

# Jobs Just Right Engineering

Members: John Locklear, Jason Johnson, and Ryan Johnson

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## **Introduction**

### ***Mission Statement***

JJR Engineering is devoted to producing current market designs that combine customer satisfaction and quality products at the highest levels.

### ***Problem Statement***

JJR Engineering strives to produce a tractor mounted weed trimmer product for M&M Engineered Products. The design should include but not limited to:

- 3 point mounted, PTO powered
- Ability to mow/cut/trim grass, weeds, and small brush (under 1 inch).
- The cutting should work adjacent to either side of the tractor.
- Work in and around buildings, fences, ponds, and structures.

Design is open to changes suggested from client or from other unforeseen issues.

### ***Scope of Work***

The project is to build a PTO powered weed eater for the client, M&M Engineered Products. The client has given a list of specifications, JJR Engineering has added to the list, which is summarized below.

- 3 point mounted, PTO powered.
  - Client desires designing for CAT I but needs to function on CAT II.
- Ability to mow/cut/trim grass, weeds, and small brush.
- The cutting should work adjacent to either side of the tractor.
- Work in and around buildings, fences, ponds, and structures.
- The client needs to be able to fabrication easily and cost effective, the best manufacturing practice for M&M Engineered Products.

A list of task to accomplish the above goal is summarized below.

1. Find and summarize the current market products.
2. Test material for the blade(s) for cutting head.
  - i. Test different blade types (plastic, metal, and composite).
  - ii. Test different blade shapes.
  - iii. Test blade(s) in different length/type of crops.
3. Design and model the complete product.
  - i. Initial hand sketches.
  - ii. Hand calculations.
  - iii. SolidWorks modeling.
  - iv. Finite element analysis of computer model.
  - v. Manufacturing drawings.
4. Build completed design that has been approved by client.
5. Test completed product to make sure that it meets acceptance criteria.
  - i. Testing on different tractors.
  - ii. Testing on different crop (like ones before).

- iii. Testing in different conditions.

### *Applicable Standards*

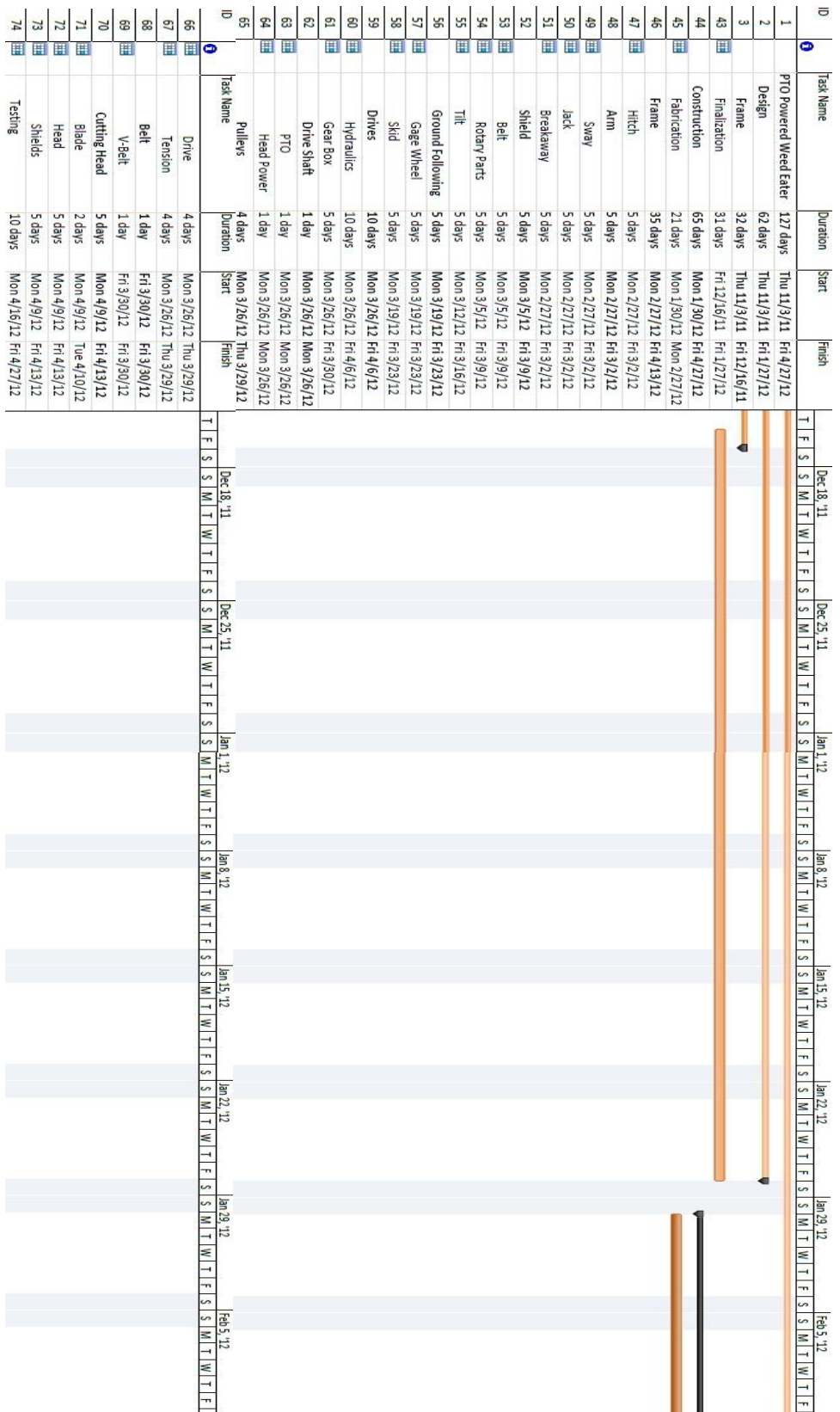
- Agricultural Rotary Mower Safety – ASAE S471.1
- Three Point Hitch Specifications – ISO 730:2009
- Agricultural Blade Specifications – ISO/CD 5718

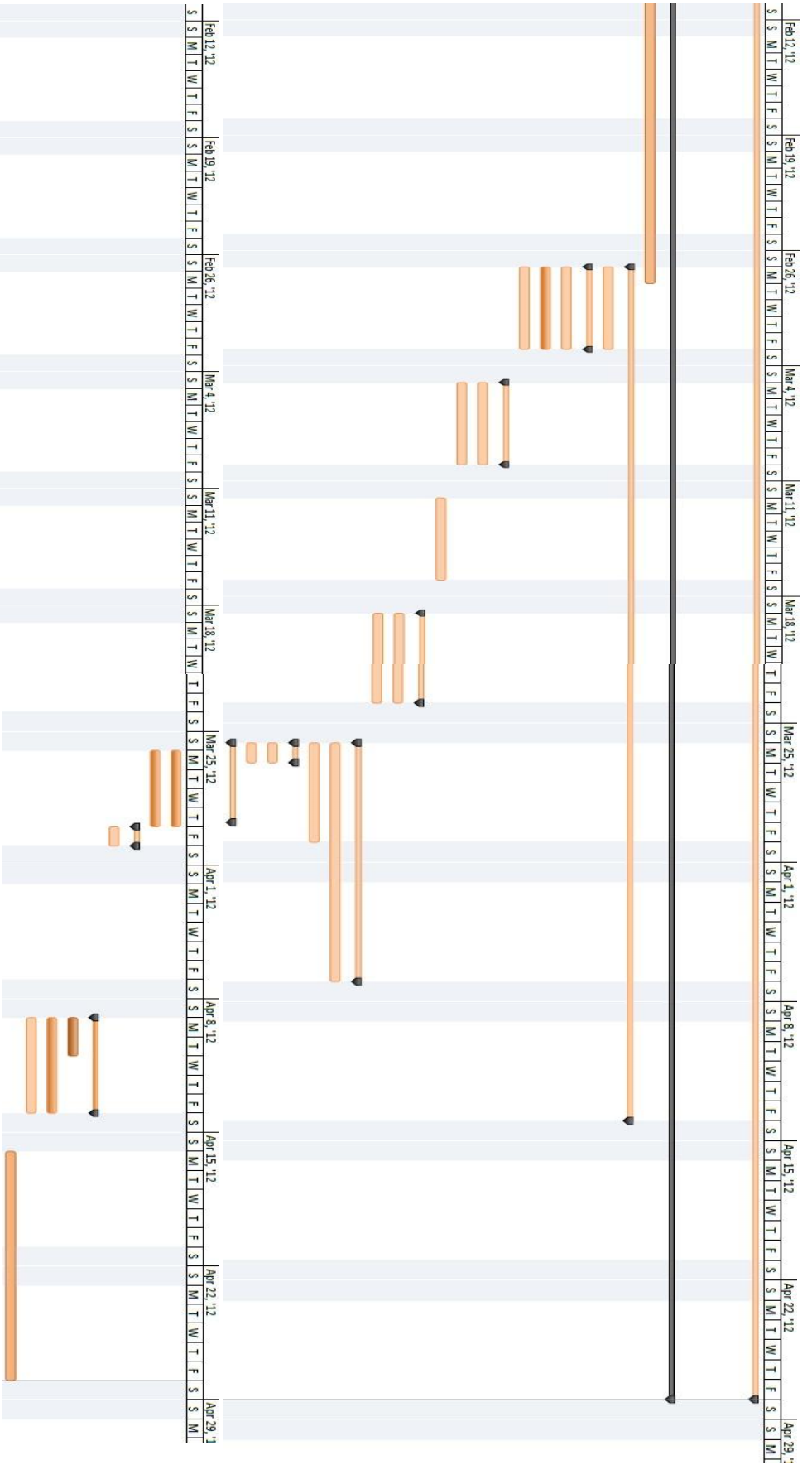
These standards apply to our project where some design constraints are governed by the standards. There are no apparent issues at the time.

### *Acceptance Criteria*

- 3 point mounted (CAT I/II), PTO powered
- Ability to mow/cut/trim grass, weeds, and small brush (under 1 inch).
- The cutting should work adjacent to either side of the tractor.
  - Ability to work in seven different designed positions.
- Work in and around buildings, fences, ponds, and structures.
- The client needs to be able to fabrication easily and cost effective.

# Gantt Chart For Spring Semester





## **Design Concept**

We started out the semester with three different design concepts that we developed in the previous semester: an all belt driven model, a gearbox and belt driven model, and a hydraulic driven model. For more information on the three models see Appendix C. In January, JJR Engineering meet with our client, M&M Engineered Products, to talk about which model of the three would be further developed. During the meeting M&M Engineered Product decided on the hydraulic driven model.



*Figure 1 - The Tractor Trimmer as a prototype.*

## **Model Decision**

In choosing the model for fabrication, JJR Engineering and M&M Engineered Products discussed the adaptability, the parts count, and overall structure of the Tractor Trimmer. The most important feature that was helpful to decide on which model to choose was the adaptability of the hydraulic model to be used on both newer/larger horsepower tractors with their hydraulic remotes and skid steer applications. Another adaptability feature of the current model is that the structure of the arms can be easily modified to new lengths. Both of the features allow for new models to be made, if desired, for more flexibility to a customer's needs. Another feature that aided in the decision was that there are lower manufactured parts for the design than the other models. This aspect of the design has allowed JJR Engineering to create the design that is cleaner looking than the other models.



*Figure 2 - Final CAD Design.*

### ***Structure Design***

While designing the Tractor Trimmer, JJR Engineering overbuilt aspects of the project to help with prototype testing. The major components for the project, like the arm, were designed to be made out of 3/8" steel to prevent any structural damage. Any smaller parts for the Tractor Trimmer were designed using 1/4" steel. The smaller parts consist of anything dealing with brackets and tabs.

### ***Hydraulic System Design***

The hydraulic system was designed in conjunction with Aberdeen Dynamic in Tulsa, OK. The system was determined to need a PTO powered pump, hydraulic motor, reservoir, filter, and a control system. JJR Engineering was limited in the PTO pumps available, so first a pump was chosen. The pump chosen was a Chief PTO pump (Bailey net #252-567), rated for a max flow of 7.2 GPM, with a displacement of 3.41 in<sup>3</sup>/rev (Figure 3). The Tractor Trimmer had a desired cutting head speed of 3000 RPM, so a change in displacements was needed to achieve this. The calculations to find the proper motor displacement are outlined below.

$$\text{Displacement Ratio} = \frac{\text{Speed of Output}}{\text{Speed of Input}}$$

$$\text{Displacement Ratio} = \frac{3000 \text{ RPM}}{540 \text{ RPM}}$$

$$\text{Displacement Ratio} = 5.56$$



$$\text{Motor Displacement} = \frac{\text{Pump Displacement}}{\text{Displacement Ratio}}$$

$$3.41 \text{ in}^3/\text{rev}$$

$$\text{Motor Displacement} = \frac{\quad}{5.56}$$

$$\text{Motor Displacement} = 0.61 \text{ in}^3/\text{rev}$$

JJR Engineering worked with Aberdeen Dynamic to find a motor that would not only fit the displacement requirement, but be cost effective and readily available. The motor that was chosen was a Parker gear motor (3349210100), with a displacement of 0.67in<sup>3</sup>/rev (Figure 4). This motor also has a relatively small overall height (~4”) which works well for the application. With this combination of pump and motor, not accounting for efficiency losses, the theoretical cutting head speed would be 2750 RPM ((3.41/.67)\*540), which was acceptable for prototyping purposes.

At the cutting head JJR Engineering assumed that a 10 horsepower load was more than adequate, because most small push lawnmowers have a 5 to 6 horsepower motor. JJR Engineering had to ensure that this motor and pump combination would satisfy these load requirements. Our validation for this is outlined in the equations below. This pressure of ~2400 PSI fell within the capabilities of our chosen motor, and the amount of pressure that the pump can produce.

$$\text{Hydraulic Horsepower} = \frac{\text{Flowrate (GPM)} * \text{Pressure (PSI)}}{1714}$$

$$10 = \frac{7.2 * \text{Pressure}}{1714}$$

$$\text{Pressure} = \frac{10 * 1714}{7.2}$$

$$\text{Pressure} = 2380 \text{ (PSI)}$$

Once the pump and motor were selected, the rest of the hydraulic system was designed and specified with the aid of Aberdeen Dynamic and Fluid Specialties. A two way directional control valve (DCV) with a pressure relief was added to the system. This allowed for the motor to “spin down” and give the system a slip point. Figure 5 shows a schematic of the hydraulic system, Figures 6 and Table 1 show a picture and a list of all the hydraulic components with their part numbers.

# PTO Gear Pump Model GP-PTO

## Technical Data

Model GP-PTO is a PTO driven Gear Pump constructed with cast iron end plates and is available with aluminum or cast iron center/gear section. It offers 4 displacement sizes from 3,41 to 9,76 cu. in/rev (56 to 160 ml/rev). Standard drive is 1 3/8 diameter 6 tooth female splines.



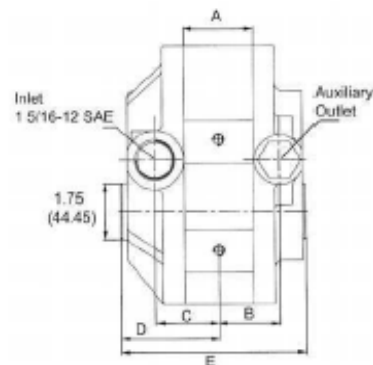
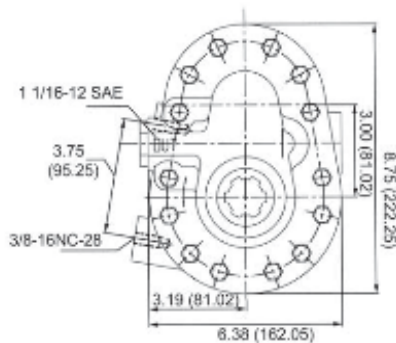
Model	Displacement		Pressure		Speed RPM		Weight	
	cu.in/rev	cm3/rev	PSI	Mpa	Rated	Max	Lbs.	Kg
GP-PTO-9	9,76	160	2500	17,25	540	595	40	18
GP-PTO-7	7,62	125	2500	17,25	540	595	38	17
GP-PTO-5	5,50	90	2500	17,25	540	595	36	16
GP-PTO-3	3,41	56	2500	17,25	540	595	33	15

Recommended working conditions:

1. FILTRATION 10 micron or better
2. OIL VISCOSITY 6 to 200 cSt
3. INLET PRESSURE 12 to 32 psi abs.
4. OIL TEMPERATURE -25 to 55 degrees C (-12 to 175 degrees F).
5. AMBIENT -22 to 55 degrees C (-8 to 130 degrees F).

Flow rate in gpm  
 Displacement (cu.in/rev) X speed (rpm) / 231  
 Volumetric efficiency % ≥93

## Installation Data



Model	A		B		C		D		E	
	mm	In.	mm	In.	mm	In.	mm	In.	mm	In.
GP-PTO-9	60.3	2.37	53.1	2.09	55.6	2.19	85.1	3.35	161.3	6.35
GP-PTO-7	50.9	2.00	48.5	1.91	50.8	2.00	80.3	3.16	151.6	5.97
GP-PTO-5	41.25	1.62	43.7	1.72	46	1.81	75.4	2.97	142.2	5.60
GP-PTO-3	32.1	1.26	39.1	1.54	41.4	1.63	70.6	2.78	132.8	5.23

Port Sizes  
 Inlet - SAE-16 (1 5/16-12)  
 Outlets - SAE-12 (1 1/16-12)

## Ordering Information

<b>GP</b>	-	<b>PTO</b>	-	<b>A</b>	-	<b>9</b>	-	<b>6</b>	-	<b>S</b>
Gear Pump		PTO Driven Series		Center Section A - Aluminum C - Cast Iron*		Displacement cm3/rev (see chart) 3,5,7,9		Drive Required 6 - 6 tooth spline 21 - 21 tooth spline*		Port Location S - Side ports

\* Special order only

Figure 3 - This is the pump configurations.

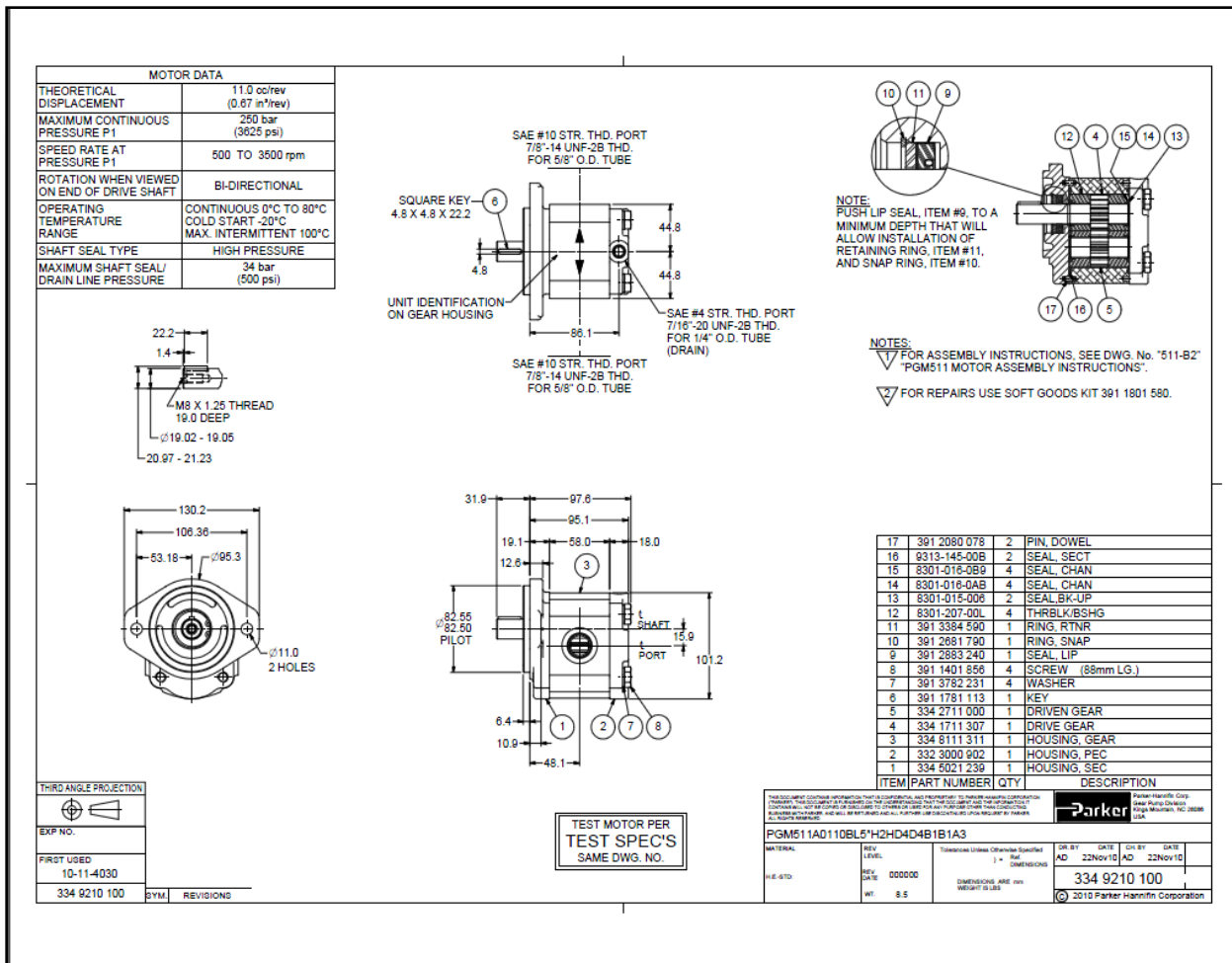


Figure 4 - The specifications for the motor.

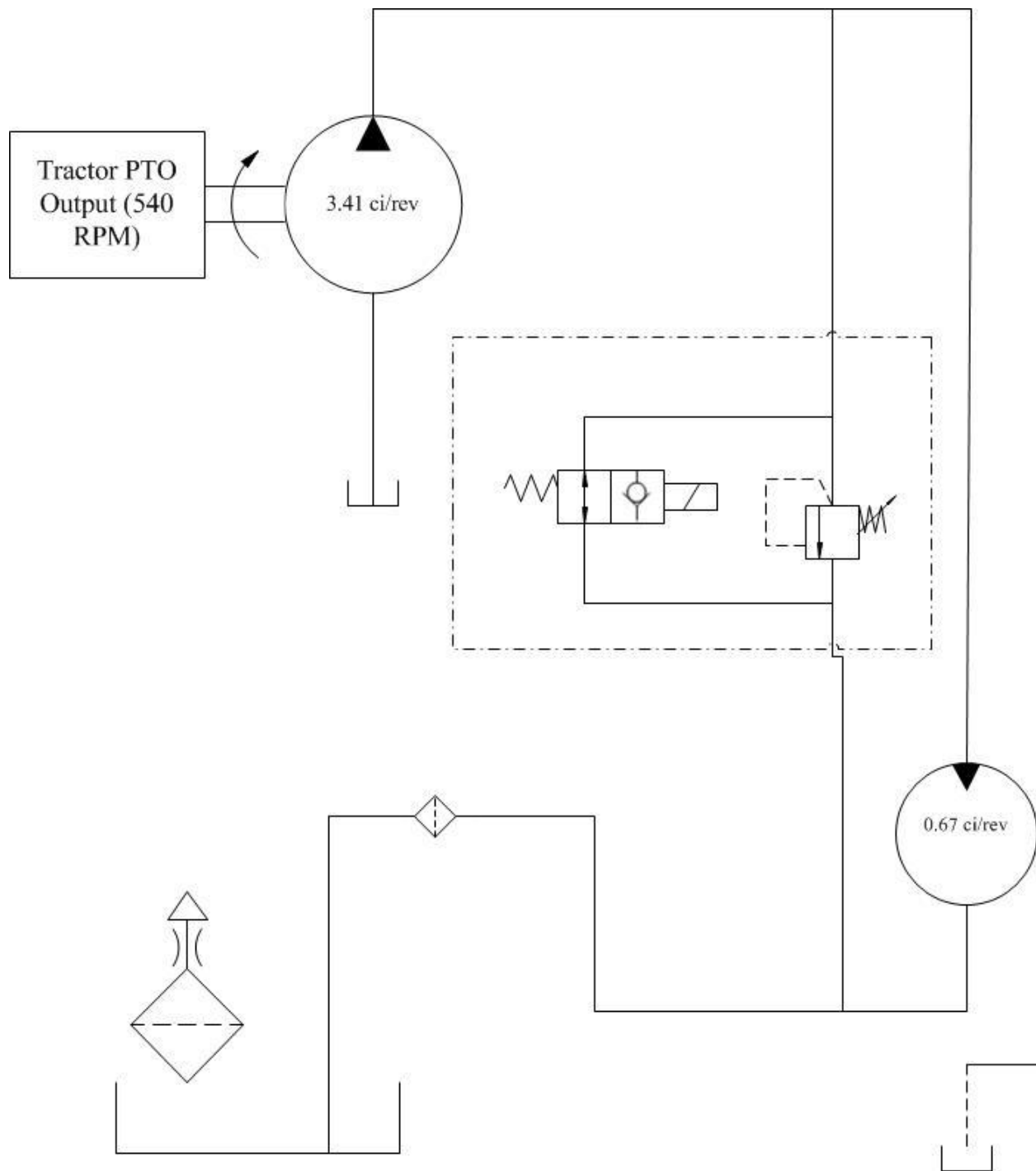


Figure 5 - Hydraulic system schematic.

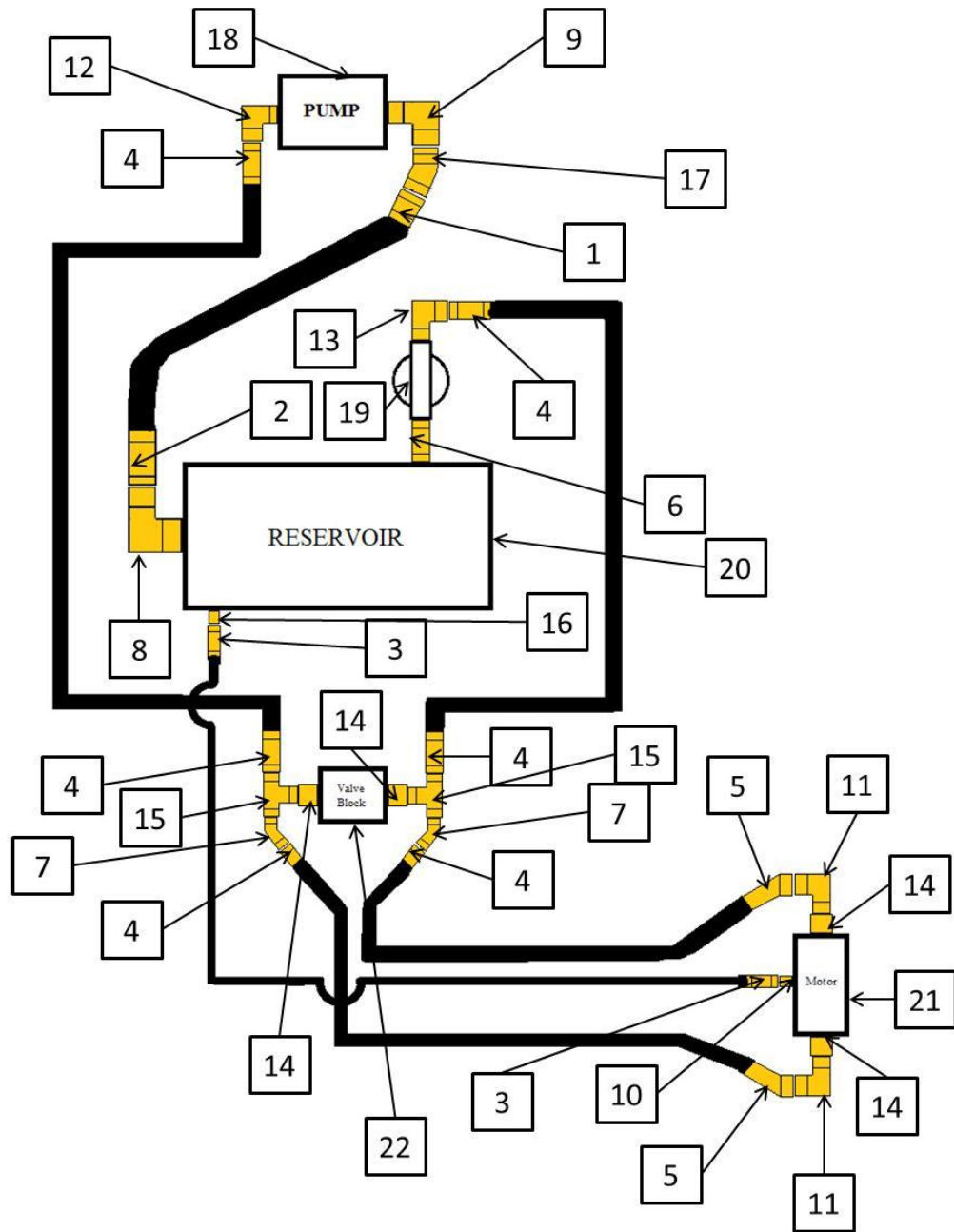


Figure 6 – Parts layout for the hydraulic system.

Picture #	Description	Supplier	Brand	Part Number	Qty.
1	Crimp on Hose Fitting (1" Hose), Female JIC	Fluid Specialties	Parker	10643-16-16	1
2	Crimp on Hose Fitting (1" Hose), Female JIC	Fluid Specialties	Parker	10643-20-16	1
3	Crimp on Hose Fitting (1/4" Hose), Female JIC	Fluid Specialties	Parker	10643-4-4	2
4	Crimp on Hose Fitting (1/2" Hose), Female JIC	Fluid Specialties	Parker	10643-8-8	6
5	45° Crimp on Hose Fitting (1/2" Hose), Female JIC	Fluid Specialties	Parker	13743-8-8	2
6	Male Pipe (3/4") to Male Pipe (3/4") Adapter	Fluid Specialties	Parker	3/4 FF-S	1
7	45° Swivel -8 FJIC X -8 MJIC ADAPTER	Fluid Specialties	Parker	8 V6X-S	2
8	90° Fitting Male Pipe(1 1/2") to Male JIC	Fluid Specialties	Parker	TLOK 20-24 CTX	1
9	90° Fitting Male SAE Straight (SAE 16) to Male JIC	Fluid Specialties	Parker	TLOK 16-C5OX-S-BP	1
10	Male SAE Straight Thread (SAE #4) to Male JIC Adapter	Fluid Specialties	Parker	TLOK 4-6 F5OX	1
11	90° Fitting Male SAE Straight to Male JIC	Fluid Specialties	Parker	TLOK 8-10-C5OX-S-BF	2
12	90° Fitting Male SAE Straight (SAE 12) to Male JIC	Fluid Specialties	Parker	TLOK 8-12-C5OX-S	1
13	90° Fitting Male Pipe to Male JIC	Fluid Specialties	Parker	TLOK 8-12-CTX-S	1
14	Male Straight Thread to Male JIC Adapter	Fluid Specialties	Parker	TLOK 8-F5OX-S-BP	4
15	Female JIC to Male JIC Tee	Fluid Specialties	Parker	TLOK 8-S6X-S	2
16	Male Pipe Thread (3/8") to Male JIC Adapter	Fluid Specialties	Parker	4-6 FTX-S	1
17	45° Swivel JIC to JIC Adapter	Fluid Specialties	Parker	16 V6X-S	1
18	PTO Pump	Baileynet.com	Chief	252-567	1
19	Filter Kit	Aberdeen	Parker		1
20	Reservoir	Baileynet.com	N/A	202-258	1
21	Motor	Aberdeen	Parker	3349210100	1
22	Control/Relief Block	Aberdeen	Aberdeen	M4976H	1

Hose Number	Length (in)	Ends (Picture Numbers)	Hose Diameter (in)	Part Number	Qty.
1	28	1,2	1	881-0606-20-16-16 X 28" OAL	1
2	42	4,4	0.5	451TC-0606-8-8-8 X 42" OAL	1
3	81	4,5	0.5	F451TC-0637-8-8-8 X 81" CNTR	2
4	35	4,4	0.5	451TC-0606-8-8-8 X 35" OAL	1
5	108	3,3	0.25	451TC-0606-4-4-4 X 108" OAL	1

Table 1 - Chart of the hydraulic components used for the system.

## ***Machine Function***

### ***Lateral Tilt Plate***

The lateral tilt plate (LTP) is a feature on the Tractor Trimmer that allows the trimmer to better follow the ground by rotating within a bushing that is attached to the three point A-frame. The other function that the LTP provides is the ability to change the cutting orientation from only cutting on the right side, like other competitors, to being in six other positions within 180° of the starting right side position. This allows the customer to have a variety of cutting techniques that our competitors do not provide. These techniques include but are not limited to mowing between narrow obstacles as well as reaching the lower bowl of shallow ditches.



*Figure 7 - LTP on flat ground tilting up.*



*Figure 8 - LTP working on a slope (ditch).*



*Figure 9 - This picture shows the indexing ability of the LTP.*

### Mowing Features

The Tractor Trimmer also provided a working hinge, 28.19 inches from the middle of the cutting head. This allows the customer to get as close to an object as possible, for a closer cut, and not destroy their property. This is achieved using a rubber guarded wheel on the cutting head to properly guide the cutting head around the object and to help protect the object from the steel frame of the cutting head. JJR Engineering is using a spring setup that features a spring on both the top and the bottom of the working hinge bracketed between two c-channels, one on both sides of the working hinge. With the current setup the working hinge is allowed to bend the spring from front to back, of the tractor, to allow the cutting head to rotate around the object.

The Tractor Trimmer features a hydraulically driven motor that spins at 2550 RPM. This feature is complimented with three different cutting heads: a four-blade disc mower blade, a regular lawn mower blade, and weed eater string. Having the three different mowing blades allows the customer to choose what type of cut they desire. The weed eater string allows for the client to use the Tractor Trimmer for clean up after the first initial cut. Four-blade disc mower blade and the lawn mower blade are intended for the customer to use as the first initial cut of the year. All of these blades are interchangeable and can be used at any time.





*Figure 10 - This is the cutting head in position 1 right before breakaway.*



*Figure 11 - The cutting head in position 2.*



*Figure 12 - The cutting head in position 3.*



*Figure 13 - The cutting head in position 4 right after the breakaway.*

### Ground Following

The Tractor Trimmer features a plethora of ground following functions. One has been described before in the LTP section. The others are a set of wheels (twin ten inch) and a rotating dome that both allow for better ground following. The twin ten inch consist of height adjustability that allows for the customer to cut at a specific height of their choice. This feature was teamed up with a rotating dome that is attached to the cutting head to allow for a backup ground follow once the main feature, the twin ten inch, fail to work.

### Twin Ten Inch

The main function of this specific ground following is to provide the most support for the arm to support the cutting head better. This is the current industry standard allowing the customer better availability for replacement parts. This feature also allows the working hinge to rotate properly while not getting in the way. A big problem with this design is that it is bulky which makes it difficult to adjust the height. We have fixed the initial problem, of multiple components for adjusting the height, by replacing the spacers for height adjustment with a rod that runs through the middle of the first arm. This feature then uses one pin that runs through specific holes to adjust the height. Another big problem with this design was the limiting ability to follow some slopes. We have partially fixed this issue by attaching a “walking axle” to the wheel base to allow for the wheels to rotate from front to back.



