Helmet Temperature Sensor Project – Progress Report

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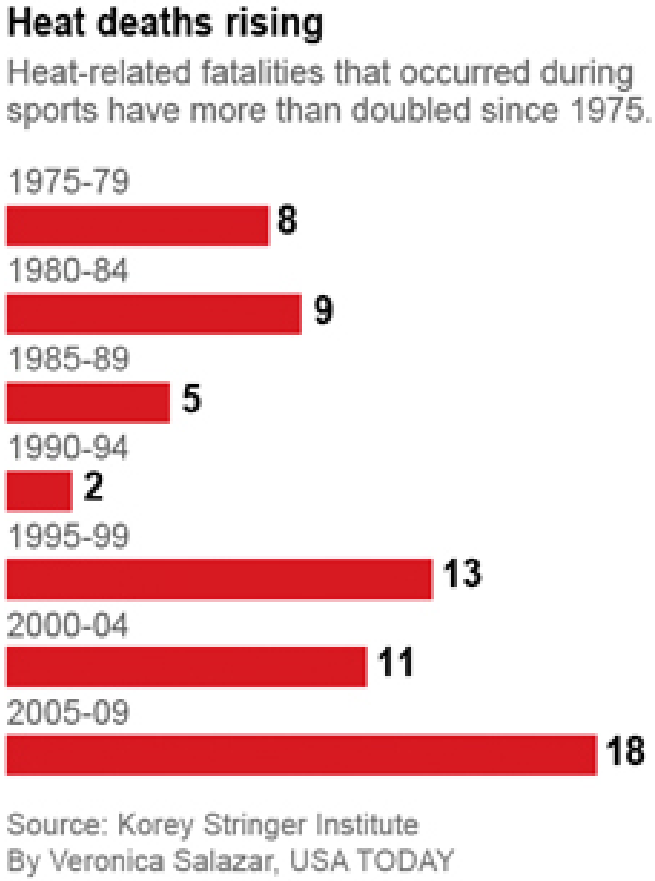
Client: Marc Schmidt, Jarden Team Sports

Background and Need

- 1979-1995: 7000 heat related deaths in the US
- Heat illness - Third leading cause of death in US high school athletes
- Since 1995, 39 football players have died of heatstroke



Design Specifications

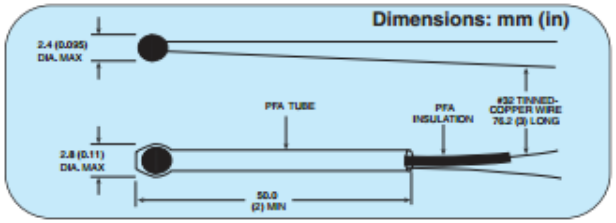
Specification	Requirement
Size	All components fit in existing equipment
Weight	2-3 ounces
Alarm	The device should be in the audible range of 70-75 dB, visible from 100 yards, or generate 1.2-26.2 g
Accurate	± .1º C
Reliable	Less than 5 false alarms per season
Durable	Can continue operating after an impact of 250-300G
Cost	No requirement

Locations to Measure Temperature

- Invasive
  - Rectal temperature
  - Esophageal temperature
- Non-invasive
  - Oral temperature
  - Body surface temperature
  - Axilla temperature
  - Tympanic membrane temperature
  - Temporal artery temperature

Method of Measuring Temperature

- Glass thermometers no longer commonly used due to their dangers
- Today, digital/electric thermometers commonly used
- Different types of temperature sensors
  - Thermocouples
  - Thermistors
  - Resistance temperature detectors
  - Infrared sensors
- Thermochromic options
  - Leuco dyes
  - Liquid crystals



Methods of Alert

- Tactile (vibration)
- Auditory
- Visual (light or color change)
- Wireless information transfer

Pugh Chart: Helmet Options

		Location: Helmet											
		Infrared Temporal Temperature				Skin Thermistor Temperature				Infrared Tympanic Membrane Temperature			
Variables	**Weight**	Sound Alert	Vibration Alert	Light Alert	Wireless Alert	Sound Alert	Vibration Alert	Light Alert	Wireless Alert	Sound Alert	Vibration Alert	Light Alert	Wireless Alert
Client Preference	10	5	5	5	5	5	5	5	5	5	5	5	5
Time	10	7	7	8	4	7	7	8	4	7	7	8	4
Size	7	6	5	6	4	7	6	7	5	6	5	6	4
Weight	7	6	5	6	4	7	6	7	5	6	5	6	4
Cost	4	7	7	7	5	8	8	8	6	7	7	7	5
Accuracy	8	9	9	9	9	6	6	6	6	7	7	7	7
Susceptibility to damage	6	7	7	5	7	7	7	5	7	7	7	5	7
Safety	10	7	7	6	7	7	7	6	7	6	6	5	6
Alert Effectiveness	8	9	7	5	6	9	7	5	6	9	7	5	6
Total		**488**	**458**	**444**	**398**	**482**	**452**	**438**	**392**	**462**	**432**	**418**	**372**

