# NFPA Fluid Power Vehicle Challenge

NFPA
Education and
Technology
Foundation

**FINAL PRESENTATION &**
**DESIGN REVIEW**
**THE FLUID MECHANICS**
**TEXAS A&M UNIVERSITY**
**APRIL 24th, 2026**

# MEET THE TEAM

Jackson Perniciaro
Project Manager

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Manufacturing Lead

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Testing Lead

Mathew Manginelli
Engineering Lead

Ulises Arreola
System Integration Lead

Sri Kotaru
Safety Lead

NFPA Fluid Power Vehicle Challenge

THE FLUID MECHANICS

# ADVISORS & MENTORS

NFPA Fluid Power Vehicle Challenge

EST. 1870 NOTT COMPANY

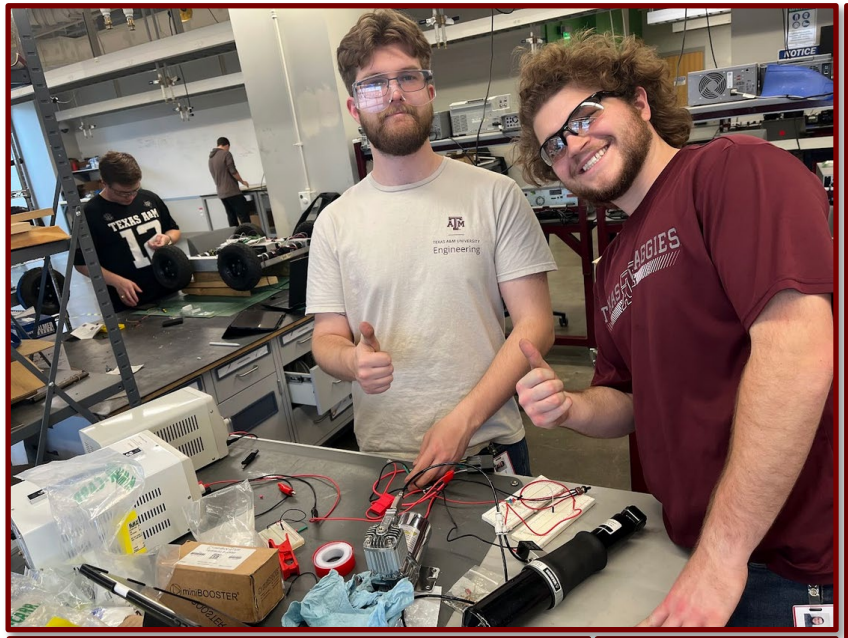
Mr. Tony Hennum
Industry Mentor

Mr. Eric Jensen
Industry Mentor

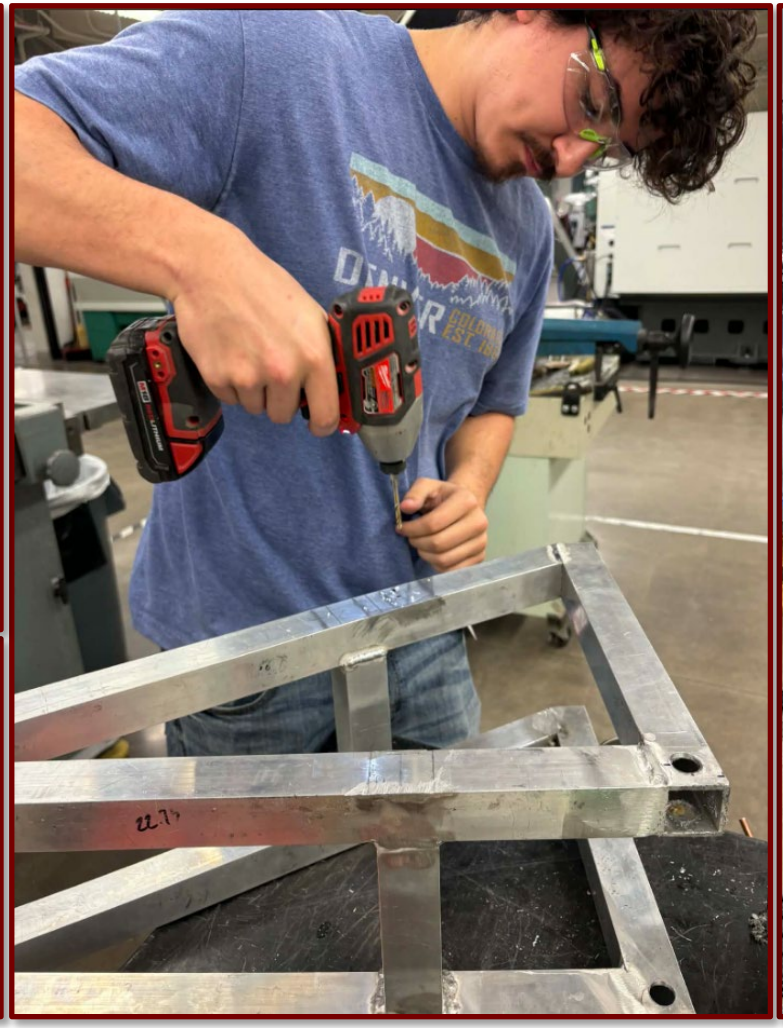
Gary D. Bradley
Faculty Advisor

# VEHICLE CONSTRUCTION


# VEHICLE CONSTRUCTION







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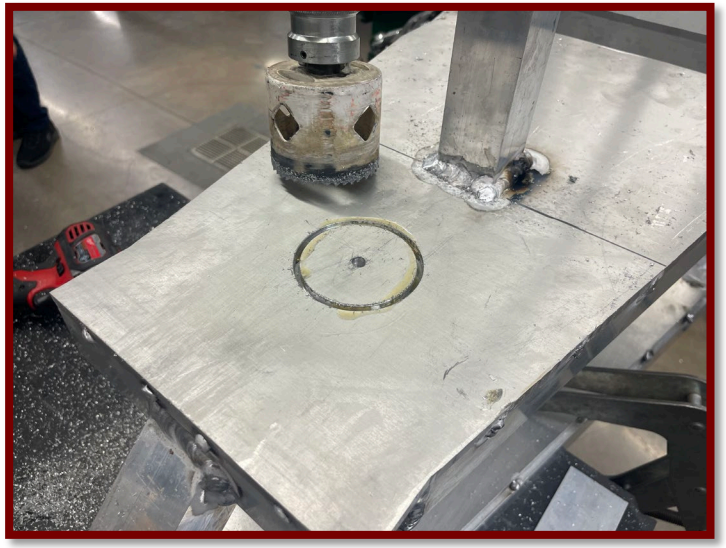
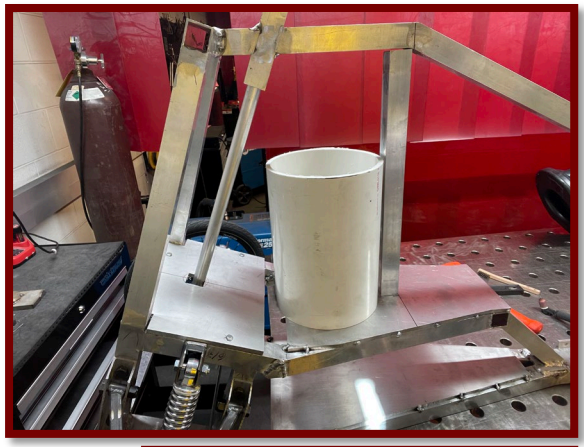