*Figure 14 - This is a picture of the walking axle tilted to the front.*



*Figure 15 - This is the walking axle tilted to the back.*



*Figure 16 - Walking axle height adjustment.*

## Rotation Dome

The rotating dome was made out of an Ultra High Molecular Weight (UHMW) plastic with a diameter of 10 inches. This feature allows for the customer to have a better cut on slope for when the twin ten inch does not cut properly. The UHMW plastic was chosen for this application because of its ability to take the damage from riding on the ground.



*Figure 17 - This is the standard rotation dome for either a lawn mower blade or a disc mower blade.*

## Storage/Transport

The Tractor Trimmer applies two different storage and transport features. One feature is the transport pin; this feature allows the arms to move freely or be pinned stationary for transport. This is part of what we discussed in the section about the LTP. There is also the storage jack; when the jack is down and the Tractor Trimmer is not being used this will help to keep the unit standing, this means that the Tractor Trimmer does not have to be attached to the tractor at all times. When you are ready to use the unit the storage jack is easily moved up and pinned in for storage of itself.

## **Fabrication**

### ***Model to Drawings***

To start this process JJR Engineering took the finish CAD model and then proceeded to print all parts of the model. These CAD drawings can be found in Appendix D. To facilitate the fabrication process a part naming structure was developed for the Tractor Trimmer; the structure can be seen in Table 2.

Number	Description
P-XX-YYY	Part (single metal piece, nuts, bolts, etc.)
W-XX-YYY	Weldment (Parts welded together)
A-XX-YYY	Assembly (Weldments and other parts together)
OA-XX-YYY	Overall Assemblies (A-Frame, LTP, Arm, Cutting Head)
ML-XX-YYY	Machine Level
ZZ-0X-YYY	Zero (0) indicates part is fabricated
ZZ-1X-YYY	One (1) Indicates part is purchased
ZZ-X1-YYY	One(1) Indicates part is used for the A-Frame
ZZ-X2-YYY	Two (2) Indicates part is used for the LTP
ZZ-X3-YYY	Three (3) Indicates part is used for the Arm
ZZ-X4-YYY	Four (4) Indicates part is used for the Cutting Head
ZZ-X5-YYY	Four (5) Indicates part is for the Drive System
ZZ-X6-YYY	Six (6) Indicates part that is found in multiple Locations
Example	
W-02-001	Weldment, Fabricated, For LTP
A-14-035	Assembly, Purchased, For Cutting Head

*Table 2 - Naming Structure for Tractor Trimmer*

### ***Fabrication Process***

The drawings from Appendix D were given to the Biosystems and Agricultural Engineering (BAE) Lab manager, Wayne Kiner. All parts were made in shop or through Stillwater Steel. This process took about a month from start to finish. Some of the processes to make the part included Computer Numerical Control (CNC) plasma, lathing, milling, and by welding. All of the CNC plasma work was done through Stillwater Steel, where the lathe, milling, welding, and other processes were done through the BAE Lab. Any work that needed to be done after the first assembly were done by JJR Engineering.

### ***Assembly***

Two big changes that were made to the Tractor Trimmer was the addition of hydraulic hose relief cuts in the arms and spring carriers on top of the working hinge. The hydraulic hose relief cuts were needed mainly when JJR Engineering added rubber matting to the hydraulic hoses for better protection at the working hinge. When the hoses were reinserted into the arm JJR Engineering had difficulty maneuvering the hoses in the working hinge enough to fit them through the other arm. Now with the relief cuts, they allow for the hydraulic hoses to be inserted by only one person not multiple. The second addition was the spring carriers on the top and the bottom of the working hinge. These were added in an attempt to find a method for allowing the working hinge to work in the proper manner.

## Experimentation and Physical Testing

During our experimentation process we conducted three main tests: hydraulic test, cutting test, and a working hinge test.

### *Hydraulic Test*

During this test the main focus was to find out if the hydraulic pump and motor would work at the theoretical numbers from the hydraulic calculations. To test the speed of the motor at the cutting head we used a strobe tachometer to find what RPM the cutting head was spinning at. A strobe tachometer is a device that uses a light to pulse at the speed at which an object is spinning. To figure out what RPM the motor is spinning at we set the machine at a set value of RPM, this was the value of 2750 RPM because of what we previously calculated. The goal for this device is to try and get the line on the rotation dome to be sitting still which in return will be the speed the motor is running. With this device we were able to find out that the motor is spinning at about 2550 RPM and the blade tip speed is 14,680 ft/min.

$$\text{Blade Tip Speed} \left( \frac{ft}{min} \right) = RPM * \pi * \text{Cutting Diameter}$$

$$\text{Blade Tip Speed} \left( \frac{ft}{min} \right) = 2550 \text{ RPM} * \pi * 1.833 \text{ ft}$$

$$\text{Blade Tip Speed} \left( \frac{ft}{min} \right) = 14,680$$

### *Cutting Test*

This test was designed for meeting the acceptance criteria of “ability to mow/cut/trim grass, weeds, and small brush (under 1 inch)”. We performed this test at the OSU Cowboy Motorsports Track and at a lawn that someone allowed us to use. The Cowboy Motorsports Track had tall grass, weeds and brush available to cut allowing use to test the Tractor Trimmer to its full extent. Our main criterion for this test was the ability to cut grass and how smooth the cut was. At the Cowboy Motorsport we tested three different cutting heads on similar grass to be able to see what the difference between them would be. The three different cutting heads were the lawn mower blade and two different weed eater string domes. The weed eater string domes consisted of both a large and small dome.



*Figure 18 - This shows the difference between the cutting heads. Plot 1 is the lawn mower blade, plot 2 is the large weed eater string head, and plot 3 is the small weed eater string.*



*Figure 19 - This is a picture of material we cut.*





*Figure 20 - Another picture material for cutting.*



*Figure 21 - Picture of the final cut of the previous section of grass.*

As you can see from Figure 18 and Figure 21 the Tractor Trimmer has the ability to cut heavy material with ease. Figure 18 – 21 shows how well the acceptance criterion was met for cutting.

### ***Working Hinge Test***

When JJR Engineering tested the working hinge we referenced to the acceptance criteria again. The criteria we are citing for this test is: “work in and around buildings, fences, ponds, and structures”. Testing started with the Tractor Trimmers ability to work around fences; we used a wooden fence that someone allowed us to use.



*Figure 22 - This picture shows the working hinge working around a building.*

Figure 22 and Figures 10 – 13 shows how the working hinge matches our acceptance criteria.

### Final Cost Analysis

JJR Engineering used the fall semester assumed cost levels to begin a final cost analysis. Listed in Table 3 is the actual prototype cost that JJR Engineering accrued. Some prices were quoted and parts purchased at a discounted “prototype” pricing. Extra material was not subtracted from the overall cost for structures, cutting head, and fabrication. Accounting for minimum cost of materials and no excessive supplies, like the testing portion, an assumed cost structure for production and sales is outlined in Table 4. Recommendations from JJR Engineering for certain design reconfigurations will allow part of the structures and fabrication cost categories to be decreased once the Tractor Trimmer is sent to full production.

### *Tractor Trimmer*

Structures	\$ 461.20
Drives	\$ 1,232.25
Cutting	\$ 216.55
Fabrication	\$ 324.15
Assembly/Paint	\$ 222.50
Testing	\$ 93.04
	\$ 2,549.69

Table 3 - Prototype costing for the Tractor Trimmer

### *Tractor Trimmer*

Structures	\$ 354.00
Drives	\$ 1,235.00
Cutting	\$ 200.00
Fabrication	\$ 285.00
Assembly/Paint	\$ 200.00
	\$ 2,274.00

Table 4 - Shows theoretical production costing for the Tractor Trimmer.

The summarized values in Table 3 are further broken down in Table 5 to subcategories to give a more precise picture of actual cost. The entire list of purchased parts including date, supplier, and quantities are compiled in Appendix G.

<b>Tractor Trimmer</b>				
<i>Cost Categories</i>		<i>Quantity</i>	<i>Cost Per Qty</i>	<i>Cost</i>
<b>Structures</b>				
	Fasteners	1	\$28.25	\$28.25
	Steel	1	\$322.97	\$322.97
	Ground Following Wheels	2	\$54.99	\$109.98
		<b>Frame Total</b>		<b>\$461.20</b>
<b>Drives</b>				
	PTO Pump	1	\$236.67	\$236.67
	Hydraulic Motor	1	\$350.00	\$350.00
	Hydraulic Hoses	1	\$130.80	\$130.80
	Hydraulic Fittings	1	\$99.51	\$99.51
	Hydraulic Oil	1	\$59.98	\$59.98
	Control Block	1	\$235.35	\$235.35
	Reservoir	1	\$73.33	\$73.33
	Filter	1	\$23.67	\$23.67
	Hose Wrap	1	\$22.94	\$22.94
		<b>Drives Total</b>		<b>\$1,232.25</b>
<b>Cutting</b>				
	Blades	1	\$38.27	\$38.27
	Ground Following	1	\$115.88	\$115.88
	Follower Wheel Accessories	1	\$62.40	\$62.40
		<b>Cutting Head Total</b>		<b>\$216.55</b>
<b>Fabrication</b>				
	Cutting Table (linear inches)	1050	\$0.10	\$105.00
	Welding (linear inches)	460	\$0.15	\$69.00
	Machining hours	2	\$70.00	\$140.00
	Bends	23	\$0.05	\$1.15
	Saw cuts (linear inches)	20	\$0.38	\$7.60
	Holes Drilled	4	\$0.35	\$1.40
		<b>Fabrication Total</b>		<b>\$324.15</b>
<b>Assembly/Paint</b>				
	Painting	1	\$100.00	\$100.00
	Assembly	3.5	\$35.00	\$122.50
		<b>Assembly/Paint Total</b>		<b>\$222.50</b>
<b>Testing</b>				
	Torsion Spring (Rake Teeth)	4	\$1.99	\$7.96
	Extension Spring	1	\$11.95	\$11.95
	Misc.	1	\$17.86	\$17.86
	Cutting Method	1	\$55.27	\$55.27
		<b>Testing Total</b>		<b>\$93.04</b>
		<b>Total Cost</b>		<b>\$2,549.69</b>

Table 5 - Cost break down.

## **Recommendations**

### ***Redesign***

During the fabrication, assembly, and experimentation phases, JJR Engineering noticed four main concerns for redesign about the Tractor Trimmer. One of the biggest concerns was with the amount of material that was used for this project. The arm was made thicker than needed for prototype purposes, to help with structural integrity of the Tractor Trimmer, because of this the amount of material used for the Tractor Trimmer could be reduced. This will also help with the overall cost of the Tractor Trimmer. Another redesign issue found was the arm itself. The biggest problem we encountered in assembly was that the hydraulic hoses barely fit in the arm. One design option proposed to fix this was to use a tapered arm instead of the straight arm currently on the Tractor Trimmer.

Two other features that need redesigning would be the cutting deck and the ground following wheels. The biggest draw back with the current design of the cutting head is that the triangular shape of the deck does not allow for the follower wheel to work to its intent at all times. Also the back part of the cutting deck is a hinder for the working hinge, the current CAD design for the cutting deck acts as a wall to the ground or tall grass forcing the working hinge to break away when not needed. On the current prototype we fixed part of the issue dealing with this by removing material from the afflicted area and making rounded guards to help crop flow into the cutting head. The final redesign feature would be the ground following wheels. The problem with these is that they hinder the working hinge. When the working hinge breaks away and starts to follow the fence post or object the walking axle will want to rotate in the direction of the breakaway creating a greater force that the springs are required to work against. The increase force was not allowing the cutting head to return to neutral.

### ***Further Development***

Features that need to be further developed would consist of the working hinge, a custom tank, and the LTP breakaway. Due to time constraints JJR Engineering was not able to develop the LTP breakaway to its fullest capabilities. One proposal for the final product would be a custom designed tank to both fit better on the a-frame and to contain the proper amount of hydraulic fluid for the system. This tank will need to be more than 7.2 gallons in size. The biggest development issue would be the working hinge. While the current design does work there are more viable ways to achieve the same solution. One problem with this current design is the improper use of the springs with more research into the proper springs for the current design this method could be the solution or at least a variance of this design.

# Jobs Just Right Engineering

Members:

Jason Johnson  
Ryan Johnson  
John Locklear

# **M&M Engineered Products L.L.C.**

**Equipment, Engineering, and Fabrication**



Specialized in hydraulic equipment for Skid Steers and Tractors.

## Product Line:

- ❧ Hydra-Clip (16" Treeshear)
- ❧ Hydra-Snip (12" Treeshear)
- ❧ Hydra-Rake HD (6', 7', 8' Models 6" Tooth Spacing)
- ❧ Hydra Rake SD (6', 7', 8' Models 12" Tooth Spacing)
- ❧ Ranch Rake (3', 4', 5' Models compact Loader)
- ❧ MORETHANAWOODSPLITTER (20 Ton Trimmer, Cutter, and Splitter)

## Hydra-Clip



## Hydra-Rake SD



## MORE THAN A WOODSPLITTER



<http://treeshear.com/index1.asp>



# Problem Statement



JJR Engineering strives to produce a tractor mounted weed trimmer product for M&M Engineered Products. The design should include but not limited to:

- 3 point mounted, PTO powered
- Ability to mow/cut/trim grass, weeds, and small brush (under 1 inch).
- The cutting should work adjacent to either side of the tractor.
- Work in and around buildings, fences, ponds, and structures.

Design is open to changes suggested from client or from other unforeseen issues.

# WEEDEN'S Fence Mower



- ❧ MSRP: \$4200
- ❧ PTO Hydraulic Pump to Drive Head
- ❧ SCV's Required to Adjust Head
- ❧ Operates on One Side



<http://www.weedensfencemower.com/index.html>

# Sauerburger Iltis



- ❧ European/German
- ❧ Adjustable length arm
- ❧ Hydraulically adjustable cutting height
- ❧ Not currently sold in the United States



# Fence Mower



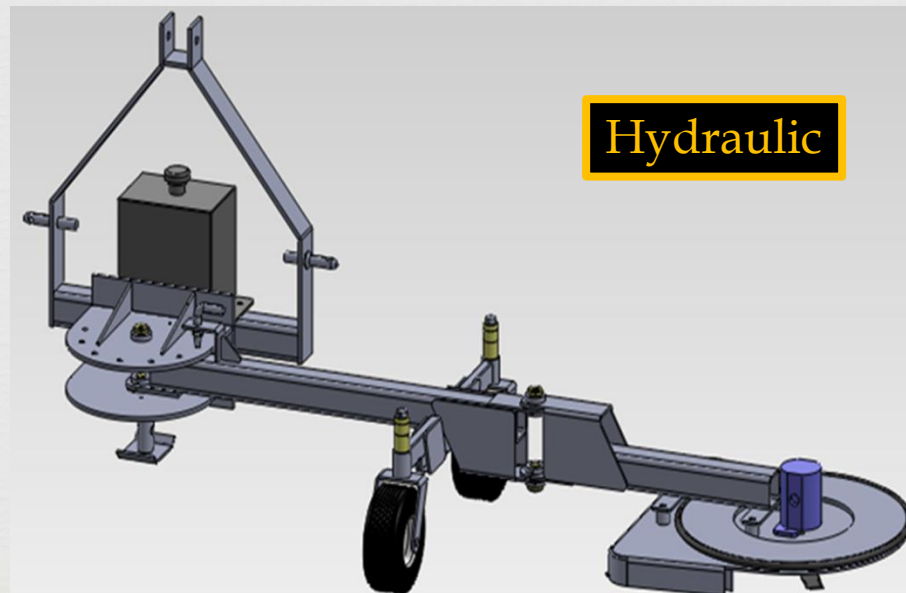
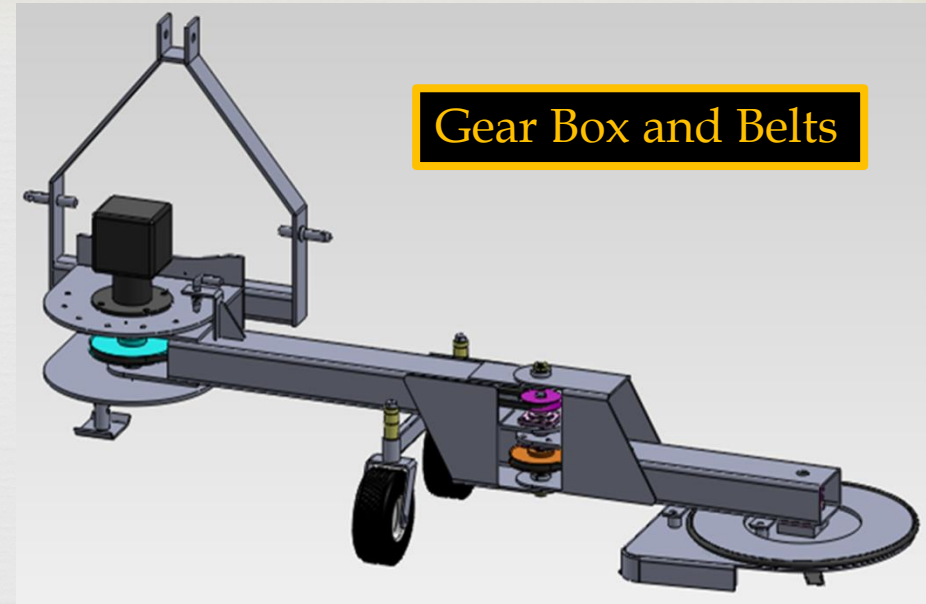
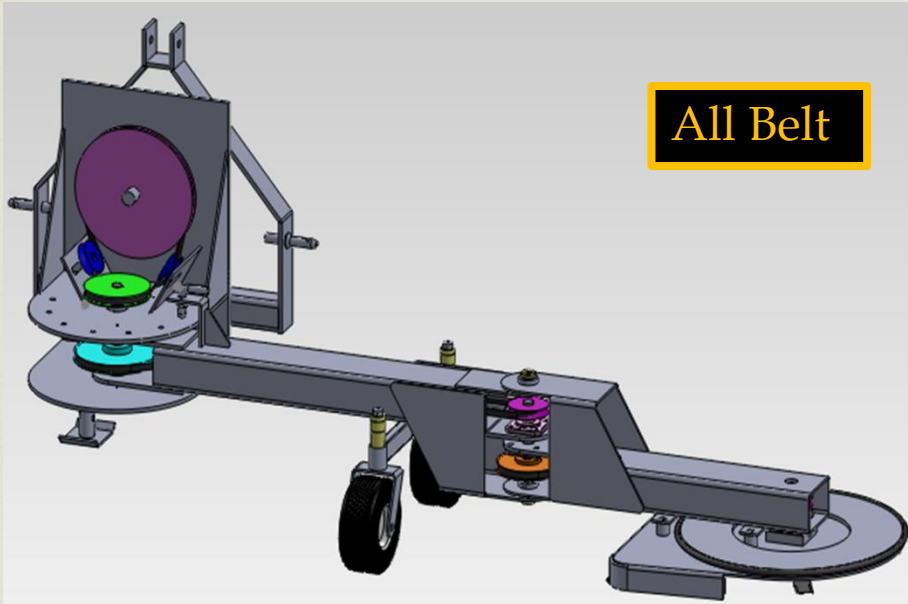
- MSRP: \$2,895.00 - \$3,295.00
- ❧ Two Size Options
- ❧ Mechanically Driven (Belt and Gearbox)
- ❧ Operates on One Side



# Initial Designs



Designs From Last Semester



# Further Development



Spring Semester

# Hydraulic Pump



☞ PTO pump selection was limited

$$\text{Displacement Ratio} = \frac{\text{Speed of Output}}{\text{Speed of Input}}$$

$$\text{Displacement Ratio} = \frac{3000 \text{ RPM}}{540 \text{ RPM}}$$

$$\text{Displacement Ratio} = 5.56$$

☞ Chief PTO Pump

☞ 7.2 GPM, 2500 PSI

☞ 3.41 in<sup>3</sup> / rev

☞ 8 HP input required

$$\text{Motor Displacement} = \frac{\text{Pump Displacement}}{\text{Displacement Ratio}}$$

$$3.41 \text{ in}^3 / \text{rev}$$

$$\text{Motor Displacement} = \frac{3.41 \text{ in}^3 / \text{rev}}{5.56}$$

$$\text{Motor Displacement} = 0.61 \text{ in}^3 / \text{rev}$$



# Hydraulic Motor



Worked with client to find an off the shelf motor to fit design and supply requirements

Parker gear motor

3625 PSI max

0.67 in<sup>3</sup> / rev

500 to 3500 RPM

Assumed 10 HP Load

$$\text{Hydraulic HP} = \frac{\text{Flowrate (GPM)} * \text{Pressure (PSI)}}{1714}$$

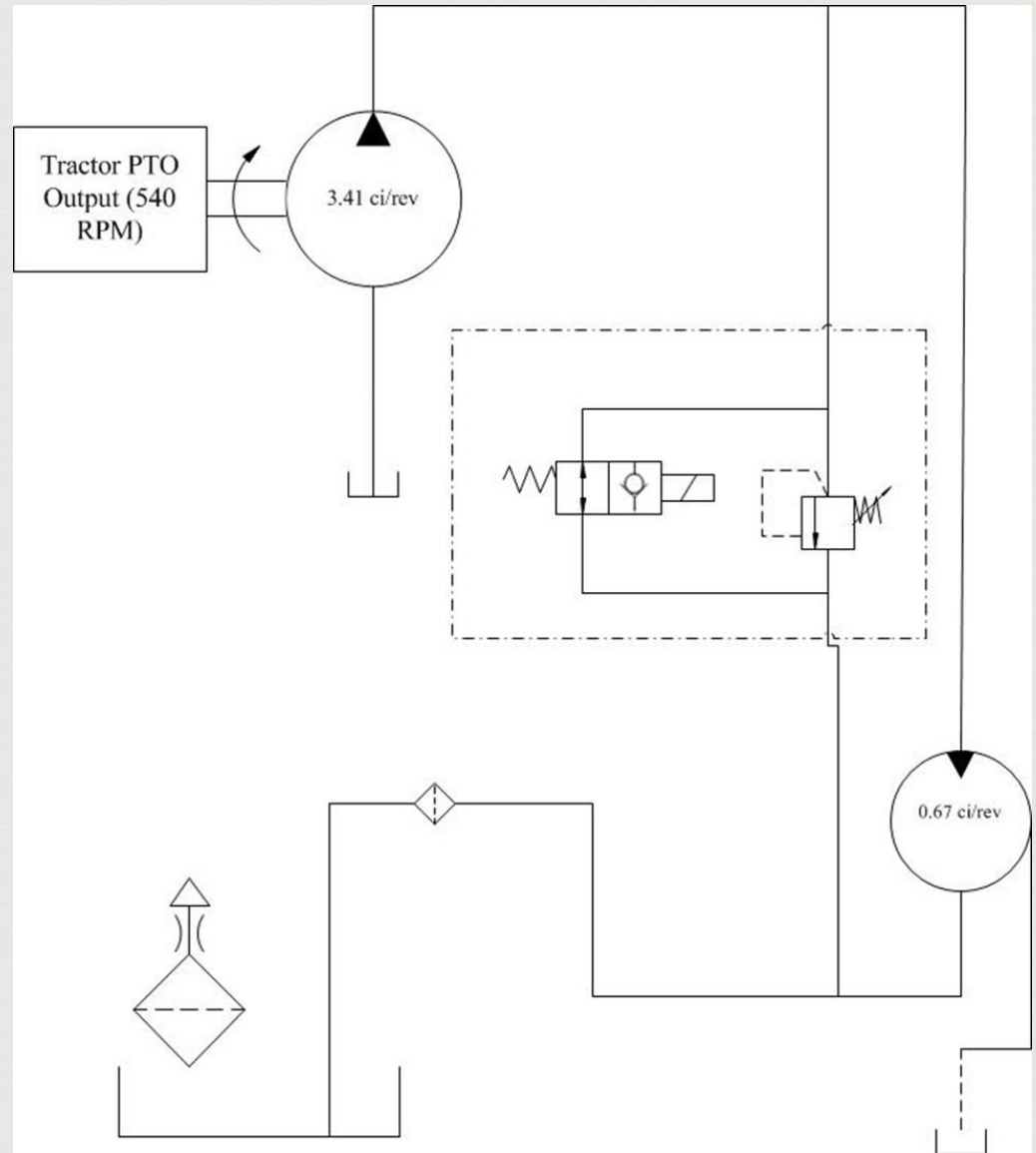
$$10 = \frac{7.2 * \text{Pressure}}{1714}$$

$$\text{Pressure} = \frac{10 * 1714}{7.2}$$

$$\text{Pressure} = 2380 \text{ PSI}$$

Pump & motor combination works within limits of application

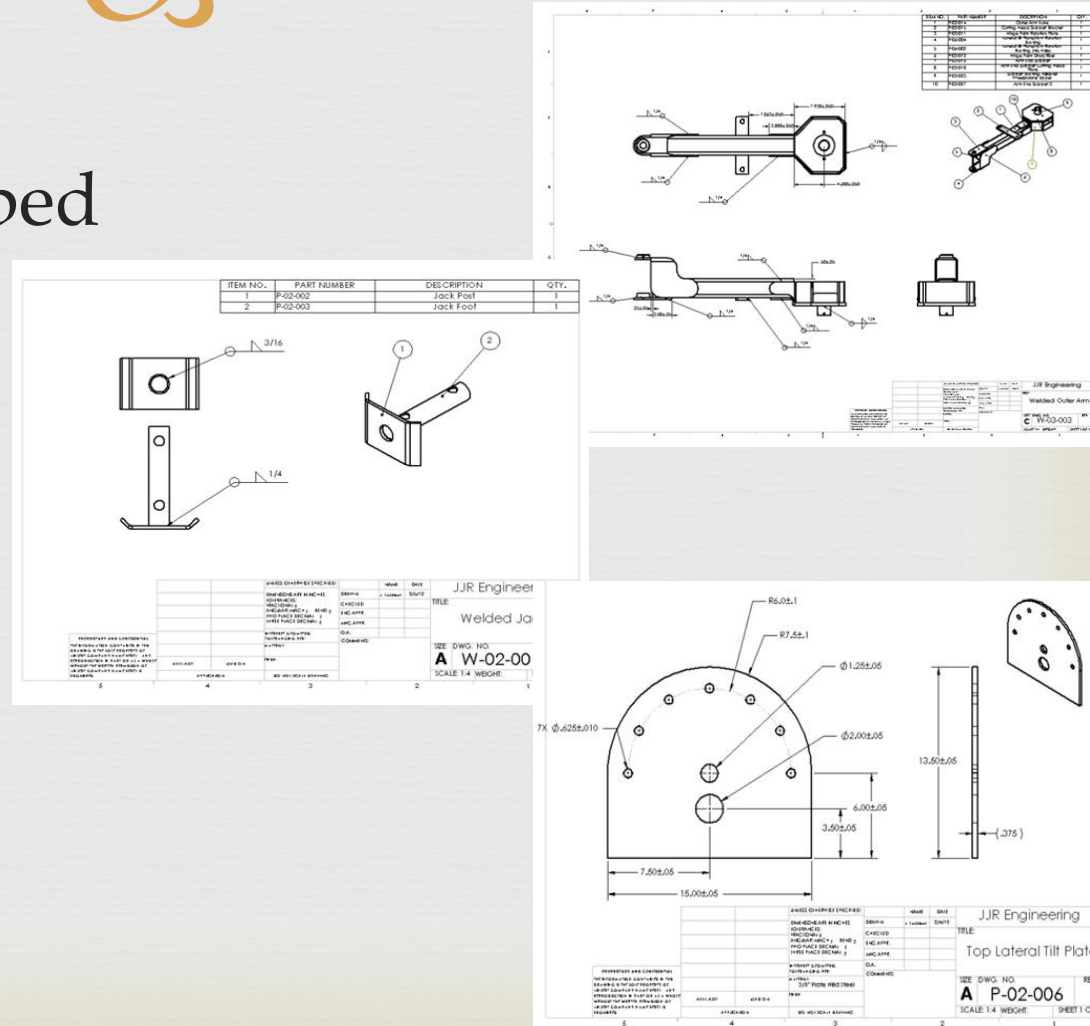
# Hydraulic Schematic



# SolidWorks Modeling



- Tractor Trimmer was fully developed using CAD modeling
- Full engineering drawings were created for manufacturing



# Tractor Trimmer CAD Model



# Tractor Trimmer



It's a weed whacker for your tractor.

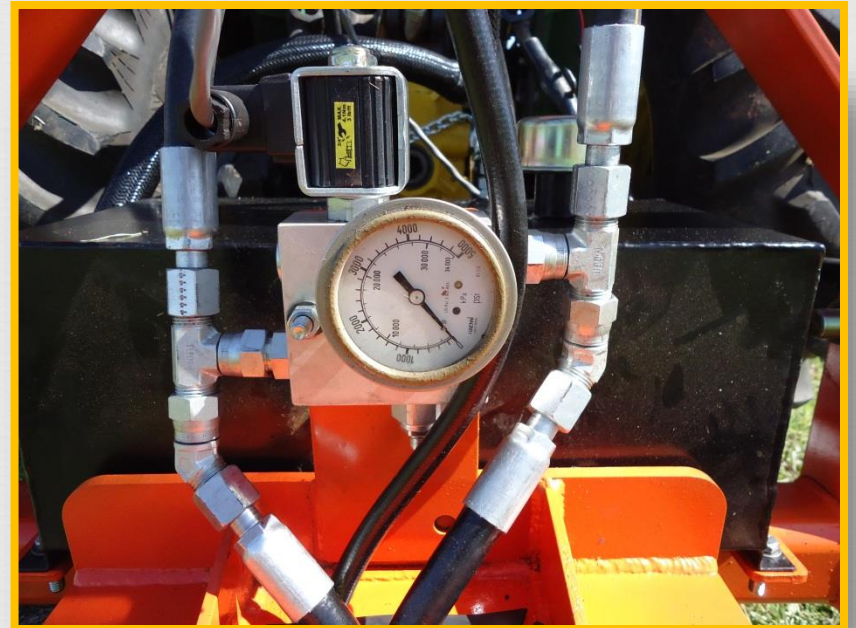
Tractor Trimmer



# Design Features



- ❧ Hydraulic System
  - ❧ Enclosed system, only PTO power and 12V source needed
  - ❧ PTO Powered Pump, Motor, Electric Control Valve, Pressure Relief



# Design Features



## ☞ Lateral Tilt Plate (LTP)

- ☞ The LTP allows the mowing arm to follow the contour of the ground
- ☞ Mounting location for other components
- ☞ Allows arm to be fixed into seven (7) different positions; Mowing can be done on either side of the tractor





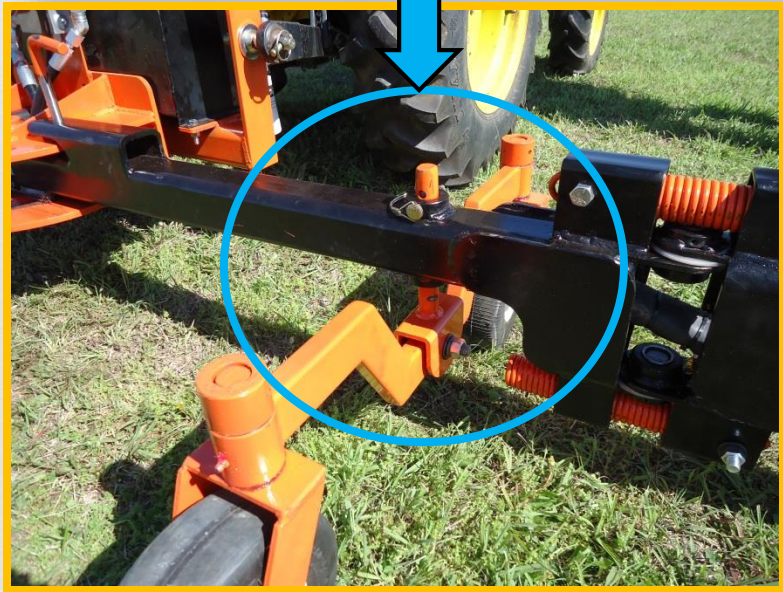
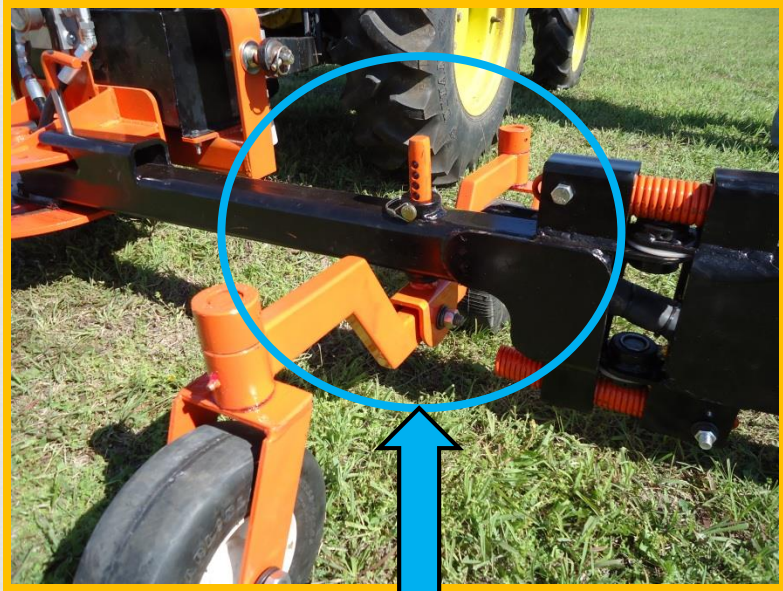


# Design Features



- ⌘ Ground Following
  - ⌘ Cutting head follows the ground with three components
  - ⌘ LTP, Walking Axle, Rotation Dome





# Design Features



- ❧ Storage/Transport
  - ❧ Lock to keep arm from rotating
  - ❧ Jack for storage
  - ❧ Arm can be put in different positions to reduce transport width

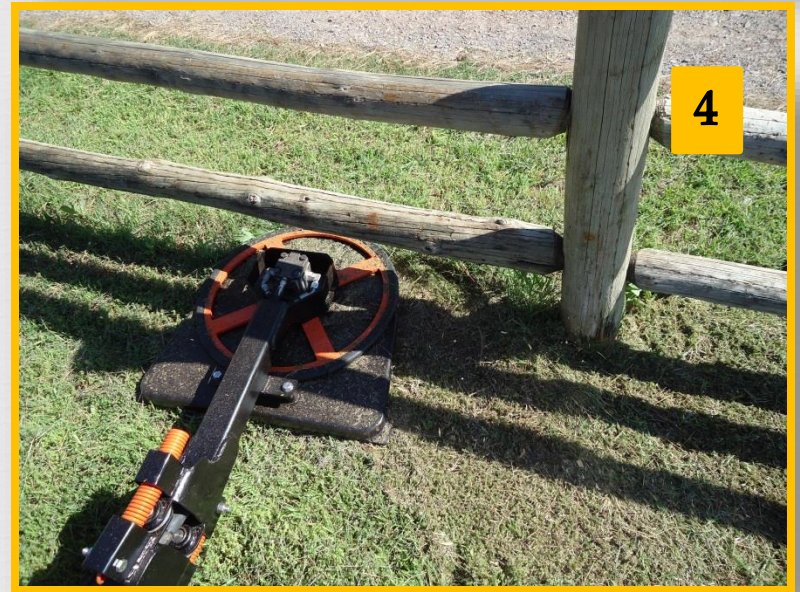


# Design Features



- ❧ Mowing functions
  - ❧ Working hinge allows cutting head to swing around posts or other obstacles
  - ❧ Follower wheel keeps cutting head a set distance from object, for a consistent cut





