Helmet Core Temperature Sensor

Presenter: Grace Murray

Group Members: Tyler Perez and Norman Luc

Client: Marc Schmidt, Jarden Team Sports

Preliminary Presentation

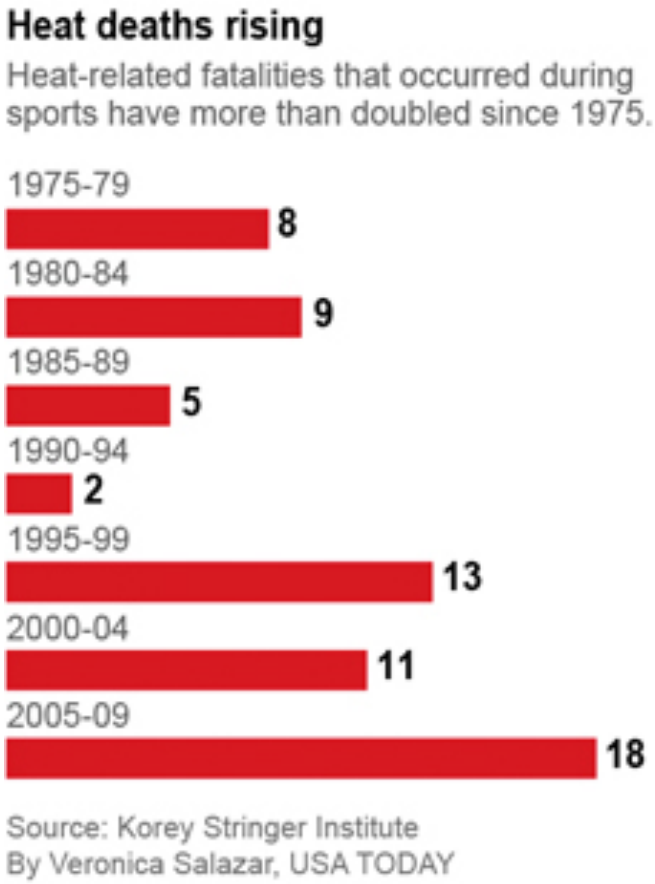
Introduction, Background, and Scope

Design Specifications

Existing Technology

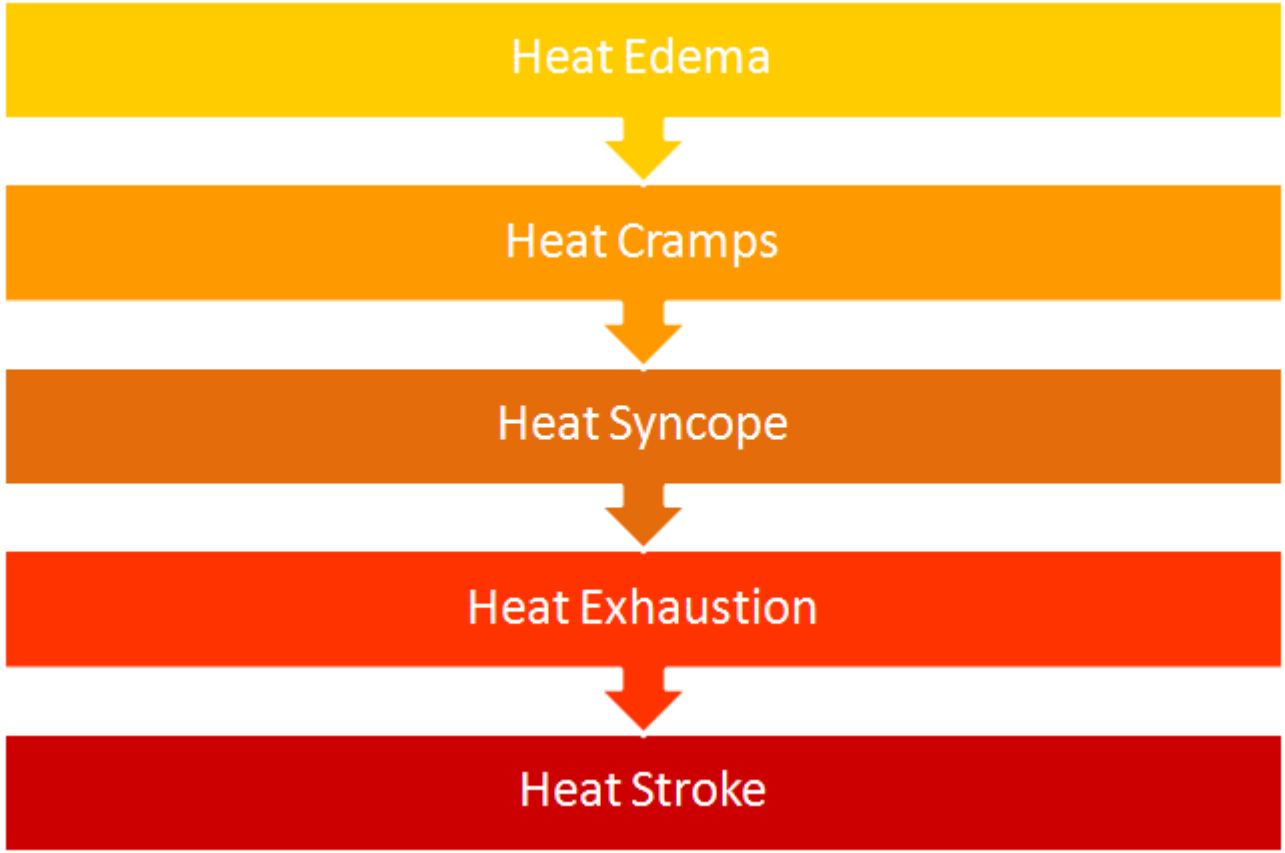
Background and Need

- 1979-1995: 7000 heat related deaths in the US (1)
- Heat illness - Third leading cause of death in US high school athletes (2)
- Since 1995, 39 football players have died of heatstroke (2)



1. "Heat Illness Among High School Athletes --- United States, 2005--2009." *Centers for Disease Control and Prevention*. Centers for Disease Control and Prevention, 20 Aug. 2010. Web. 29 Sept. 2013.
2. Coris, Eric E., Arnold M. Ramirez, and Daniel J. Van Durme. "Heat Illness in Athletes."*Sports Medicine* 34.1 (2004): 9-16. Print.

Stages of Heat Illness



Coris, Eric E., Arnold M. Ramirez, and Daniel J. Van Durme. "Heat Illness in Athletes."*Sports Medicine* 34.1 (2004): 9-16. Print.

Project Scope

- System that uses sensors to measure a player's core temperature
- installed in a football helmet or mouth guard and will alert the player if he/she is overheating
- Accurately measure core temperature in a timely manner allowing athletes to get immediate treatment
- Research will be done to determine the best location for the sensors and the number of sensors needed
- system must not compromise the helmet or mouth guards protective integrity and must meet current industry durability standards for repeated impacts

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Design Specification

Specification	Requirement
Size	All components fit in existing equipment
Weight	Light enough to not alter equipment's position
Audible	Alarm is easily heard by athlete (~75 dB)
Accurate	± .1° C
Reliable	Limited false alarms
Durable	Can continue operating after an impact of 1200 SI
Cost	No requirement

