NFPA Fluid Power Vehicle Challenge

NFPA Education and Technology Foundation

FINAL PRESENTATION
University of Cincinnati
TEAM ADVISOR: Muthar Al-Ubaidi
4/11/2018

Agenda (1 of 2)
Informational Only

- Team Introductions (include photo)
- Problem Statement & Objectives
- **Summary** of Midway presentation
  - Note: Do not spend too much time on this section
  - Design objectives
  - Vehicle design
  - Fluid power circuit design
  - Selection of hardware
  - Results and incorporation of analyses (e.g., finite element analysis)

Agenda (2 of 2)
Informational Only

- Vehicle construction
  - Succinct and well organized
- Vehicle testing
  - Was performed and improvements were made based on results
- Final vehicle brought to the competition
  - Appears reliable, safe and of quality craftsmanship
- Lessons learned
  - Are clearly stated and appropriate to the design/build experience described
- Presentation
  - Completed on time and demonstrates good team synergy

University of Cincinnati Team

Muthar Al-Ubaidi, PhD
Team Advisor

Team Members

- Mateo Oquendo-Chandler- Communication, Braking System
- Chelsie King- Documentation, Braking System
- Daniel Luken- 3D Modeling, Machining, Fabrication Design
- Evangelos Stathis- 3D Modeling, Machining, Fab Design
- Brandon Kohli- Hydraulic Loop Design
- Jon Von Hoene- Component Selection/Hydraulic System

- Muthar Al-Ubaidi- Team Advisor

DESIGN OBJECTIVES

Challenge Expectations

- Three Main Challenges
  - Sprint Race
    - 600 ft course
    - Score based on best time
  - Efficiency Challenge
    - Minimum distance of 100 ft
    - Score based on ratio of the weight of the rider (lb) and distance traveled (in) divided by the gas pre-charge pressure (PSI) and gas volume of storage device (in^3).
  - Endurance Challenge
    - Couse done in slalom fashion and total no more than 1 mile.
    - Score based on best time with a maximum of 30 minutes.

Our Expectations

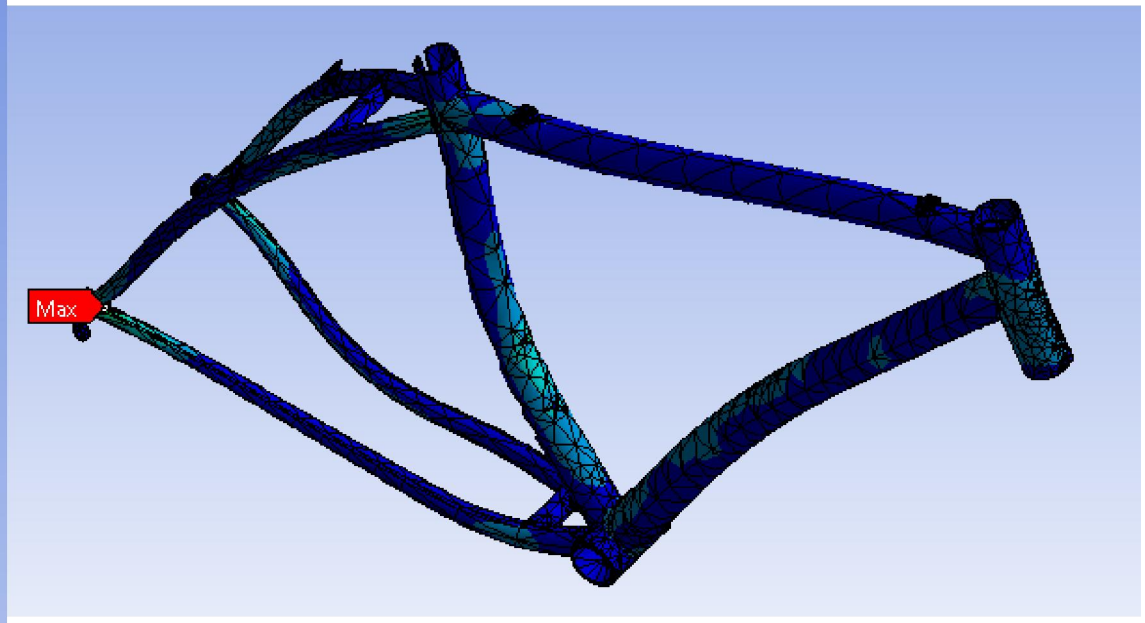
- Finished product under 150 lbs.
- Maintain the structural integrity of the original bike
  - Keep everything tight and streamline
- Easy maintenance and repair
- Safety during construction as well as opperration