# Testing and Physical Experimentation



Hydraulic Testing

Cutting Tests

Working Hinge Testing

# Hydraulic Testing



- ☞ Tested for system function and performance
- ☞ Cutting head spins at ~2550 RPM
- ☞ Theoretical Cutting Speed  $(3.41 / .67) * 540 = 2750$  RPM (system is 93% eff.)
- ☞ Tank surface temperatures never exceeded 120° F





# Cutting Tests



- ❧ Three different cutting implements were tested
  - ❧ Lawnmower blade
  - ❧ Weed-eater string with a large and small dome



# Working Hinge Testing



✧ The working hinge was tested in different situations to ensure it performed as expected



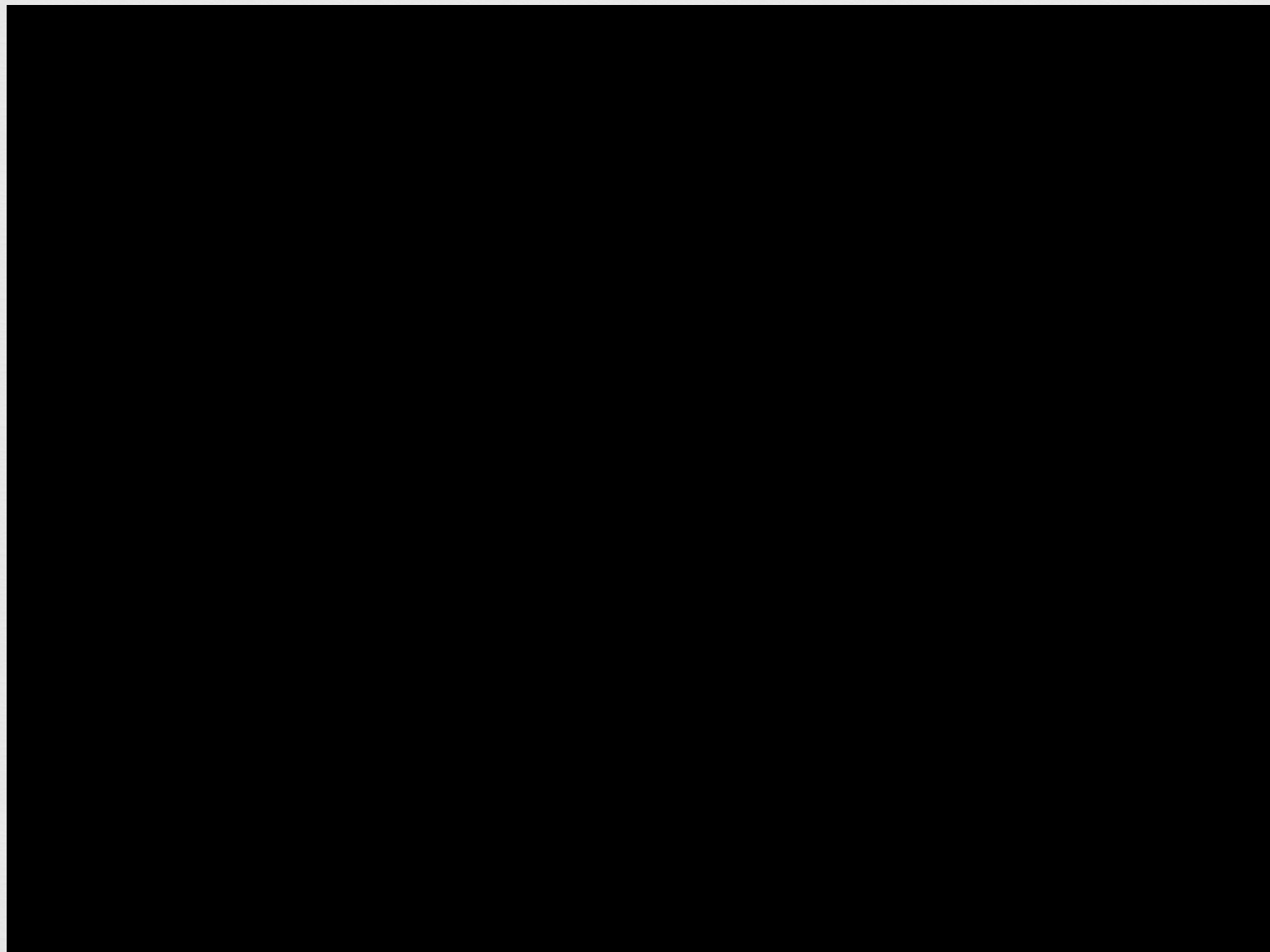


# Overall Testing Results



- ❧ The lawnmower blade worked best, string may be good for a “maintaining” cut
- ❧ Cutting head design was changed to facilitate crop flow
- ❧ Concept/Drive System works, can be adapted to other platforms





# Cost Breakdown



# Prototype Cost



Tractor Trimmer		
Structures	\$	461.20
Drives	\$	1,232.25
Cutting	\$	216.55
Fabrication	\$	324.15
Assembly/Paint	\$	222.50
Testing	\$	93.04
	\$	2,549.69

# Cost Analysis



Tractor Trimmer	
Structures	\$ 354.00
Drives	\$ 1,235.00
Cutting	\$ 200.00
Fabrication	\$ 285.00
Assembly/Paint	\$ 200.00
	\$ 2,274.00



# Recommendations



# Recommendations



## Redesign

- ❧ A least cost study could be done to reduce material sizes
- ❧ Arm redesign
- ❧ Ground following wheels
- ❧ Custom tank

## Further Development

- ❧ LTP breakaway
- ❧ Further development of working hinge
- ❧ Drive system reconfiguration for a remote hydraulic system i.e. larger tractors and skid steers

# Acknowledgments



- ❧ M&M Engineered Products
- ❧ Aberdeen Dynamics
- ❧ Fluid Specialties
- ❧ BAE Lab
- ❧ Dr. Weckler
- ❧ Dr. Taylor

Jobs

Just

Right

Engineering

# Jobs Just Right Engineering

Members: John Locklear, Jason Johnson, and Ryan Johnson

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## **Introduction**

### ***Mission Statement***

JJR Engineering is devoted to producing current market designs that combine customer satisfaction and quality products at the highest levels.

### ***Problem Statement***

JJR Engineering strives to produce a tractor mounted weed trimmer product for M&M Engineered Products. The design should include but not limited to:

- 3 point mounted, PTO powered
- Ability to mow/cut/trim grass, weeds, and small brush (under 1 inch).
- The cutting should work adjacent to either side of the tractor.
- Work in and around buildings, fences, ponds, and structures.

Design is open to changes suggested from client or from other unforeseen issues.

### ***Scope of Work***

The project is to build a PTO powered weed eater for the client, M&M Engineered Products. The client has given a list of specifications, JJR Engineering has added to the list which is summarized below.

- 3 point mounted, PTO powered.
  - Client desires designing for CAT I but needs to function on CAT II.
- Ability to mow/cut/trim grass, weeds, and small brush.
- The cutting should work adjacent to either side of the tractor.
- Work in and around buildings, fences, ponds, and structures.
- The client needs to be able to fabrication easily and cost effective, the best manufacturing practice for M&M Engineered Products.

A list of task to accomplish the above goal is summarized below.

1. Find and summarize the current market products.
2. Test material for the blade(s) for cutting head.
  - i. Test different blade types (plastic, metal, and composite).
  - ii. Test different blade shapes.
  - iii. Test blade(s) in different length/type of crops.
3. Design and model the complete product.



- i. Initial hand sketches.
  - ii. Hand calculations.
  - iii. SolidWorks modeling.
  - iv. Finite element analysis of computer model.
  - v. Manufacturing drawings.
4. Build completed design that has been approved by client.
5. Test completed product to make sure that it meets acceptance criteria.
  - i. Testing on different tractors.
  - ii. Testing on different crop (like ones before).
  - iii. Testing in different conditions.

### ***Location of Work***

The majority of the project will be completed at Oklahoma State University and the surrounding areas. The design work will be done on campus and through the CAD program SolidWorks. The fabrication and assembly of the product will be done at the Biosystems and Agricultural Engineering Laboratory. Testing and experimentation of the product(s) will be done in areas surrounding Stillwater where crop and conditions are available.

### ***Period of Performance/Deliverables Schedule***

Our two main time constraints are to have a design that is approved by M&M Engineered Products by Christmas and a final product by the end of May. There will be other constraints and deliverables that come up as the semester's progress.

### ***Applicable Standards***

- Agricultural Rotary Mower Safety – ASAE S471.1
- Three Point Hitch Specifications – ISO 730:2009
- Agricultural Blade Specifications – ISO/CD 5718

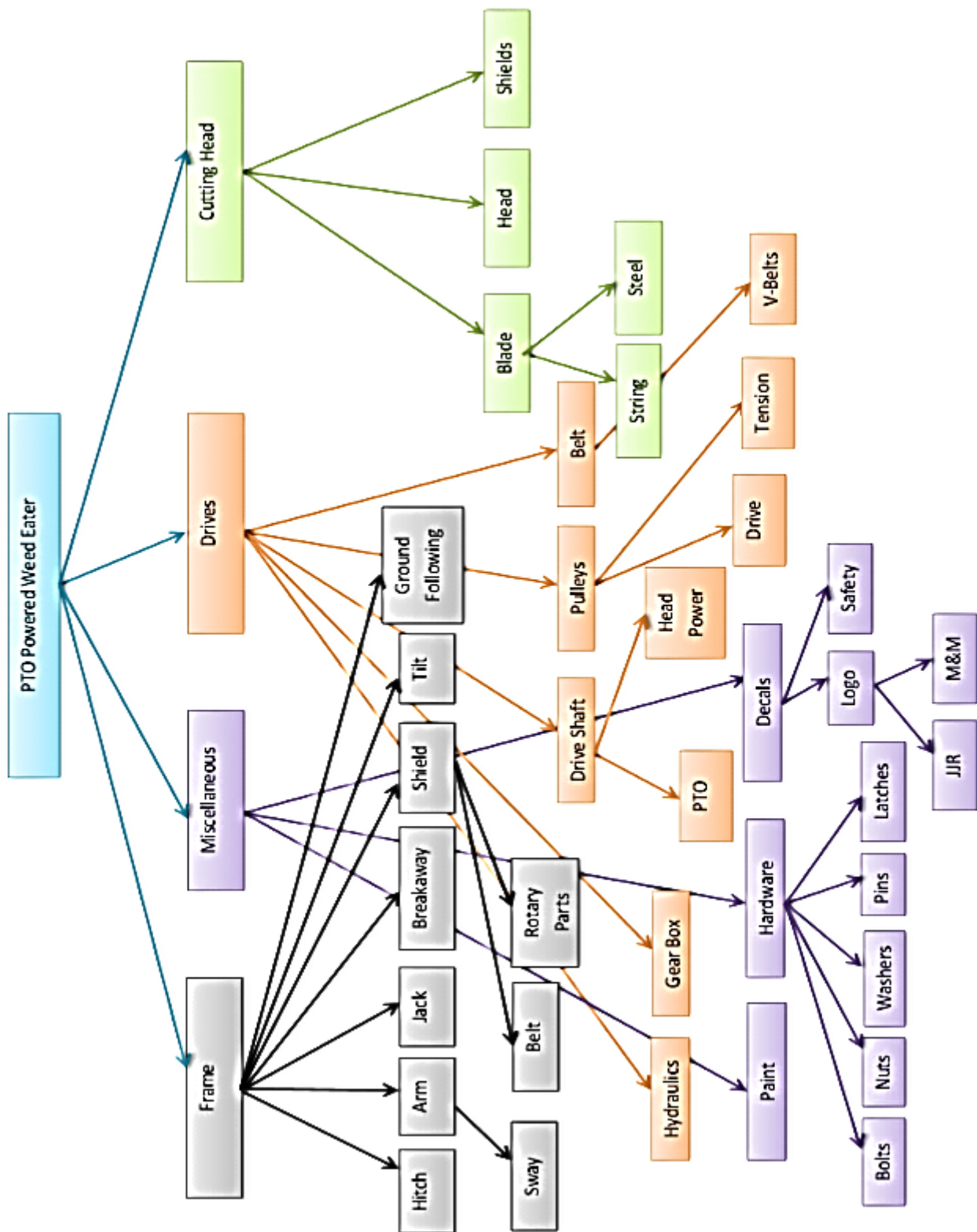
These standards apply to our project where some design constraints are governed by the standards. There are no apparent issues at the time.

### ***Acceptance Criteria***

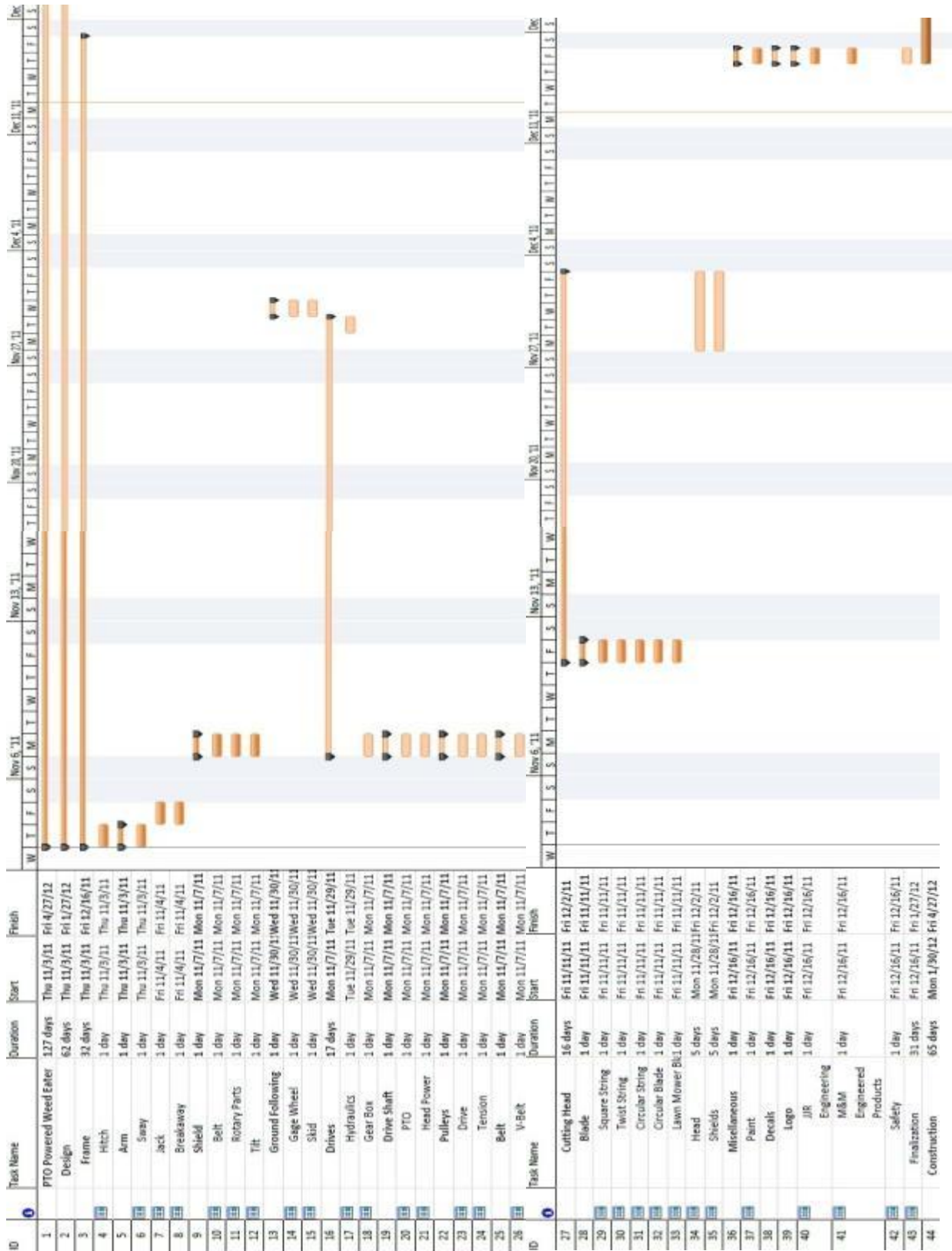
- 3 point mounted (CAT I/II), PTO powered
- Ability to mow/cut/trim grass, weeds, and small brush.
- The cutting should work adjacent to either side of the tractor.

- Work in and around buildings, fences, ponds, and structures.
- The client needs to be able to fabrication easily and cost effective.

***Work Breakdown Structure***



# Gantt Chart



## Competitive Analysis

### *Market Research*

The market for fence mowers is very diverse in the scope of drives, style of attachment, blade types, and manufacturers suggested usage. The client, M & M Engineered Products, has accumulated the idea from multiple fence mower products in the market and asked JJR Engineering to develop a unique design to accomplish multiple tasks in one application. Because of the uniqueness of the product, direct market competition is minimal in comparison to market influence. In Appendix A will be the full web pages for the following market influence machines.

- WEEDEN'S Fence Mower
  - MSRP: \$4200.00
  - Reference number 8
- HAYSPEAR Fence Runner
  - MSRP: \$4,995.00
  - Reference number 3
- Tractor Mounted Slop and Ditch Mowers
  - MSRP: \$11,995.00 to \$14,139.00
  - Reference number 6
- Offset Mounted Brush Mowers
  - MSRP: \$6935.00 to \$7365.00
  - Reference number 7
- Fence Mower FM 30
  - MSRP: \$2,895.00
  - Reference number 1
- Fence Mower FM 60
  - MSRP: \$3,295.00
  - Reference number 2
- Sauerberger Iltis Fence Mower
  - MSRP: not available
  - Reference number 5



### ***Patent Searches***

See Appendix B for full patents.

Below is a list of relevant patents for the PTO driven side mower.

- Boom Breakaway Assembly
  - Patent No. US 7,740,190 B2
- Fence Mower
  - Pub No. US 2008/007815 A1
- Fence Row Mower Attachment For Farm Tractors
  - Serial No. 646,583
- Weed Shredder
  - Serial No. 23,546
- Fence Row Mower Attachment for farm Tractors
  - Serial No. 251,677
- Fence Row Mower
  - Patent No. 4,901,508
- Fence Row Cleaner
  - Patent No. 5,050,372
- Garden Cleaning Implement for Cutting/Macerating Weeds Above and Below Ground
  - Patent No. 5,491,963
- Tractor Mounted String Trimmer Mechanism
  - Patent No. US 7,690,177 B2
- Fence Mower
  - Pub No. US 2006/0288679 A1

### **Experiments and Physical Testing**

#### ***Blades***

On Friday November 11, 2011 JJR engineering went to the Cowboy Motor Sports Track and tested multiple blade types. The testing consisted of the following types: cable, chain, three different types of weed eater string (square, round, and braded; all at .155 inches), and a circular disk blade. The experiment was to measure the cutting methods ability to cut growth in a period of time. Testing started with marking off a number of plots (one for each type) the width of two

push lawn mowers and attaching the blade cutting types to the mower itself. Testing produced the following data in table 1:

Cutting Method	Plot	Time (seconds)	Comments
Two piece cable	1	47.9	Grounded dead grass; left stemy uncut more folded over
Disk mower blade	2	38.0	Define cut, crisps edges; cut grass not ground
Weed eater circular string	3	43.3	Left green growth - half cut; similar to plot 3 cut when dropped onto grass made cleaner cut
Square weed eater string	4	34.2	Quality cut on grass; laid over heavy green stem more than plot 3
Four separate chains	5	39.1	Chain sucks; left too much tall grass
Vortex (breaded) weed eater string	6	31.9	needed larger string; left some; taller, more stemy, and uneven cut

Table 1: This table shows the plot number, cutting method, and the time that each method too to cut the plot.

The following figures (1 – 26) are of the blades (disk mower blade, chains, weed eater string, and cable), the plots (before and after), and the lawn mower used during the experiment.

Lawn Mower



Figure 1: John Locklear getting the lawn mower ready for testing.

Figure 2: Ryan Johnson recording information about the lawn mower used for testing different blades.

Plot 1 – Two Piece Cable



Figure 3: This is the before image of plot 1 where we used the cable to cut the given brush.

Figure 4: This is the after picture of plot 1. The cable more or less folded over the grass than cut the grass. The cable also took the longest time to cut at 47.9 seconds.

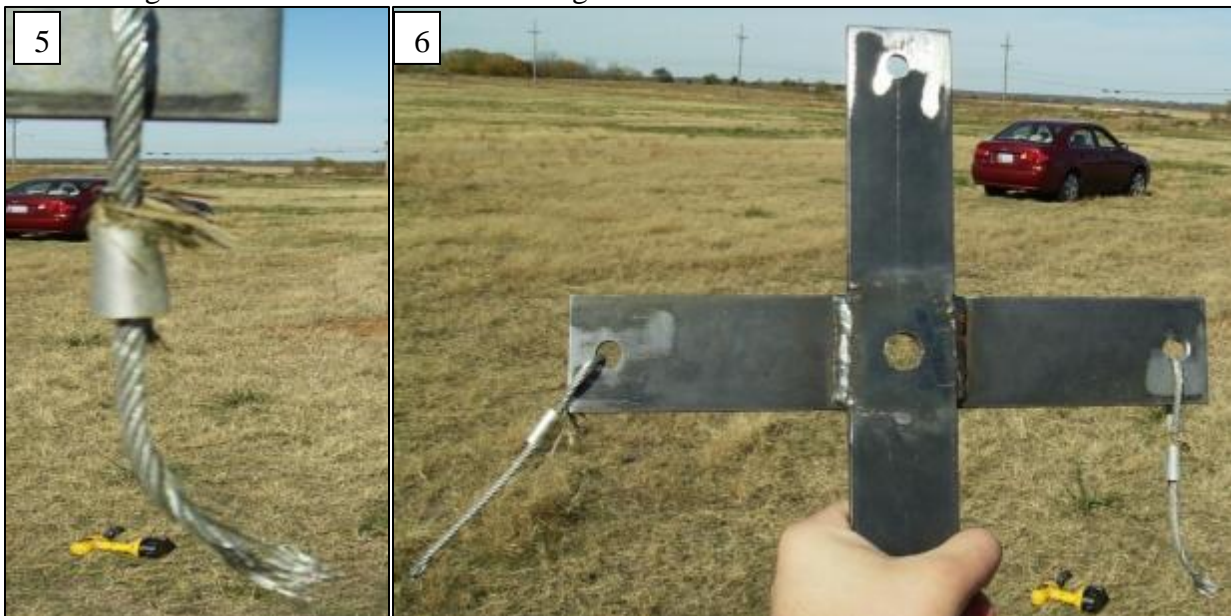


Figure 5: This is a close up of what the cable looked like after the cutting of the brush/grass.

Figure 6: This is the full image of what the implement and the cable looked like after cutting plot 1.



Plot 2 – Disk Mower Blade

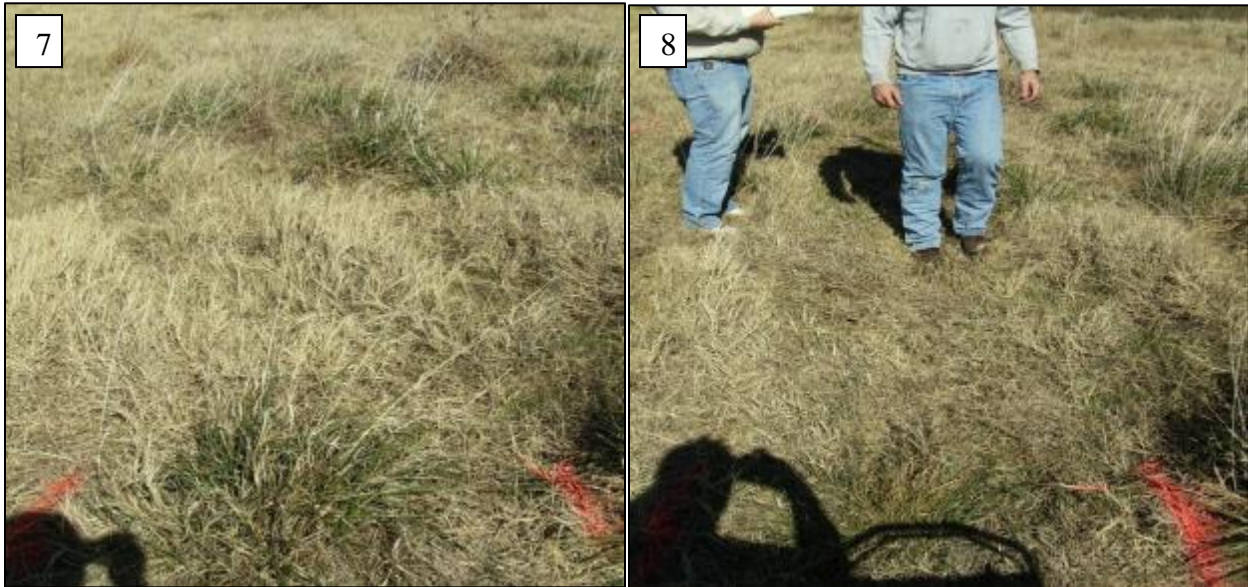


Figure 7: This picture is of plot 2 before using the disk mower blade.

Figure 8: This is what the brush/grass looked like after using the disk mower blade.

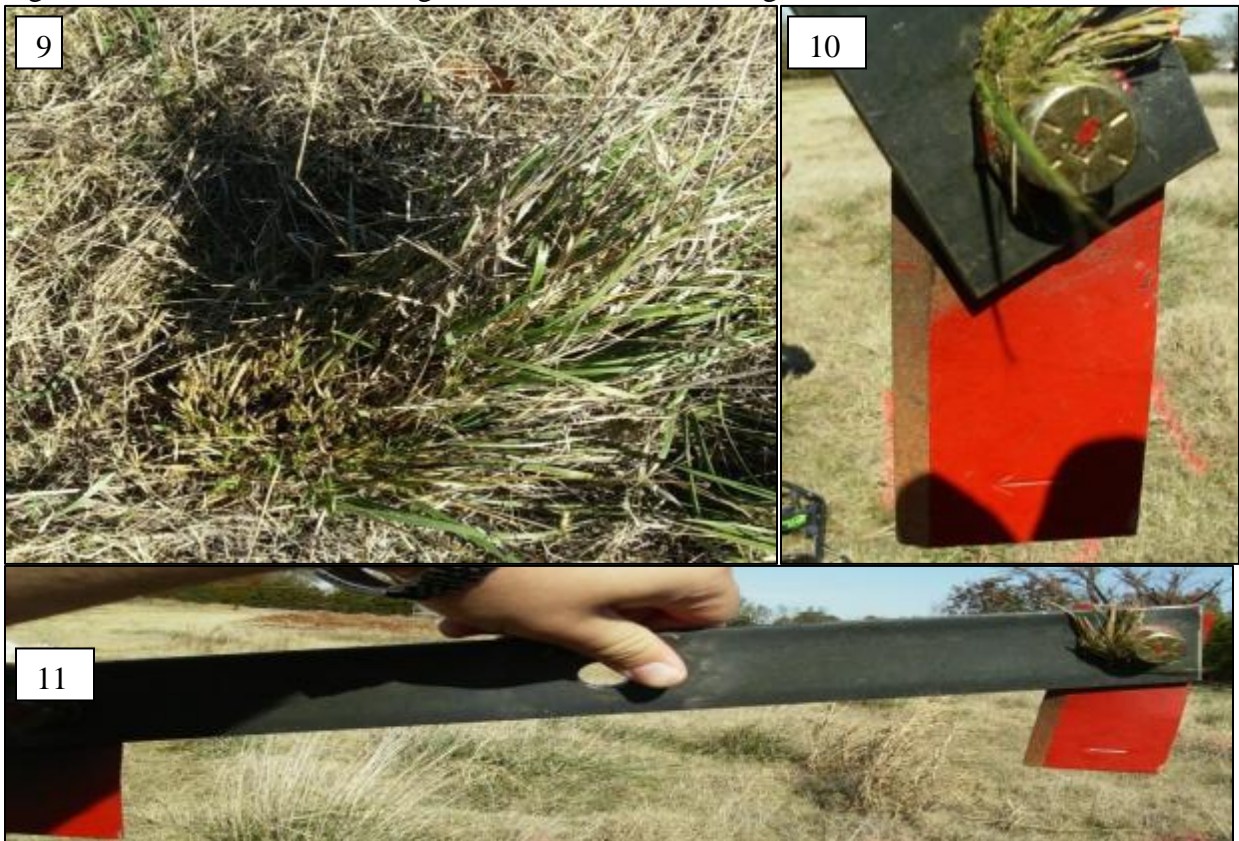


Figure 9: This close up is of brush that was in the middle of plot two and plot three that shows how the disk mower blade cuts.

Figure 10: After cutting the brush/grass this is what the disk mower blade looked like.

Figure 11: This picture is a close up of the previous picture.

Plot 3 – Circular Weed Eater String



Figure 12: This picture shows what the brush/grass looked like before the cut with the circular weed eater string.

Figure 13: The circular weed eater string did not cut as well as we wanted.



Figure 14: This picture is a close up of brush that was not cut completely with the circular weed eater string.

Figure 15: This is a similar image to the one above but on the opposite side of the plot.

Plot 4 – Square Weed Eater String



Figure 16: This picture shows what the plot looked like before using the square weed eater string.

Figure 17: this picture shows what the plot looked like after using the square weed eater string.



Figure 18: This is a close up of some brush/grass that was cut due to the square weed eater string.

Plot 5 – Four Separate Chains



Figure 19: This picture shows what plot 5 looked like before cutting it with the chain.

Figure 20: This picture shows how well the chain cut the brush/grass. Most of the brush/grass was stripped/shredded not cut.



Figure 21: This picture shows what the chain set –up looked like.

Figure 22: This is a close up of how the chain stripped the brush from being large to just the stem.



Figure 23: This is a close up of how the chain stripped the brush from being large to just the stem. Just like the previous picture.

Plot 6 – Vortex (Breaded) Weed Eater String



Figure 24: This is a picture of what the plot looked like before using the vortex weed eater string.  
Figure 25: This was the set-up for the vortex weed eater sting.



Figure 26: This is a small look of what the plot looked like after cutting it with the vortex weed eater string.

### Tractor Measurements

On November 18, 2011, JJR Engineering went to a tractor supply store measure different models of tractors to find the distances of specific spots for help with modeling in SolidWorks, as seen in figure 27. The points needed for the modeling process were: A the tractor wheel width; B the height of the PTO shaft from the ground; C the width of the three point arm (bottom pins); D the height from the lower limb of the three point to the top arm of the three point; E the length of the three point; F the height to the lower arm of the three point from the ground; G the blind spot for the driver.

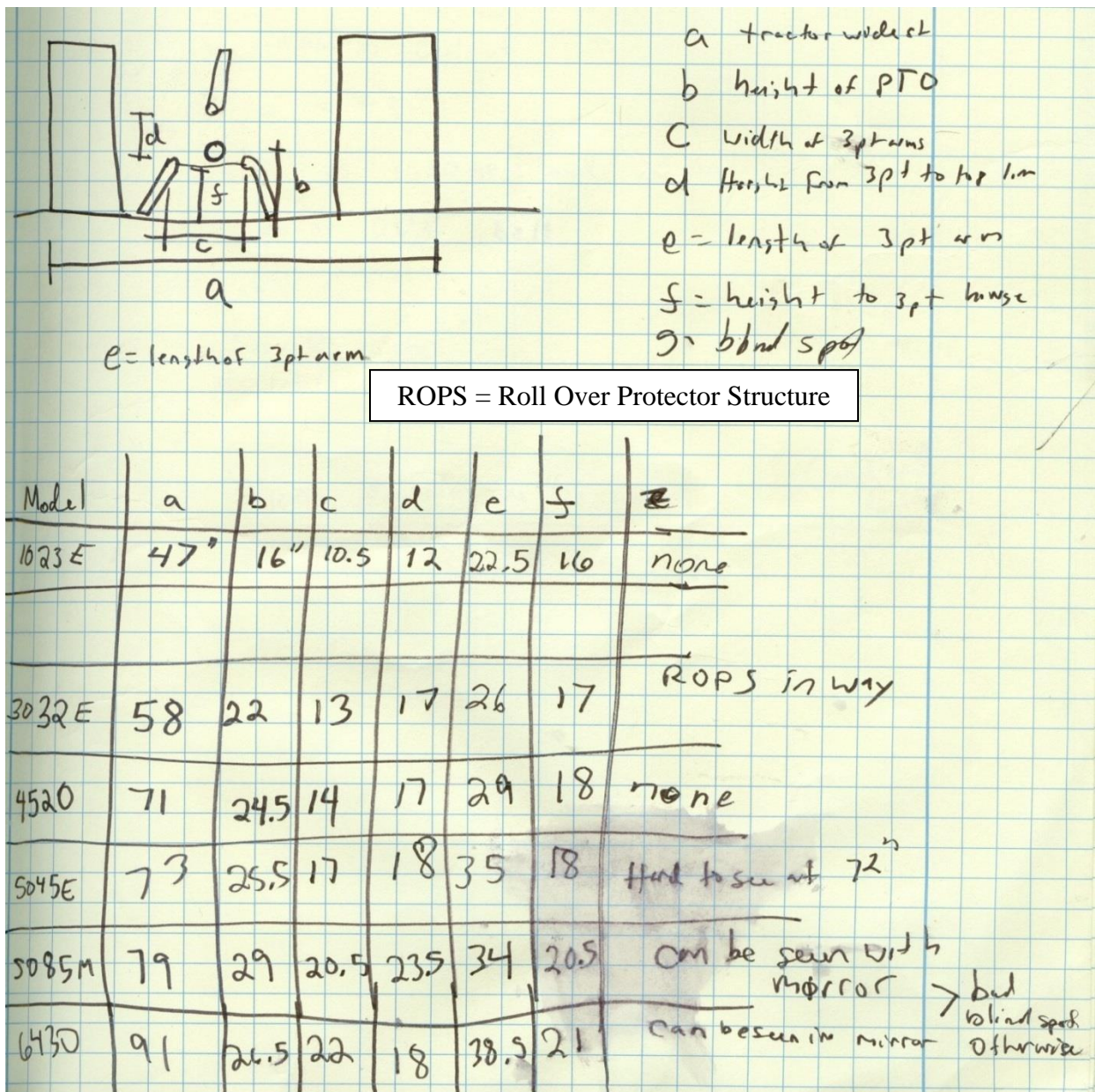


Figure 27: This is an image of the notes taken while measuring the tractors.