Design Specification

- Sensor Placement
- Number of Sensors
- Frequency of Readings
- Power Requirement
- Equipment Standards
  - Acceptable Severity Index on all impact tests

$$SI = \int_0^T a(t)dt$$

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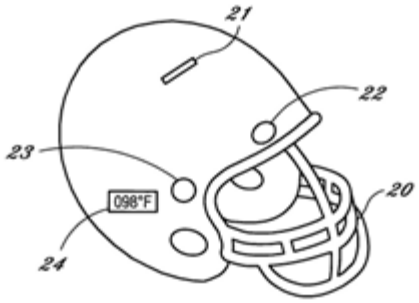
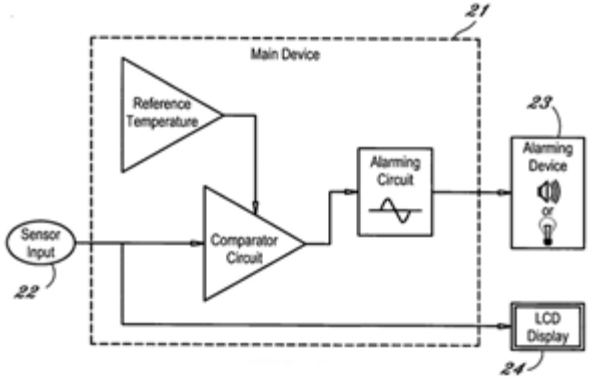
Patent: Temperature Measuring Helmet

- A patent filed for a temperature monitoring device
- The device uses thermistor sensors and comparison circuit
- Measures skin temperature on the forehead





Daugherty, Craig, and Edward P. Daugherty. Body Temperature Measuring Device for Helmet or Head Gear. Craig Daugherty, assignee. Patent US20070177651 A1. 31 Jan. 2006. Print.

Patent: Helmet Sensor

- A patent for a device to monitor helmet temperature and movement
- The device measures skin temperature on the forehead

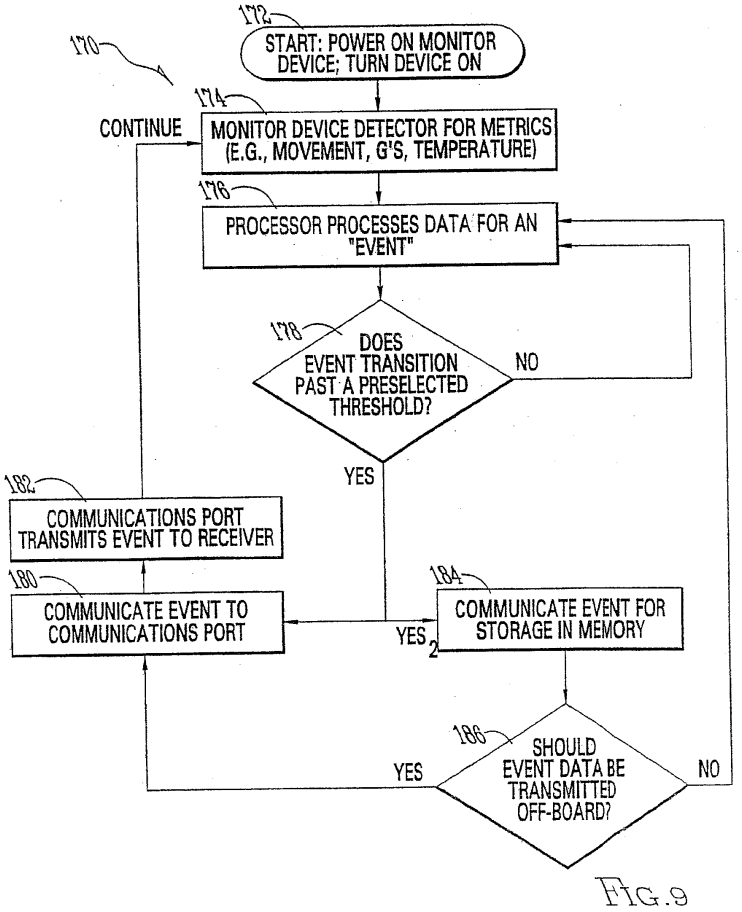


FIG.9

Vock, Curtis, Adrian Larkin, Robert Muir, Burl Amsbury, Eric Edstrom, Perry Youngs, and Paul Jonjak. System For Determining Helmet Temperature And Events. Curtis Vock, assignee. Patent US20120265477 A1. 20 June 2012. Print.

