TRENCH CUTTERS

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PROBLEM DESCRIPTION

This Capstone project has the purpose of contributing to the coffee industry by aiding in the execution of an ardeous process that many coffee growers in steep terrains face: trench making. Infiltration trenches prevent soil erosion, and therefore enhance coffee production. By building a tiller-like mechanism that facilitates and expedites the trench-making process, the hard labor losses coffee growers face would be mitigated. This team will focus on designing the saw blade mechanism that will be used to penetrate the soil and create the trench.

SCOPE OF WORK

- The team will focus on designing the saw blade mechanism that will be used to penetrate the soil and create the trench.

- The goal is creating a design which incorporates the softening of the terrain with the blades and the complete removal of the soil with a plow attachment.

COMMONLY USED ROTAVATOR BLADES IN AGRICULTURE

L Shape
C Shape
J Shape
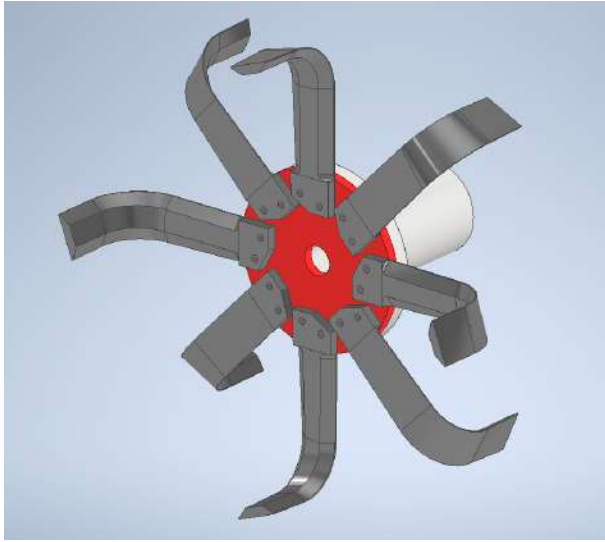
OPTIMIZED DESIGN

- A design consisting of a flange with removable L-shaped blades was chosen.
  - Diameter: 15"
  - Horizontal sections on each blade: 3"
  - Blade thickness: 8mm (~5/16")
  - Clearance Angle: 20°
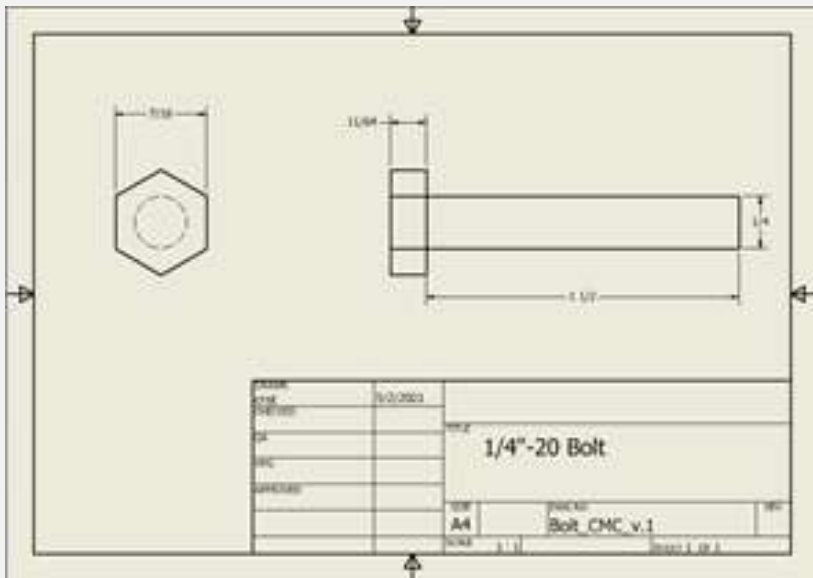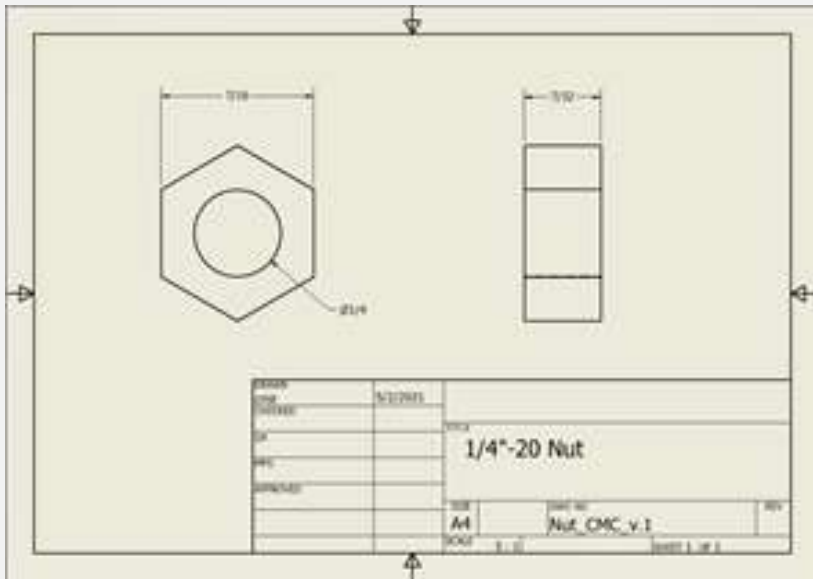- Designed to fit on mount provided by PTO team.

