Midterm Presentation 2

HANScycle: Reciprocating Lever Transmission

Team 8:

Darren Beckford
Nick Khayata
Ali Pustelniac
Kyle Roddenberry

Sponsor: Gordon Hansen

Advisor: Keith Larson

Instructors: Dr. Nikhil Gupta & Dr. Chiang Shih

Introduction

- Problem Statement:
  - "A traditional bicycle is difficult to ride up hill due to its limited torque output and can also be damaging to a rider's joints."
- Main Objectives
  - Optimize the existing Reciprocating Lever Transmission (RLT) prototype
  - Test prototype for comparison data:
    - Various crank arm lengths
    - Compare with Traditional bicycle

Presenter: Nick Khayata

Project Scope

- 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: Nick Khayata

Sponsor's Project Needs

Sponsor Needs	Requirements	Approach
Working Reciprocating Lever Transmission	Optimize and Replace Broken Components	Test and Research Various Materials and Components
Higher Torque Output	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

Presenter: Nick Khayata

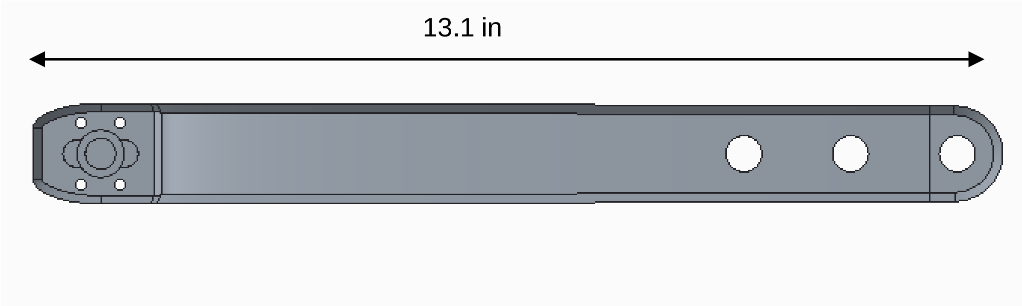
Recap

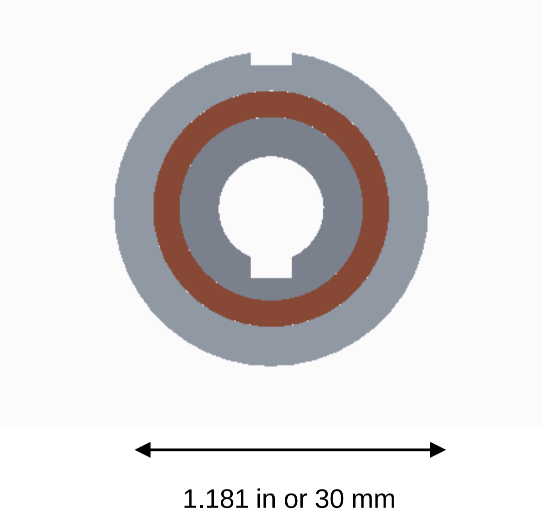
- Reverse Engineering:
  - The RLT and bike were taken apart and analyzed
- Failure Analysis
  - Crank arm keys began to shear
  - RLT mounting tabs were bending due to only one point of contact
  - RLT output shaft made of two materials
  - Ratchet and pawl teeth grinding
  - Crank arm mounting holes didn't line up
  - Crank arm bolts sheared

Presenter: Nick Khayata

Project Planning and Changes

- Since last presentation
  - Crank arms tapped to multiple lengths
  - One way bearing sourced
  - New crank arms designed
  - Higher grade bolts sourced
- Future
  - Purchase materials and components
  - Machine and assemble new crank arms
  - Implement one way bearing
  - Testing at full potential

