Midterm Presentation

HANScycle: Reciprocating Lever Transmission

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Introduction

- Project Goal:
  - Use last year's progress to 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 up to 12" with an arc no greater than 100º
  - Utilize existing prototype
- Budget: $2,000

Presenter: Ali Pustelniac

Main Objectives

- Remodel existing Reciprocating Lever Transmission (RLT) prototype
- Test prototype for various comparison data:
  - Various crank arm lengths
  - Compare with traditional bicycle
- Be able to fit a disassembled bicycle into a 26”x26”x10” storage box

Last Year's Project Progress


Figure 1: Last Year's HANScycle Team

Presenter: Ali Pustelniac

Testing

Requirements:
- Proof of torque increase
- Proof of decreased joint wear
- Comparable cadence rate
- Select optimal BTC location

Results:
- Power and torque generation is increased
- Cadence rate is faster
- RLT and frame need refinement

Conclusion

Success as proof of concept

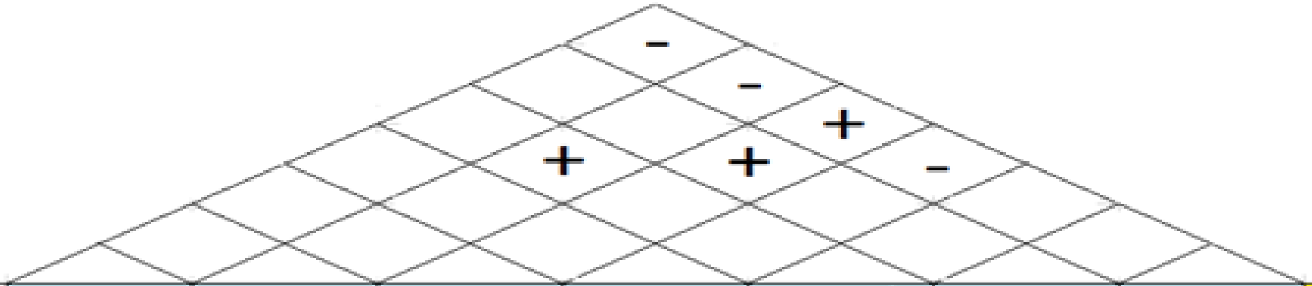
Design needs to be refined:
- Better RLT placement
- Improve axle design

Component Research
- Bearing selection
- Ratchet and pawl alternative

Sponsor’s Project Needs

Sponsor Needs	Requirements	Approach
Working Reciprocating Lever Transmission	Improve Shaft Strength	Test Various Materials and Material Processes
Higher Torque Output / New Crank Design	Determine Crank Arm Length	Test Torque Output at Various Crank Arm Lengths
Testing Data	Torque, Power, Cadence, Speed, Time	Test Prototype and Compare with Traditional Bicycle

House of Quality



	Wheel Size	Weight	RLT	Component Choice	Material Choice	Torque Output	Frame Design	Total	Rank
Ergonomics	4	6	9	10	2		10	41	2
Cost	1	1	8	8	9		2	29	4
Performance	6	7	8	6	7	10	4	48	1
Size	9	8	2	1	1	5	8	34	3
Wheel Size	10	2				4	5	21	5
Reliability			6	3	9			18	6
Total	30	24	33	28	28	19	29		
Rank	2	6	1	4	5	7	3		

Figure 2: House of Quality (HOQ)

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Original RLT vs Simplified RLT

