



# Aftermarket Child Detection for Car Seats

Virtual Design Review 2

Presenting:

Charlie Cruzan, Troy Brumm, and Spencer Nguyen



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MECHANICAL ENGINEERING

# Our Team



**Justin Craig**  
Team Leader



**Troy Brumm**  
Senior CAD Designer



**Spencer Nguyen**  
Lead Researcher



**Charlie Cruzan**  
Software Architect



**Stephen Carr**  
Financial Advisor





# Overview

- Project Summary
- Background
- Persona Development
- Targets
- Concept Generation
- Conclusion



# Project Summary

- Problem: An average of 37 children die each year due to vehicular heatstroke
- Objective: Design a system that detects when an infant is in a vehicle and subject to dangerous temperatures
- Project Expectations:
  - Implement Device
  - SAE World Congress Paper
  - Compete in InNOLEvation Challenge

Project Summary | Background | Persona Development | Targets | Concept Generation | Conclusion

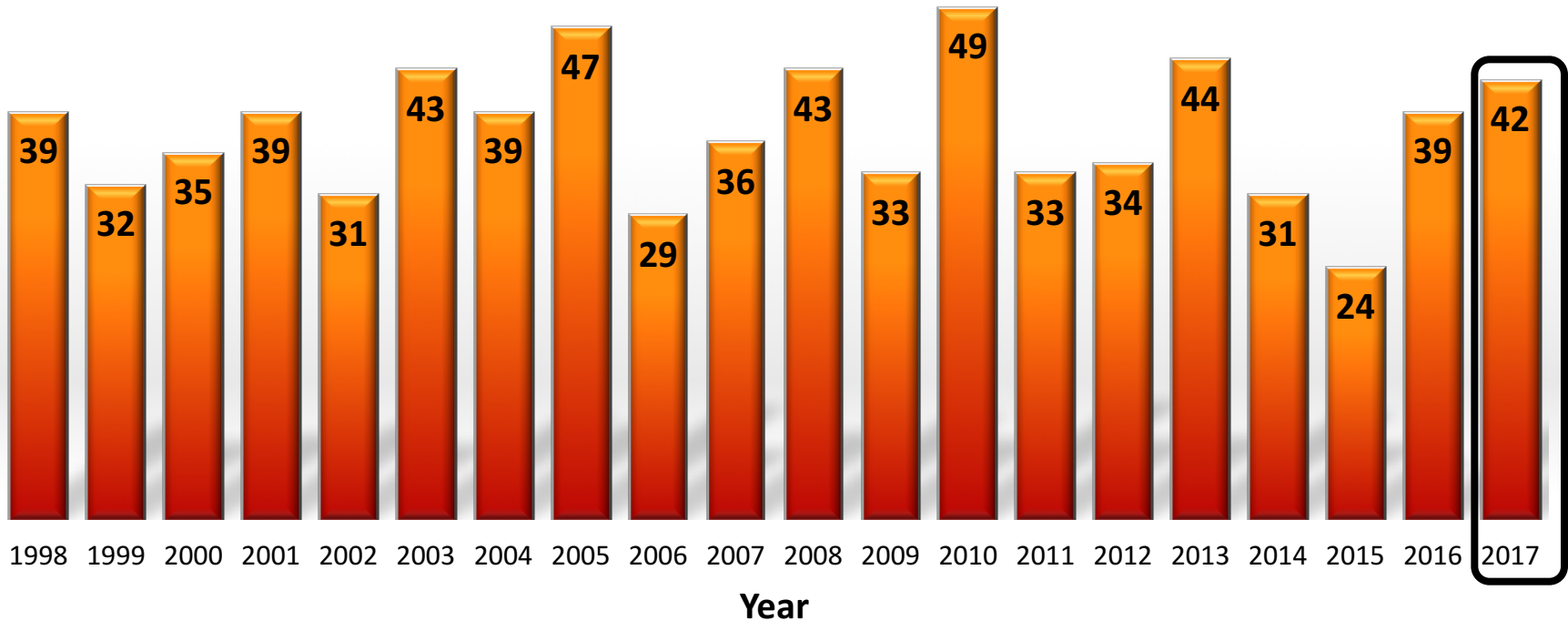


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Charlie Cruzan

# Background

Child Vehicular Heatstroke Deaths in U.S.  
**Total: 742 since 1998**



\*Data gathered from noheatstroke.org

Project Summary | [Background](#) | Persona Development | Targets | Concept Generation | Conclusion