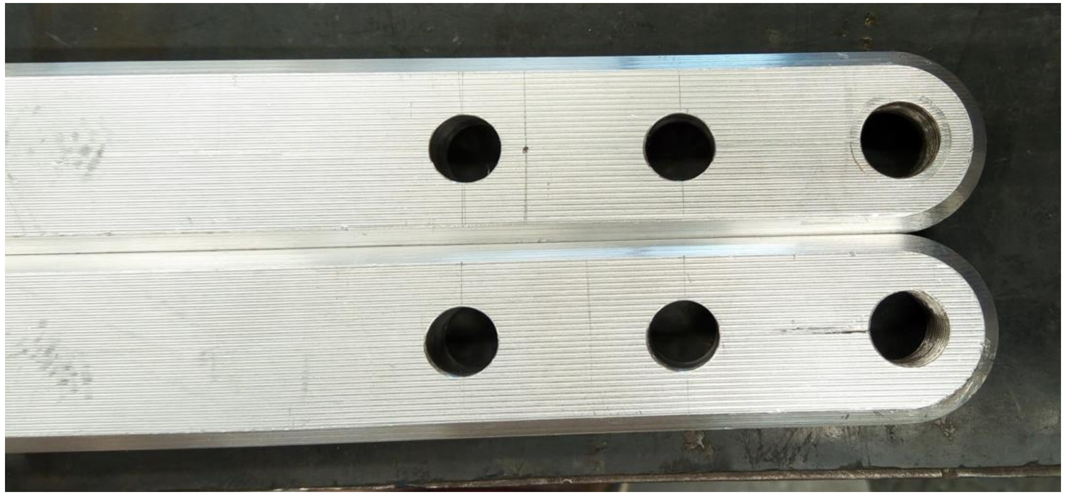




Presenter: Nick Khayata

Crank Arms

- New crank arms with adjusting holes for data
- Improved current crank arms (press keys,new bolts)
- Impeding progress on testing



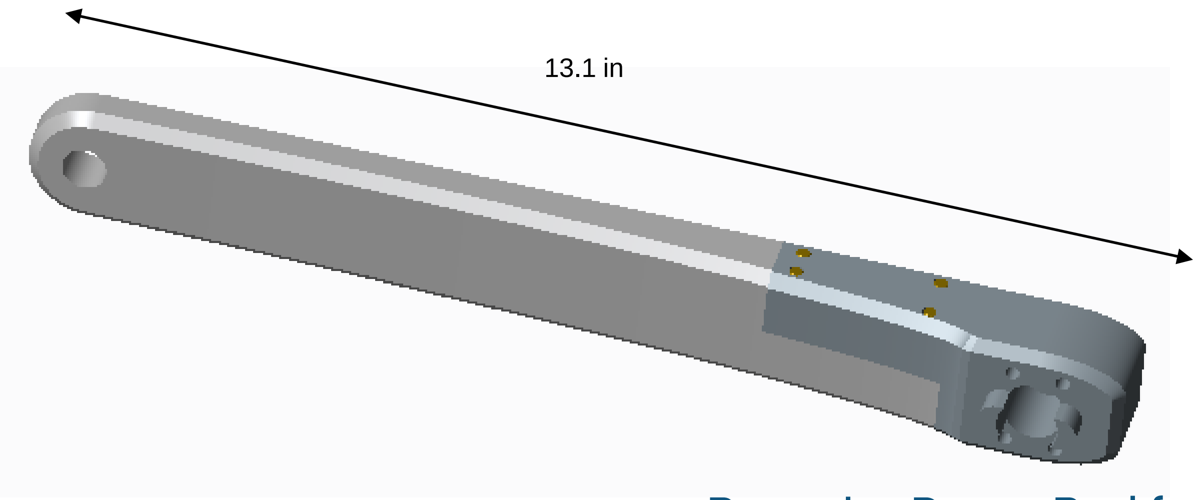
3 in (center to center)

