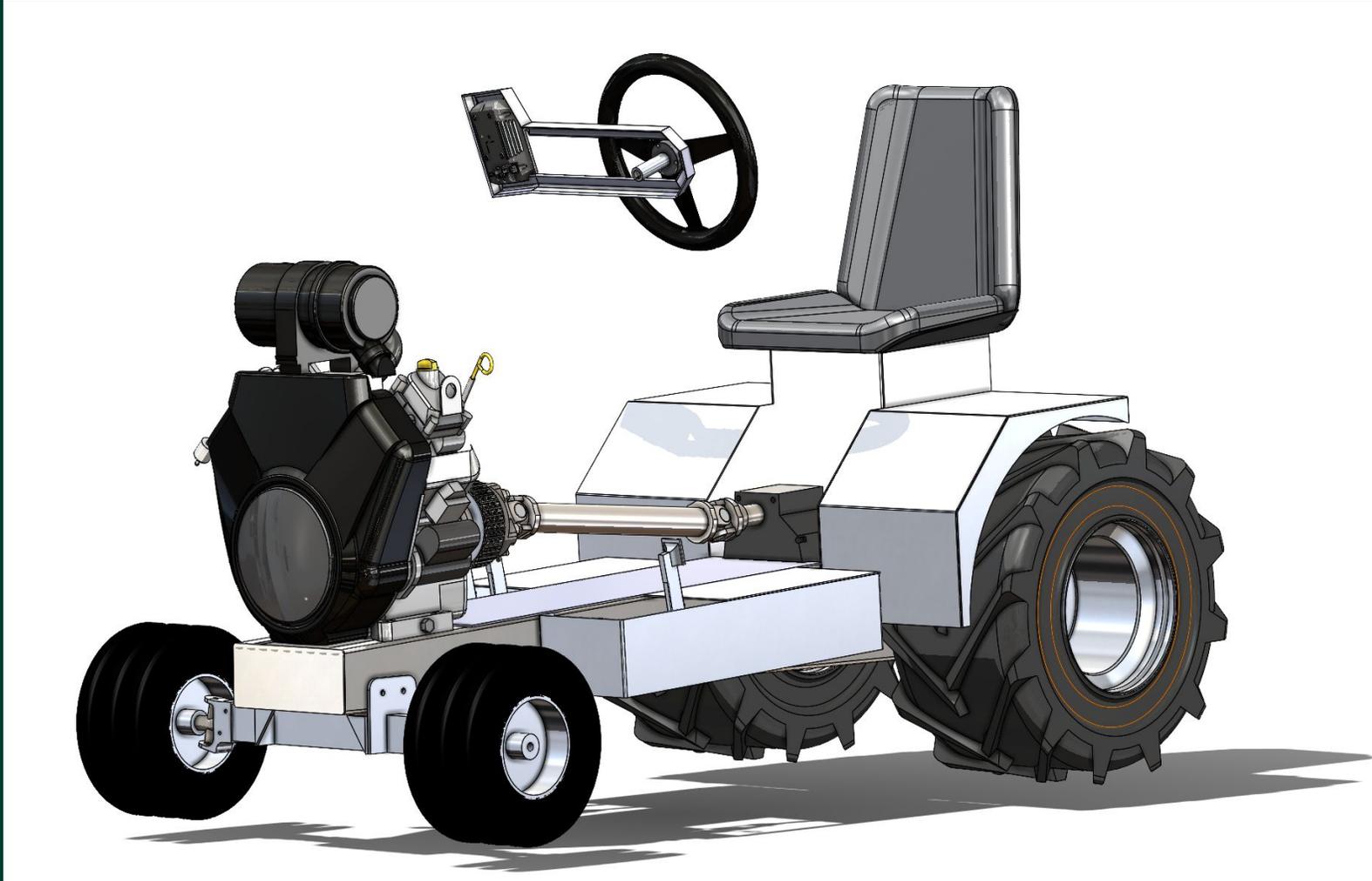


# Polybuilt

California Polytechnic State University – San Luis Obispo



## Design Concept: Specifications

### Engine

- Briggs & Stratton 31hp Vanguard V-twin

### Transaxle

- Midwest Super Cub 3 Forward & 1 Reverse Gear

### Steering

- Hydraulic Steering 2.75 Turns Lock to Lock

### Capacities

- Fuel Tank - 5.5 Quarts
- Engine Oil - 2.3L w/ Filter
- Hydraulic Oil - .5 Quart