While at the tractor supply store we were able to find multiple tractor sizes with different styles. The only model we could not find was a John Deere 2000 model.

## **Design Concepts**

For the development of a tractor mounted, PTO weed eater, three different models were designed. Each of the models was based on the same basic frame, consisting of flat sheet metal and rectangular tubing. What differs between the models is the way the cutting head is powered. These methods are outlined below.

### ***Complete Belt***

In this design power is transferred from the PTO to a large pulley mounted vertically. This power is run through a v-belt and two directional transfer pulleys to a horizontally mounted pulley. This takes the PTO power and turns it 90°. Power then runs through two belts on the arm to the cutting head. See figure 28.

### ***Gearbox and Belt***

In this design power is transferred from the PTO to a 90° rotary mower gearbox. Power is then transferred through two belts to the cutting head. See figure 29.

### ***Hydraulic***

In this design, power is transferred from the PTO to a hydraulic pump. Lines run from the pump to a motor which powers the cutting head. See figure 30.

*Complete Belt Images*

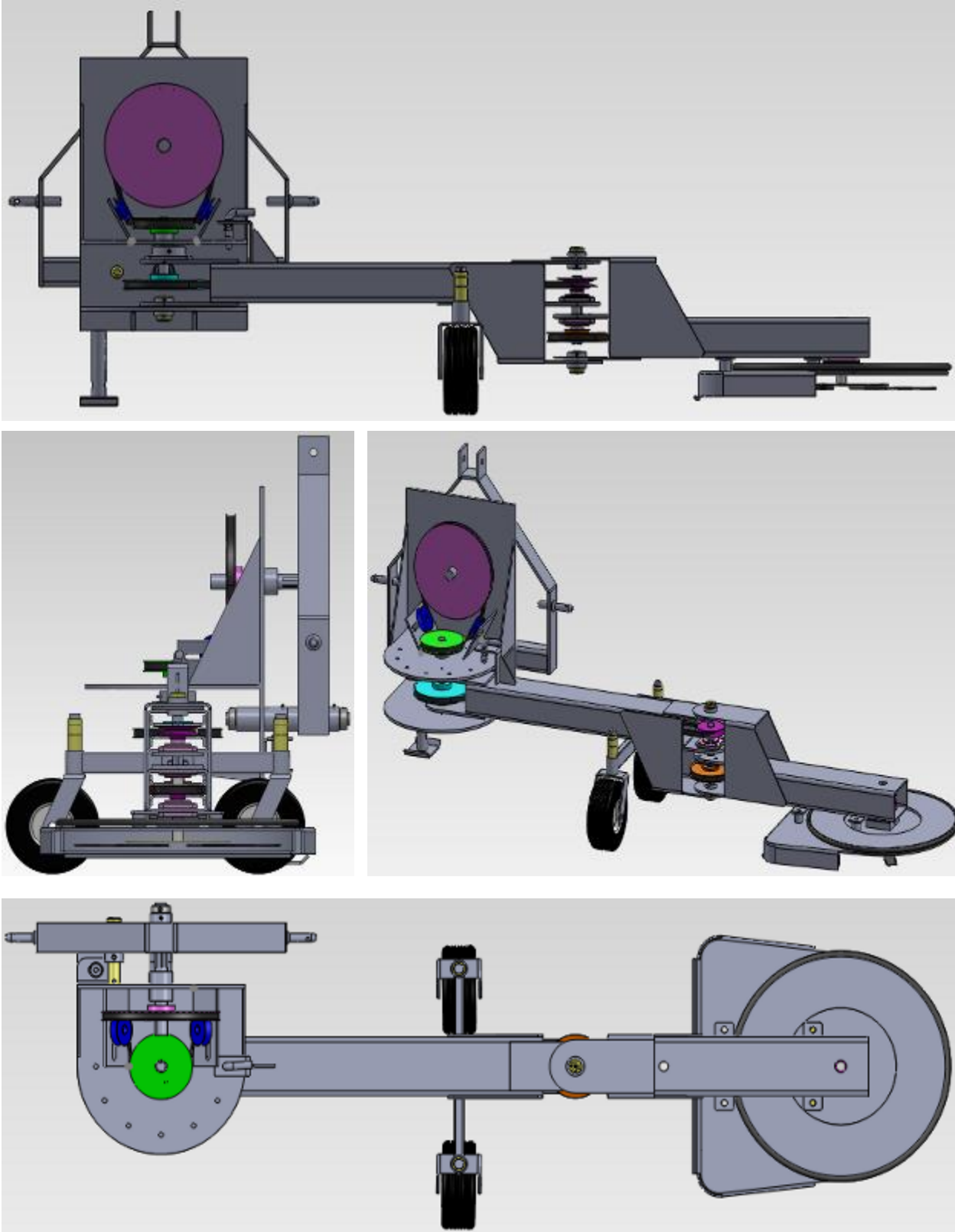


Figure 28: SolidWorks Views of the All Belt model.



*Gearbox and Belt Images*

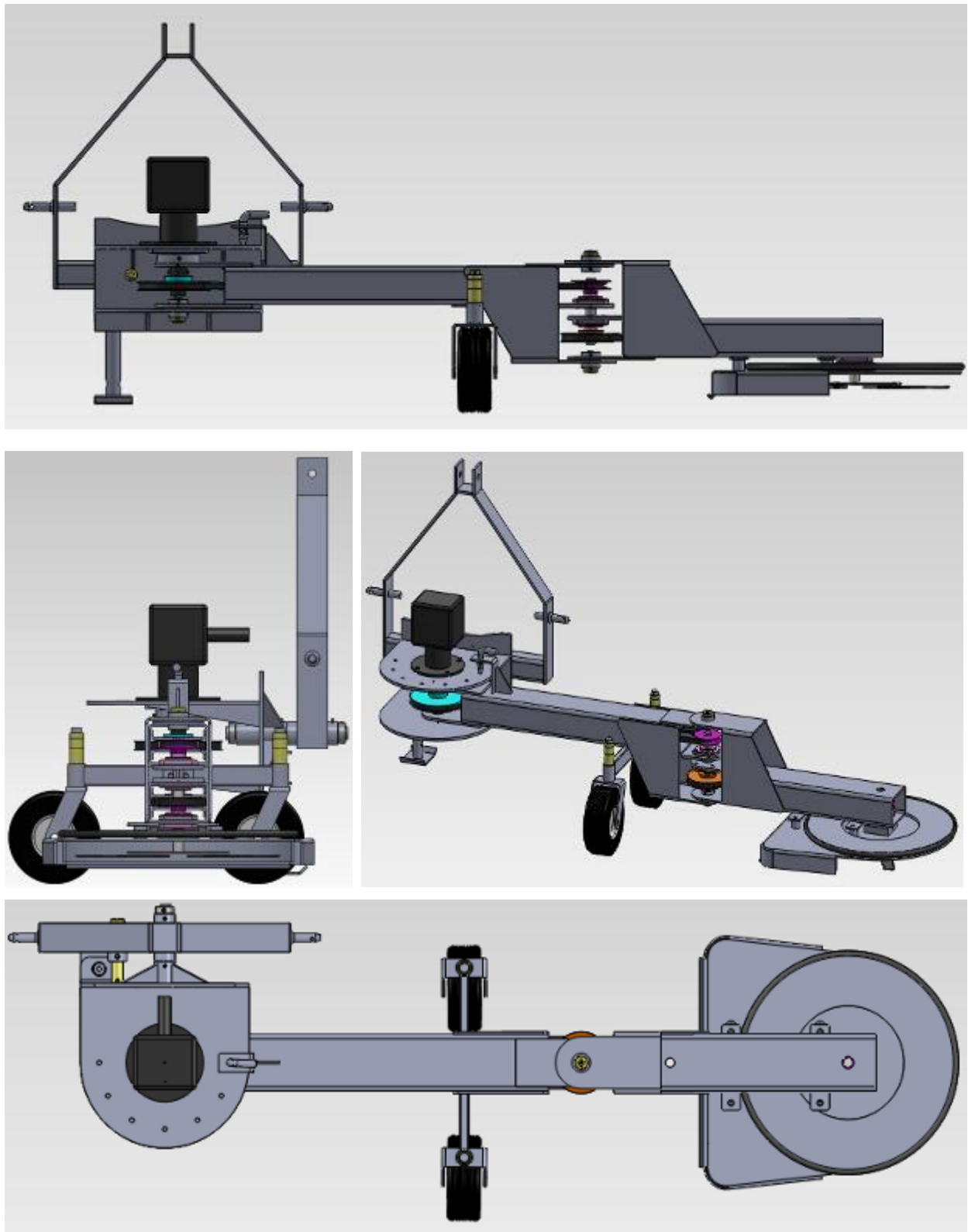


Figure 29: SolidWorks Views of the Gearbox and Belt model.

*Hydraulic Images*

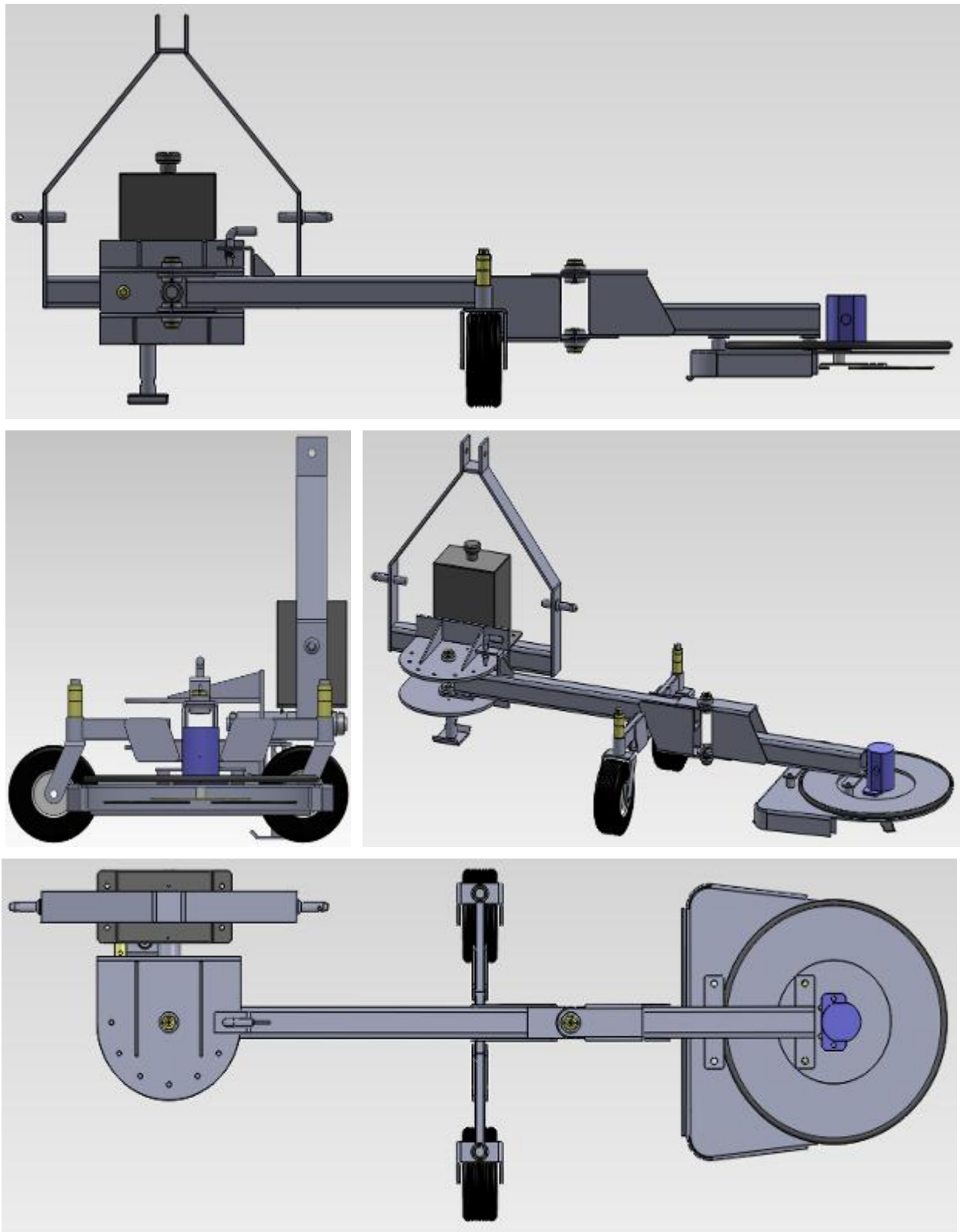


Figure 30: SolidWorks Views of the Hydraulic model.

### *Design Features*

Each of the above models has similar features of functionality. An A-Frame assembly mounts to the tractor 3-point hitch. A lateral tilt plate is mounted off of the A-Frame and allows rotation of the cutting arm, which allows it to follow the contour of the ground (figure 31). This lateral tilt plate allows the cutting arm to move 180°. This means the operator can use the implement on either side of the tractor (figure 32). The arm is hinged in the middle to allow the arm to swing around objects, such as fence posts, trees, and buildings. The cutting head also features a “follower wheel,” which in conjunction with the hinged arm, allows the head to follow around obstacles (figure 33 and figure 34). The cutting head on this implement has the ability to be changed, from a multi-blade head, to a single blade, to a string type blade (figure 35). The implement has a transport pin that locks the LTP in the horizontal position for transport; the storage jack is shown in figure 36 with the transport pin. The LTP features a breakaway that locks the arm in one of seven positions, but also will release from the position when the arm hits a stationary object too hard.

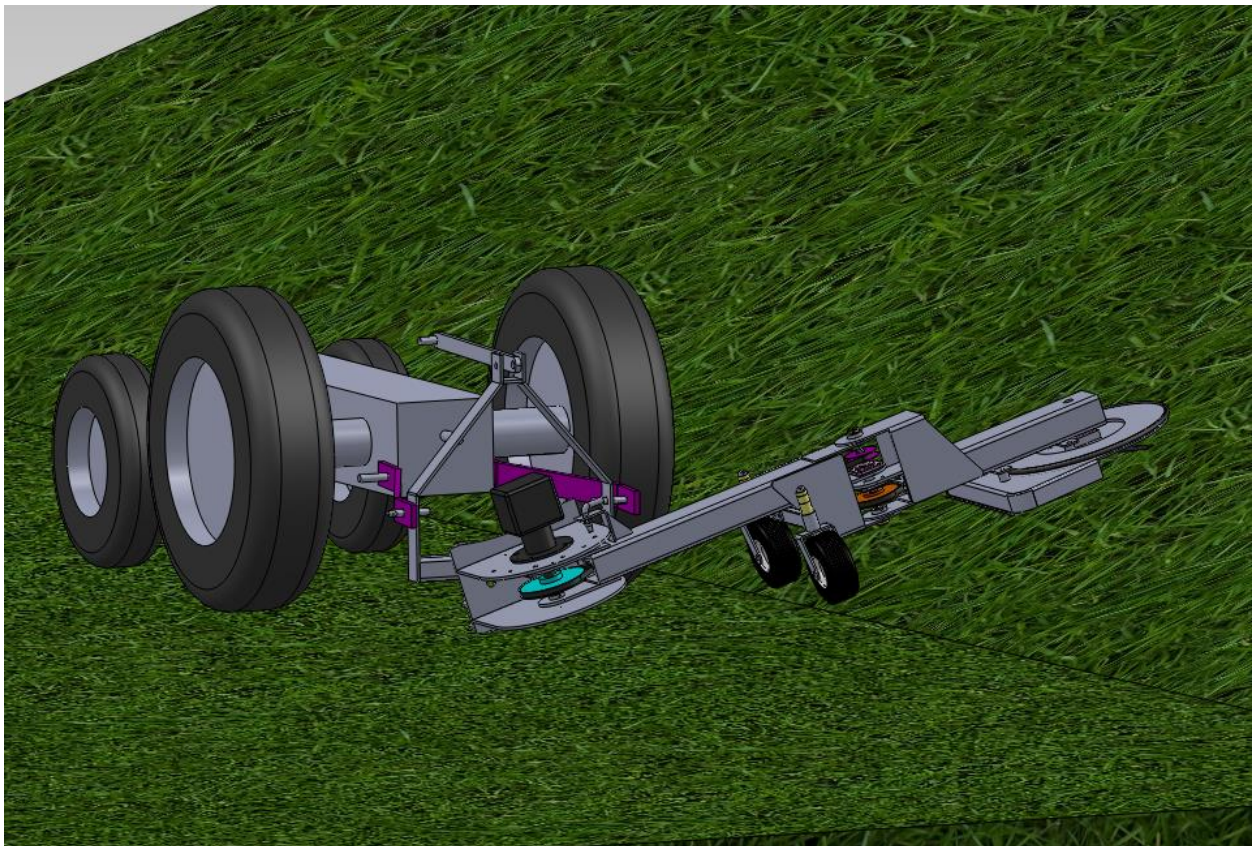


Figure 31: The Lateral tilt plate allows the arm to follow the contour of the ground.

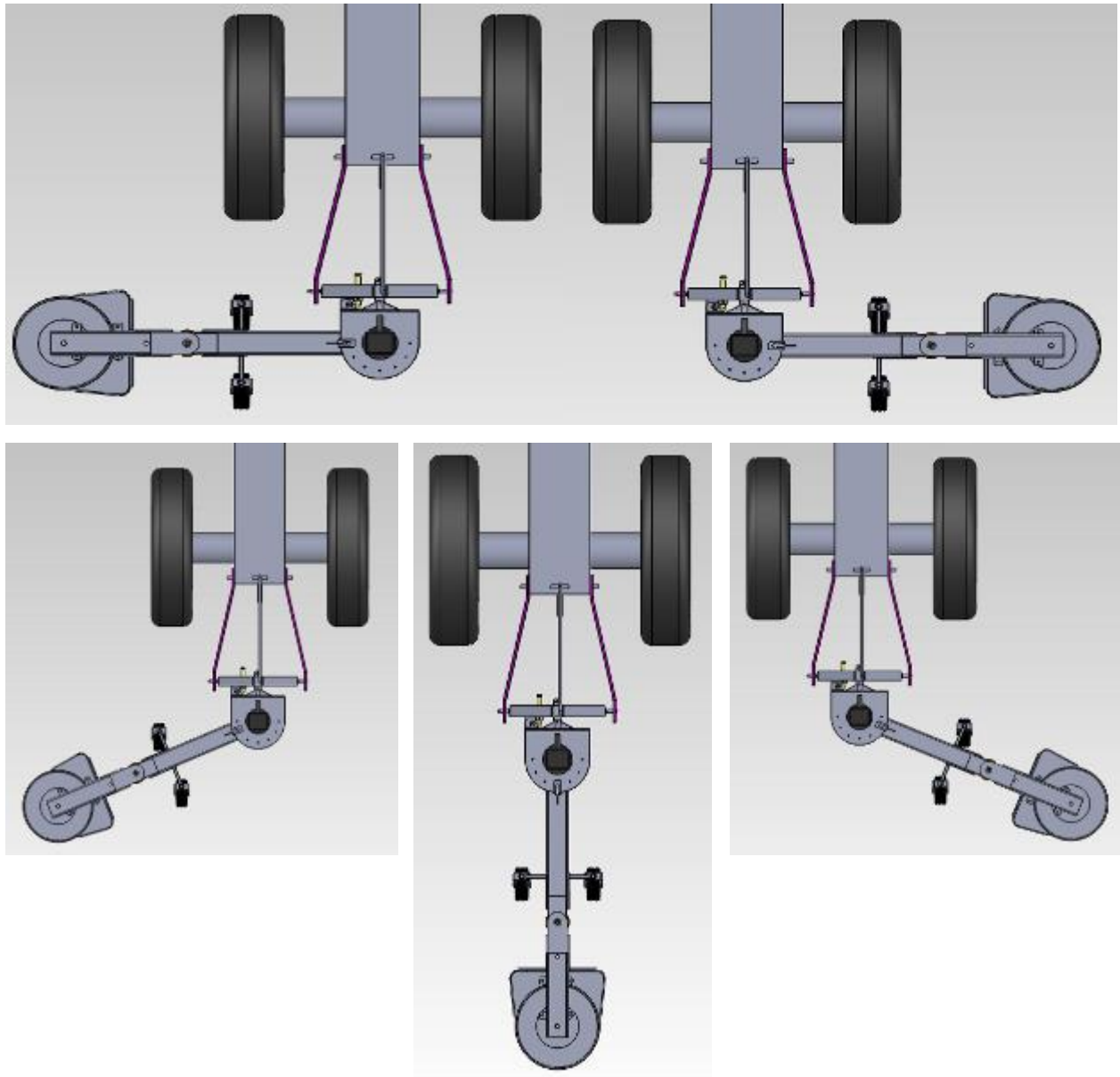


Figure 32: The lateral tilt plate allows the arm to move 180<sup>0</sup>, for mowing on both sides of the tractor.

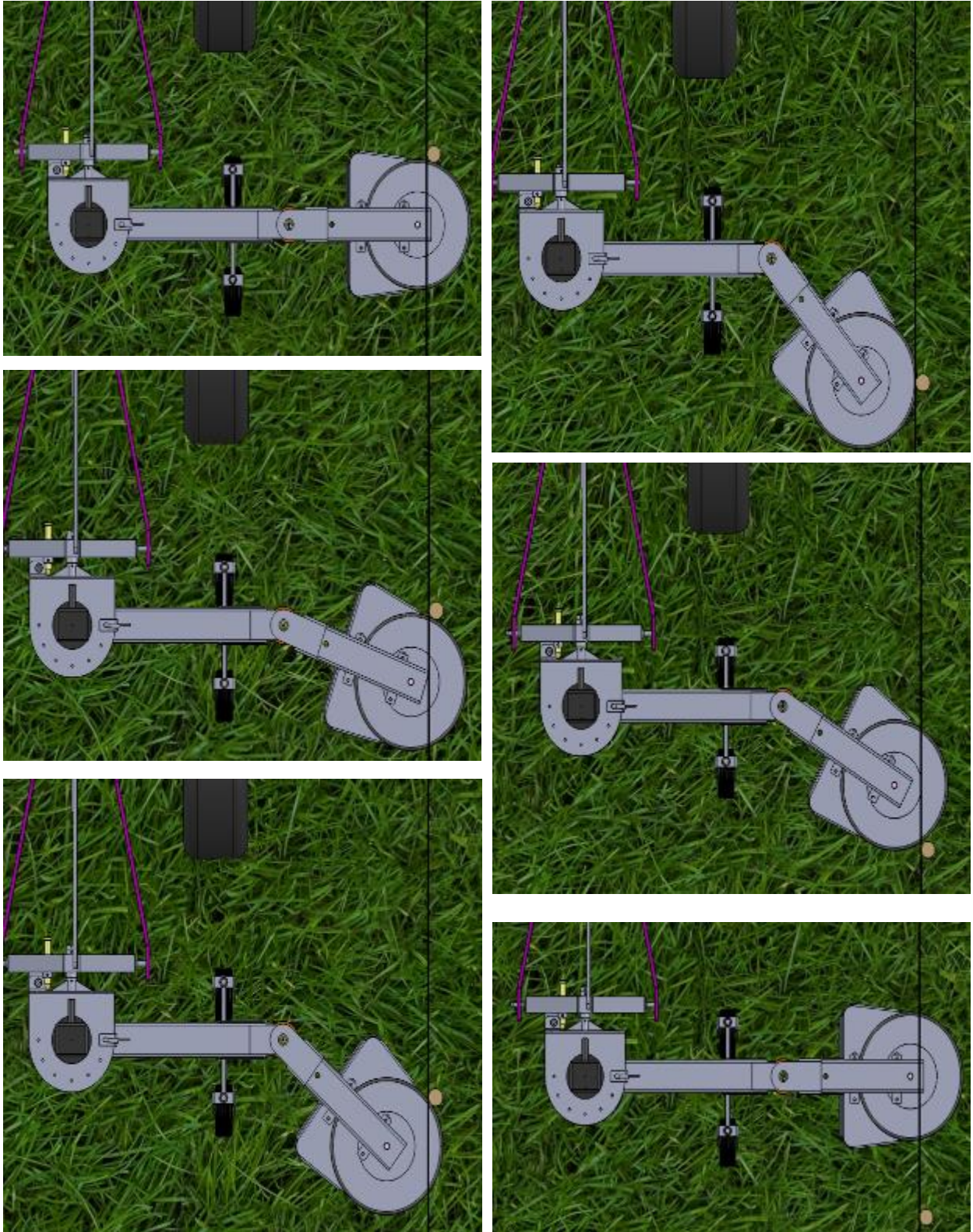


Figure 33: These six figures show the action of the arm moving around a fence post.

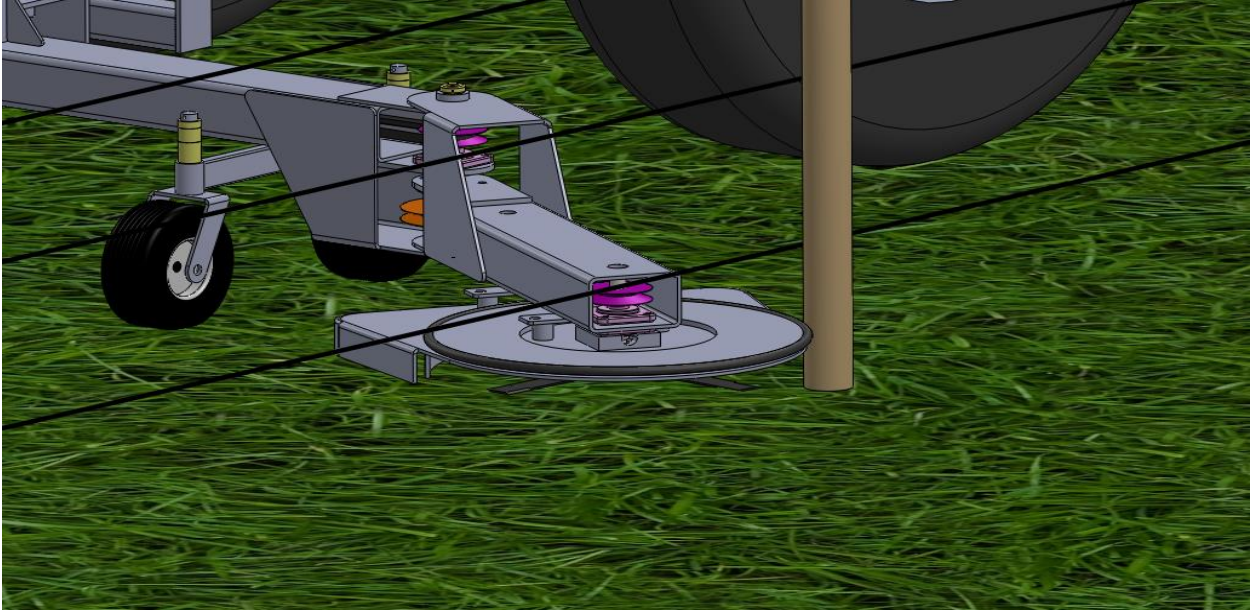


Figure 34: Close up of the follower wheel as it contacts the fence post.

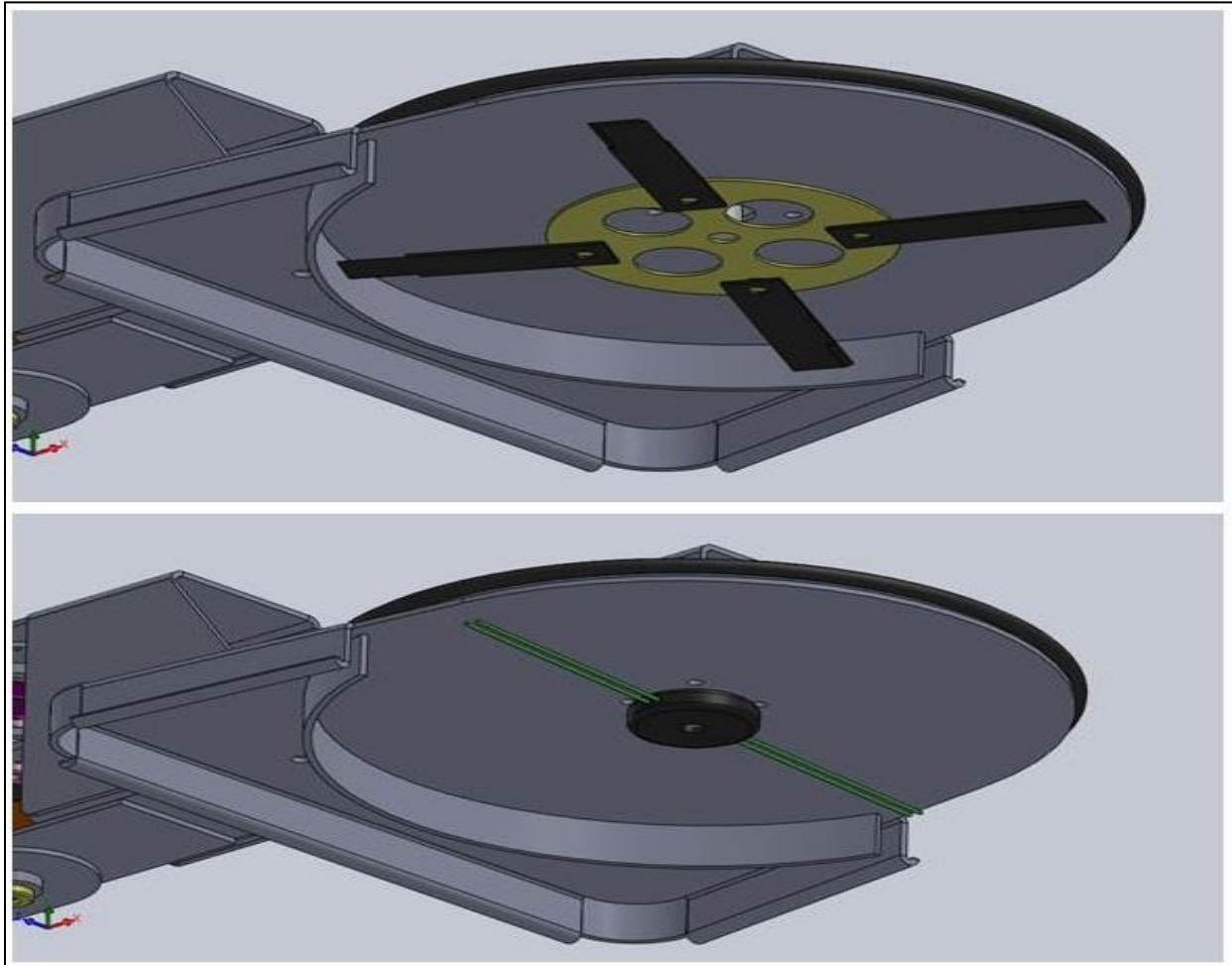


Figure 35: Two of the cutting head options, a multi-blade head and weed eater string.

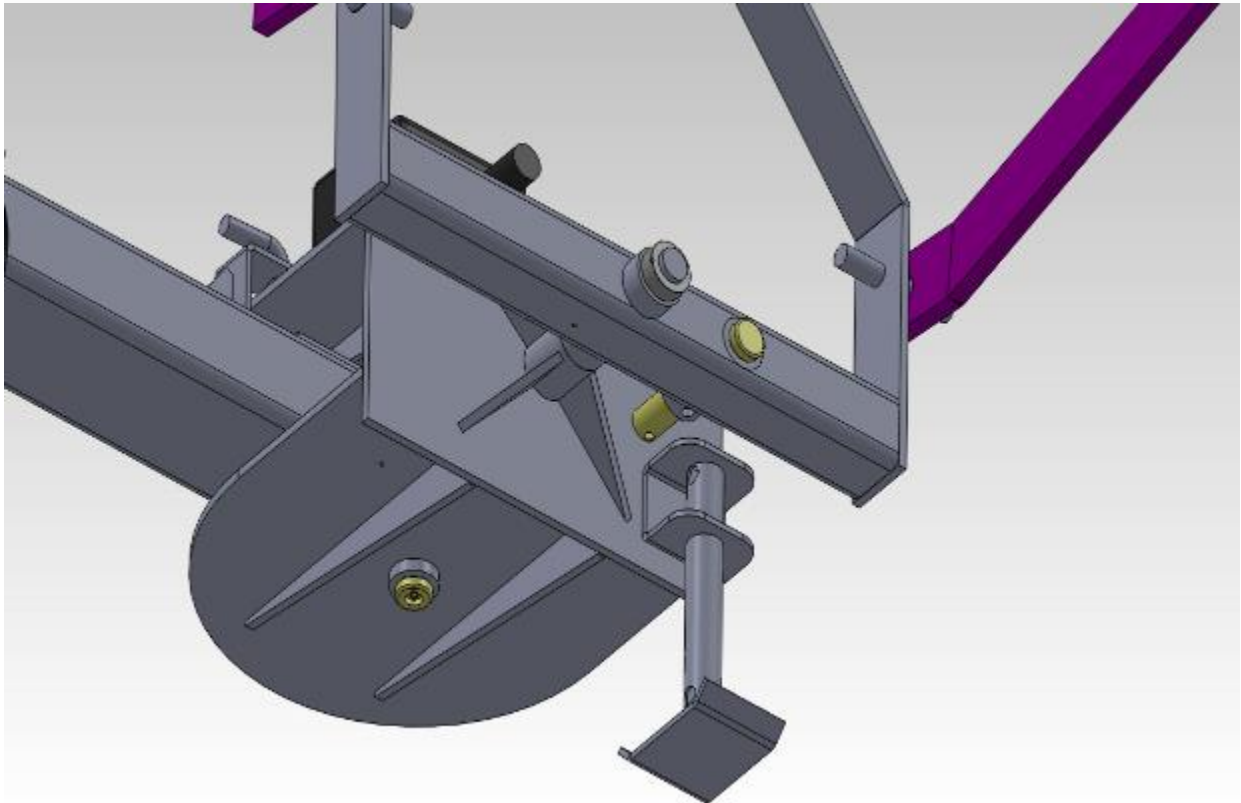
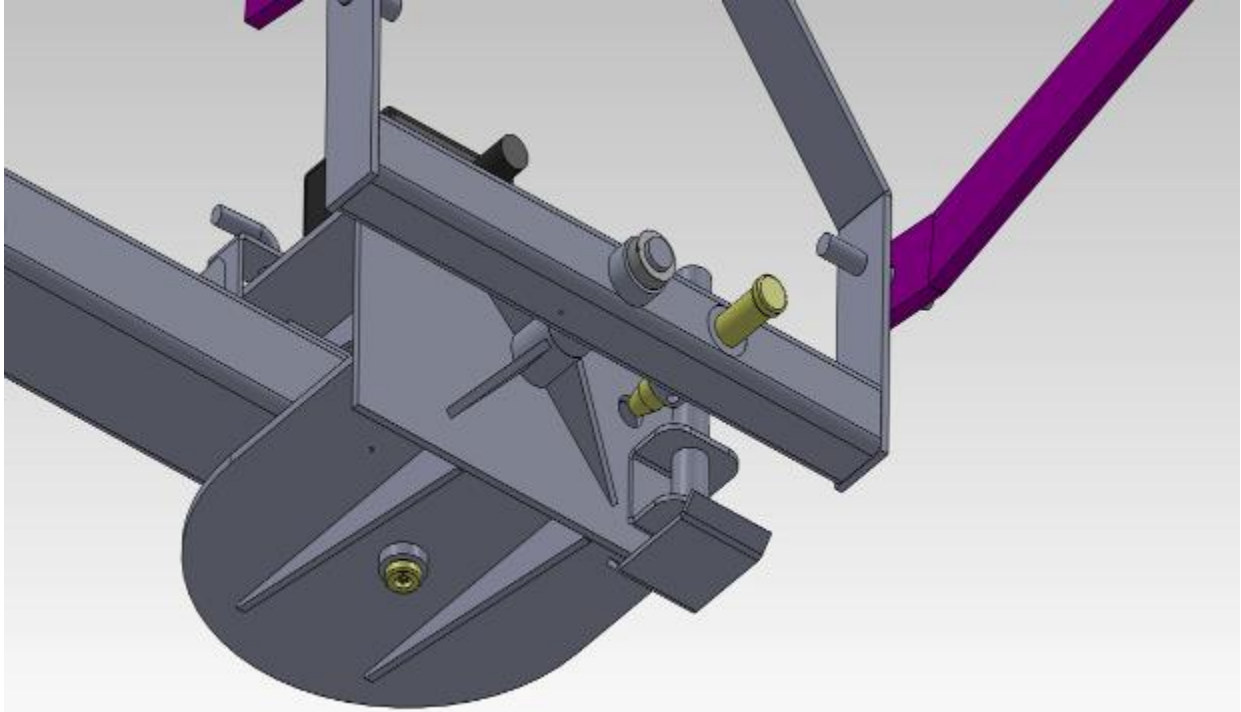


Figure 36: Top picture shows transport pin out and jack up; bottom shows the opposite.