NUTS AND BOLTS

Bolts:

¼"-20, 1-½" long high strength steel bolts.

Nuts:

¼"-20 high strength steel nuts.

Blade Length	3 in
Blade Width	1.5 in
Angular Velocity of Rotor	293 RPM
Forward Velocity	3 mph
Radius of Rotor	7.5 in

L-BLADE AND MACHINE PARAMETERS

SOIL SPECIFICATIONS

For clay soil

- Surface layer is reddish brown, friable clay

- Subsoil is thick, red, friable clay at upper part and silty clay at lower part

Cohesion (C)	2.9 psi
Adhesion (C$_a$)	2.9 psi
Angle of internal Friction	0.436 rad (25 degrees)
Coefficient of Soil-Metal Friction	0.54
Specific Weight	74.49 lbf/ft^3
Trench depth	6 in

STATIC ANALYSIS RESULTS
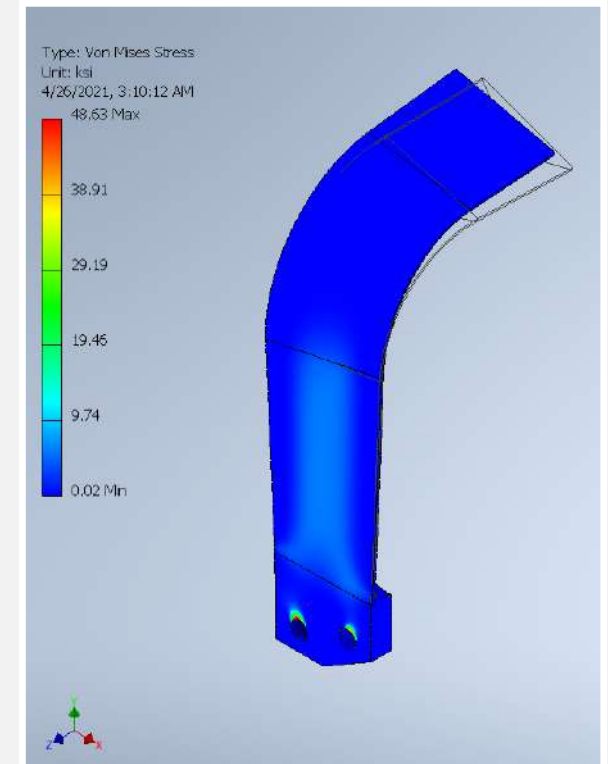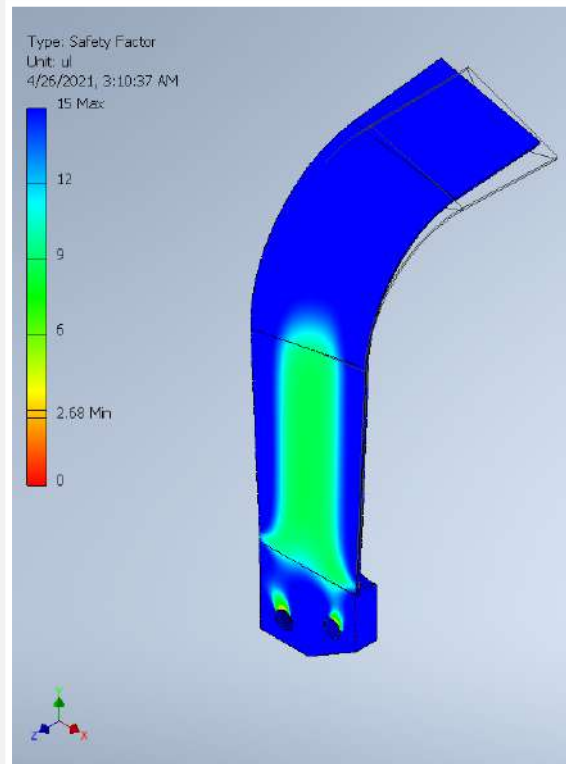
Maximum Soil Resistance Force: 34.69 lbf

Minimum Torque Requirement: 65.04 lbf-ft

Torque Provided by Output RPM: 209.72 lbf-ft

Exerted Force per Blade @ Output RPM: 167.7 lbf

- EN 1.5520 Boron Steel was chosen for the analysis:
  - Tensile Strength: 200 ksi
- Maximum Von Misses Stress:
  - 48.63 ksi
- Minimum Safety Factor:
  - 2.68