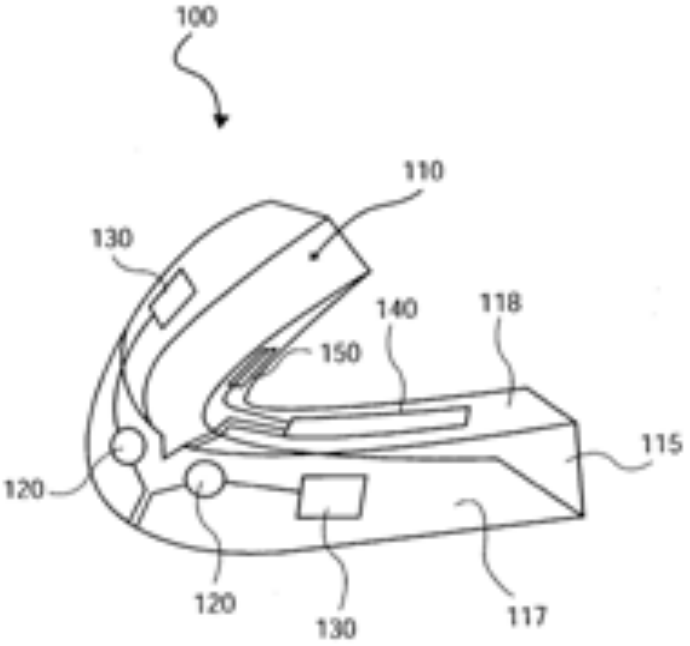
Heat Observation Technology

- Hothead Technologies, Inc
- Collects body temperature inside a helmet on an individual
- Monitors forehead skin temperature
- Transfer information to cloud based database

Wickwire PJ, Buresh RJ, Tis LL, Collins MA, Jacobs RD, Bell MM. Comparison of an In-Helmet Temperature Monitor System to Rectal Temperature During Exercise. *The Journal of Strength and Conditioning Research.* 2012;26(1):1-8.

Mouthpiece Monitor

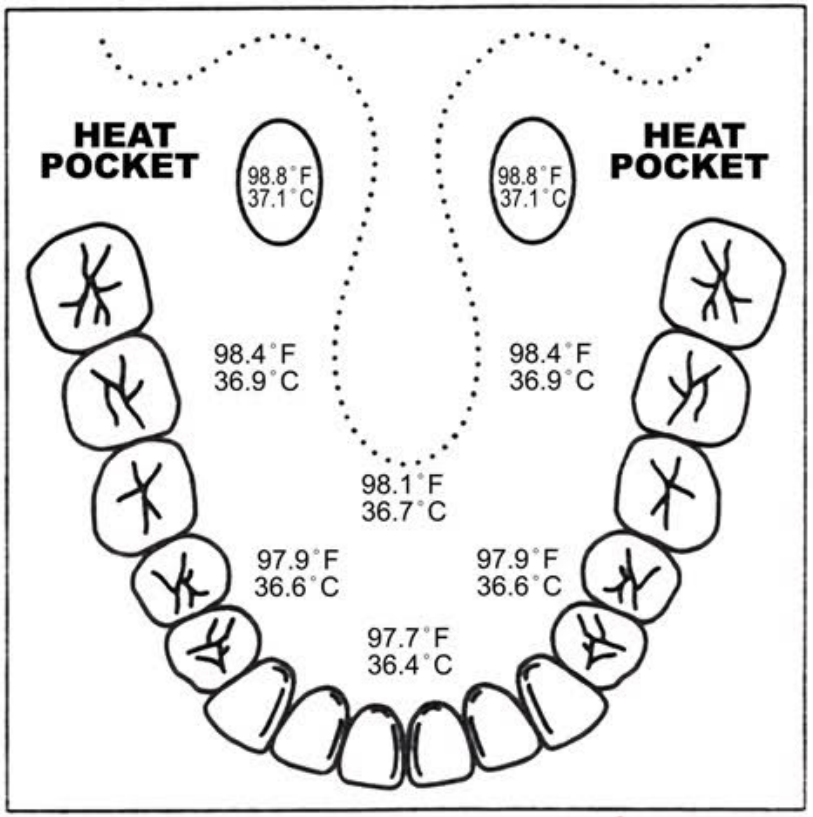
- monitor a subject's core temperature during physical exercise using a mouthpiece
- temperature sensor that can read the subject's core temperature and is then transmitted to the processor
- temperature passes a certain set threshold, an alarm will be activated