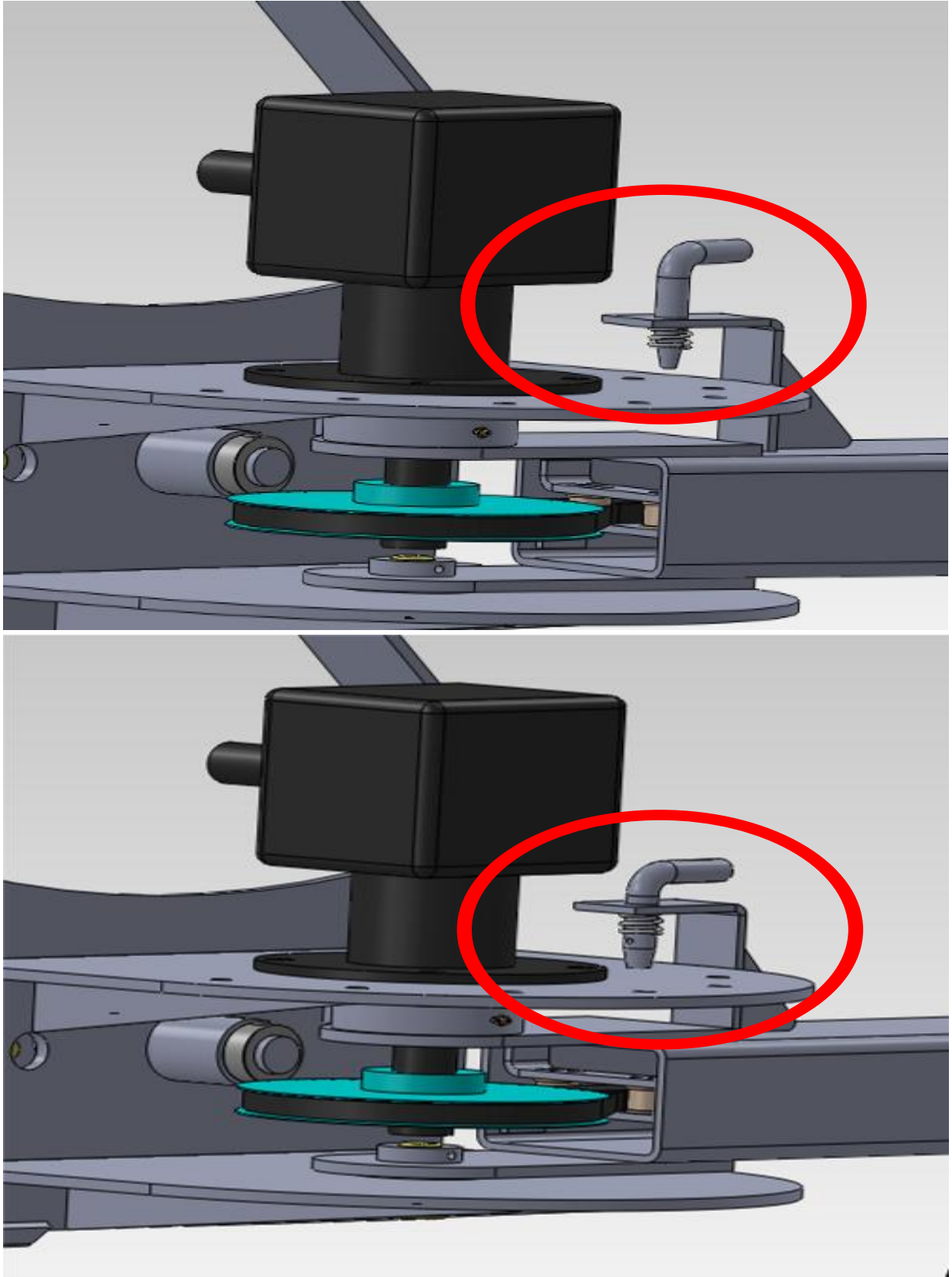


Figure 37: This is an image for the breakaway for the LTP.



### **Ground Following**

Below are the image (figure 38) and the pros and cons for the three different ground followings: twin ten inch, single five, and the rotation dome.

Twin Ten Inch	
Pros	Cons
<ul style="list-style-type: none"><li>• Offers the most support</li><li>• Current industry standard</li><li>• Allows working hinge to rotate the easiest</li></ul>	<ul style="list-style-type: none"><li>• Bulky</li><li>• Multiple components for proper height adjustment</li><li>• Limits ground following on slopes</li></ul>

Single Five	
Pros	Cons
<ul style="list-style-type: none"><li>• Easiest height adjustment</li><li>• Sleek/compact design</li></ul>	<ul style="list-style-type: none"><li>• Possible custom wheel</li><li>• May inhibit working hinge</li></ul>

Rotation Dome	
Pros	Cons
<ul style="list-style-type: none"><li>• Eliminates fulcrum point for slope mowing</li><li>• Least moving parts</li><li>• Cheapest</li></ul>	<ul style="list-style-type: none"><li>• Hardest to adjust</li><li>• Requires extensive machining</li><li>• Does not work with hydraulic model</li><li>• May be destructive to ground</li></ul>

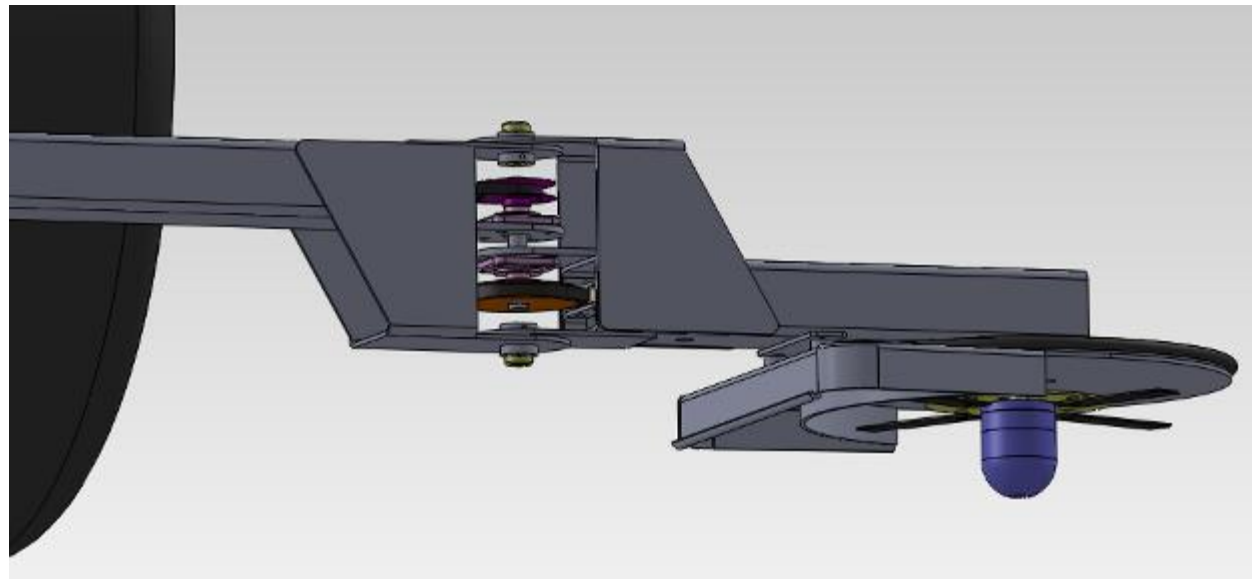
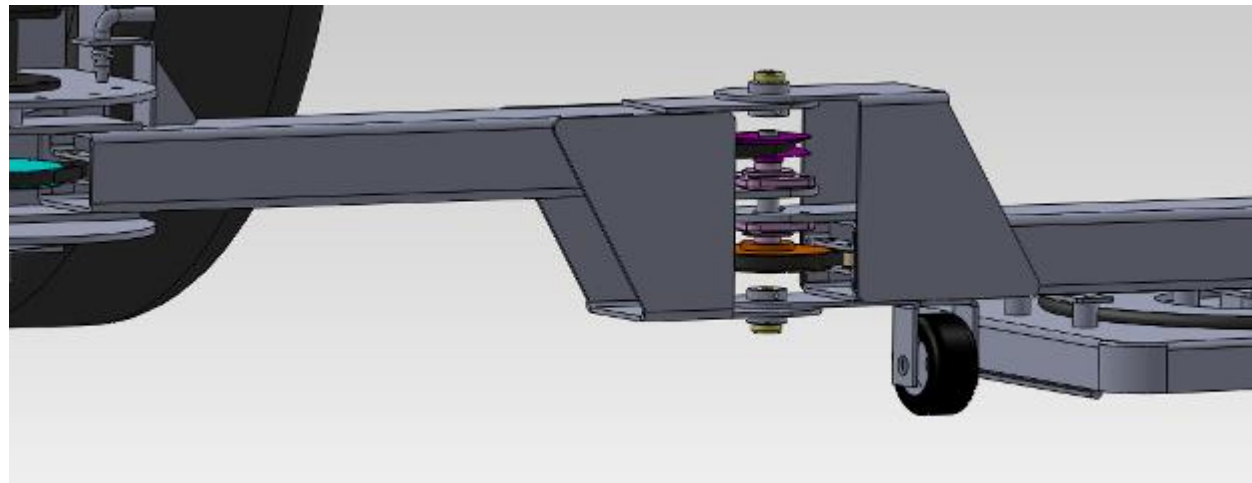
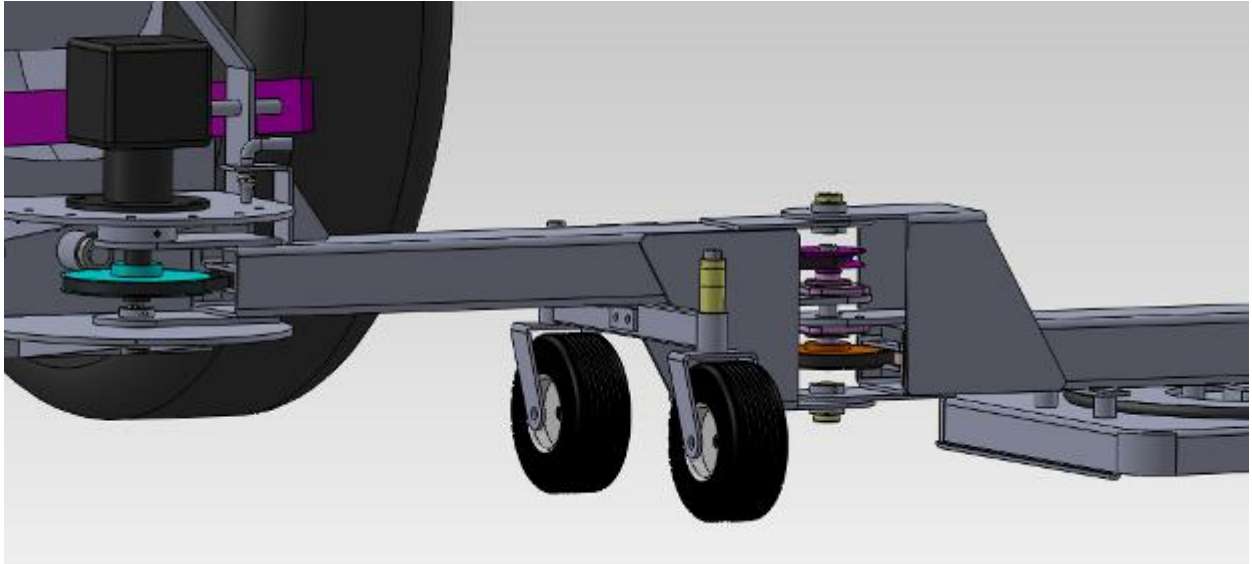


Figure 38: This is an image of the three different ground following wheels.

## Hand Calculations

### Blade Ratio

The blade ratio needs to be calculated, in figure 39, because of the set speed at the PTO will need to be transferred through the arm and into the cutting head. While calculating the blade ratio we found that we will need to have a 1:6.23 from the PTO shaft to the cutting head.

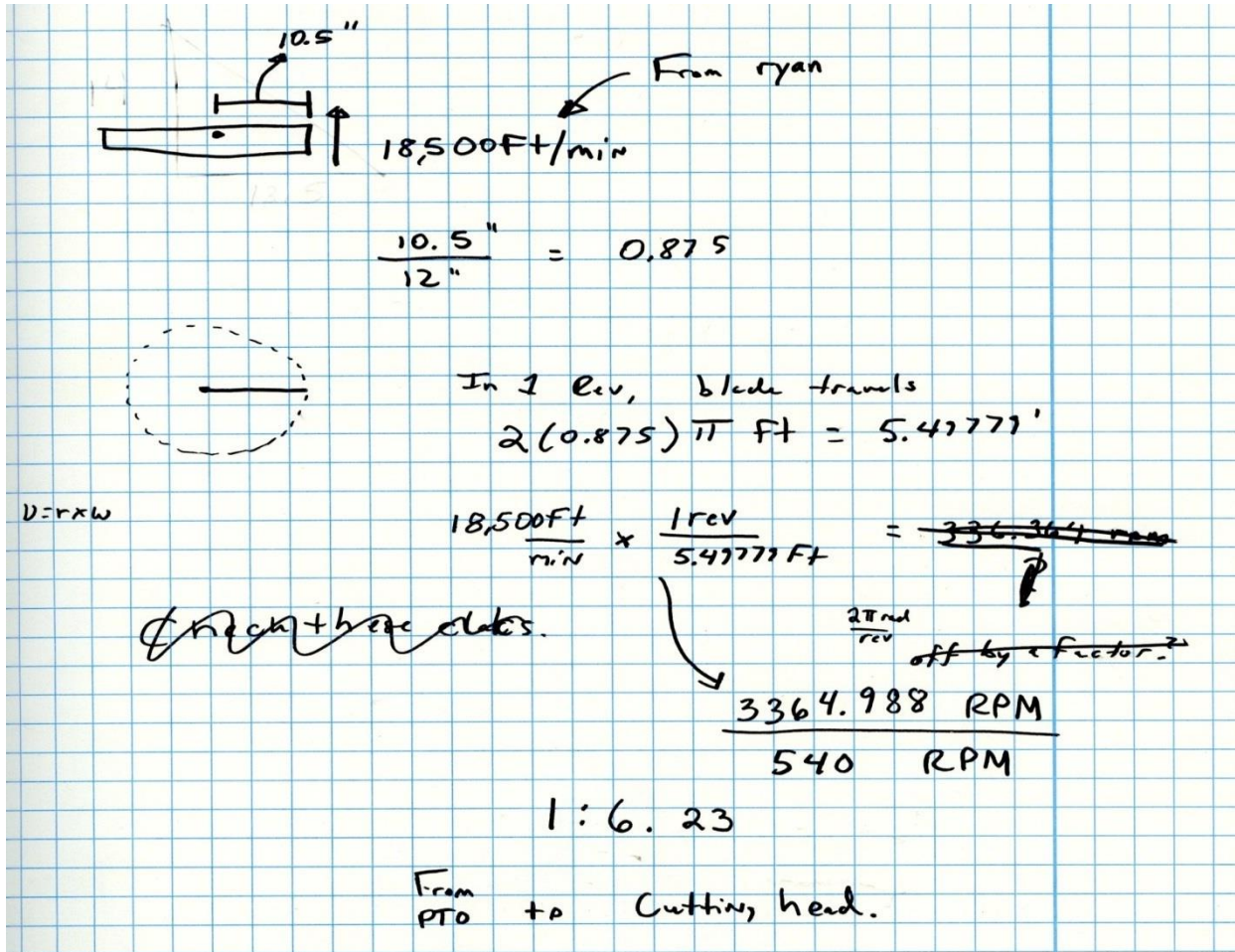


Figure 39: Hand calculations done in John Locklear's engineering notebook for the blade ratio.

### Belt Sizing

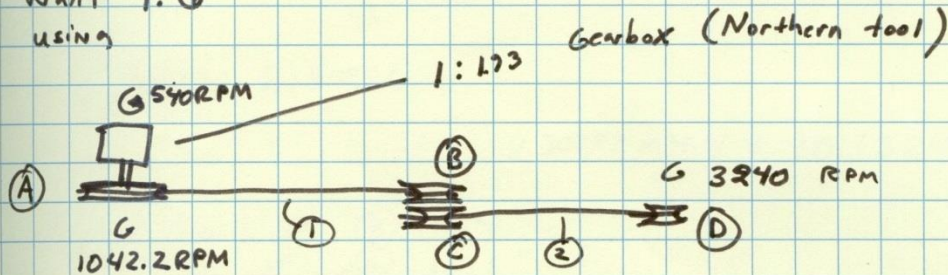
When determining what belt(s) are needed for the project, JJR Engineering used the Gates Heavy Duty V-belt: Drive Design Manual (4). While finding which belts would apply for the project we use Table 10 and Table 21, which are represented in figure 40 and figure 41, to find the rated HP per belt. The calculations can found in figure 42 through figure 44.



## Belt sizes, cont'nue

### - Gear ratio

Want 1:6  
using



$$\frac{3240}{1042.2} = 3.1 \text{ ratio between two sets of belts and sheaves.}$$

~~Belt 2 is the critical belt. It will be spinning faster so HP will be more limiting on this belt.~~

### Gates V-belt design manual

From minimum sheave dia sizes, I will assume sheave D can be 4.4" Dia minimum. It will spin 3240 RPM ~~not belt~~ most critical point. (Table No 43)

#### Assume:

$$\begin{aligned} \text{D} &= 4.4'' \\ \text{C} &= 6.0'' \end{aligned}$$

$$\frac{6.0}{4.4} = 1.36 \text{ speed ratio}$$

\* Need to use notched belt

~~on Table No 7~~ Table No. 10

~~Small sheave~~

~~with Super HC molded Notch belt, a~~

Table No. 10

@ 3200 RPM, sheave  $\phi$  4.4 Rated HP per belt is

$$12.8 \text{ HP} \times 1.79 = 14.59 \text{ HP per belt} \quad \left( \text{5VX Super HC molded notch} \right)$$

Figure 42: Calculations done by John Locklear for belt sizing.

Belt #2 calculations

Shaft RPM = ~~2400~~  $\frac{3240}{1.35} = 2400$

$\frac{2400}{1042.2} = 2.30292$

$2.30292 \times 4.4 = 10.1324$

Need small  $\varnothing$  (B) 4.4"  
Large  $\varnothing$  (A) 10.1"

@2400 RPM,  $\varnothing$  4.4 Table 10

SVX Super HC molded notch 10.5 HP + 1.34 = 11.84 HP per belt

Need SVX Super HC molded V-notch Belts, lengths

Yet TBD

- (A) 10.0"
- (B) 4.4"
- (C) ~~5.5~~" 6.0"
- (D) 4.4"

Gearbox 1:1.93

$540 \times \frac{1.93}{1} \times \frac{10}{4.4} \times \frac{6}{4.4} = 3229.96$   $\frac{3229.96}{540} = 5.98 \checkmark$

---

Size For a B or C section Pulley

For BX min sheave  $\varnothing = 4"$

For B MN sheave  $\varnothing = 4.6"$

Size For BX sheave

Figure 43: The continuation of the calculations done by John Locklear for belt sizing.

Assume (D) = 4.0  
 (C) = 6.0      Speed ratio  $\frac{6.0}{4.0} = 1.5$

From Table N. 21

@ 3200 RPM  $\phi$  4.0      Rated hp per belt = 8.44  
 $= 8.44 + 1.23 = 9.67$  HP per belt  
 ↑  
 From Speed Ratio

$$\frac{3240}{1.5} = 2160$$

$$\frac{2160}{1042.2} = 2.07253$$

$$2.07253 \times 4.0 = 8.29$$

Assuming (B) = 4.0  
 (A) = 8.0

@ 2160 RPM  $\phi$  4.0      Table 21

RHP per belt = 6.97 + 0.99 = 7.96 hp per belt

For BX belt

Need (A) 8.0  
 (B) 4.0  
 (C) 6.0  
 (D) 4.0

$$540 \times \frac{1.93}{1} \times \frac{80}{4} \times \frac{6}{4} = 3126.6 \checkmark$$

BX pulleys are much easier to find than SVX pulleys.

Figure 44: The finalization of the calculations done by John Locklear for belt sizing.

## Cost Analysis

### Complete Belt

<b>All Belt</b>					
<i>Sub Assembly</i>		<i>Size</i>	<i>Quantity</i>	<i>Cost Per Qty</i>	<i>Cost</i>
<b>Frame</b>					
	3-point Upper A Frame	3" x 0.375"	5.67	\$2.45	\$13.89
	3-point Lower Member	3" x 3"	2.25	\$6.00	\$13.50
	LTP (Lateral Tilt Plate)				
		0.375" Plate (ft <sup>2</sup> )	7.29	\$7.94	\$57.88
		0.25" Plate (ft <sup>2</sup> )	1.91	\$5.72	\$10.93
	Arm (inner)	4" x 6"	3.00	\$10.45	\$31.35
	Arm (Outer)	4" x 6"	2.33	\$10.45	\$24.35
	Flanges				
		0.375" Plate (ft <sup>2</sup> )	1.39	\$7.94	\$11.04
		0.25" Plate (ft <sup>2</sup> )	4.03	\$5.72	\$23.05
	Bushings				
		2.25" OD	1.17	\$15.75	\$18.43
		2.00" OD	0.42	\$12.25	\$5.15
	Ground Following Dome		1	\$10.00	\$10.00
	Jack		1	\$20.00	\$20.00
	Bearings/Rotation Shafts				
		Timken SCJ 1	4	\$35.70	\$142.80
		60355K606	4	\$35.68	\$142.72
		1.25" OD	1.17	\$4.75	\$5.56
		1.00" OD	1.67	\$3.90	\$6.51
	Misc. (Hardware, Pins, Etc.)		1	\$100.00	\$100.00
			<b>Frame Total</b>		<b>\$637.15</b>
<b>Drives</b>					
	Input PTO Shaft		1	\$150.00	\$150.00
	Pulleys				
	Initial Driver	12" X 1.25"	1	\$13.51	\$13.51
	LTP Bottom	8"	1	\$7.95	\$15.90
	LTP Top / Bottom Pivot	6"	2	\$6.88	\$13.76
	Top Pivot Point/Head Driven	4"	2	\$6.28	\$6.28
	Directional Transfer	3"	2	\$5.95	\$11.90
	Tensioner		2	\$18.00	\$36.00
	Belt Shielding		1	\$30.00	\$30.00
	Belts				
		BX50 (Directional Transfer)	1	\$19.99	\$19.99
		BX105 (Inner Arm)	1	\$36.99	\$36.99
		BX69 (Outer Arm)	1	\$36.99	\$36.99
			<b>Drives Total</b>		<b>\$371.32</b>
<b>Cutting Head</b>					
	Blades		4	\$5.00	\$20.00
	Shield/Guard				
		0.375" Plate (ft <sup>2</sup> )	2.78	\$7.94	\$22.07
		0.25" Plate (ft <sup>2</sup> )	5.53	\$5.72	\$31.63
	Hub		1	\$10.00	\$10.00
			<b>Cutting Head Total</b>		<b>\$83.70</b>
<b>Fabrication</b>					
	Cutting Table	Linear Inches	1390	\$0.10	\$139.00
	Welding	Linear Inches	732	\$0.15	\$109.80
	Machining	Hourly	2	\$70.00	\$140.00
	Bends		23	\$0.05	\$1.15
	Saw cuts	Linear Inches	24	\$0.38	\$9.12
	Holes Drilled		4	\$0.35	\$1.40
			<b>Fabrication Total</b>		<b>\$400.47</b>
<b>Assembly/Paint</b>					
	Paint		2	\$50.00	\$100.00
	Assembly		2	\$35.00	\$70.00
			<b>Assembly/Paint Total</b>		<b>\$170.00</b>
<b>Total Cost</b>					<b>\$1,662.64</b>



<b>All Belts</b>	
<b>PROS</b>	<b>CONS</b>
<ul style="list-style-type: none"> <li>• Replacement parts can be obtained at all farm supply or auto parts stores</li> <li>• Very elementary concept – easy for everyone to grasp</li> <li>• Multiple slip points if the cutting head were to be obstructed</li> </ul>	<ul style="list-style-type: none"> <li>• The service points – most greased bearings on rotational parts</li> <li>• Numerous sizes of similar parts increasing total part count</li> <li>• Most extensive shielding requirements over initial directional transfer pulleys</li> <li>• Bending belts increases stress, in turn wearing belts faster and requiring more frequent replacement</li> </ul>

## Gearbox and Belt

<b>Gearbox/Belt</b>					
<i>Sub Assembly</i>		<i>Size</i>	<i>Quantity</i>	<i>Cost Per Qty</i>	<i>Cost</i>
<b>Frame</b>					
	3-point Upper A Frame	3" x 0.375"	5.67	\$2.45	\$13.89
	3-point Lower Member	3" x 3"	2.25	\$6.00	\$13.50
	LTP (Lateral Tilt Plate)				
		0.375" Plate (ft <sup>2</sup> )	5.28	\$7.94	\$41.92
		0.25" Plate (ft <sup>2</sup> )	0.78	\$5.72	\$4.46
	Arm (inner)	4" x 6"	3.00	\$10.45	\$31.35
	Arm (Outer)	4" x 6"	2.33	\$10.45	\$24.35
	Flanges				
		0.375" Plate (ft <sup>2</sup> )	1.39	\$7.94	\$11.04
		0.25" Plate (ft <sup>2</sup> )	4.03	\$5.72	\$23.05
	Bushings				
		2.25" OD	0.83	\$15.75	\$13.07
		2.00" OD	0.25	\$12.25	\$3.06
	Ground Following Dome		1	\$10.00	\$10.00
	Jack		1	\$20.00	\$20.00
	Bearings/Rotation Shafts				
		Timken SCJ 1	4	\$35.70	\$142.80
		1.25" OD	1.17	\$4.75	\$5.56
		1.00" OD	1.08	\$3.90	\$4.21
	Misc. (Hardware, Pins, Etc.)		1	\$100.00	\$100.00
			<b>Frame Total</b>		<b>\$462.27</b>
<b>Drives</b>					
	Input PTO Shaft		1	\$150.00	\$150.00
	Gearbox		1	\$207.35	\$207.35
	Pulleys				
	Initial Driver	8"	1	\$7.95	\$7.95
	Pivot Point	6"	1	\$6.88	\$6.88
	Head Driven	4"	2	\$6.28	\$12.56
	Tensioner		2	\$18.00	\$36.00
	Belts				
		BX105 (Inner Arm)	1	\$36.99	\$36.99
		BX69 (Outer Arm)	1	\$36.99	\$36.99
			<b>Drives Total</b>		<b>\$494.72</b>
<b>Cutting Head</b>					
	Blades		4	\$5.00	\$20.00
	Shield/Guard				
		0.375" Plate (ft <sup>2</sup> )	2.78	\$7.94	\$22.07
		0.25" Plate (ft <sup>2</sup> )	5.53	\$5.72	\$31.63
	Hub		1	\$10.00	\$10.00
			<b>Cutting Head Total</b>		<b>\$83.70</b>
<b>Fabrication</b>					
	Cutting Table	Linear Inches	1280	\$0.10	\$128.00
	Welding	Linear Inches	627	\$0.15	\$94.05
	Machining	Hourly	2	\$70.00	\$140.00
	Bends		23	\$0.05	\$1.15
	Saw cuts	Linear Inches	24	\$0.38	\$9.12
	Holes Drilled		4	\$0.35	\$1.40
			<b>Fabrication Total</b>		<b>\$373.72</b>
<b>Assembly/Paint</b>					
	Paint		2	\$50.00	\$100.00
	Assembly		2	\$35.00	\$70.00
			<b>Assembly/Paint Total</b>		<b>\$170.00</b>
<b>Total Cost</b>					<b>\$1,584.41</b>

### **Gearbox / Belts**

<b>PROS</b>	<b>CONS</b>
<ul style="list-style-type: none"><li>• Gearboxes have many previously proven uses in agricultural equipment</li><li>• Reduces structural material in LTP over complete belt design</li><li>• Reduces the number of bearings and rotational parts</li><li>• Eliminates one guarded structure over all belts design</li></ul>	<ul style="list-style-type: none"><li>• Additional parts count (gear box)</li><li>• Added maintenance point (gear oil)</li><li>• Not every farm supply or auto store will have a replacement gear box</li></ul>

## Hydraulic

<b>All Hydraulic</b>					
<i>Sub Assembly</i>		<i>Size</i>	<i>Quantity</i>	<i>Cost Per Qty</i>	<i>Cost</i>
<b>Frame</b>					
	3-point Upper A Frame	3" x 0.375"	5.67	\$2.45	\$13.89
	3-point Lower Member	3" x 3"	2.25	\$6.00	\$13.50
	LTP (Lateral Tilt Plate)				
		0.375" Plate (ft <sup>2</sup> )	3.48	\$7.94	\$27.63
		0.25" Plate (ft <sup>2</sup> )	0.42	\$5.72	\$2.40
	Arm (inner)	3" x 3"	3.00	\$6.00	\$18.00
	Arm (Outer)	3" x 3"	2.00	\$6.00	\$12.00
	Flanges				
		0.375" Plate (ft <sup>2</sup> )	0.61	\$7.94	\$4.84
		0.25" Plate (ft <sup>2</sup> )	1.89	\$5.72	\$10.81
	Bushings				
		2.25" OD	0.83	\$15.75	\$13.07
		2.00" OD	0.33	\$12.25	\$4.04
	Ground Following Dome		1	\$10.00	\$10.00
	Jack		1	\$20.00	\$20.00
	Rotation Shafts	1.25" OD	1.17	\$4.75	\$5.56
	Misc. (Hardware, Pins, Etc.)		1	\$100.00	\$100.00
			<b>Frame Total</b>		<b>\$255.75</b>
<b>Drives</b>					
	PTO Pump		1	\$355.00	\$355.00
	Hydraulic Motor		1	\$175.00	\$175.00
	Hydraulic Hoses		1	\$100.00	\$100.00
	Hydraulic Fittings		1	\$25.00	\$25.00
	Reservoir		1	\$120.00	\$120.00
	Filter		1	\$25.00	\$25.00
	Relief valve		1	\$100.00	\$100.00
			<b>Drives Total</b>		<b>\$900.00</b>
<b>Cutting Head</b>					
	Blades		4	\$5.00	\$20.00
	Shield/Guard				
		0.375" Plate (ft <sup>2</sup> )	2.78	\$7.94	\$22.07
		0.25" Plate (ft <sup>2</sup> )	5.53	\$5.72	\$31.63
	Hub		1	\$10.00	\$10.00
			<b>Cutting Head Total</b>		<b>\$83.70</b>
<b>Fabrication</b>					
	Cutting Table	Linear Inches	1050	\$0.10	\$105.00
	Welding	Linear Inches	460	\$0.15	\$69.00
	Machining	Hourly	2	\$70.00	\$140.00
	Bends		23	\$0.05	\$1.15
	Saw cuts	Linear Inches	20	\$0.38	\$7.60
	Holes Drilled		4	\$0.35	\$1.40
			<b>Fabrication Total</b>		<b>\$324.15</b>
<b>Assembly/Paint</b>					
	Paint		2	\$50.00	\$100.00
	Assembly		2	\$35.00	\$70.00
			<b>Assembly/Paint Total</b>		<b>\$170.00</b>
<b>Total Cost</b>					<b>\$1,733.61</b>

## Hydraulic Transfer

PROS	CONS
<ul style="list-style-type: none"><li>• Allows for a much smaller Lateral Tilt Plate (LTP) and arm by eliminating belts and gear box – less material cost</li><li>• Least number of rotating parts – most serviceable option (fewer grease spots and no bearings)</li><li>• Lowest total parts count – highest manufacturability</li><li>• Simplifies working pivot joint with no rotating shaft to integrate</li></ul>	<ul style="list-style-type: none"><li>• Bulky reservoir to add to implement</li><li>• Hydraulic fluid can coat surfaces if a line were to bust</li><li>• Needs pressure relief valve to allow for “slip joint” of cutting drive system</li></ul>

# **Appendix A - Market Research**

## WEEDEN'S Fence Mower

# WEEDEN'S Fence Mower

*Patent Pending*

Hydraulic mower constructed with commercial grade steel, grade 8 bolts and lock nuts and powder coated

Built to last

This mower has 3 steel blades 4" long which cut 1/8" from fence post

Has the ability to mow over 4,000 feet of fence per hour

Hydraulic control to level mower as you are mowing

Mows under fence and around 3 sides of post

Now located in Burleson, TX

*Call for demo*

**Darryll Weeden**  
940-736-1361  
weedens43@yahoo.com



## HAYSPEAR Fence Runner



ATV, Small tractor, lawn mower with a good traction system Need to maintain up to 2 to 3 miles of fence per hour? Fence Runner mows under fence and when it approaches post, tree, or other vertical obstruction,

Fence Runners patented spring loaded deck eases around the fence post.

Just drive parallel to the fence and after the deck passes by the tree post or other vertical obstruction the deck returns to mowing underneath the fence.

ALL you do is drive parallel to the fence and Fence Runner mower's spring loaded deck does the rest!

**YOU CAN MAINTAIN 2 TO 3 MILES OF FENCE PER HOUR!! FENCE HOG TOWS BEHIND ATV, LAWN MOWER, OR SMALL TRACTOR. WITH THIS SELF CONTAINED UNIT ALL YOU NEED IS A HITCH PIN!**

Fence Runner Mower has many features:

- 16 HP Briggs & Stratton Twin Cylinder Vanguard Engine
- Electric Clutch to engage and disengage the deck with remote switch operable from the seat of the towing vehicle
- Rigid 33 inch blade for cutting short or tall grass, weeds, blackberry briars, small sprouts and trees, etc.