FEA RESULTS

Type: Safety Factor
Unit: ul
4/26/2021, 3:10:37 AM
15 Max
12
9
6
2.68 Min
0

Type: Von Mises Stress
Unit: ksi
4/26/2021, 3:10:12 AM
48.63 Max
38.91
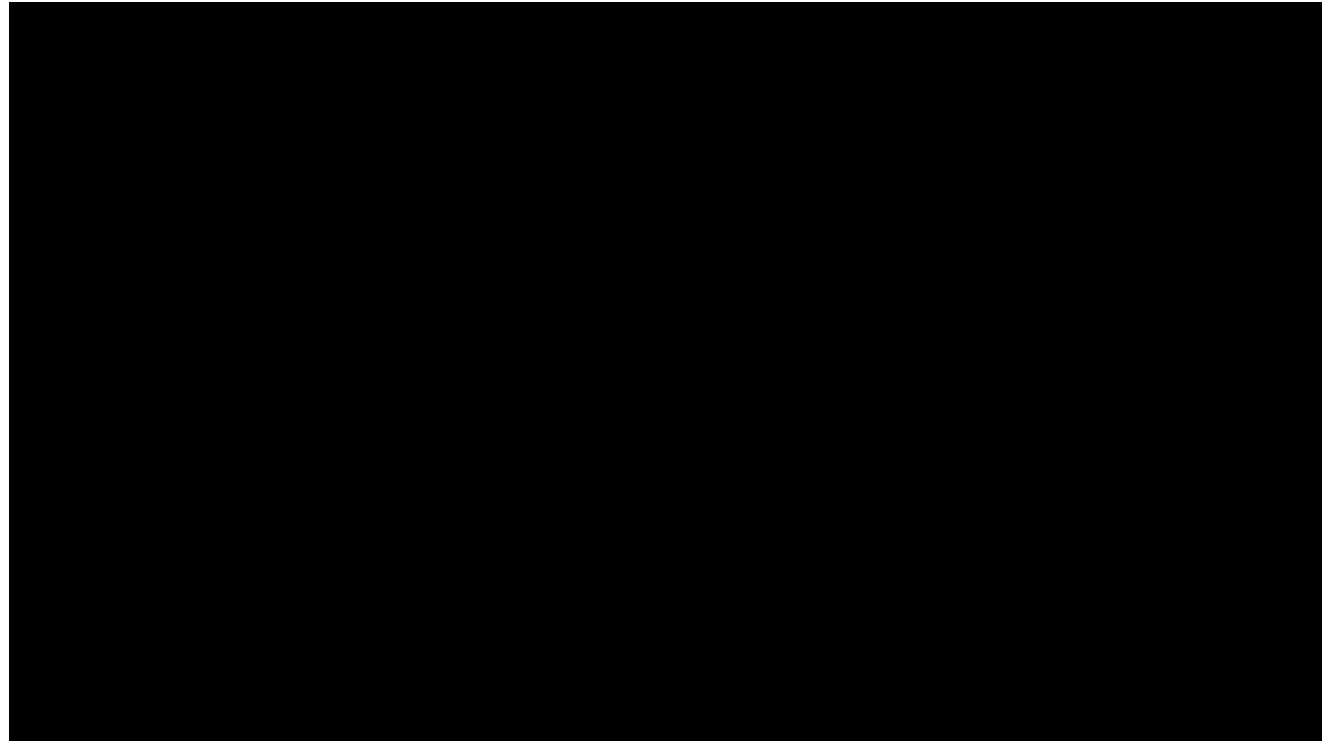29.19
19.46
9.74
0.02 Min

PLOW CONCEPT

- The "Hiller/Furrower" can be easily attached to BCS tractor with a hitch pin

- Adjustable Width Range: 12"-22"

ROTARY TILLER BLADES + PLOW

COST ESTIMATE

- **For off the shelf materials**

Part	Supplier	Quantity	Cost per Part	Shipping Costs	Total Cost
Blades	Agristore USA	16	$8.75	$61.67	$201.67
Flanges	Pipe Fitting Direct	2	~ $60	~$15	$135
Plow	BCS	1	$80	~$20	$100
Bolts	McMaster-Carr	32	$4.30 (100 pack)	$37.81	$62.90
Nuts	McMaster-Carr	32	$14.30 (two packs of 25)		
Estimated total					$499.57

CONCLUSIONS AND RECOMMENDATIONS

- An effective implementation of our blades with the PTO system was accomplished.

- Research other suppliers of tiller blades to reduce cost expenses.

- Investigate the possibility of in-house manufacturing the blades and buying the plow attachment locally.

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