Spring Final Presentation

HANScycle: Reciprocating Lever Transmission

Team 8:

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Kyle Roddenberry

Sponsor: Gordon Hansen

Advisor: Keith Larson

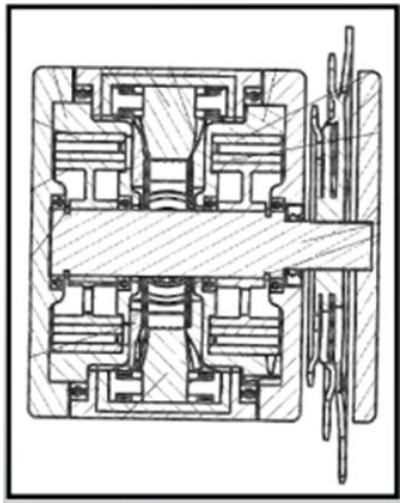
Instructor: Dr. Chiang Shih

Introduction

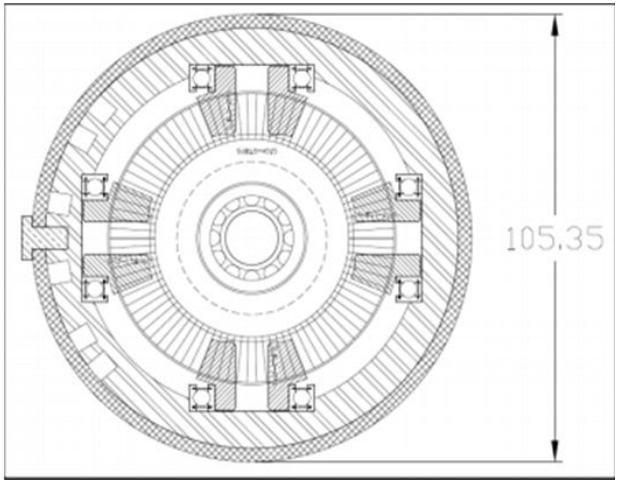
- Project Goal:
  - Build a working HANSCycle prototype using the Reciprocating Lever Transmission
- Constraints:
  - Bicycle must be designed for 26” wheels
  - Bicycle must fit into a 26”x26”x10” storage box
  - Utilize crank arms no longer than 12” with arc no greater than 100º
  - Utilize existing prototype
- Budget: $2,000

Background On The RLT

- Gordon Hansen (Sponsor) patented the RLT (Reciprocating Lever Transmission)
- Uses reciprocating motion to pedal
- Crank arms dependent on each other
- Produces power in both downward and upward strokes