Cutout for Accumulator and Reservoir ports


Accumulator mount on Chassis shelf



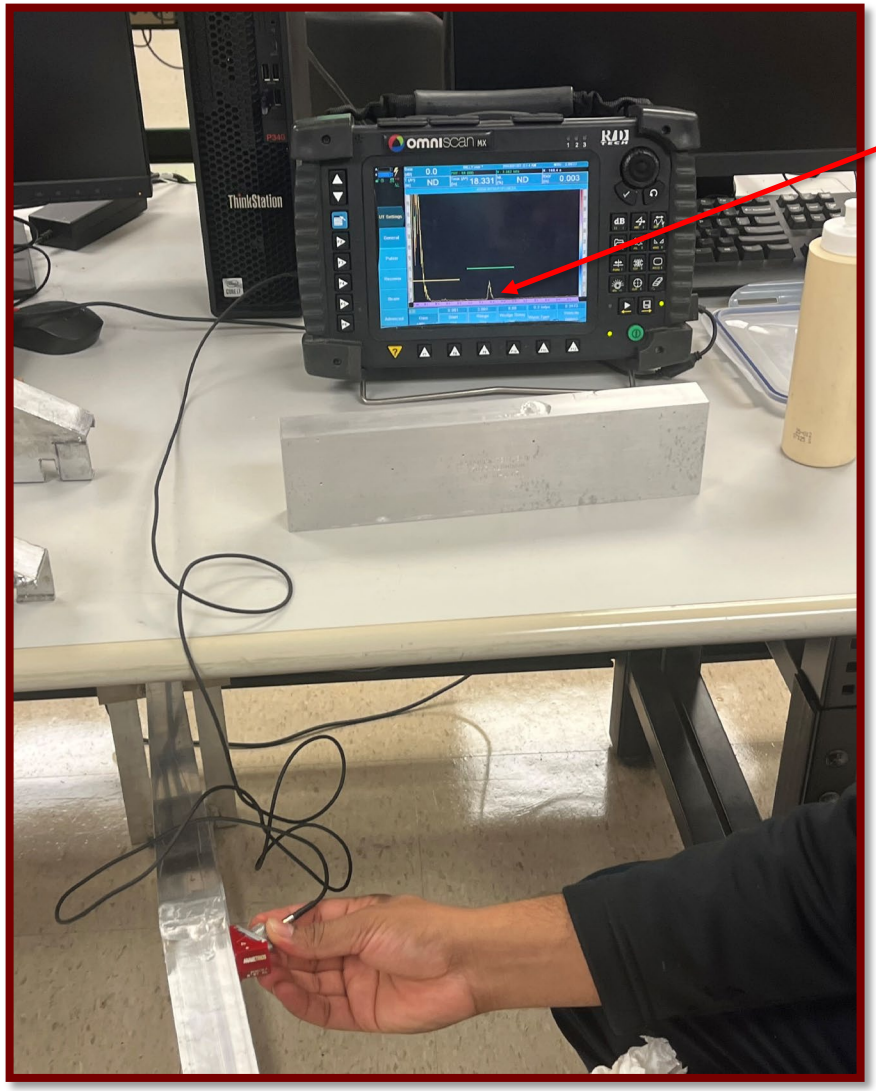
-06 JIC Bulkhead Manifold/Regen

-10 JIC Bulkhead Pump Inlet

Completed PVC Reservoir and mounting position

# VEHICLE CONSTRUCTION

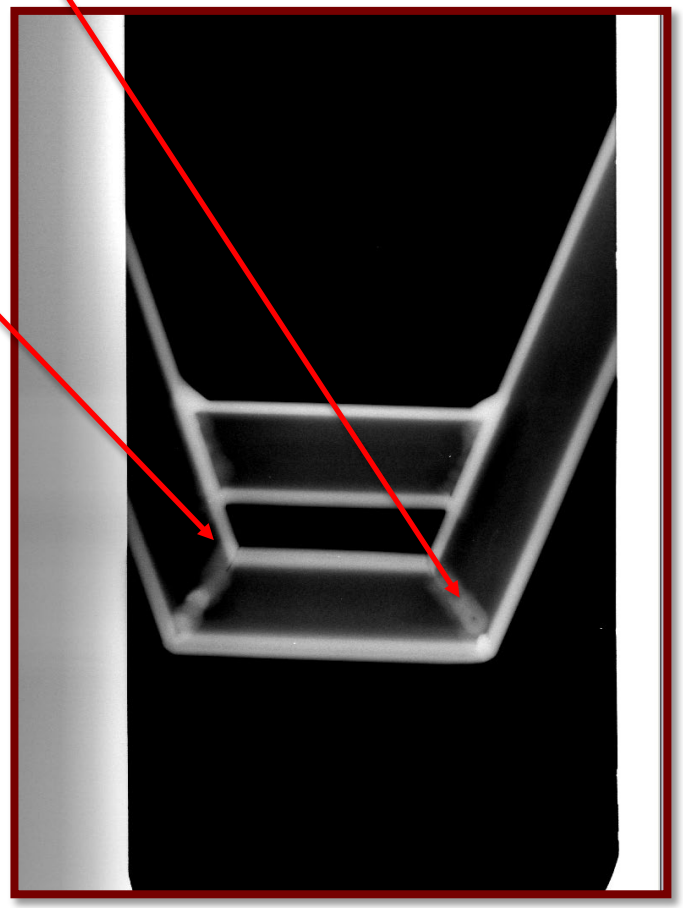
# VEHICLE TESTING - WELDING




Backwall Echo

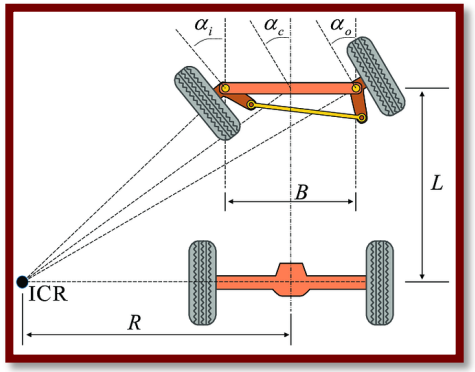
Discontinuity 1

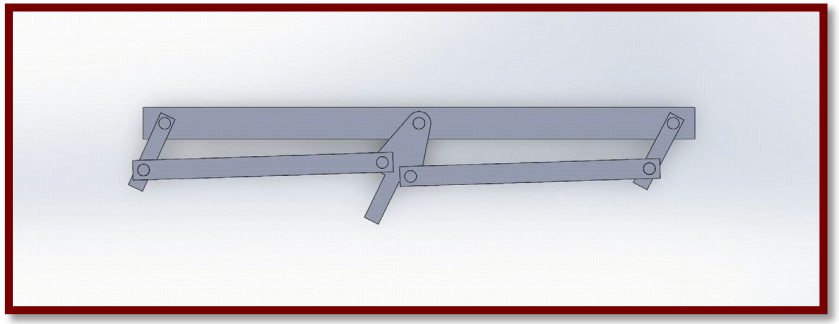
Discontinuity 2

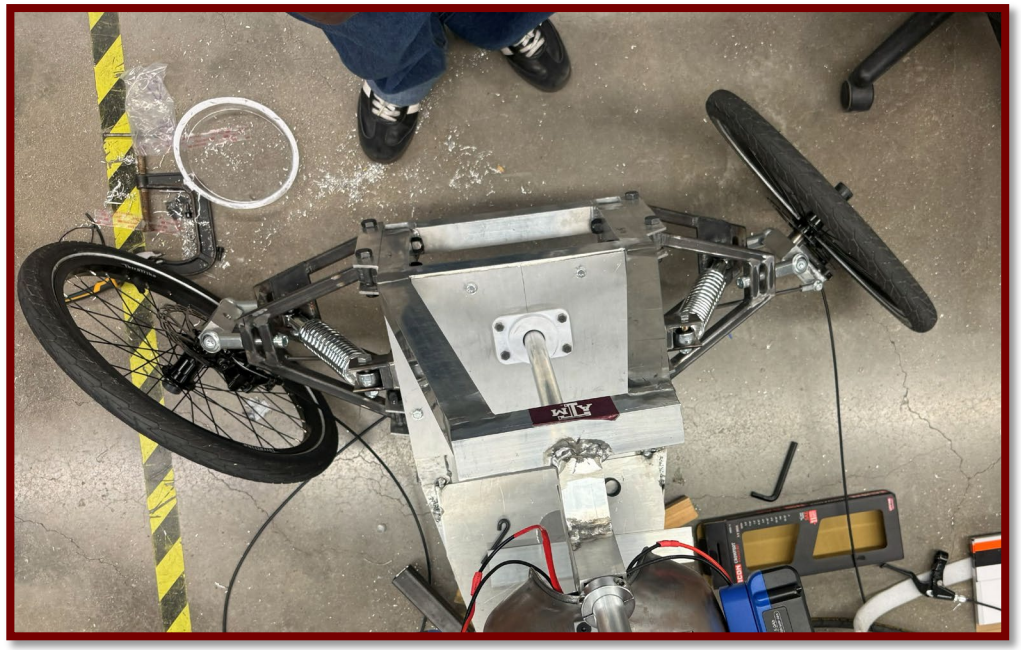
# VEHICLE TESTING - MANUVERABILITY

Ackermann Steering



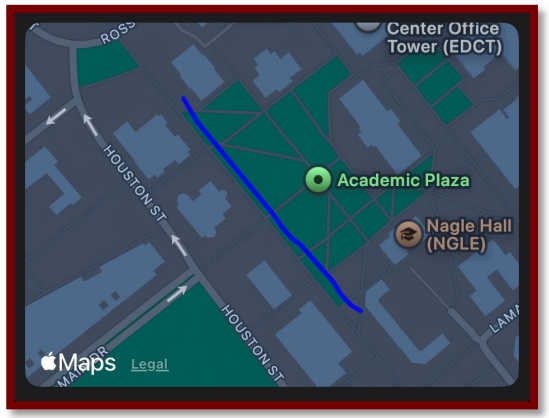



| Given | | | |
|---|---|---|---|
| Max Wheel Angle | 58 | degrees | |
| Wheelbase | 7 | ft | |
| Front Track Width | 30 | inches | |
| | | | |
| Turning Radius | 5.624 | ft | |
| | | | |
| Outside Wheel Angle | 0.794 | 45.520 | degrees |
| Inside Wheel Angle | 1.012 | 58 | degrees |
| | | | |
| Lever Arms | | | |
| Tie Rod Lever | 3.250 | inches | |
| Outside Articulation | 2.319 | inches | |
| Inside Articulation | 2.756 | inches | |
| Difference | 0.437 | inches | |

