Virtual Design Review 5

Team 09: Sprag Clutch Addition to Reciprocating Lever Transmission

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Project Goals

- Addition of sprag clutches to RLT
- Increase efficiency by minimum of 10%
  - Comparing power output of regular bicycle pedals with the RLT
  - Longer crank arms

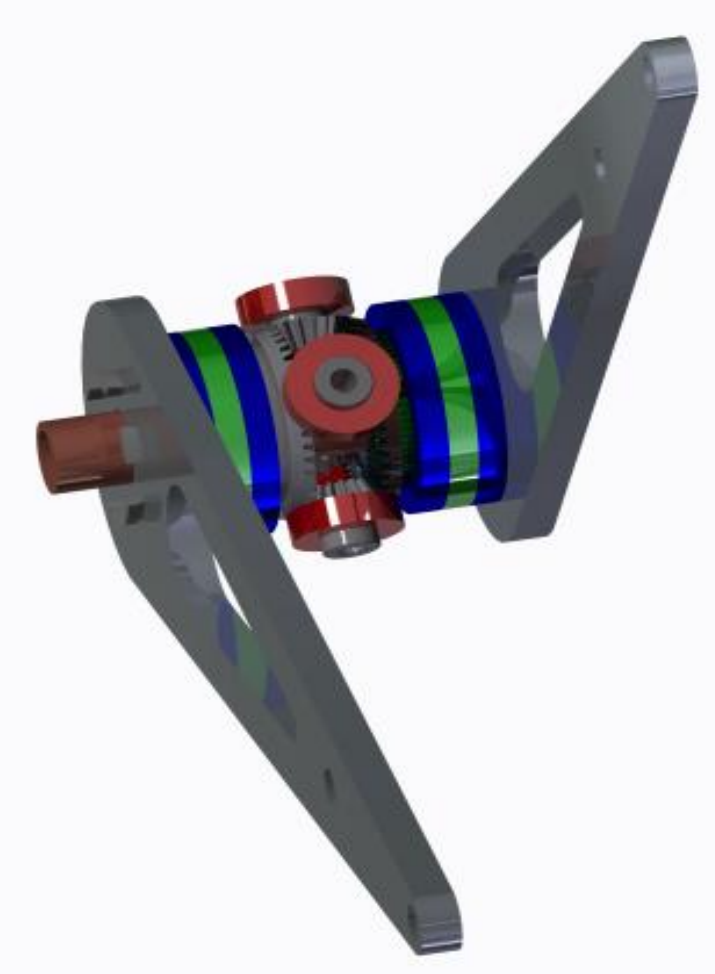


Figure 1. RLT CAD Model.

Sprag Clutch and Bevel Hub

Sprag Clutch

- GMN FE433M
- Outer Diameter: 33mm
- Inner Diameter: 25mm
- 2 sprag clutches per side
- 252 Nm torque capacity per side

Figure 2. FE400M Series Sprag Clutch.

Bevel Housing

- SUS303 stainless steel bevel gear
- Outer diameter: 63.67mm
- Inner diameter: 33mm
- Houses sprag clutches

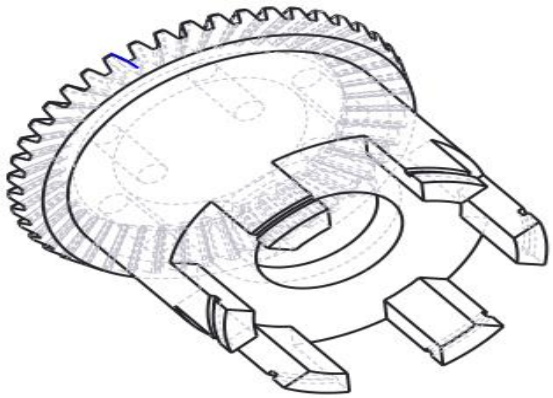


Figure 3. Bevel housing.