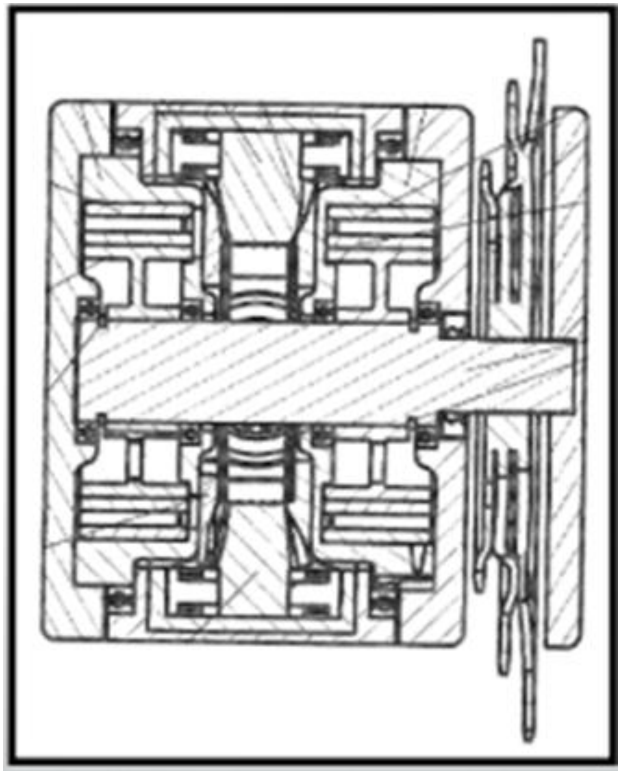

Figure 3: Patented RLT Design

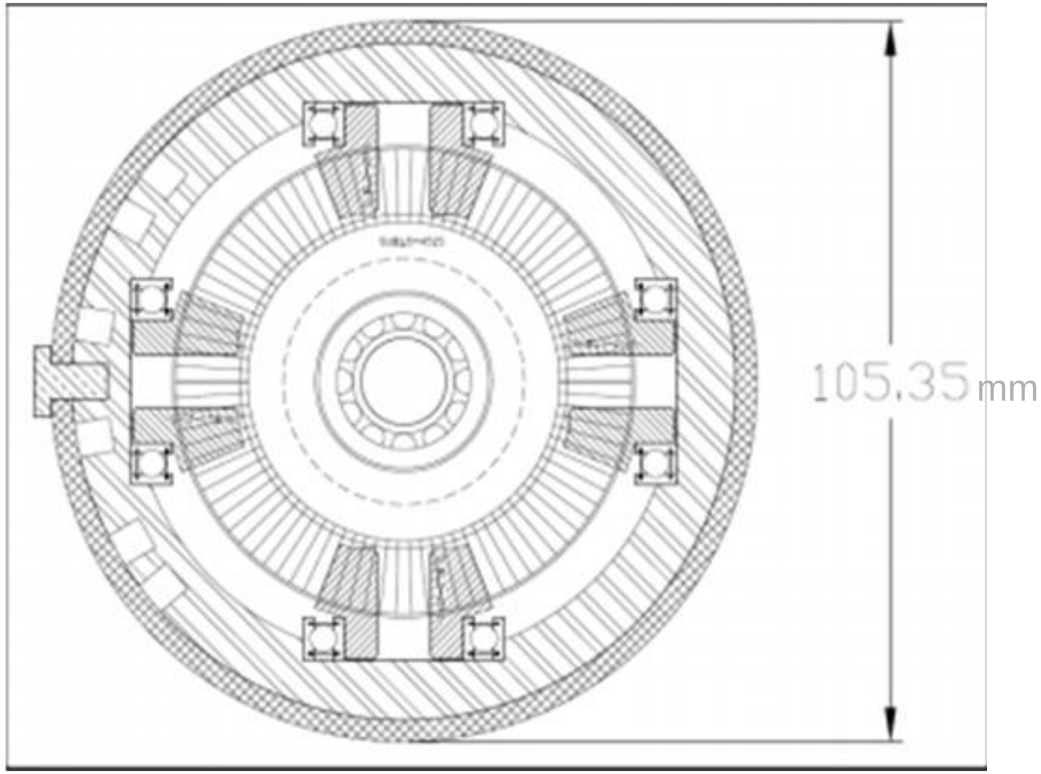

Figure 4: Simplified RLT Redesign

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Last Year’s RLT Design

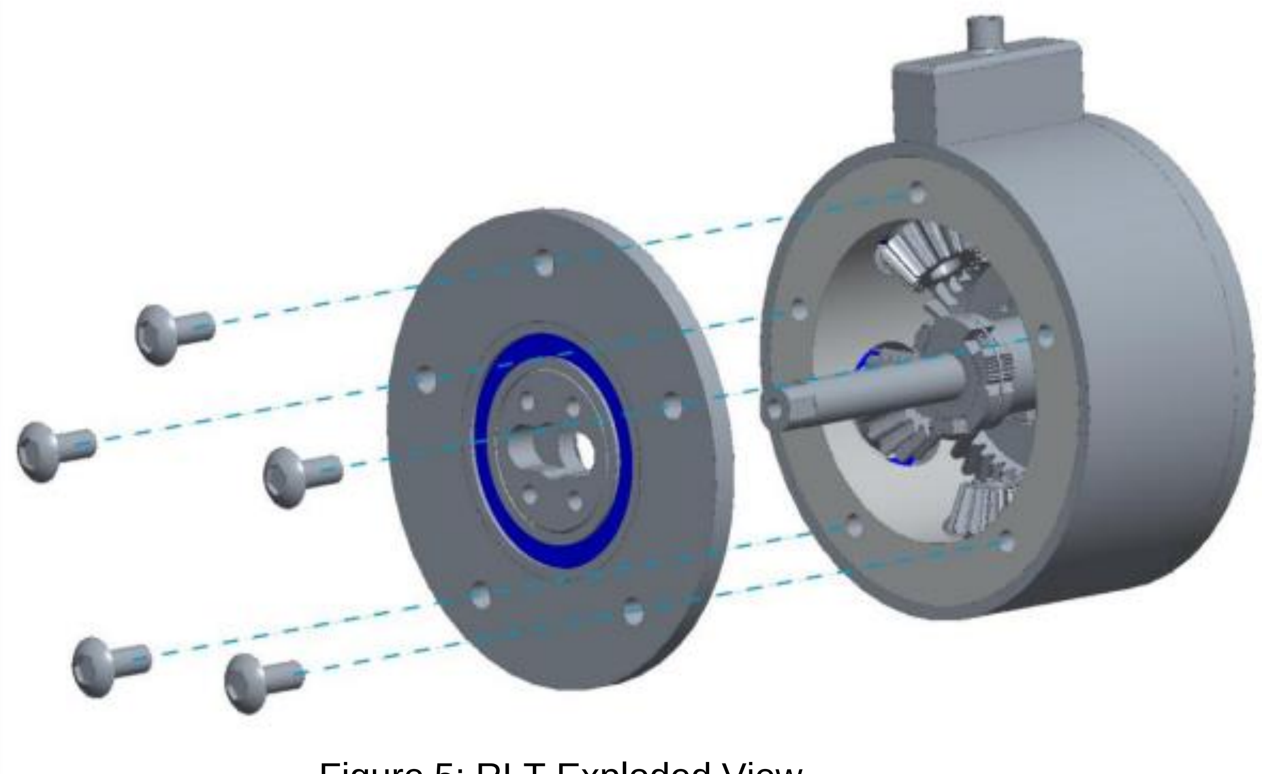

Figure 5: RLT Exploded View

