

# Low-Cost Thermometer

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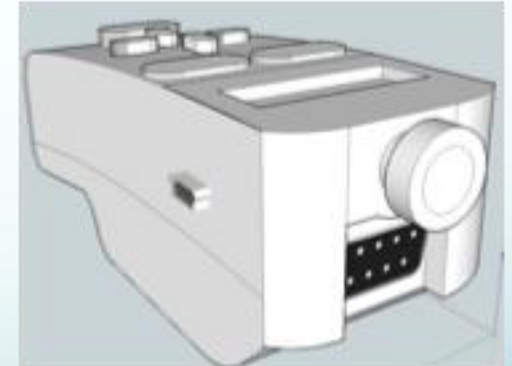
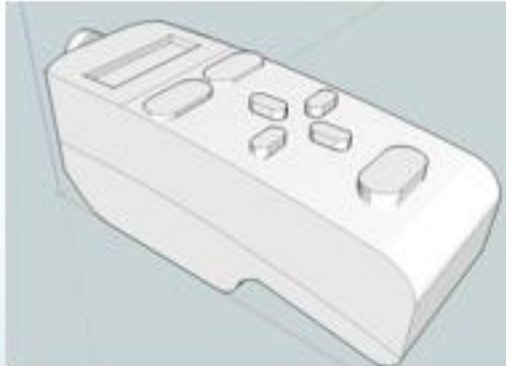


# Overview

- Description of MedCal
- Problem Statement
- Background
- Client Requirements
- Competition
- Common Design Features
- Alternative Designs
- Design Matrix
- Ergonomics
- Future Work

# MedCal

- Medical Calculator
  - Complete package for emerging countries
- Interface for several devices
  - Thermometer
  - Pulse oximeter
  - Spirometer



# Problem Statement

Emerging countries are in need of a **durable**, **low-cost** thermometer to operate with the **MedCal**, a handheld medical output device. The thermometer's incorporated circuitry should produce **accurate** temperature measurements through the use of a **human interface**.

# Background

- Medical equipment in emerging countries
  - Lack of technical knowledge
    - Underused equipment
  - Reduced useful lifetime of equipment
    - Lack of maintenance and repair
  - Lack of spare parts
    - Unpredictable funds
    - Limited qualified staff
  - Unpredictable electric power

# Client Requirements

- Low-cost \$3 or under
- Durable
- Accurate to  $\pm 1^{\circ} \text{C}$
- Detection within 32 to 42  $^{\circ} \text{C}$
- Simple with little or no maintenance
- Calibrated for both oral and rectal use