Chain Wheel to Drive Shaft

- Drive shaft length: 161mm
- Outer diameter: 25mm
- Inner diameter: 10mm
- Square cut: 17mmx17mm
- Thread diameter: 16mm
- Fastened with a nut

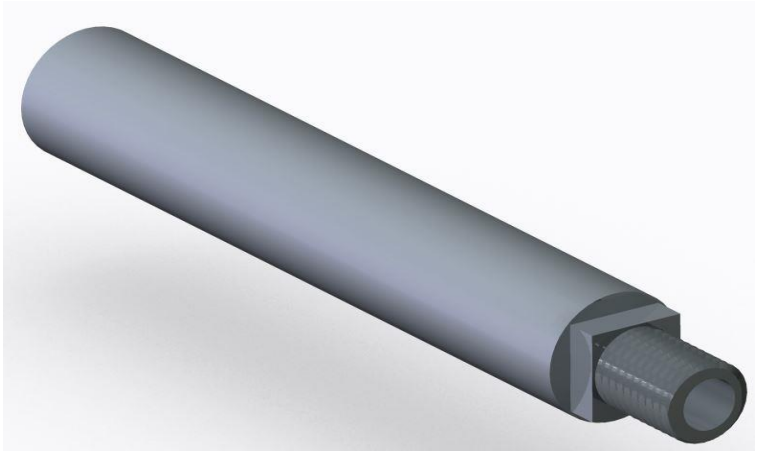


Figure 4. Drive Shaft

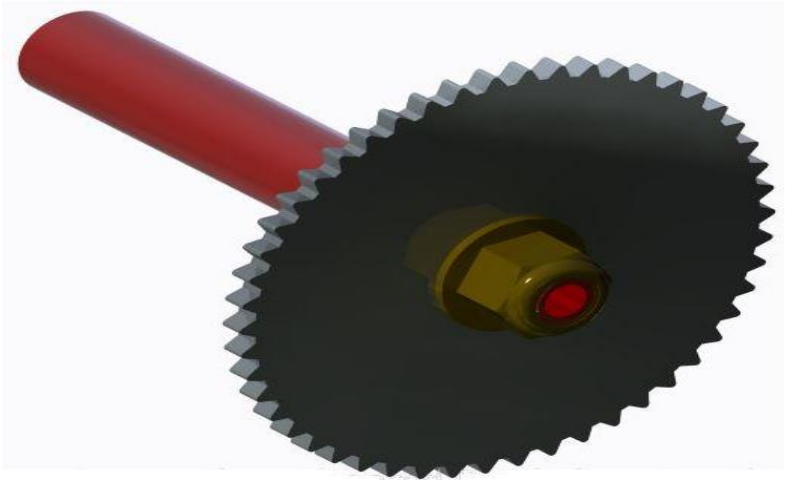


Figure 5. Chain wheel attached to drive shaft.

