PURDUE UNIVERSITY

CAPSTONE EXPERIENCE 2014

PARKER HANNIFIN'S CHAINLESS CHALLENGE

Agricultural & Biological ENGINEERING

♦ Team Members:

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♦ Other Department Members:

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♦ Objective

Designed according to Parker Chainless Challenge Specifications, our hydraulic trike, the ***Hydrover***, is a mix of a competition and commercial prototype. Our solution predominately focuses on optimization for the four races. It implements a dual stage hydraulic pump and hydraulic motor as the main means of transmitting power. Additionally, it has regeneration capabilities by using a dog gear clutch mechanism instead of a left brake handle. There is also automatic 8-speed shifting utilizing a free wheel Shimano gear hub. This trike also accommodates heavy loads by balancing on three wheels rather than two.

♦ Marketability

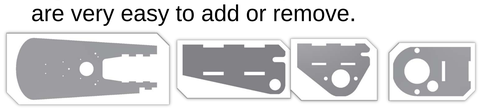
- Features up to 16-speeds with dual chamber pump and 8-speed gear hub.
- Automatic shifting means less user interaction and ease of use.
- Dual Chamber Pump allows greater accumulator charging for exciting boosts.
- User-friendly IQAN electronic display allows manual shifting and chamber selection
- Regenerative braking system allows energy recovery normally lost due to stopping.
- Professional and sleek design.
- Incredibly stable and easy get on and ride.

♦ Safety

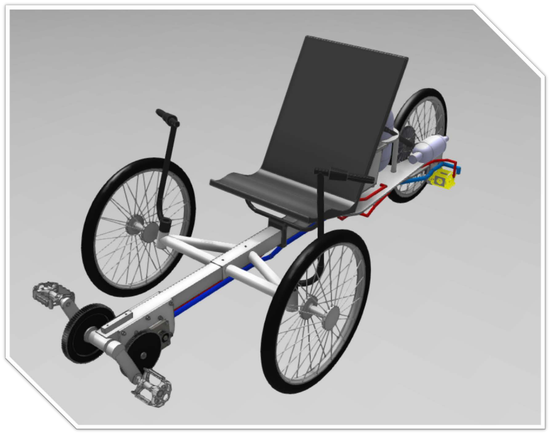
- Safety mode allows discharge of the system.
- Pressure relief valve relieves the system when 200 bar is exceeded
- Gear and electrical enclosures remove pinch-points and shock concerns.

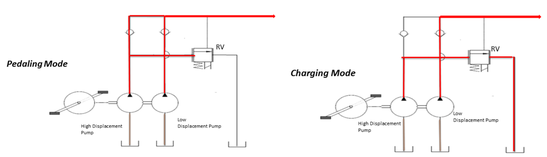
♦ Manufacturability

- Primarily comprised of commercial parts that can easily be scaled to production.
- Cheap waterjet cut aluminum plates.
- Slotted frame welds for simplicity.
- Requires only simple tools to assemble.
- The design is very modular and the additional regeneration mode or expensive electronics are very easy to add or remove.



♦ CAD and Final Product

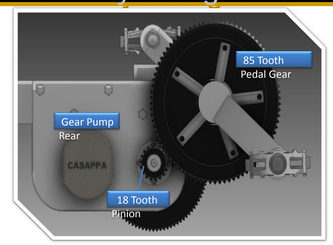


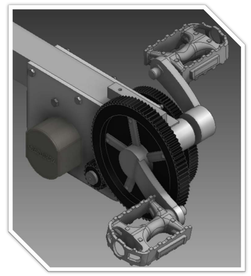


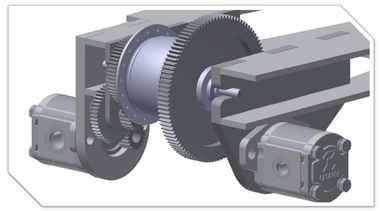
Schematic of Duplex Pump

♦ Hydraulic Component and Gear Design

♦ Gear Assembly Designs







♦ Cost Analysis

Type	Cost
Prototype Model	
Parts	$5,099.67
Labor	$10,800.00
Total	$15,899.67
Production Model	
Parts	$2,849.40
Labor	$4,800.00
Total	$7,649.40

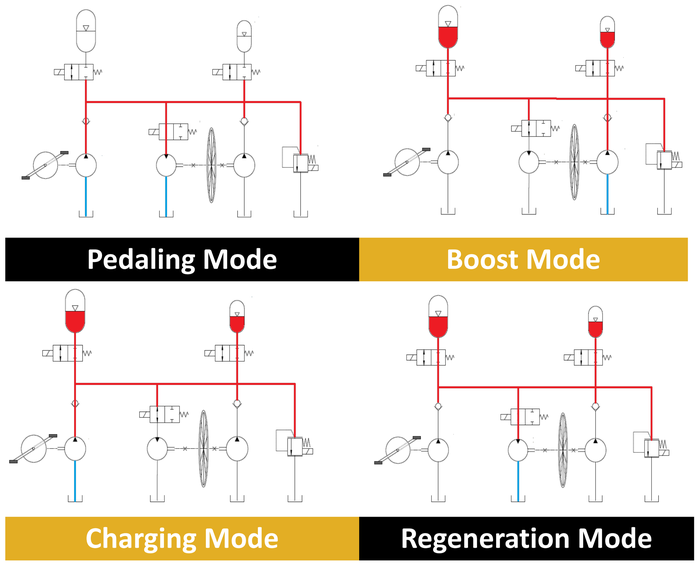
♦ AMEsim Objectives / Optimization

Four Races	Design Requirements
•Sprint Race	•High Speed
•Best Team Relay	•Variable Power Input
•Efficiency Challenge	•High output to input ratio
•Time Trial Race with slalom	•Able to function at a high level for a long time

Component	Specifications
Pump1	Displacement: 2.7 cc/rev
Pump 2	Displacement: 1 cc/rev
Regeneration Pump	Displacement: 1 cc/rev
Motor	Displacement: 2.24 cc/rev
Accumulator 1	Size: 1 Gal
Accumulator 2	Size: 1 Pt
Front Gear Ratio	20
Rear Gear Ratio	4
Pedaling Mode Velocity	10 mph
Boost Mode Velocity	12 mph

Component	Pressure (bar)	Flow rate (L/min)
Pump 1 / Pump 2		
Pedaling Mode	41.78	2.96
Charging Mode	210.08	0.80
Motor		
Pedaling Mode	41.31	3.01
Boost Mode	210.08 – 19.74	1.6 - .81
Accumulator 1 / 2		
Charging Mode	210.08 / 250.08	0.77 / 0.01

♦ Hydraulic Modes



♦ Alternative Design

Other alternative designs were considered to design a cost effective hydraulic bicycle that could be mass produced. The design shown here consists of two cylinders and a unique pedaling system.

Faculty Mentors:
Dr. Vacca, Dr. Stwalley, Dr Engel

Special Thanks to: Anthony Franklin