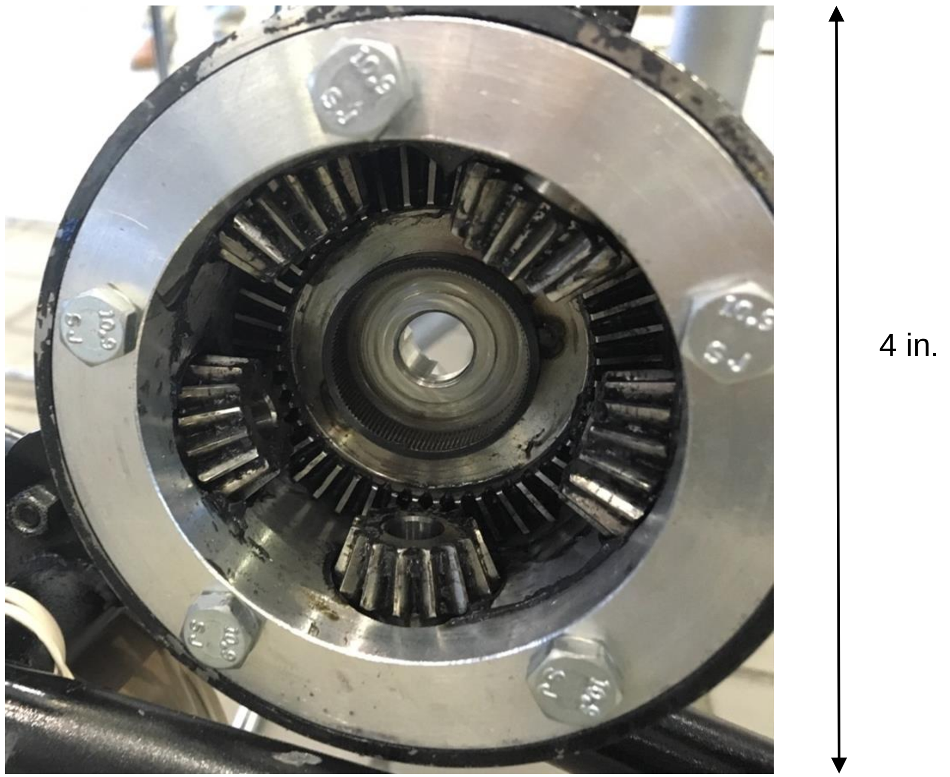

Figure 6: Current RLT Internal Components

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Reverse Engineering

- Bike frame and seating position more fit for mountain bike than a cruiser.
- RLT brackets flex under load.