**Adjustable deck spring tension** to adjust the amount of pressure that it takes to retract the deck to go around fence posts but still cut tall vegetation.

- Deck can be easily raised to a vertical position beside the main frame to allow easy access to blade and bottom side of the deck
- This is not a low powered string trimmer, The high powered engine and driveline components of the fence hog will cut off most anything that the heavy duty deck will push over, like sprouts the size of your finger and rows of blackberry briars
- It has a remote electric clutch to engage and disengage the deck from the driver's seat
- Electric start, hour-meter and on-off key



## Tractor Mounted Slope and Ditch Mowers

The Rear Tractor Mounted Slope and Ditch articulated flail mowers, are suited for grass, bushes, and branches. The unit consists of a cutting head and a shifting arm which enable the machine to incline itself up to 90 degrees up and to 65 degrees down. There is a slot in the third connection point on the linkage, which enables the machine to follow the unevenness of the ground. The proprietary anti-shock device built into the mowers improves the safety of the operator and of the machine itself, if you hit an obstacle in your mowing path.



## Offset Mounted Brush Mowers

The MK series offset tractor mounted brush mowers are PTO powered 5 ft. and 6 ft. mowers mounted on an articulated arm to give you extended reach. The pendular mounting of the mower deck enables the cutter deck to follow the contour of the ditch when the control cylinder is in the float position. The arm offsets the mower deck 84 inches to the right to let you mow in ditches and closer to water using your tractor and the brush mowing deck which allows you to mow heavy weeds and brush fast and efficiently.



### **FENCE MOWER FM 30**

The FM 30 is designed for tractors with a wheelbase of 48 to 66 inches wide. It is an excellent choice for cleaning up fence lines that have not been maintained for several years. The mower includes a roller track for an even swing action to position itself back under the fence line. The FM 30 ships with a medium lift cutting blade.

### **FENCE MOWER FM 60**

The FM 60 is designed for tractors with a wheelbase of 68 to 92 inches wide. It is an excellent choice for cleaning up fence lines that have not been maintained for several years. The mower includes a roller track for an even swing action to position itself back under the fence line. The FM 60 ships with a medium lift cutting blade.



## **Sauerburger Fence Mower Iltis**

### **Comfortable mowing with simple technology**

After mowing your field or pasture land there are always areas around fences and trees that need to be reworked. The specially designed Iltis from SAUERBURGER enable you to get to these areas without the need to walk around the whole field with a strimmer. With Iltis you can now do it from the comfort of your tractor. The grass is mulched into a good decomposable product that is spread evenly out from the back of the mowing head. Iltis is built with simplicity in mind, increasing the reliability and reducing downtime.

With its heavy duty light running drive train Iltis can be used on tractors from 22Kw upwards with a CAT 1 or 2 mounting system. On request Iltis can also be front mounted. During the design phase extra attention was paid to the weight of the mowing head in order to keep the swinging mass down to a minimum. Attention was also paid to the height of the mowing head to ensure that you can mow underneath the lowest fences. The SAUERBURGER design team has managed to keep spring tensioner ensures the mowing head follows the contour of the ground. The return spring for the mowing head can also be adjusted to suit the obstacle that must be mowed around eg. light enough to mow around young fruit trees or light fence posts or strong enough to get through the thickest undergrowth and larger trees and posts. With the hydraulically adjustable dolly wheel, the cutting height can be comfortably adjusted to suit all terrains.

### **Standard features:**

- 90 cm diameter mowing head
- Slide plate under cutting knives
- Low slung cover on mowing head
- Swinging dolly wheel on the left
- Hyd. adjustable dolly wheel on the right
- Mechanical transport lock-off
- CAT 1 or 2 mounting
- Storage stand
- Reach from middle of tractor, 2.10 M

### **Optional extras:**

- PTO shaft with slip clutch
- Hydraulic retractor for transport
- CAT I and II mounting
- Hydraulic drive
- Yard Loader mounting Euro 8



## **Appendix B - Patents**



US007740190B2

(12) **United States Patent**  
**Peterson et al.**

(10) **Patent No.:** US 7,740,190 B2  
 (45) **Date of Patent:** Jun. 22, 2010

- (54) **BOOM BREAKAWAY ASSEMBLY**
- (75) Inventors: **John Peterson**, Jackson, MN (US);  
**Steve Seubert**, Sherburn, MN (US);  
**Dave Friesner**, Estherville, IA (US)
- (73) Assignee: **AGCO Corporation**, Duluth, GA (US)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 490 days.
- (21) Appl. No.: **11/444,159**
- (22) Filed: **May 31, 2006**
- (65) **Prior Publication Data**  
 US 2007/0131791 A1 Jun. 14, 2007

(58) **Field of Classification Search** ..... 239/159, 239/722, 727, 737, 726, 164, 165, 166, 167, 239/168, 169, 161; 414/22.55, 543, 686; 172/126, 456, 459; 16/281; 248/900, 289.31, 248/292.11, 564; 403/111  
 See application file for complete search history.

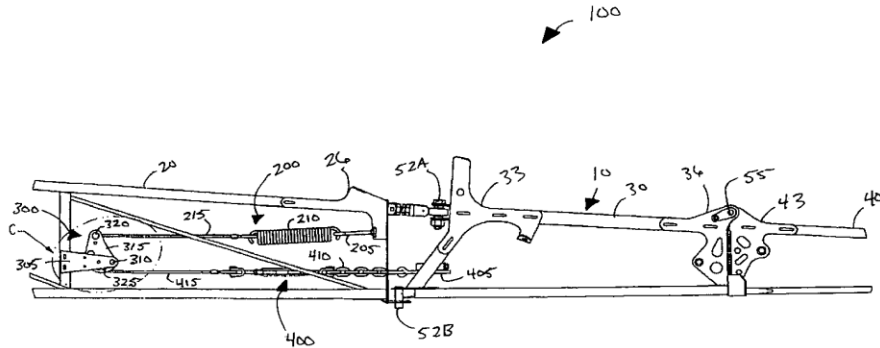
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- Related U.S. Application Data**
- (60) Provisional application No. 60/685,856, filed on May 31, 2005.
- (51) **Int. Cl.**  
**B05B 1/20** (2006.01)  
**B05B 3/00** (2006.01)  
**E21B 19/00** (2006.01)  
**B65F 1/00** (2006.01)  
**B66C 23/00** (2006.01)  
**A01B 17/00** (2006.01)  
**A01B 63/00** (2006.01)  
**A47F 5/00** (2006.01)  
**E04G 3/00** (2006.01)  
**F16M 13/00** (2006.01)  
**E05F 1/14** (2006.01)  
**F16C 11/00** (2006.01)
- (52) **U.S. Cl.** ..... **239/159**; 239/722; 239/737; 239/164; 239/166; 239/169; 414/22.55; 414/543; 414/686; 172/126; 172/456; 172/459; 248/900; 248/289.31; 248/292.11; 248/564; 16/281; 403/111

(Continued)  
*Primary Examiner*—Dinh Q Nguyen  
*Assistant Examiner*—Steven Cernoch  
 (57) **ABSTRACT**

A boom breakaway assembly for a spray boom used by a vehicle. The boom breakaway assembly includes a reciprocating system having a first position and a second position, a retention system, and a bias system. In the first position, the bias system applies a maximum effective bias rate to the reciprocating system and the retention system applies a holding force upon the spray boom to maintain the spray boom in a desired outward position. In the second position, the bias system applies a minimal effective bias rate to the reciprocating system and the retention system reduces or disengages the holding force upon the spray boom, thereby allowing the spray boom to move from the outward position to a breakaway position when the spray boom encounters an obstacle. The bias system returns the reciprocating system to the first position once the spray boom clears the obstacle.

**13 Claims, 4 Drawing Sheets**





US 20080078154A1

(19) **United States**

(12) **Patent Application Publication**  
**Wright**

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(43) **Pub. Date: Apr. 3, 2008**

(54) **FENCE MOWER**

**Publication Classification**

(76) Inventor: **Larry D. Wright, Spring, TX (US)**

(51) **Int. Cl. A01D 75/18 (2006.01)**

(52) **U.S. Cl. 56/10.4**

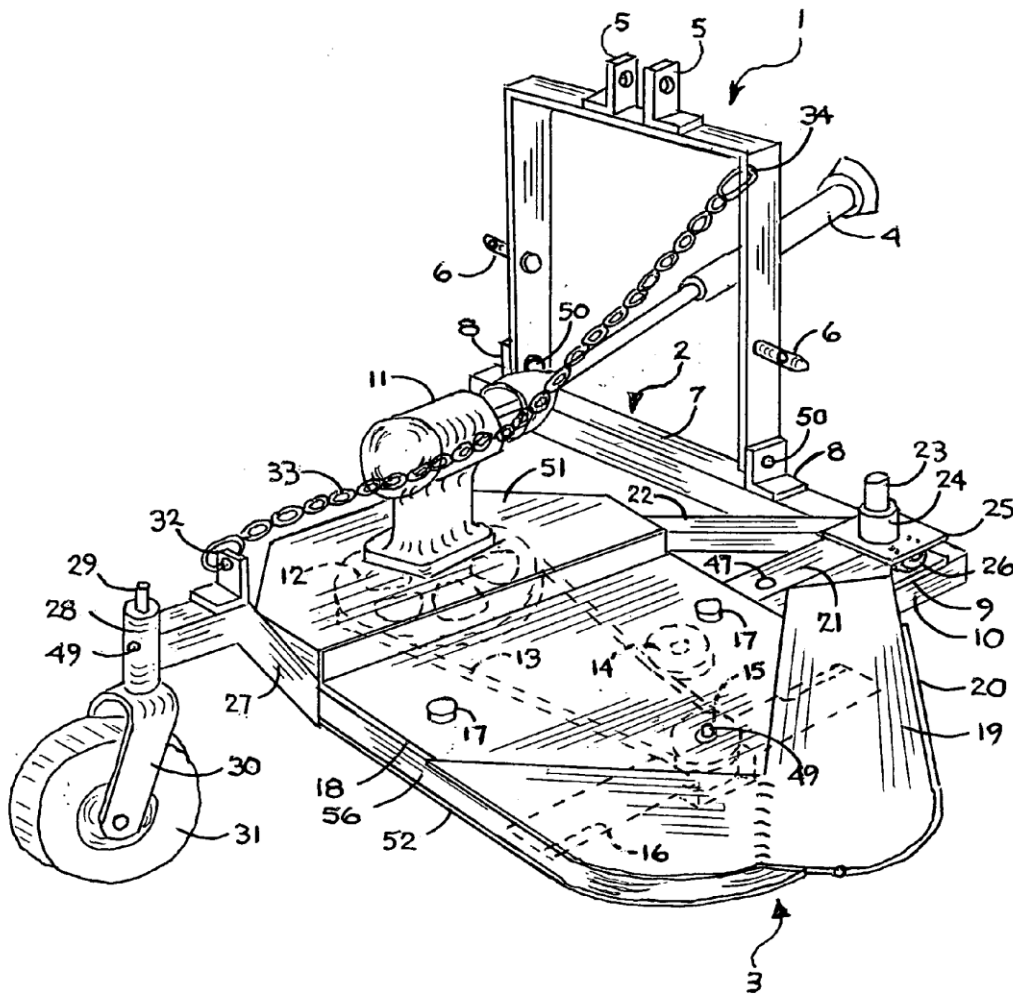
(57) **ABSTRACT**

Correspondence Address:  
**LARRY D. WRIGHT**  
**1218 PINSON FORK DR.**  
**SPRING, TX 77379**

A fence mower attached to an agricultural tractor having a 3 point hitch in which the fence mower is used for cutting and mowing vegetation under the lowest or closest horizontal rail of a fence line and to both sides of the fence line where a fence line is a series of vertical post secured in the ground and connected to one another by horizontal rails.

(21) Appl. No.: **11/542,020**

(22) Filed: **Oct. 3, 2006**



1

2,851,842

FENCE ROW MOWER ATTACHMENT FOR  
FARM TRACTORS

Boyd R. Harp, Decatur, Ill.

Application March 18, 1957, Serial No. 646,583

2 Claims. (Cl. 56—25.4)

This invention relates to a fence row mower attachment for farm tractors.

Heretofore, considerable difficulty has been experienced, particularly by farmers to keep their fence rows clear of grass and weeds.

While the growth of both grass and weeds in fence rows distract from neatness, the weeds are in particular objectionable in that the seeds thereof are distributed over a relatively wide area of ground with a resulting damage to crops.

While farm fences in general comprise spaced posts interconnected by longitudinal vertically spaced members, usually of wire with the lowermost stand thereof spaced from the ground sufficient to receive a power driven cutting member such as a cutter bar, the relatively closely spaced posts would be in the path of the cutter bar and cutting could be carried out only by zig-zagging the mowing machine which would be a difficult operation and then many weeds would remain adjacent the successive posts.

For the above reasons, it has heretofore been almost the exclusive practice to mow the fence rows by hand in the use of a scythe or the like.

It is accordingly a general object of the present invention to provide a power mower for cutting grass and weeds in fence rows including longitudinally spaced vertical posts interconnected by vertically spaced longitudinal wire strands with the lowermost strand in vertical spaced relation to the ground as in common practice, and wherein the mower operates beneath the said lowermost wire strand and automatically moves around the successive posts with a resulting cutting of substantially all weeds in the fence row.

A further object of the invention is the provision of a fence row mower having the above noted characteristics which is in the form of an attachment and which is adapted for ready mounting on a farm tractor.

Other objects and advantages of the invention will become apparent in the course of the following detailed description, taken in connection with the accompanying drawings, wherein—

Fig. 1 is a perspective view of the improved mower attachment shown in operative association with a farm tractor, indicated fragmentally by dotted lines.

Fig. 2 is a reduced schematic top plan view of a tractor and the mower operatively associated therewith and disclosing in particular the automatic movement of the cutting member about a fence post.

Fig. 3 is a view similar to Fig. 2 wherein the cutting member is in a post clearing position.

Fig. 4 is an enlarged top plan view disclosing in particular the co-action of a cutting member guard wheel with a fence post.

Fig. 5 is a vertical sectional view as observed in the plane of line 5—5 on Fig. 4.

Fig. 6 is an elevational view corresponding to Fig. 5 but with the tractor frame in section.

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Fig. 7 is an elevational view as observed from the left of Fig. 6.

Referring now in detail to the drawings, the improved mower attachment is adapted for use with a tractor T including a side frame member F and front and rear wheels, W, W'.

The mower attachment comprises a bracket 10 which is removably secured to the tractor side frame member F and which provides a frame receiving recess 11, outwardly of which are opposite vertical flanges 12 and the bracket further comprises a rectangular plate 13 engageable with the inner wall of frame F and which is secured to flanges 12 by means of bolts 14 whereby the bracket is rigidly but removably secured to the side frame member.

The bracket 10 further comprises a cylindrical vertical bearing post 15 having an axial aperture 16. A stop bar 17 projects outwardly from said bracket 10 for a purpose later to appear.

The mower attachment further comprises a cutter member supporting and guiding frame 18 which is bodily movable about the axis of said bearing post 15 and which includes a pair of vertically spaced upper and lower horizontal cylindrical bars 19 and 20 whose inner ends are apertured and through which and the bearing aperture 16 extends a vertical king pin 21 whose lower end is provided with a washer 22 and a retaining cotter pin 23.

The said frame bars 19 and 20 are rigidly connected adjacent their said inner ends by means of a vertical cylindrical bar 24.

The outer ends of said frame bars 19 and 20 are rigid with a relatively long tubular bearing post 25 in which is rotatably journaled a vertical spindle 26. The said bearing post 25 projects a substantial distance below the frame bar 20 and accordingly a diagonal brace bar 27 has its opposite ends rigidly connected to said bar 20 and the bearing post 25.

A cutter blade disc 28 is secured to the lower end of the spindle 26 and same is provided with a plurality of cutter blades 29 and the upper end of spindle 26 is provided with a V-belt pulley 30.

A guard wheel 31 is adjustably supported in rigid position on the bearing post 25 and for this purpose same comprises a tubular hub 32 which is secured to said bearing post by means of a screw 33.

The upper end of the king pin 21 is provided with a dual V-belt pulley 34 and a V-belt 35 is engaged with pulley 30 and the upper belt groove in pulley 34, as clearly shown in Fig. 5.

A tension pulley 36 for the belt 35 is adjustably secured to the bar 19 by means of a bracket 37.

The frame 18 is normally yieldably retained in right angular relation to the tractor side frame member F by means of an elongated coil spring 38, one end of which is suitably secured to the tractor frame, and the opposite end of which is secured to a metal loop 39 on the bar 20.

In the normal position of the frame 18 the bar 24 engages the stop bar 17.

The pulley 34 is connected to the source of tractor power by means of a belt 40 operatively engaged with pulley 34 and a tractor pulley 41.

Having set forth the structure in accordance with a preferred structural embodiment of the invention, the operation thereof is as follows:

Both the cutter disc 28 and the guard wheel 31 are adapted to operate beneath the usual lower wire strand S of a fence including horizontally spaced vertical posts P.

As indicated diagrammatically in Figs. 2 and 3, the tractor T is moving in the direction of the arrow.

According to Fig. 2, the guard wheel 31 shown in solid



Sept. 16, 1958

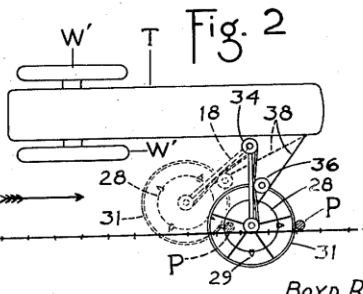
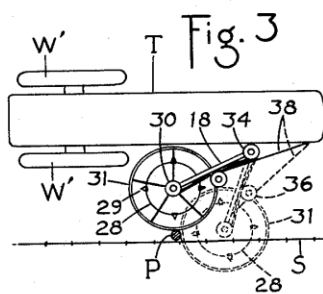
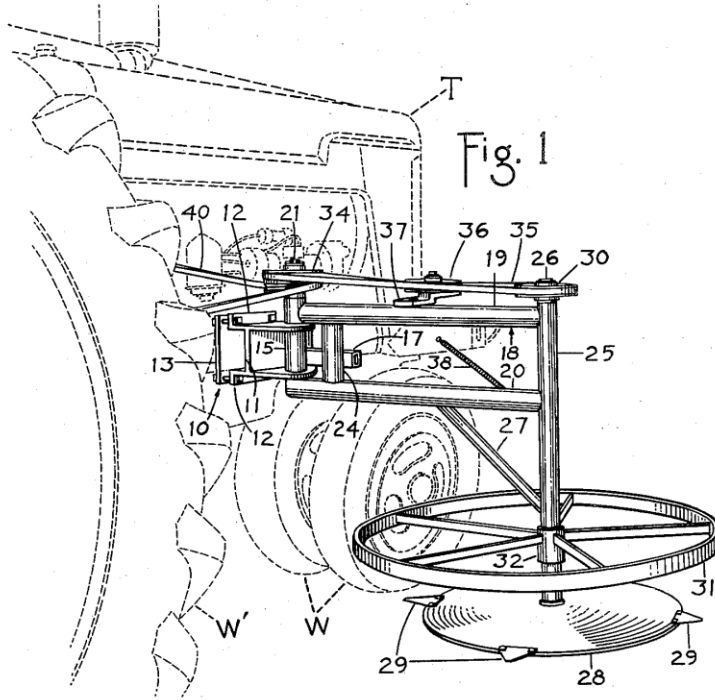
B. R. HARP

2,851,842

FENCE ROW MOWER ATTACHMENT FOR FARM TRACTORS

Filed March 18, 1957

3 Sheets-Sheet 1



BOYD R. HARP  
INVENTOR.

BY *Boyd R. Harp*  
ATTORNEY

1

3,047,995

## WEED SHREDDER

Frank E. Chestnut, Rte. 1, Alamo, Tex.  
Filed Apr. 20, 1960, Ser. No. 23,546  
3 Claims. (Cl. 56—25.4)

This invention relates to a novel and useful weed shredder, and more particularly to a weed shredder which is particularly well adapted for controlling the growth of weeds around low hanging trees and shrubbery.

The weed shredder is adapted for securement to a tractor of the type having either a two point or three point lift hitch and the shredder includes a rotary cutter assembly which projects laterally to one side of the tractor when in the operational position. The weed shredder includes a lift frame which is adapted to be secured to either a two point or three point lift hitch of a tractor. The lift frame when secured to the tractor projects rearwardly therefrom and the cutter assembly or housing is pivotally secured to the lift frame along one side thereof for movement about a longitudinally extending and horizontally disposed axis between a first horizontally disposed position projecting laterally from one side of the lift frame and a second upstanding position projecting upwardly from the same side of the lift frame.

In the past, cutter bar mowers have been utilized to control the growth of grass, weeds and the like under low hanging trees and shrubbery but the cutter bar type of mower merely cuts the tall stalks of grass or weeds and enables the cuttings to fall to the ground in one piece.

It is well known that the rotary mowers not only cut tall weeds and grasses quite effectively, but that they also shred the cuttings into fine pieces before the mower is moved to the next position. The rotary type of mower would therefore be more highly desirable. However, all of the rotary mowers now in use are specifically adapted to trail or to precede the vehicle to which they are attached. This position of a rotary mower relatively to the powering vehicle is, of course, not conducive to cutting tall grasses and weeds from beneath the lower boughs of low hanging trees or shrubs.

It is therefore the main object of this invention to provide a rotary mower which is specifically adapted for securement to either a two point or three point tractor hitch and which is provided with a rotary mower construction that is laterally offset to one side of the tractor to which it is connected.

A further object of this invention, in accordance with the immediately preceding object, is to provide a weed shredder having a lift frame adapted for securement to either a two point or three point lift hitch of a tractor and which will be positioned rearwardly of the tractor when secured thereto and be provided with a rotary mower construction pivotally secured to one side of the lift frame for movement about a longitudinally extending and horizontally disposed axis between a first horizontally disposed position projecting laterally from one side of the lift frame and a second upstanding position projecting upwardly from that same side of the lift frame so that the rotary cutter assembly, when not in use, may be pivoted to an upstanding position so as not to project laterally beyond the sides of the tractor to which it is secured thus enabling the tractor to pass through restricted areas without having to disconnect the weed shredder therefrom. It is to be noted that when the rotary cutter assembly is pivoted to an upstanding position that the lift frame may also be lifted by means of the two point or three point hitch to which it is secured to provide additional ground clearance while the tractor is travelling over rough ground and through narrow places.

Still another object of this invention is to provide a means by which the rotary cutter assembly may be op-

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erated even if the tractor to which it is secured is slightly inclined about its longitudinal axis toward the laterally projecting cutter assembly.

And a final object to be specifically enumerated herein is to provide a weed shredder which will conform to conventional forms of manufacture, be of simple construction and easy to operate so as to provide a device that will be economically feasible, long-lasting and operable by substantially every person capable of operating a tractor.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a top plan view of the shredder comprising the instant invention;

FIGURE 2 is a side elevational view of the shredder shown in FIGURE 1;

FIGURE 3 is a longitudinal vertical sectional view taken substantially upon the plane indicated by the section line 3—3 of FIGURE 1;

FIGURE 4 is an enlarged perspective view of the weed shredder shown with the protective cover of the cutter housing removed;

FIGURE 5 is a top plan view of the weed shredder shown attached to a two point hitch carried by the rear of a tractor;

FIGURE 6 is an end elevational view of the attachment as seen from the left side of FIGURE 5 showing the manner in which the cutter assembly of the weed shredder is adapted for controlling the growth of weeds and grasses beneath low hanging limbs;

FIGURE 7 is an enlarged fragmentary perspective view of a portion of the lift frame showing the manner in which the cutter assembly may be rotated about a longitudinally extending horizontally disposed axis extending along one side of the lift frame; and

FIGURE 8 is an enlarged fragmentary vertical sectional view taken substantially upon the plane indicated by the section line 8—8 of FIGURE 4.

Referring now more specifically to the drawings, the numeral 10 generally designates the weed shredder comprising the instant invention which is shown in FIGURES 5 and 6 of the drawings secured to the rear of a tractor generally designated by the reference numeral 12 by means of a two point hitch generally referred to by the reference numeral 14.

With particular reference now to FIGURE 4 of the drawings it will be noted that the weed shredder includes a lift frame generally designated by the reference numeral 16 which is substantially rectangular in plan and includes front and rear members 18 and 20 and opposite side members 22 and 24. The lift frame 16 includes a pair of forwardly directed mounting arms 26 and 28 which mounting arms are formed integrally with the member 20 and the member 22 respectively. The forward ends of the arms 26 and 28 are apertured as at 30 for securement to the apertured rear ends of the arms 32 and 34 of the two point lift 14. The lift frame 16 also includes suitable cross bracing 36 and 38 for providing the desired rigidity.

A pair of mounting arms 40 and 42 are secured to members 20 and 18, respectively, and project beyond the side member 24.

With particular attention directed to FIGURE 7 of the drawings it will be noted that the outer end portions of each of the arms 40 and 42 terminate in downturned portions 44. The outer extremities of the arms 40 and 42 are suitably apertured as at 46 and these outer extremities are pivotally secured to and between the furcations 48 of the bifurcated mounting brackets which are gen-

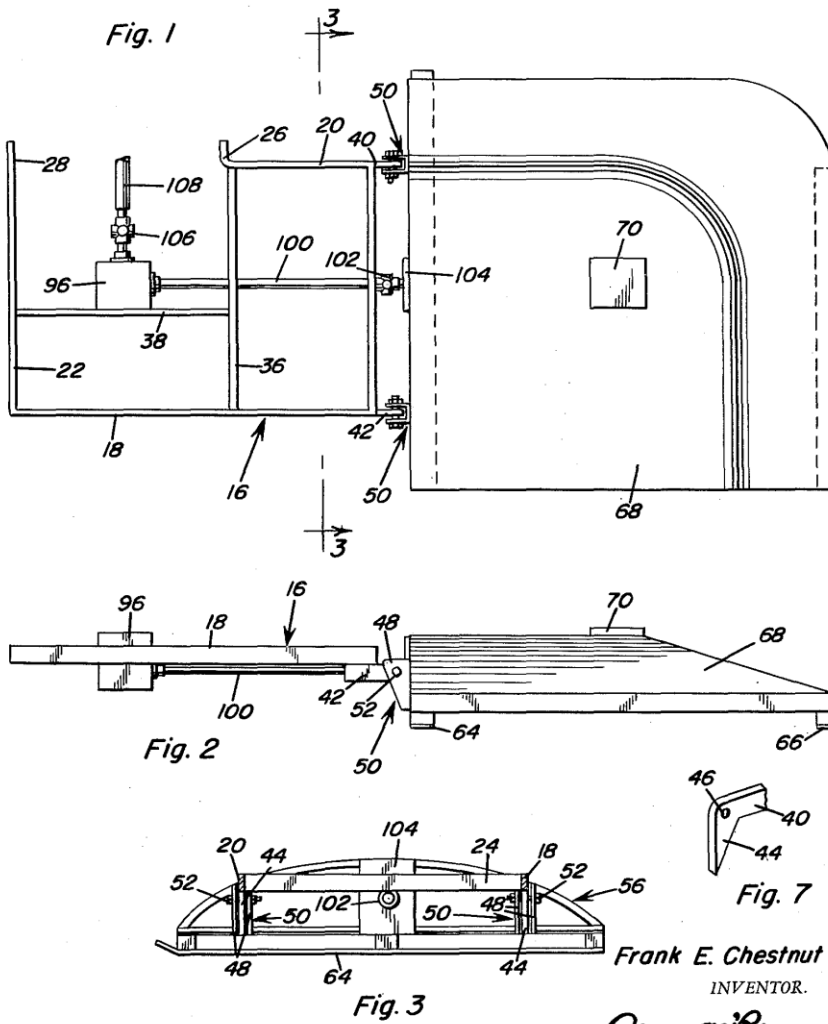
Aug. 7, 1962

F. E. CHESTNUT  
WEED SHREDDER

3,047,995

Filed April 20, 1960

3 Sheets-Sheet 1



Frank E. Chestnut  
INVENTOR.

BY *Alvanice A. Dixon*  
*and Harvey R. Jackson*  
Attorneys

1

3,115,739

FENCE ROW MOWER ATTACHMENT FOR  
FARM TRACTORS

Roy M. Thoen, 1323 Marsh St., and Leander Kassucke,  
605 Lyndale, both of Mankato, Minn.  
Filed Jan. 15, 1963, Ser. No. 251,677  
2 Claims. (Cl. 56-6)

The present invention relates to mowing machines and more particularly to a mower adapted to be used in cutting substantially all of the vegetation below and upon both sides of a highway guard rail or fence.

The present application is a continuation-in-part of our copending application Serial No. 132,275, filed August 14, 1961, now abandoned, for Tractor Mounted Power Specially Designed for Highway and County Roadways.

A variety of mowing machines have been previously proposed for cutting grass and other kinds of vegetation. Most of these prior devices have been utterly unsuitable for cutting grass around a fence because it is impossible to steer the vehicle upon which the mower is mounted with sufficient accuracy to cut grass located under the fence while at the same time avoiding contact with fence posts. Moreover, these prior devices can be used to cut the grass on only one side of the fence.

In order to overcome these shortcomings in the prior art, proposals have been made for mounting a mower cutting head so that it will swing toward the fence when in operation. A wheel is also mounted upon the cutting head to keep the blade from striking the fence posts.

This type of device also suffers from certain shortcomings, the most important of which is that the swath cut by the mower is of necessity positioned on one side of the fence only. Furthermore, none of the grass on one side of each fence post can be cut at all. As a result, it is necessary to run the mower first along one side of the fence and then along the other side at double the operating cost of running the mower along only one side of the fence.

In view of these and other shortcomings of the prior art it is one object of the invention to provide an improved mower for cutting grass around fences which is rugged in construction and will reliably cut in a single pass the vegetation located upon both sides of a fence as well as that located below the fence.

It is another object of the present invention to provide an improved mower for clearing fences which will not skip areas when cutting between fence posts.

Still another object of the present invention is the provision of an improved mower for fences including a means for quickly and easily placing the mower blades in position for operation adjacent to a fence and for removing the blades from their operating position adjacent the fence when the work has been completed.

These and other more detailed and specific objects will be disclosed in the course of the following specification, reference being had to the accompanying drawings, in which:

FIG. 1 is a plan view of a mower according to the present invention as seen when supported upon a farm tractor.

FIG. 2 is a side elevational view of the apparatus shown in FIG. 1.

FIG. 3 is an enlarged front elevational view of the apparatus of FIGS. 1 and 2.

Referring now specifically to the drawings which illustrate a preferred form of the present invention, there is shown a mower 10 supported upon a motor vehicle such as a farm tractor 12 of any well known construction. The mower 10 includes a supporting framework 11 comprising vertically disposed guide rails 14 and 16 which are rigidly connected at their upper and lower ends

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by cross members 18 and 20, respectively. The framework 11 is suitably secured to the tractor 12 by bolts or other fasteners (not shown).

Mounted upon the framework 11 for vertical sliding movement is a carriage 22 composed of front and rear structural members 26 and 28 connected by cross members 30 and 32. Below member 26 is provided a member 34 on one end of which is mounted a roller 36 (FIG. 3). The other end of member 34 is connected to a vertically disposed tube 38. Similar rollers 40 and 42 are mounted upon one end of each of the members 26 and 28. Each of the rollers 36, 40 and 42 are mounted for movement upon the guide rails 14 and 16, as best seen in FIGS. 1 and 3. In this way, the carriage 22 is free to be moved along a vertically disposed path upon the framework 11.

Mounted upon the framework 11 below the carriage 22 is a motive power source such as hydraulic cylinder 44. The cylinder 44 includes a connecting rod 46 the upper end of which is secured to cross member 32 of carriage 22. During operation, hydraulic fluid is supplied from a conventional source of fluid pressure (not shown) through a control valve 48 and line 50 to the cylinder 44. Thus, to raise the carriage 22, the valve 48 is opened allowing fluid under pressure to pass into cylinder 44 and thereby force the rod 46 upwardly.

Rigidly secured to the outer end of the member 28 is a vertically disposed tube 52. As best seen in FIGS. 1 and 3, the member 28 extends laterally a substantial distance beyond the outward end of member 26, thus positioning the tube 52 laterally of tube 38 as well as rearwardly thereof.

Rotatably mounted upon the lower end of tubes 38 and 52 are sleeves 58 and 60. Extending rearwardly from sleeves 58 and 60 respectively are mower support arms 62 and 64. Suitable journals 66 and 68 are mounted in a vertical position at the rearward end of each of arms 62 and 64 respectively. Within these journals are rotatably mounted mower shafts 70 and 72 respectively. Rigidly affixed to the lower ends of the shafts 70 and 72 respectively are mower heads 74 and 76. Each mower head includes a horizontally disposed mower blade 75. A large cup-shaped guide member 75' is affixed to each blade 75 to prevent the latter from striking the ground.

Mounted for rotation upon the lower end of each of journals 66 and 68 are guide means such as wheels 78 and 80 respectively. The diameter of the wheels 78 and 80 is slightly larger than that of the heads 74 and 76 so as to prevent the latter from hitting obstructions or from hitting each other during use. The wheels 78 and 80 act as idler wheels and thus rotate independently of the shafts 70 and 72. The periphery of each of the wheels 78 and 80 is preferably formed from a resilient material such as rubber to prevent damage to fence posts and the like.

Rigidly mounted upon the sleeve 60 is a rearwardly extending bracket 90. A similar bracket 92 extends forwardly from the sleeve 58. Connected to the bracket 90 and member 28 is a spring 94 for yieldably biasing the mower head 76 toward the left in FIG. 1. A similar spring 96 is connected between bracket 92 and member 26 for biasing the arm 62 and head 74 in the opposite direction. In this way, the heads 74 and 76 are yieldably biased toward one another about the center of tubes 58 and 60 respectively.

As best seen in FIGS. 2 and 3, a stop 98 is provided on the tube 52 to limit the inward movement of arm 64 about tube 52. A similar stop 100 is provided on tube 38 for limiting the outward movement of arm 62 about the center of tube 38. The stops 98 and 100 thus serve as a means for establishing the lateral position of mower heads 74 and 76 with respect to the carriage 22.