Mouthpiece Monitor. Robert W. Parker, assignee. Patent US20030154990 A1. 14 Feb. 2003. Print.

Oral Temperature

- -0.4 degrees below core temperature
- different temperatures in different parts of mouth cavity
- highly influenced by food or fluid intake and breathing - impractical for exercise



Moran DS, Mendal L. Core temperature measurement. *Sports Medicine.* 2002; 32(14):879-85.

Temporal Scanner™

- Exergen Corporation
- Measures core temperature based on the temporal artery
- Scans for temperatures while in contact with skin
- Displays highest temperature read

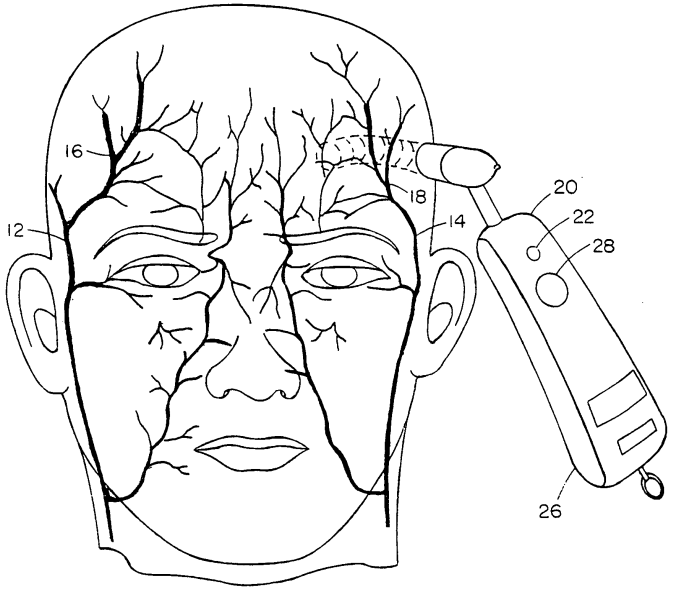


FIG. 1

Pompei, Francesco. Temporal Artery Temperature Detector. Francesco Pompei, assignee. Patent US 20110092822 A1. 21 Apr. 2011.

Temporal Artery Thermometry

- $T_c=(h/pc)(T_s - T_a)+T_s$
- Represents heat transfer from blood to skin and heat loss of skin to surroundings
- Parameters are empirically derived
- Most accurate when p is at a maximum

T_c	core temperature
T_s	surface temp.
T_a	ambient temp.
h	heat transfer
p	perfusion rate
c	blood specific heat

Pompei, Francesco. Temporal Artery Temperature Detector. Francesco Pompei, assignee. Patent US 20110092822 A1. 21 Apr. 2011.

Preliminary Design Schedule

	September					October				November				December	
Tasks	1	8	15	22	29	7	14	21	28	3	10	17	24	1	8
Team/Project Selection															
Project Scope															
Preliminary Literary Search															
Preliminary Report and Presentation															
Design Options															
Web Page															
Design Safe															
Progress Report and Presentation															
Final Design															
Final Report and Presentation															
Poster															

Current Organization

Grace

- Preliminary Report
- Existing Technologies (Temperature Sensors)
- DesignSafe

Norman

- Progress Report
- Existing Technologies (Exergen)
- Project Website

Tyler

- Final Report
- Project Specifications
- Sensor Locations/CAD