The average human body at rest emits about 350,000 J of energy per hour and human average skin surface area is 17,000 \( \text{cm}^2 \).

This equals to a heat flux of 5.7 \( \text{mW/cm}^2 \).

Effective area of our wrist is about 10 \( \text{cm}^2 \). This means there is 57 mW of useful energy!

This sparks interest in creating wearable, body heat powered mobile electronics and sensors using Thermoelectric Generators (TEGs).

Past research for this project involved creating a prototype body-heat powered mobile fan.

Current research seeks to design a body-heat powered digital watch.

**Innovation**

Equivalent circuit of the pathway from human body heat to a wearable hardware platform.


**Current Status**

- Performed thermal simulations on the first watch design model to evaluate the change in temperature of TEG and heat transfer within the overall assembly.
- Identified the design limits and constraints of wearable thermoelectric generator (TEG) through numerical simulation.
- Compared the difference in temperature gradient and electric potentials under ideal condition and design conditions. [Different Boundary conditions]
- Designing an effective heatsink structure using additive manufacturing.

**Future Work**

- Data acquisition and analysis from experimental measurements on the material properties of designed circuits of commercial thermoelectric modules. (e.g. thermal conductivity, internal resistance, figure of merit ZT).
- Increase the efficiency by using customized flexible thermoelectric modules.

Team members: Jiahui Cao, Jingyi Luo, Justin Burba, Alexander Medrano, Elin Baghoomian Dolatabadi, Kailey Martin, Sebastian Yuzhe Gao. Advisor: Dr. Jaeho Lee

**UCI Thermoelectric**

Department of Mechanical & Aerospace Engineering, University of California, Irvine

**Background**

- The average human body at rest emits about 350,000 J of energy per hour and human average skin surface area is 17,000 \( \text{cm}^2 \).
- Effective area of our wrist is about 10 \( \text{cm}^2 \). This means there is 57 mW of useful energy!

**Objective**

- Create a wearable, body-heat powered digital watch.

**Requirement**

- A basic digital watch requires a voltage of 3V, a battery capacity of 90mAh, and a battery life of 7 hours.

\[
\text{Power} [W] = \frac{0.000652 \times 3V}{24 \text{h} \times 3600 \text{sec} \times 7\text{days}} = 4.4\mu W
\]

Minimum Power Requirement = 4.4\mu W

**Timeline**

- **Fall 2018**
  - Initial research
  - Finite Element Analysis
  - Literature review
  - Systematic literature review
  - Literature review
- **Winter 2019**
  - Execution
  - Systematic literature review
  - Literature review
- **Spring 2019**
  - Execution
  - Systematic literature review
  - Literature review
- **Summer 2019**
  - Execution
  - Systematic literature review
  - Literature review
- **Fall 2019**
  - Execution
  - Systematic literature review
  - Literature review
- **Winter 2020**
  - Execution
  - Systematic literature review
  - Literature review
- **Spring 2020**
  - Execution
  - Systematic literature review
  - Literature review
- **Summer 2020**
  - Execution
  - Systematic literature review
  - Literature review

**Future Work**

- Data acquisition and analysis from experimental measurements on the material properties of designed circuits of commercial thermoelectric modules. (e.g. thermal conductivity, internal resistance, figure of merit ZT).
- Increase the efficiency by using customized flexible thermoelectric modules.

**Budget and Cost**

- Expected Cost: $350-$400
- Available Funding from UROP: $2000