

N F P A

Fluid Power

VEHICLE

Challenge



NFPA
Education and
Technology
Foundation

FINAL PRESENTATION
FLUID POWER CLUB
AT SOUTH DAKOTA STATE
DOUG PRAIRIE
4/21/22



Team Introductions: ABE



Ethan Geraets



Dylan Hanisch



Dalton VanderWal



Team Introduction: OM



Bret Barnett



Patrick Lovrien



Cole Shannon





Design Objectives

- Utilize last year's bike
- Focus on hydraulics
- Maximize efficiency
- Improve user experience

Summary of Midway



- Analyzed last years' bike for problems
- Tested with altercations and validated
- Set baseline to improve

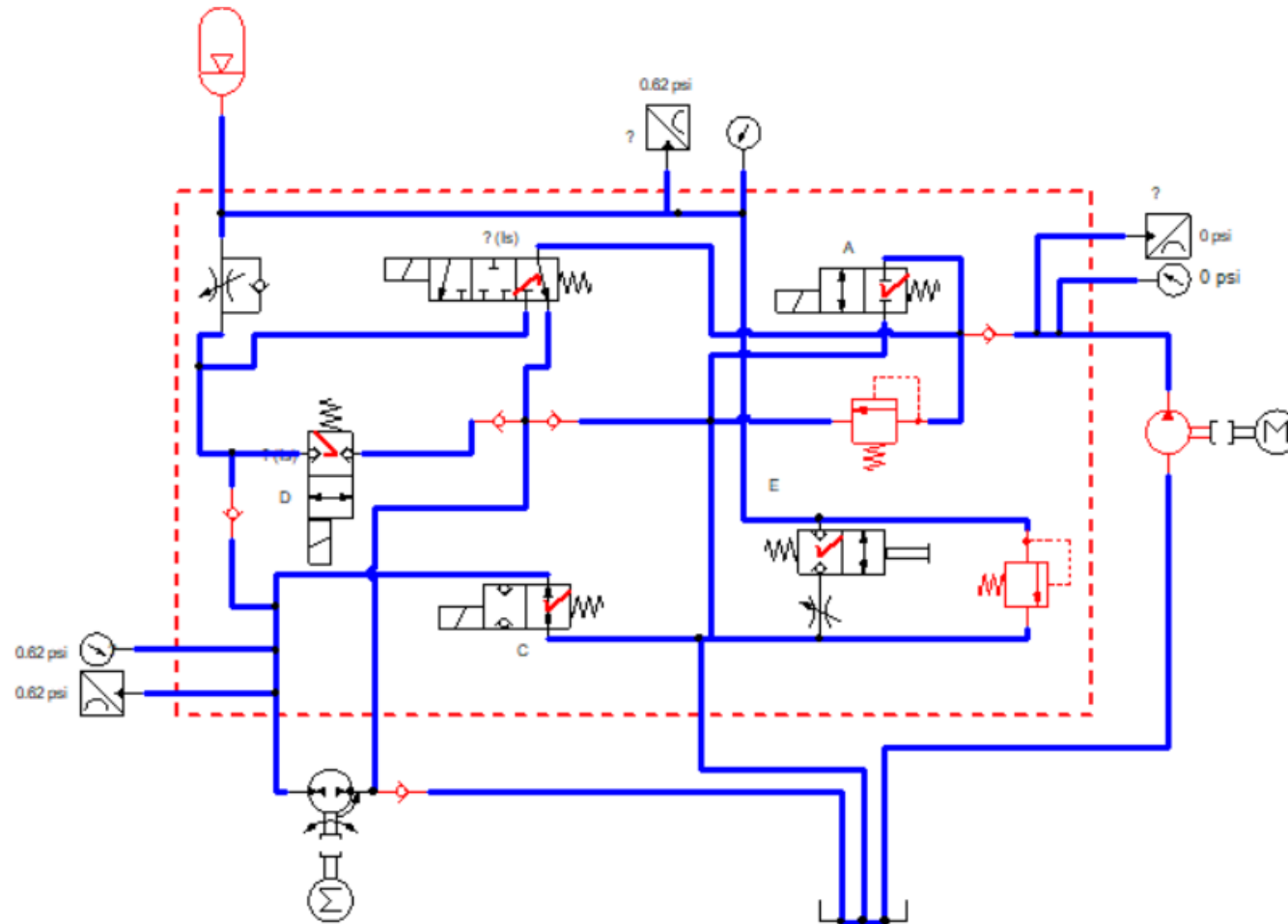
Hydraulic Calculations

| <i>Given</i> | | <i>Calculated</i> | | <i>Measured</i> | |
|---------------------|-------------|--------------------|--------------|--------------------|--------------|
| Motor Displacement: | 5.34 cc/rev | Pump Flow Rate: | 1.47 L/min | Pump Flow Rate: | 1.46 L/min |
| Pump Displacement: | 3.40 cc/rev | Motor Shaft Speed: | 264.33 RPM | Motor Shaft Speed: | 254.80 RPM |
| Pump Speed: | 465.00 RPM | Wheel Speed: | 101.66 RPM | Wheel Speed: | 98.00 RPM |
| Pressure: | 1500.00 PSI | Shaft Power: | 337.91 Watts | Shaft Power: | 336.24 Watts |

Summary of Midway

- Use same frame but condense component locations
- Improve hydraulic circuit based on issues noticed from testing
- Increased pump size
- Utilize controller kit for electronics and programming

Hydraulic Circuit



Changes:

- Removed filter from suction line.
- Added relief valve in parallel with valve E.
- Tied in relief valves to tank
- Added testing and pressure transducer points.
- Added one more pressure transducer.
- Added external low-crack check valve after motor-out side.