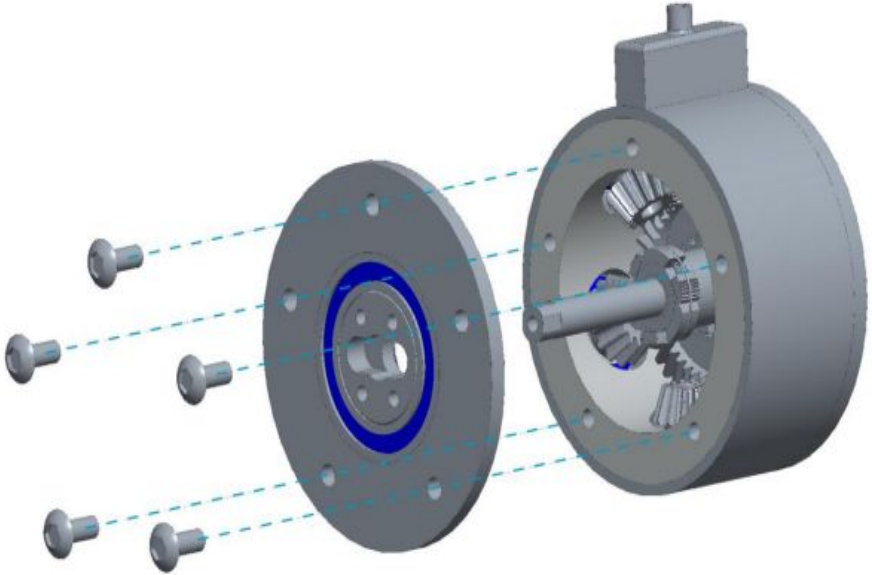


Original RLT Design

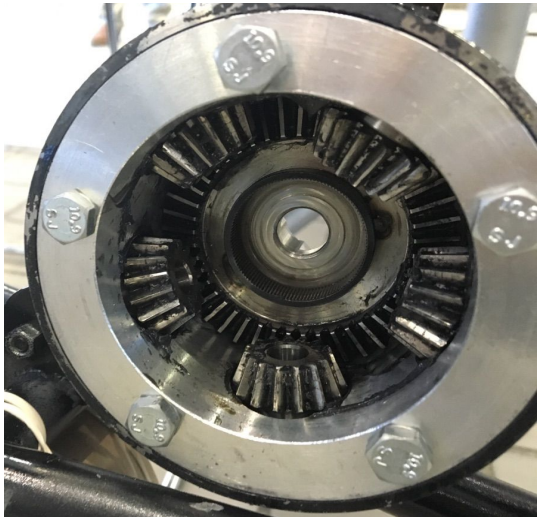


Simplified RLT Design

