ELCT 404
Power Wheels
Final Presentation

Team Leader: Sean Jervey

Team Members: Alex Thompson, Caleb Kerr, George Charles

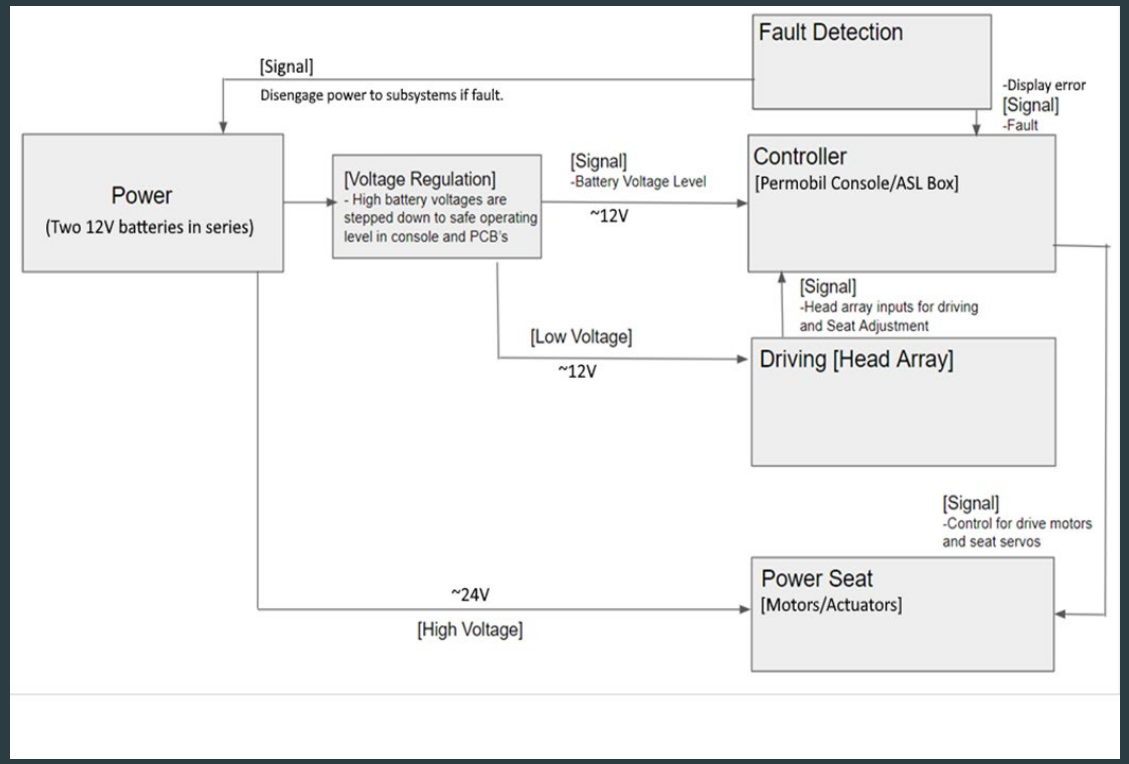
The Project

- *Design Philosophy: Design necessary electrical functionality and components of a power wheelchair in order to make independent movement a possibility.
- Team Organization:
  - Sean Jervey – Parts & Group Coordination, Building, Coding
  - Alex Thompson – Power & Circuit Design, Coding
  - Caleb Kerr - Building, Planning, Group Coordination, Rnet Research/Initiative
  - George Charles - Signal Processing, Analysis, & Circuit Design

The Project

- We have accounted for several factors based upon our patient of interest.
  - Adequate safety features
  - Operation time & charging
  - Comfort & Accessibility
  - Personal requests
  - Final Adjustments (Active)

The Project



Subsystems: Driving, Controller, Power, Power Seat, Fault Detection

Overall Schedule/Status

- Start of Semester: Testing with temporary batteries, chargers not working? Power console?
- Design Review: New batteries! Chair powered on, detailed system capabilities.
- ASL box, Replace sip and puff -> power supply -> mechanical switch -> buttons (toggle & drive)
- First test: map all errors, relays
- Recap first test: adjustments
- Safety sensors? Onboard charging? Extensions? Cameras? Rnet Dongle? New buttons? Find solutions.
- Safety sensors✓ Onboard charging✓ Extensions✓ Cameras* Rnet Dongle* New buttons* <- We are here
- Second Test - April 11th
- Tech Manual/All Work Products - 22nd

Financials

- New Battery – Covered!
- Mechanical buttons – $23.48
- Adapter - $82.60
- VGA, New buttons - $20.37
- Sensors - $10.03
- Camera - $74.99
- Rnet cable/power connector – $21.31
- Total: $232.78

Problems & Resolution

Mechanical Team
Travel
Covid-19
Power Chair
Control Method
Communication
Budgeting
Software Changes
Design/Integration