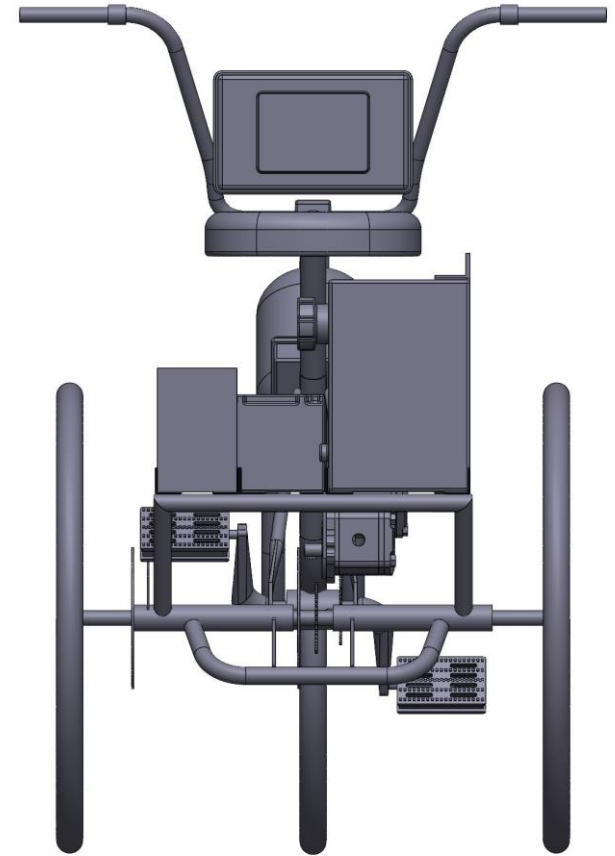
Mode Valve Breakdown



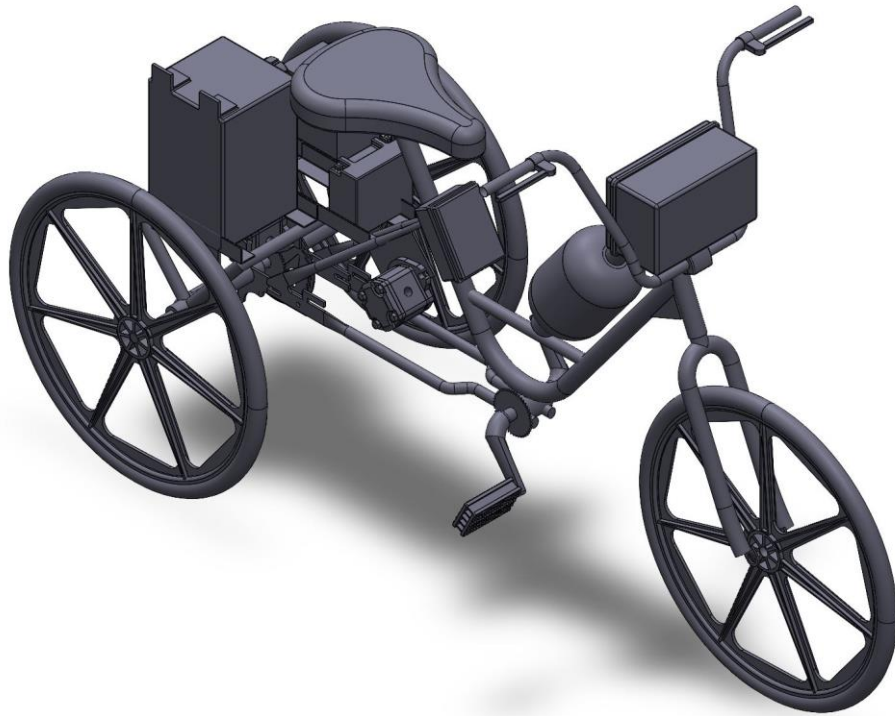
| | | Valve | | | |
|------|-----------------------|-------|---|---|---|
| | | A | B | C | D |
| Mode | Pedal to Power | 0 | 0 | 0 | 1 |
| | Accumulator Charge | 0 | 1 | 0 | 0 |
| | Accumulator Discharge | 0 | 1 | 0 | 1 |
| | Regenerative Braking | 0 | 0 | 1 | 0 |
| | Pressure Dump | 1 | 1 | 0 | 0 |

*There is a valve E used for manually dumping the pressure.