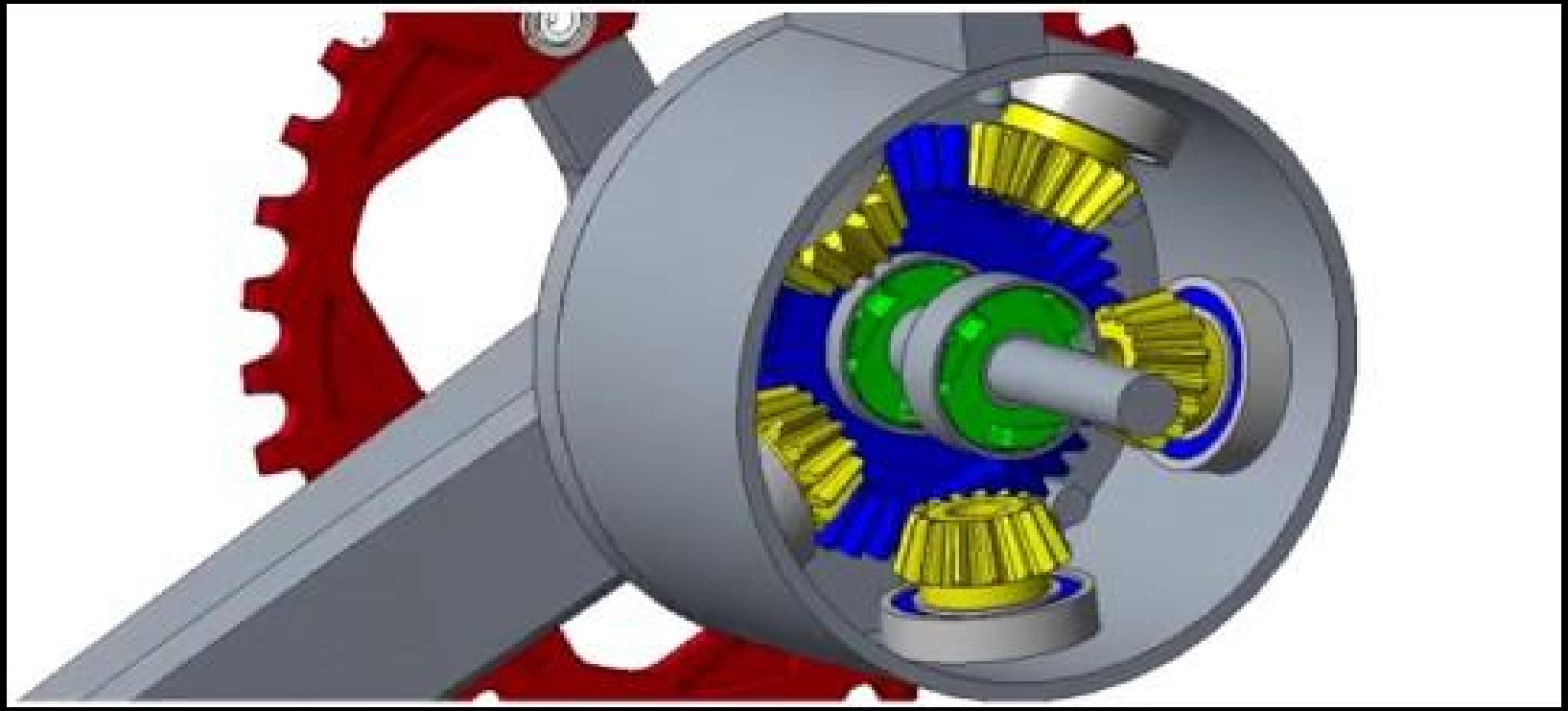
Reciprocating Lever Transmission

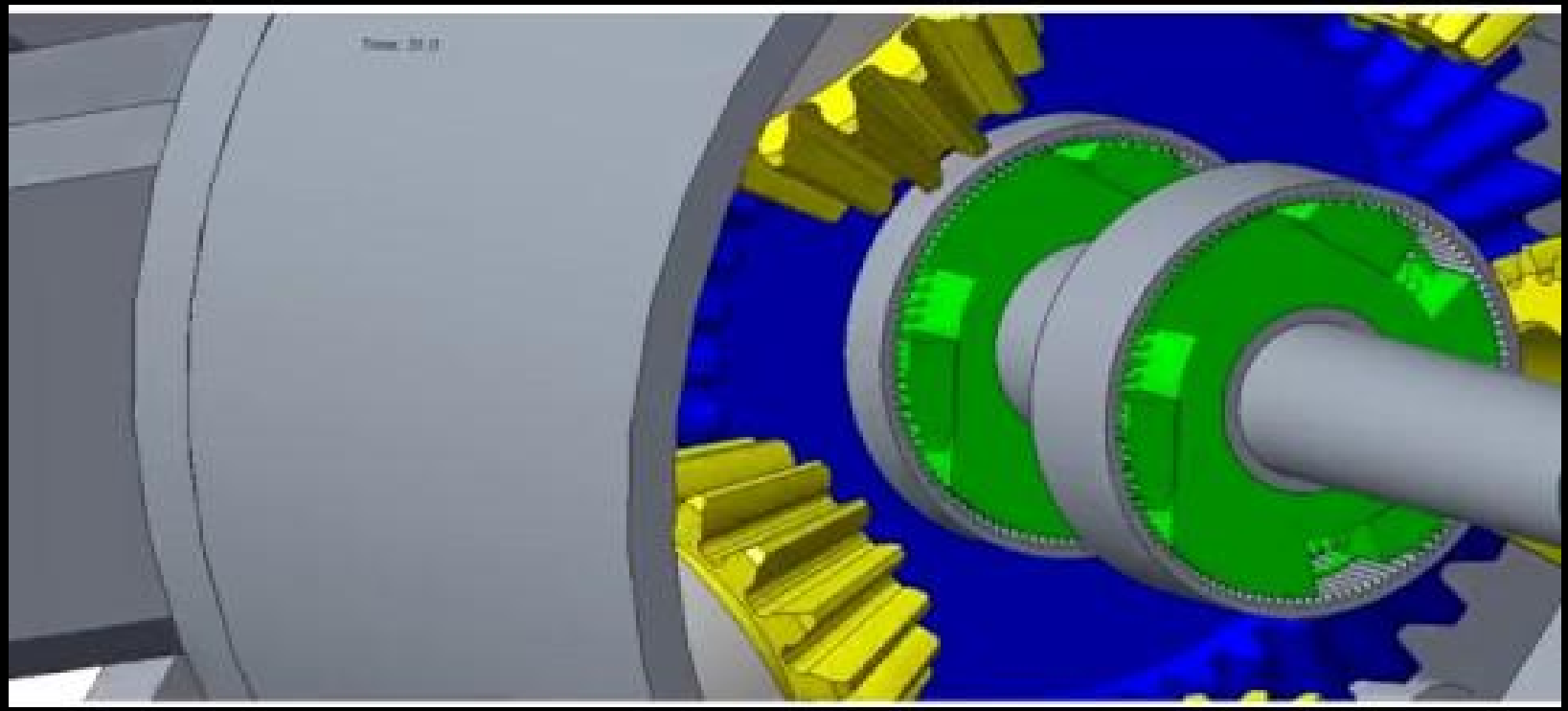


Current RLT Design (CAD)



