TEAM LIQUID RECREATION

HUMAN-POWERED HYDRAULIC BICYCLE

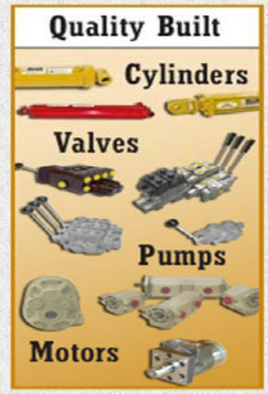
Purdue University College of Engineering
Senior Capstone Design in Agricultural and Biological Engineering
ABE 485 - Spring 2006, Presented April 20th 2006

Project Team Members
Christopher B. Torsell - Agricultural and Biological Engineering, Machine Systems
Philip W. Wetzel - Agricultural and Biological Engineering, Machine Systems
Brandon S. Bechtel - Agricultural and Biological Engineering, Machine Systems
Peter L. Rummel - Agricultural and Biological Engineering, Machine Systems
Aditya Singhal - Mechanical Engineering

Course Coordinator
Dr. Klein E. Ileleji

Project Technical Advisors
Dr. Gary W. Krutz
Dr. John H. Lumkes Jr.

Project Sponsor
Parker Hannifin Corporation

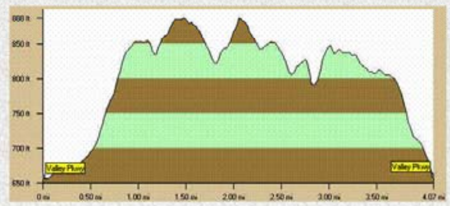


Problem Statement:

In order to encourage student interest in fluid power and engineering problem solving, Parker Hannifin Corporation is sponsoring the "Chainless Challenge Bicycle Competition". This competition will be held July 31-August 1 2006 at the Brecksville Reservation Park (Brecksville, OH). Each participating university must design and build a human-powered vehicle with a fluid-powered final drive system. The human input RPM into this hydraulic system will be much lower than those typically seen in industrial or mobile applications. This is an excellent opportunity to research the capabilities of small hydraulic systems with low input speeds.

Objectives:

- Design a "Chainless" Bicycle for the "Chainless Challenge"
- Bicycle Must Complete 12.21 Mile Endurance Race and 300 ft. Sprint Course
- The Bicycle Must Be Safe
- The Bicycle Must Be Cost Effective, and Appealing to the Customer



Brecksville Course Elevation

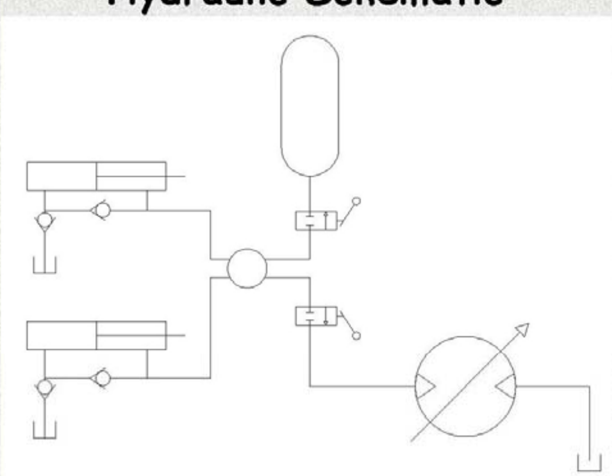
Design Process

- Quality Function Deployment (QFD Process)
- Brainstorming
- Tractive Calculations
- Hydraulic System Design
- Ordering of Hydraulic Components
- Frame Design
- Component and Frame Solid Modeling with PRO/Engineer Wildfire®
- Finite Element Analysis with ANSYS®
- Fabrication and Road Testing

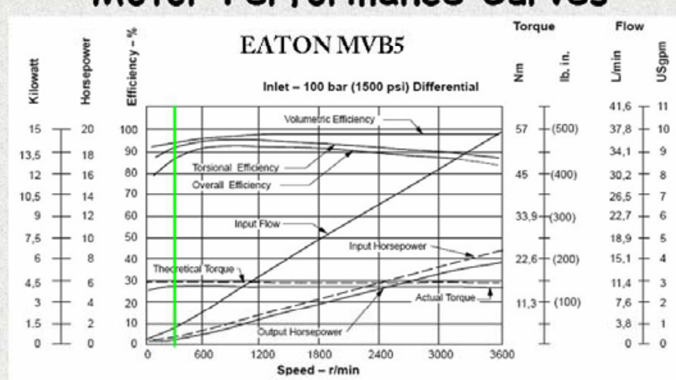
Tractive Calculations

Percent Grade	10	%		Hydraulic Motor RPM	300	RPM
Wheel Slip, s	0.02			Hydraulic Motor Displacement	0.643	ci
Rolling Resistance Constant, ρ	0.03			Volumetric Efficiency	0.94	
Net Tractive Coefficient, μ	0.95			Theoretical Volumetric Flow	0.89	GPM
Gross Tractive Coefficient, μg	0.98			Torque Efficiency	0.93	
Front Tire Rolling Radius	13	in		Theoretical Pressure	781.7	PSI
Rear Tire Rolling Radius	13	in		Horsepower Needed	0.406	HP
Number of Rear Tires	2					
Back Axle Weight	300	lbs		Max System Pressure @ 0.47 HP	905	PSI
Front Axle Weight	100	lbs		Max Motor Torque	80.85	in-lbs
Front Towed Force	3	lbs		Torque Surplus	0.85	in-lbs
Rear Towed Force	9	lbs		Ground Speed	2.27	MPH
Incline Force	39.8	lbs		Pedal Speed at Max Torque	45	RPM
Hydraulic Motor Torque	80	in-lbs				
Gear Ratio Between Motor and Wheel	10			Max Pedal Speed	90	RPM
Applied Rear Wheel Torque	800	in-lbs		Max Ground Speed @ 1/4 Displacment	18.19	MPH
Net Horizontal Force, H	2.97	lbs				
Tractive Efficiency, TE	0.95	%				
Gearbox Torque Efficiency	0.89	%				

Hydraulic Schematic



Motor Performance Curves



Green line denotes motor minimum operating speed of 300 RPM for maximum system torque.

Expected Specs @ max operating pressure of 905 psi

Motor Torque = 80.85 in-lbs Input hp needed = 0.47

PURDUE UNIVERSITY