Vehicle Construction



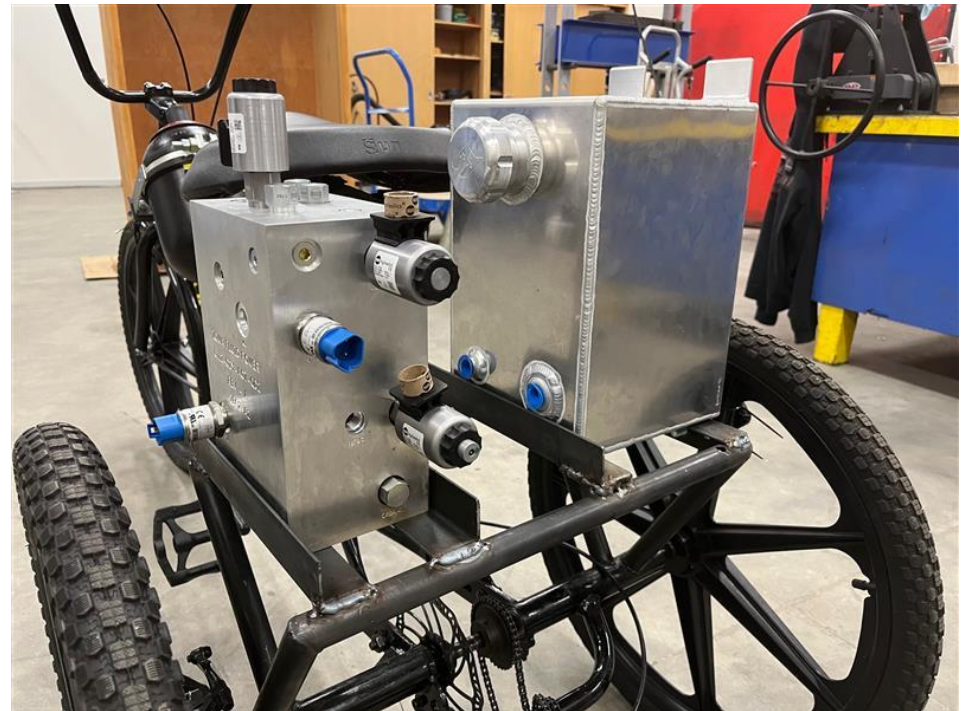
Vehicle Construction



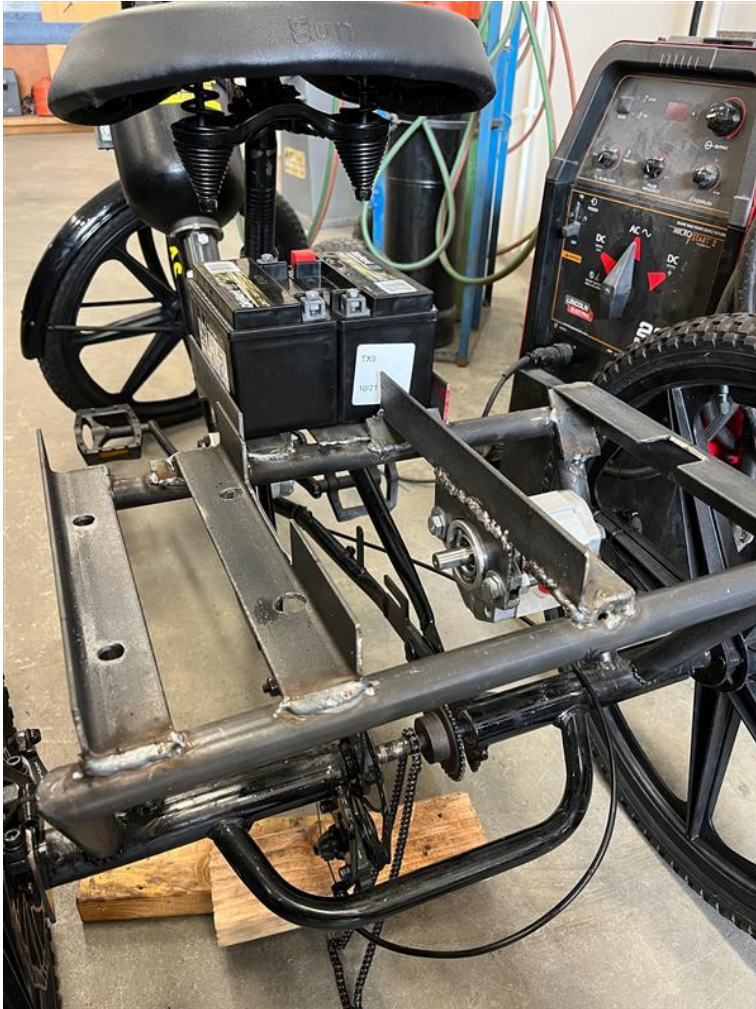