Current RLT Design (Prototype)

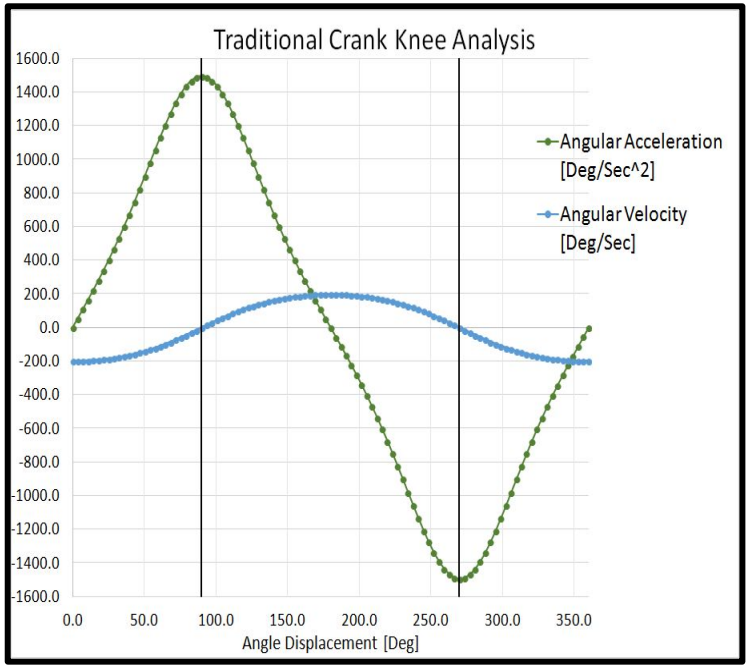




Motivation

- Why this design?
- Dead spots at 90º and 270º on a traditional bike
  - Trouble riding uphill
- Natural pedal motion
- Minimize joint damage
- Everyday commuting
- Produces more power and torque

Knee Joint Damage



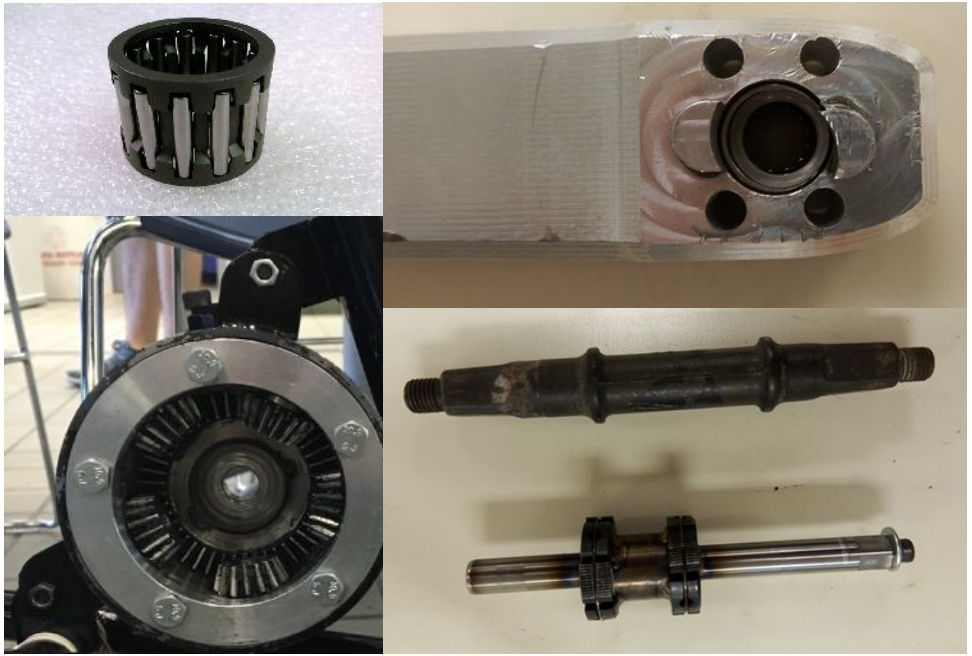
- Dead spots cause internal forces on knee joints which can lead to:
  - Permanent knee joint damage
  - Inflammation and joint pain
- The knee is where the most damage is caused in cycling.