Traditional Bicycle Power Tests

- 2 traditional-style bicycles

Gear ratios: 2.35:1
2.79:1

Percent Change in Power relative to different gear ratios

$$\Delta P = \left(\frac{g_r}{g} - 1\right) * 100\% \quad [1]$$

g_r: reference gear ratio
g: compared gear ratio

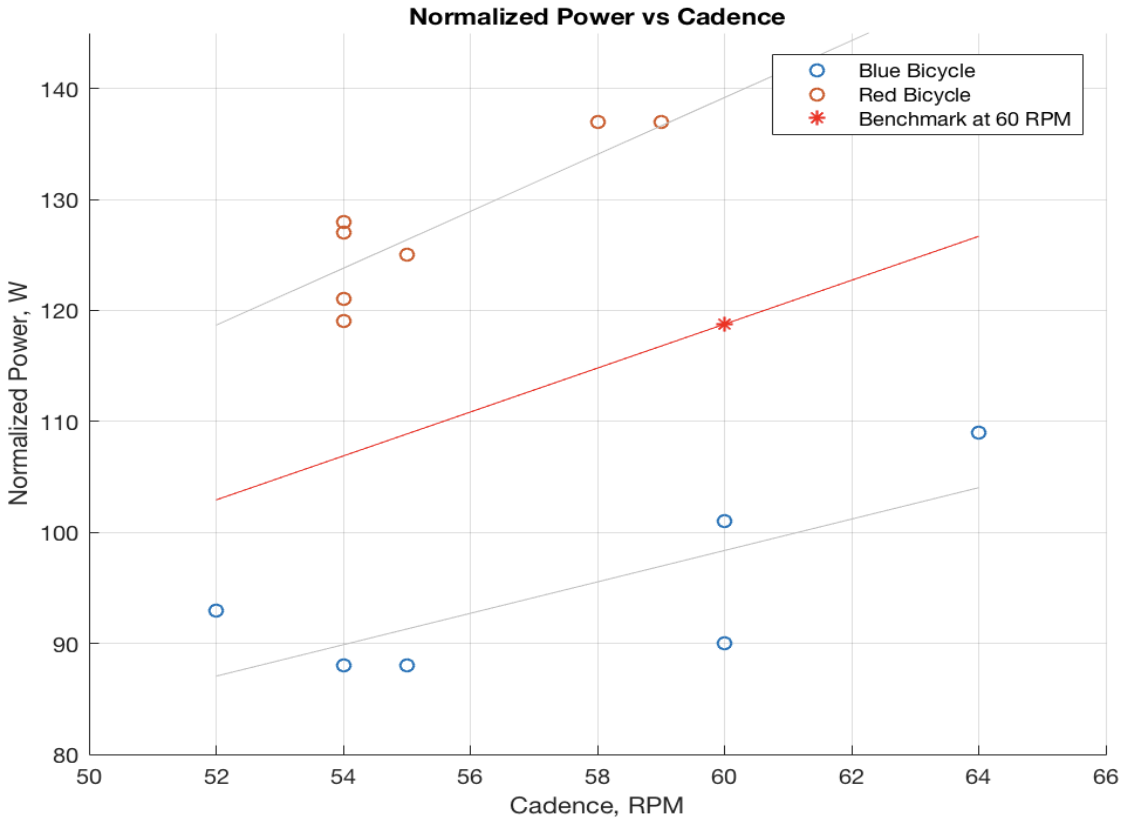


Figure 6. Power Generated vs Cadence.

Traditional Bicycle Power Tests

Goal: Minimum of 10% increase in power generated measured in Watts (W).

Cadence (RPM)	Average Measured Normalized Power (W)	Target Normalized Power (W)	Testing Conditions
60	118.8	130.7	Warm Up: 15 s Interval: 60 s Rest: 60 s

Traditional Bicycle Heart Rate Tests

Goal: Minimum of 10% reduction in rider's heart rate measured in beats per minute (BPM).

Cadence (RPM)	Measured Heart Rate (BPM)	Target Heart Rate (BPM)	Testing Conditions
60	67	60	Warm Up: 15 s Interval: 60 s Rest: 60 s
90	112	101	Warm Up: 15 s Interval: 30 s Rest: 60 s

Future Work

- Manufacturing of all the parts in the COE Machine Shop
  - Possible final design alterations
- Assembly of the RLT
- Confer with Team 20 on chain routing and mounting to their vehicle
- Testing of the RLT to compare to a conventional bicycle

