Needs Assessment

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Abstract

The main objective of the HANSCycle Senior Design project is to design a Reciprocating Lever Transmission (RLT). The sponsor, Gordon Hansen, has tasked the team with creating a functioning RLT system on a bicycle. The idea behind the new RLT bike design is to avoid "dead" spots that occur at the vertical top and bottom of the traditional bicycle crank mechanism. This dead spot causes not only a loss of power, but also potential harm to the user's joints. The RLT design has not yet been successfully functioning on a bicycle, so the team is tasked with not only creating a successful design, but also testing and collecting data from the model, to compare with traditional bicycle mechanisms. The design must be suited for a bicycle with 26" wheels, which can fit in a 26"x26"x10" bicycle box for ease of shipping and storage. The project must be completed within a budget of $2,000.

Introduction

This project is aimed at improving the design of the traditional bicycle mechanism, which may offer a more efficient bicycle experience. Traditional bicycle mechanisms have two “dead” spots, where power is lost and potential joint harm can be done to the user. These “dead” spots are located at the top and bottom of the crank mechanism, and are not ideal for optimum energy-to-power ratios. This means that while pedaling on a standard bicycle, the user is not only losing power, but also potentially causing harm to themselves in two places for each full pedal rotation. This loss of power and joint harm is especially magnified when the bicycle is used on an increasing grade, or sloped path. For these reasons, the Reciprocating Lever Transmission (RLT) design has been introduced.

The sponsor of this project, Gordon Hansen, has proposed the new bicycle design which must be built and tested. This design utilizes the Reciprocating Lever Transmission, which consists of two pedals connected to a drive shaft with one-way clutches. This optimizes power efficiency because as one pedal is pushed downwards, the other pedal is simultaneously pushed upwards, by means of the RLT mechanism. In addition to this, the pedal cranks will be longer than the 7” cranks of Traditional bicycles. This will not only make pedaling easier, but will also create more torque. However, it should be noted that last year’s HANSCycle team had trouble getting the longer cranks to successfully work with the gears and assembly. So this year’s team will be working to design a system that successfully functions.

Possible problems that could be encountered include the functionality of the pedal system, and testing of the final product. Because of the longer crank arms, stronger shafts and clutches must be used in order to be able to support the increased torque. The team must analyze the material, size, and shape of last year’s design, in order to find a way to improve the function

of the mechanism. Testing the functioning design will also be an important challenge. Because RLT's are fairly uncommon, testing and data are not well documented. The team will need to acquire an accurate testing method, to then be able to compare results with traditional bicycle mechanisms.

Background Research

For flatland cities like Amsterdam and Copenhagen, bicycles are becoming the primary source chosen to for transportation. The belief is the popularity of bicycles will continue to grow if they have the ability to climb hills in a less harmful way. Generally bicycle drive chains consist of round chainrings and 7" short pedal crank arms. These bicycle cranks have a bottom dead-spot and a top dead-spot where no useful work is produced. Also damaging forces can be introduced to human joints causing knee problems among other joint injuries. The combination of the round chainrings and short pedal crank arms require the user to spin the pedal crank arms at a high speed in order to climb a hill. In addition, conventional bicycles have an unnatural pedaling motion which also contribute to the various knee problems caused by the round drive chains. Other types of chainrings have been introduced in an attempt to minimize knee injuries and improve the performance of hill climbing. Oval rings was one of the prototypes introduced but it has not been widely accepted. By evaluating and redesigning the reciprocating lever transmission (RLT) created by the 2015-2016 design team; design team 8 hopes to improve the discomfort of riding uphill.

Needs Statement

Gordon Hansen, the HANSCycle sponsor, believes his redesign of the traditional bicycle will lead to a new age of bicycling. He has redesigned the traditional bicycle in an effort to maximize efficiency and ease stress on the user's joints. He believes that the two "dead spots" on a traditional bicycle mechanism cause joint harm and are unconducive to an efficient ascent uphill. He believes that the short crank arms on traditional bikes require more work from the bicycle rider, and has therefore patented his redesign. The new design consists of an RLT mechanism that makes bicycling more efficient and less stress-inducing to the rider.

Below, Figure 1 displays the disassembled bicycle components that were used to construct the bicycle last year.

Figure 1: Disassembled bicycle components

The bicycle is still intact with the above parts, but certain aspects require improvement. Specifically, the driveshaft and clutches must be made stronger, in order to be able to support the

increased torque from the longer cranks and Reciprocating Lever Transmission, seen below in Figure 2.