Team 8 Annual Goals

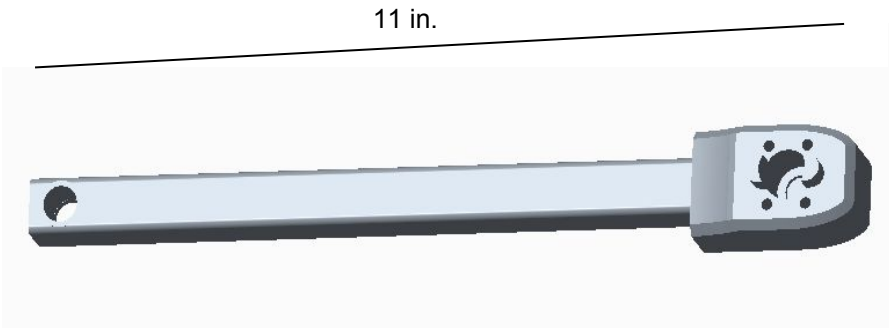
- Reverse engineer prototype from last year
- Test prototype for comparison data
  - Various crank arm lengths
  - Torque, Power, Cadence, Speed
  - Compare values with traditional bicycle
- Redesign components
- Focus on ergonomics
  - Handlebars
  - Seating

Failure Analysis

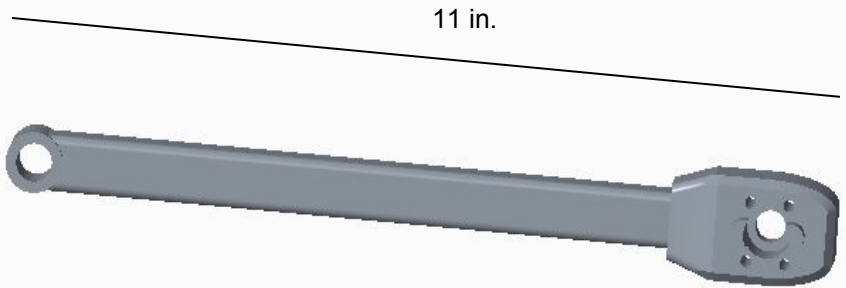
- Crank arms
  - Keys sheared
  - Bolts sheared
- Shaft misaligned
  - Needle bearing broke
  - Ratchet and pawl wear
- RLT brackets flexed under load
- Output shaft sheared



