# Team PISO

Gemstone Cohort of 2023


Ian Brady
Sanjali Yadav
Liam Mc Carthy
Mark Wedzielewski
Rithik Sebastian
Mikaila Esuke
Catherina Samson

# Introduction

## The Need for Clean Energy...

- Coal, natural gas, and oil were used the most initially

  **combustion → pollution**

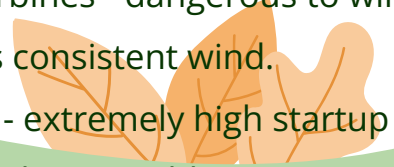
  - *Climate change*
  - *Devastating effect on wildlife*
  - *Dangerous health conditions*

- These materials are exhaustible

## Issues With Existing Solutions...

**Renewable energy** is becoming more utilized (*solar, wind, nuclear power*)

- Solar panels - limited to specific conditions to work properly
- Wind turbines - dangerous to wildlife, requires consistent wind.
- Nuclear - extremely high startup costs
- In general, renewable energy is more situational



# OUR SOLUTION

Every day, thousands of people travel through public transportation hubs

Each footstep/impression made *deforms* the floor and creates friction from *pressure*

**We want to harness the kinetic energy from pedestrian traffic, to produce electricity.**

# Proposal/Research Question

***How can piezoelectric energy harvesting technology be improved?***

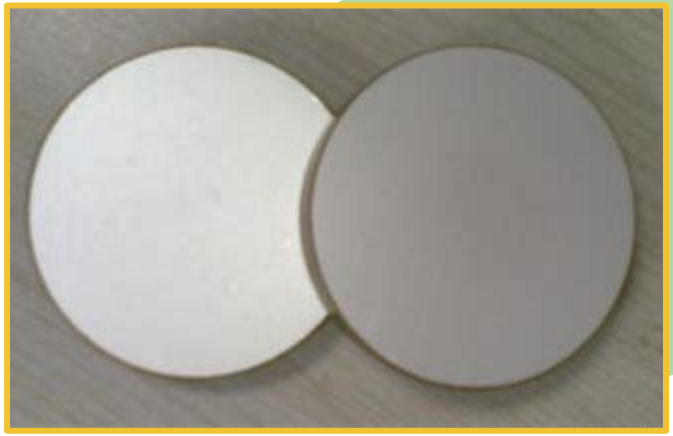
*How can we optimize the shape, design, and materials of the tile to maximize energy production?*

*Which materials can the components be fabricated from in order to minimize environmental impact?*

# The Piezoelectric effect

**Piezoelectricity**:

- Materials with certain polar structures
- Convert *deformation* into electricity



Lead zirconate titanate (PZT), the most popular industrial piezoelectric ceramic.

Four types of piezoelectric materials:

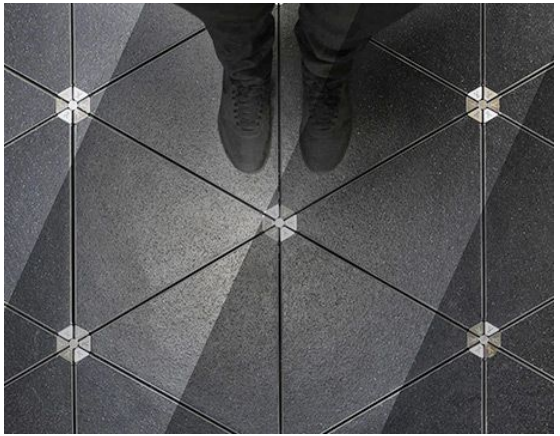
1. **Ceramics**: very effective, usually made with lead
2. **Crystals**: expensive, but very useful in certain situations
3. **Polymers**: flexible, but produce less charge
4. **Composites**: combine polymers and ceramics/crystals

# How is Piezoelectricity Used?

- Usually used in precision instruments like microscopes and actuators
- Piezoelectric generators exist, but are largely inefficient
- Generators have a peak output at their resonance frequency
- Piezoelectric floor tile proofs of concepts have been made
- To make the technology commercially viable, **it must be optimized**

# What factors affect the output of piezoelectric floor tiles?

- Duration of pedestrian traffic
- Shape of the tile
- Energy harvester model



# Power Generation and Storage

- Variety of options for storing energy
  - Ex: compressed air, pumped hydro, supercapacitors, batteries, etc.
- Advantage of using batteries
  - Energy transfer does not generate carbon emissions
  - Flexible in power and energy characteristics
  - Long cycle lives, and are low maintenance
  - A variety of batteries can be recycled, minimizing the impact on the environment

# Methodology

## PHASE 1

Create a model of piezoelectric floor tile → Develop a simulation to collect pedestrian traffic data → Conduct experiments on piezoelectric materials → Conduct experiments on optimal energy storage

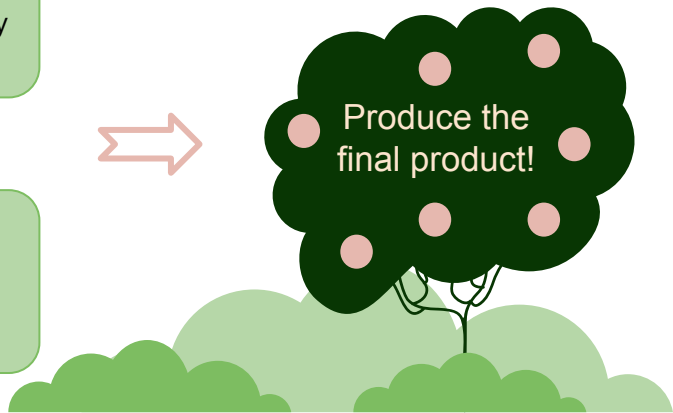
## PHASE 2

Split into Subteams

***Electronics Subteam*** → Combine electrical components to improve efficiency of the tile

***Construction Subteam*** → Designing the structure of the tile to include all components

→ Produce the final product!



# Timeline

- **Spring 2021:**
  - **Thesis Proposal**
  - Materials Acquisition
  - Reserve Lab Space
- **Autumn 2021:**
  - Data Collection (Materials and Battery work)
  - Finalize Outline
  - **Do-Good Showcase**
- **Spring 2022:**
  - Data Collection (Construction and Design of Prototype)
  - Presentation at **Undergraduate Research Day**
- **Autumn 2022:**
  - Data Analysis
  - Prepare Thesis
- **Spring 2023:**
  - Finalize Thesis
  - **Thesis Conference**
  - **Citation Ceremony**

# Conclusion

## Problem

Society needs more sources of **renewable energy** to protect the planet from pollution

## Solution

We want to design a **piezoelectric tile** that will efficiently harvest renewable energy from pedestrian traffic

## Process

We will **construct and test a variety** of piezoelectric tile designs and materials in order to optimize the tile to output as much energy as possible.

# Acknowledgements and References

## Citations

**Team PISO would like to thank:**
Rick Blanton
Jonathan Brodsky
Team GEMSTONE Staff
Nevenka Zdravkovska