- Crank arm fastener holes do not line up.
- Crank arm keys beginning to shear.
- Shaft inside RLT made of multiple materials.

Failure Analysis - RLT

4 in

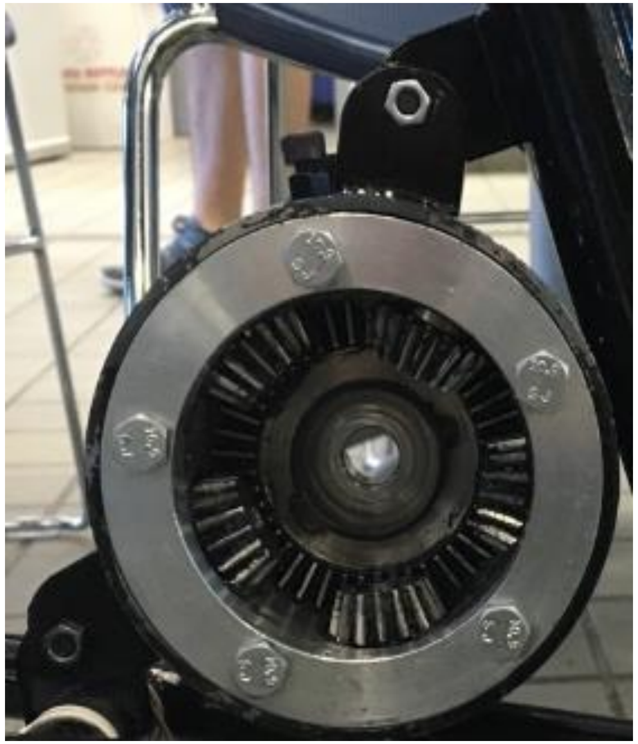

Figure 7: Brackets in single shear

RLT brackets had only one point of contact and underwent a bending moment.