VEHICLE DESIGN

Frame Stress Analysis

A: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: psi
Time: 1
11/29/2017 5:29 PM

2546.4 Max
2263.5
1980.6
1697.6
1414.7
1131.7
848.81
565.87
282.94
4.3599e-5 Min



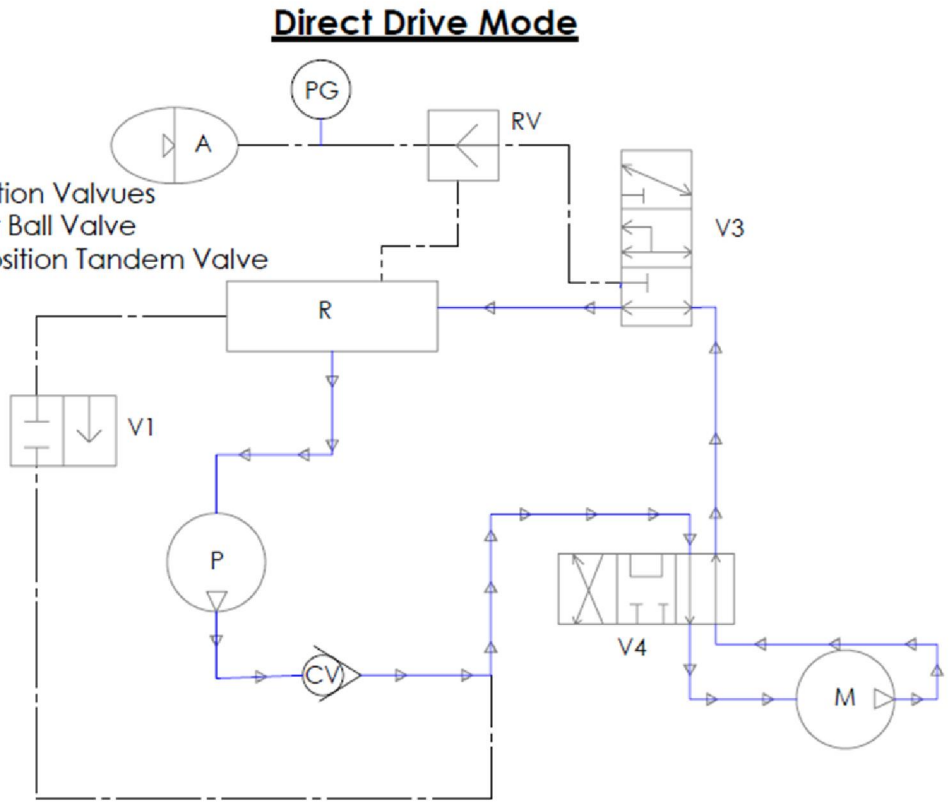
Frame Design

- Pump Bracket
- Reservoir
- Motor Bracket
- Pedal Shaft

FLUID POWER CIRCUIT DESIGN

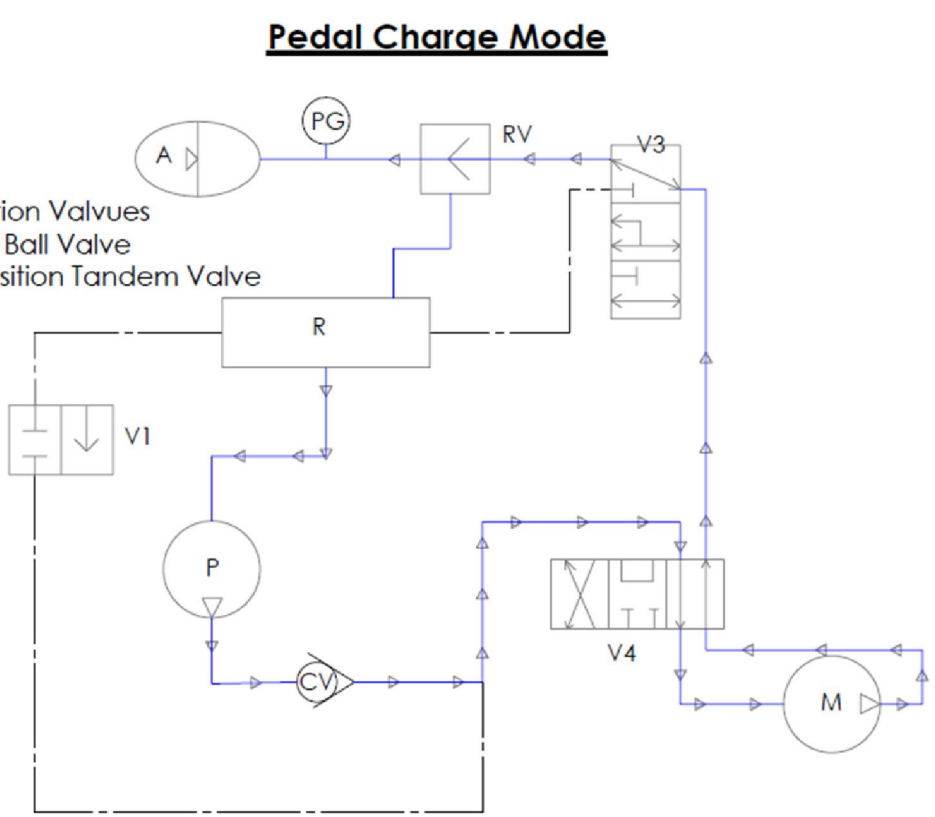
Hydraulic System- Direct Drive

A-Accumulator
