**Hot Car Emergency: Design Criteria**

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### Introduction

Due to rising global temperatures and an increase in worldwide vehicle ownership, an average of 38 children die each year due to incidents related to heatstroke and vehicular suffocation (Sommer et. al, 2007). It was determined that a need exists for a versatile, reliable, and fast-acting system that can detect children and pets trapped in vehicles and notify potential rescuers or function independently before heat stroke or suffocation can occur. Through discussions with the client, an initial understanding of the problem was developed and a list of priority-ranked needs was compiled. To develop a solution that addresses these needs, they must be translated into specific design criteria that will be taken into account during the design process. The proposed solution will endeavour to meet all target specifications while respecting any additional constraints imposed by the client.

### Needs Translation

| **Client Need** | **Importance** | **Design Criteria** |
| --- | --- | --- |
| The system is versatile. | 3 | * Installation method * Physical dimensions * Adjustability of physical dimensions * Language options |
| The system is reliable. | 5 | * Heat tolerance * Force tolerance * Success rate * Back-up mechanisms |
| The system is fast-acting. | 4 | * Response time |
| The system prevents heat stroke and suffocation. | 5 | * Function of primary mechanism * Success rate * Carbon monoxide detection * Temperature and humidity detection |
| The system is affordable. | 2 | * Cost |
| The system notifies users and other potential rescuers. | 5 | * Communication capabilities * Communication methods |
| The system can act independently. | 4 | * Autonomy of main mechanism |
| The system detects trapped passengers. | 5 | * Motion detection |

### Benchmarking

| **Specifications** | **Importance** | **Device 1** | **Device 2** | **Device 3** |
| --- | --- | --- | --- | --- |
| Company | - | First Alert | X-sense | System Sensor |
| Product Type | - | Carbon monoxide detector | Carbon monoxide detector | Heat and humidity detector |
| Cost (CAD) | 2 | $36.99 | $37.64 | $55.61 |
| Weight (lbs) | 1 | 0.7 | 0.36 | 0.19 |
| Consistency | 3 | Very high | Very high | Very high |
| Independence | 2 | Yes | Yes | Yes |
| Indication of Error | 3 | - Low battery beeps  - Lifeline indicated | - Light flashes while functional  - Signal when reached end of life | Light flashes while funcional |
| Type of sensor | - | Electrochemical | Electrochemical | Photoelectric |
| User review | 2 | Highly rated | High rating for installation but was tested in a controlled environment and failed | None available |
| **Total** | **-** | **37** | **29** | **24** |

### Target Specifications

| **#** | **Design Specifications** | **Relation** | **Value** | **Units** | **Verification Method** |
| --- | --- | --- | --- | --- | --- |
|  | Functional Requirements |  |  |  |  |
| 1 | Response time (notification) | < | 10 | sec | Testing |
| 2 | Success Rate | > | 98 | % | Testing |
| 3 | Ability to detect carbon monoxide | = | yes | N/A | Testing |
| 4 | Ability to detect motion | = | yes | N/A | Testing |
| 5 | Ability to detect temperature | = | yes | N/A | Testing |
| 6 | Autonomy of main mechanism | = | yes | N/A | Testing |
| 7 | Mobile app to notify users | = | yes | N/A | Testing, user feedback |
| 8 | Ability to withstand force | = | yes | N/A | Testing, user feedback |
| 9 | Ability to connect to GPS | = | yes | N/A | Testing |
|  | Constraints |  |  |  |  |
| 10 | Installation does not involve internal components of the vehicle | = | yes | N/A | N/A |
| 11 | Cost | < | 40 | CAD | Estimates |
| 12 | Operating conditions: high heat | > | 75 | °C | Testing, analysis |
|  | Non-Functional Requirements |  |  |  |  |
| 13 | Weight | < | 5 | lbs | Measurement |
| 14 | Language options | > | 1 | N/A | User feedback |
| 15 | Aesthetics | = | yes | N/A | User feedback |
| 16 | Reliability | = | yes | N/A | Testing, user feedback |

It is important to note that some values in the chart above were deduced according to benchmark data (e.g. cost), while others were decided with respect to practicality. For example, no precedent has been set for the weight of an aftermarket device; it is reasonable to assume that this system will be considerably heavier than any sensor integrated into the vehicle itself.

### Conclusion

Solution development will focus on delivering a design that meets the target specifications within the given constraints. An emphasis will be placed on functional requirements and other criteria that that client has deemed important. The design thinking process is inherently client driven, and each step in the process above was determined with the client’s needs in mind. The specifications and needs above have been continually adjusted based on discussions with the client. For example, the client communicated that alarm systems reliant on rear door activity are unacceptable given the probability that a child evades detection. Thus, the client needs and specifications reflect the need for the solution to be able to detect the presence of a child in the vehicle. The client also expressed extreme concern with regards to the involvement of human lives, and emphasized the need for the alarm to sound in any circumstance where a child is locked in a vehicle—regardless of temperature—without the ability to be muted. Thus we have adjusted the importance score of the ability to notify potential rescuers from a 4 to a 5. The client also expressed a desire for a mobile app, so this will be taken into consideration as a non-functional requirement of the device. The specifications above will be used to develop an initial design plan and adjusted based on client feedback as needed.

1. References

Sommer, M., Gately, D., & Dargay, J. (2007). Vehicle Ownership and Income Growth, Worldwide: 1960-2030. The Energy Journal. Retrieved September 29, 2021, from <https://www.researchgate.net/publication/46523642_Vehicle_Ownership_and_Income_Growth_Worldwide_1960-2030>

*2151T*. English (US). (n.d.). Retrieved October 7, 2021, from   
<https://www.systemsensor.com/en-us/Pages/2151T.aspx>.

*X-sense CO03D carbon monoxide detector and CO alarm with LCD display*. and CO Alarm with LCD Display. (n.d.). Retrieved October 7, 2021, from <https://www.x-sense.com/products/carbon-monoxide-alarm-with-lcd-co03d-1?gclid=EAIaIQobChMIytWxkLe58wIVD6bICh3vCANIEAQYBCABEgJ74PD_BwE>.

*First alert CO605A carbon monoxide plug-in alarm with battery backup, carbon monoxide detectors - Amazon Canada*. , Carbon Monoxide Detectors - Amazon Canada. (n.d.). Retrieved October 7, 2021, from <https://www.amazon.ca/First-Alert-CO605A-Monoxide-Battery/dp/B0812P1NGT/ref=asc_df_B0812P1NGT/?tag=googleshopc0c-20&linkCode=df0&hvadid=344720073734&hvpos=&hvnetw=g&hvrand=9119937576376697864&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000668&hvtargid=pla-857811795065&psc=1>.