Remotely Adjustable Cast

ECE 445: Group 10

Alice Getmanchuk, Saloni Garg, Jack Burns

Professor Viktor Gruev + TA Stasiu Chyczewski

Alice Getmanchuk

Jack Burns

Saloni Garg

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OBJECTIVE

CLEAN

Traditional casts **can develop mold** due to their irremovable nature.

PORTABLE

Traditional casts **inhibit mobility** and in some cases **require the use of scooters**.

ACCURACY

Patients may not properly re-tighten the AirCast which can **hinder recovery plan**.

SOLUTION

CONTROL

PRESSURE

MOTOR

POWER

BOOT
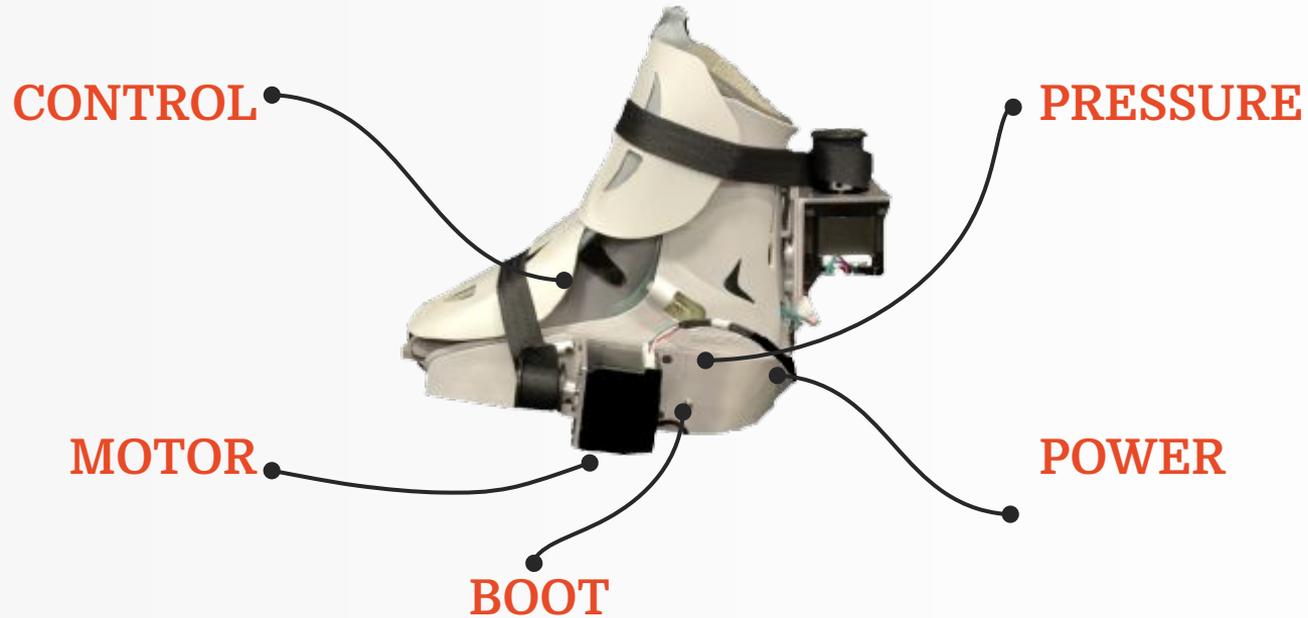
High-Level Requirements

1

The cast's straps are adjusted/tightened per doctor's settings without manual adjustment

2

The doctor's cast adjustments for pressure and tightness can be stored

3

All necessary components for auto-adjustment of the cast fit on the cast without extreme addition to the original weight of the cast