P-Pump
M-Motor
PG-Pressure Gauge
RV-Relief Valve
CV-Check Valve
V1- Two way Two Position Valvues
V3-Three way Diverter Ball Valve
V4- Four way Three Position Tandem Valve



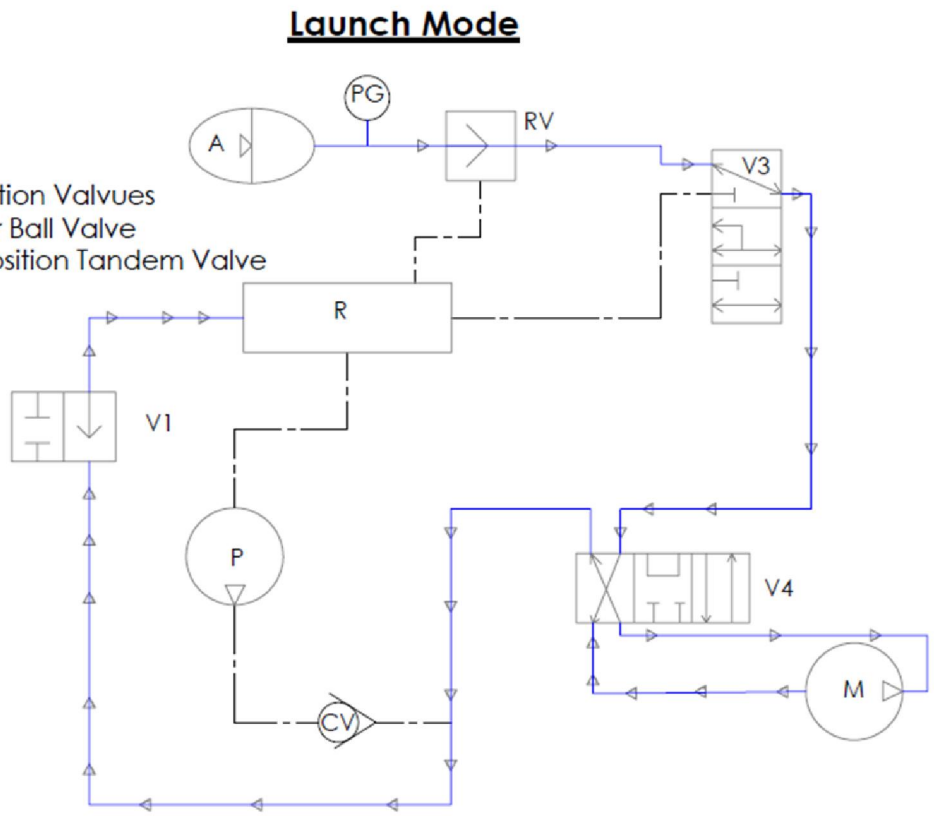
Hydraulic System- Accumulator Charging

A-Accumulator
P-Pump
M-Motor
PG-Pressure Gauge
RV-Relief Valve
CV-Check Valve
V1- Two way Two Position Valvues
V3-Three way Diverter Ball Valve
V4- Four way Three Position Tandem Valve