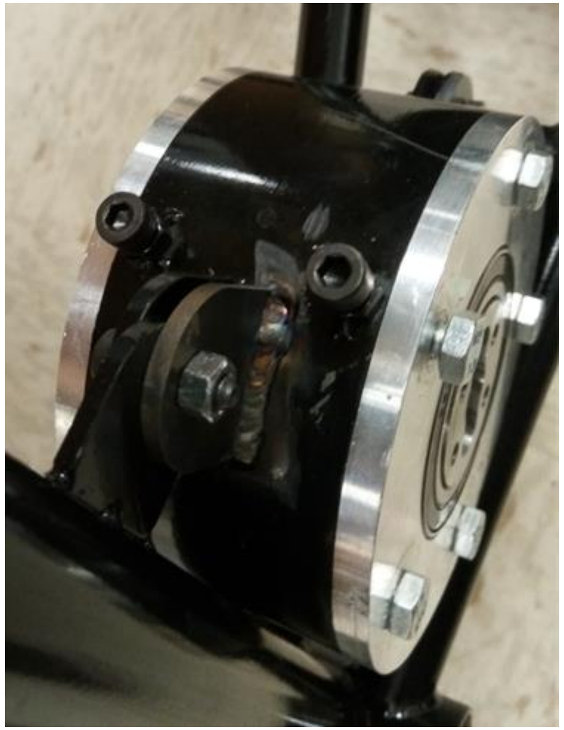

Figure 8: Brackets in double shear

New brackets were designed, cut out by waterjet, and welded onto the RLT.

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Failure Analysis - Crank Arms

Crank arm keys began to shear.