### Dimensions

- 72" Wheel base
- 95" OAL
- 42" Max Width
- COG 23" Forward of Rear Axle

Target Customer

Small family farm owner



Needs	Features
Multi-use	Designed with space for adding implements
Easy to maintain	Adequate space to access and service drivetrain components
Durable	Aluminum in previous models was replaced with steel
Maneuverable	Greater steering radius and new steering brakes

## Market Position

Low end market position

Requirements: production  
and cost efficiency

Theory of Constraints

## Product Cost: Manufacturing, Cost, and Process Design Combined Strategy

System Strategy: Optimal *combination* of material, design, and process

Aluminum for the front axle and parallel shaft gearbox

Simple Design

CNC machining process



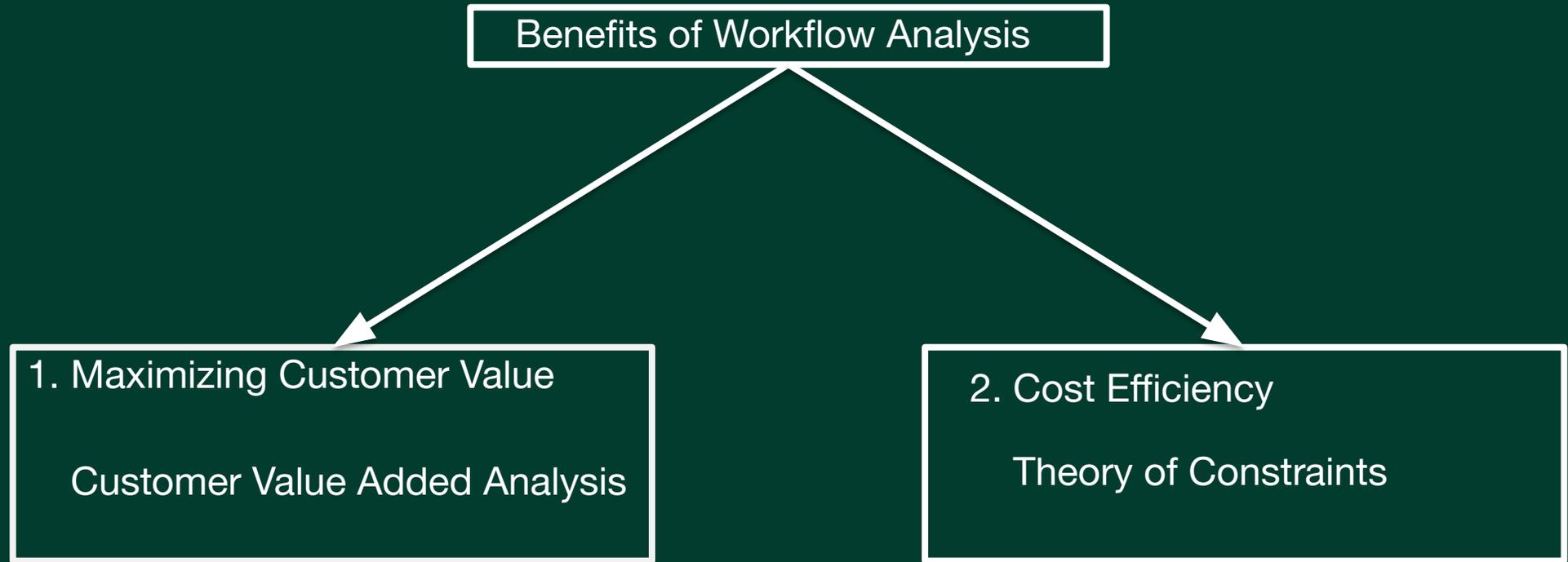
Manufacturing Strategy: Selected Lean Concepts

Prepare organized workstations

Identify and eliminate select applicable lean wastes



# Product Cost: Workflow Analysis



## Tractor Cost Overview

Profit margin	20%
Total Manufacturing Cost / Unit	\$13,546.17
Manufacturing Variable Cost	<b>\$11,779.28</b>
*Indirect Manufacturing Cost	10%
*Research and Development Cost	5%
Suggested sales price	\$16,255.00