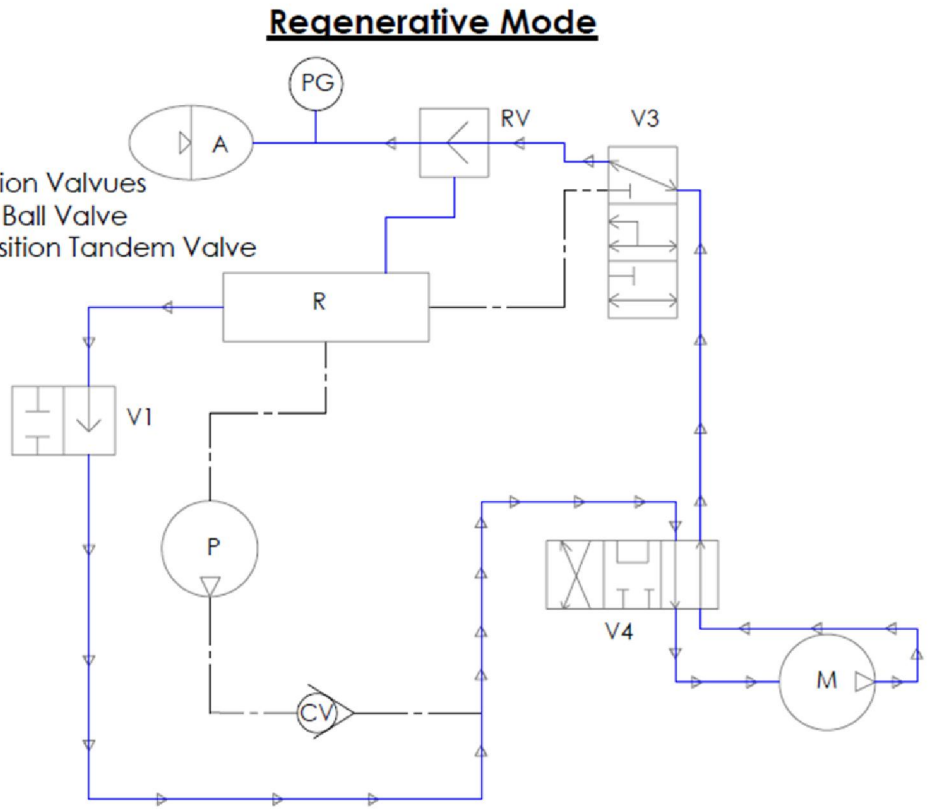
Hydraulic System- Launching

A-Accumulator
P-Pump
M-Motor
PG-Pressure Gauge
RV-Relief Valve
CV-Check Valve
V1- Two way Two Position Valvues
V3-Three way Diverter Ball Valve
V4- Four way Three Position Tandem Valve



Hydraulic System- Regenerative Braking

A-Accumulator
P-Pump
M-Motor
PG-Pressure Gauge
RV-Relief Valve
CV-Check Valve
V1- Two way Two Position Valvues
V3-Three way Diverter Ball Valve
V4- Four way Three Position Tandem Valve



