CAPSTONE EXPERIENCE 2015

Purdue Utility Project:

Clutching Mechanisms

Agricultural & Biological ENGINEERING

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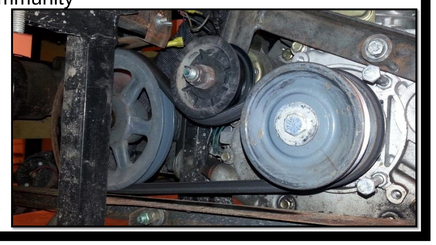
Introduction

Problem Statement:

- A robust, reliable, easily-manufactured clutching mechanism is needed to finalize the Practical Utility Platform design for future production
- The team has been tasked with designing a new, innovative clutching mechanism to implement on future vehicles and retrofit on existing platforms

Background:

- Purdue has partnered with ACREST, a NGO located in Cameroon to provide an affordable vehicle for local transportation of people, water, crops, and supplies
- The PUP can carry 2000 lbs, traverse rough roads, and is manufactured locally in Africa with only local parts, making it affordable for the community
- The overall design has been previously finalized, except for the clutch
- Current solution uses a V-belt system with spring-loaded tensioner
- Belt quality is unpredictable in Africa and has resulted in the clutch becoming the weakest failure point of the design



Impact on Society

- Team will travel in May to reproduce the design in Cameroon using only locally available resources
- The PUP will be used on a day-to-day basis by ACREST hauling people, food, water, supplies, etc.
- The vehicle will reduce small-holder farmer labor challenges and improve productivity and food security
- Reproducing this design locally on a micro-factory scale creates sustainable employment opportunities
- Attachments, such as a maize grinder and a water pump, turn the PUP into a mobile power unit

Roads in Africa are not maintained and are in chronic disrepair, making travel treacherous

Project Goals

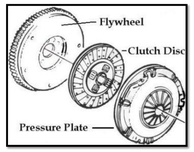
- Design innovative clutching mechanism to implement on newly-built vehicle and future construction
- Design a clutch module system to retrofit onto existing vehicles
- Manufacture prototypes to test at Purdue and to compete in an endurance event
- Travel to Cameroon, Africa, in May to build new vehicle, implement new clutch design, and retrofit old vehicles with new clutch module

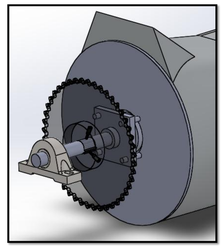
Alternative Solutions

To allow the greatest range of options for both retrofitting and new construction, three main designs were considered. Only locally-available parts and components were considered to allow for optimal design sustainability.

Option 1: Automotive Clutch

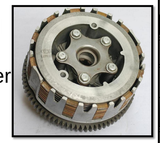
- Uses standard automotive parts
- Sits entirely inside bell housing
- Chain + sprocket transmits power
- Incredibly robust, but complex

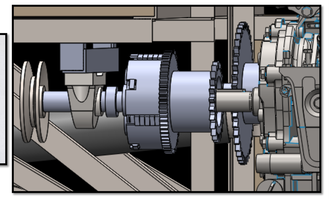




Option 2: Motorcycle Clutch Pack

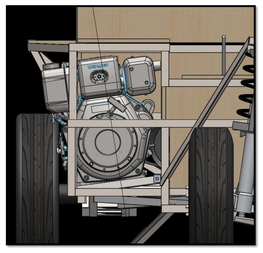
- Uses commonly available parts
- Clutch pack is normally run in oil bath, but this design is run dry
- Chain + sprocket transmits power
- Nature of design is modular
- Testing will determine viability





Option 3: Tilting Engine with Multiple V-Belts

- Uses weight of engine to tension belts
- Clutch pedal raises engine and de-tensions belts
- Using 2 or 3 belts decreases load on each belt
- Simple, but unreliable
- Doesn't entirely solve the belt issue



Cost Analysis

The Practical Utility Platform can be constructed for under $2,000 (USD). The addition of the clutch design adds some marginal cost, but a more reliable system will decrease future maintenance and replacement costs.

Automotive Clutch Design:
- Total Cost: $150

Motorcycle Clutch Pack Design:
- Total Cost: $100

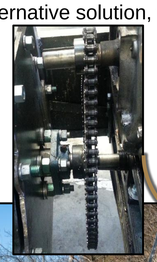
Tilting Engine Design:
- Total Initial Cost: $40 (+ future costs)

Items	Cost
Frame	
Angle iron (15 pieces, 6 meters each)	$300.00
Plywood	$75.00
Driveline	
1998 GMC Sonoma Pickup Truck for parts -Transmission, Driveline, Rear Axle, Mic. Parts	$500.00
10 HP Diesel Engine	$625.00
Rim & Tires	$ -
Clutch (Automotive, Motorcycle, or Tilting)	Max $150
Suspension	
Front Strut – Ford Taurus	$ -
Springs (4)	$60.00
Shocks (2)	$40.00
Driver Ergonomics	
Brake cylinder and lines	$20.00
Lights, driver controls, handlebars, pedals	$30.00
Miscellaneous	
Misc. Components/Tools/Supplies	$200.00
Total	**$1850.00**

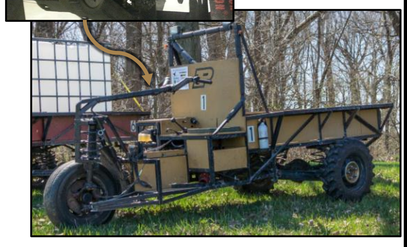
Final Design

After manufacturing and testing each alternative solution, final designs were chosen.

Automotive Clutch Design
- Built on the newly-constructed 2015 PUP
- Manufactured as simply as possible, with very few issues
- Uses all existing clutch components in transmission, plus two bearings, a short section of keyed shaft, and a chain + sprocket system
- Disengages cleanly
- No slippage – can kill engine in gear with brakes
- Withstood a full day of rigorous testing
- Chosen as design for future construction



Motorcycle Clutch Pack Design
- Retrofitted on the 2014 PUP
- 24T to 42T sprocket system replaces existing pulley system to gain same reduction
- Spacer is required to align sprockets and clear frame
- Design utilizes existing pedal assembly for actuation
- Actuated with a standard throwout bearing
- Withstood testing with minimal slippage
- Chosen as modular option for retrofitting existing vehicles



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