Personal Contributions – Sean

- Coding
- Organization/Communication
- Building/Testing/Integration
- Ordering Parts

```
    else if (state == 1) //Seat Control = blue
    {
        green = 1;
        red = 1;
        blue = 0;
    }
    else //Driving = green
    {
        green = 0;
        red = 1;
        blue = 1;
    }
}

void stopInput(void)
{
    led1 = 0;
    led2 = 0;
    led3 = 0;
    led4 = 0;
    led5 = 0;
    led6 = 0;
    left = false;
    right = false;
}

void Left() //Move the chair
{
    if (state != 0) //Not Idle
    {
        //ticker.attach(&tickerFixer, CONTROL_PERIOD);
        if (state == 1) //Seat control ****************************************
        {
            //Repeat for seat controls
            //GO VERTICAL UP (Tap Once) & LUMBAR UP (Tap Twice)
            wait(0.25); //Give them time to move head off switch **AFTER PRESS WAIT x BEFORE GIVING NEXT INPUT
```

```
#include "mbed.h"
#include <vector>

//Microcontroller LEDs
DigitalOut red(LED1); //Onboard red LED

//Error Indicator LED
DigitalOut led1(PTC12); //Red LED

//Bypass Signal
AnalogOut stopChair(PTC13); //Stop Chair Signal

//Sensor inputs
AnalogIn sensor1(PTB2);

//Serial Port for printing and debugging
Serial pc(USBTX, USBRX); //used to communicate as a serial port

//Variables
bool fault = false;

////////////////////////////////////////////////////////////////////////////////

void initiate(){
    red = 1; //for onboard LED5, 1 = off, 0 = on
    led1 = 0;
}

bool checkFault()
{
    fault = false;

    if (sensor1 > x) //Sensor value greater than x, bad
    {
        fault = true;
    }

    return fault;
}

void STOP(void) //Fault Detected, Stop Car
{
    red = 0;
    led1 = 1; //Light up red led to visually show fault

    //Stop chair, activate brakes
    stopChair.write(0.1f);  //Inject some random analog signal at a very low value
}
```

Alex Thompson

Early Steps and Overview

- The needs of the power subsystem changed several times.
- When we started the project, we didn't expect to receive so much help from donations, i.e., receiving a near-fully-functioning wheelchair.
  - We were ready to design power infrastructure for everything.
- Our relevant power concerns became about safety.

Power Recap and Process

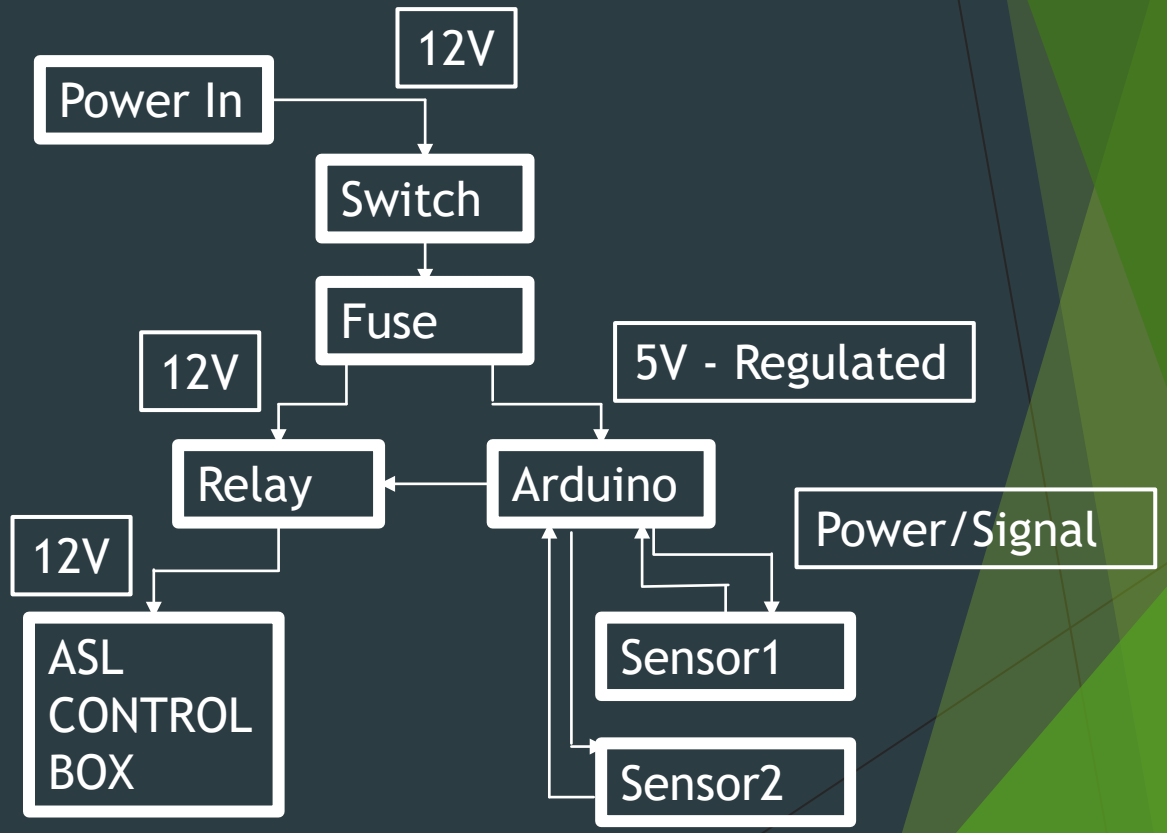
- Step One: with batteries secured, analyze the system.
- Step Two: once we have established the capabilities of our system, reevaluate need.
  - From here, we discovered that the chair was functional – we no longer had to worry about getting power to and from our controls.
- Step Three: With the chair powered, we can move on to the final phase: implementing quality-of-life improvements.

