PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2019

LJ-2

MiniPUP IV (Purdue Utility Platform)

Agricultural & Biological ENGINEERING

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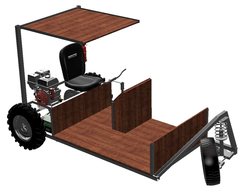
Problem

The current MiniPUP III design is more complicated than necessary and has a retail price that is too high for small farmers in developing countries.



Background

Approximately 300 million Africans struggle on a day to day basis with obtaining the proper nutrients they need to survive. The MiniPUP IV is a good solution to develop small farms by providing strong reliable mechanization that will enhance their yield and their ability to harvest crops while maintaining a price point that is suitable for buyers.

- Continuing project since 2009
- Previous PUPs are operating daily in various African countries

Purpose

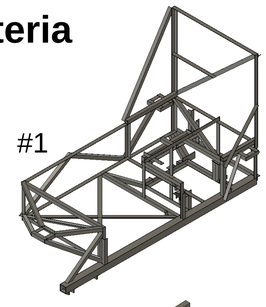
To design a vehicle that must be built in developing countries with limited access to parts and tools. The design must be low cost to manufacture and must be assembled easily and efficiently. Furthermore, the design must be able to power attachments and pull implements.

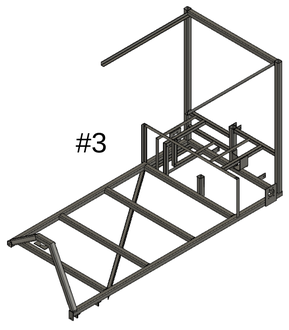
Design Constraints and Criteria

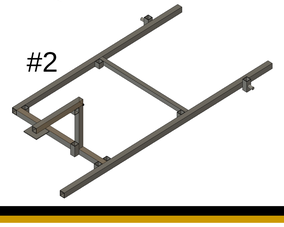
- Power attachments and pull implements
- Cost less than $750
- Carry 1000 lbs. payload
- Manufacturable in-country

Alternative Solutions

1. Existing MiniPUP – Complex truss with expensive three-wheel suspension
2. Overhead front wheel mount – Simple frame with no suspension
3. Flatbed – Ladder frame with front suspension only







Value Proposition

Vehicle	MSRP	Carrying Capacity (lbf)	Storage Space (compared to PUP)	PTO to Power Attachments	Pulls Implements
Mini-PUP	$1,500	1000	Comparable	√	√
PUP	$4,500	2000	-	√	√
Pickup Truck	$40,000	2000	Comparable	x	x
Car	$20,000	1000	Small	x	x
2-Wheel Tractor	$6,000	na	na	√	√
Trike	$2,500	1760	Small	x	x
Bicycle	$100	200	Very Small	x	x

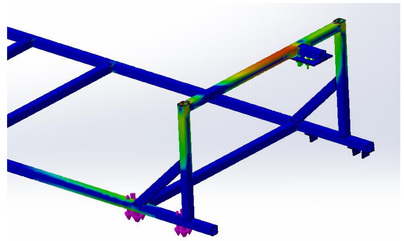
Analysis of Final Solution

FEA Simulations:

- Cargo loads
- Side loads
- Draft loads
- Point loads

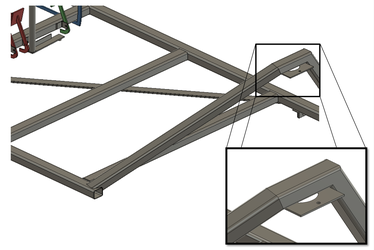
Driveline Analysis:

- Gear ratios
- Pulley diameters
- Belt sizes
- Tire diameters

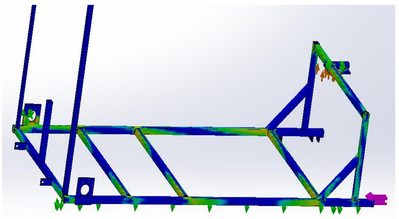


Corner Point Load - Torsional Stress

Improvements

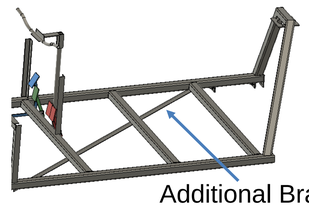


New Over Strut Mount – Plate Centered Under Tube Member



Impact Load – Racking of Frame

Improvements



Frame with Diagonal Member

Conclusion

The flatbed, ladder frame design for the MiniPUP drastically reduces the manufacturing time, which reduces the cost of the product. This allows more farmers to enter the market of mechanization. Small farms will be able to adopt the technology thus increasing their yields and overall utility.

- Projected decrease in weight: 84lbs
- Decreased cost by ~$150.00
- Increased payload area by ~ 8.5 ft^2 (39%)
- Lowered center of gravity by ~1.5 inches (6%)

Impacts

- Global – scalable to any developing country
- Social – improves standard of living
- Cultural – easily integrates without change
- Environmental – recycles scrap materials
- Safety – shielding of moving parts
- Health – lowered physical work load

Recommendations

Extensive field testing should be conducted to validate simulation results. In addition, the design should be evaluated for comfort and ergonomics with the new suspended seat. Since this is the first iteration with a flatbed frame, it has various points that could be refined, such as: cross member spacing, bed width, operator station, and optimization of steel section size.

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