnell	 Figure 19.	The device will have a backup heater/A/C unit for use during all seasons that will automatically turn on after 10 mins to keep the car at a safe temperature while the user returns to the vehicle
Kobe Belanger		The device will have an air conditioning unit to cool the cab of the car, as well as a heater for use in the winter or on colder days. The vehicle should also have properly filtered vents to prevent inhalation of poisonous gasses.
Steven Wilson	 Figure 20.	The vehicle will be equipped with an emergency a/c unit that will turn on once the temperature inside the vehicle is above 28 °C.

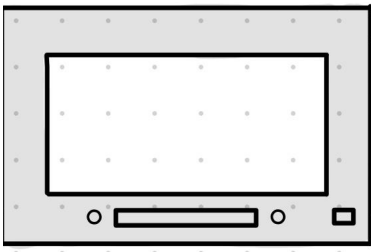
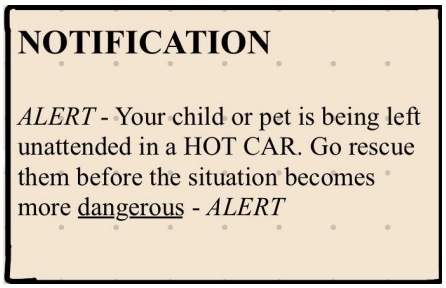
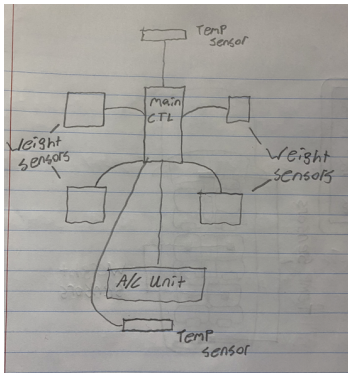
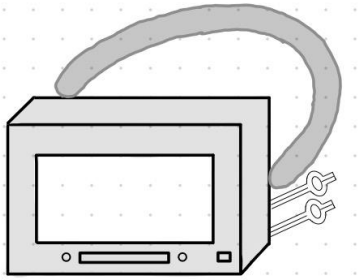
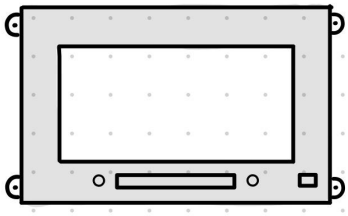
Kaitlynn Sampel	 Figure 21.  Figure 22.	Firstly, the device will be equipped with a cooling system that will be turned on if there is no response by the guardian within 10 minutes. Secondly, if the guardian can not get to the vehicle within 10 minutes, the device will start playing a video to keep the child occupied. As stated in Table 2, the owner of the vehicle will be notified via app every 10 minutes when a pet or child is left unattended in a hot vehicle. The notification can only be turned off by pushing a button on the side of the physical device, which is located inside the hot vehicle.

Table 6: Concepts for Implementation

Team Member	Sketch	Concept
Hans Rao Ladkoo		The device will be installed by the user since the solar-powered fan is easily set up by following instructions.
Benjamin McConnell	 Figure 23.	The device should feature a simple installation process, so the user does not require previous knowledge to install and be simple enough for any mechanic/shop to fix.

Kobe Belanger		The device should be simple enough to install in the vehicle to the point where people with minimal experience can install it. It should also be simple for mechanic shops or dealerships to install it for the user.
Steven Wilson		The device will be installed by a professional since the emergency a/c unit receives power from a generator that takes fuel from the car's fuel tank.
Kaitlynn Sampel	 Figure 24.  Figure 25.	The device will be installed by the guardian/ user of the vehicle. In a car, the device will be mounted at the back of the front seat headrests. In a bus, the device will be mounted to the ceiling of the bus (every four rows).

3.0 Product Proposals

The following are proposals for the final design.

