

Bicycle Brake Testing Machine



Introduction



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- ▶ Sponsor: Paul Component Engineering
- ▶ Faculty Advisor: Professor Watkins
 - ❑ Designs and manufactures high end niche market bicycle components
 - ❑ Currently has many different brake levers and caliper assemblies in production
 - ❑ Does not have a means of testing the performance of these products



Need Statement

Currently, Paul Component Engineering lacks the capability of testing their different styles of bicycle brake systems for various performance related data for the sake of comparison.

Goal Statement

- Design, build, and test a machine that will measure brake system performance while accommodating different brake mounting configurations provided by the sponsor



Must Do

Ability to apply constant force to the brake lever	Quantitative
Ability to Measure force applied at brake pads	Qualitative
Repeatable testing	Quantitative
Accommodate various brake mounting configurations	Qualitative

Should Do

Dynamic testing	Qualitative
Machine Footprint	Quantitative
Applied brake force profile modeled after human hand	Qualitative

Would Be Nice

Lightweight	Quantitative
Measure heat and deflection (For Dynamic Test Only)	Qualitative
Aesthetically pleasing	Qualitative

Engineering Specifications

<u>Requirement</u>	<u>Specification</u>	<u>Method/Device</u>	<u>Metric</u>	<u>Target Values</u>
Repeatable Testing	Percent Error	Statistical Analysis	N/A	+/- 5%
Ability to Apply Constant Force to Brake Lever	Percent Error	Load Cell	lbs.	+/- 5%
Machine Footprint	Area	Tape Measure	ft.	<10ft ²
Machine Weight	Weight	Spring Scale	lbs.	<110 lbs



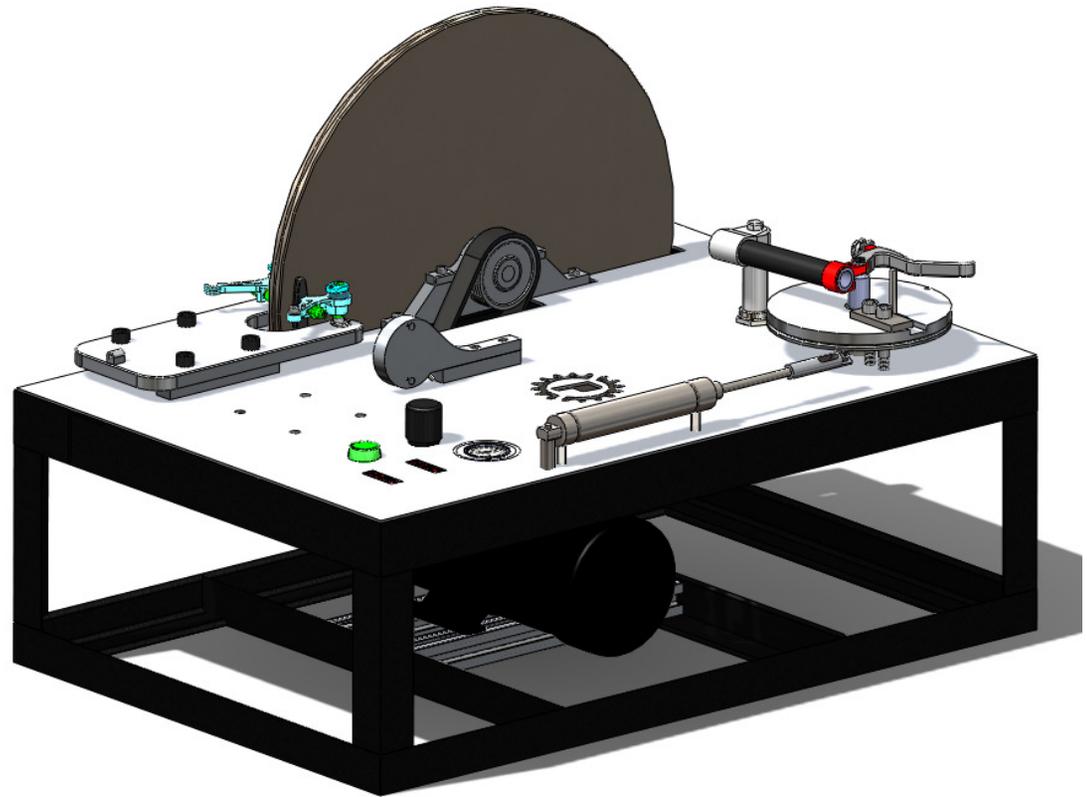
Changes

Original Requirement	Reason for change
Accommodate various brake mounting configurations	Sponsor decided to only test one brake set up instead of various set ups.
Applied brake force profile modeled after human hand	Outside of project scope. Simplified solution of resultant force works for our means.
Measure heat and deflection (For Dynamic Test Only)	Outside of project scope.