Vehicle Construction



Vehicle Construction



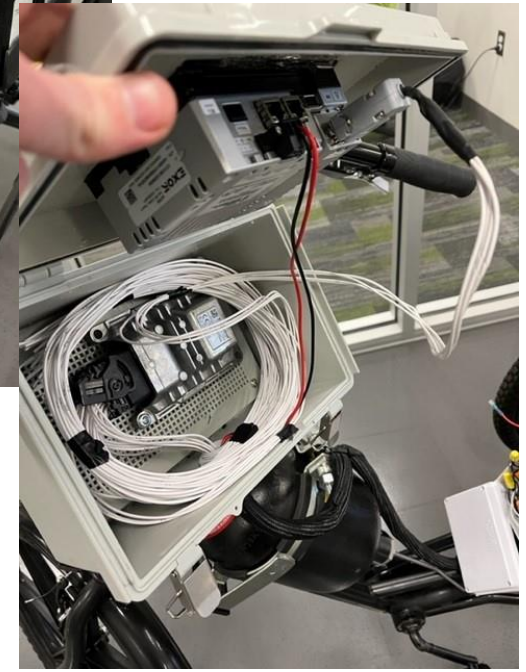
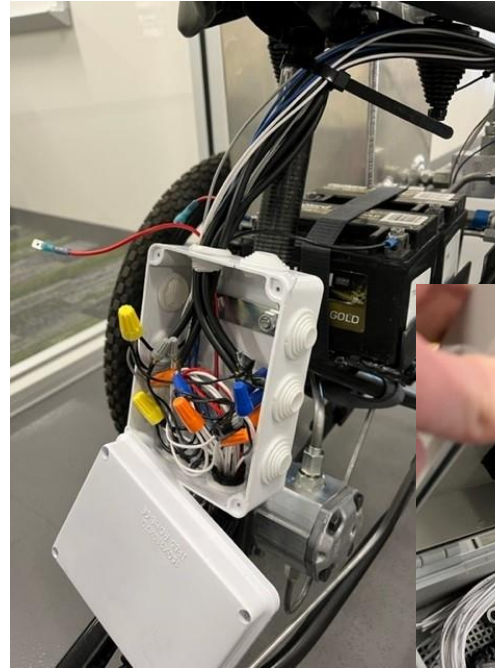
