

Fourteenth Annual School of Science, Engineering, and Health Symposium
Friday, April 28, 2017

Sustainable Mobility

Taking an Assistive Mobility Technology from Prototype to Production

Daniel Barrett
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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



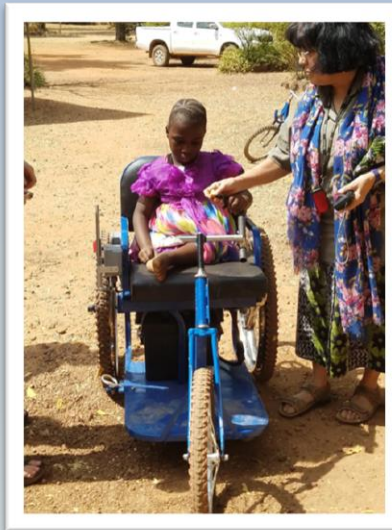
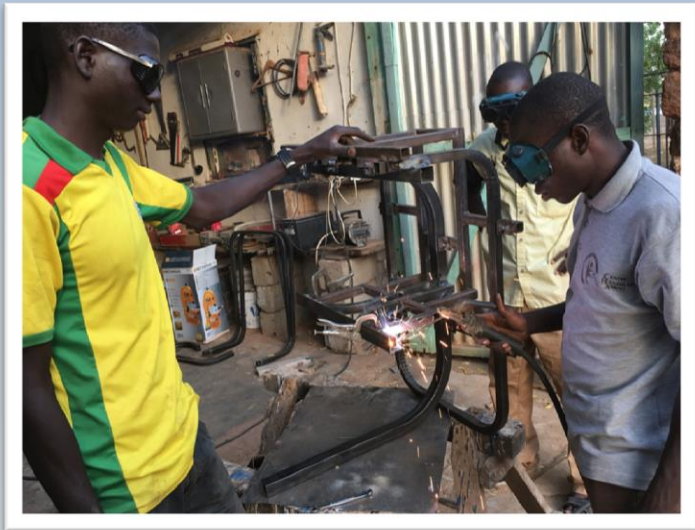
Our Mission

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:

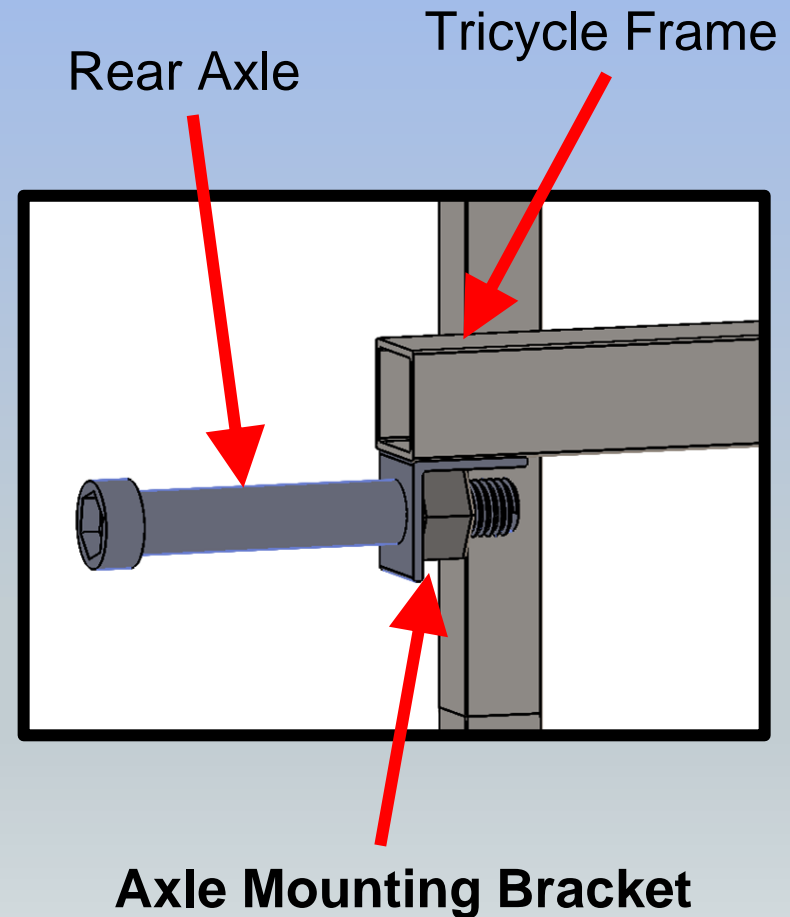
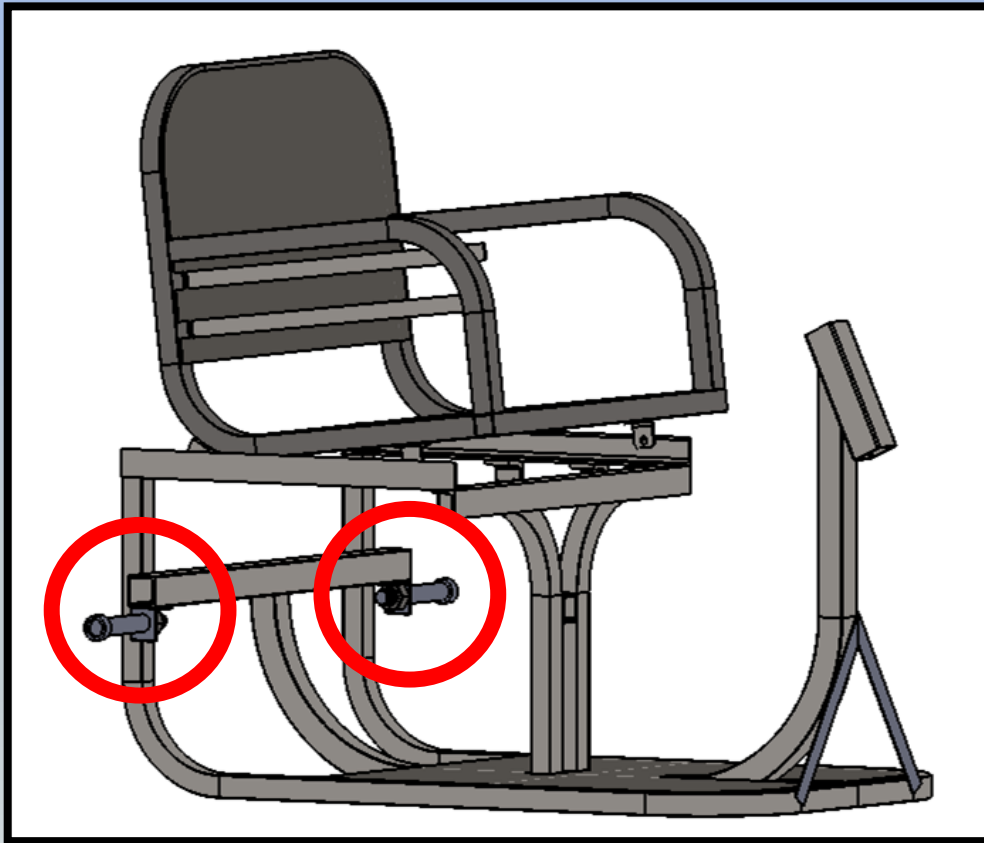
Axle Mounting Bracket Redesign