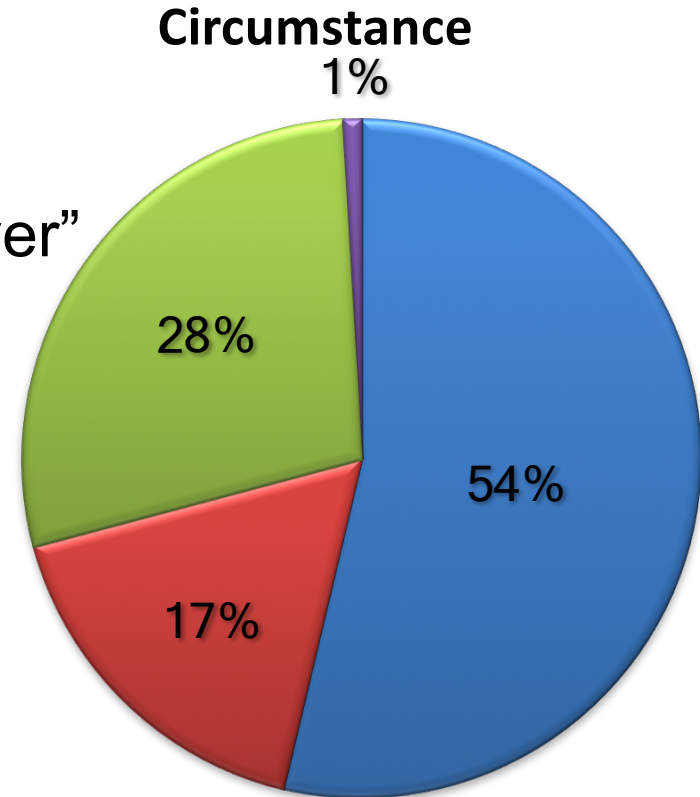


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Charlie Cruzan

# Background

- Focusing on:
  - “Forgotten by caregiver”
  - “Intentionally left by caregiver”
- 71% of all cases



- Forgotten by caregiver
- Intentionally left by caregiver
- Playing in unattended vehicle
- Unknown

\*Data gathered from noheatstroke.org

Project Summary | **Background** | Persona Development | Targets | Concept Generation | Conclusion



# Persona Development

- Requires clear understanding of the market
- Benefits of Personas:
  - Establish consistent interpretation of user base
  - Provide a “face” to the story of the user
  - Overwrites stakeholder’s wish list with user priorities





# Persona Development



I-Mom



Stay at  
home  
Dad



Soccer  
Mom

Project Summary | Background | **Persona Development** | Targets | Concept Generation | Conclusion



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Charlie Cruzan

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# Now Presenting:

## Troy Brumm

Project Summary | Background | Persona Development | [Targets](#) | Concept Generation | Conclusion



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# Targets



Detect temperature

- 70-120 °F

Withstand temperature range

- 0-200 °F

Detect child in car seat

- No false negatives

# Targets



Determine temperature rate of change

Communicate to user

- $\leq 20$  seconds

Compatibility

- $\geq 5$  top selling car seat brands

# Device Systems

1. *Vehicle Interior Temperature Sensing*

2. *Child Detection*

3. *Dangerous Temperature Calculation*

4. *Threatening Condition Indication*

5. *Response Initiation*

Project Summary | Background | Persona Development | Targets | **Concept Generation** | Conclusion



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# Vehicle Interior Temperature Sensing

## System 1

Project Summary | Background | Persona Development | Targets | **Concept Generation** | Conclusion



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# NTC Thermistor

## ➤ Pros

- High sensitivity
- Inexpensive
- Low response time

## ➤ Con

- Requires linearization



Figure 1: NTC Thermistor (Lee's Electronic)

# Child Detection

## System 2

Project Summary | Background | Persona Development | Targets | **Concept Generation** | Conclusion



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# Chest Restraint Harness Clip