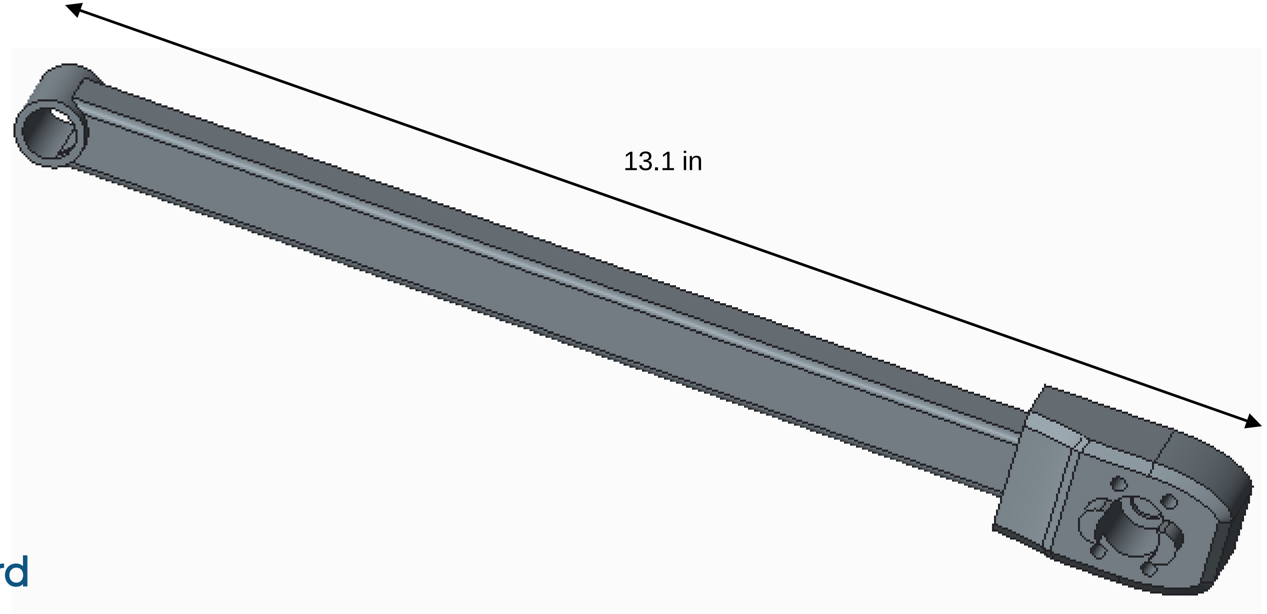
9 in

Presenter: Darren Beckford

Crank Arms Cont.

- Alternate designed crank arms
- Steel and aluminum vs all steel
- Just for data (not final design)



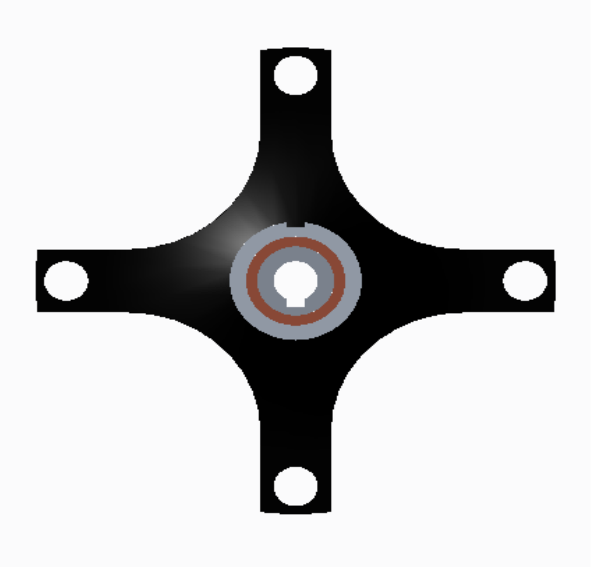


Presenter: Darren Beckford

One Way Bearing

- Satisfies one main project goal
- Shaft fits inside keyway etc.
- Should allow bike to roll backwards
- Provides torque one way

1.181 in or 30 mm



4.75 in

6.25 in

Presenter: Darren Beckford

8620 vs 4130 Shaft Material

8620 Steel

- Known for case hardening
- Easier to machine
- High surface wear resistance
- Much stronger once hardened
- Used for shafts, pins, gears, ratchets

4130 Steel

- Known for through hardening
- Slightly stronger due to higher carbon content
- Easily heat treated
- Used for aircraft engine mounts, valve bodies and pumps, auto racing

Presenter: Darren Beckford

Updated Budget

#	Part	Material	Vendor	Cost	Quantity	Subtotal
1	One-way Bearing	steel	VXB bearings.com	$24.95	1	$24.95
2	rachet and pawl	plastic/steel	Trilton cycles (UK)	$90.00	2	$180.00
3	square tube (5ft)	steel	speedy metals	$5.95	1	$5.95
4	round bar (shaft)	8620 steel	speedy metals	$6.89	1	$6.89
5	steel plate	A-36 steel	speedy metals	$29.53	1	$29.53
6	square bar	A-36 steel	speedy metals	$21.16	1	$21.16
7	socket screws	steel	Mcmaster.com	$9.82	1	$9.82
					Total	$278.3
					Remaining Budget	**$1,721.7**