Daniel Barrett

Background

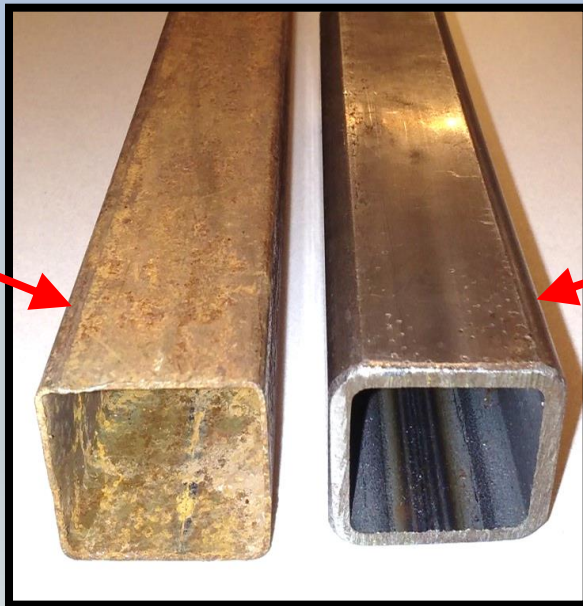
Axle Mounting Brackets: Configure rear axles to the tricycle frame using simple steel parts



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



Burkina Faso

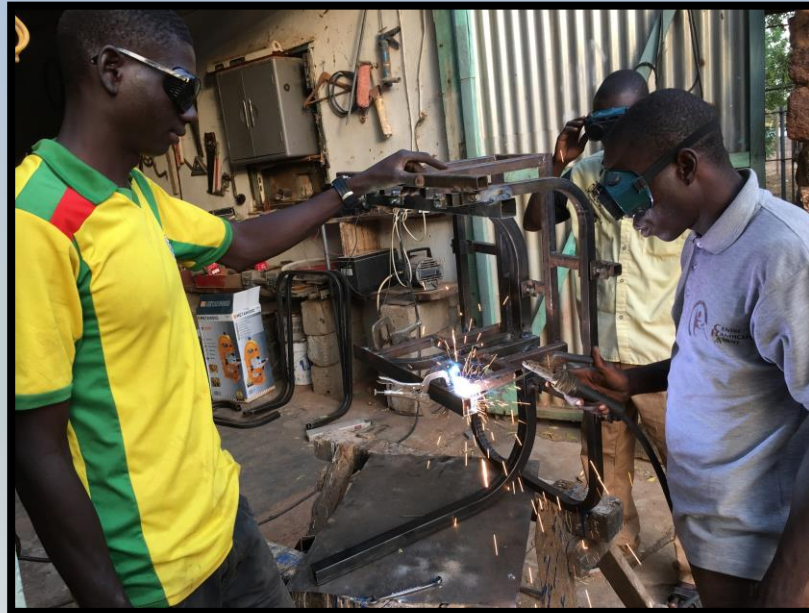
United States



Tricycle with Correctly Aligned Wheel

Design and Manufacturing Criteria

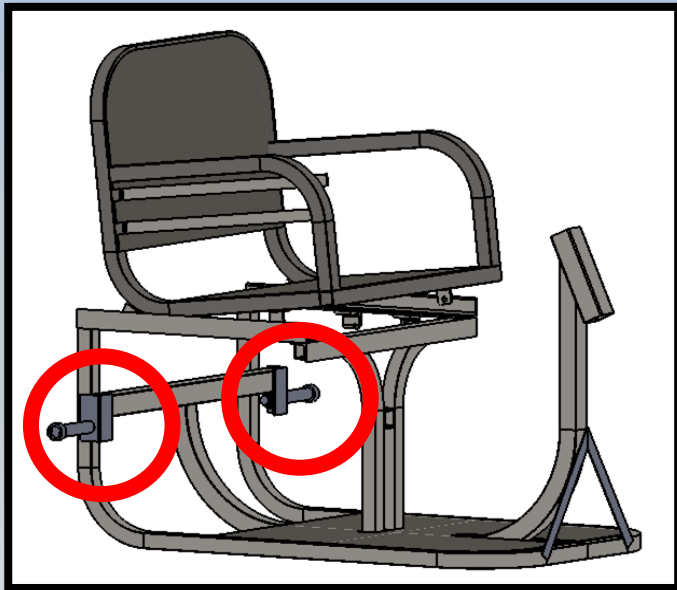
1. Manufactured in Burkina Faso
 - *Material Limitations*
 - *Tool/Labor Limitations*
2. Simple Axle Alignment
3. Reduced Manufacturing Variability