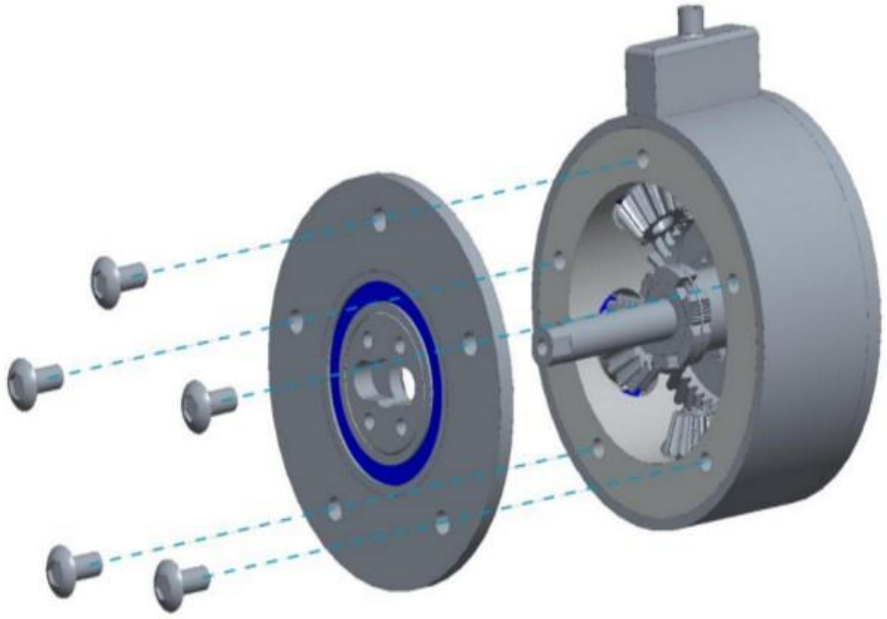


Figure 2: Reciprocating Lever Transmission CAD exploded view

Gordon Hansen has also requested, if possible, that the team try to find a way to alter the position of the bike rider. Currently, the seat and handlebars are at a position that causes the rider to lean forward. For optimum comfort and use, an upright position is favored. While this is a request from the sponsor, it was not one of his priorities, so the team will focus on the actual function of the mechanism before adjusting the design for rider comfort.

Goal Statement and Objective

One primary objective is to design and test a new bicycle design using at least 12” crank arms that reciprocate in arcs no greater than 100 degrees. The new design should improve the comfortability of uphill riding. Building on the work of last year’s team, team 8 will redesign the reciprocating lever transmission (RLT). The new reciprocating lever transmission should be designed so the clutch will be able to drive the bicycle forward and backwards. Using the test rig to provide performance data of the bicycle is another important objective. The test rig will provide data on the power output, which will be able to give a good estimate of how much power is needed to ride uphill. The second objective is to include the new drivetrain in a bicycle frame that includes cargo-mounting stations that can be used for shopping errands and daily commuting in cities with hills. This bicycle design should fit in a standard shipping box with the dimensions of 26”x26”x10” when disassembled, in order to save on shipping costs.

Constraints

- The bicycle must be designed for use with 26” wheels
- Bicycle must disassemble into a 26”x26”x10” packaging box
- Utilize crank arms 12” or longer, with an arc of no more than 100 degrees

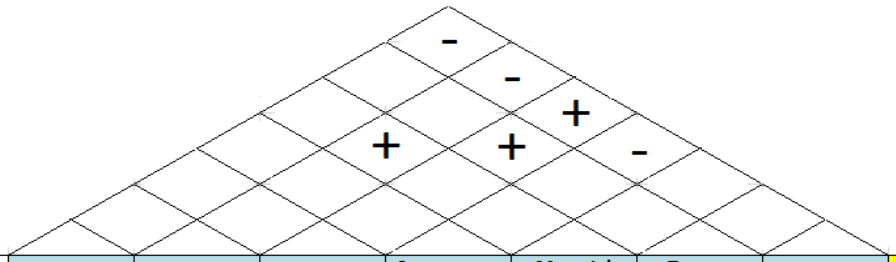
Methodology

In order to successfully complete this project, Team 8 has agreed upon various methods of organization, planning, and communication. Nicholas Khayata has been designated as the Team Leader. As Team Leader, he is in charge of delegating tasks to fellow group members, along with keeping in close contact with the sponsor, finalizing purchase orders, and ensuring an overall productive work environment. Darren Beckford, the Financial Advisor, is responsible for creating purchase orders, managing the budget, and keeping a record of all costs throughout the

project. Michael Roddenberry, the Lead Mechanical Engineer, is responsible for knowing and justifying all mechanical design decisions, and relaying the information to fellow team members, advisor, and sponsor. As the Organizational Lead, Alison Pustelniac is in charge of recording minutes and details of all group, advisor, and sponsor meetings, along with keeping the Google Drive up to date, where all project documents will be kept in an orderly fashion.