3.1 Proposal #1 - Kobe Belanger

The device should be a relatively small, discrete object that can be installed beside or under a seat in the vehicle. It will be purchased by the user and installed by a professional. If possible, car dealerships would be able to complete the installation with ease. It will need to be installed by a professional because the integrated air conditioner and heater built into the device require

power from the car’s battery to charge. The device itself will barely be interacted with. The only interaction that would take place would be a switch or button easily accessible to disable the alarm. This is used for when the user places other items on the seat and does not want to activate the system. To avoid forgetting to turn it back on, the device would re-activate when the item is removed from the seat. Once installed, the user installs an application on all of their mobile devices and signs in with the device. They will set all of their preferences in the app.

A series of door sensors, weight sensors, and temperature sensors will be fed into the central computer. The computer will know when there is a child in the seat, and also whether there is a parent or guardian in the vehicle with the child. Once the system recognizes that there isn't a parent or guardian present for a set amount of time, the system will start sending messages to all the mobile devices connected to the device. If no action is taken within a set amount of time after that, the device will turn on the air conditioner or the heater to make the temperature in the cabin safe and comfortable, and it will call the mobile devices connected. If there still isn't any action taken, the device will notify a third party with a vehicle description and location so that they can call local authorities. If the third party cannot be reached for some reason, the device will play an alarm letting people around the vehicle know of the situation.

3.2 Proposal #2 - Steven Wilson

The user will purchase the device and will have it installed by a professional. It is best if the installation is done by a professional since the emergency a/c unit is connected to the car’s fuel tank. Once the a/c unit is installed, the user will interact minimally with the hardware components. The device will include wireless sensors (thermometer, carbon monoxide meter, pressure sensor, and alarm) which will be placed based on the indications in the user manual. Using an app the user will set up the emergency contacts and verify that all the components of the device are working appropriately. Once the basic information has been set up the user will no longer need to interact with the device.

The device will constantly monitor if the child is left unattended, this will be done using two motion sensors and two pressure sensors. The device will notify the emergency contact when the sensors located in the driver position have not registered any movement/pressure and the sensors located in the child’s seat are active indicating the child is alone in the vehicle. If the child has not been attended to within five minutes of the emergency notification an alarm will alert the people near the car. In addition to the notifications, the device will also constantly monitor the temperature inside the vehicle. If the temperature inside the vehicle is greater than 28 °C and a child is in the vehicle the emergency a/c unit will start cooling.

3.3 Proposal #3 - Kaitlynn Sampel

User Interface. When the first-time user opens the device box, they will be asked to put batteries in the device and to download an app. Once the user has downloaded and opened the app, step-by-step instructions will be given to help with the setup process.

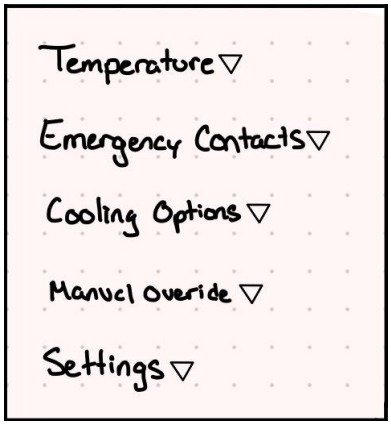


Figure 26. Homepage of the Cooler app.

During this process, the user must input two main guardians and three emergency contacts. As seen in Figure 27 they must enter their name, phone number, email address, and relation to child or pet

Name: John Doe
Phone Number: (123)-456-7890
Email Address: JohnDoe@gmail.com
Relation to Child/Pet: Father

Figure 27. Contact information.

Once that is done, the user will turn on the Cooler device and a six number verification code will pop up, this code will be used to connect the device to the app.

Design and Notification Concepts. There will be two types of sensors; a temperature gauge to detect when the vehicle's interior is above 28°C and heat sensors that will detect if a child or pet is left unattended in a hot vehicle. As seen in Figure _ in a car, sensors will be located right under the screen and at the back of the device.