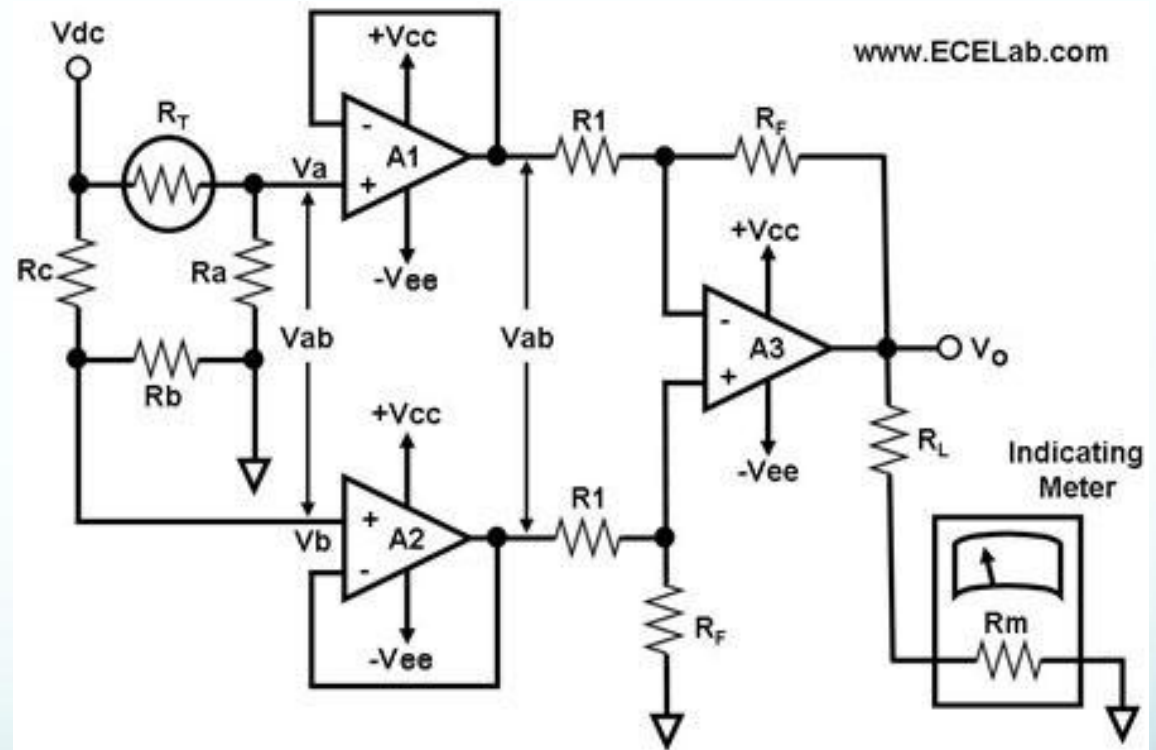
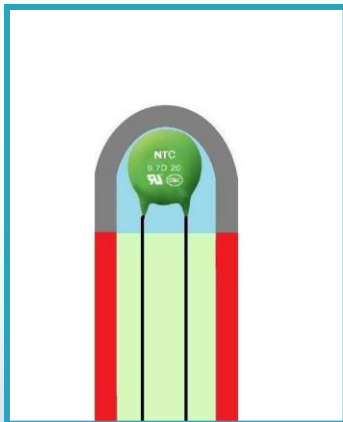
# Competition

- Mercury thermometer
- Digital thermometer
- Infrared thermometer



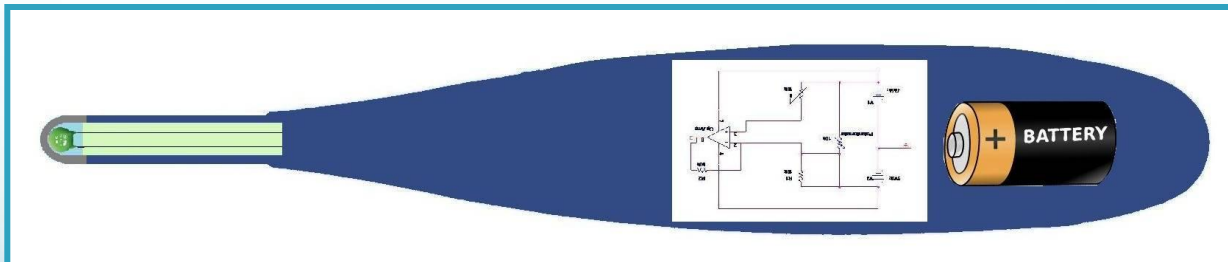
# Common Design Features

- Thermistor
- Circuitry
- Microcontroller



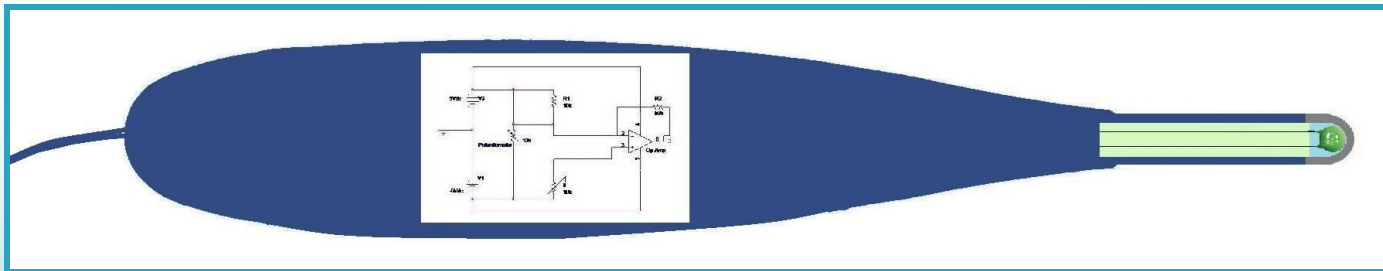
# Option #1 Portable

- Thermometer houses power supply and microcontroller
  - Battery power supply
- Take temperature and then plug into MedCal for reading output
  - Microcontroller stores temperature reading



