CAPSTONE/SENIOR DESIGN EXPERIENCE 2018

PUP High/Driveline Option

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Project Overview

The PUP (Practical Utility Platform) exists to assist developing countries in producing a low cost, simple, multipurpose utility platform that provides a user access to services such as:

- Transportation
- Agricultural Processes
- Mobile power sourcing

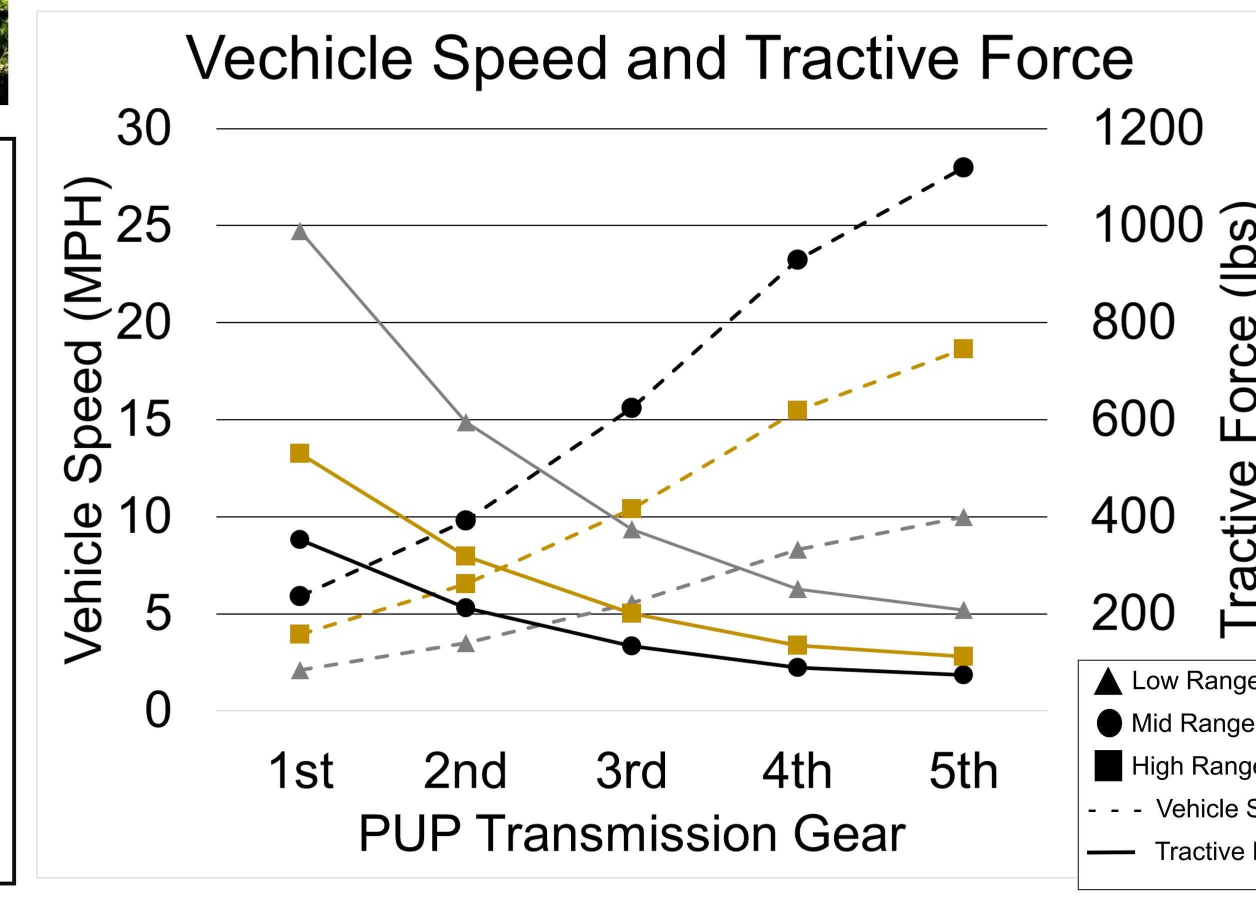
This design team exists to construct and install a high/low driveline option to provide custom gearing ratios for more flexible use. The design uses a motorcycle transmission commonly found in Africa to help provide a 3-way reduction for different speeds/torques. This allows end users to use the PUP to enact a wider range of activities, ranging from high torque applications (plowing) to high speed applications like travel.