## ➤ Pros

- Seamless integration for user
- Reliable

## ➤ Cons

- Requires child to be buckled in to be detected
- Difficult to design for universal adaptability

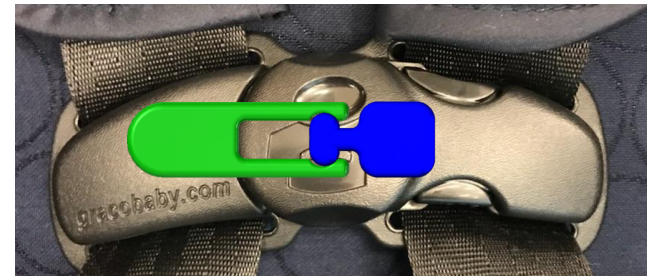


Figure 2: Closed circuit



Figure 3: Open circuit



# Pressure Switch

## ➤ Pros

- Simple installation
- Compatible with any car seat
- Low cost

## ➤ Con

- Pad must be properly positioned
- Possible false positives



Figure 4: Pressure Activated Switch (RehabMart)



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# Now Presenting:

## Spencer Nguyen

Project Summary | Background | Persona Development | Targets | **Concept Generation** | Conclusion



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# Dangerous Temperature Calculation

## System 3

Project Summary | Background | Persona Development | Targets | **Concept Generation** | Conclusion



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Spencer Nguyen

# Temperature Rate Extrapolation

- Predicts dangerous temperature before the vehicle physically reaches it
- Uses rate of temperature change to extrapolate data and determine if a response should be initiated

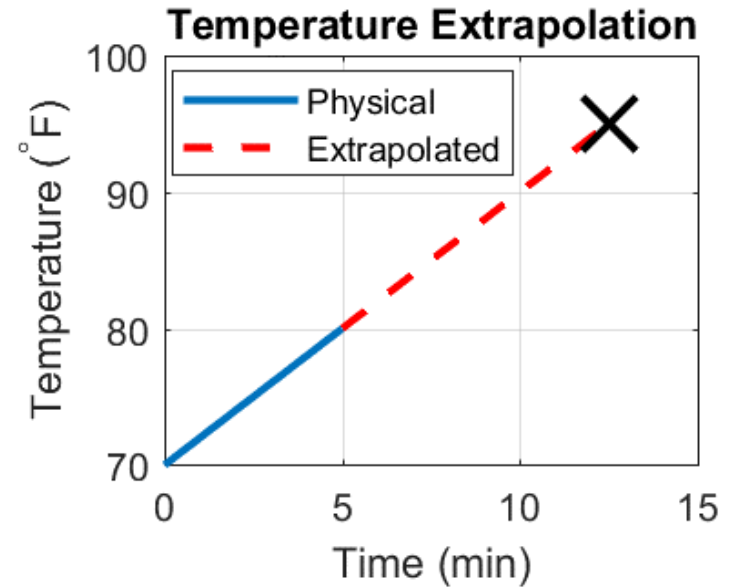


Figure 5: Temperature extrapolation example

# Threatening Condition Indication

## System 4

Project Summary | Background | Persona Development | Targets | **Concept Generation** | Conclusion



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Spencer Nguyen

# Verification of Threatening Conditions

- System evaluates the device's sensors to determine the appropriate response
- If required conditions are met, the algorithm will proceed to System 5

• Dangerous Temp. Calculation



• Child Detection 1



• Child Detection 2



**Response Initiation**



# Response Initiation

## System 5

Project Summary | Background | Persona Development | Targets | **Concept Generation** | Conclusion



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# Key Fob Alarm

- Utilizes two wireless communication antennas: One in the vehicle and one placed inside a key fob
- Capabilities to alert the holder, e.g., by sound or vibration