All team members are responsible for working in a cooperative and professional manner, as well as fulfilling all designated duties. This includes good communication between the group, advisor, and sponsor throughout the project span. Communication between group members will primarily be through a group text message, along with weekly meetings. Group meetings will consist of finalizing any deliverables or necessary assignments, discussing upcoming tasks, and voicing questions or concerns. Bi-weekly meetings will occur with Dr. Gupta and Dr. Shih on Tuesdays at 4:15pm, where project status will be discussed and input and advice will be given. Bi-weekly meetings will also be held on Thursdays with the sponsor, Gordon Hansen, to discuss progress, receive input, and ask any questions. Any additional meetings or discussions will be arranged on a necessary-need-basis.

In addition to communication, the methodology and planning of this project is very important in order to have a successful project. A House of Quality (HOQ), a type of priority matrix which relates various customer requirements and prioritizes all elements, can be seen below in Figure 1.



	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 3: House of Quality (HOQ)

Important aspects have been listed, rated, and related to one another, in an effort to determine importance. The HOQ will assist the team in prioritizing various aspects of the project, thus maximizing productivity. Additionally, a Gantt Chart, seen in Figure 2, has been created, to show a timeline of the various steps throughout this project, and when they are expected to be completed.

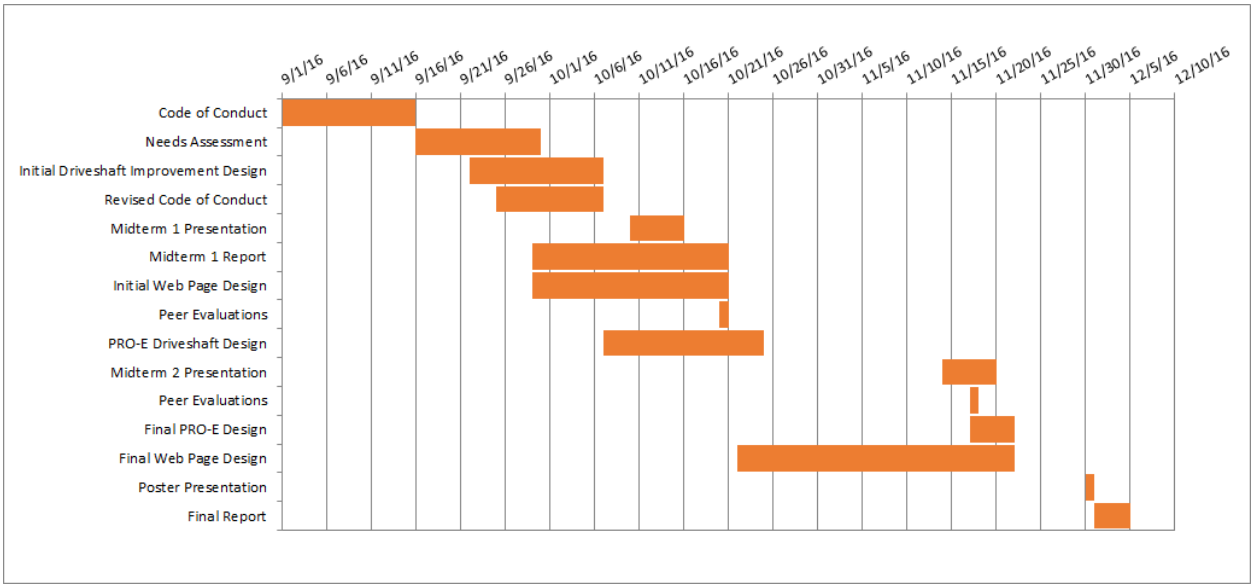


Figure 4: Gantt Chart

The team will stick to the above planned schedule as much as possible, making various changes and arrangements as needed. Both the HOQ and the Gantt Chart will be useful in creating and following a methodical approach to completing this project.

Conclusion

The RLT transmission is a redesign of the generic bicycle transmission with the intent of eliminating the “dead’ spots on the top and bottom of each stroke in a traditional crank mechanism. At these dead spots no work is done and joint injury is possible for individuals with bad knees or other previous ailments. The RLT eliminates these “dead” spots with the use of a stepping motion which also allows for a greater amount of torque to be produced because longer lever arms can be utilized. With some changes and more research Team 8 will take the progress that was made last year and create a working model and a testing setup to gather the information required by Gordon Hansen.

Team 8 will work closely with both Gordon Hansen and Mr. Larson to properly continue moving forward in the research and development of the HANScyle. Using a designated work schedule, good communication and set expectations team 8 plans to take the previous prototype and move towards a more practical model that is capable of meeting all of Gordon Hansen's expectations. These include but are not limited to: packaging within a 26"x26"x10" box, allowing for the transmission to be back driven allowing for reverse motion, and a higher torque output for easier hill climbs.

References

1. Hansen, Gordon Harold. Reciprocating Lever Transmission. Gordon Hansen, assignee. Patent US20130205928 A1. 15 Aug. 2013. Print.
2. Holland, Connor. *Needs Assessment: Team 20: HANS Cycles*. Rep. 2015. Print.