Background

To solve this project, knowledge of basic machine components and ideal speeds and gearing ratios were required. The end user of this project is a small business owner in a developing African country who desires a more diverse range of gearing on a PUP than what is provided with the normal package. The problem emerged from The risk of non-solution would be a loss of potential productivity that could result from this efficient, low-cost vehicle.

System Overview

The following chart breaks down the different gearing options. The system uses a 6.5 hp engine and a 3.5 primary reduction based on a pulley clutch system. This compares to the original system ranging between 4-20 MPH and 100-500 lbs. tractive force.



Impact and Sustainability

Transportation is critical to a growing nation. Reliable transportation of people/commodities impacts food security and regional security. The impact of this project includes:

- Replacing manual labor with mechanization. (Low range)
- Timely transportation of people/commodities (High range)
- Follows the sustainability model of the mini-PUP by utilizing common parts readily available.
- Low-cost part components for production and part replacement .

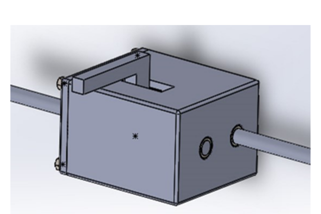
Reflection on Design

The life cycle of this product will be determined via testing, but is designed to last five years with regular maintenance. Market threats to the product include part availability, manufacturing precision required, and the ability to successfully communicate the need of replacing manual labor. Overall, this design will improve the effectiveness of the PUP and increase marketability for end users.

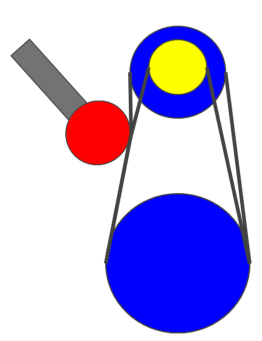
Alternative Solutions/Design

Designs Considered

- DIY Gearbox
- Custom made gearbox



- Belt System
- Two clutching belt pulleys with different ratios



- Chain Derailleur System
- Similar to bicycle gearing

Selection of Final Design

It was determined via decision matrix that using a locally-sourced motorcycle transmission (shown below) with a pulley clutch system was the most effective design based on the following criterion:

- Estimated Cost
- Availability in Africa
- Durability
- Feasibility
- Repair Time
- Size and Weight

Evolving the Design Using Autodesk Fusion

Step 1. Internal Modeling

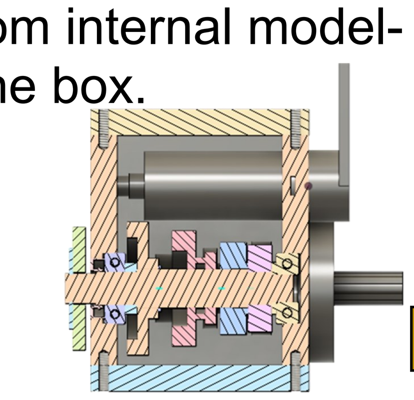
Modeling all of the purchased gearing and shafts required precise measuring and reverse engineering.

Step 2. Deciding on an Outside Shape

The base material, ½" steel, was chosen in order to be able to tap ¼" holes into the sides. Dimensions were gathered from internal modeling to model spacing of holes and set the size of the box.

Step 3. Select Bearings

Proper bearing selection considering rating and size ensures smooth rotation of the shafts.



Step 4. Specify Spacing

Specifications were made of press fit depth for the bearings and how to effectively space gearing away from the gearbox walls.

Step 6. Specify Sealing

3 methods were used to seal based on industry standards given in the Parker manual (right).