\* = shown as a percentage of total manufacturing cost

## Decision Process for Design Details: Operator's Station

Design decision I: Steering column material

Design decision II: Frame length

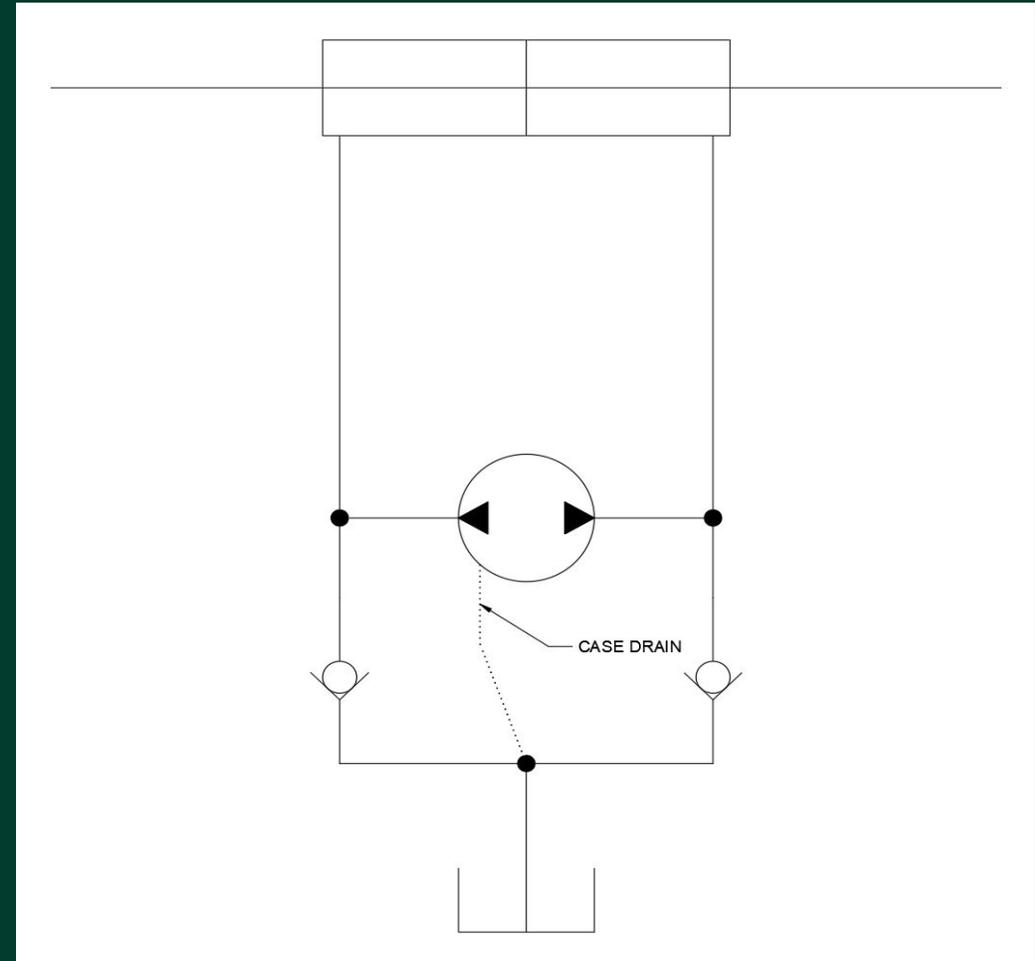


## Decision Process: Steering System Design

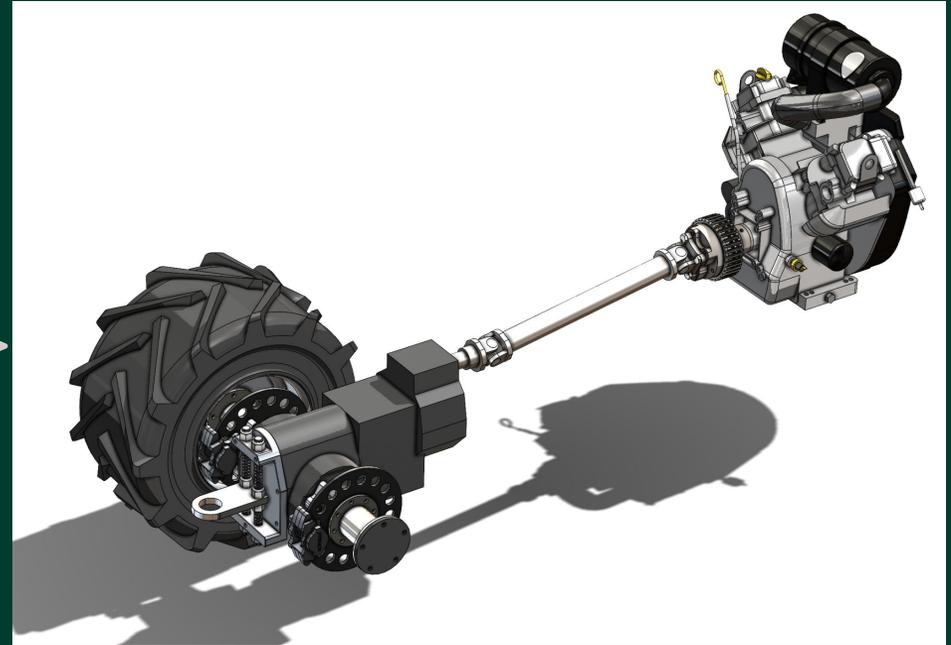
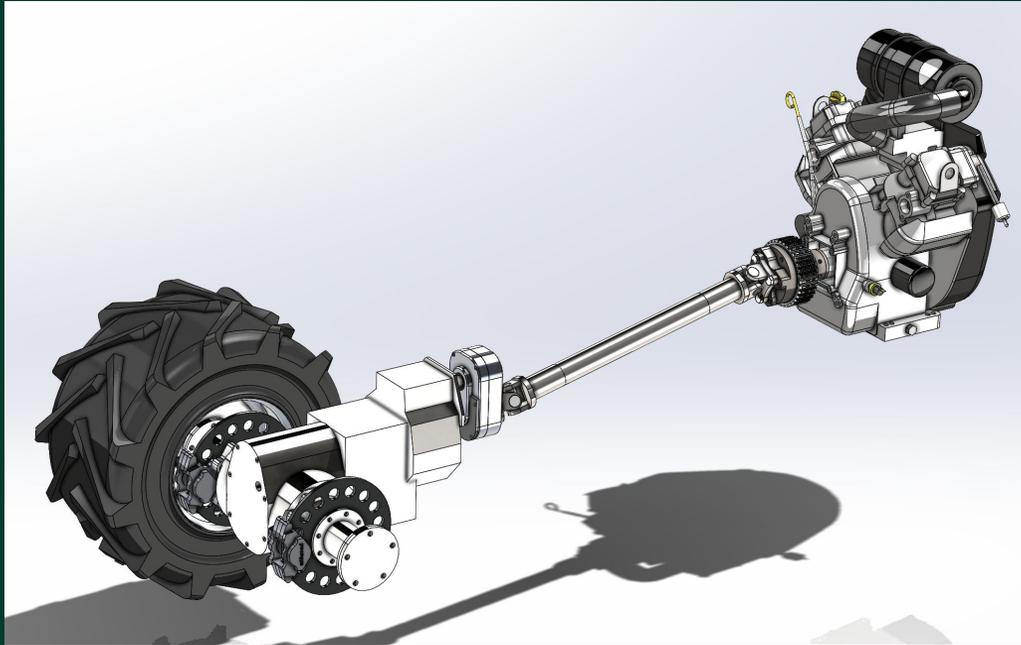
### Steering System Options