Powering QOL-inclusions

- First of the QOL steps to implement was edge-sensing.
  - In scenarios where Carol may be near a curb, we must be able to prevent her from going over.
  - Front-mounted sensors will give us our warning signals.
  - With an Arduino controller, we implemented sensors.
  - The sensors, through the Arduino, have the authority to power-off all user-control of the chair.
  - The system is easy to replicate or adjust, if we need more sensors or finer operational control.

Sensor System Design/Implementation

- Sensor Control sits between the ASL-box fuse and the control-circuit power-in.
  - Any time the switch is on, the sensors are on.
- When a danger-state is sensed, Sensor Control cuts power to the rest of the ASL box. This causes the chair to enter full braking.
  - Con: Carol cannot maneuver herself out of danger-states.

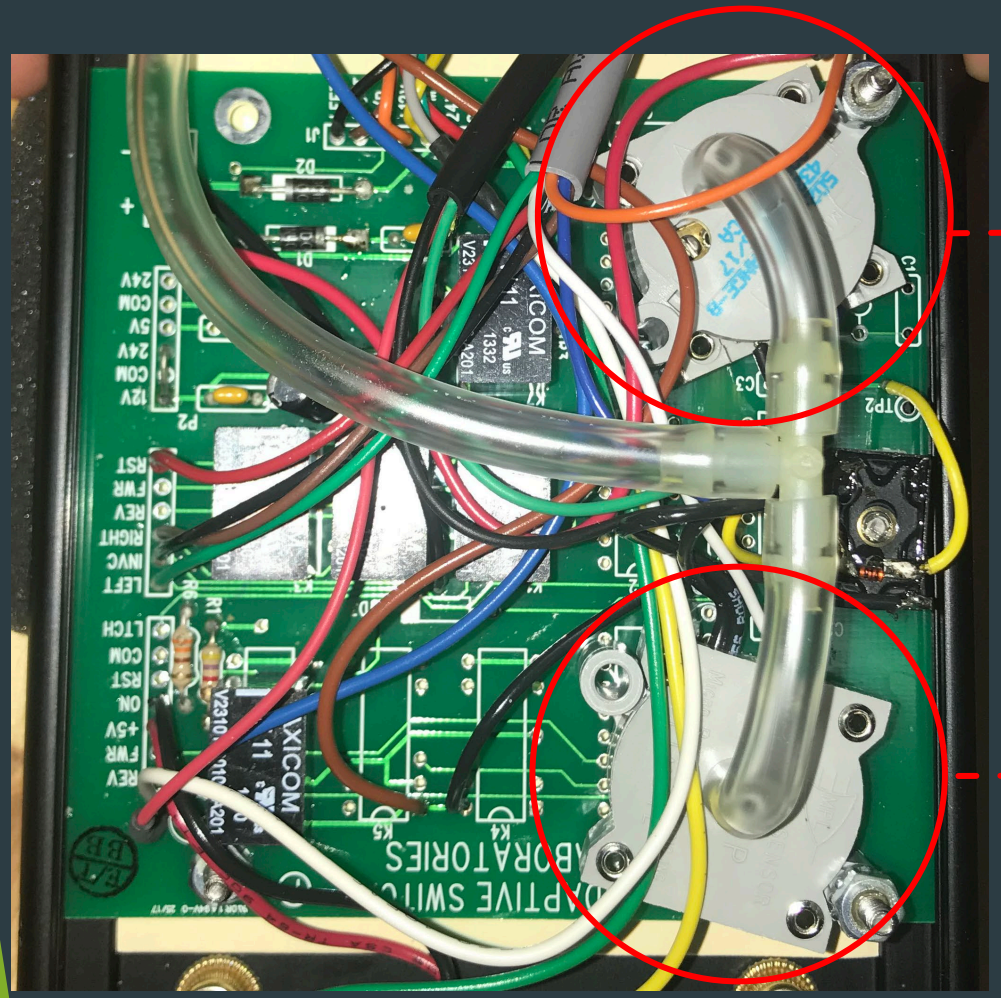


Caleb Kerr

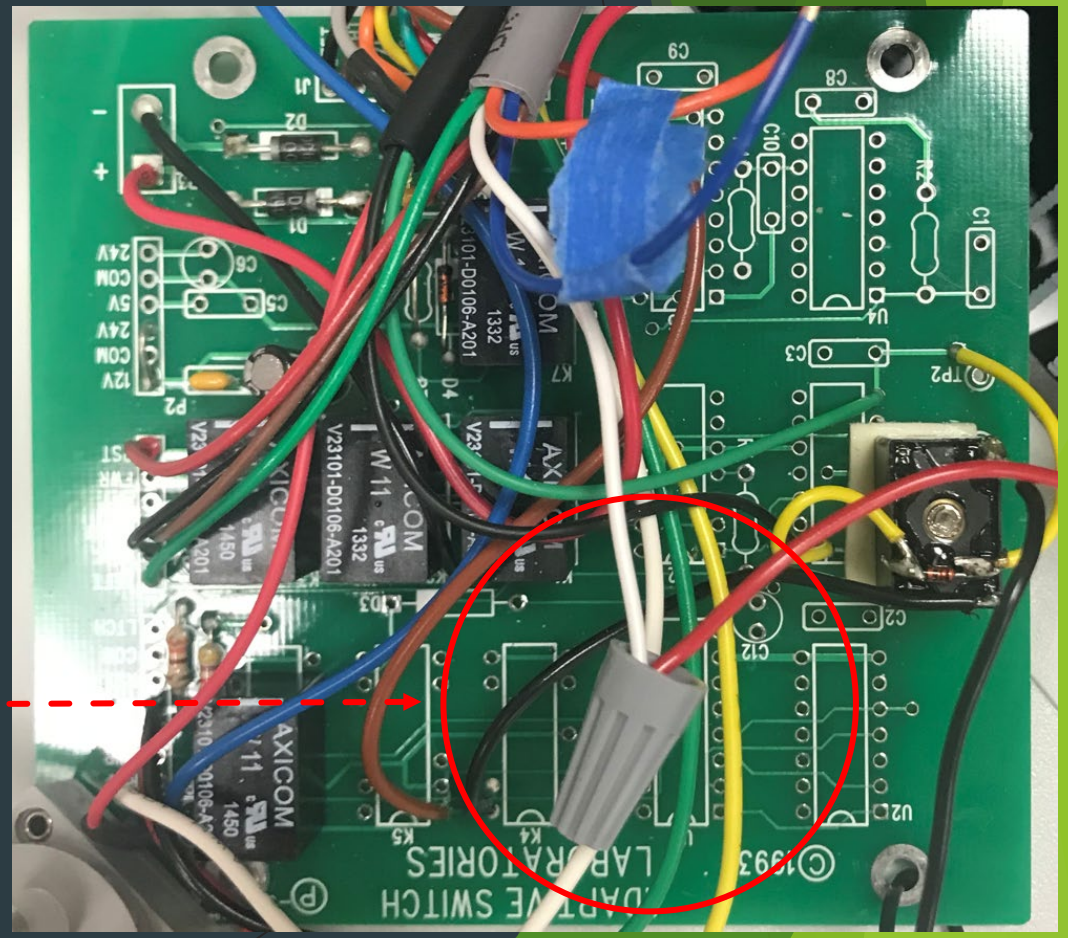
Involvements & Contributions

- Started joining the ME team for their project meetings, improving communication between teams to prepare for testing with Carol
- Worked with Sean to replace sip-n-puff controller for mechanical buttons
- Lead investigating R-net computer used for the Permobil chair
- Contacted Permobil about acquiring R-net dongle
- Worked with the ME to reassemble the chair with adjusted electrical and mechanical features
- Took part in testing with Carol before spring break and aided revising project goals
- Created Subsystem Validation Plan and Report for seat motion subsystem
- Have been regularly communicating with our team project tasks and deadlines