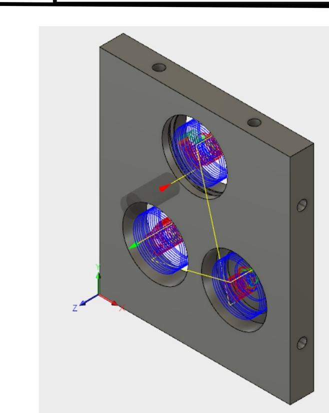
- Seal Carrier with O-Ring
- Gasket Maker on the Inside
- External Lip Seal

Step 7. Add Oil Fill Implements

The addition of oil fill holes and a sight gauge, allowing with specifying oil ensured proper lubrication.

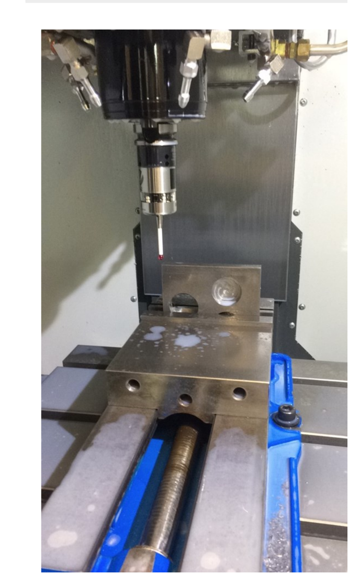
Manufacturing/Assembly

The manufacturing for this project was accomplished in the new Bechtel Innovation Design Center and the ADM Agricultural Innovation Center.



Step 1. Developing the CAM

A mill was selected due to the precision needed for the shaft and bearing holes/depths. In order to prepare the mill, the CAM was developed (Example above).



Step 2. Milling the Parts

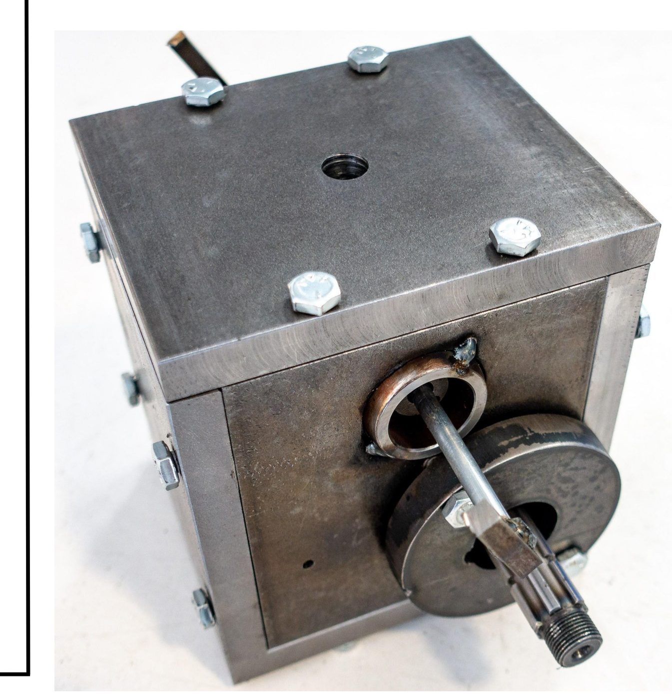
Machine time was scheduled and the code was implemented, sometimes taking up to an hour to finish one side of a part, but resulting in a quality, tightly tolerance part.

Step 3. Assembly/Fine Tuning

Lastly, the gearbox was carefully assembled and sealed paying special attention to the alignment of the shifting cylinder for proper function and smooth rotation.

Final Design

Below shows the finished gearbox, prepared to test. An economic analysis along with a gearbox specification follows:



Project Cost

Gearing	$72
Parts	$90
Oil/Seal	$45
Driveline	$50
Material	$50
Total	**$307**

Est. Cost $250

Specifications

Weight	21 lbs.	Oil Spec.	SAE Grade 90
Volume	137 cubic inches	Sealing	Gasket Maker, Lip Seal, and O-Ring
Approx. Cost	$250	Min. Reduction	0.958
Material	½" Steel	Max Reduction	2.833

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