Presenter: Darren Beckford

Test Data

Traditional Bicycle			
Length (in)	Power (W) Average/Maximum	Cadence (rpm) Average/Maximum	Speed (mph) Average/Maximum
7	212/668	80/160	17.6/29.2

HANScycle			
Length (in)	Power (W) Average/Maximum	Cadence (rpm) Average/Maximum	Speed (mph) Average/Maximum
9	18/28	16/29	5.0/6.4
10.5	20/31	23/32	5.4/6.7
12	18/29	17/30	5.2/6.5

Presenter: Kyle Roddenberry

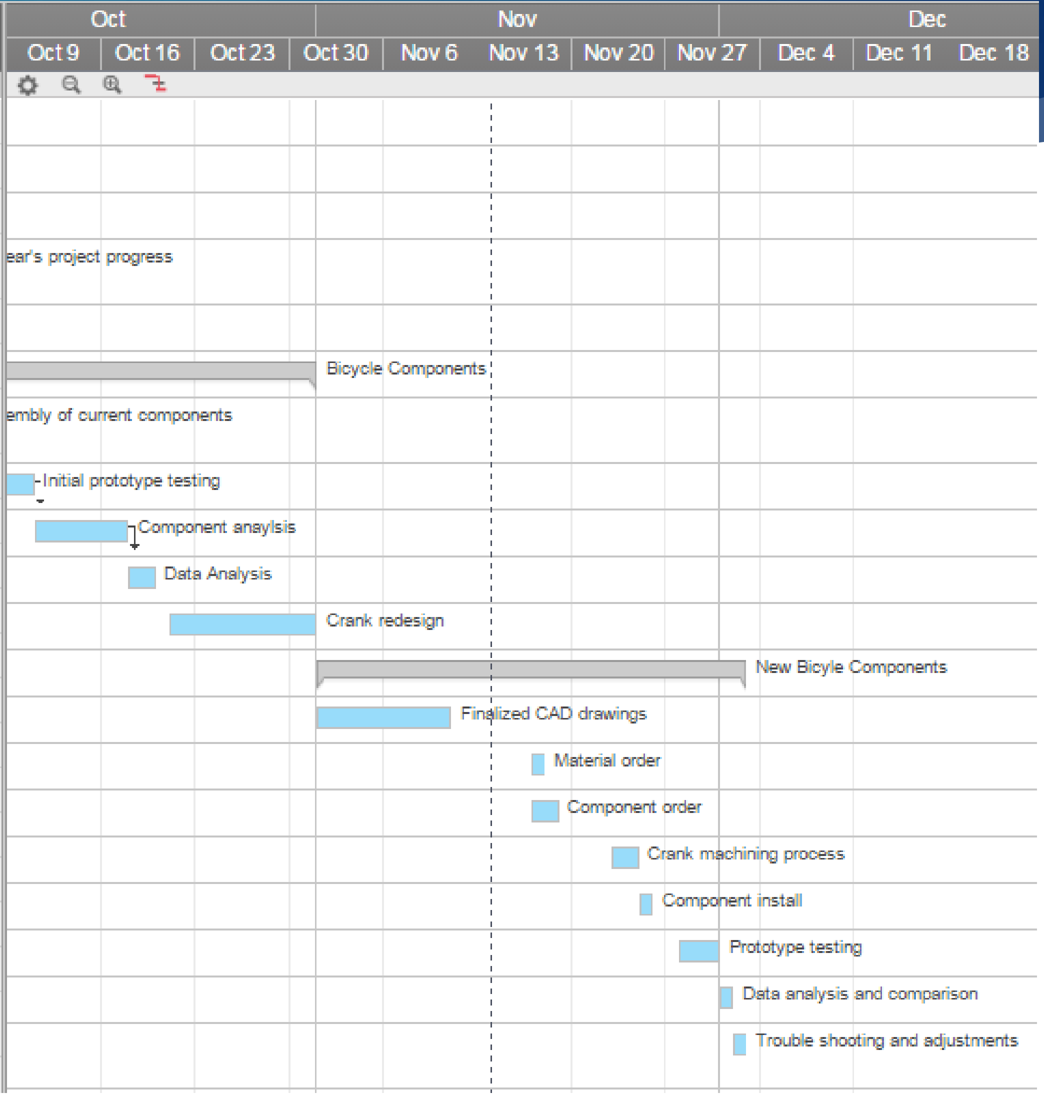
Data Analysis

- The traditional bicycle had a maximum speed of over 4 times that of the HANScycle.
    - This is partially attributed to internal slippage of the RLT
- The 10.5 inch crank produced the best results
    - Due to the additional torque on the 12 inch crank
    - It also had the best ergonomics and maneuverability
- The target data is equal to or greater than the traditional bicycle
    - 212 Watts
    - 17.6 mph

Presenter: Kyle Roddenberry

Gantt Chart

Task Name	Start Date	End Date	Status	Dur...
Initial Analysis	**09/04/16**	**09/26/16**	**Completed**	**17d**
Team member roles assigned	09/04/16	09/08/16	Completed	5d
Prototype analyzed	09/04/16	09/26/16	Completed	17d
Evaluation of last year's project progress	09/08/16	09/26/16	Completed	13d
Needs and goals established	09/08/16	09/20/16		9d
Bicycle Components	**09/30/16**	**10/31/16**	**In Progress**	**22d**
Assembly of current components	09/30/16	10/05/16	Completed	4d
Initial prototype testing	10/06/16	10/10/16	Completed	3d
Component anaylsis	10/11/16	10/17/16	Completed	5d
Data Analysis	10/18/16	10/19/16	Completed	2d
Crank redesign	10/21/16	10/31/16	Completed	7d
New Bicyle Components	**11/01/16**	**12/02/16**	In Progress	**24d**
Finalized CAD drawings	11/01/16	11/10/16	Completed	8d
Material order	11/17/16	11/17/16	Not Started	1d
Component order	11/17/16	11/18/16	Not Started	2d
Crank machining process	11/23/16	11/24/16	Not Started	2d