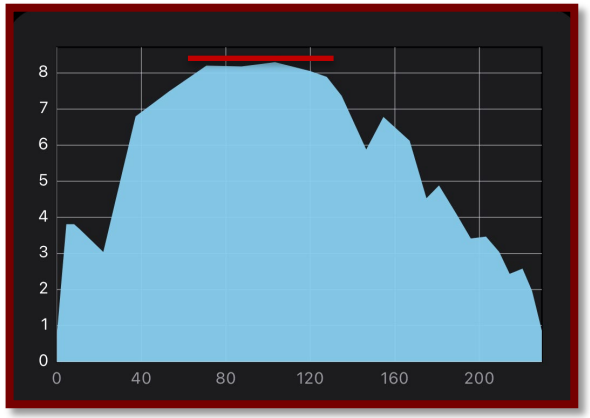


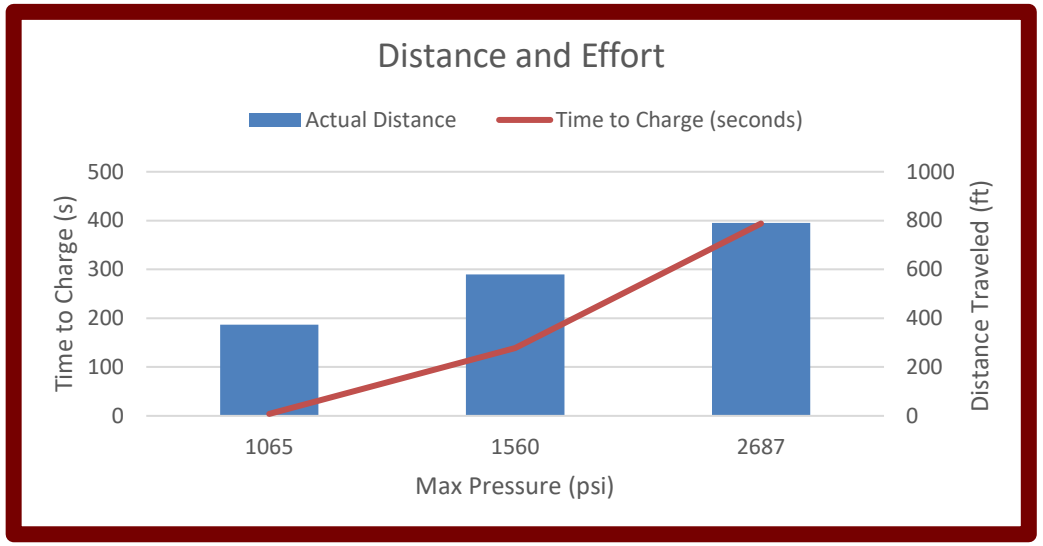
# VEHICLE TESTING EFFICIENCY/SPEED

791 [ft] | 0.15 [mi]




8.4 [m/s] | 18.79 [mph]




| Gearbox | Ratio | Train Value High | CVT High rpm | High Torque | CVT High Speed (mph) |
|---|---|---|---|---|---|
| 1st | 1.82 | 1.7937 | 44.6015 | 645.7177 | 3.4499 |
| 2nd | 1.47 | 1.4487 | 55.2209 | 521.5412 | 4.2713 |
| 3rd | 1.19 | 1.1728 | 68.2141 | 422.2001 | 5.2763 |
| 4th | 0.95 | 0.9363 | 85.4471 | 337.0505 | 6.6093 |
| 5th | 0.76 | 0.7490 | 106.8089 | 269.6404 | 8.2617 |
| 6th | 0.62 | 0.6110 | 130.9271 | 219.9698 | 10.1272 |
| 7th | 0.49 | 0.4829 | 165.6628 | 173.8471 | 12.8140 |
| 8th | 0.4 | 0.3942 | 202.9370 | 141.9160 | 15.6971 |
| 9th | 0.32 | 0.3154 | 253.6712 | 113.5328 | 19.6214 |

Motor: 12 Teeth
Wheel: 45 Teeth

| Gearbox | Ratio | Train Value High | CVT High rpm | High Torque | CVT High Speed (mph) |
|---|---|---|---|---|---|
| 1st | 1.82 | 1.1958 | 66.9023 | 430.4785 | 5.1749 |
| 2nd | 1.47 | 0.9658 | 82.8314 | 347.6942 | 6.4070 |
| 3rd | 1.19 | 0.7819 | 102.3212 | 281.4667 | 7.9145 |
| 4th | 0.95 | 0.6242 | 128.1707 | 224.7003 | 9.9140 |
| 5th | 0.76 | 0.4993 | 160.2134 | 179.7602 | 12.3925 |
| 6th | 0.62 | 0.4074 | 196.3906 | 146.6465 | 15.1908 |
| 7th | 0.49 | 0.3219 | 248.4943 | 115.8981 | 19.2210 |
| 8th | 0.4 | 0.2628 | 304.4055 | 94.6107 | 23.5457 |
| 9th | 0.32 | 0.2102 | 380.5068 | 75.6885 | 29.4321 |