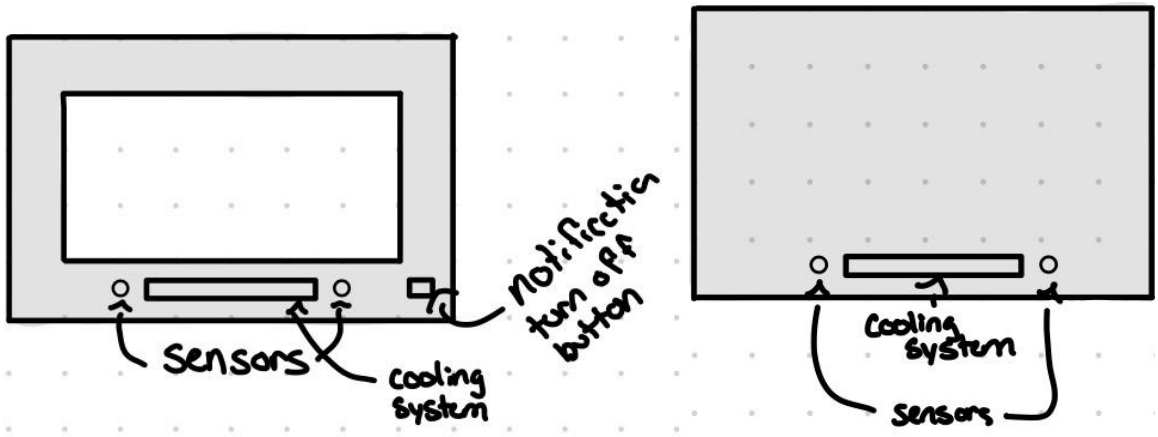


Figure 28. Location of Sensors.

Child and Pet Safety. To keep the child or pet safe, the device is connected to multiple contacts, as well as being equipped with a cooling system.

As stated in Notification Concepts, if the sensors detect that there is a child or pet in a hot vehicle, a notification will be sent out to the two main guardians. To add, if there is no response within 10 minutes, the three other emergency contacts will be notified. Also, a notification will be sent out every five minutes to ensure that the contacts know their child or pet is in danger.

NOTIFICATION

ALERT - Your child or pet is being left unattended in a HOT CAR. Go rescue them before the situation becomes more dangerous - *ALERT*

Figure 29. Text message alert.

If the notification is not turned off within 10 minutes, a cooling system will automatically be turned on until the interior of the car reaches a safe temperature (22℃). To add, if the guardian can not get to the vehicle within 10 minutes, the device will start playing a video which will keep the child calm and occupied until the guardian returns.

Finally, the notification can only be turned off by pushing a button on the side of the physical device, which is located inside the hot vehicle.

Implementation Concepts. This device is very easy to use and can be purchased and installed by the owner of the vehicle. In a car, the device will attach to the back of the headrests. As seen in Figure 30, there are two metal prongs that are fastened to the bottom of the device which will attach to the two metal prongs on a headrest, and a velcro strap that goes around the cushion.

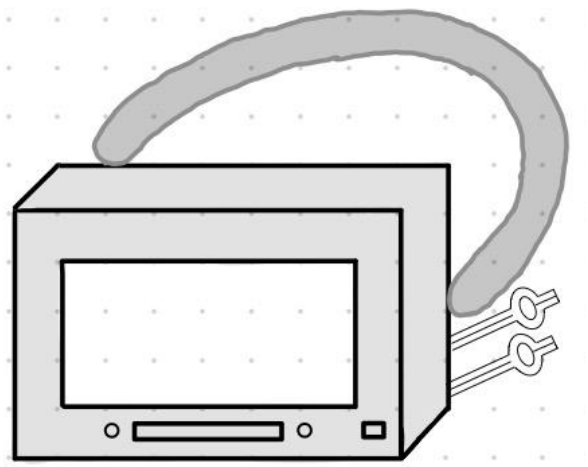


Figure 30. Car’s device design.

In a bus, the device has the same design, although, instead of using metal prongs and velcro strips, the device will be mounted to the ceiling with the use of screws.