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Block Diagram
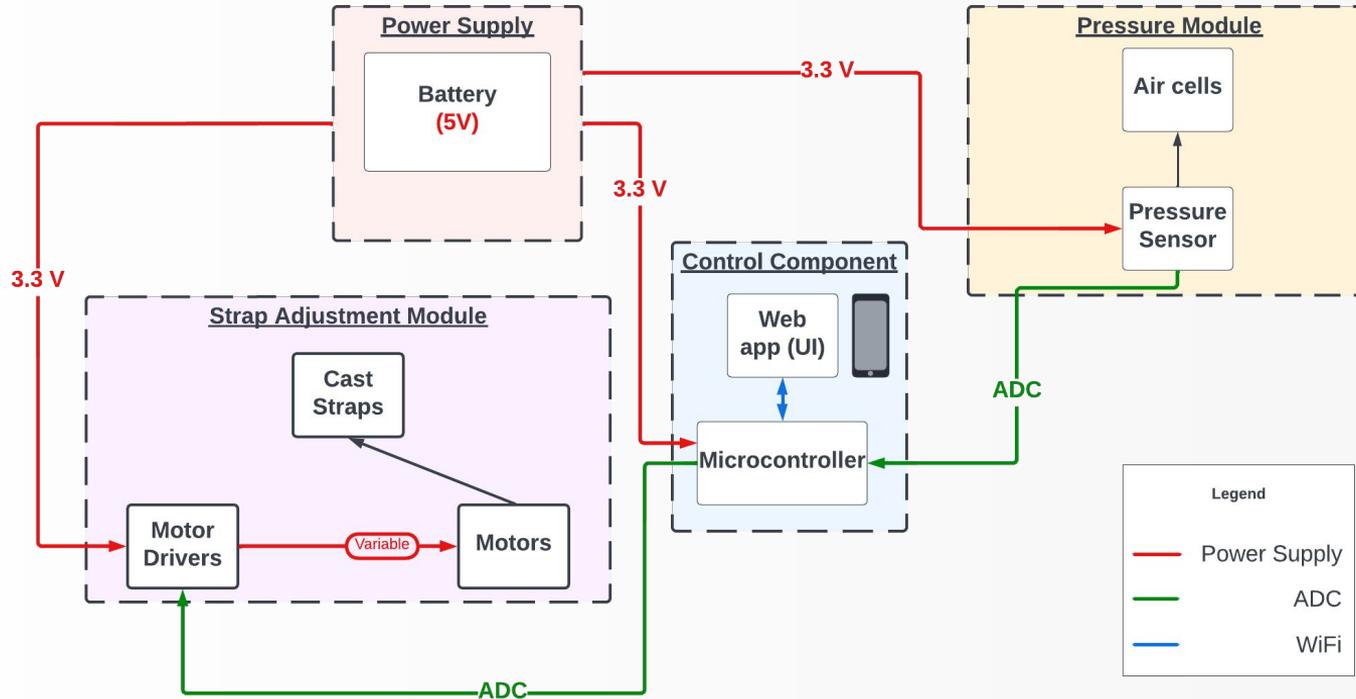
Subsystems & Requirements

Strap Adjustment

Able to tighten straps to doctor prescribed tension and to **not hurt the patient** even more

Pressure

Able to read the pressure exerted by the patient's foot and not over–tighten the foot til unhealthy

Subsystems & Requirements Cont.
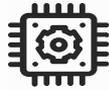
Control Unit

**Able to interface with pressure and motor subsystems** to properly adjust all parts of the boot
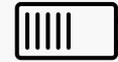
Power