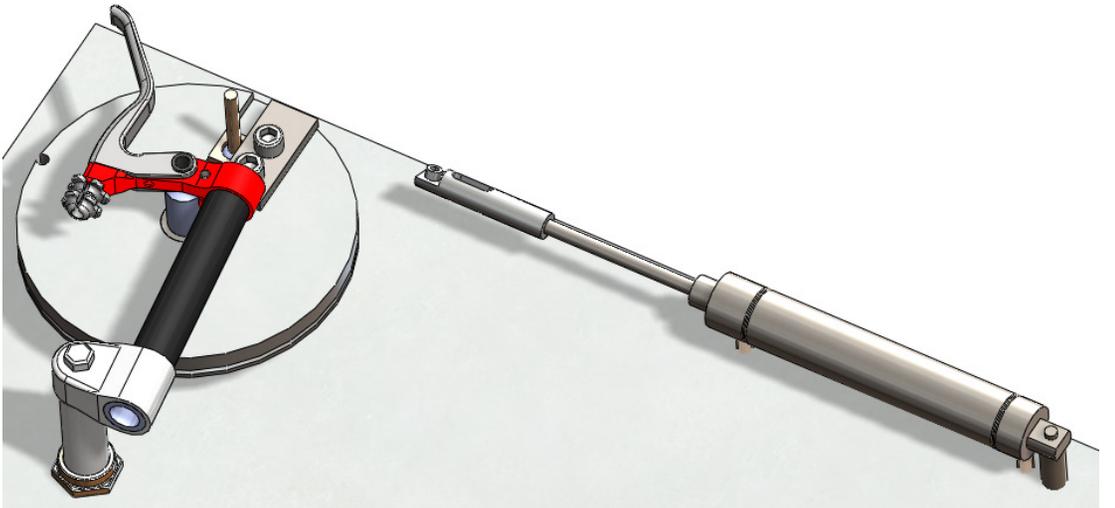
Final Design Solution

- ▶ One machine to accommodate all our needs.



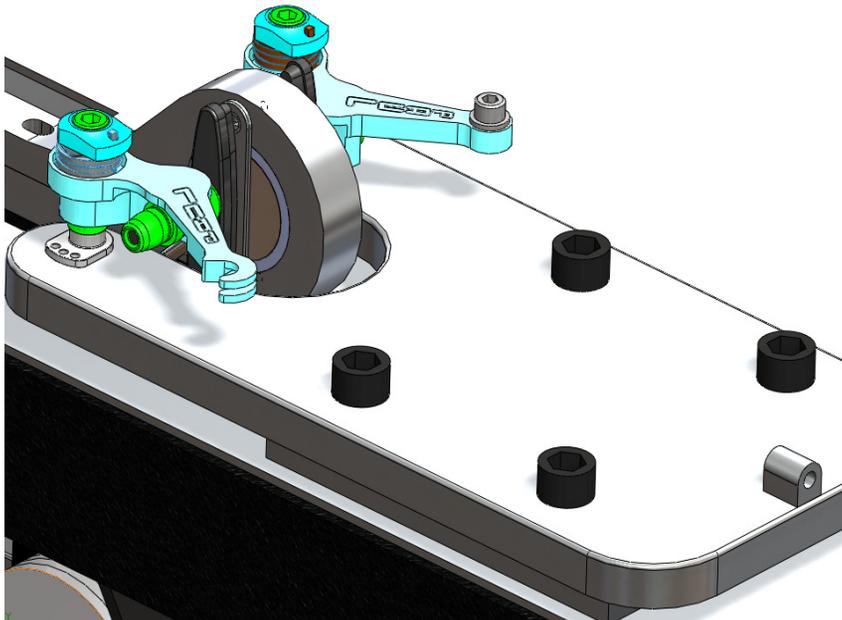
Lever Actuator

- ▶ Uses compressed air to actuate lever with constant force
- ▶ Design allows different brake levers to be mounted consistently
- ▶ Force can be applied at specified point



