Sustainable Mobility
Taking an Assistive Mobility Technology from Prototype to Production

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Establishing the Need

The life of people with disabilities:

• Slow with difficult mobility
• Limited contributions to household
• Shoes on hands
• Callouses on knees and feet
Our Mission

To equip our partners with an appropriate, sustainable method for building and distributing our mobility tricycle design to disabled persons in their local communities.
January 17’ Burkina Faso Trip

- Built 5 new electric trikes
- Met clients receiving trikes
- Reconnected with partner
- Trained local builders
Presentation Overview

1. Frame: Axle Mounting Bracket Redesign
2. Drivetrain: Splined Shaft and Motor Mounting
3. Transmission Housing: Cast Housing
   Process Redesign
4. Control System: Control Box Redesign
Tricycle Frame:
Axle Mounting Bracket Redesign

Daniel Barrett
Background

Axle Mounting Brackets: Configure rear axles to the tricycle frame using simple steel parts
Problem

Previous Axle Mounting Bracket Designs:
• Too weak when constructed with materials readily found in Burkina Faso
• Too much variability in manufacturing so that axle and wheel are effectively aligned to frame
Design and Manufacturing Criteria

1. Manufactured in Burkina Faso
   - Material Limitations
   - Tool/Labor Limitations
2. Simple Axle Alignment
3. Reduced Manufacturing Variability
Solution – pt. 1

New Axle Mounting Bracket Design

- Uses steel parts commonly found in Burkina Faso
- Provides accurate axle to frame alignment
- Adapts to multiple faces of frame to provide more structural support

![Diagram of the new axle mounting bracket design](image)
Solution – pt. 2

Welding Fixture – quickly aligns components for welding

- Provides precise alignment of axle mounting bracket
- Fits to tricycle frame to provide quick and easy location
- Leaves adequate room for welding bracket to tube

Frame Tube

Axle Mounting Bracket  Welding Fixture  Components Aligned in Welding Fixture
Summary

Produced this academic year:

• Improved and successful Axle Mounting Bracket

• Effective welding fixture for aligning Axle Mounting Bracket to tricycle frame

• Production Documentation for manufacturing Axle Mounting Bracket
Drivetrain:
Splined Shaft and Motor Mounting

Daniel Vivolo
Drive Train Assembly

1. Speed Reducer
2. Splined Shaft
3. Bearing
4. Cast Housing
5. Sprocket Adapter
6. Sprocket
7. Drive Plate
Drive Train Assembly

1. Speed Reducer
2. Splined Shaft
3. Bearing
4. Cast Housing
5. Sprocket Adapter
6. Sprocket
7. Drive Plate
Splined Shaft Problem:

- Splines wearing too much
  - Heat treatment process needed to increase its strength
  - Could cause deformation

Task: Test for change in geometry and adjust machining process accordingly

- Current heat treatment process didn’t yield desired hardness
Results:

- Heat treatment process
  - Increased pre-quenching heating time from 10 min to 20 min.

Splined shaft diameter
- Decreased by ~0.02 mm
- Deformation not uniform along length
- Diameter decreased less near flange

- Solution: Increase machined diameter to 12.02 mm and sand near flange
Motor Mount Redesign

Adjustable mount to adjust chain tension

Motor Mounts

Cast Housing
Splined Shaft Problem:

- Interference
  - Chamfer on housing flange
  - Edge of motor mount

Cannot adjust drive train position
Chain tension
Proposed Solution

• Extend one tab and drill two holes

Must be cautious of stress at flange-housing interface
Transmission Housing:
Cast Housing Process Redesign

Anders Laub & Matthew Tomasetti
The Cast Housing

Cast Housing (Speed Reducer)
Background: Sand Casting

- Method of casting metal parts
- Uses a mold made of sand and an oil or water-clay binder

- Need for smooth, laminar metal flow within mold
- Desire directional solidification

![Diagram of sand casting process](image-url)
Problem:

- Limited to production of one housing at a time
- Poor and inconsistent casting results
- Time consuming process
- Excess material waste

Successful Solution:

- Produce a high percentage of good castings with limited surface defects
- Time and material efficient process
Layout Redesign

Assembly Top View

3D Printed Runner and Gate Patterns

Runners
Well
Gate
Runner Extension
Casting Pattern
Research of Foundry Tools

**Sand Ramming**
- Desired a ramming tool that could compact sand faster
- Modified and welded a small impact bit to chisel

**Sand Screening**
- Needed a coarser sand screening tool fitted to flask
- Constructed custom sand riddle
Conclusions

• New process reduced molding time from approximately 3 hrs to 2 hrs
• Reduced raw aluminum material usage from 6 lbs (Fall 2016) to 4 lbs
• Casting Results:
  ▪ Excellent surface finish
  ▪ Porosity and flash eliminated
Control System:
Control Box Redesign

Cordell King
Control Box Redesign

- Power Switch
- Forward/Reverse Switch
- Throttle and Brake Control
Control Box Improvements

Old Design:
Three Control Boxes

New Design:
Two Control Boxes
Easier Installation of Control Boxes

Old Design

New Design
Creating and Finalizing Production Documents

Throttle Control Box Exploded View

Power and Forward/Reverse Control Box Exploded View
Creating and Finalizing Production Documents

II. Assemble Potentiometer.

1. Attach the Potentiometer bracket to the Potentiometer as described and shown in Figure 19.
   1. Remove Potentiometer nut and washer.
   2. Put the Potentiometer Bracket onto the Potentiometer.
   3. Put Potentiometer washer and nut back onto the Potentiometer.

2. Slide the 42 tooth gear as far as it can go onto the shaft of the potentiometer and tighten the set screw so the gear does not slide off. See Figure 20.

- Simple layout
- Clear Instructions
- Labeled Pictures
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Questions?

Regarding...

• Frame: Axle Mounting Bracket Redesign
• Drivetrain: Drive Shaft and Motor Mounting
• Transmission Housing: Cast Housing Process Redesign
• Control Systems: Control Box Redesign