**Able to be power all subsystems** via portable battery pack (5V) cut down to 3.3V reliably

PCB and Breadboard

Original Design

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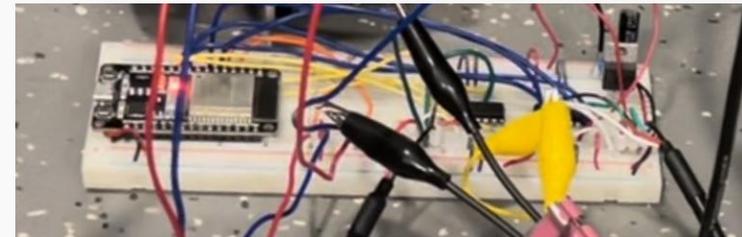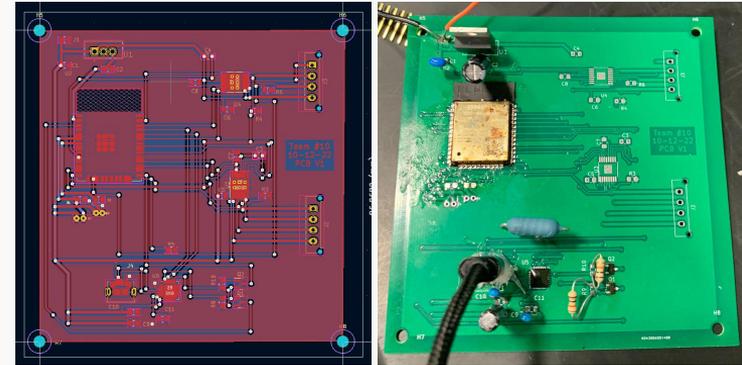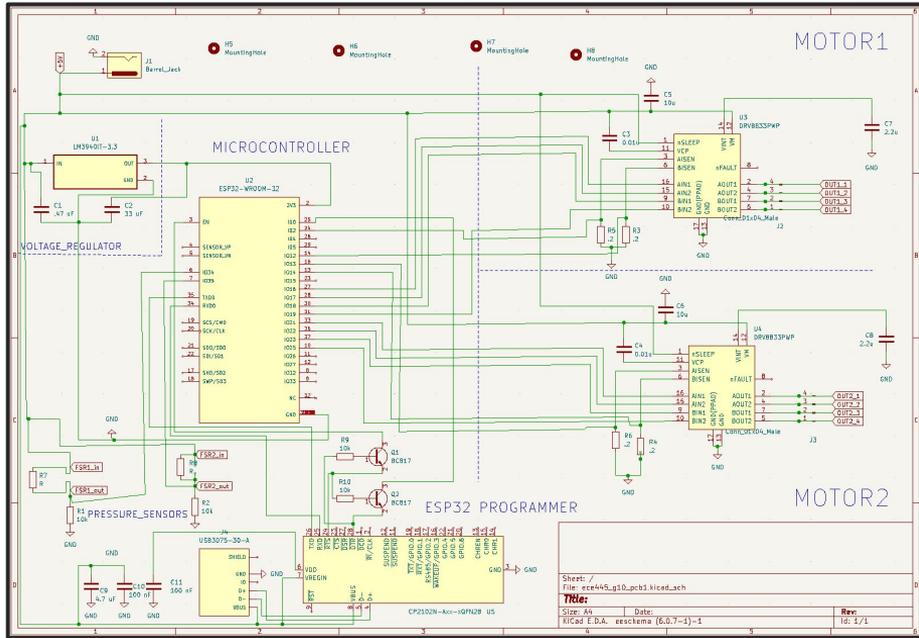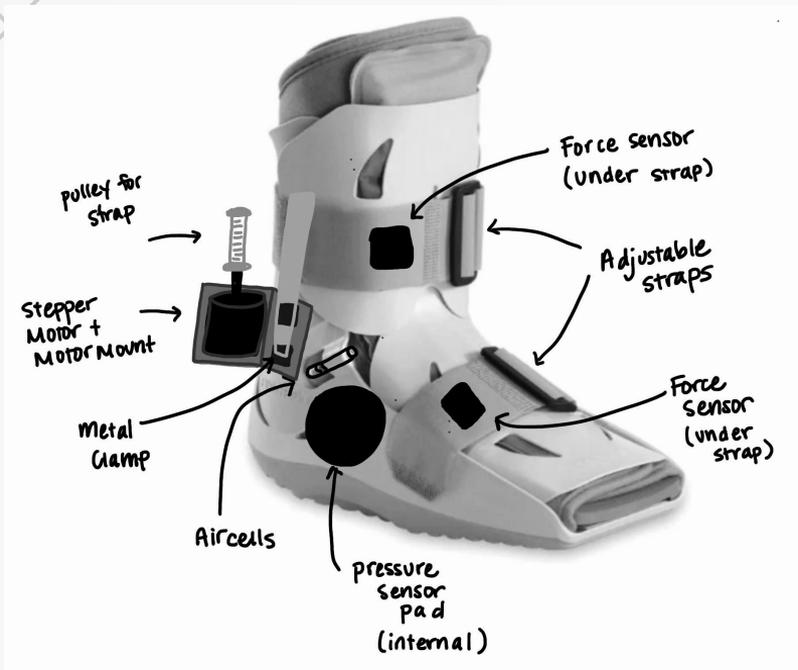
Design Changes

Elimination of Force Sensors in Strap Subsystem

Bluetooth vs WiFi
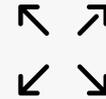
Size and Location of Pressure Sensors

Boot Logic Flowchart [Original Design]