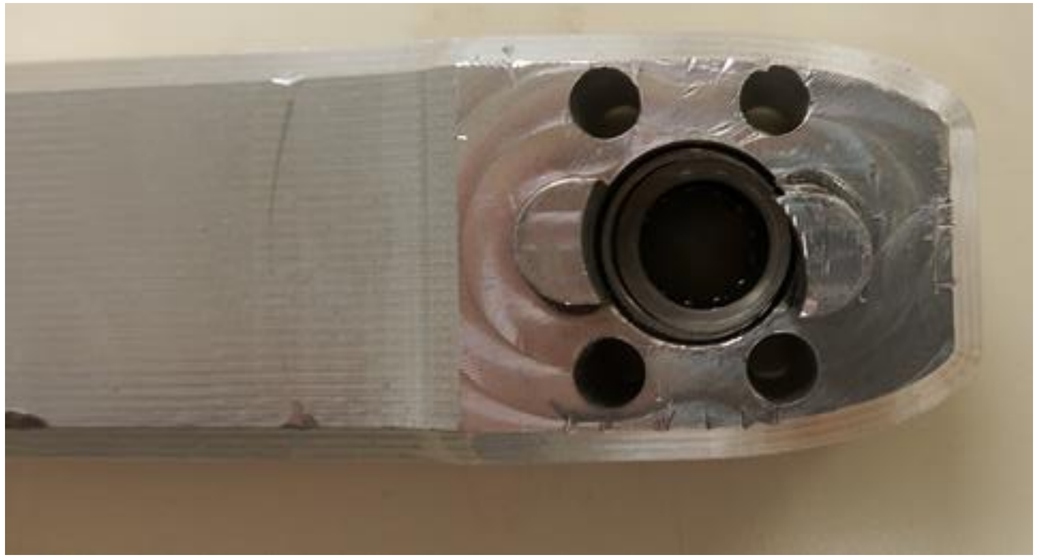

Figure 9: Top View of Sheared Key

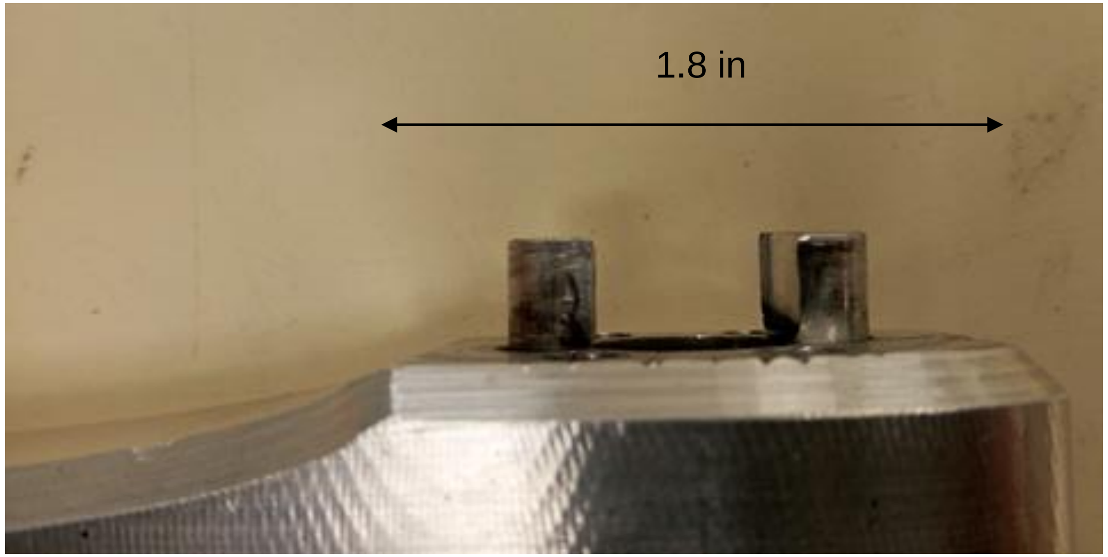

Figure 10: Side View of Sheared Key

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Failure Analysis - Output shaft

Figure 11: Traditional Bike output shaft (top) vs RLT Output Shaft (bottom)

The RLT output shaft was originally made of mild steel which failed. The second rendition (bottom) was made of a hardened steel shaft (smaller diameter) welded to the mild steel center shaft (larger diameter).

The first attempt completely failed. The second attempt (bottom) is better but should be made from one material.

Presenter: Nick Khayata

Conceptual Designs

- Possible Solutions to Crank Arm Failure:
  - Press Fit Steel Keys
  - Properly Machine Crank Arms with Aligning Holes
  - Use Bolts That Fit and Are a Higher Grade
  - Use a Different Material or Complete Redesign

- New Design Components
  - Multiple Holes in Crank Arms for Testing Different Lengths