Pugh Chart: Mouth Guard Options

		Location: Mouth Guard													
		Infrared Temperature				Thermistor Temperature				Thermocouple Temperature				Leuco Dye	Liquid Crystal
Variables	**Weight**	Sound Alert	Vibration Alert	Light Alert	Wireless Alert	Sound Alert	Vibration Alert	Light Alert	Wireless Alert	Sound Alert	Vibration Alert	Light Alert	Wireless Alert		
Client Preference	10	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Time	10	7	7	8	4	7	7	8	4	7	7	8	4	8	8
Size	9	6	5	6	4	7	6	7	5	7	6	7	5	9	9
Weight	7	6	5	6	4	7	6	7	5	7	6	7	5	9	9
Cost	4	7	7	7	5	8	8	8	6	8	8	8	6	5	5
Accuracy	8	7	7	7	7	8	8	8	8	6	6	6	6	3	3
Susceptibility to damage	6	6	6	4	6	7	7	5	7	7	7	5	7	8	8
Safety	10	7	7	6	7	7	7	6	7	7	7	6	7	6	6
Alert Effectiveness	8	5	9	5	6	5	9	5	6	5	9	5	6	5	5
Total		**486**	**502**	**474**	**424**	**520**	**536**	**508**	**458**	**504**	**520**	**492**	**442**	**506**	**506**

Types of Mouth Guard

- Stock mouth guard
- Bite and boil mouth guard
- Custom fit mouth guard

Potential Mouth Guard Form

- Plan to use Double Braces Mouth Guard from Shock Doctor as measurement reference
  - Is not a boil and bite
  - Is a large model

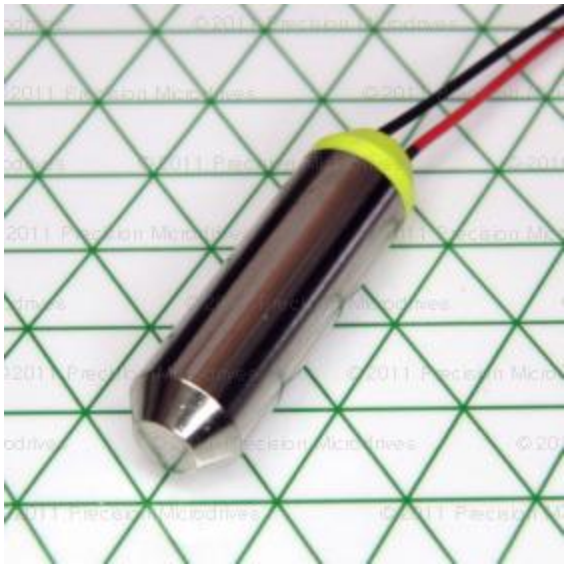
Deciding on a Thermistor

- Three considerations
  - Base Resistance
  - Temperature vs. Resistance relationship
  - Size and Sensor Package Type
- Want it to be waterproof

Thermistor Model Number	Resistance at 25°C	Resistance Change per °C at 50°C
44004	2252 Ω	30.7 Ω
44005	3000 Ω	42 Ω
44007	5000 Ω	70 Ω

Deciding on a Motor

- Precision Microdrives offers several motor designs
- Considerations:
  - –Environment
  - –Strength of signal
  - –Programmability