Selected:  
Hydraulic system

Alternatives:  
Rack and Pinion  
Electric



## Design Details: Drivetrain Design



## Design Verification: Brakes

### Brake Design Version I

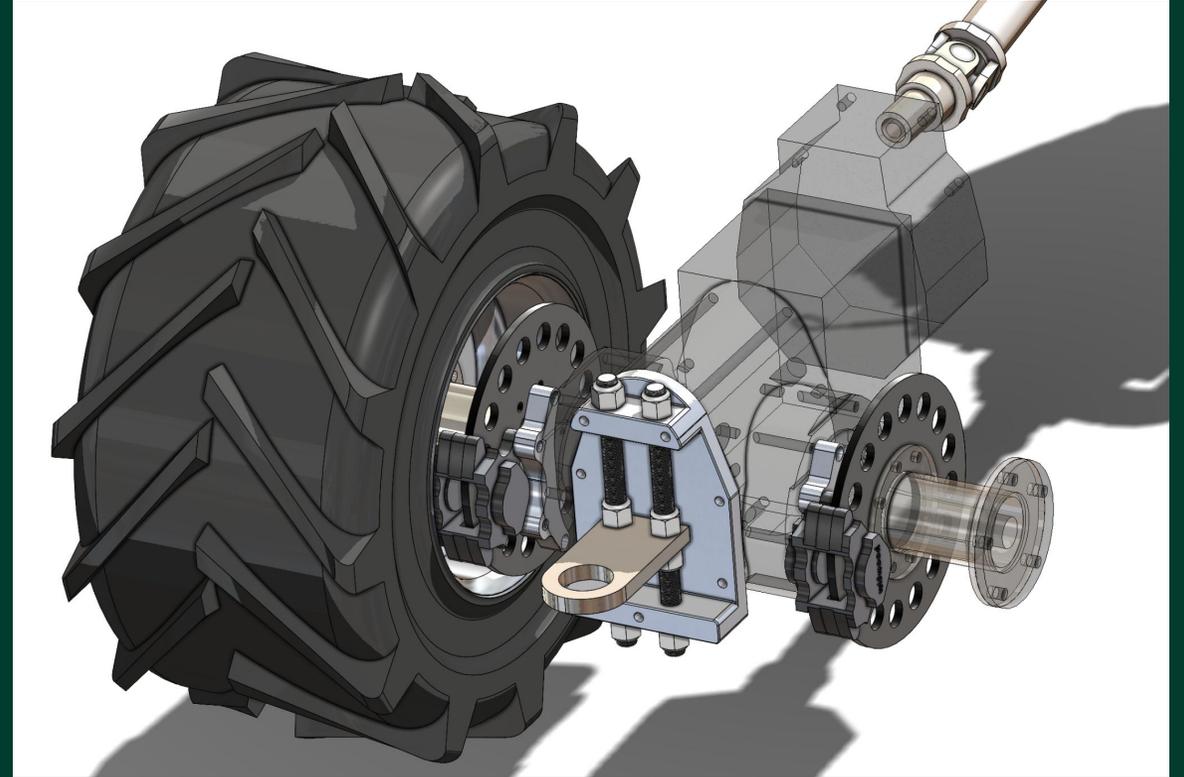
- Internal brake built into the transaxle

### Testing

- 6' moment arm on axle shafts

### Brake Design Version II

- Disk brakes on both rear wheels



Disk Brakes

## FMEA – Electric Kill Switch

Bolt connection failure

- Lock nut

Loss of battery power

- Warning message on operator's display

Wiring failure on switch end or battery end

- Final quality control test before shipping

Internal switch failure

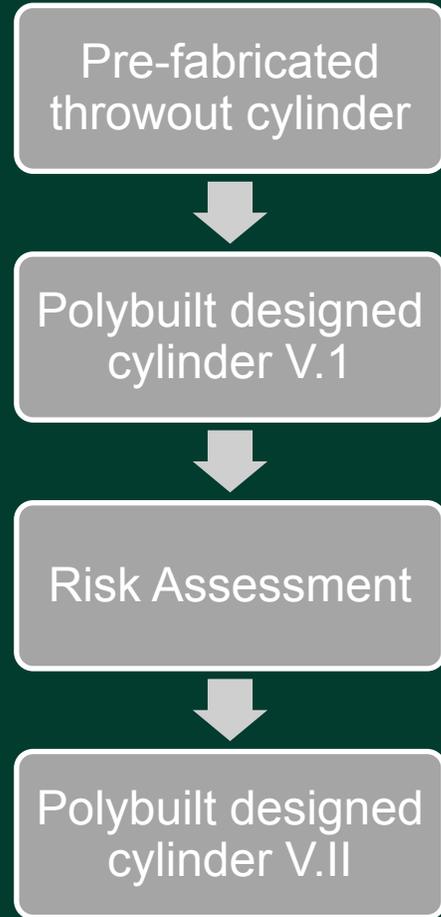
- Switch is tested 10 times before installation

Switch failure due to contaminants

- Operator's manual reminder to check the pin for contaminants after each oil change

# Risk Identification, Assessment, and Resolution

## Clutch Hydraulic Throwout Cylinder Evolution and Re-Design



Hydraulic Throwout Cylinders

## User Safety

Pressure switches on the brakes

Gear position sensor

One breakaway switch and 1 kill switch

Heat shielding improvements

## Product Liability Assessment

### Operator Safety Requirements Met:

1. Back of seat does not reach past the back of the rear tires
2. Maximum seat width of 20" and depth of 22" were not exceeded
3. Maximum backrest height of 12" was not exceeded
4. Shafts in the drivetrain are made of steel and contain safety loops

### Remaining Area of Potential Risk: Roll-over

Proposed Corrective Action: Development and testing of bars

# Polybuilt Company Organization, Team, Product, and Process Planning

Organization Structure – Matrix

Level of specialization – 3 focuses for product development

Advantages of cross functional product subsystem development teams