Solution – pt.1

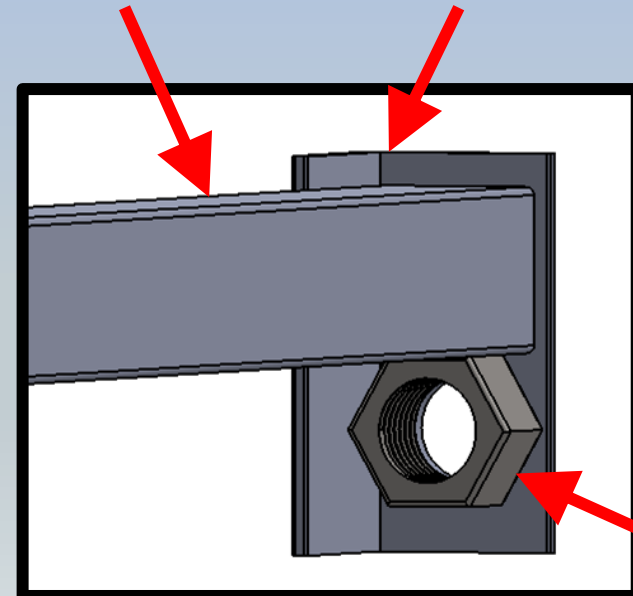
New Axle Mounting Bracket Design

- 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



Frame Tube

Angle Iron



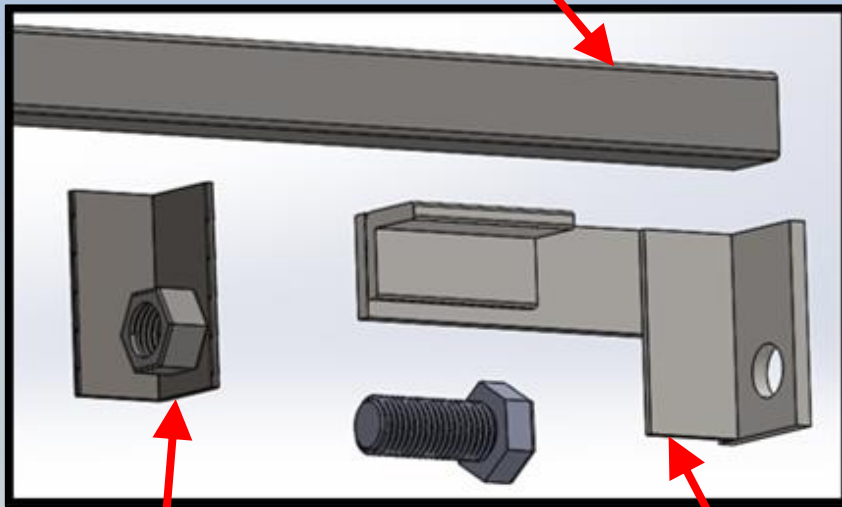
Hex Nut

Solution – pt. 2

Welding Fixture – quickly aligns components for welding

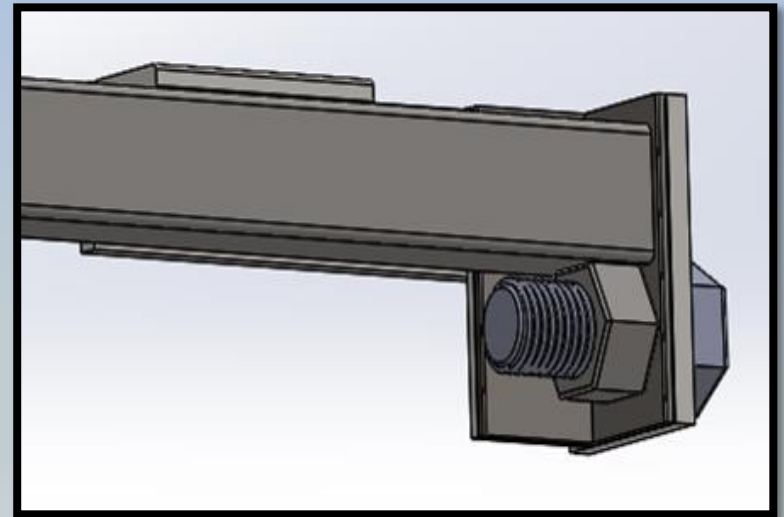
- Provides precise alignment of axle mounting bracket
- Fits to tricycle frame to provide quick and easy location
- Leaves adequate room for welding bracket to tube

Frame Tube



Axle Mounting Bracket

Welding Fixture

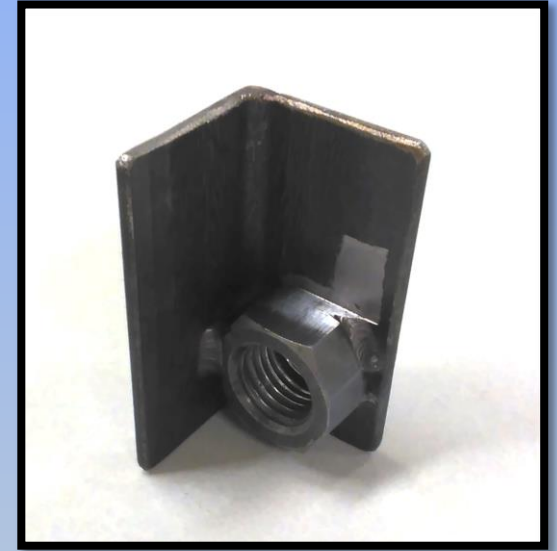


Components Aligned in Welding
Fixture

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:

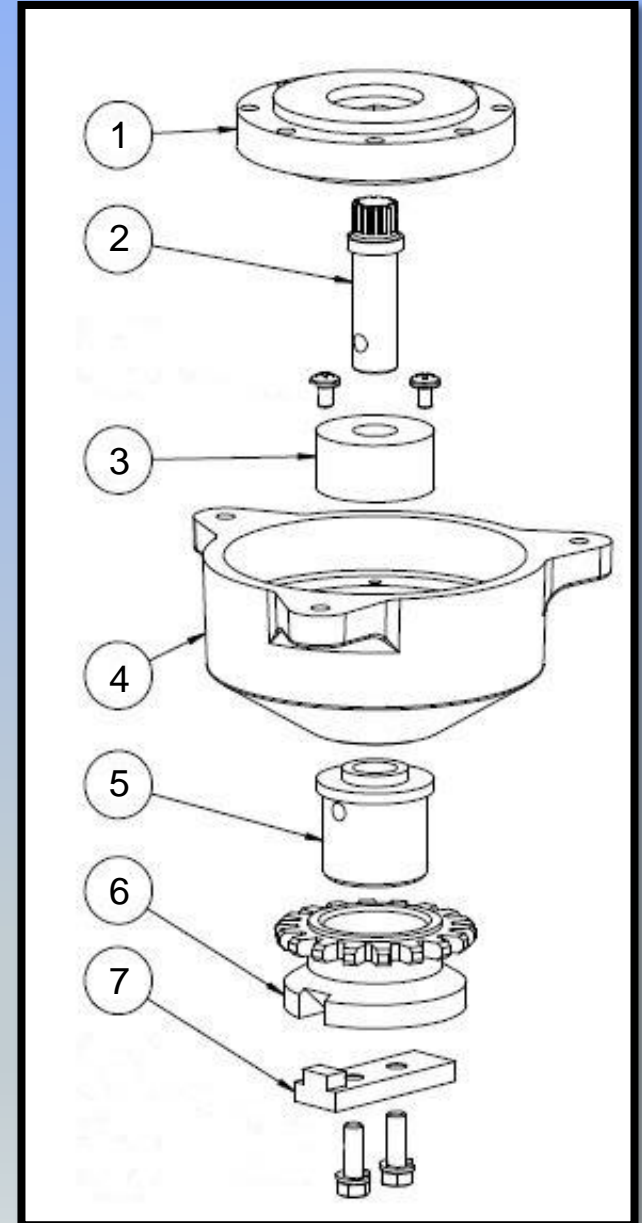
Splined Shaft and Motor Mounting



Daniel Vivolo

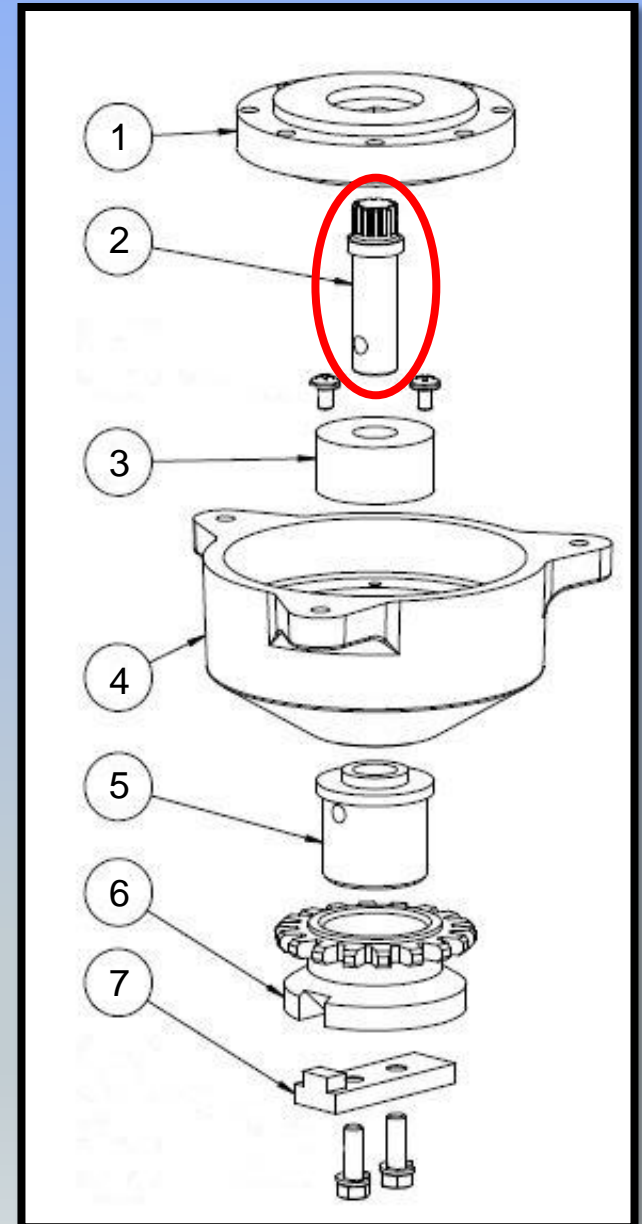
Drive Train Assembly

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



Drive Train Assembly

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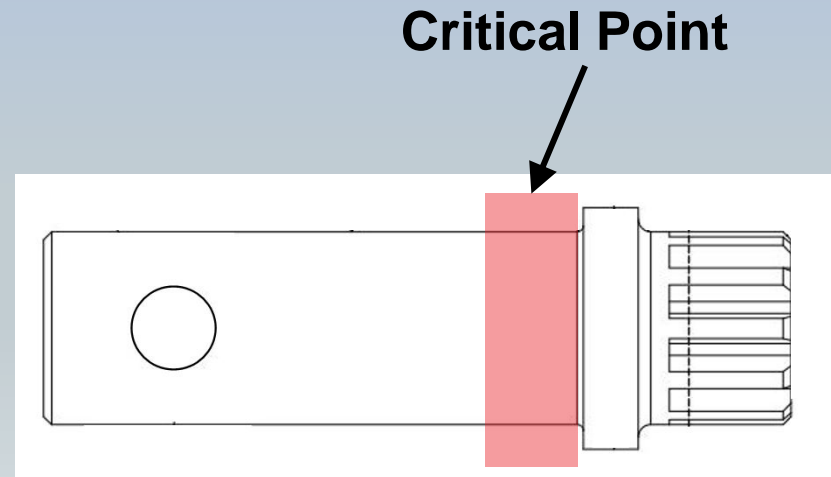


Splined Shaft Problem:

- 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



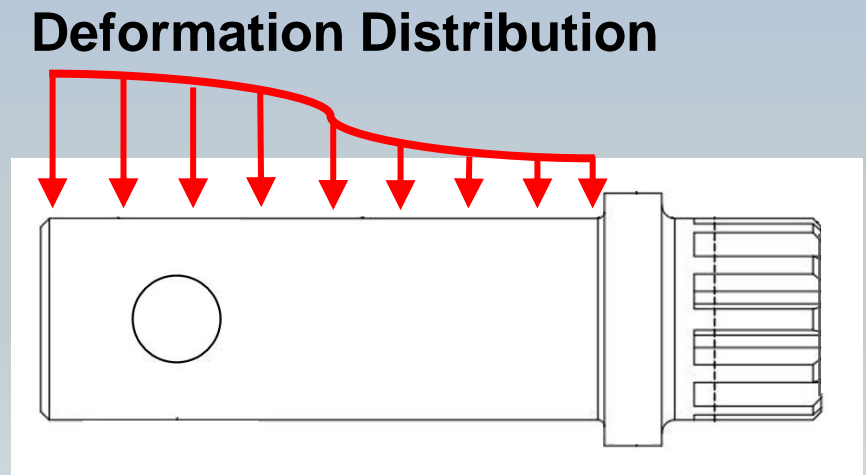
Results:

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

Splined shaft diameter

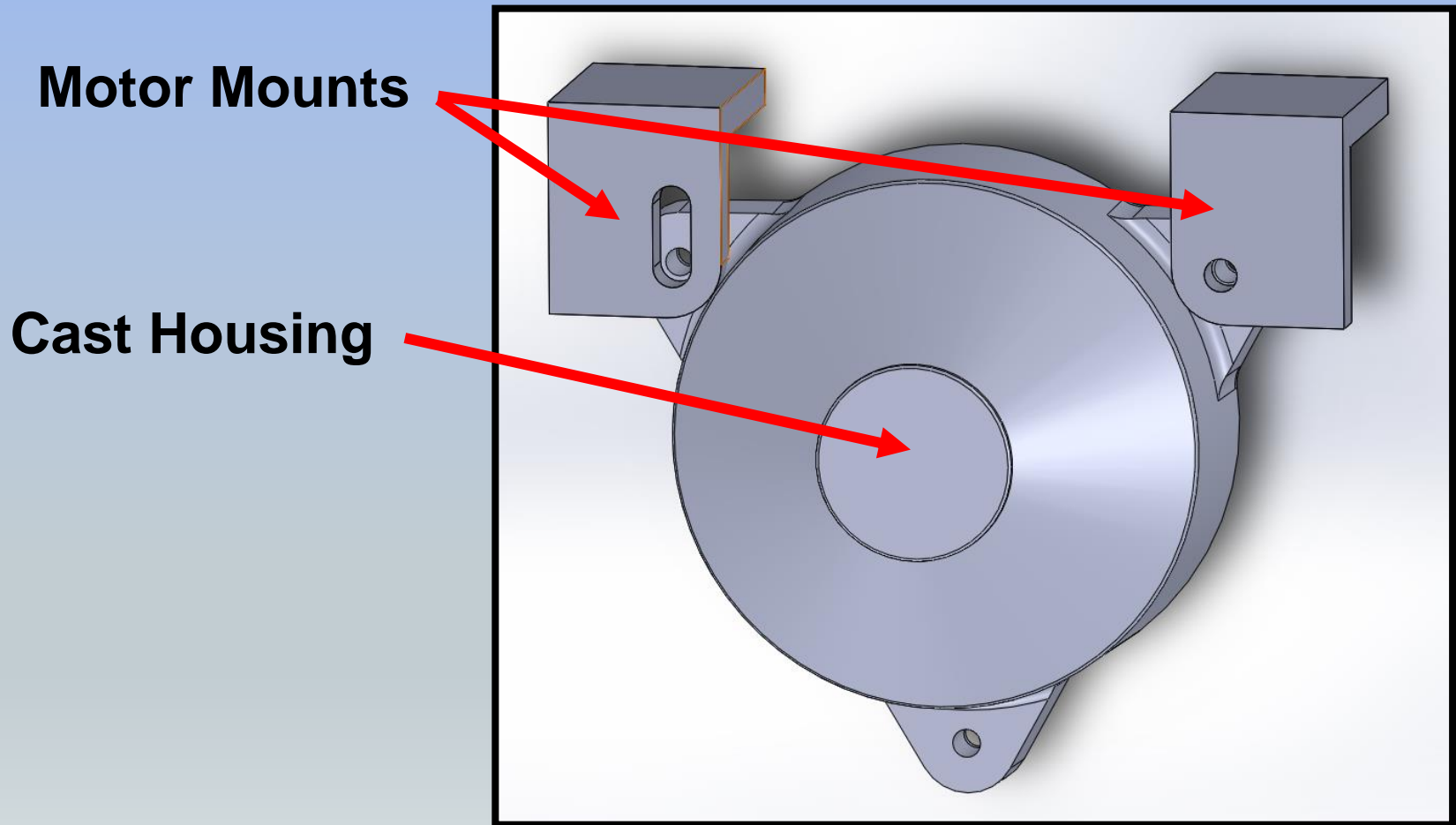
- Decreased by ~ 0.02 mm
- Deformation not uniform along length
- Diameter decreased less near flange