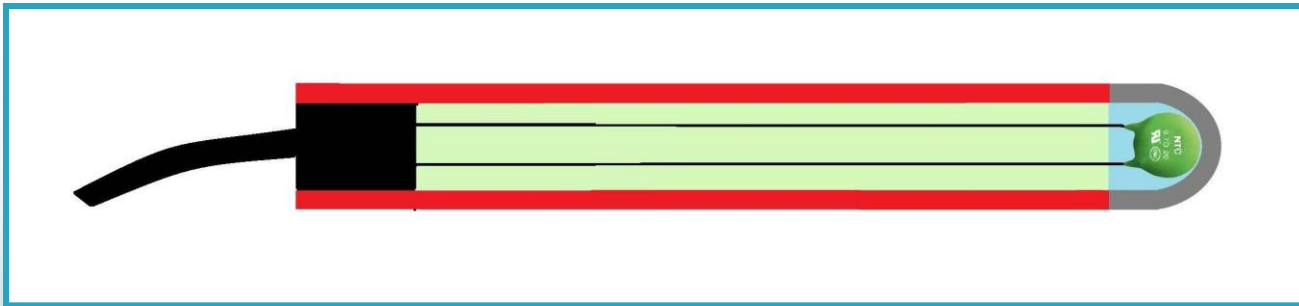
# Option #2 Attached with Internal Circuitry

- Thermometer contains circuitry elements
- Connected to MedCal at all times
  - MedCal provides power for operation
  - Will not take temperature if not connected



# Option #3 Attached with External Circuitry

- Circuitry within MedCal
- Powered by MedCal
- Thermometer probe contains only the thermistor circuit component



# Design Matrix

Weights-	0.1	0.2	0.15	0.4	0.1	0.05	Y/N	
<u>Design Options</u>	Accuracy	Durability	Usability	Cost	Size/Weight	Feasibility	Safety	Total
<i>Portable w/ internal circuitry</i>	3	2	4	2	3	2	Yes	2.5
<i>Attached w/ internal circuitry</i>	3	3	3	4	4	4	Yes	3.55
<b><i>Attached w/ circuitry in MedCal</i></b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>Yes</b>	<b>4.25</b>

# Ergonomics

- Language and literacy
- Modes of use
- Tolerance for error
- Simple and intuitive

# Future Work

- Casing
- Simplify circuitry
- Calibration
- Cord connection to MedCal

# Acknowledgments

- Jonathan Baran
- Amit Nimunkar
- Professor Webster
- Chris Esser
- EWH seminars
- Hackett-Hemwall Foundation, Mary Doherty

# References

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Questions?

# Cost Analysis

Single Thermometer	
<u>Part</u>	<u>Price</u>
10 kOhm thermistor	0.70
Casing	0.50
Epoxy	0.01
Tip	0.04
Cord	0.50
Port connection	1.00
<b>Total:</b>	<b>\$2.75</b>

Circuitry in MedCal		
<u>Part</u>	<u>Quantity</u>	<u>Price</u>
10 kOhm resistor	7	0.004
Wire	~10 cm	0.01
Op Amp	3	0.25
<b>Total:</b>		<b>~\$0.79</b>
<b>Overall Total:</b>	<b>~\$3.54</b>	

# Why Thermistor?

- Thermistor-
  - Advantages: less expensive than thermocouples
  - Disadvantages: slower speed of response compared to a thermocouple
- Thermocouple-
  - Advantages: speed of response (2-5 seconds), accuracy, capable of recalibration, good for high temperature readings
  - Disadvantages: more expensive than thermistors
- Infrared-
  - Advantages: most accurate, speed of response
  - Disadvantages: moving parts

# Thermistor Testing