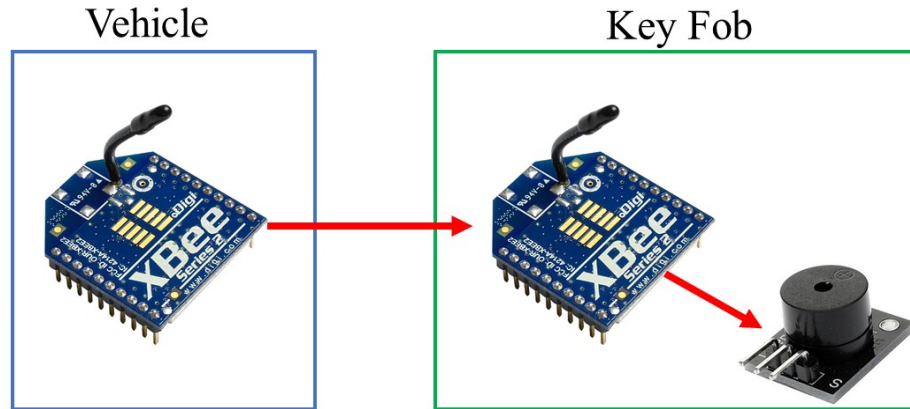


Figure 6: Interaction of antennas (Gravitech and Vetco Electronics)

# Cellular

- Sends alerts and information to the user's cellphone
- Allows more information to be communicated to the user

ARDUINO GSM SHIELD 2  
(INTEGRATED  
ANTENNA)

Code: A000105



Figure 7: Arduino compatible GSM shield (Arduino)

# Future Work

## 1. Concept Selection

- Perform iterations of the Pugh matrix to screen and select the final concepts
- Entrepreneurial aspect of the project will heavily affect final concept selection

## 2. Prototyping

- We plan to begin prototyping by December



# Conclusion

- Thank you to...
- Dr. Michael Devine
- Dr. Shayne McConomy
- FAMU-FSU College of Engineering
- Jim Moran School of Entrepreneurship



# References

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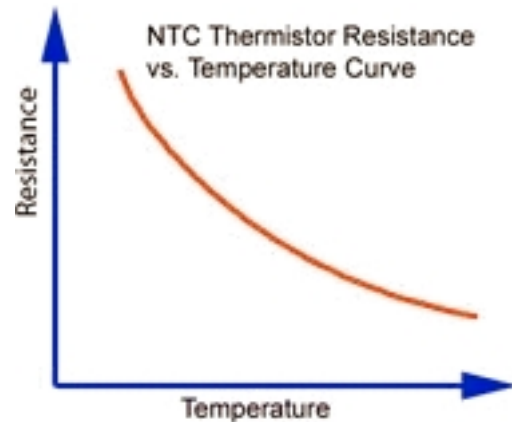
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# Temperature Sensors

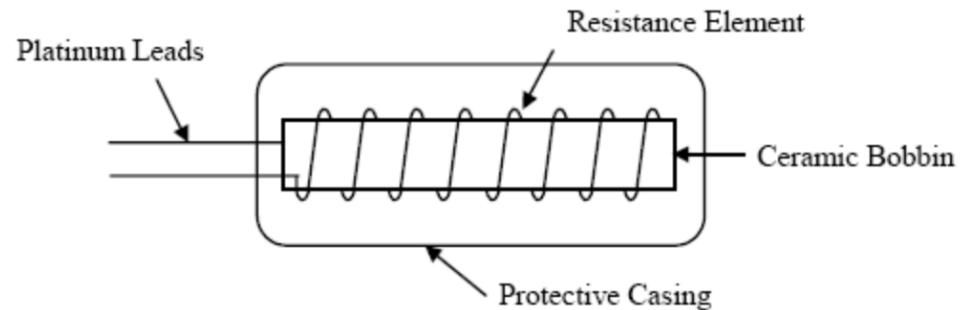
## ➤ Negative Temperature Coefficient Thermistor

- Pros- High accuracy and inexpensive
- Cons- Requires linearization



## ➤ Resistance Temperature Detector

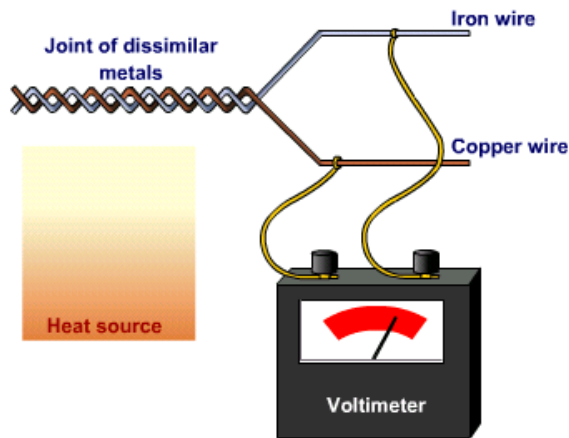
- Pros- Highest accuracy
- Cons- Expensive and fragile