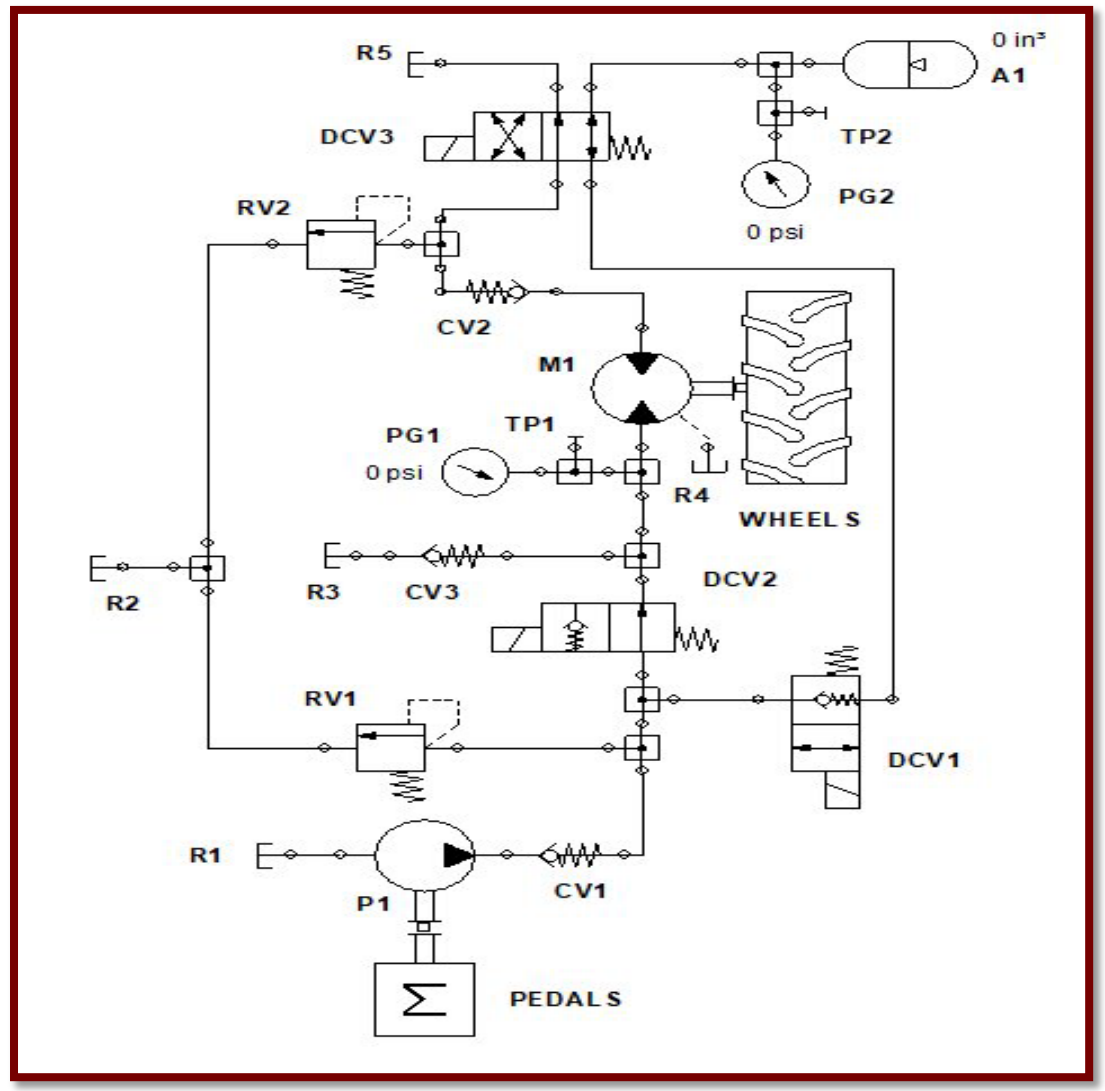
Motor: 12 Teeth
Wheel: 30 Teeth

# VEHICLE DESIGN REVIEW

NFPA Fluid Power Vehicle Challenge

THE FLUID MECHANICS

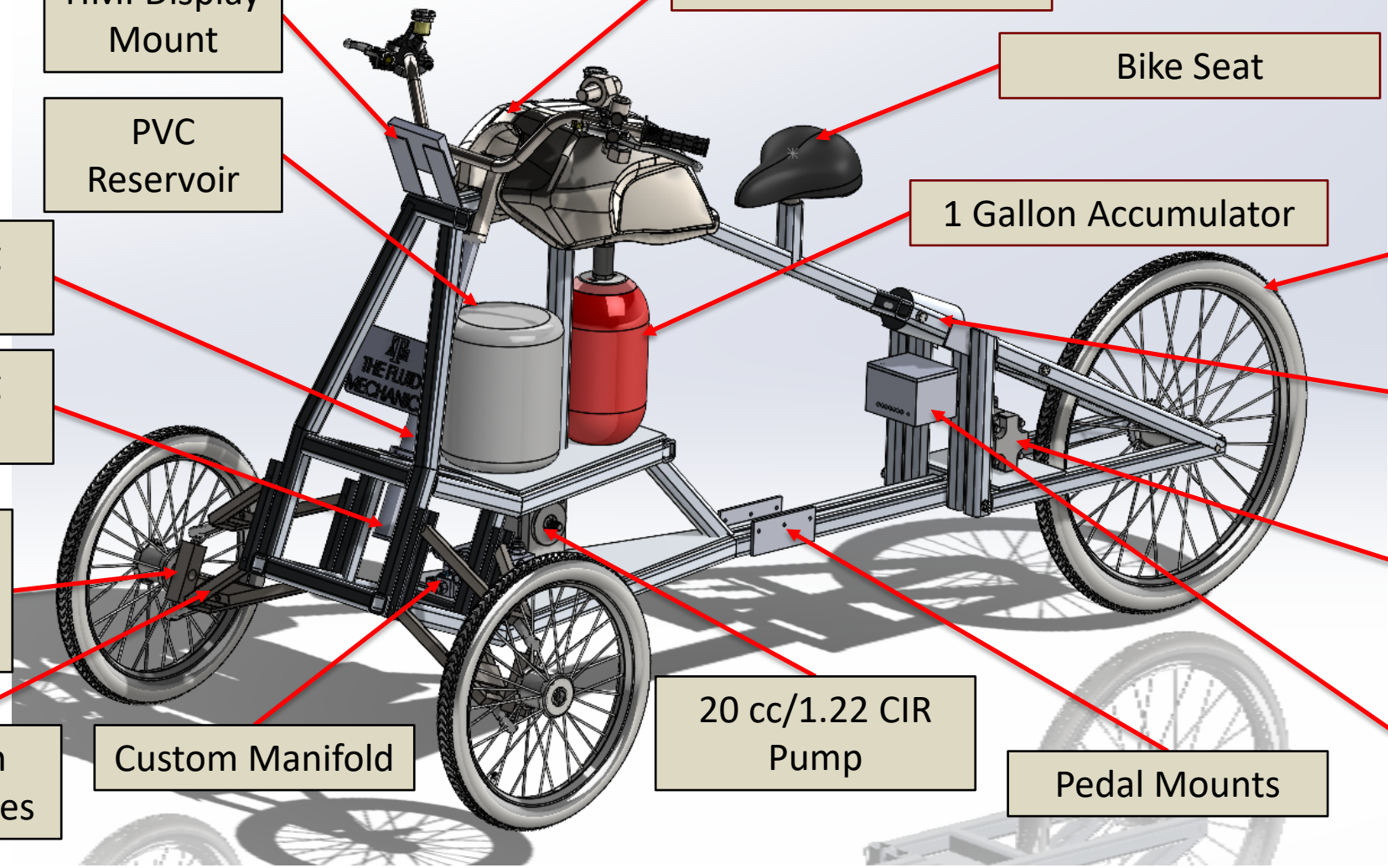
# TEAM GATR 2024-2025
# HYDRAULICS DESIGN



# TEAM GATR 2024-2025
# ADVANTAGES & DISADVANTAGES

| Advantages | Disadvantages |
|---|---|
| Implemented gearbox | Not all gearbox ratios could be used |
| Convenient electronic placement | No implementation of CVT |
| Lightweight | No implementation of Manifold |
| Fairly Efficient hydraulic circuit | Multiple components attached with little foresight |
| Compact Implementation | No use of Pneumatics |

# MECHANICAL DESIGN



HMI Display Mount

Electrical Housing

Bike Seat

PVC Reservoir

1 Gallon Accumulator

25” Drive Wheel
30-tooth Sprocket

Steering Column

Steering Shoe

“Softail” Swing-Arm Suspension (Pneumatic Shock)