Crank Arm Redesign

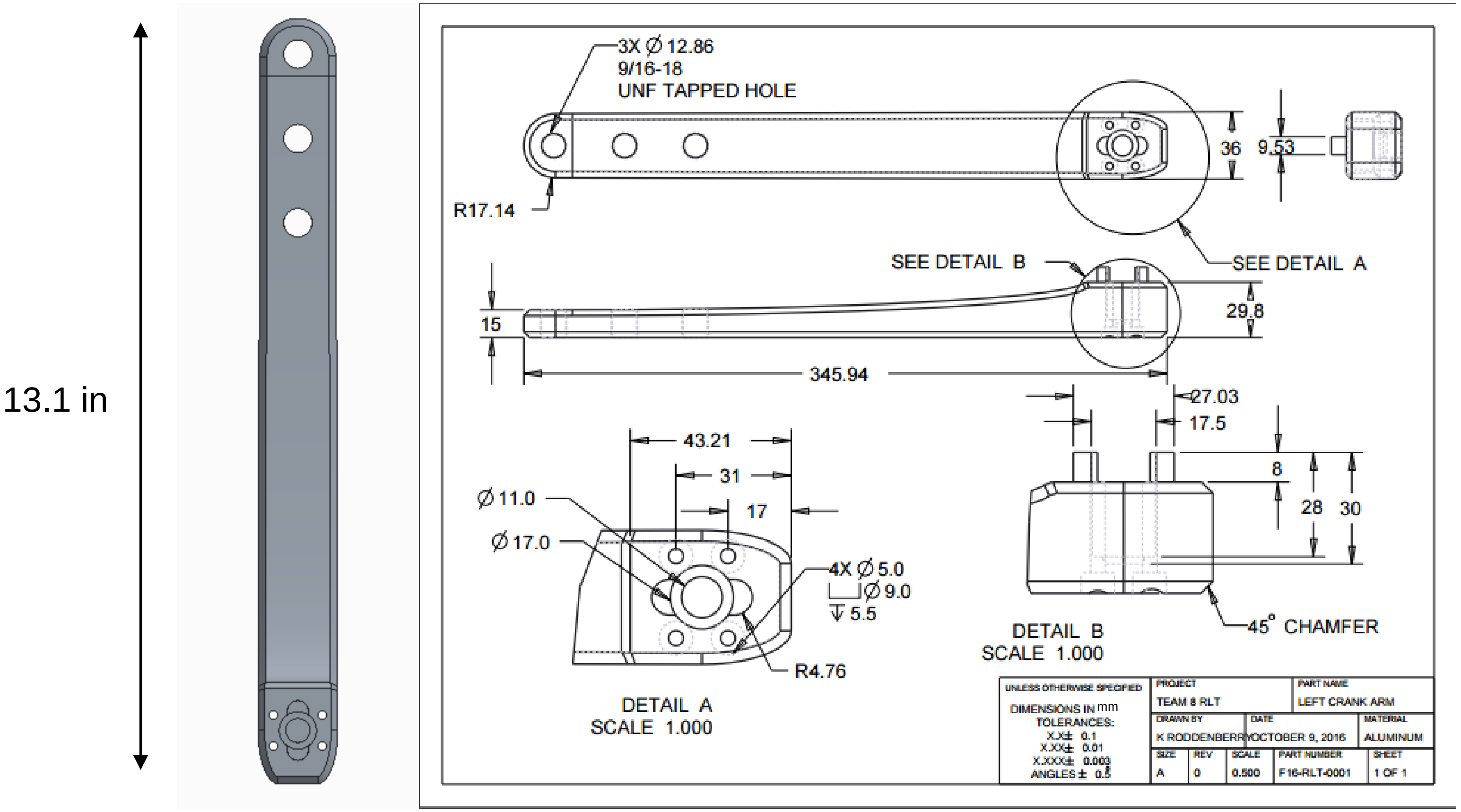

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Figure 12: Crank Arm part (left) and drawing (right)

Preliminary Budget

#	Part	Material	Vendor	Cost	Quantity	Subtotal
1	Shaft	Titanium	Online Metals	35.14	1	35.14
2	Crank Arms	6061-T6511 Aluminum	Speedy Metals	25.72	2	51.44
3	One Way Bearing	Chrome Steel 52100	Boca Bearings	34.95	2	69.90
Total						**156.48**
Budget						**2,000.00**
Remaining Budget						**1,843.52**

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Future Plans

- Modify the crank arms
  - Fix mounting issues
  - Drill holes in the crank arms for adjusting
- Remodel the one-way clutch
  - Allow for backwards motion
  - Buy the appropriate steel
- Test prototype
  - Test the working prototype for data
  - Use kinetic road machine