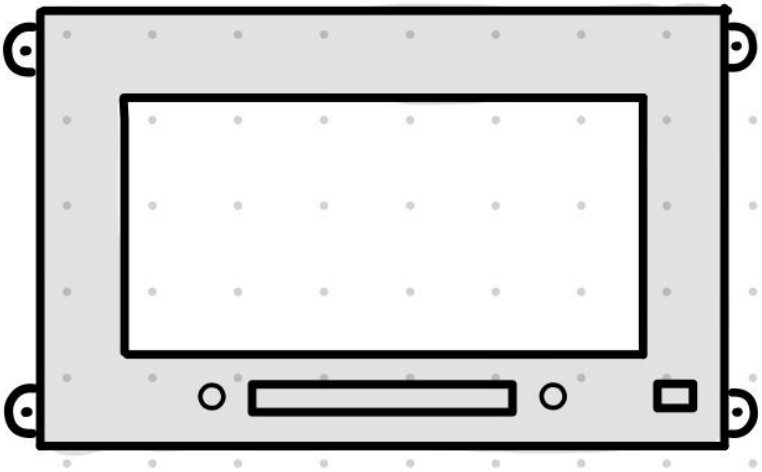


Figure 31. Bus device design.

4.0 Benchmarking

Benchmarking allows a team to determine the superior product, and provides opportunities to learn about different specific design approaches. The proposals were evaluated on a scale of 1-3 to quantify how close they are to meeting the specification, where 1 (orange) is the lowest, 2 (yellow) is medium, 3 (green) is the highest.

4.1 Team Member Concepts Benchmarking

Table 7: Benchmarking

Specification	Importance (weight)	Hans	Benjamin	Kobe	Steven	Kaitlynn
Detects when a child or pet is present and unattended	5	Yes	Yes (weight sensor)	Yes (weight/ door sensor)	Yes (pressure/ motion sensor)	Yes (heat sensor)
Detects if the child is safe (heat/gases)	5	Yes (passive infrared temp.)	Yes (temp.)	Yes (temp.)	Yes (hazardous gases /temp.)	Yes (thermocouple)
The device alerts the owner if a child or pet is left unattended	4	Yes (owner/emergency contacts)	Yes (User/ emergency contacts)	Yes (SMS/call, GPS)	Yes (emergency contacts/alarm)	Yes (Text messages to guardians and emergency contacts)
The device keeps the child or pet safe while waiting for help	5	Yes (Solar powered fan)	Yes (A/C/heat unit)	Yes (heated, a/c)	Yes (a/c)	Yes (video entertainment and cooling system)
The device alerts people in close proximity	5	Yes	Yes	Yes	Yes	No
The device is easy to install	3	Yes (user)	Yes (User/Professional)	Yes (user/dealerships)	No (professional)	Yes (user)
TOTAL	81	66	71	76	70	66

4.2 Benchmarking Results

Based on our Team member concepts benchmarking, Kobe's idea is deemed as the most appropriate solution for the problem, reaching a total score of 71 out of 81. His concept scored highest in almost all design criteria and includes unique features such as a GPS sensor to help authorities find the exact location of the car in case all other options fail. Weight sensors and door sensors are also implemented to detect the child's presence as well as multiple temperature sensors to determine whether the air conditioning unit or heating unit should be turned on. However, we will try to improve on the concept and possibly integrate the design criteria of the other team members' concepts into Kobe's idea. For example, Hans' idea of using a solar-powered fan as a cooling method is a unique idea that may still be up for consideration since it uses a renewable source of energy and is a cost-friendly alternative. Furthermore, Kaitlyn's idea is the only one that features an onboard entertainment system and thus can be considered for implementation in the final product.

5.0 Final Concept

The design of this product was based on Mansour Kharoub's needs, therefore we expect this product to be affordable, notify the owner of the vehicle in case a child/pet is left unattended, and maintain a safe temperature inside the vehicle to prevent death from heatstroke. Some of the valuable ideas from the proposals were: incorporating an entertainment system, making use of solar power, and weight/door sensors for detecting passengers in the vehicle. Although not all solutions could be implemented, we have taken the ideas that help us most to meet our client's needs.

After reviewing the six subsystems and three project proposals, Kobe's proposal combined the best characteristics from each team member. Kobe's proposal mentioned that this device will be the following: (a) a compact device that would require minimal interactions; (b) uses a series of door, weight, and temperature sensors to detect if a child or pet is left unattended in a vehicle; (c) will use air conditioning to keep the child safe; (d) will notify guardians: and (e) will notify a third party to call local authorities.