Crank Arm Designs

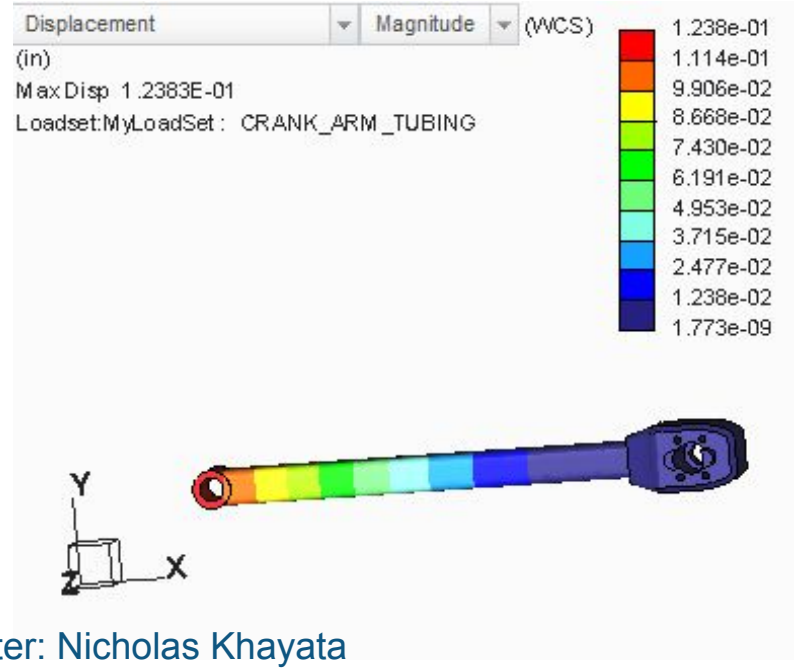


Crank Arm Design Revision 1



Crank Arm Design Revision 2

Crank Arm Analysis



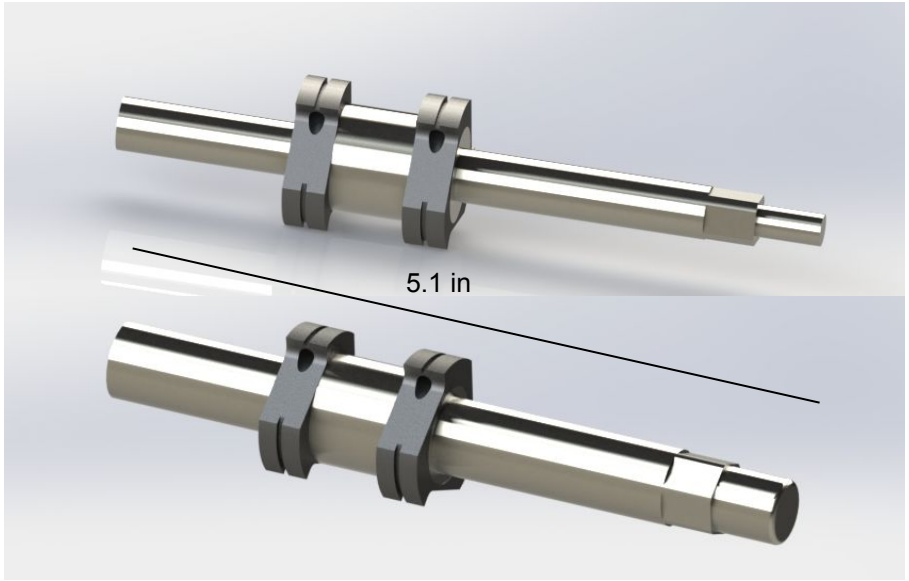
- Materials: 1018 and 4130 Steel
- Load: 250 lbf at the pedal location
- Deflection: 0.1238 in or 3.1 mm
- Weight: roughly 1.25 lbs

Finished Crank Arms

11 in.

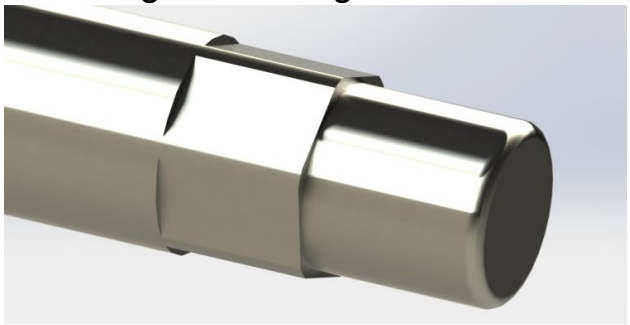
Presenter: Nicholas Khayata

New Output Shaft



Old output shaft (above) vs new output shaft (below)

- Significant Changes:
  - Shaft is 40% larger in diameter
  - Shaft to chainring adapter mating point is 50% larger.
  - Material: 4340 300M alloy steel
  - Hexagonal mating surface



Hexagonal section

Finished Output Shaft

Test Data

Preliminary Data

	RLT	Traditional Bike
Average Power	22 W	33 W
Average Speed	6.0 mph	6.0 mph
Average Cadence	18 rpm	32 rpm