ASL Box: Converting Diaphragms to Switches



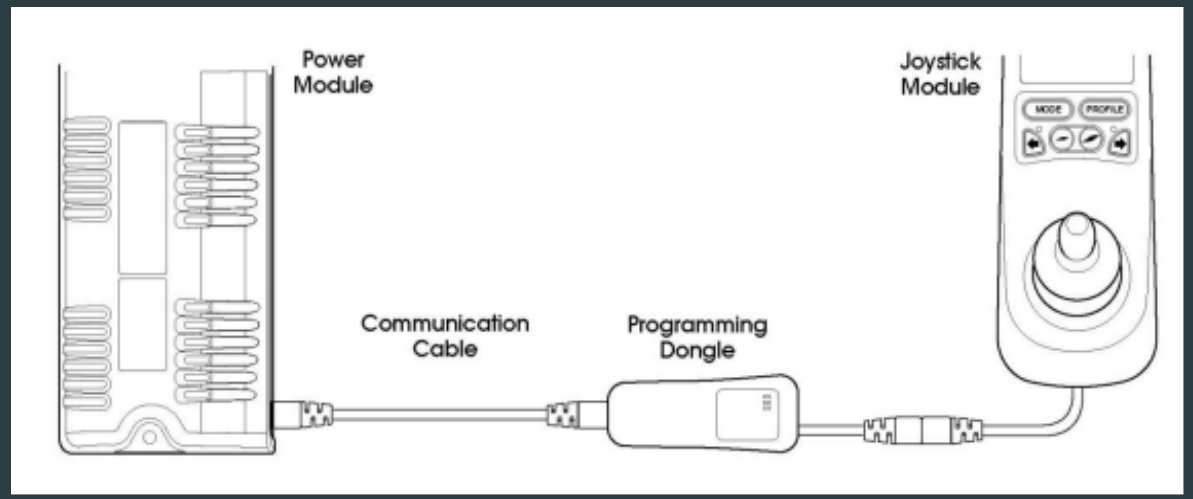
X



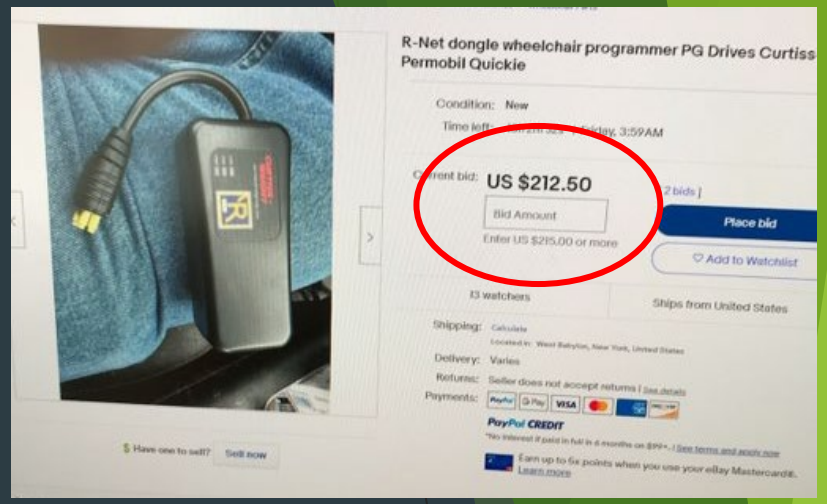
R-net Dongle

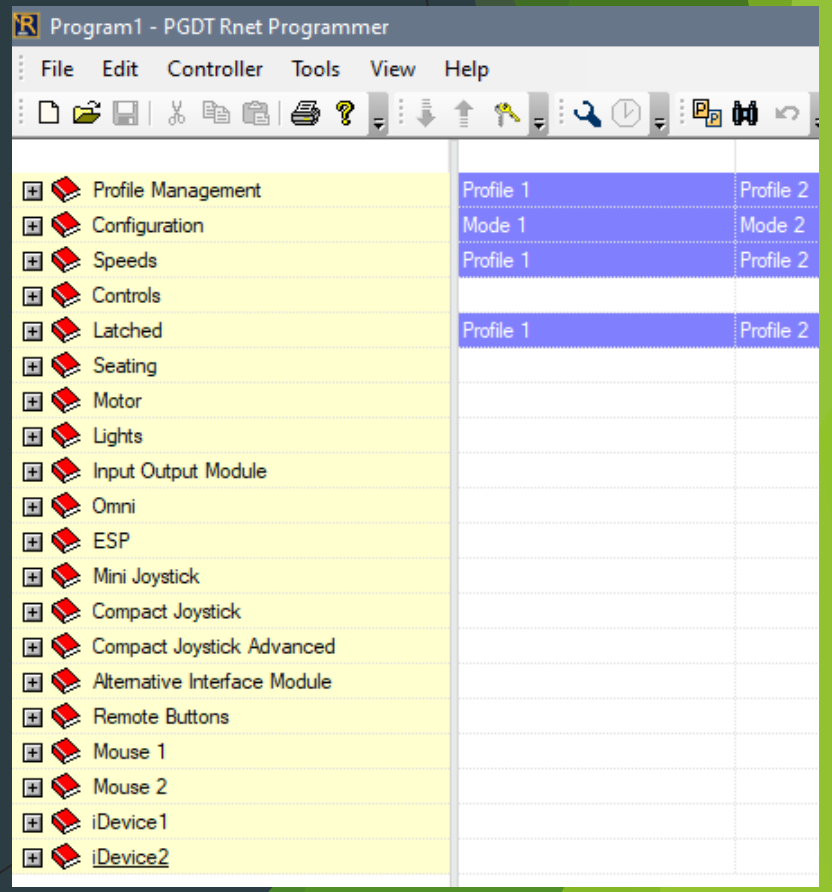
- Can be used to redesign values and settings in the PGDT R-net computer.
- Tried to contact Permobil to either borrow or purchase the programming dongle:

Allen McKinley --> Ken Korth --> Michael Duda --> Daniel Dawson?