Figure 13: Kinetic Road Machine

Gantt Chart/ Project Schedule

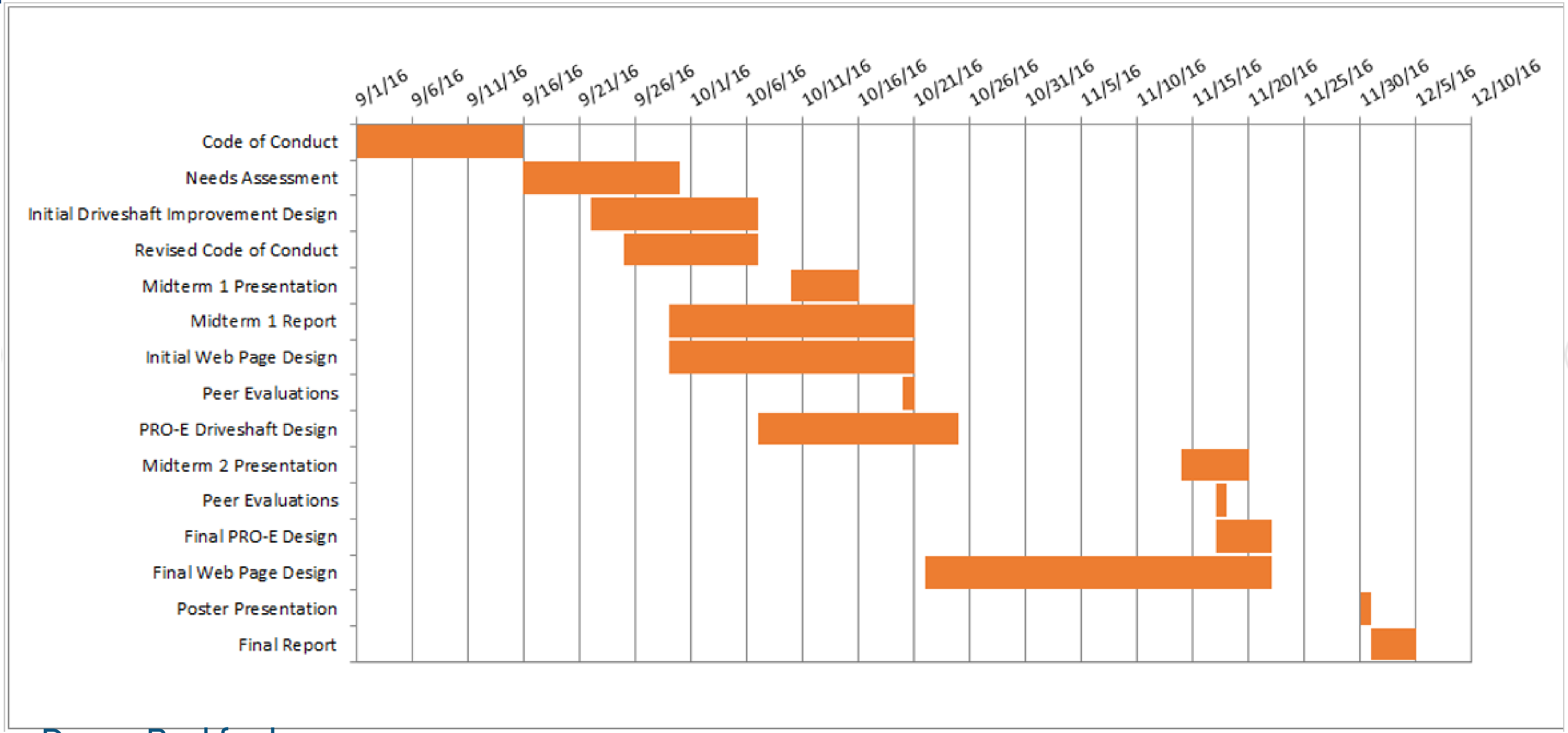

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Figure 14: Gantt Chart

Conclusion

- Main Objectives
  - Project/Sponsor needs
  - Produce a working prototype
- Reverse Engineering
  - Design, ordering, simplifying
  - Crank arms, shafts, one way clutch
- Testing
  - Assemble Hans Cycle
    - Test for Torque output, power, top speed
    - Use kinetic testing machine

Presenter: Darren Beckford

References

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Questions?