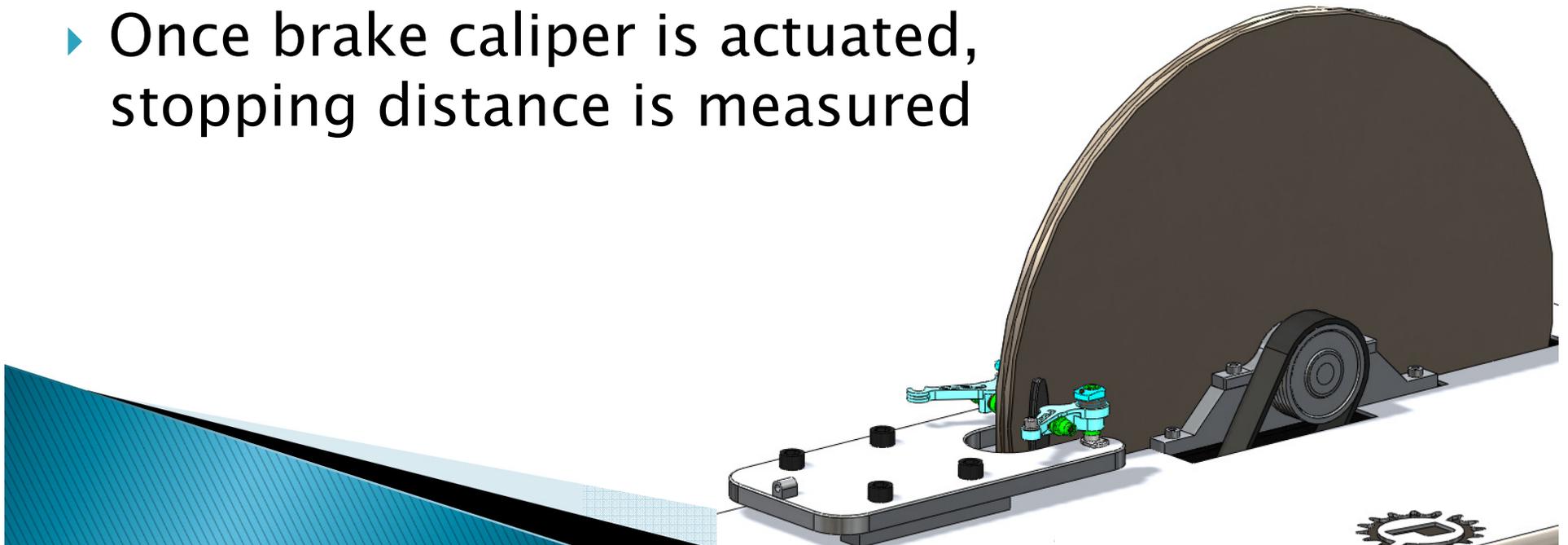
Static Test

- ▶ Measures resulting force at brake pads
- ▶ Utilizes compression load cell
- ▶ Mount designed to restrict forces to load button



Dynamic Test

- ▶ Flywheel provides angular momentum to model rider
- ▶ Flywheel is spun to specified velocity
- ▶ Once brake caliper is actuated, stopping distance is measured



Fabrication

- ▶ **Purchased parts:** all electrical components, controllers, flywheel assembly, all compressed air components, load cell, motor, belt.



- ▶ Fabricated parts: Frame, component mounts.



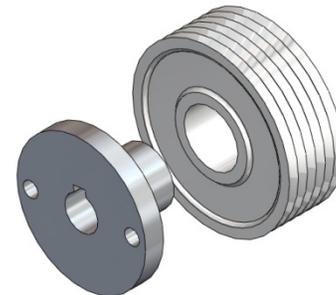
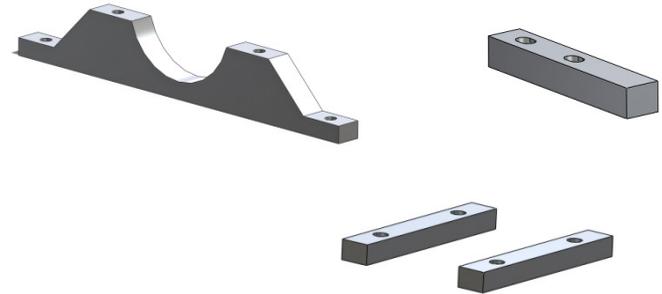
▶ Outside support:

- Paul Price (sponsor): manufactured lever actuator pulley subassembly, caliper mount, air cylinder mount, cable mount,
- Scott Vanni (Tech shop): manufactured motor pulley bushing insert
- Leonard Fallscheer: Pillow block flywheel mounts



Design Changes

- ▶ Spacers utilized rather than cutting the frame
 - Load cell mount
 - Caliper mount
 - Flywheel pillow block mount
- ▶ Modification of pre-existing parts
 - Motor pulley adaptor
 - Lever mount



Testing

<u>Requirement</u>	<u>Target Values</u>	<u>Measured Values</u>	<u>Pass/Fail</u>
Repeatable Testing	+/- 5%		?
Ability to Apply Constant Force to Brake Lever	+/- 5%		?
Machine Footprint	<10ft ²	4.17ft ²	✓
Machine Weight	<110 lbs		?



<u>Qualitative Requirement</u>	<u>Yes</u>	<u>No</u>
Dynamic Testing	✓	
Ability to Measure Force Applied at Brake Pads	✓	
Aesthetically Pleasing	✓	

Budget

	Labor rate	Hours worked	Total \$
Machining	20.60	90	1854.00
Engineering Labor with Benefits and Overhead	64.68	334	21603.12
Purchased Parts	NA	NA	767.98
Raw Material	NA	NA	103.23
Total Cost			24328.33



Additional Content

- ▶ What could be improved:

- Definition of performance
- Speed the flywheel to higher rpm

Linear correlation between force transfer test and dynamic test?

- Suggestions for future:

- Construct with lighter/less materials



Conclusion

- ▶ With a little more debugging we are confident that this project will be successful in all of the required areas

- ▶ We would like to thank... Paul Price, Scott Vanni, Scott Brogden, Steve Eckhart, Leonard Fallscheer, James Holloway, Steven Lemos



Questions?