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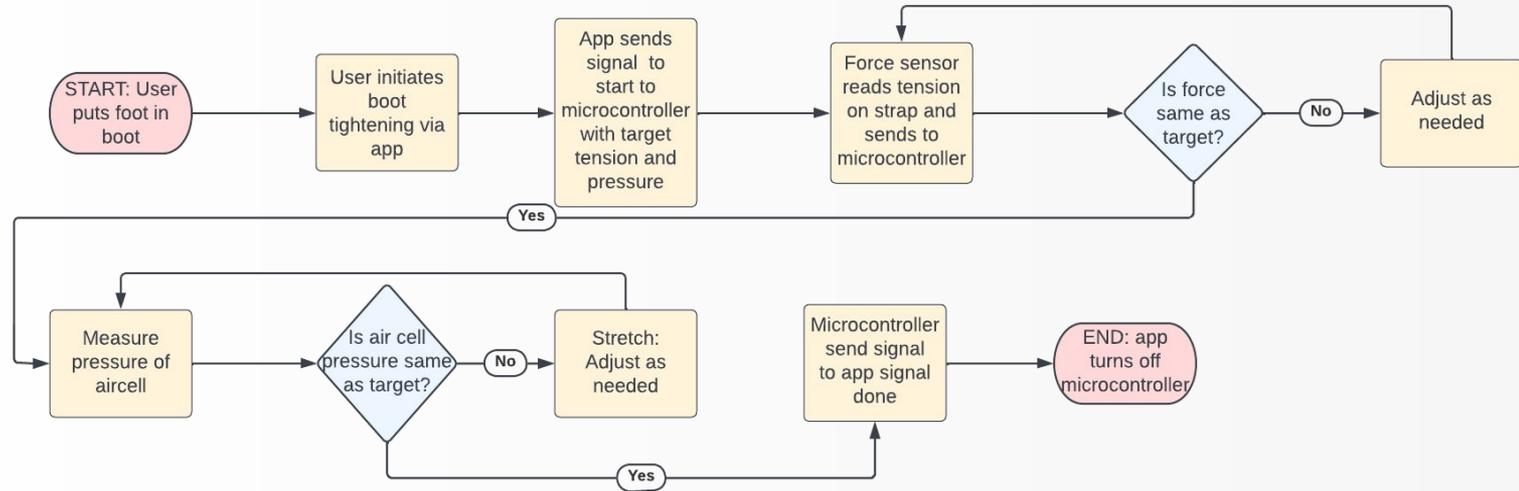
Project Video
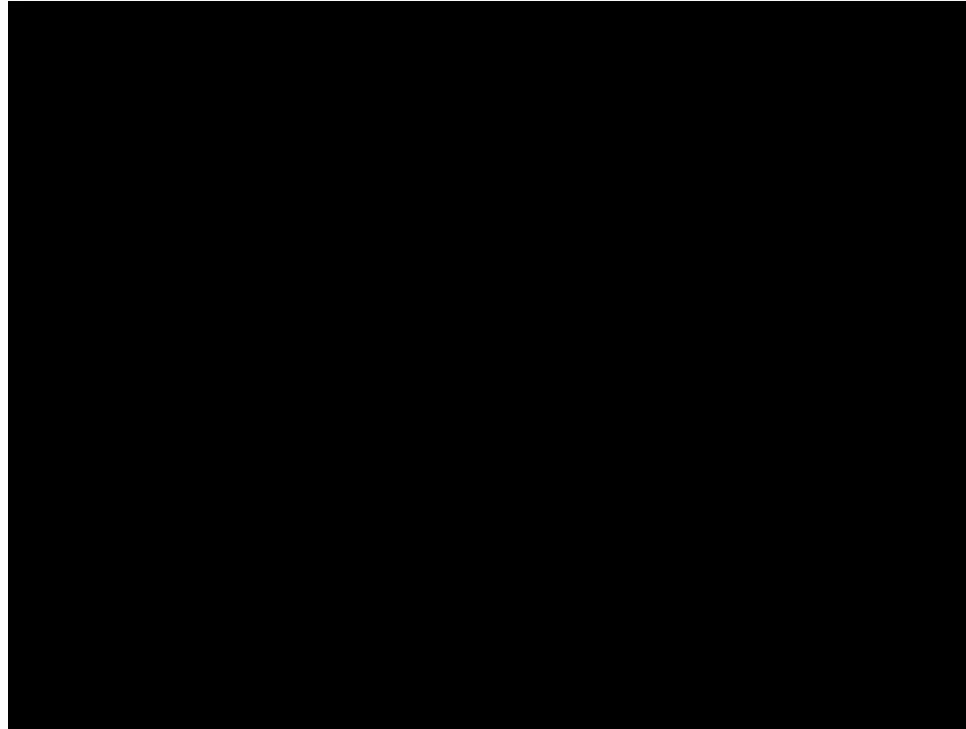
# Results [Quantitative]