Custom Steering Knuckles

0.513 CIR Motor
12-tooth Sprocket

Custom Wishbones

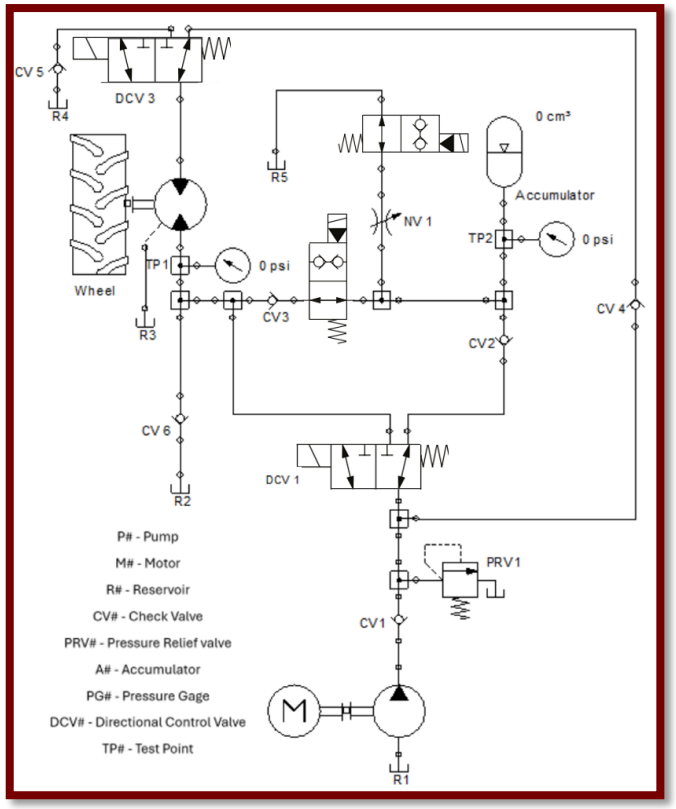
Custom Manifold

20 cc/1.22 CIR Pump

Pedal Mounts

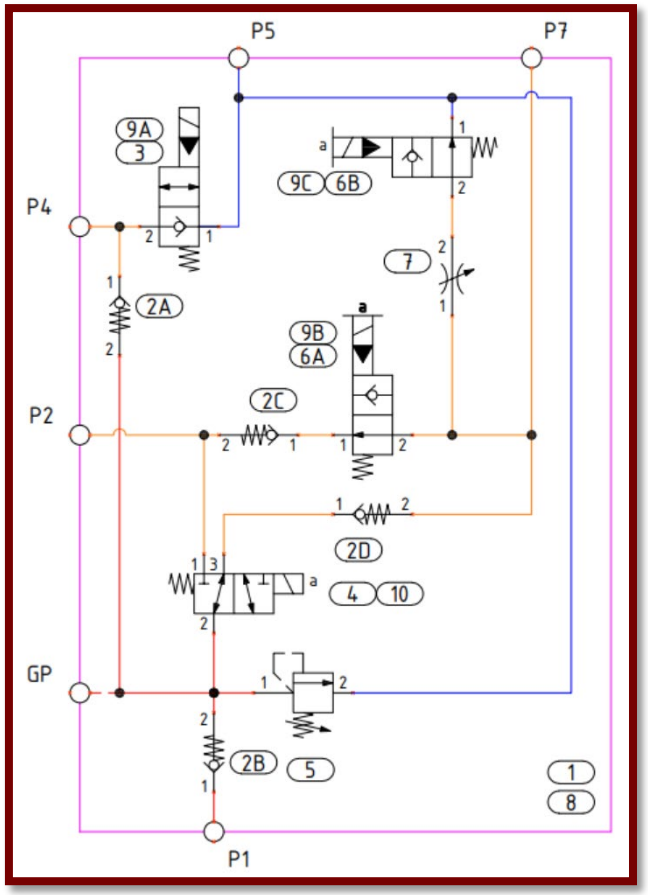
Pneumatic Electrical Housing

# HYDRAULIC DESIGN




8th Iteration Schematic

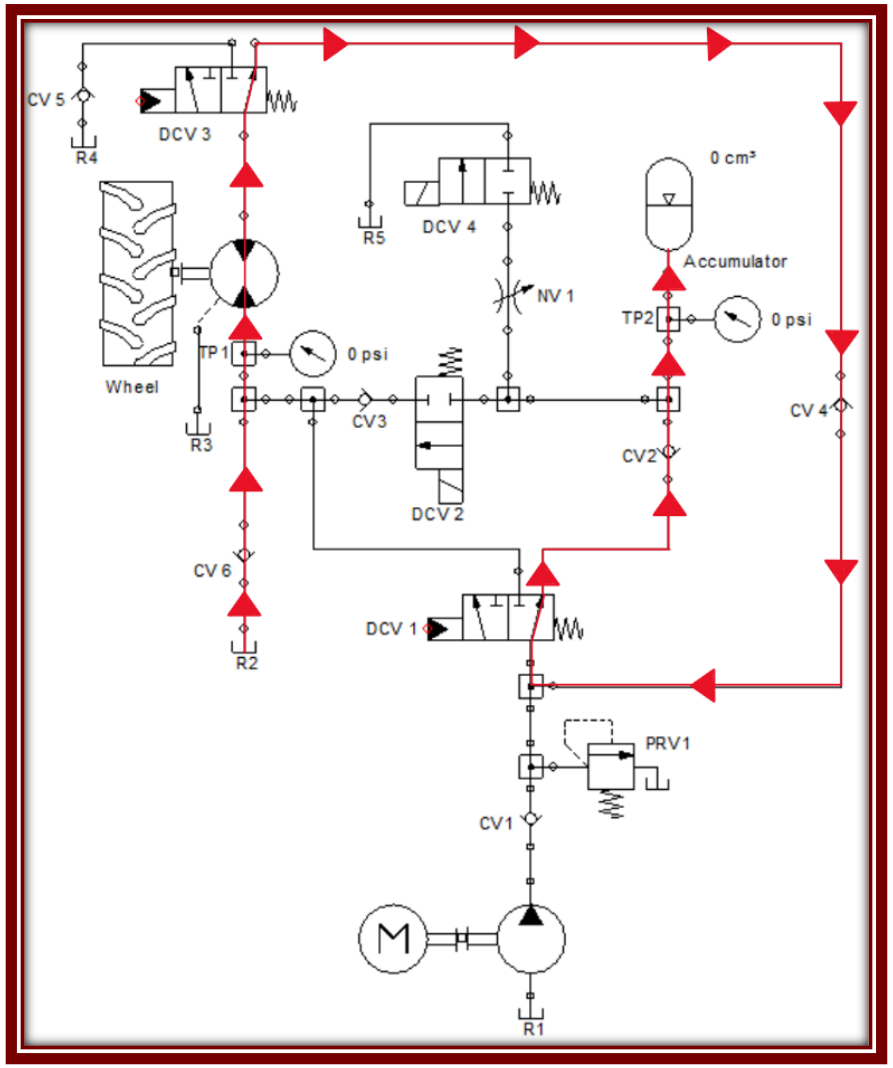
- Added Needle Valve to bleed Accumulator
- Default "Kill Switch"
  - Failsafe
- Design Approved by Team's Industry Mentor Tony Hennum and Technical Liaison Ernie Parker




Updated Schematic w/Manifold

- Replaced SBV11 with SVP08
- Removed CV5
- DCV3 replaced with 2-way poppet valve
- P5 acts as common reservoir return

# REGENERATIVE BRAKING




## 1900 SERIES

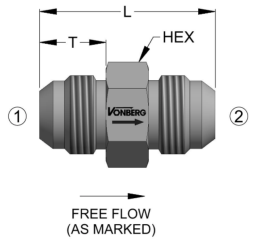
### CHECK VALVE - POPPET

INLINE • MALE JIC

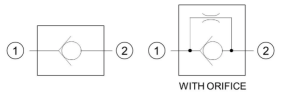
### DESCRIPTION

AN IN-LINE STYLE, POPPET TYPE CHECK VALVE WITH MALE JIC CONNECTIONS INTENDED FOR BLOCKING FLUID FLOW.

### PRODUCT RENDERING




### SCHEMATIC

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### OPERATION

- FLOW FROM (2) TO (1) IS BLOCKED WITH A SPRING BIAS TO ASSIST IN STATIC AND LOW LOAD CONDITIONS.
- FLOW FROM (1) TO (2) IS ALLOWED WITH A STANDARD CRACK PRESSURE OF 3-5 PSI.

### FEATURES

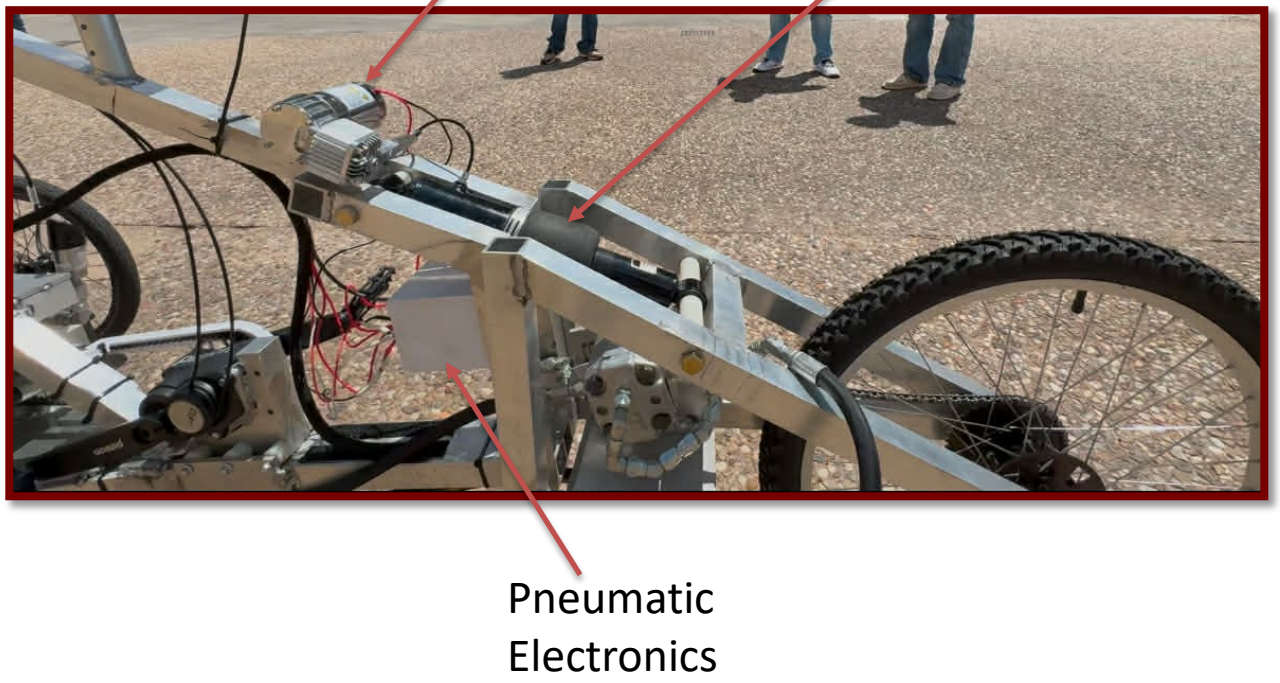
- SPECIAL CRACK PRESSURES AVAILABLE UPON REQUEST.
- LOW INTERNAL LEAKAGE, 5 DPM.
- NO INTERNAL PACKINGS
- STEEL BODY AND POPPET.