Vehicle Construction



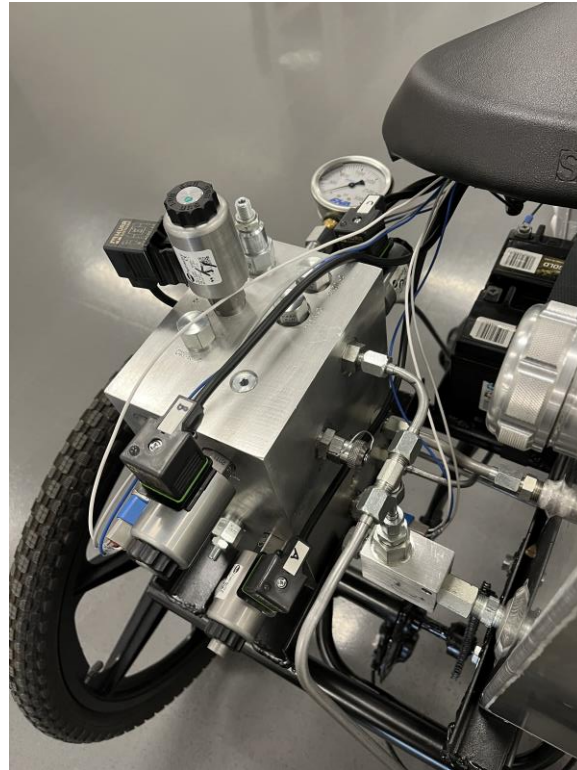
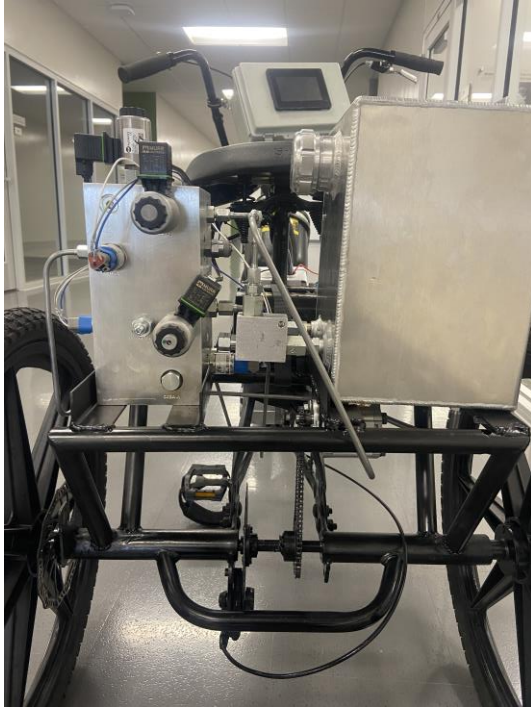
Vehicle Construction