Assembly

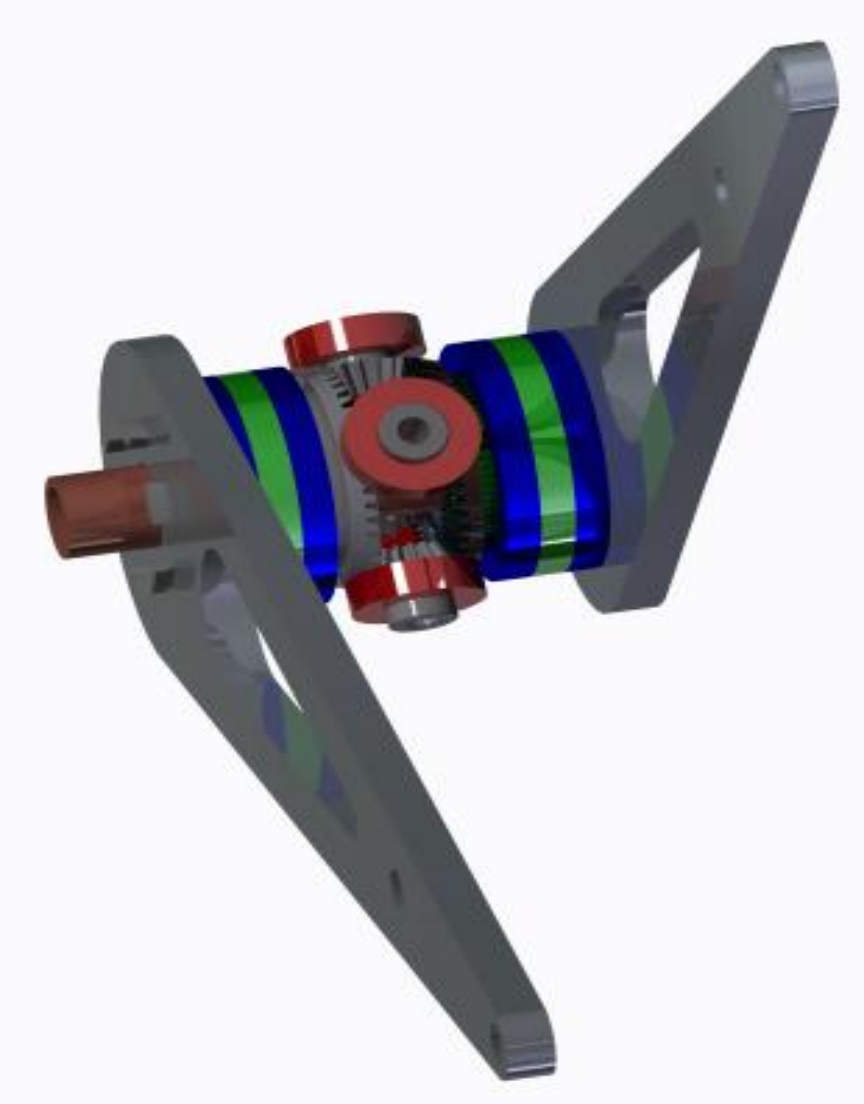
References

- Hull, M.L., Jorge, M. (1985). “A method for biomechanical analysis of bicycle pedaling.” Journal of biomechanics **18**(9): 631-644.
- Kautz, S. A., M. E. Feltner, et al. (1991). "The Pedaling Technique of Elite Endurance Cyclists: Changes with Increasing Workload at Constant Cadence." International Journal of Sport Biomechanics **7**(1): 29-53.