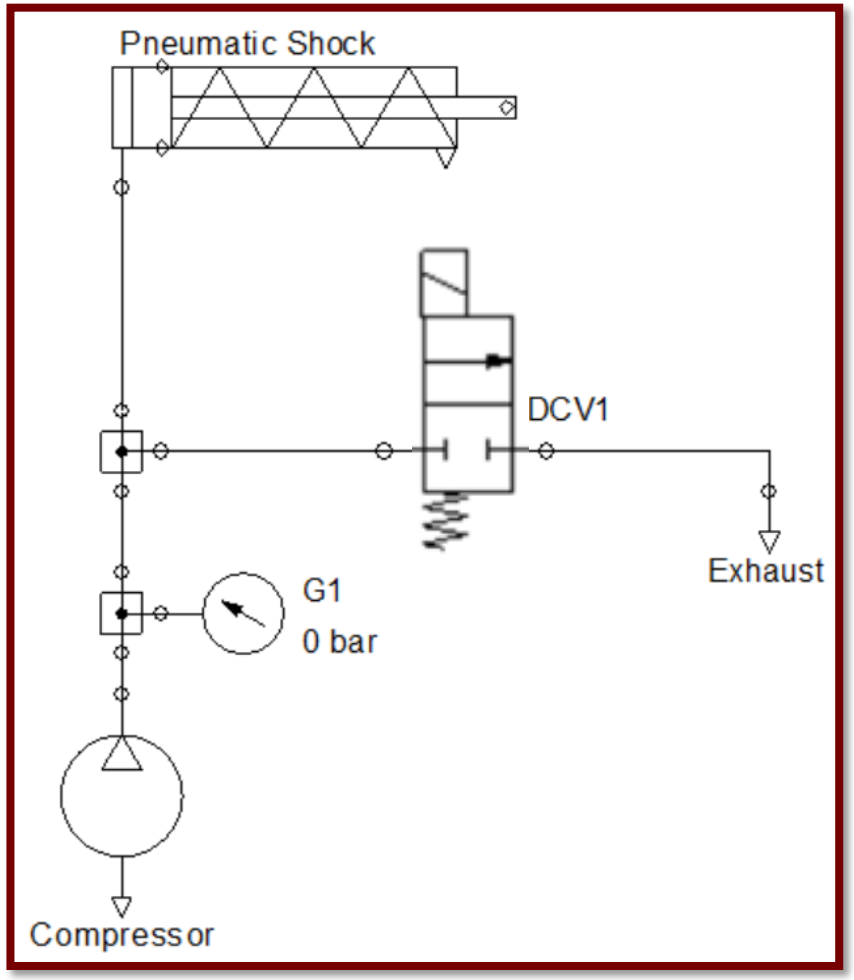
### SPECIFICATIONS

| | |
|---|---|
| OPERATING PRESSURE | 3500 PSI |
| STANDARD CRACK PRESSURE | 3-5 PSI |
| TEMPERATURE RANGE | 250° F TO -40° F |

Vonberg
1906-00 Poppet Type
Check Valve

# PNEUMATIC DESIGN



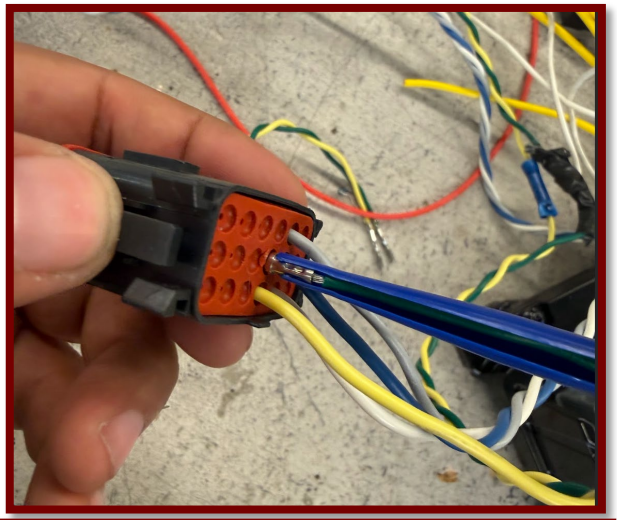



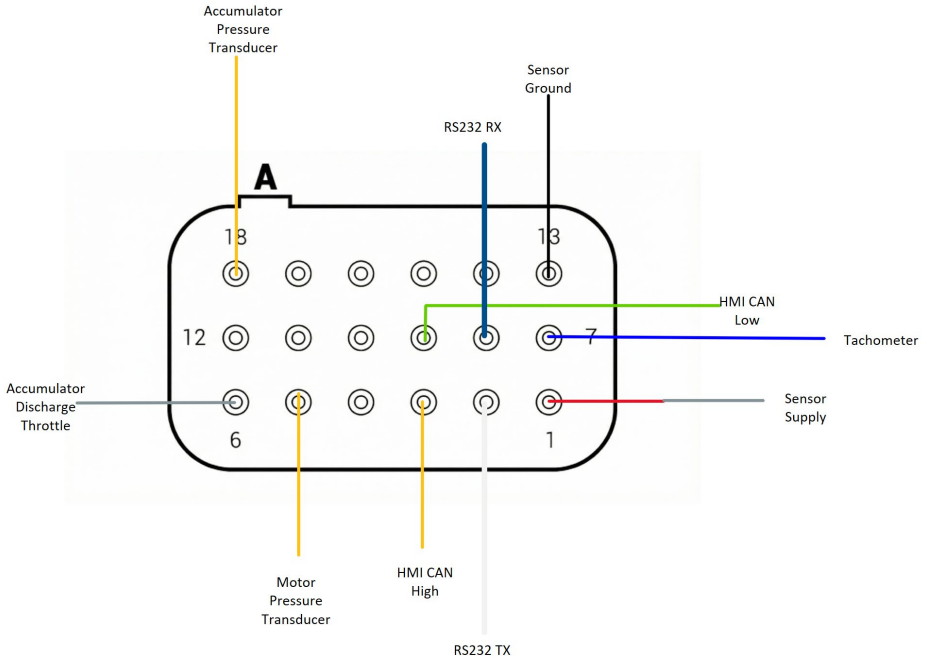
# ELECTRICAL

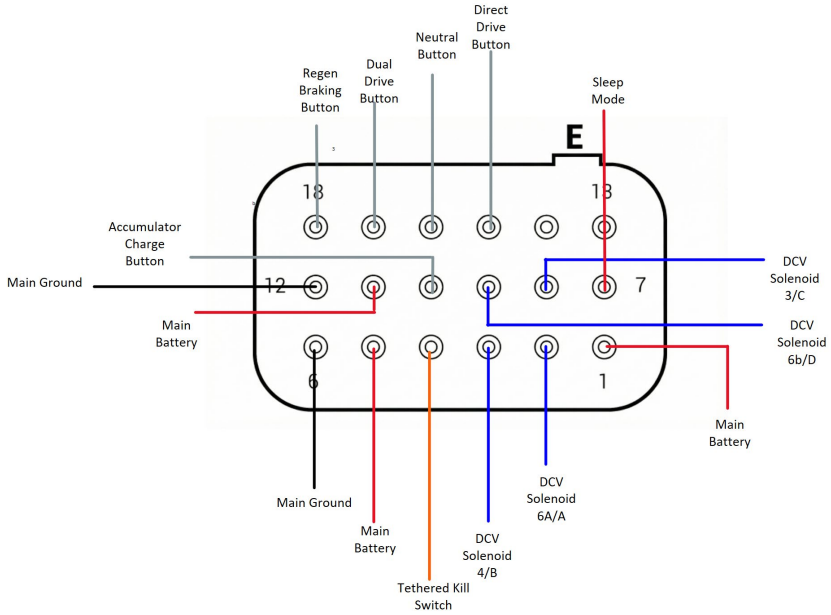

OFF
SELECTOR 6007
IGNITION PROTECTED
1
2
m
1+2
BLUE SEA SYSTEMS


987 hr
5:45 min
RPM
1750
STOP
103 % Soot
67 % Ash
70 °C
Cool Temp
12.3 V
Battery Voltage
40 PSI
Oil press
45 %
DEF Level