Dec. 31, 1963

R. M. THOEN ET AL

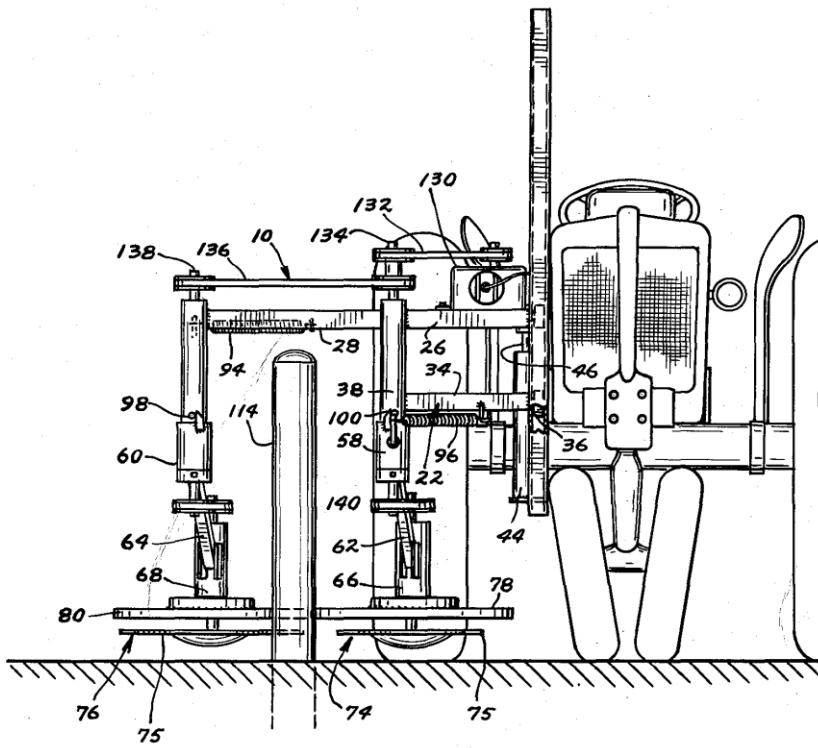
3,115,739

FENCE ROW MOWER ATTACHMENT FOR FARM TRACTORS

Filed Jan. 15, 1963

2 Sheets-Sheet 2

FIG. 3



INVENTORS  
ROY M. THOEN  
BY LEANDER KASSUELKE  
*Carlson Carlson and Sturm*  
ATTORNEYS

**United States Patent** [19]  
**Whitley**

[11] **Patent Number:** 4,901,508  
 [45] **Date of Patent:** Feb. 20, 1990

- [54] **FENCE ROW MOWER**  
 [76] **Inventor:** Douglas L. Whitley, Rte. 1, Box 44A,  
 Paoli, Okla. 73074  
 [21] **Appl. No.:** 217,490  
 [22] **Filed:** Jul. 11, 1988

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*Primary Examiner*—John Weiss  
*Attorney, Agent, or Firm*—Robert K. Rhea

**Related U.S. Application Data**

- [63] Continuation-in-part of Ser. No. 109,026, Oct. 16, 1987,  
 abandoned.  
 [51] **Int. Cl.<sup>4</sup>** ..... A010,38/86; A010 34/66  
 [52] **U.S. Cl.** ..... 56/10.4; 56/15.5;  
 56/15.2; 56/235  
 [58] **Field of Search** ..... 56/10.4, 15.2, 15.5,  
 56/10.7, 15.9, 15.3, 14.9, 15.1, 235; 172/98, 99

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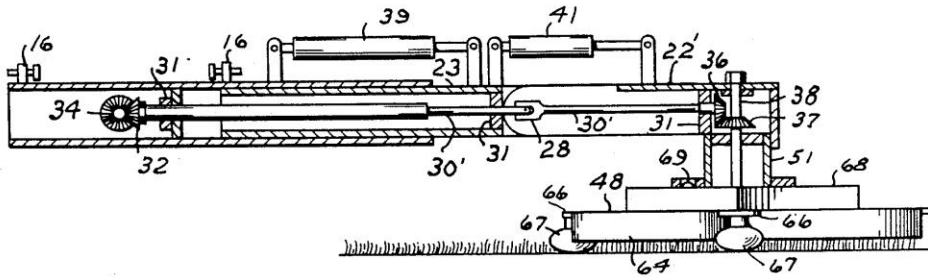
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[57] **ABSTRACT**

A mower for mowing vegetation under a fence supported above the surface of the earth by a series of spaced posts comprising a horizontal boom connected at one end with a prime mover and supporting a mowing head at its other end. The mowing head is pivotal about a vertical and horizontal axes so that when contacting one of the fence posts the mowing head pivots around the position of the post while drawn by the prime mover in a forward direction. The mowing head is angularly tilted vertically for mowing a fence row or other surface on an incline with respect to the surface of the earth supporting the prime mover.

5 Claims, 2 Drawing Sheets



**United States Patent** [19]  
**Heiskell**

[11] **Patent Number:** 5,050,372  
 [45] **Date of Patent:** Sep. 24, 1991

- [54] **FENCE ROW CLEANER**  
 [76] **Inventor:** Merle L. Heiskell, 602 Cherry, Dalhart, Tex. 79022  
 [21] **Appl. No.:** 551,491  
 [22] **Filed:** Jul. 11, 1990  
 [51] **Int. Cl.:** ..... A01D 34/64  
 [52] **U.S. Cl.:** ..... 56/12.7; 56/15.2; 56/15.6; 56/255; 56/295; 56/DIG. 9  
 [58] **Field of Search** ..... 56/14.9, 12.7, 15.1, 56/15.2, 15.9, 255, 295, DIG. 9, DIG. 10, DIG. 14

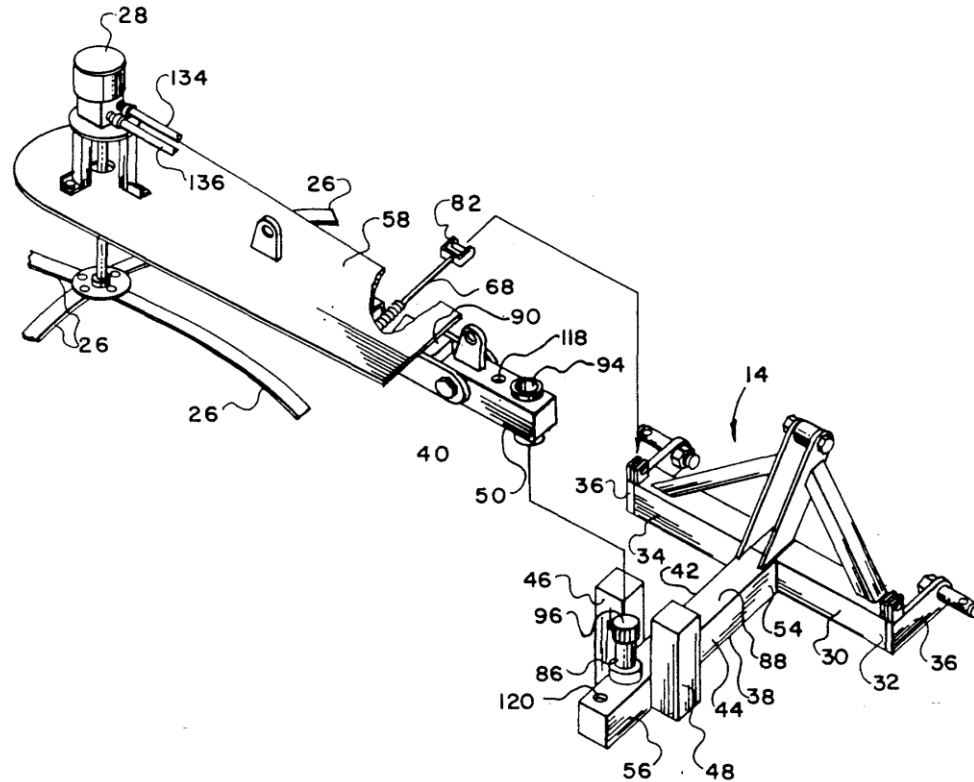
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*Primary Examiner—Terry L. Melius*  
*Attorney, Agent, or Firm—Wendell Coffee*

[57] **ABSTRACT**  
 This invention is a mowing machine which is to be hitched to the back of an agricultural tractor. The primary purpose of the invention is to cut and clean vegetation and debris from along agricultural fence rows. The cutting assembly of the mowing machine includes flails which are rapidly rotated and are made from fabric reinforced rubber. The flails are flexible and are about two feet long, about three-fourths of an inch thick, about three inches wide, and weigh about five pounds. The invention may be used to cut and remove vegetation and debris from under fence rows since the flails are flexible and easily mow around fence posts without damaging either the posts or the flails. The cutting assembly can be positioned so that a plane in which the cutting flails rotate is either inclined or declined to match the inclined slopes of embankments and declined slopes of drainage ditches.

16 Claims, 3 Drawing Sheets





**United States Patent** [19]  
**Jerez**

[11] **Patent Number:** **5,491,963**  
 [45] **Date of Patent:** **Feb. 20, 1996**

- [54] **GARDEN CLEANING IMPLEMENT FOR CUTTING/MACERATING WEEDS ABOVE AND BELOW GROUND**
- [76] Inventor: **Orlando Jerez**, 3333 Delaware Ave., Kenner, La. 70065
- [21] Appl. No.: **288,959**
- [22] Filed: **Aug. 11, 1994**
- [51] **Int. Cl.**<sup>6</sup> ..... **A01D 34/68**; A01B 1/06; A01B 39/08; A01B 39/18
- [52] **U.S. Cl.** ..... **56/17.1**; 56/17.4; 56/17.5; 56/320.1; 172/14; 172/41; 172/111
- [58] **Field of Search** ..... 56/16.9, 17.4, 56/17.5, 17.1, 320.1, 295, DIG. 24; 30/122, DIG. 5; 172/14, 41, 111, 247, 522, 720
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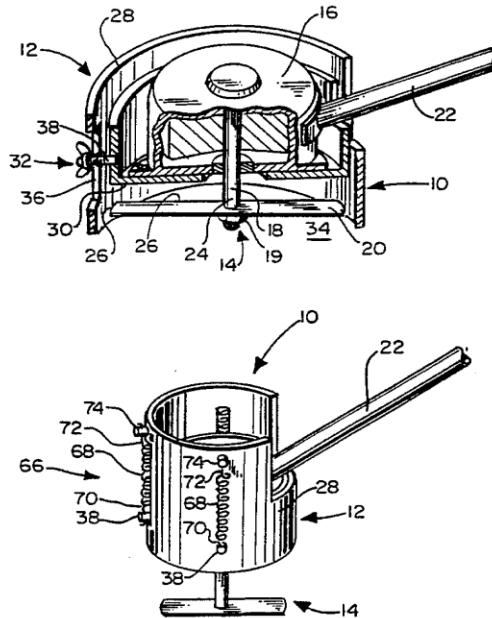
Primary Examiner—Stephen J. Novosad

Attorney, Agent, or Firm—C. Emmett Pugh; Pugh/Associates

[57] **ABSTRACT**

A garden cleaning implement (10) for weeds and the like comprising a cutting mechanism (14) and a retractable guard mechanism (28), generally free to “float” up and down about the cutter mechanism, carried on, for example, an extended pole handle (22). The cutting mechanism includes—an associated rotational power source (16/116); an intermediate, rotatable shaft (18) connected thereto; and a rotatable, rectangular blade, cutting member (20). The guard mechanism includes—a cylindrically-shaped, retractable housing (28) providing an enclosing cavity of a size sufficient to receive therein and protectively cover over the rotating cutting member; and a guide means (32) for guiding the retraction of the retractable housing along a path substantially parallel to the rotatable shaft’s longitudinal axis between first, lower and second, upper positions, in which the rotatable cutting member is disposed within the enclosing cavity, and in which the rotatable cutting member is below and outside of the enclosing cavity, respectively. When the cutter mechanism is above ground level, the guard mechanism is in its down, cutter covering position under the force of gravity or biasing springs (68), protecting the user and any surrounding desirable vegetation (V) from the cutter; but, when the cutter mechanism is lowered down into the ground to macerate the weed roots and till the ground (G) around the roots, the guard mechanism is raised up by the ground contact of its lower periphery on the ground, allowing the cutter mechanism to easily go down into the soil outside of the protective enclosure as the guard moves up.

22 Claims, 5 Drawing Sheets







US007690177B2

(12) **United States Patent**  
**Spitzley**

(10) **Patent No.:** **US 7,690,177 B2**  
(45) **Date of Patent:** **Apr. 6, 2010**

(54) **TRACTOR MOUNTED STRING TRIMMER MECHANISM**

(76) Inventor: **Larry W. Spitzley**, 12716 Boyer Rd., Muliken, MI (US) 48861

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/683,107**

(22) Filed: **Mar. 7, 2007**

(65) **Prior Publication Data**

US 2008/0216459 A1 Sep. 11, 2008

(51) **Int. Cl.**

**A01D 34/00** (2006.01)

(52) **U.S. Cl.** ..... **56/14.9; 56/15.9**

(58) **Field of Classification Search** ..... 56/10.8, 56/10.9, 11.9, 12.7, 13.5–13.8, 14.7, 14.9–15.3, 56/15.5, 15.9, 16.7, 17.1, 320.1, DIG. 14; 37/468, 903

See application file for complete search history.

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*Primary Examiner*—Thomas B Will

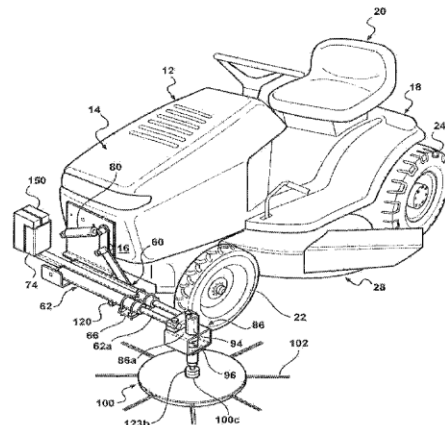
*Assistant Examiner*—Mai T Nguyen

(74) *Attorney, Agent, or Firm*—Young Basile

(57) **ABSTRACT**

A string trimmer mechanism intended for mounting on the front end of a mowing tractor. The mechanism includes a mounting bracket for attachment to the front end of the tractor; an extension power cylinder pivotally mounted on the bracket and extending laterally of the tractor; a string trimmer carried on the free end of the power cylinder and including a hydraulic motor driving a trimmer dish; and a lift power cylinder pivotally mounted on the bracket and driving a lever pivotally mounted on the bracket and carrying a roller positioned under the extension power cylinder. The string trimmer is moved selectively laterally inwardly and outwardly utilizing the extension power cylinder and is moved selectively upwardly and downwardly utilizing the lift power cylinder. The extension power cylinder, lift power cylinder, and hydraulic trimmer motor are selectively supplied with pressurized hydraulic fluid from a pressurized hydraulic fluid source onboard the tractor. The string trimmer mechanism converts between left hand operation, with the string trimmer positioned on the left side of the tractor, and right hand operation, with the string trimmer positioned on the right side of the tractor, simply by reversing the direction in which the extension power cylinder extends from the mounting bracket and by interchanging the pivotal mounting of the lift cylinder and the lever on the mounting bracket.

**9 Claims, 9 Drawing Sheets**





US 20060288679A1

(19) **United States**

(12) **Patent Application Publication**  
**Wright**

(10) **Pub. No.: US 2006/0288679 A1**

(43) **Pub. Date: Dec. 28, 2006**

(54) **FENCE MOWER**

(76) Inventor: **Larry D. Wright**, Spring, TX (US)

Correspondence Address:  
**William S. Dorman**  
**Suite 830**  
**406 South Boulder**  
**Tulsa, OK 74103-3825 (US)**

(21) Appl. No.: **11/166,664**

(22) Filed: **Jun. 24, 2005**

**Publication Classification**

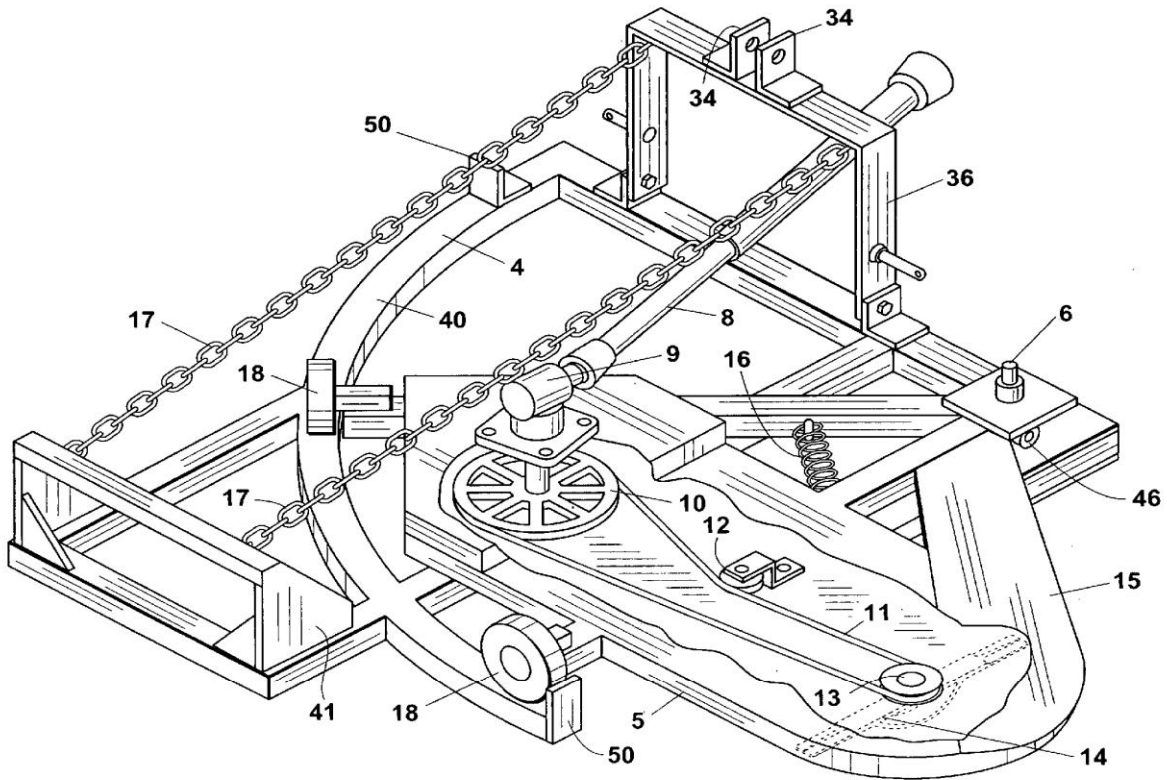
(51) **Int. Cl.**  
**A01D 75/18** (2006.01)

(52) **U.S. Cl.** ..... **56/10.4**

(57) **ABSTRACT**

A fence mower comprising a base frame connected to an agricultural tractor, a swing away cutting and dirt removal arm mounted by a pivot pin to the base frame to produce a

mower assembly which is free floating by being connected to the agricultural tractor using a 3-point hitching system. Power to the invention is supplied by the tractor's power take off by way of a power take off shaft connected to a right angle gear box mounted on the swing away cutting arm. Through a pulley system, power is delivered to a spindle with a cutting and dirt removal blade attached on the bottom side. The swing away cutting and dirt removal arm is designed to extend beyond the side of the tractor, thus allowing the arm to be positioned under the last, or bottom fence rail closest to the ground of a fence. As the operator of the tractor engages the power take off, power generated is distributed to the cutting blade previously positioned under the fence line. As the tractor moves forward in a line parallel to the fence line, the invention cuts and also removes surface dirt in its path of travel until it comes in contact with a fixed fence post. Upon contact with the fixed fence post, the swing arm automatically moves around the post allowing the tractor to continue moving in a straight line parallel to the fence line. As the swing arm clears the fixed fence post, it automatically repositions itself under the fence line using assistance of a wedge nose design and adjustable spring system.



## **Appendix C – References**

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- (3) "Fence Runner Mows Trims Bush Hogs Small Brush under Fences." *Hay Farm Equipment / Skidsteer Attachments / Hay Spear Attachments*. Hayspear. Web. 29 Nov. 2011. <<http://www.hayspear.com/product/FR/Fence-Runner-mows-trims-bush-hogs-small-brush-under-fences.html>>.
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# Jobs Just Right Engineering

Members:

Jason Johnson  
Ryan Johnson  
John Locklear



# Mission Statement

JJR Engineering is devoted to producing current market designs that combine customer satisfaction and quality products at the highest levels.

# Problem Statement

JJR Engineering strives to produce a tractor mounted weed trimmer product for M&M Engineered Products. The design should include but not limited to:

- 3 point mounted, PTO powered
- Ability to mow/cut/trim grass, weeds, and small brush (under 1 inch).
- The cutting should work adjacent to either side of the tractor.
- Work in and around buildings, fences, ponds, and structures.

Design is open to changes suggested from client or from other unforeseen issues.

# WEEDEN'S Fence Mower

- MSRP: \$4200
- PTO Hydraulic Pump to Drive Head
- SCV's Required to Adjust Head
- Operates on One Side



<http://www.weedensfencemower.com/index.html>



# Sauerburger Iltis

- European/German
- Adjustable length arm
- Hydraulically adjustable cutting height
- Not currently sold in the United States



# Fence Mower

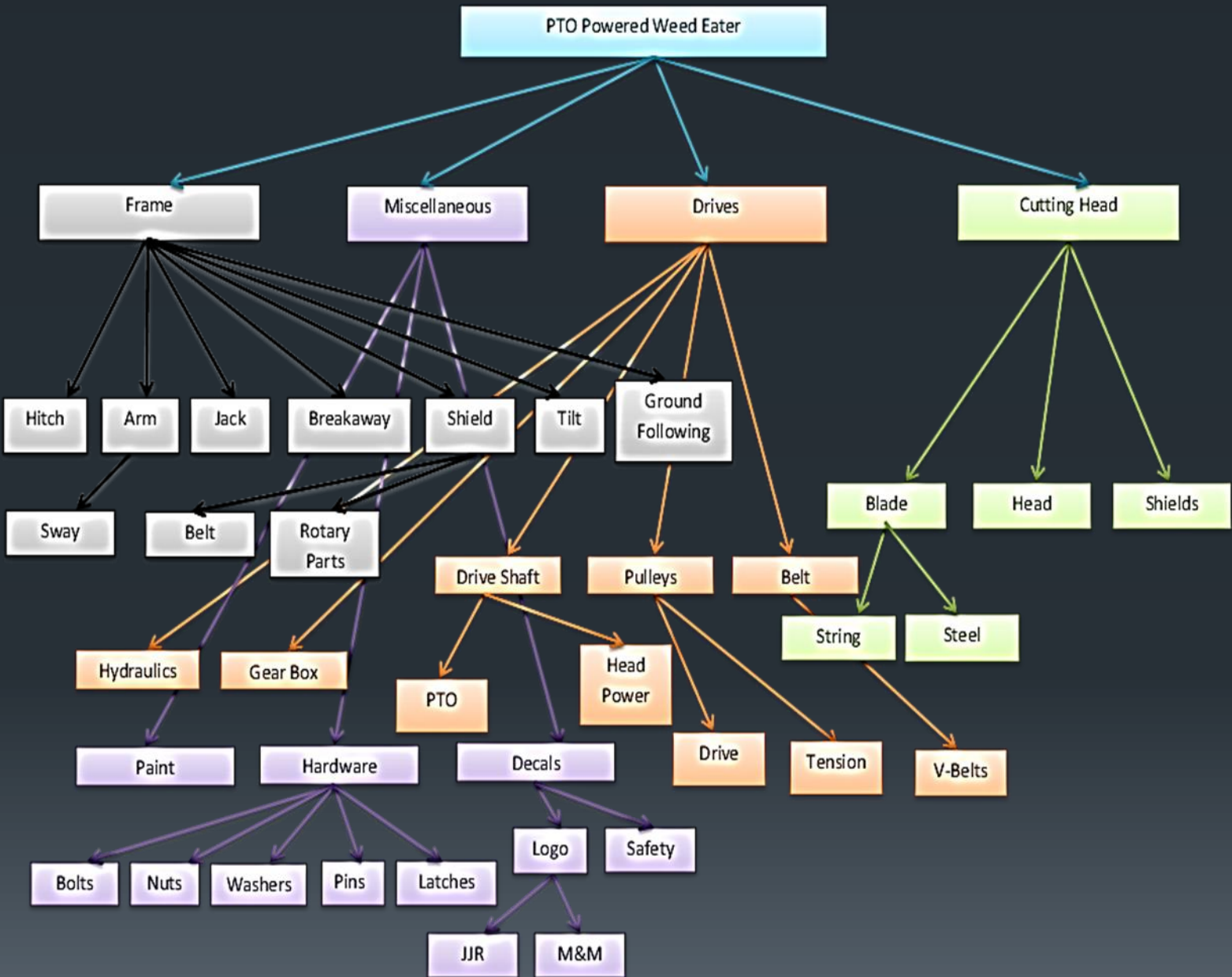
- MSRP: \$2,895.00 - \$3,295.00
- Two Size Options
- Mechanically Driven (Belt and Gearbox)
- Operates on One Side





# Design Concepts

- Three Design Ideas for CAD
- Determine Testing for Blade Testing
- Work Breakdown Structure Needed for Help with Ideas





Cutting Material Testing

# Experiments and Physical Testing

# Test Planning

- Gathered Several Materials for Cutting Evaluation
- Test Unit Was Fitted with Drive Components to Facilitate Material Assessment.





# Test Execution

## Experimental Set-Up

- Six Plots
- Six Different Cutting Types
- Acceptance Criteria
  - Visual Appearance of Cut
  - Time Elapsed

## Results

- Pursue Three Cutting Types
  - Straight Blade
  - Multi-Blade
  - String Type

# Cutting Head Types



<http://www.buywright.co.nz/buywrightparts.html>

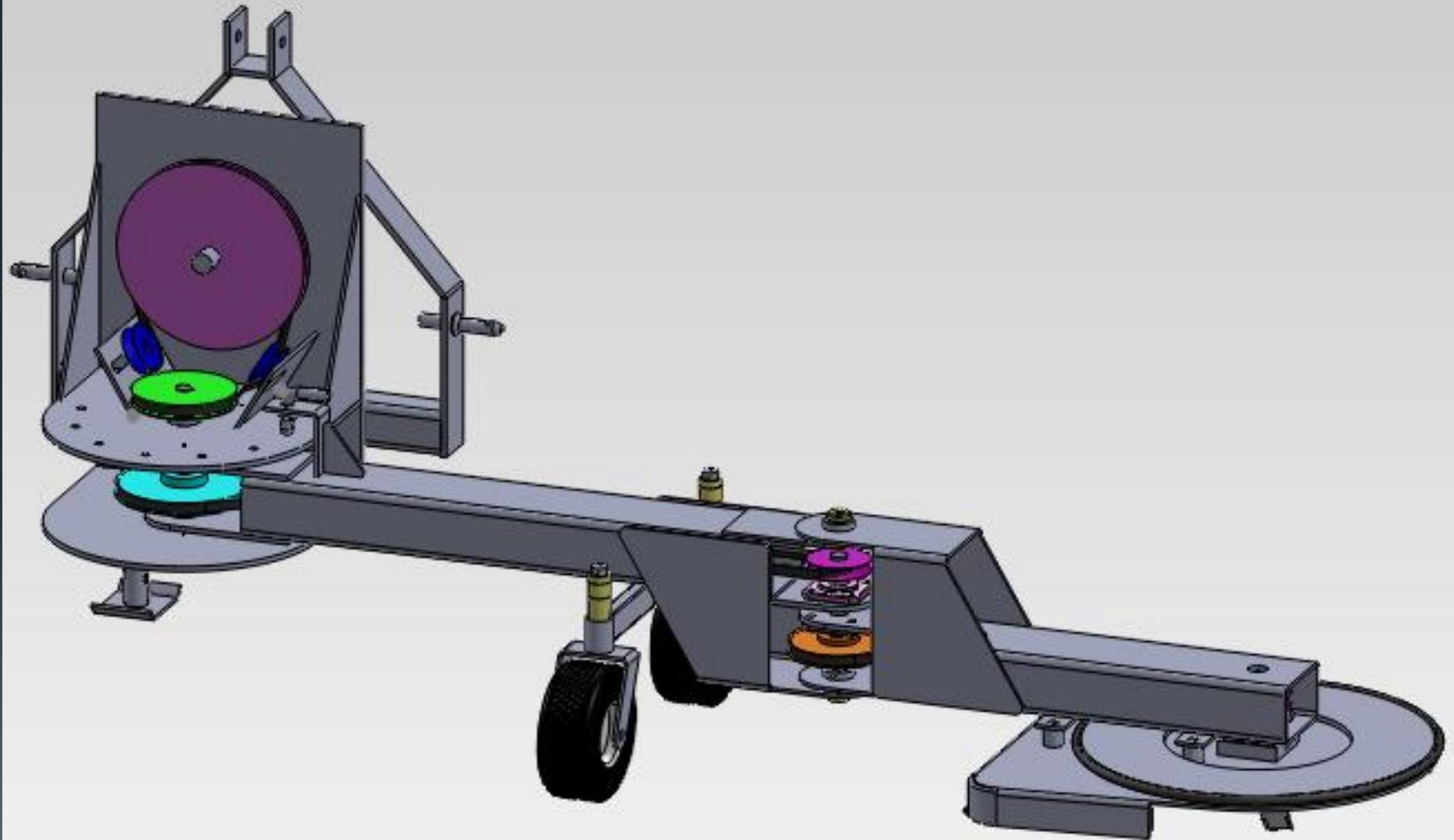




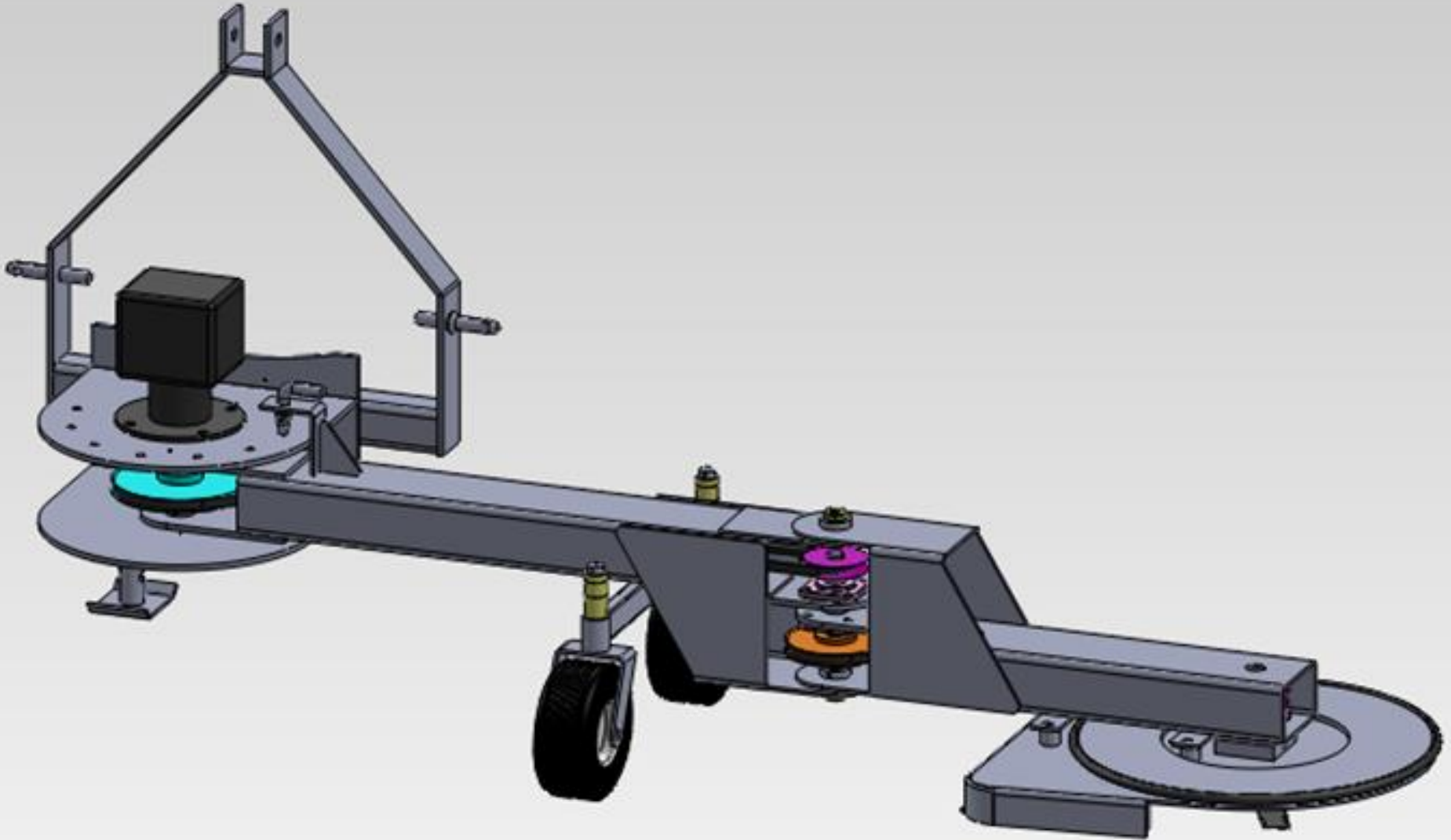
# Tractor Trimmer

It's a weed whacker for your tractor!