https://brokenwheelchairs.com/resources/R-NET/How_To_Enter_OBP_Mode.pdf

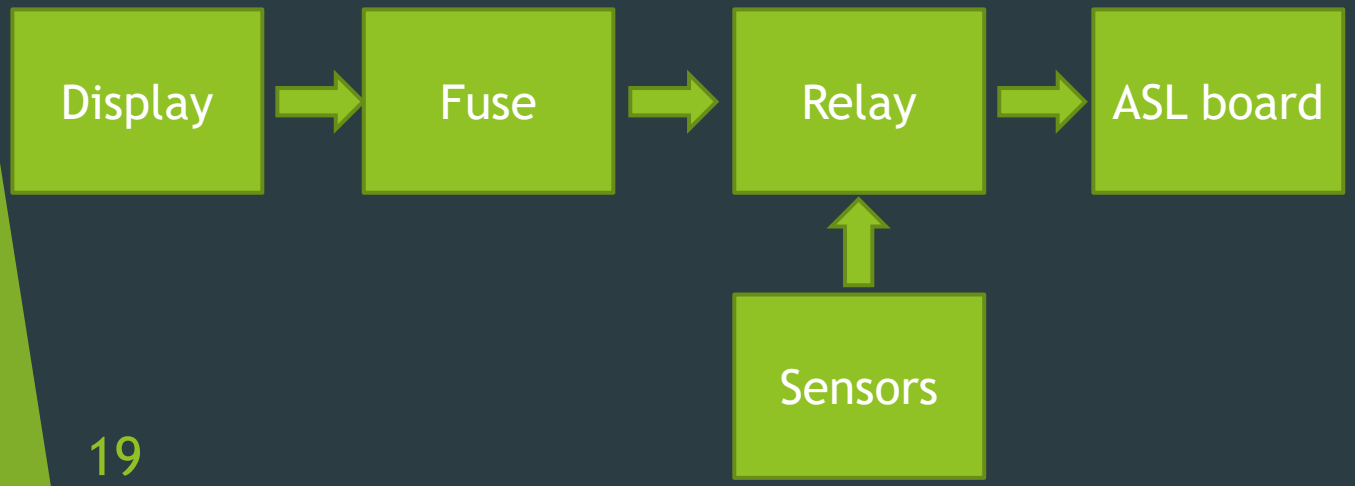


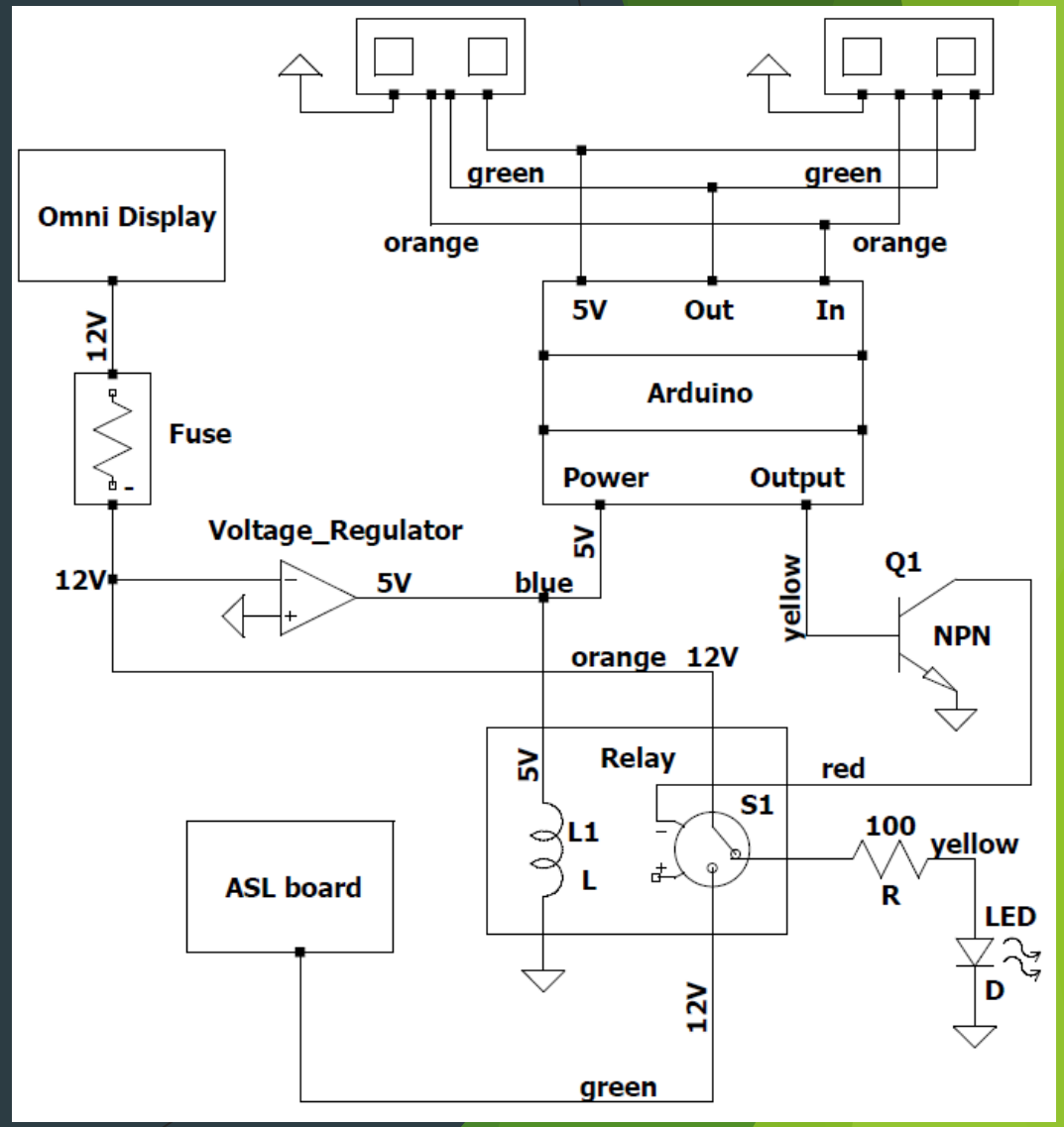


Sensor System Overview

Previous System

New System

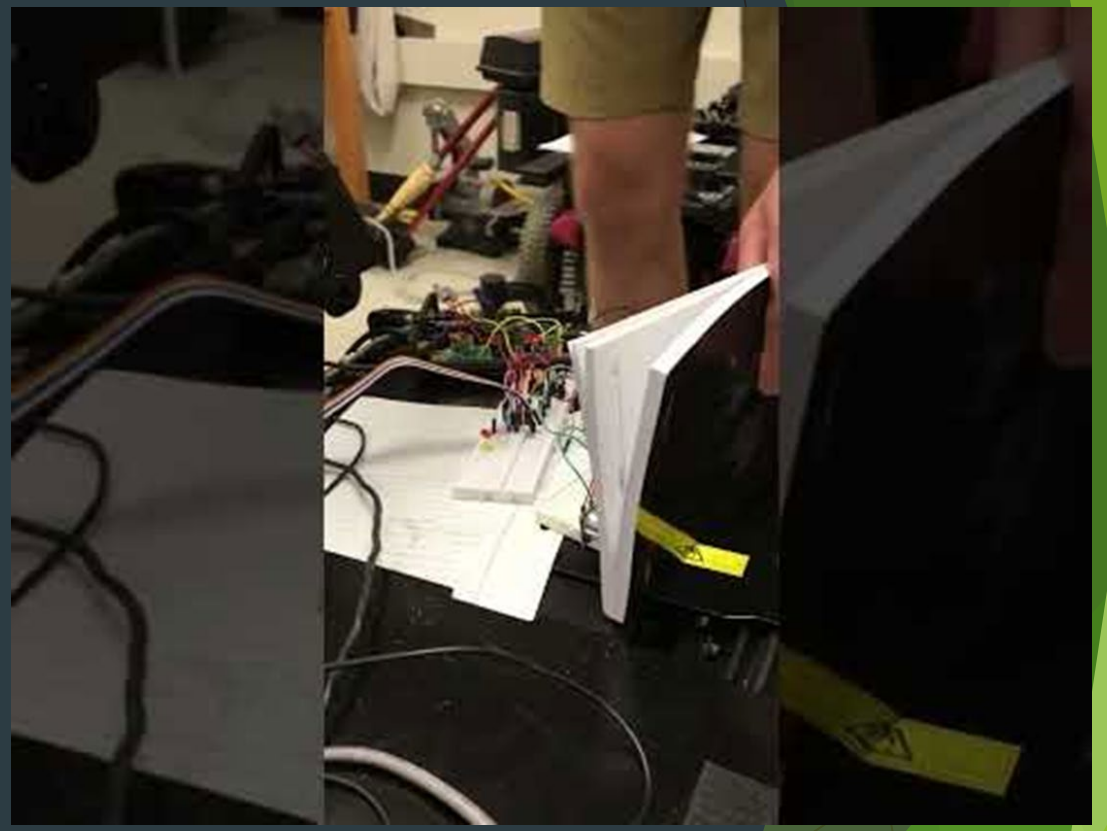




Sensor Testing

- Sensors permit power to be supplied to the ASL box unless they no longer "feel" the ground.
- Carol's controls will be turned off and require assistance from a nurse to move her away from the hazard.
- Will prevent unintentional falls off a curb or any other elevated platform.

- The video on the right shows the chair in motion before the surface (the book) is removed and the chair immediately brakes.



Ongoing

- Continue reaching out to Permobil about R-net dongle
- Staying connected with ME team for communicating project expectations and team progress
- Waiting to hear back from David Thrope (ME) about plans for adding a servo motor arm-bar
- Will be involved with changing our current breadboard sensor circuit to prototype board
- Planning out building and integrating a photoresistor button for Carol's forward/reverse control

George Charles

Involvement & Contributions

- Updated Work Breakdown Schedule to accommodate for new task for the semester as well as include ME team in scheduling.
- Updated system block diagram with new and altered subsystems.
- Assisted in identifying issues with current chair set up on visit to Saluda for testing.
- Worked with the team in identifying methods for stopping the chair in a safety scenario.
- Worked on identifying ideal location for powering external systems in the chair (ASL BOX).
- Researched and selected camera for backup system.

Visit to Saluda & Initial Testing With Carol

- Head Array system involved two mechanical buttons to drive the chair and two capacitive buttons for steering the chair.
- Carol did not have as much freedom with moving her neck as we expected.
- This presented issues with carol being able to use the mechanical buttons easily, either not being able to get good contact with them or having the button's support rod give in leading to further difficulties.
- When testing the different speed level settings, it became apparent that turning acceleration would increase as well do to this change. At least with the current button issues this was a problem.
- Many other needed mechanical changes were also identified such as having a solid plate for the leg rest, hip pads, and elevation on armrest.

What to change?

- The key points for the buttons were that either less force was needed for the mechanical buttons, or the support needed more rigidity.
- The Mechanical team has already started to resolve the rigidity issue by means of a new mounting method which will be adjustable for carol.
- Carol had much more neck movement on the side of the function button, as the drive button saw much more use, we decided to swap the places of these two so Carol would have an easier time holding the gas pedal down.
- More sensitive buttons have been looked at, as well as maybe mounting pads on the ends of the current set to increase their surface area.
- To address the issue of speed states raising the acceleration would require a coding dongle to be able to change the acceleration value in the R-net code.