Key Components

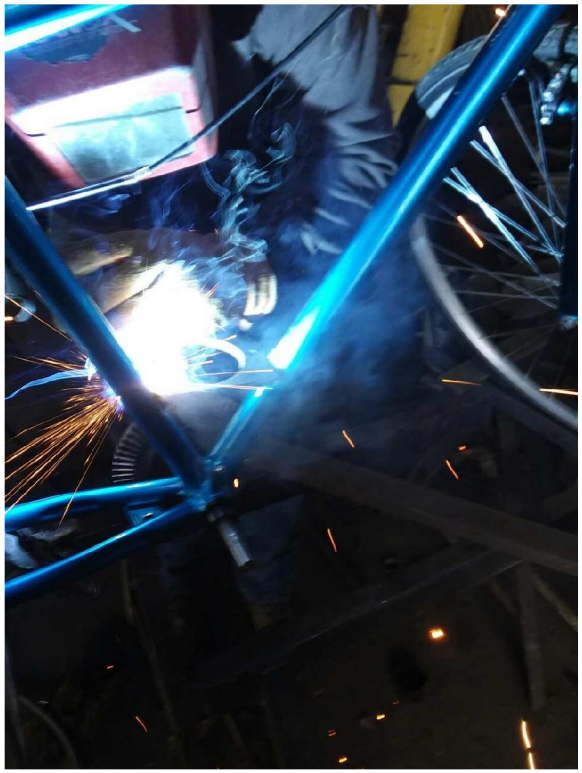
- Accumulator
- Gear Pump
- Gear Motor
- 4-way valve
- 3-way valve
- 2-way valve
- Relief valve
- Check valve

Hydralic Loop BOM

Item	P/N	Discription	QTY
1	26002-RZJ	8.2cc RH Gear Pump	1
2	26703-DAA	10.2cc Gear Motor	1
3	A1QT31003	1 QT Accumulator, 3000 PSI 1-1/16" SAE Fluid Connection	1
4.1	DG17V38C60	4W 3P Directional Control Valve	1
4.2	DGMS31E1OS	Subplate and Bolt Kit	1
5	BV3D-0375SA-1111	3/8" 3000psi 3 way diverter ball value	1
6	BVH-0375S-1111	3/8" 2000psi ball valve	1
7	203101-6-6S	3/8" 37' tee one female swivel and two male	2
8	2071-6-6S	3/8" 37' male to female swivel - 90'	5
9	T3000-6D	ISOBARIC 3100 psi hose	12 ft
10	T203-0609	3/8" male JIC hose ends	5
11	T204-0609	3/8" female JIC hose ends	8
12	T224-0609	3/8 female JIC 90 degree	7
13	C5305-6	3/8" JIC union	3
14	T5000-6D	ISOBARIC 5100 psi hose	1 ft
15	B3HFC	3/4 X 3/8" hex bushing	4
16	6 D5OX-S	Straight tread fitting	3
17	6 F65OX-S	Straight tread swivel 37 d fitting	2
18	6-8 F5OX-S	Straight tread fitting	4
19	6-12 F5OX-S	JIC fitting	1
20	6-6 F6X-S	Straight Swivel	3
21	6-8 C5OX-S	Straight tread	3
22	12-8 F5OG5-S	Reducer-expande	3
23	6-6 F6X-S	Straight Swivel	1
24	10-3/8 F5OG-S	Female adapter	1
25	6 G6X-S	Adapter	1
26	6 HX6-S	Tube fitting	2
27	6 HTX-S	Union	2
28	6-6 FTX-S	Male connector	2
29	19RT59	Spherical Bearing, bore diam 0.625"	3
30	15V660	Involute splined coupling, 9 spline x 2" length	1
31	L1567Y-P	Bevel pinion gear, 3:1 ratio, 0.875" bore, 10 pitch, 20 teeth	1
32	L157Y-G	Bevel gear, 3:1 ratiuo, 1.00" bore, 10 pitch, 60 teeth	1
33	RV-2H	Differential poppet relief valve, cast iron, 3000 psi, 30 gpm, 3/4" NPTF	1
34	-	Reservior	1

Vehicle Construction

Fabrication and Machining



Completed Vehicle

- Boring
- Turning
- MIG Welding
- Stick Welding
- Drilling

VEHICLE TESTING

Testing Issues

- Pump Orientation
  - Had to pedal backwards to drive wheel forward
  - Switched pump to other side
- Broken Gear Teeth
  - Gear slipped and broke teeth (cast iron)
  - Ordered and installed new hardened steel gear

Lessons Learned

- Dan Luken
- Mateo Oquendo-Chandler
- Jon Von Hoene
- Brandon Kohli
- Evan Stathis
- Chelsie King

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THANK YOU!

QUESTIONS?