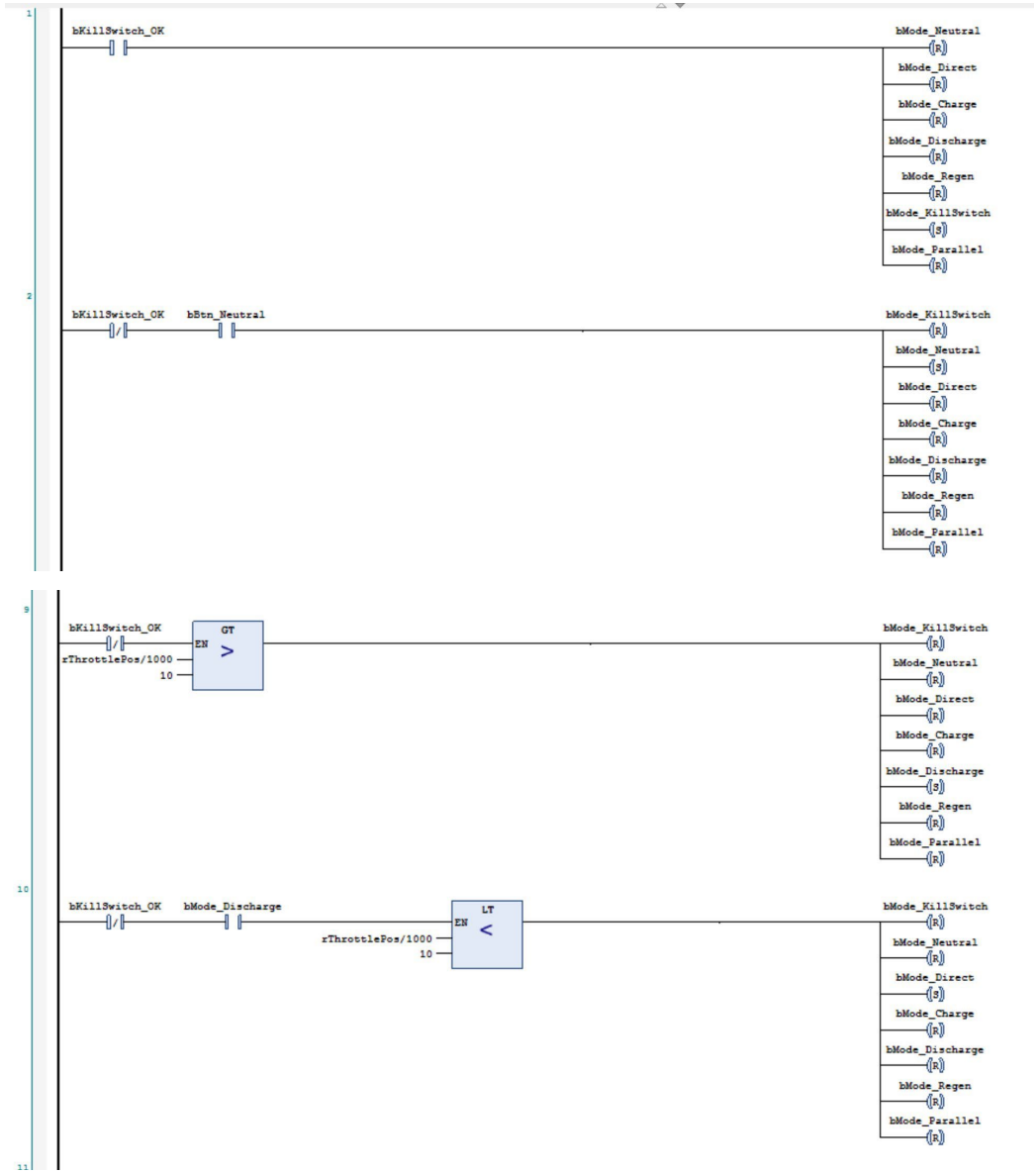
# ELECTRICAL

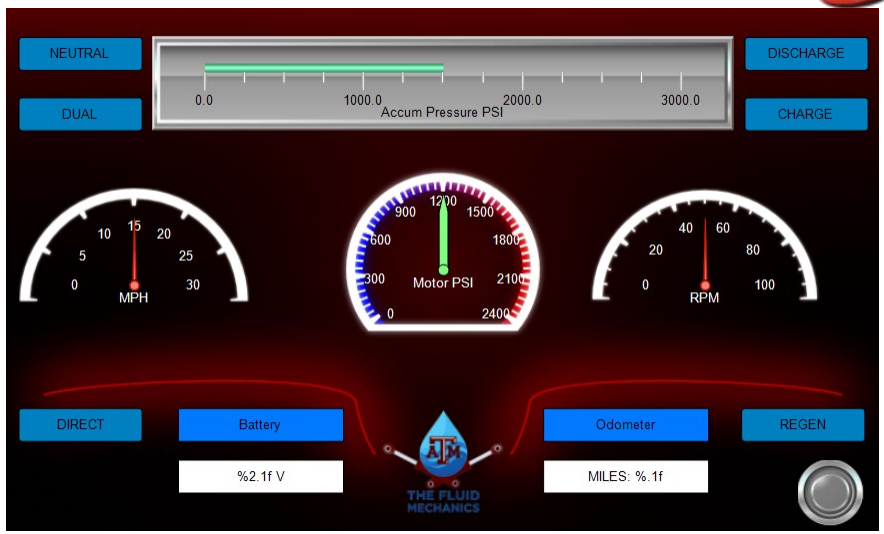



A
Accumulator Pressure Transducer
Sensor Ground
RS232 RX
HMI CAN Low
Tachometer
Sensor Supply
Accumulator Discharge Throttle
Motor Pressure Transducer
HMI CAN High
RS232 TX
18
13
12
7
6
1


E
Regen Braking Button
Dual Drive Button
Neutral Button
Direct Drive Button
Sleep Mode
Accumulator Charge Button
Main Ground
Main Battery
DCV Solenoid 3/C
DCV Solenoid 6b/D
Main Battery
Main Ground
Main Battery
DCV Solenoid 6A/A
DCV Solenoid 4/B
Tethered Kill Switch
18
13
12
7
6
1