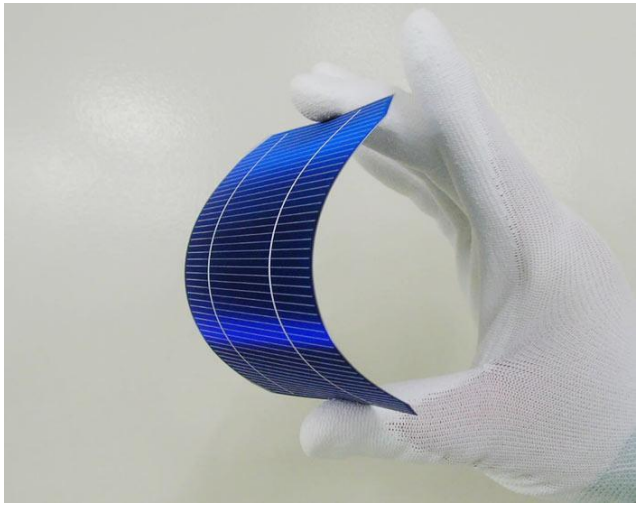
Possible Power Supplies

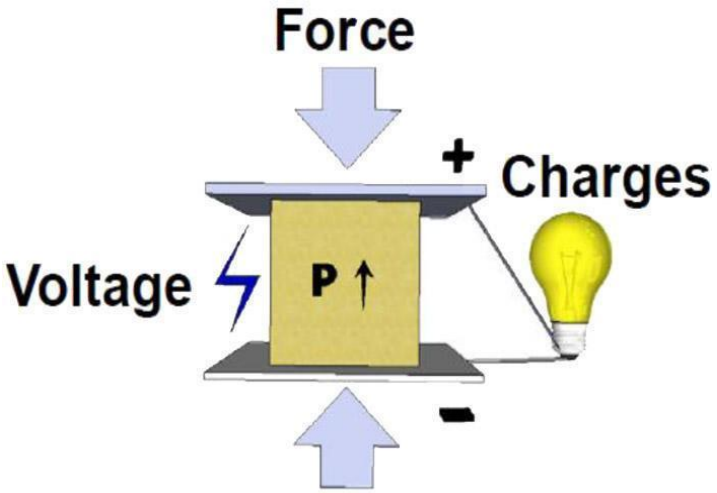
Unlikely

- Generators
- Solar Cells

Potential

- Piezoelectricity
- Battery





Best Power Supply

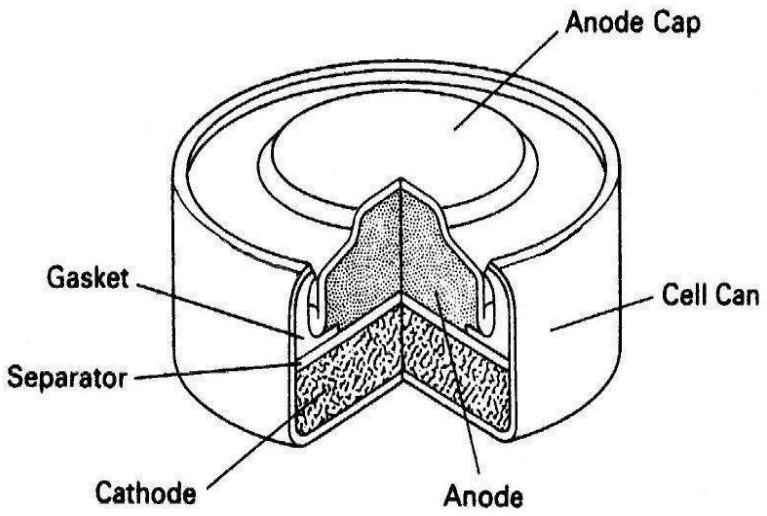
Variable	**Weight**	Generator	Solar Cells	Piezoelectricity	Battery
Capacity	9	10	6	5	7
Size	6	1	4	7	8
Durability	7	5	3	6	7
Consistency	4	8	3	3	7
Safety	8	7	4	6	7
Cost	2	3	2	6	8
Total		**225**	**147**	**201**	**260**

Variety of batteries

- For device with high vs. low operating current
- Rechargeable vs. disposable
- Considerations
  - Size
  - Capacity
  - Safety

Types of Button Cell Battery

- Rechargeable batteries do not have enough capacity
- Disposable batteries
  - Zinc-air batteries cannot be turned on and off
  - Alkaline batteries have too low of a capacity
  - Silver oxide fits the system



Updated Design Schedule

		November				December	
Tasks	28	3	10	17	24	1	8
Design Options							
Progress Report and Presentation							
Select Temperature Location							
Select Method of Temperature Measurement							
Select Alert System							
Select Power Source							
CADD Designs							
Design Circuitry							
Susceptibility to Damage							
Final Design							
Choose Specific Thermistor							
Choose Specific Vibrating Motor							
Choose Specific Power Source							
Design Safe							
Final Report and Presentation							
Poster							

Week of work	
Week of completion	

Division of Responsibilities

Grace Murray	Tyler Perez	Norman Luc
Preliminary Presentation	Final Presentation	Progress Presentation
Existing Technologies	Design Specifications	Existing Technology (Temporal artery research)
Research locations of measuring temperature	CADD drawings	Website Design
Research methods of measuring temperature	Research into Power Sources	Research into Alert Systems
DesignSafe		

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