Component install	11/25/16	11/25/16	Not Started	1d
Prototype testing	11/28/16	11/30/16	Not Started	3d
Data analysis and comparison	12/01/16	12/01/16	Not Started	1d
Trouble shooting and adjustments	12/02/16	12/02/16	Not Started	1d



Presenter: Kyle Roddenberry

Summary

- Achievements
  - Crank arms were tapped to 10.5 and 9 inches
  - A keyed one way bearing has been sourced
  - Chain ring adapter deigned to accept the one way bearing
  - Two additional crank arms were designed
  - High grade (class 12.9) bolts were sourced
- Decisions
  - The use of 8620 steel for the shaft
  - Use a 10.5 inch iteration of the crank
  - Implement a one way bearing

Presenter: Kyle Roddenberry

Summary

- Future Plans
  - Order all of the new material and components
  - Replace broken components of the ratchet pawl system
  - Machine a new crank arm design
  - Install the new crank arms
  - Install the keyed one way bearing
  - Install the high grade bolts
  - Test the completed design

Presenter: Kyle Roddenberry

Sources

- [1] C. Holland, "Needs Assessment: Team 20: HANS Cycles.," 2015. [Online]. Available: Print.
- [2] G. H. Hansen, "Reciprocating Lever Transmission.," Patent US20130205928 A1, 2013.
- [3] O. Metals, "titanium round alloys , 6Al-4V, 6Al-4V ELI, grade 2 in small quantities at OnlineMetals.com," Online Metals. [Online]. Available: http://www.onlinemetals.com/merchant.cfm?id=266&step=2&top_cat=1353. Accessed: Oct. 10, 2016.
- [4] S. Metals, "Aluminum," 2006. [Online]. Available: http://www.speedymetals.com/c-8342-aluminum.aspx. Accessed: Oct. 10, 2016.
- [5] B. Bearings, "Boca Bearings," http://www.bocabearings.com/, 2004. [Online]. Available: http://www.bocabearings.com/bearing-inventory/One-Way-Bearings/19159/20x26x26-FCB20. Accessed: Oct. 10, 2016.

Presenter: Kyle Roddenberry

QUESTIONS?