A. JAMES CLARK SCHOOL OF ENGINEERING

Mechanical Engineering Design Day

Date: November 30, 2010

Flaptuator

Team WingThing: Erin Benson, Ben Brooke, Dave Eng, Chris Giler, Will Guarino, Chris Watson

Objective

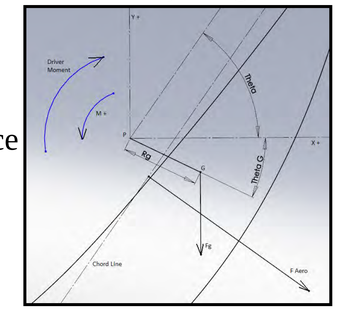
Improve winged vehicle performance by dynamically reducing drag from rear wing.

Survey: $ for .1s Faster Lap

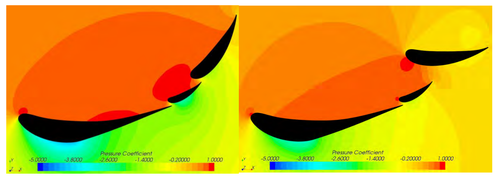
Market
- Formula SAE
- SCCA A-Mod Autocross
- Unlimited Hill Climb

Constraints
- Fit current aero package
- Simple, one-handed actuation
- Flap must return to rest position
- Must detach with steering wheel

Free Body Diagram



Pressure Coefficient Data

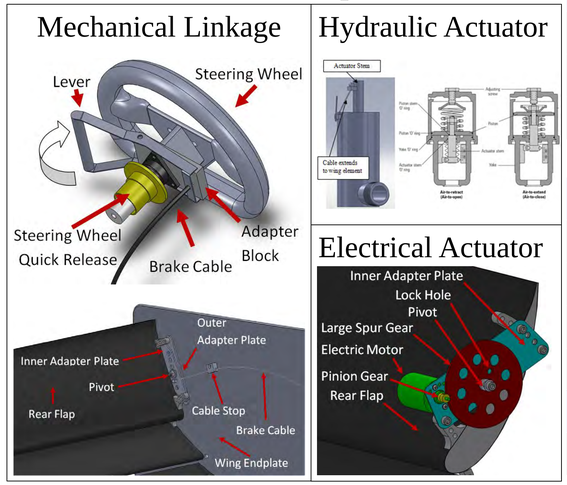


Flap Angle 50˚ Flap Angle 0˚

Customer Requirements
- Lap Time
- Weight
- Aerodynamics
- Controls
- Price
- Maintenance
- Automatic
- Override
- Aesthetics
- Warranty

Concept Generation

Three Concepts



Concept	Advantages	Disadvantages
Mechanical	Easy adjustability	High driver effort
Hydraulic	Fast actuation time	Taps into oiling system
Electrical	*Low driver effort*	*System Complexity*

Decision Characteristics

Characteristic	Weight	Characteristic	Weight
Manufacturing Cost	2.2%	Manufacturability	9.5%
Compactness	4.8%	Driver Effort	19%
Weight	27.6%	Adjustability	16%
Simplicity	16%	Maintenance	4.8%

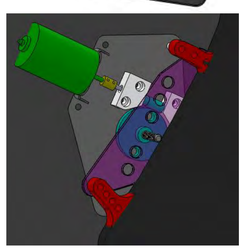
Concept	Mechanical	Hydraulic	Electrical
AHP Weight	0.348	0.186	**0.437**

Design

Operation
1. Driver activates system via cockpit-mounted push-button switch
2. Electric motor (green) drives worm gear assembly (teal) to rotate wing flap (red) to horizontal position

Innovation	•Modular design •Manual or electric operation •Compact gear packaging
Tradeoffs	•Adds weight to vehicle •Complexity of electrical system
Customer Req.	•Fast actuation time •Low driver activation effort

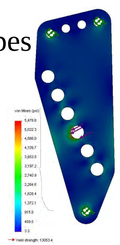
Side View of Rear Wing

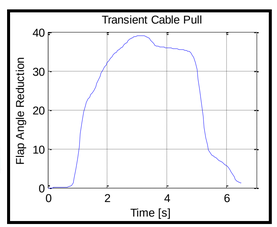


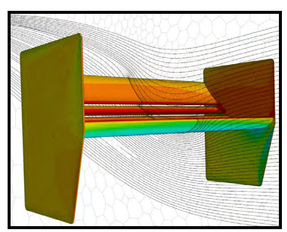
The Worm Drive Assembly

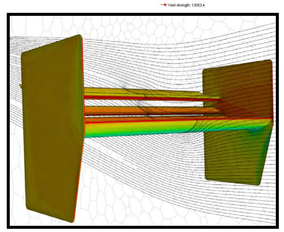
Prototype and Testing

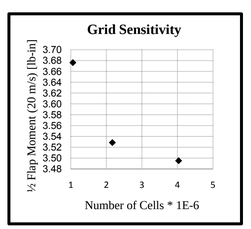
- CFD for pivot point selection
- Cable pull (slow) & electric prototypes
- FEA of stressed components
- Rotary pot to measure flap position
- Coast down for final drag values











Test Results and Future Work

Summary
- Created an effective system for on-demand drag reduction in winged cars, requiring minimal driver effort

Performance Gains	No Flaptuator	Flaptuator
75m Standing Acceleration		
Autocross course		

Future design ideas
- Fully automated actuation system
- Package components inside wing elements

Reflection
- AHP proved extremely useful for concept selection
- Testing was the key to a successful design.

ENME472 - Integrated Product and Process Design and Development