Motor Subsystem
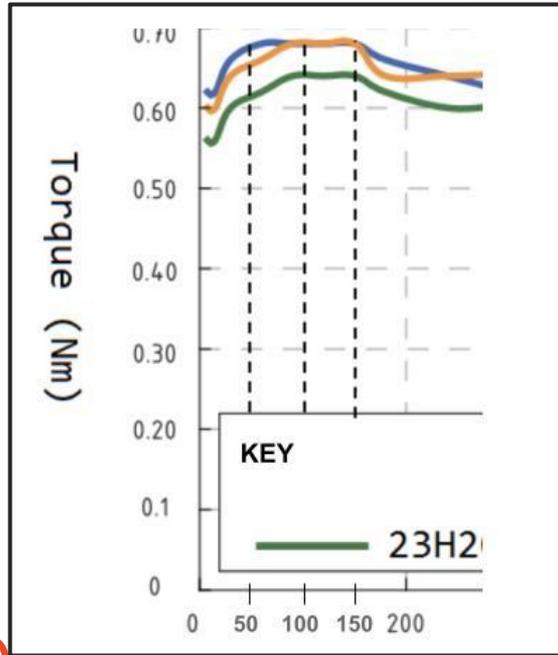
NEMA-23 RPM vs torque

Torque applied: 0.6 N
Speed of each motor: 60 RPM
Foot strap angle: ~90 degrees
Strap length (radius): 0.177 m
Equation used: $\tau = F * r * \sin\theta$

...

Pulling Tension Force: 3.37 N*m
(*"as prescribed by doctor"*)

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Results [Quantitative]

Pressure Subsystem
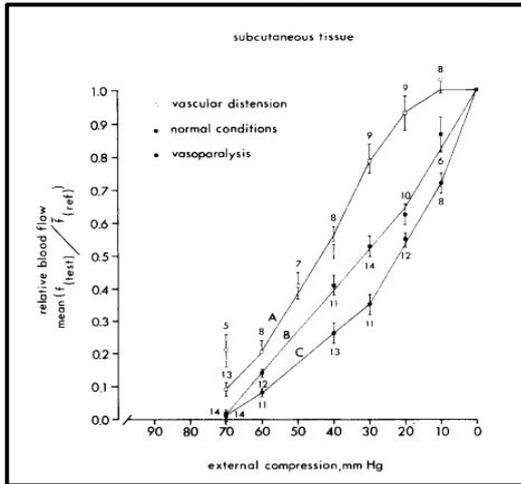
Limb compression and blood
flow relationship

```cpp
for(int counter = 0; counter < 10; counter ++) {
 int a1 = analogRead(PRESSUREPIN1);
 int a2 = analogRead(PRESSUREPIN2);
 int aModulus1 = int (a1 / (600));
 int aModulus2 = int (a2 / (600));
 intervals1[aModulus1] += 1;
 intervalValues1[aModulus1] += int(a1 % 600);

 intervals2[aModulus2] += 1;
 intervalValues2[aModulus2] += int(a2 % 600);
```

```cpp
pressure1 = map(pressure1, 0, 4095, 0, 51.671);
```

Interval probing to eliminate noise &
Mapping FSR resistance to mmHg

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Successes and Challenges
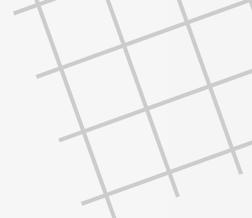
Subsystem Successes

- All of the subsystems work as desired

- High level requirements satisfied

PCB Challenges

- Designing a programming circuit

- ESP32 not connecting to WiFi

Other Challenges

- Broken components

- Unexpected part tolerances

- Communicating with ESP32

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Reflection

What We Learned

- Fail often and adjust
- How to design a PCB
- Idea -> final product
- Design process is never done
- Having the right parts