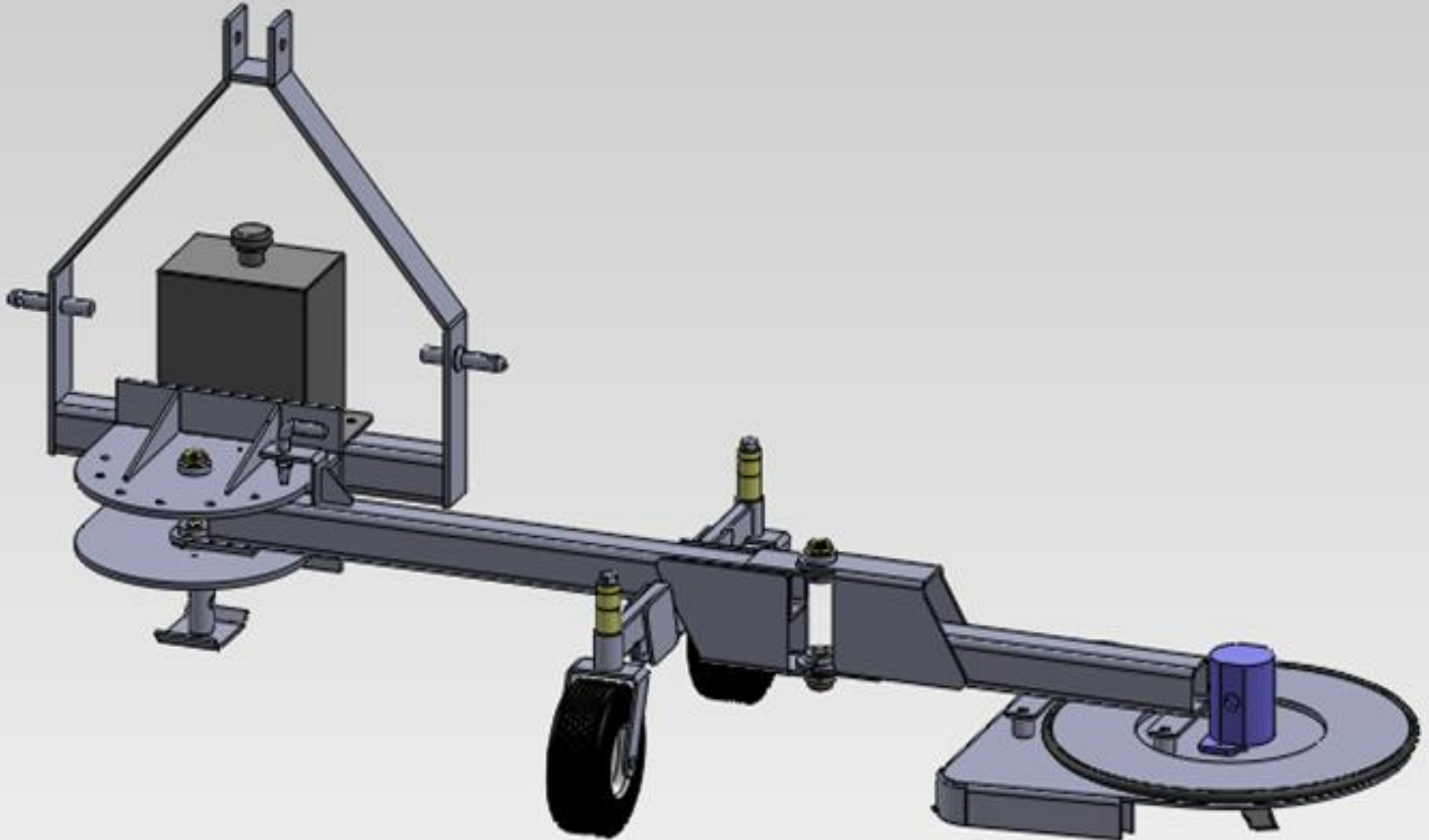
# All Belt



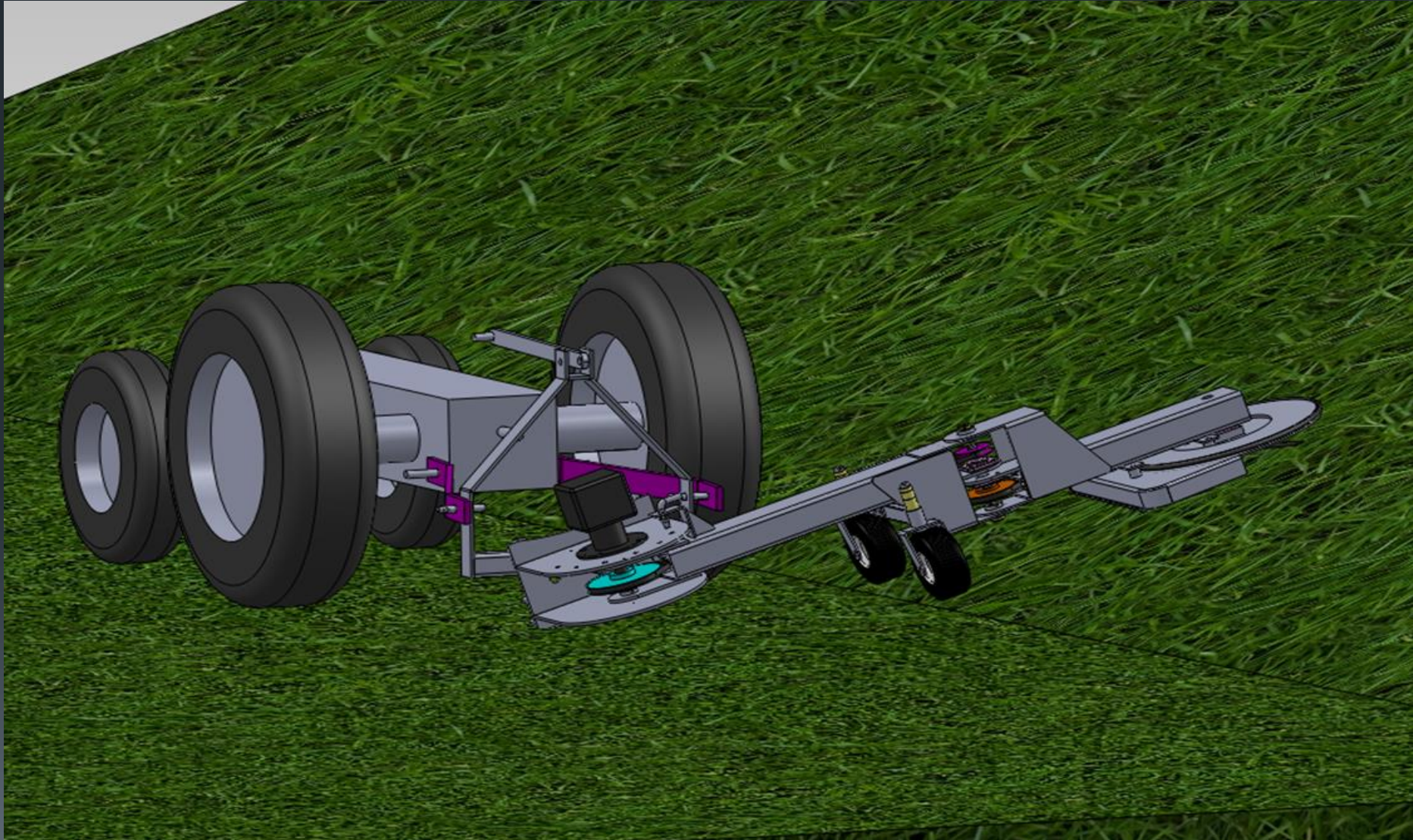
# Gear Box and Belts



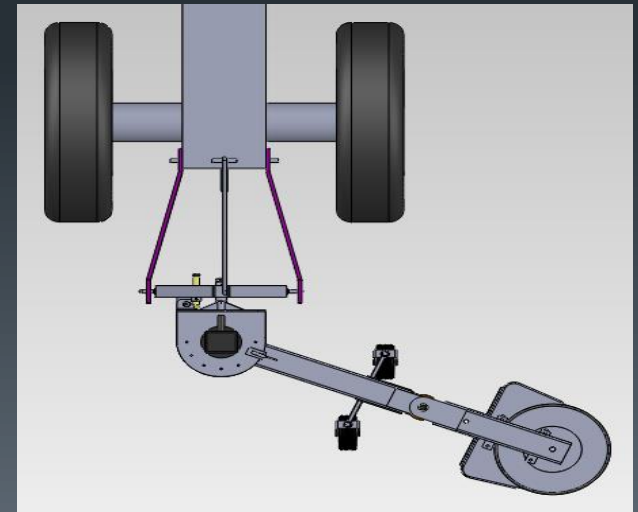
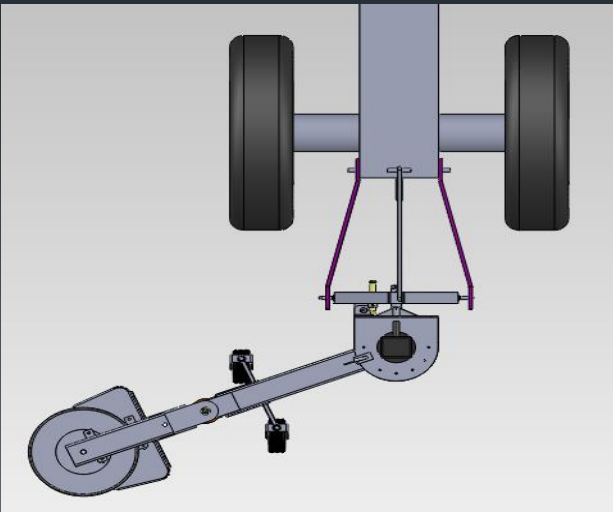
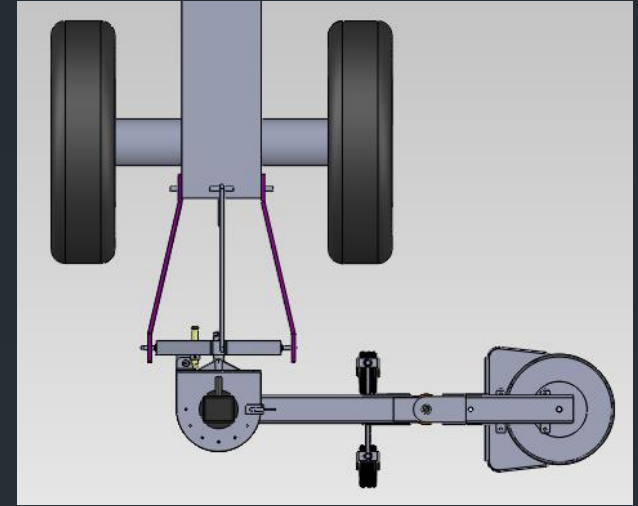
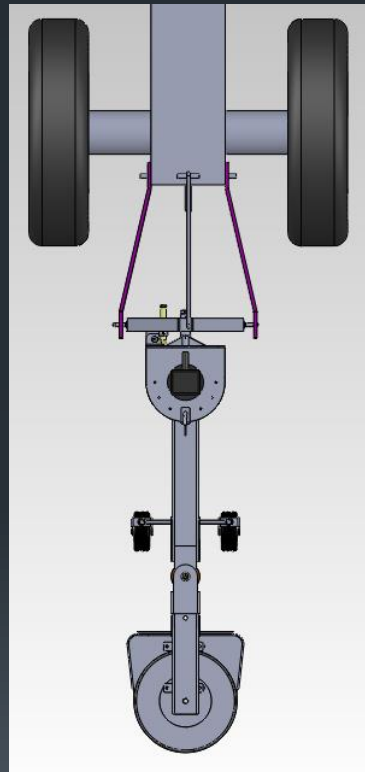
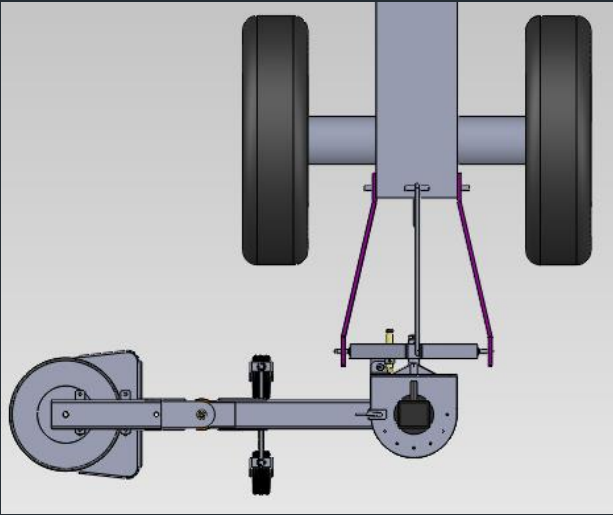
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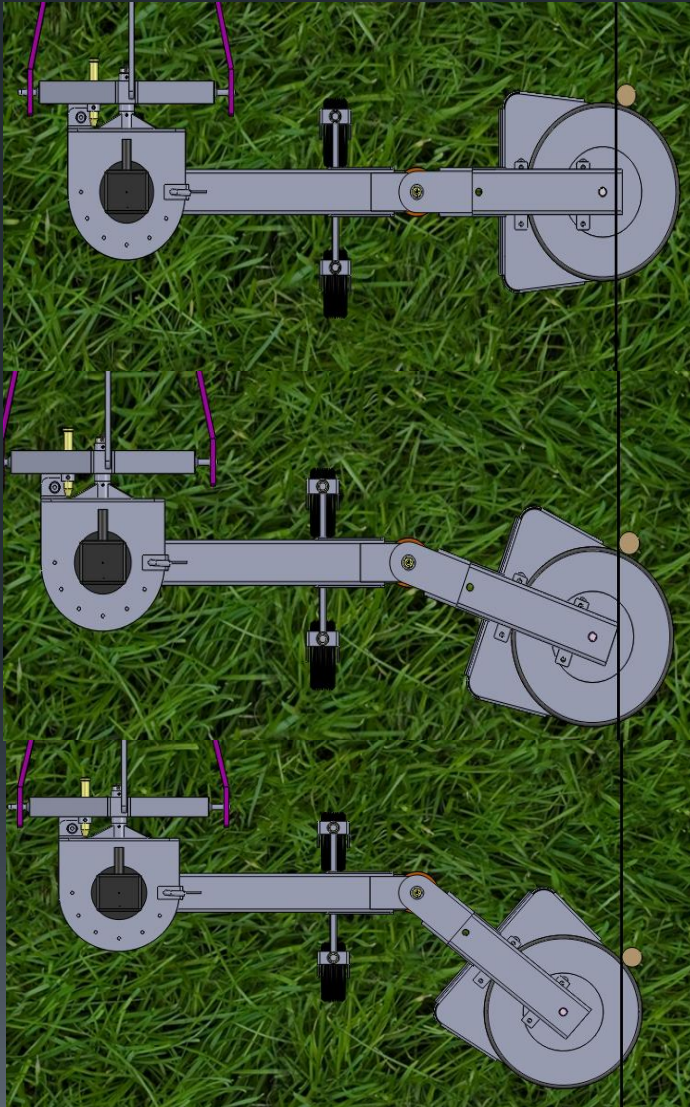
# Common Design Features



# Common Design Features



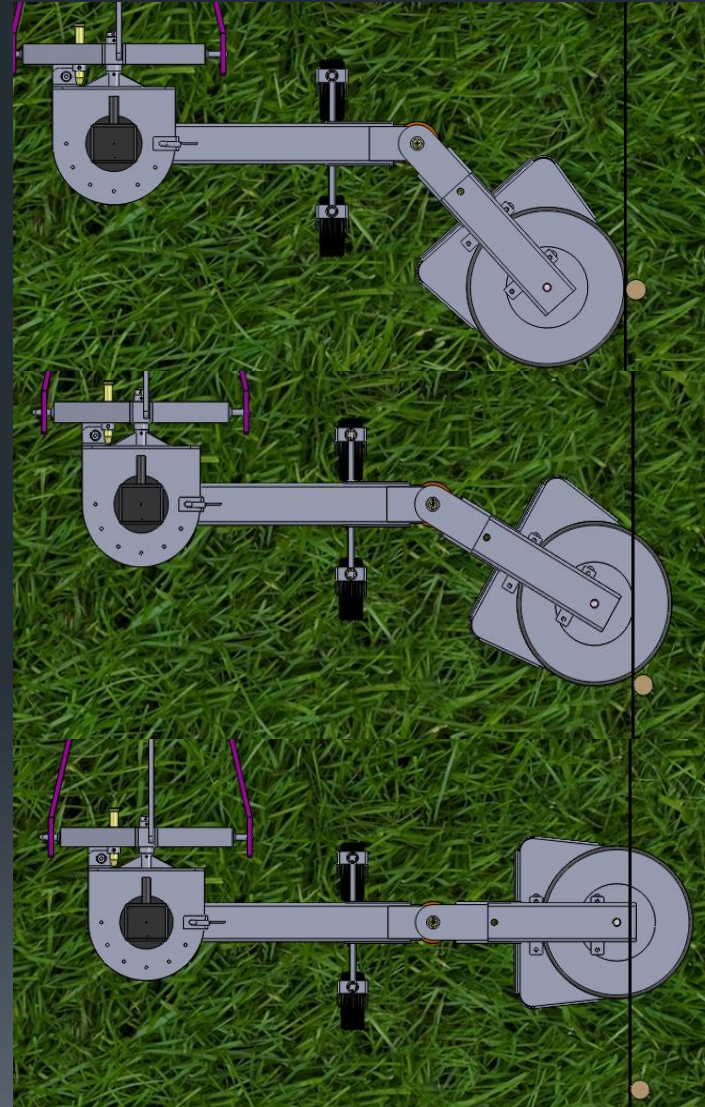
# Common Design Features



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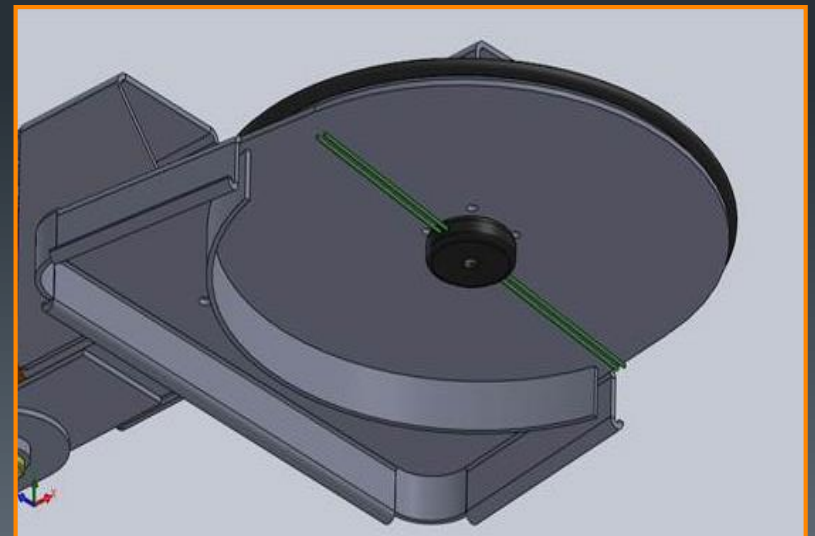
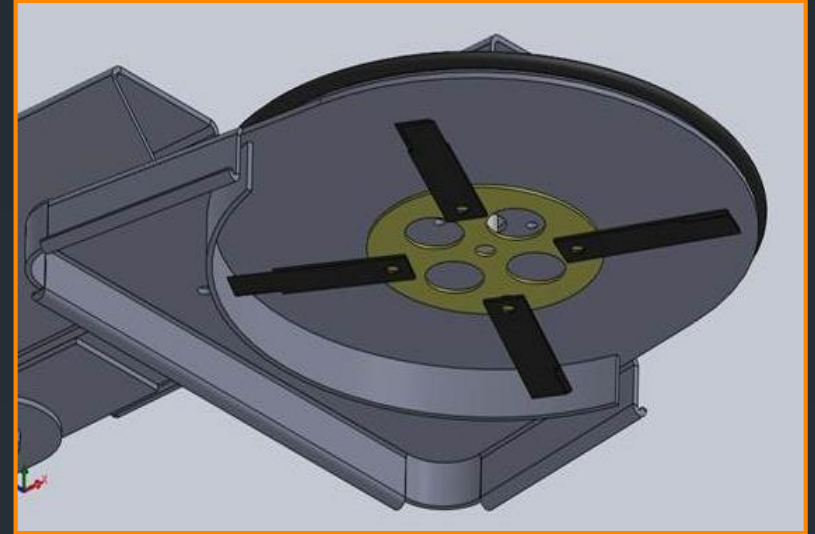
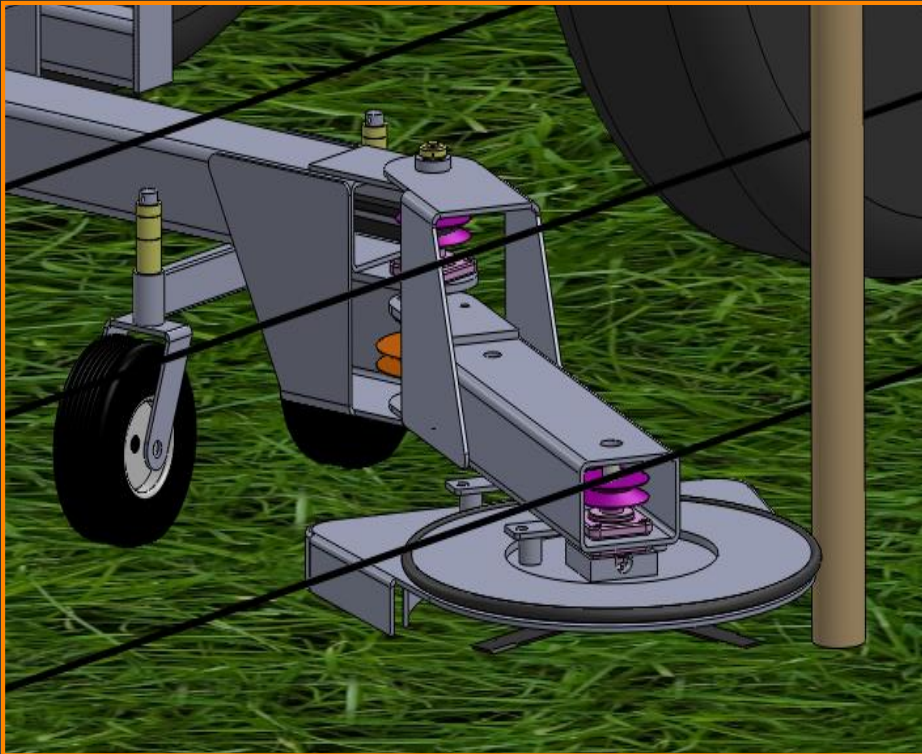


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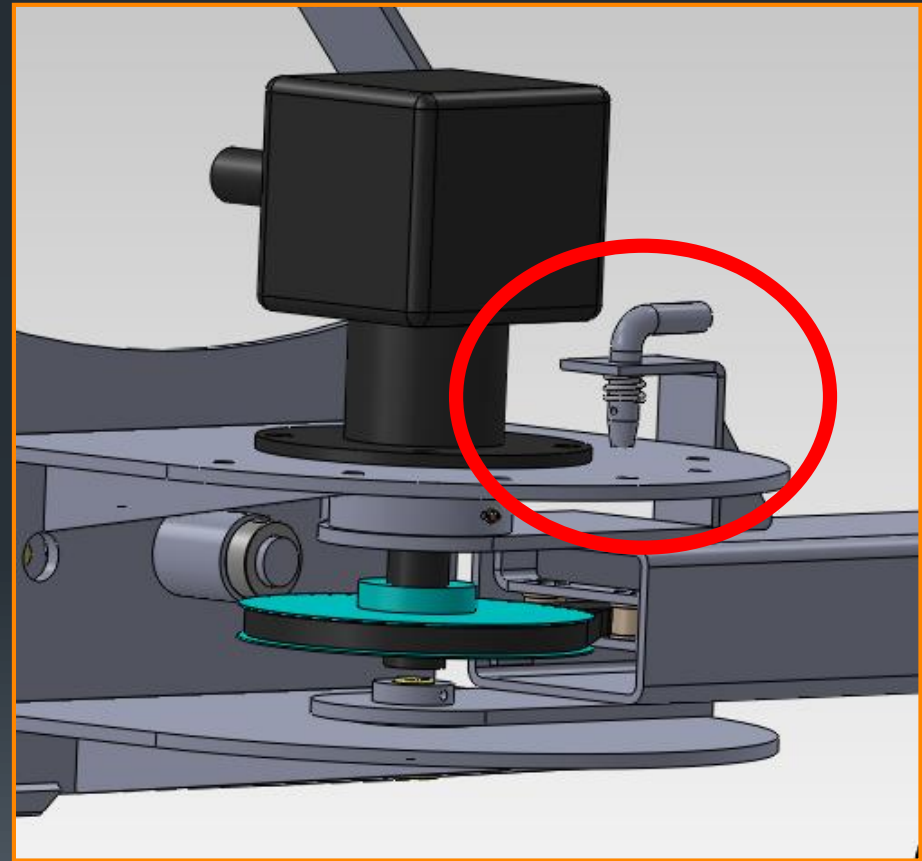
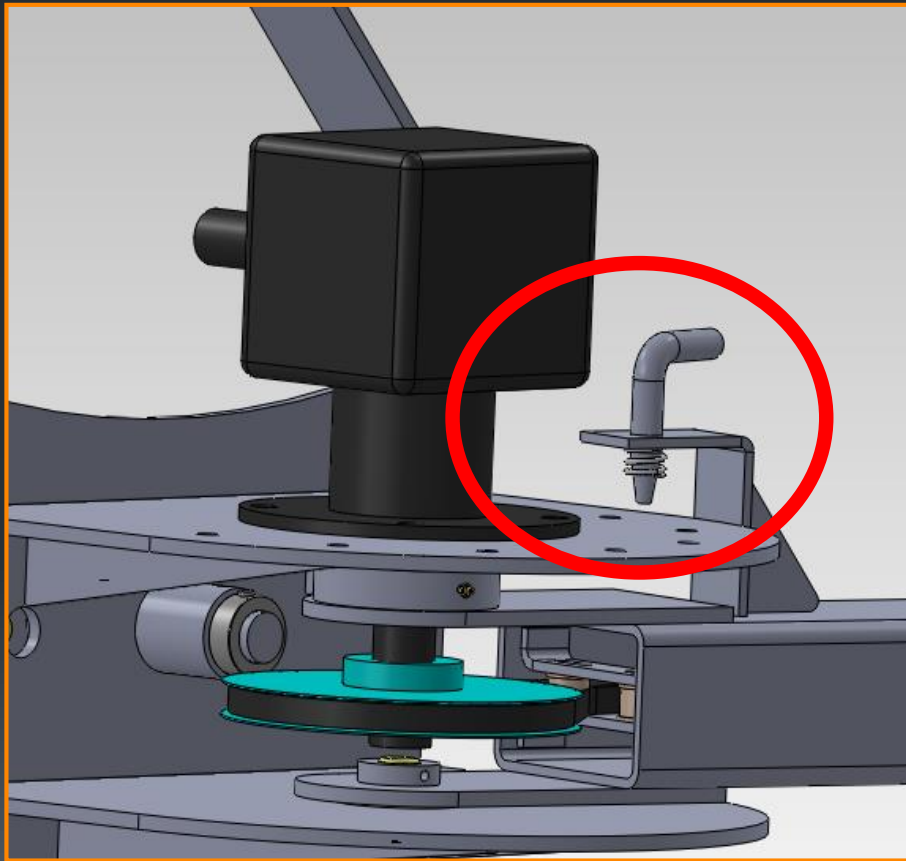
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# Common Design Features

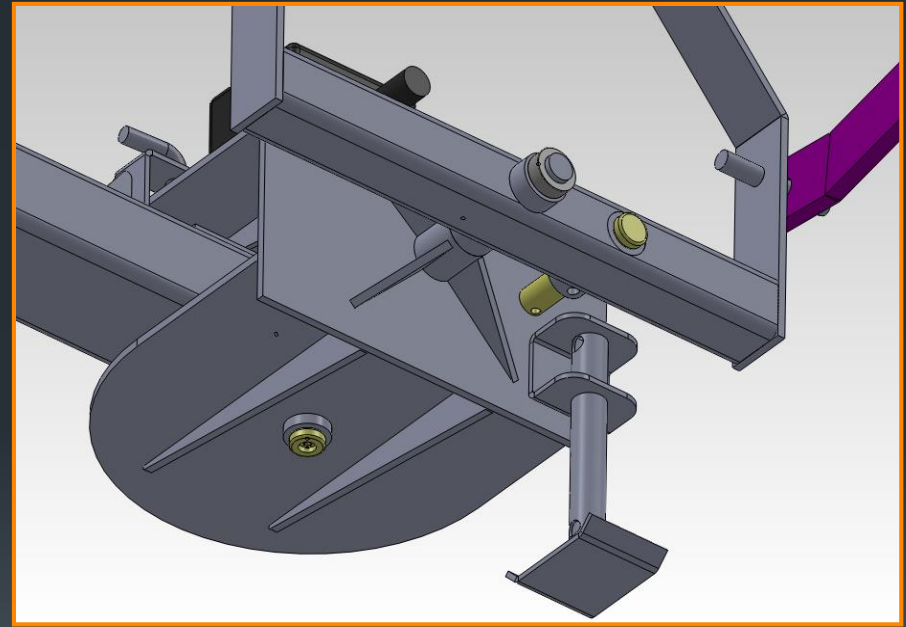
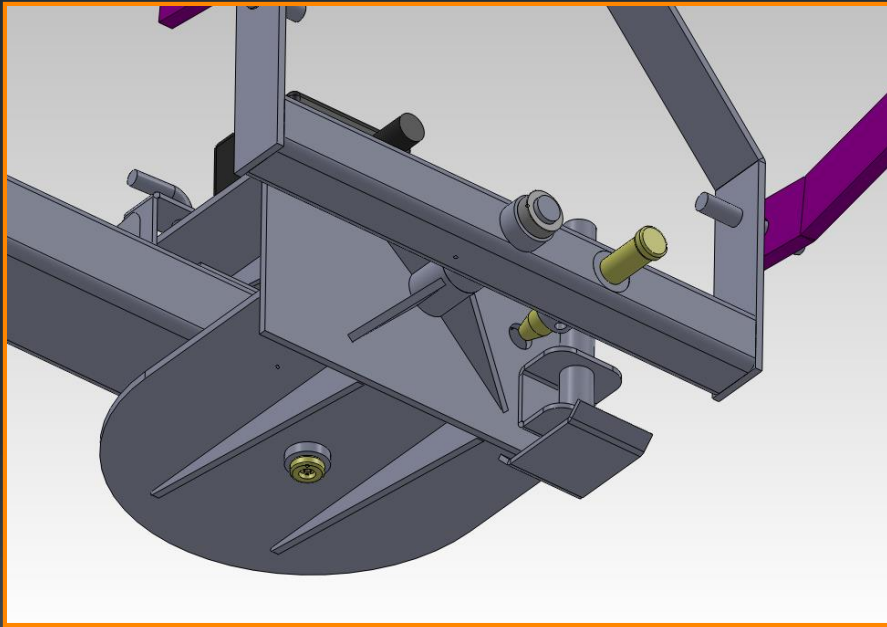




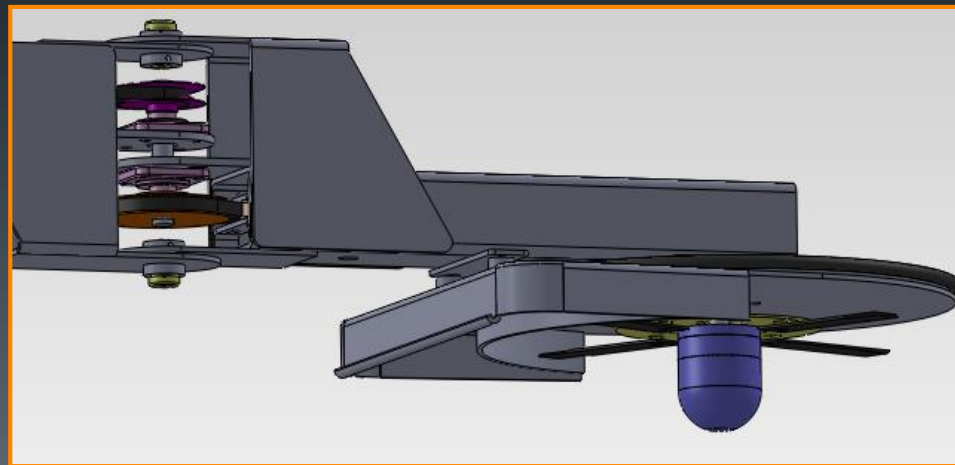
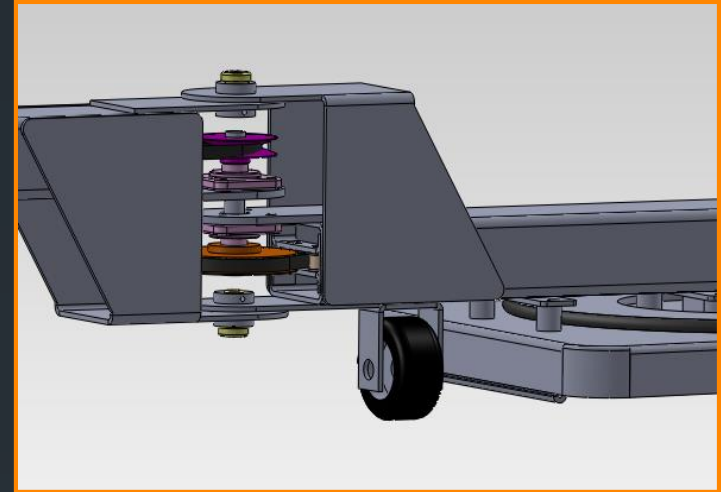
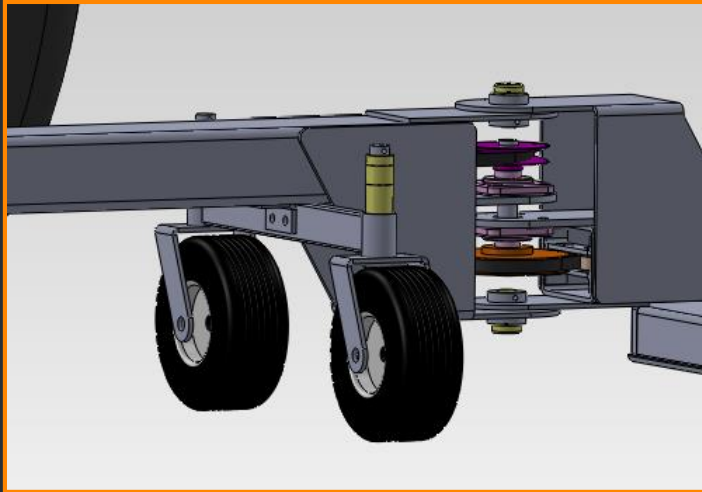
# Common Design Features



# Common Design Features



# Ground Following



# Pro and Cons

## All Belts

### PROS

- Replacement parts can be obtained at all farm supply or auto parts stores
- Very elementary concept – easy for everyone to grasp
- Multiple slip points if the cutting head were to be obstructed

### CONS

- The service points – most greased bearings on rotational parts
- Numerous sizes of similar parts increasing total part count
- Most extensive shielding requirements over initial directional transfer pulleys
- Bending belts increases stress, in turn wearing belts faster and requiring more frequent replacement

# Pro and Cons

## Gearbox / Belts

### PROS

- Gearboxes have many previously proven uses in agricultural equipment
- Reduces structural material in LTP over complete belt design
- Reduces the number of bearings and rotational parts
- Eliminates one guarded structure over all belts design

### CONS

- Additional parts count (gear box)
- Added maintenance point (gear oil)
- Not every farm supply or auto store will have a replacement gear box

# Pro and Cons

## Hydraulic Transfer

### PROS

- Allows for a much smaller Lateral Tilt Plate (LTP) and arm by eliminating belts and gear box – less material cost
- Least number of rotating parts – most serviceable option (fewer grease spots and no bearings)
- Lowest total parts count – highest manufacturability
- Simplifies working pivot joint with no rotating shaft to integrate

### CONS

- Bulky reservoir to add to implement
- Hydraulic fluid can coat surfaces if a line were to bust
- Needs pressure relief valve to allow for “slip joint” of cutting drive system

# Cost

All Belt	
Frame	\$ 637.15
Drives	\$ 371.32
Cutting Head	\$ 83.70
Fabrication	\$ 400.47
Assembly/Paint	\$ 170.00
	\$ 1,662.64

Gearbox/Belt	
Frame	\$ 462.27
Drives	\$ 494.72
Cutting Head	\$ 83.70
Fabrication	\$ 373.72
Assembly/Paint	\$ 170.00
	\$ 1,584.41

Hydraulic	
Frame	\$ 255.75
Drives	\$ 900.00
Cutting Head	\$ 83.70
Fabrication	\$ 324.15
Assembly/Paint	\$ 170.00
	\$ 1,733.61

# Next Semester

- Choose Drive System Concept with Client
- Further Develop Design
  - Size torsion springs for working hinge and breakaway
  - Develop shielding
    - ❖ Safety- ASAE S471.1 (Rotary Mower Safety)
- Fabrication of Tractor Trimmer
- Assembly
- Testing
  - Ground following concepts



Jobs  
Just  
Right  
Engineering