# ELECTRICAL



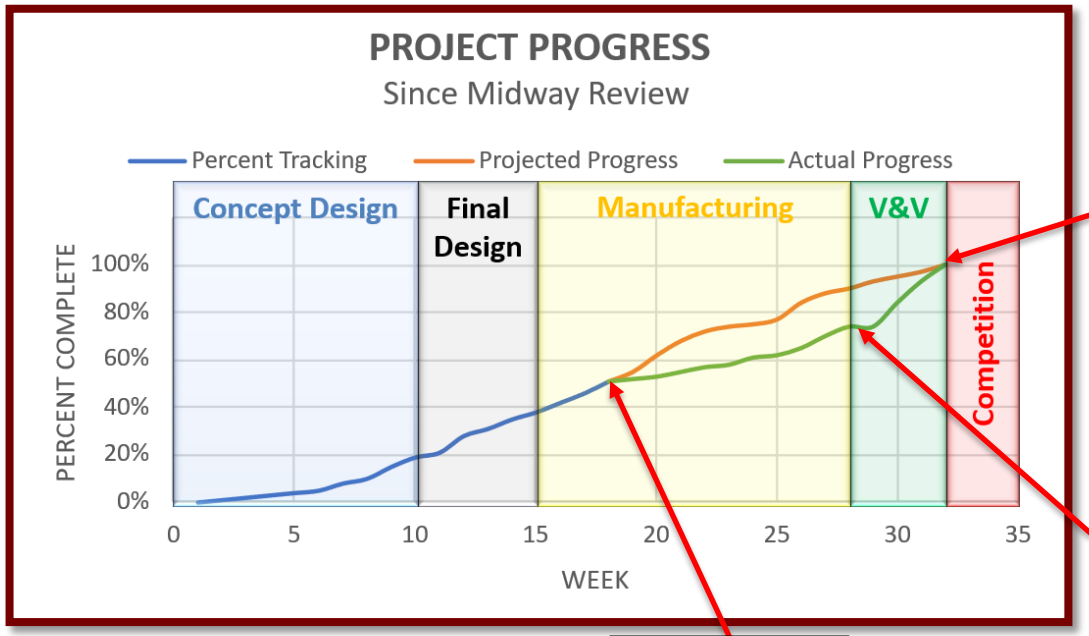




```
(* ========================================== *)
(* PHYSICAL DIGITAL INPUTS (Buttons & Switches) *)
(* ========================================== *)
bBtn_DirectDrive   : BOOL;  (* Pin E15: Button for Direct Drive *)
bBtn_Neutral       : BOOL;  (* Pin E16: Button for Neutral *)
bBtn_Regen         : BOOL;  (* Pin E18: Digital signal from brake handle *)
bBtn_Parallel      : BOOL;  (* Pin E17: Button for Parallel Drive *)
bBtn_Charge        : BOOL;  (* Pin E10: Button for Accumulator Charge *)
bKillSwitch_OK     : BOOL;  (* Pin E04: Safety Loop (True=Safe, False=Kill) *)


(* ========================================== *)
(* PHYSICAL ANALOG INPUTS (Sensors)           *)
(* ========================================== *)
rThrottlePos       : REAL;  (* Pin A06: 0.5V-4.5V Input from Throttle *)
rAccumulatorPres   : REAL;  (* Pin A18: Pressure Transducer 1 (PSI) *)
rMotorPres         : REAL;  (* Pin A05: Pressure Transducer 2 (PSI) *)
//rFlowRate          : REAL;  (* Pin A10: Transducer reading (GPM) *)


(* ========================================== *)
(* SYSTEM STATE INPUTS (Internal MC2 Readings) *)
(* ========================================== *)
rBattery_Voltage   : REAL;  (* Resulting Voltage for local PLC logic *)

(* ========================================== *)
(* PHYSICAL DIGITAL OUTPUTS (Valves & Relays)  *)
(* ========================================== *)
bValve_A           : BOOL;  (* Pin E02: DCV Solenoid 1 *)
bValve_B           : BOOL;  (* Pin E03: DCV Solenoid 2 *)
bValve_C           : BOOL;  (* Pin E08: DCV Solenoid 3 *)
bValve_D           : BOOL;  (* Pin E09: DCV Solenoid 4 *)
```

# LESSONS LEARNED

- Technical Lessons:
  - Model mounts and fastener locations before manufacturing.
  - Use thinner mounting plates to save on weight.
  - Create second sprocket to allow for regen braking with CVT wheel.
  - Add Oil level dipstick to easily check oil amount.
  - Use thinner Aluminum plates for the frame instead to help with the vehicle weight
  - Conduct intermittent weight tests.
- Abstract Lessons:
  - Finishing a project without cutting corners takes a lot of dedication and time, even if it seems simple from the outside.
  - Your first design will probably not be the best option.
  - Small mistakes can turn into bigger problems, have contingencies for your contingencies.
  - Collaborating with others outside of the team can lead to a different perspective of your project and problem you're facing.
  - When sourcing components ensure vendors understand what you need and efficiently communicate with vendors to reduce miscommunication.
  - Do not procrastinate on the small things

# PROJECT TRACKING




Ship Date (April 10th)

Spring Break

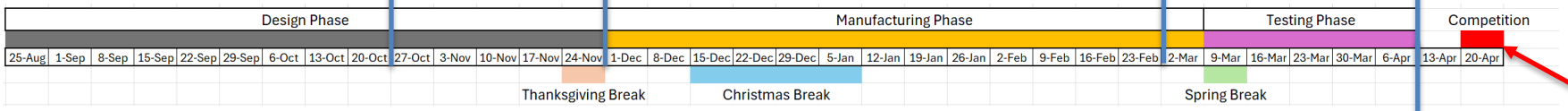
Midway Review (January 8th)

Concept Design Review

Final Design Review

Manufacturing & Assembly Review

Verification & Validation Review




We Are Here

Ship Date (April 10th)

# FUTURE COMPETITORS


Justin Below
Class of ‘28


Jesus Munoz
Class of ‘28

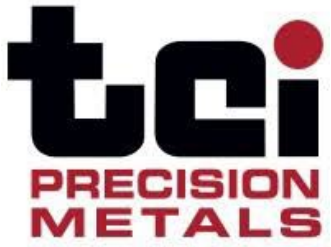

Foster Cave
Class of ‘28

# ACKNOWLEDGMENTS









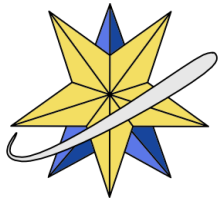




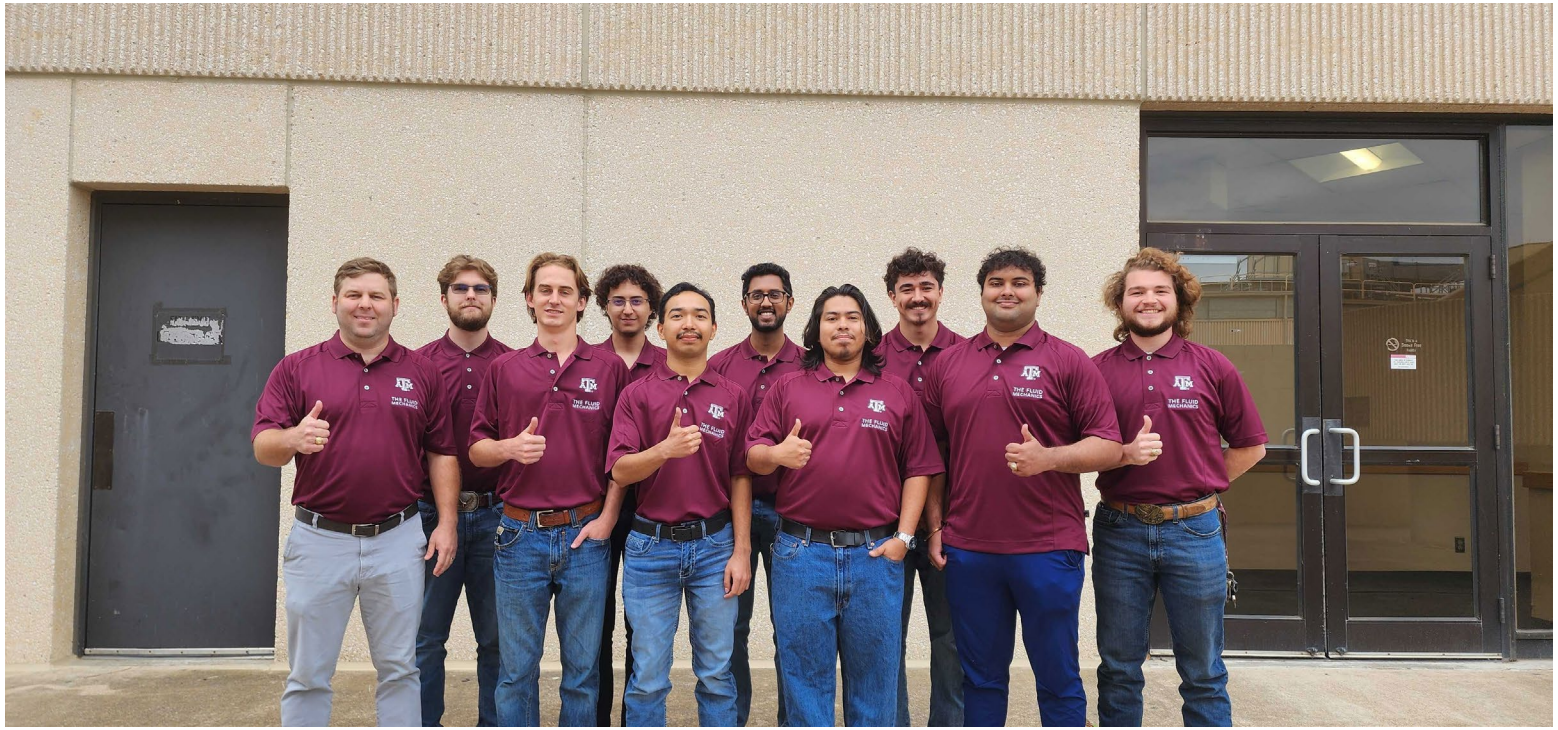








# Thank You, Questions?



THE FLUID MECHANICS