What We'd Change

- Create final PCB
- Add belt to house electronics
- Install permanent clamps to secure straps
- Smaller motors
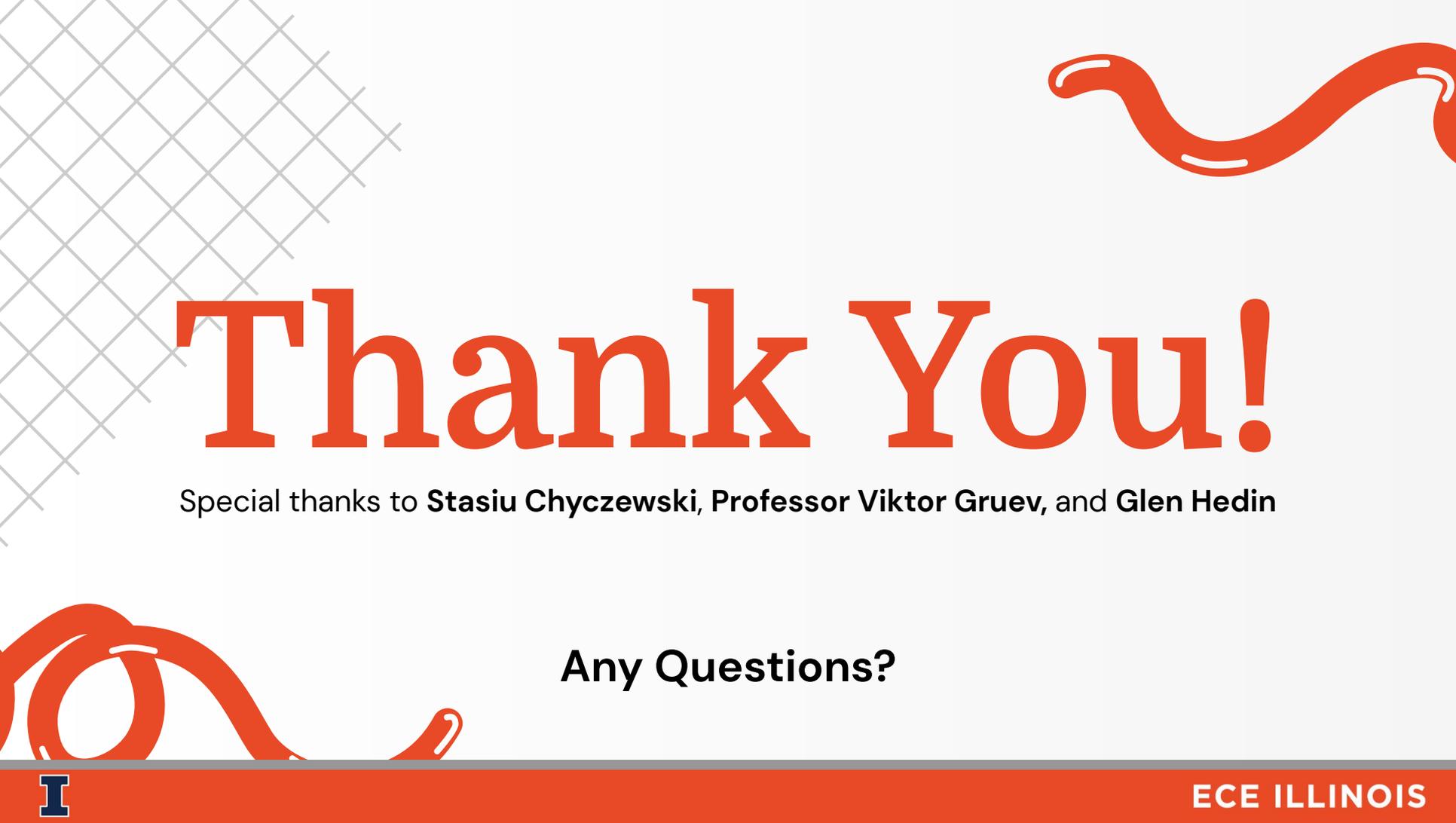
Thank You!

Special thanks to **Stasiu Chyczewski**, **Professor Viktor Gruev,** and **Glen Hedin**

Any Questions?