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



Motor Mount Redesign

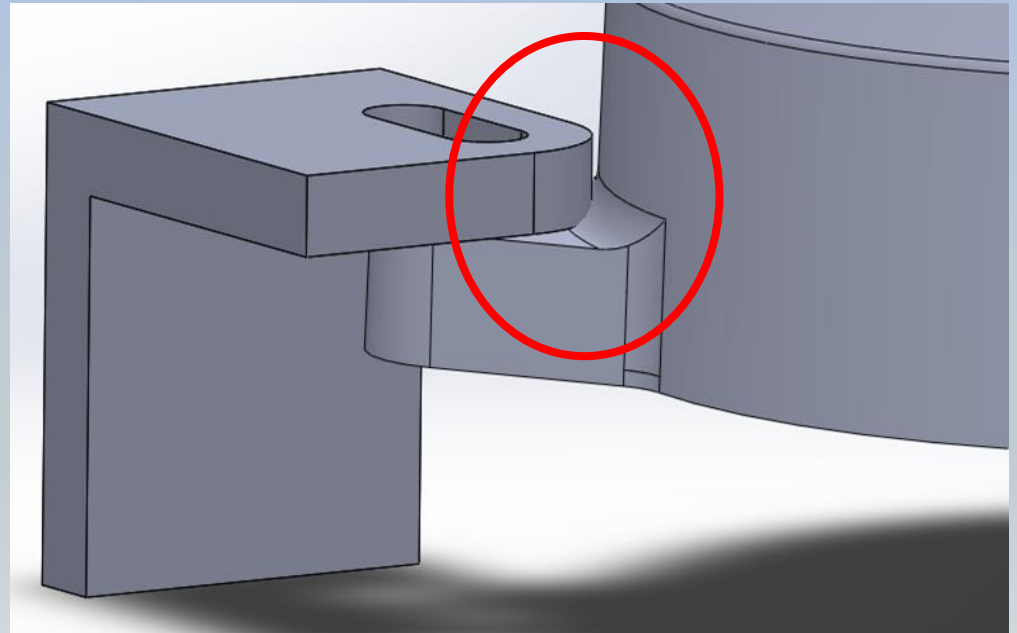
Adjustable mount to adjust chain tension



Splined Shaft Problem:

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

Cannot adjust drive train position
Chain tension



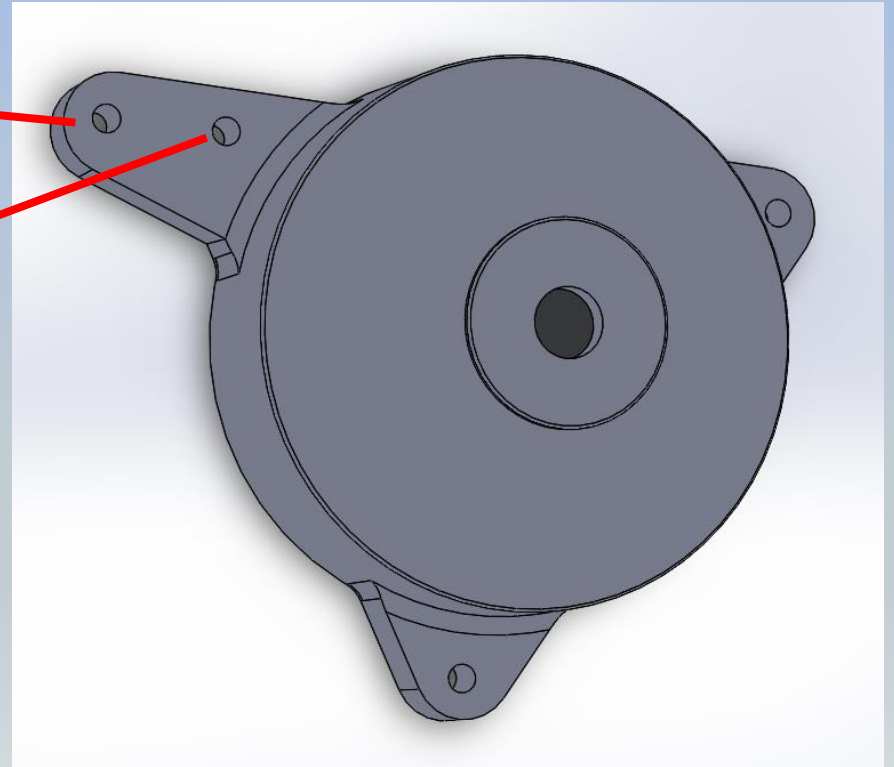
Proposed Solution

- Extend one tab and drill two holes

Must be cautious of stress at flange-housing interface

Mount

Motor

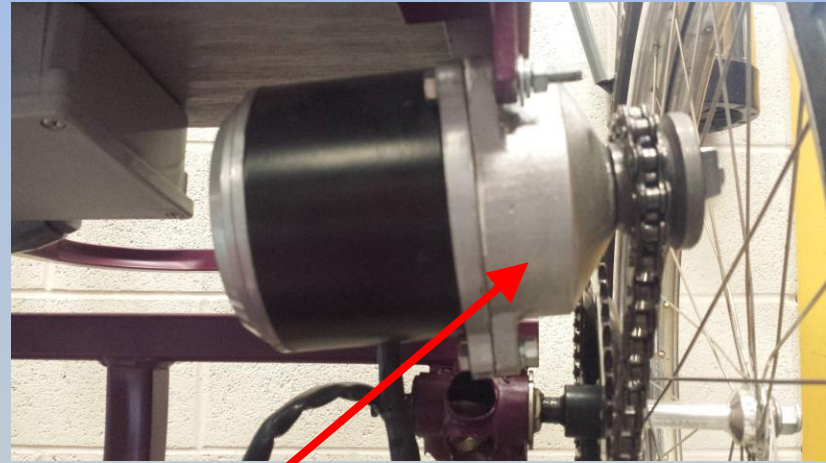
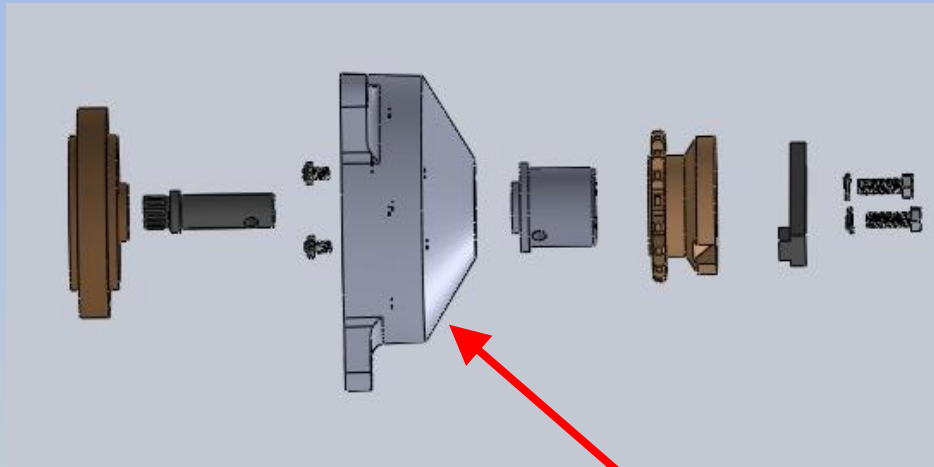