# Temperature Sensors

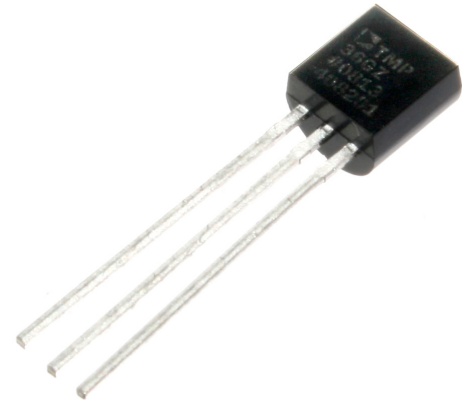
## ➤ Thermocouple

- Pros- Widely used, large temperature range, and inexpensive
- Cons- Least accurate ( $\pm 5^{\circ}\text{C}$ )



## ➤ Semiconductor Based Sensor

- Pros- No linearization required
- Cons- Least accurate ( $\pm 5^{\circ}\text{C}$ ), response time of up to 60 seconds





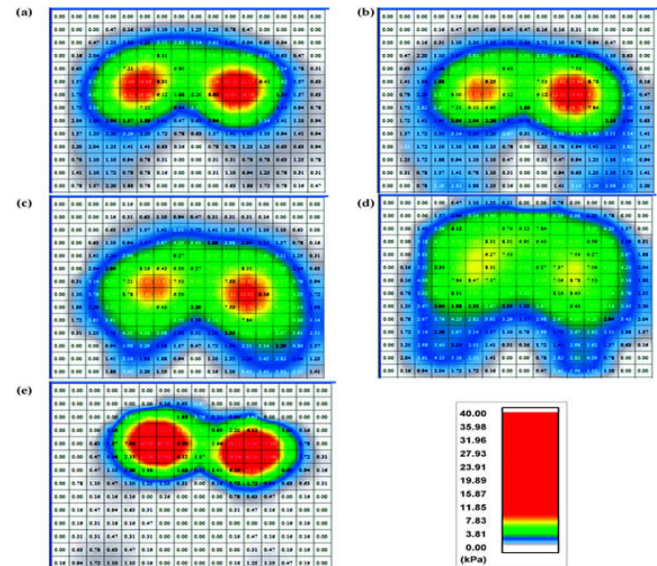
# Pressure Sensor

## ➤ Pros

- Simple installation
- Detects difference of object vs. child in the car seat

## ➤ Cons

- Expensive
- Requires microcontroller to handle large amounts of data
- Requires complex programming

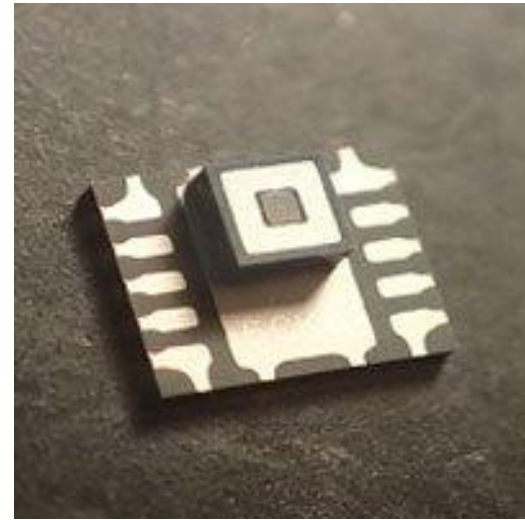


Pressure Map (Sensor Products Inc.)



# Coupled Motion & IR Sensor

- Pros: If one system fails, the other systems can still detect the presence of a child
- Cons: Complex design, higher cost and difficult setup



AKM Human Detection IR Sensor Module (AKM)



# Temperature Threshold Switch

- Similar to a household thermostat
- If a certain temperature range is reached in the vehicle, the algorithm will apply the assigned response for that range.