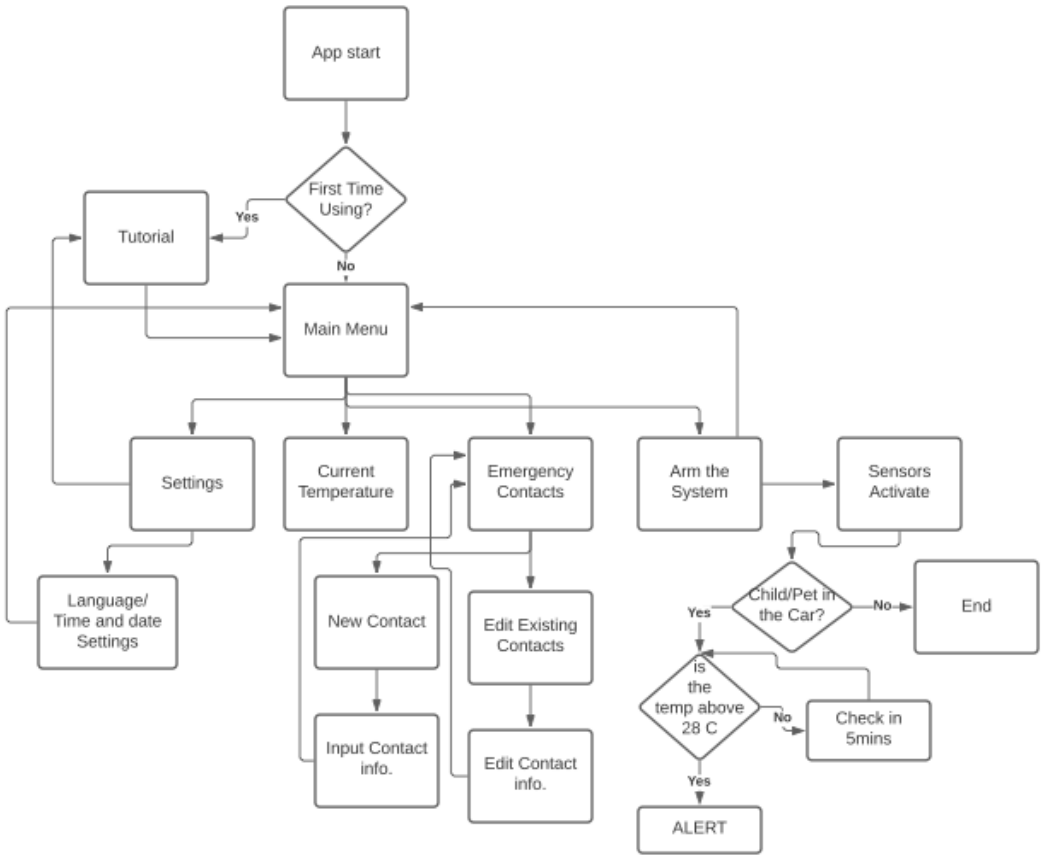


Figure 30. Flowchart for the functioning of the final concept.

Shown in Figure 30 above, is a flowchart clarifying how exactly the device will work. Once the user downloads the app, they will be presented with a tutorial video or presentation so that they know not only how to use the device, but also all the features of the app and where to find them. From the app, the user will be able to manage all the contacts and devices that the device will recognize, as well as provide information about the vehicle and the child/pet. The device will use information gathered by all the sensors to determine when the system needs to be activated, and that notifications need to start being sent. The device will manage the temperature in the cabin as well. Once the user either disables the device or shuts it off in the app, it will reset and stay in a “sleep” state until it is used again.

7.0 Conclusion

In this deliverable, each group member developed his own idea and used sketches to better explain how they think their concept works. Moreover, three proposals were explored in greater detail to have an even better understanding. From our benchmarking results, it has been concluded that Kobe’s idea is the best one since the idea scored the highest in almost all of the design criteria and hence has a greater total. However, the idea will keep on being refined and

adjusted by all team members until it is even better and if necessary we will keep going to the problem definition and try coming up with new ideas or re-evaluating current ones until all of us are satisfied with the final idea.

References

[1]https://www.freeasestudyguides.com/ac-in-car-temperature-sensor.html
[2]http://vehiclesecurity.co.nz/blog/pir-sensors/