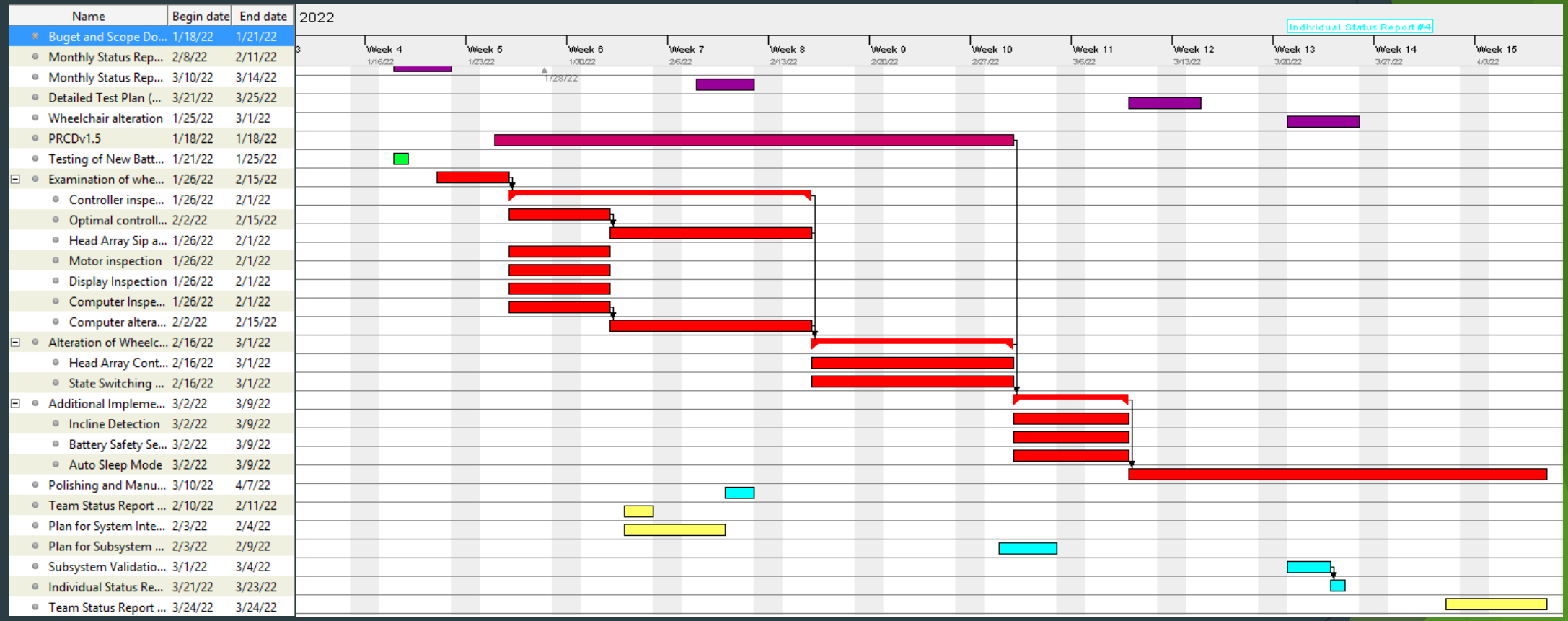
Back Up Camera

- This system was implemented to give Carol the ability to use her phone or Ipad, which will have a mount and charging station built into the chair, to connect wirelessly an be able to back up with visual aid.
- This system required that the camera be wireless, independent of a home wifi, and powered off the chair's batteries.
- The camera selected was a LASTBUST Backup Camera 12-24V DC. This will be able to establish its own wifi network for carol to connect, and then using the camera's app, will be able to see a live feed of what is behind her.
- With the chair operating at the same voltage as the camera, we plan to integrate this into the ASL Box 12V circuit at the same location powering the sensor circuit.

Camera Downsides

- Because this device will not be integrated with the Permobile display we are counting on Carol using her mouth stylist she uses to operate her phone to use this camera.
- Carol will have to navigate to app using her stylist setup every time she wants to see while backing up
- Because this camera establishes its own wifi and does not work off a hosted network, Carol's non-cellular devices will lose internet connection while she is connected, meaning if she wants to go from browsing the internet on her iPad to backing up, it will require a wifi change.

Work Breakdown Schedule



Name	Begin date	End date
Buget and Scope Do...	1/18/22	1/21/22
Monthly Status Rep...	2/8/22	2/11/22
Monthly Status Rep...	3/10/22	3/14/22
Detailed Test Plan (...	3/21/22	3/25/22
Wheelchair alteration	1/25/22	3/1/22
PRCDv1.5	1/18/22	1/18/22
Testing of New Batt...	1/21/22	1/25/22
Examination of whe...	1/26/22	2/15/22
Controller inspe...	1/26/22	2/1/22
Optimal controll...	2/2/22	2/15/22
Head Array Sip a...	1/26/22	2/1/22
Motor inspection	1/26/22	2/1/22
Display Inspection	1/26/22	2/1/22
Computer Inspe...	1/26/22	2/1/22
Computer altera...	2/2/22	2/15/22
Alteration of Wheelc...	2/16/22	3/1/22
Head Array Cont...	2/16/22	3/1/22
State Switching ...	2/16/22	3/1/22
Additional Impleme...	3/2/22	3/9/22
Incline Detection	3/2/22	3/9/22
Battery Safety Se...	3/2/22	3/9/22
Auto Sleep Mode	3/2/22	3/9/22
Polishing and Manu...	3/10/22	4/7/22
Team Status Report ...	2/10/22	2/11/22
Plan for System Inte...	2/3/22	2/4/22
Plan for Subsystem ...	2/3/22	2/9/22
Subsystem Validatio...	3/1/22	3/4/22
Individual Status Re...	3/21/22	3/23/22
Team Status Report ...	3/24/22	3/24/22