Transmission Housing: Cast Housing Process Redesign



Anders Laub & Matthew Tomasetti

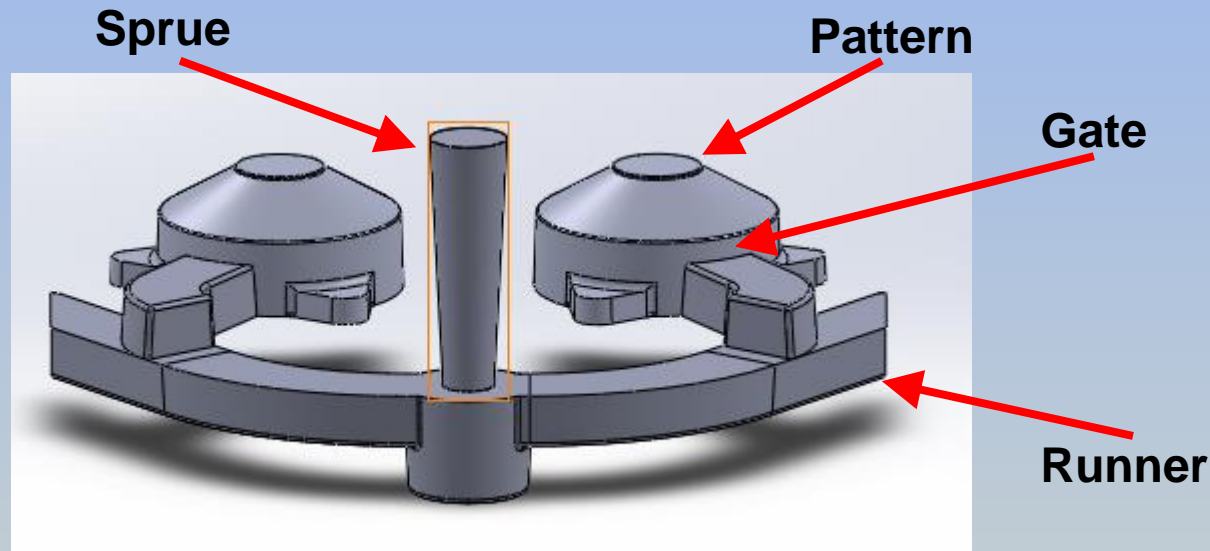
The Cast Housing



*Cast Housing
(Speed Reducer)*

Background: Sand Casting

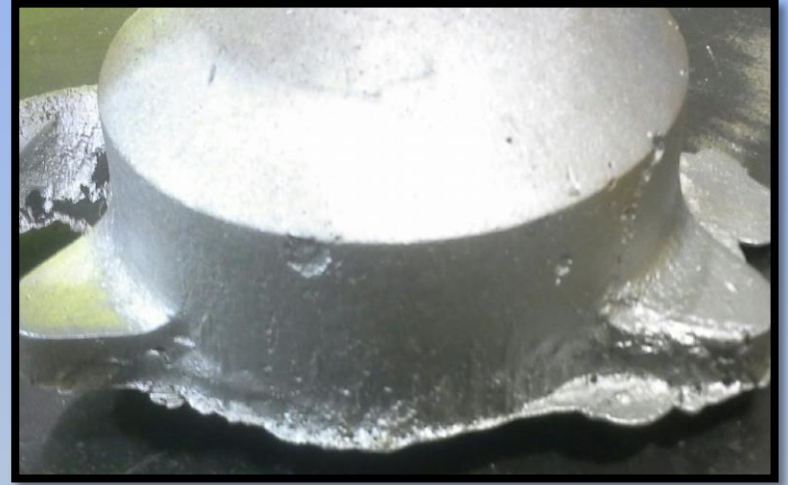
- Method of casting metal parts
- Uses a mold made of sand and an oil or water-clay binder



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

Problem:

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

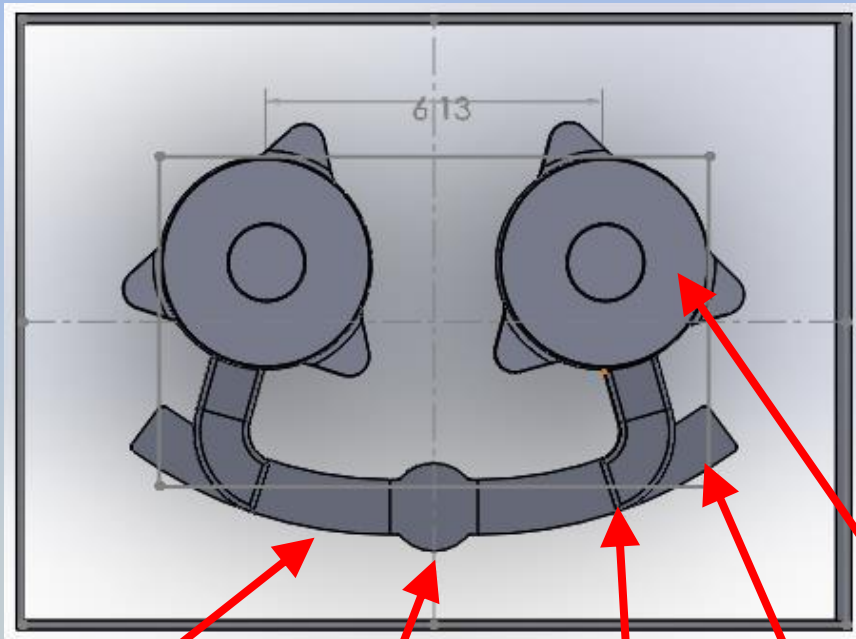


Successful Solution:

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

Layout Redesign

Assembly Top View



Runners

Well

Gate

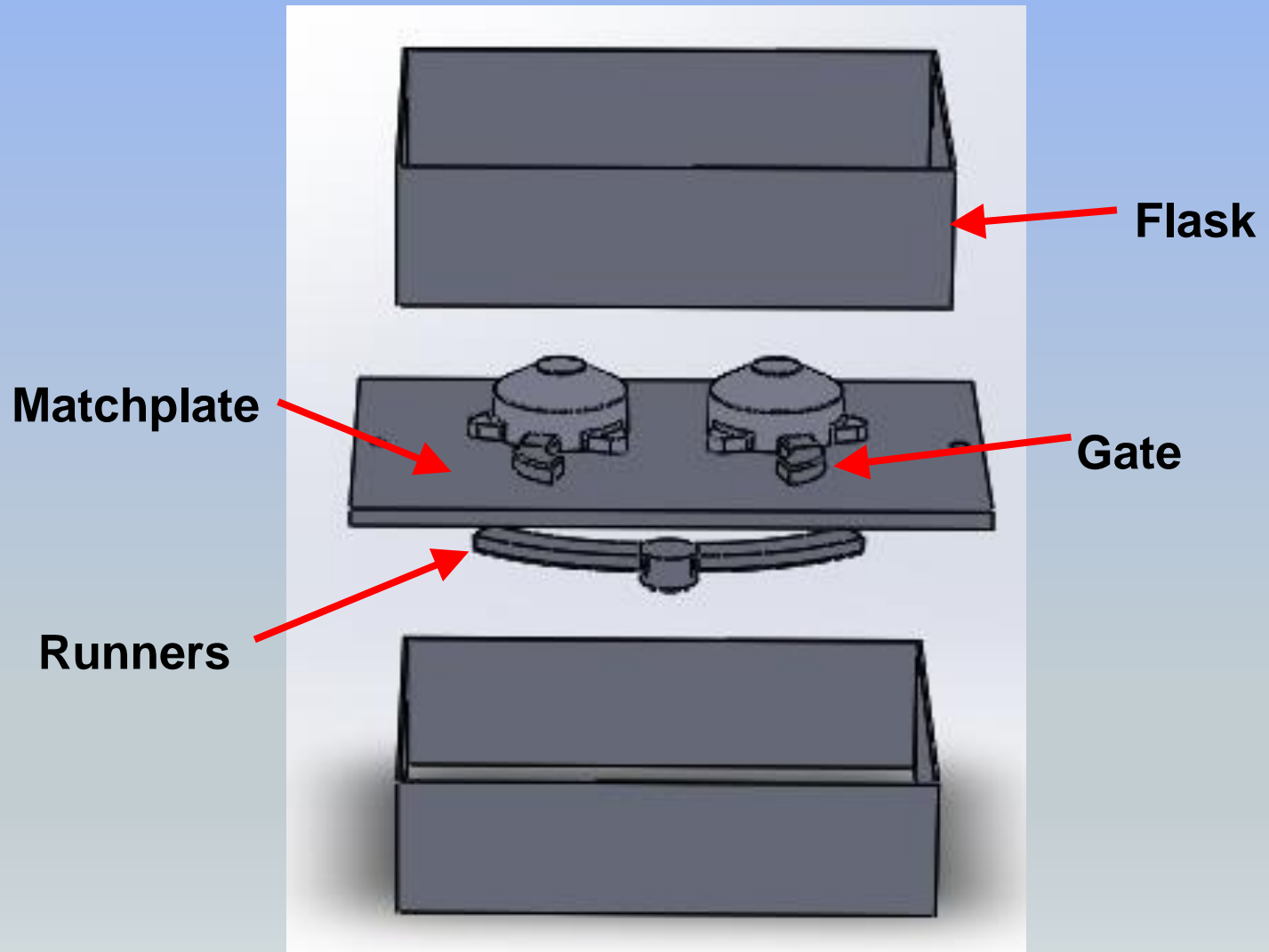
Runner Extension

Casting Pattern

*3D Printed Runner
and Gate Patterns*



Model of Pattern Assembly



Research of Foundry Tools

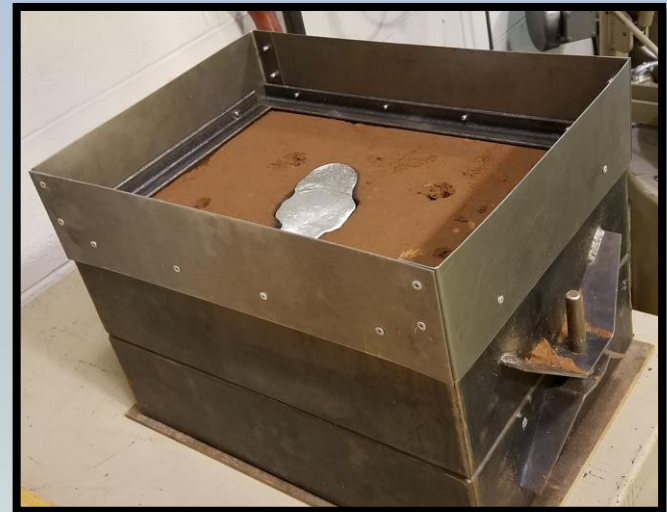
Sand Ramming

- 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

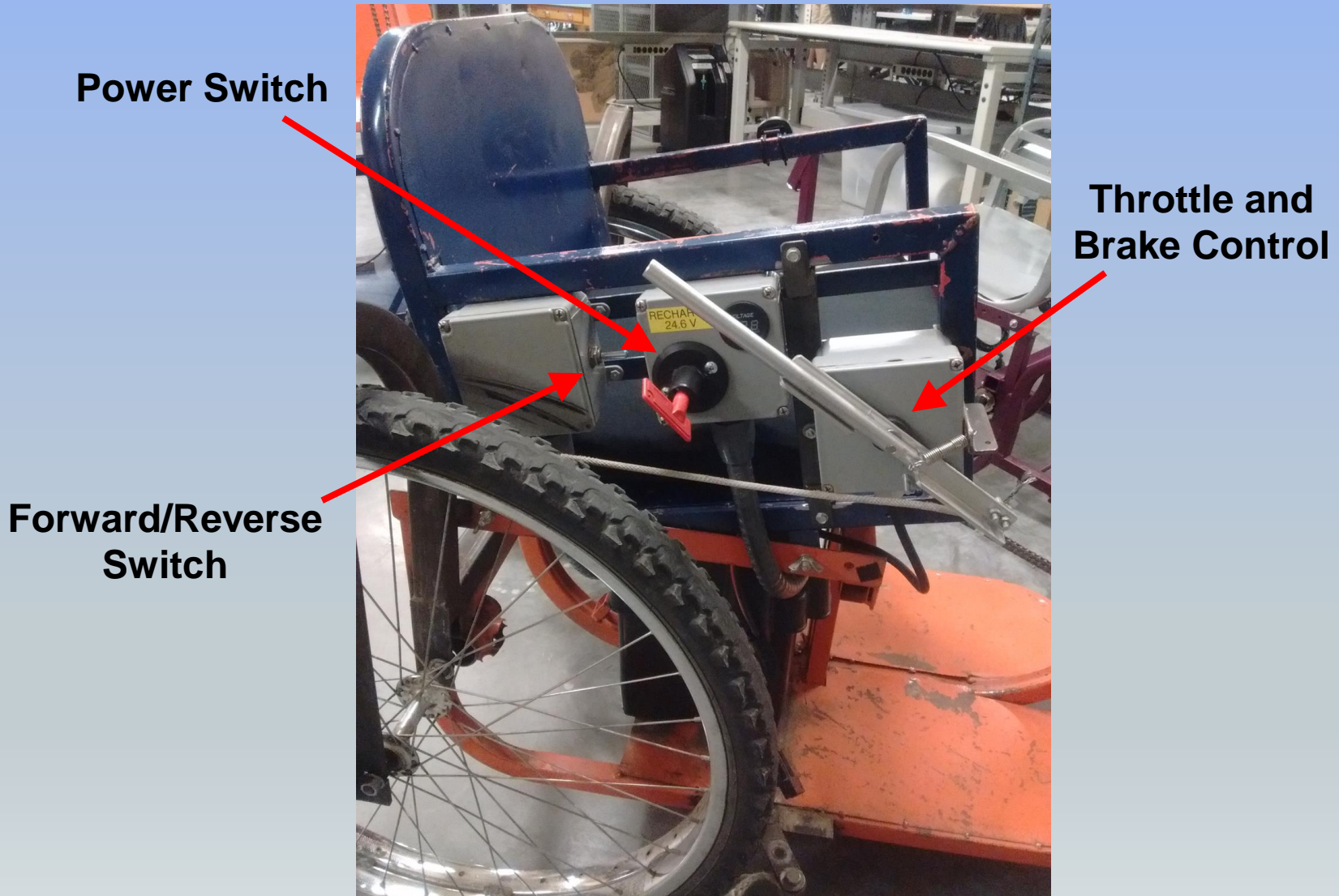


Control System: Control Box Redesign



Cordell King

Control Box Redesign



Control Box Improvements

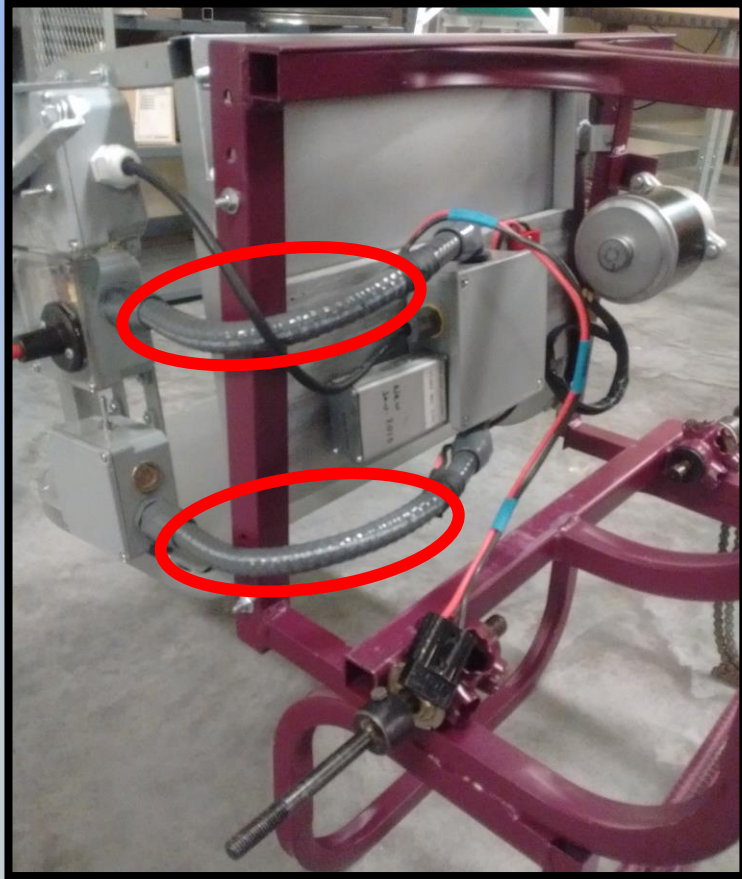


Old Design:
Three Control Boxes

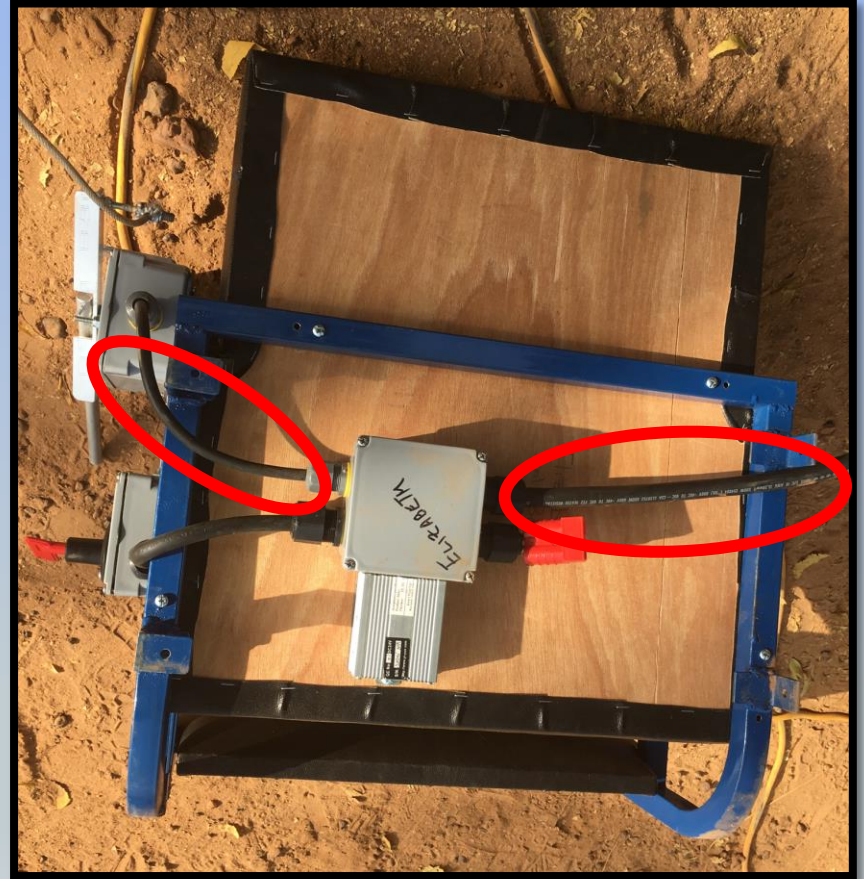


New Design:
Two Control Boxes

Easier Installation of Control Boxes



Old Design



New Design

Creating and Finalizing Production Documents

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.



Figure 19

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.

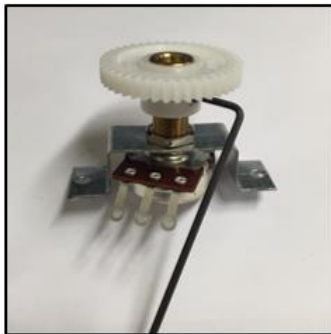


Figure 20

- Simple layout
- Clear Instructions
- Labeled Pictures

Acknowledgements

Advisors:

- Mr. John Meyer
- Dr. David Vader

Sponsors:

- Benjamin & Erin Bergen
- Kate Elizabeth Johnstone

Team Members:

- Jakob Davenport, Josh Kunkle, Morris Taylor
 - Presenting posters at 11:20am in Frey 070

Questions?

Regarding...

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