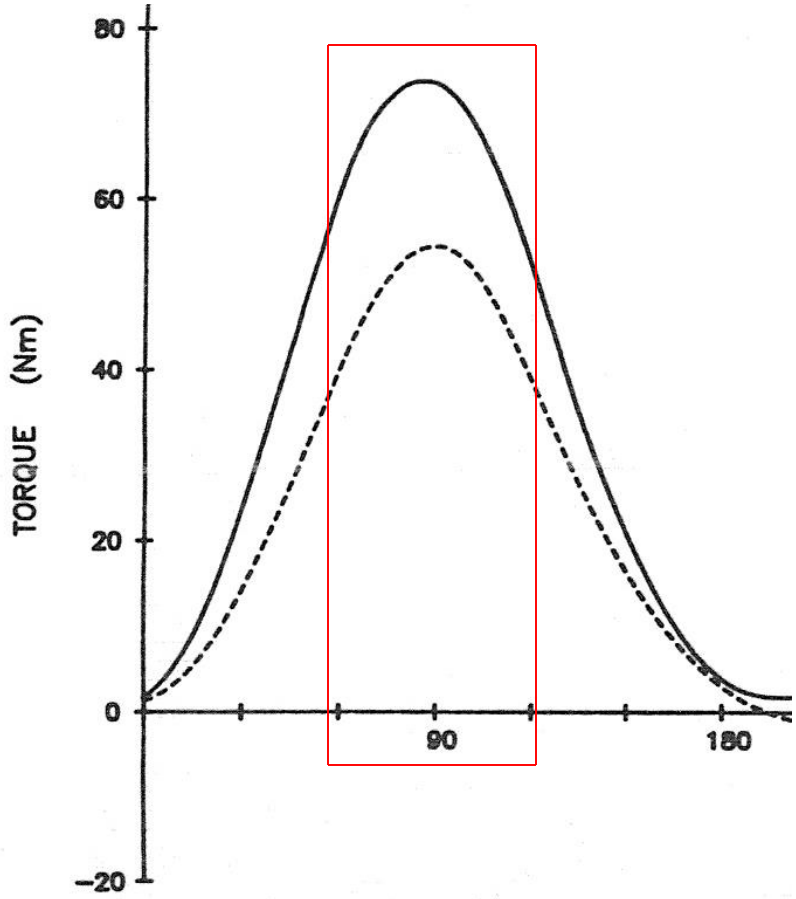
Thank you!

Any Questions?

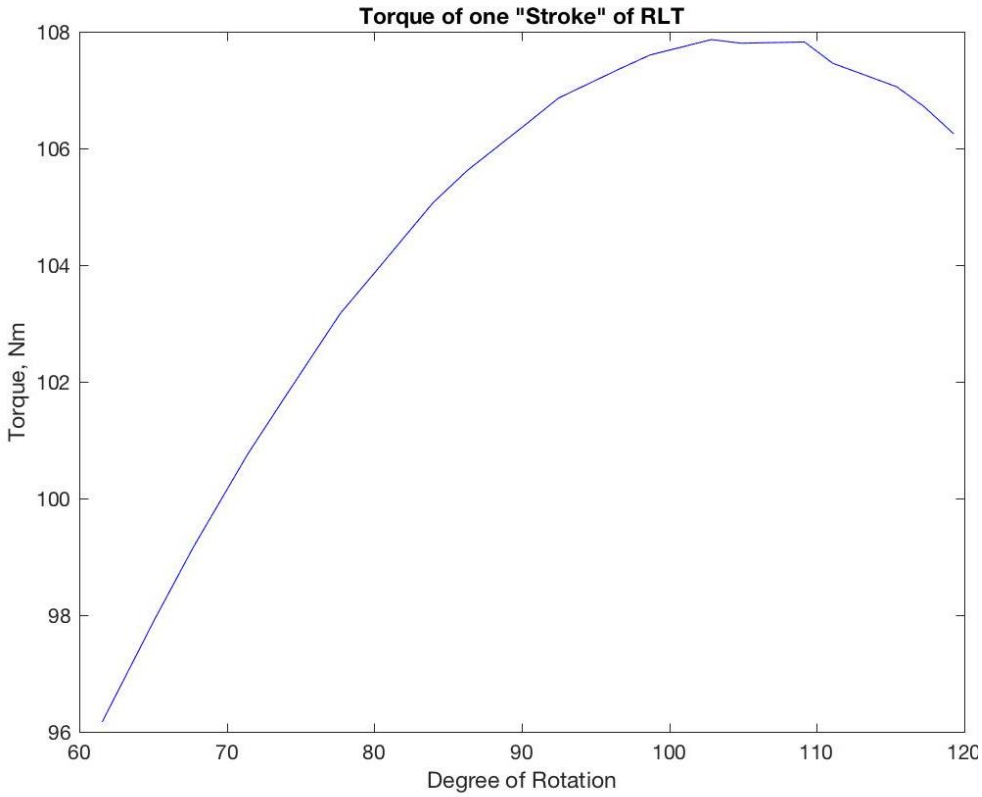
Assembled View



Torque Comparison



Traditional Bicycle Torque [2].



RLT Torque [1],[2].