Vehicle Construction



Vehicle Construction



Vehicle Construction



The image displays the CoDeSys software environment for a PLC project titled "Bike Base (1).pro". The left pane shows a project tree with folders for "IOs" and "Programs". The main window is split into two views: a ladder logic editor and a graphical HMI editor.

PLC Logic (Ladder Logic):

```
PROGRAM logic
VAR
  controller_on: BOOL := FALSE;
  low_pressure_motor: BOOL := FALSE;
  low_pressure_acc: BOOL := FALSE;
  enable_output_A: BOOL := FALSE;
  enable_output_B: BOOL := FALSE;
  enable_output_C: BOOL := FALSE;
  enable_output_D: BOOL := FALSE;
  enable_output_3: BOOL := FALSE;
  enable_output_4: BOOL := FALSE;
  enable_output_5: BOOL := FALSE;
  enable_output_6: BOOL := FALSE;
  enable_output_7: BOOL := FALSE;
END_VAR

(* see if initialization routine was completed *)
0004 PLC_PRG_x_initialized = TRUE
0005 THEN
0006   controller_on := TRUE;
0007 ELSE
0008   controller_on := FALSE;
0009 END_IF

(* set that bit to false so we can see the failure *)
0010 END_IF

(* if the transducer is below 250 PSI we set a
0011 low_pressure_motor = TRUE;
0012 ELSE
0013   low_pressure_motor := FALSE;
0014 END_IF

(* if the transducer is below 250 PSI we set a
0020 low_pressure_acc = TRUE;
0021 THEN
0022   low_pressure_acc := TRUE;
0023 ELSE
0024   low_pressure_acc := FALSE;
0025 END_IF
```

HMI Interface:

The HMI screen, titled "Controller Status", features the Fluid Power VEHICLE Challenge and iFP logos. It includes five control buttons: "Pedal to Power", "Acc Charge", "Acc Dischrg", "Regen", and "Elec Dump". On the right, there are three vertical gauges labeled "Pump", "Motor", and "Accumulator", each with a scale from 0 to 4000 and a red needle. The gauges are currently showing 0. A "Script / Keyboard" input field is visible at the bottom.

Properties Panel:

| | |
|----------------|--------|
| Page: | Main |
| Width: | 800 |
| Height: | 480 |
| Fit to Screen: | Fit to |
| Background: | Base |
| Template: | Base |
| Events: | |

Testing



- Technical issues off the start
- Tested two motor sizes
- Validated every mode

Hydraulic Calculations V2

| <i>Given</i> | | <i>Calculated</i> | | <i>Measured</i> | |
|---------------------|-------------|--------------------|--------------|--------------------|--------------|
| Motor Displacement: | 5.34 cc/rev | Pump Flow Rate: | 1.77 L/min | Pump Flow Rate: | 1.72 L/min |
| Pump Displacement: | 4.10 cc/rev | Motor Shaft Speed: | 318.75 RPM | Motor Shaft Speed: | 308.40 RPM |
| Pump Speed: | 465.00 RPM | Wheel Speed: | 124.03 RPM | Wheel Speed: | 120.00 RPM |
| Pressure: | 1800.00 PSI | Shaft Power: | 407.48 Watts | Shaft Power: | 394.25 Watts |

Final Vehicle



Lessons Learned

- Don't overcomplicate tasks
- Time management
- Start small for troubleshooting
- Don't be afraid to ask for help
- Circuit follow through
- Gear ratios and free wheel
- Be flexible

Questions?



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