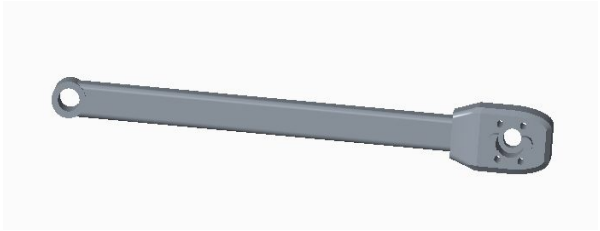
-Further testing and comparison will be done next week

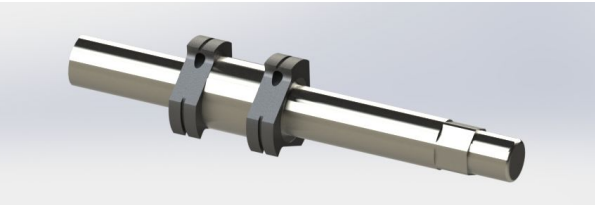
Updated Budget (Spring)

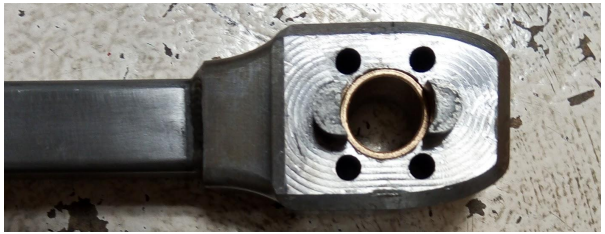
#	Part	Vendor	Cost	Quantity	Subtotal
1	½ in. Hexagon Broach	McMaster.com	$241.89	1	$241.89
2	M12-1.75 Class 10 flange locknut	McMaster.com	$10.65	1	$10.65
3	⅞ in. diameter 3 ft. 8620 alloy steel rod	McMaster.com	$22.68	1	$22.68
4	14mm ID 18mm OD Oil-embedded sleeve bushings	McMaster.com	$1.75	4	$7.00
5	14mm ID 16mm OD Dry-running sleeve bearing with steel shell	McMaster.com	$4.23	2	$8.46
6	New OEM Components (handlebars, kickstand, seat, lights)	University Cycles	-	6	$179.94
				Total	**$650.56**
				Remaining Budget	**$714.72**

Updated Final Progress

- Design and implement new crank arms
  - Steel design
  - Proper hole and key alignment
- Design and implement the new output shaft
  - Machined larger 16mm holes
  - Press fit oil-embedded bushings with 14mm ID
  - Used hexagon broach in order to maximize mating surface
  - Installed larger output shaft







Updated Final Progress

- Optimize ergonomics
  - New cruiser/urban style handlebars
  - Adjustable handlebar stem
  - New larger cruiser/urban style seat
- Accessorize
  - Legal lights
  - Kickstand
  - Horn

Future Suggestions

- Future Suggestions
  - Custom ratchet pawl design
  - Sprag clutch
  - Possible storage/cargo equipment
  - Increase gear ratio to improve performance

Acknowledgments

- We would like to say a special thanks to our…
  - Sponsor: Gordon Hansen
  - Advisor: Keith Larson
  - Instructor: Dr. Chiang Shih

References

- [1] "Hexagon Broaches | Hex Dimensions Across Corners." DuMONT. Web. 23 Mar. 2017. <http://dumont.com/our-broaches/hexagon-broaches/>
- [2] G. H. Hansen, "Reciprocating Lever Transmission.," Patent US20130205928 A1, 2013.
- [3] "McMaster-Carr." McMaster-Carr. Web. <https://www.mcmaster.com/>
- [4] SUB1.5-4515." KHK-USA. N.p., n.d. Web. 20 Mar. 2017. <https://www.khkgears.us/catalog/product/SUB1.5-4515>.
- [5] Web. 26 Mar. 2017. <http://www.bicycling.com/sites/bicycling.com/files/posture-main.jpg>.

Questions?