**Deliverable C: Design Criteria**

Group 18: Calum Avon, Poula Rezkalla, Ashley Larocque

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# Design criteria

**Functional Needs-**

* Measure temperature and CO levels accurately
* Detects the presence of an occupant
* No modifications to the vehicle
* Compatible with all vehicles
* Universal
* Fail-safe system to ensure occupants safety
* Ability to send persistent notifications to a cell phone
* Ability to contact authorities if needed

**Non-Functional Needs-**

* Easy to install
* Affordable
* Accessible to all
* User friendly
* Resistant to shocks that occur on a road

**Constraints-**

* The cost must be less than $50
* Operating temperatures: -40℃ to 45

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# Technical Benchmarking

| Device/ Specifications | Rear Seats Reminder (GM) | Vita Sense | Sense a life  | Rear Occupant Alert (Hyundai) |
| --- | --- | --- | --- | --- |
| Cost | Included with vehicle  | N/A | $200 USD | Included with vehicle |
| Contact function(s) | Alert on instrument panel/ Chime  | Flashing lights, soundsSmartphone notification | Messages on Phone,Speaker with verbal message, LED  | Flashing lights, HornSmartphone notification |
| Install  | N/A | Inside headliner  | Two pieces stuck to the seats  | N/A |
| Variables being measured | N/A | Movement sensor | Weight and optical sensor  | Movement sensor  |
| Occupant detection | Doors opening before start | Radar  | Weight sensor in child's seat | Ultrasonic movement sensor  |
| Measurement accuracy | N/A | 95% | High  | 97% |
| Failsafe  | None  | None | 3 emergency contacts  | None |
| Retrofitting support | None  | None | High  | None |
| Universality | General Motors only  | Moderate | High  | Hyundai Motor Company only |

*Table 1: Specifications are coloured in order of best to worst, green being best, yellow being moderate and red being worst.*

There are many systems that exist to detect the presence of a child forgotten in a vehicle. The *Rear Seat Reminder* is a system that utilizes the door opening sequence to notify the driver if the sequence was not performed after the engine’s shutdown. Whereas the *Rear Occupant Alert* uses Ultrasonic movement sensors to detect the presence of a child in the rear seats of the vehicle. Similarly, the *Vita Sense* system uses motion sensors to detect the presence of a child and alert the driver using flashing lights, sounds, and an alert sent to the driver’s phone. Finally, there is the *Sense-A-Life* system which utilizes weight and optical sensors to notify the driver upon opening their door if there is an occupant in the seat.

When comparing these systems it was concluded that the *Sense-A-Life* system is the best system for detecting the presence of a child in a vehicle. However, it utilizes weight sensors rather than the motion sensors preferred by the client and it is not as affordable as the others. However, this system provides the highest level of accuracy, a fail-safe mechanism, and is universally available.

| Device/ Specifications | Importance  | Rear Seats Reminder (GM) | Vita Sense | Sense a life  | Rear Occupant Alert (Hyundai) |
| --- | --- | --- | --- | --- | --- |
| Cost Score | 4 | 3 | 1 | 2 | 3 |
| Contact function(s) Score | 5 | 1 | 2 | 3  | 2 |
| Install Score  | 3 | 3 | 1 | 2 | 3 |
| Variables being measured Score | 4 | 1 | 3 | 2  | 3 |
| Occupant detection Score | 4 | 1 | 3 | 2 | 3 |
| Measurement accuracy Score | 4 | 1 | 2 | 3 | 3 |
| Failsafe Score  | 4 | 1 | 1 | 3  | 1 |
| Retrofitting support Score | 5 | 1 | 1 | 3 | 1 |
| Universality Score | 4 | 1 | 2 | 3 | 1 |
| Total score |  | 51 | 66 | 96 | 80 |

*Table 2:*

# Target Specifications

It is important that the product meets as many of the client’s needs as possible. Thus there are several specifications that must be met with a high degree of effectiveness.

The client emphasized their need for the system to be effective in terms of shock resistance. The system will need to be able to withstand the forces applied during violent acceleration or sudden stops. To fulfill this need, the product must be able to withstand an acceleration of 10 m/s2.

Another important criterion is the need for the system to be universal. This means that the system must work in different climates, not just hot weather. For that reason, the system must be effective between temperatures of -45℃ to 40℃.

The client also expressed their desire for the system to be user-friendly. The goal is to design a system that can be easily set up by the intended user, which will be tested in the prototyping stage of development.

The overall goal is to create a system that has a 97% accuracy to justify the need for the system. To do so we must consider many requirements that have been summarized in *Table 3.*

|  | Design Specifications  | Relation(>,=,<) | Value  | Units  | Verification method |
| --- | --- | --- | --- | --- | --- |
|  | **Functional Requirements**  |  |  |  |  |
| 1 | Temperature and CO measurements accuracy  | > | 97 | % | Test |
| 2 | Universal  | = | 100 | % | Test |
| 3 | Occupant detection | > | 97 | % | Test |
| 4 | Persistent notifications  | = | Yes | N/A | Test |
| 5 | Failsafe system  | = | Yes | N/A | Test |
| 6 | Ability to contact authorities | = | Yes | N/A | Test |
|  | **Constraints**  |  |  |  |  |
| 1 | Cost | < | 50 | $ | Estimate/ Final Check |
| 2 | Operating Temperatures  | = | -40 to 45 | ℃ | Test |
|  | **Non Functional Requirements** |  |  |  |  |
| 1 | Easy to install  | = | Yes | N/A | Test |
| 2 | Accessible  | = | Yes | N/A |  |
| 3 | User Friendly  | = | Yes | N/A | Test |
| 4 | Shock Resistance | = | 10 | m/s2 | Test |

*Table 3*

# Client Meeting Reflection

The Client meeting changed several design criteria, such as the importance of the cost, the importance for the system to be universal and for it to be user friendly. Initially, as a group, the importance of the cost being low was perceived to be an importance of 5. But after the client meeting, it was apparent that this wasn't as necessary as initially thought. Whilst there is still a large amount of focus on it, there should be a larger amount put into ensuring the product functions as optimally as possible. Additionally, there is a larger focus on ensuring the system is universal and compatible with all vehicle types than the group initially thought. The client meeting shined a light on the fact that the system should be applicable on all on-road vehicles, including buses. Since the creation of deliverable B, some needs have changed. These needs include the requirement for resilience to shock and violent accelerations that might be induced by poorly maintained road or emergency braking. This is important because vehicles are often subject to large forces, and whilst some of it is reduced by the suspension of the vehicle, there is still the possibility that a poorly made system that isn’t designed to withstand such abuse would survive.

# Citations

 Mousel, Thierry, Peter Larsen, and Holger Lorenz. "Unattended children in cars–radiofrequency-based detection to reduce heat stroke fatalities." In *Proc. Int. Tech. Conf. on the Enhanced Safety of Vehicles, Detroit Michigan, United States*, pp. 5-8. 2017.

Visconti, Paolo, Roberto de Fazio, Paolo Costantini, Simone Miccoli, and Donato Cafagna. "Innovative complete solution for health safety of children unintentionally forgotten in a car: A smart Arduino-based system with user app for remote control." *IET Science, Measurement & Technology* 14, no. 6 (2020): 665-675.