

Executive Summary

The purpose was to develop a safe and easy system for farmers to get in and out of their combines. Farmers struggle with mobility as the average age of farmers keeps increasing. A retractable combine ladder prototype was designed, modeled, and built. The prototype is bifunctional first as an easy to climb staircase with a low ground clearance, and second as a traditional ladder for regular harvest operations. It is an affordable upgrade only costing \$1,200. The mobility assist combine ladder can positively benefit the production agriculture industry as it provides farmers a safe, easy to climb, efficient alternative to entering their combines.

PROBLEM

Modern combines are equipped with steep, upright ladders which require significant lower and upper body strength. Many older farmers are deprived of operating their combines as they cannot climb the ladder. The traditional stock ladder is a safety hazard that must be improved to protect our nation's farmers.

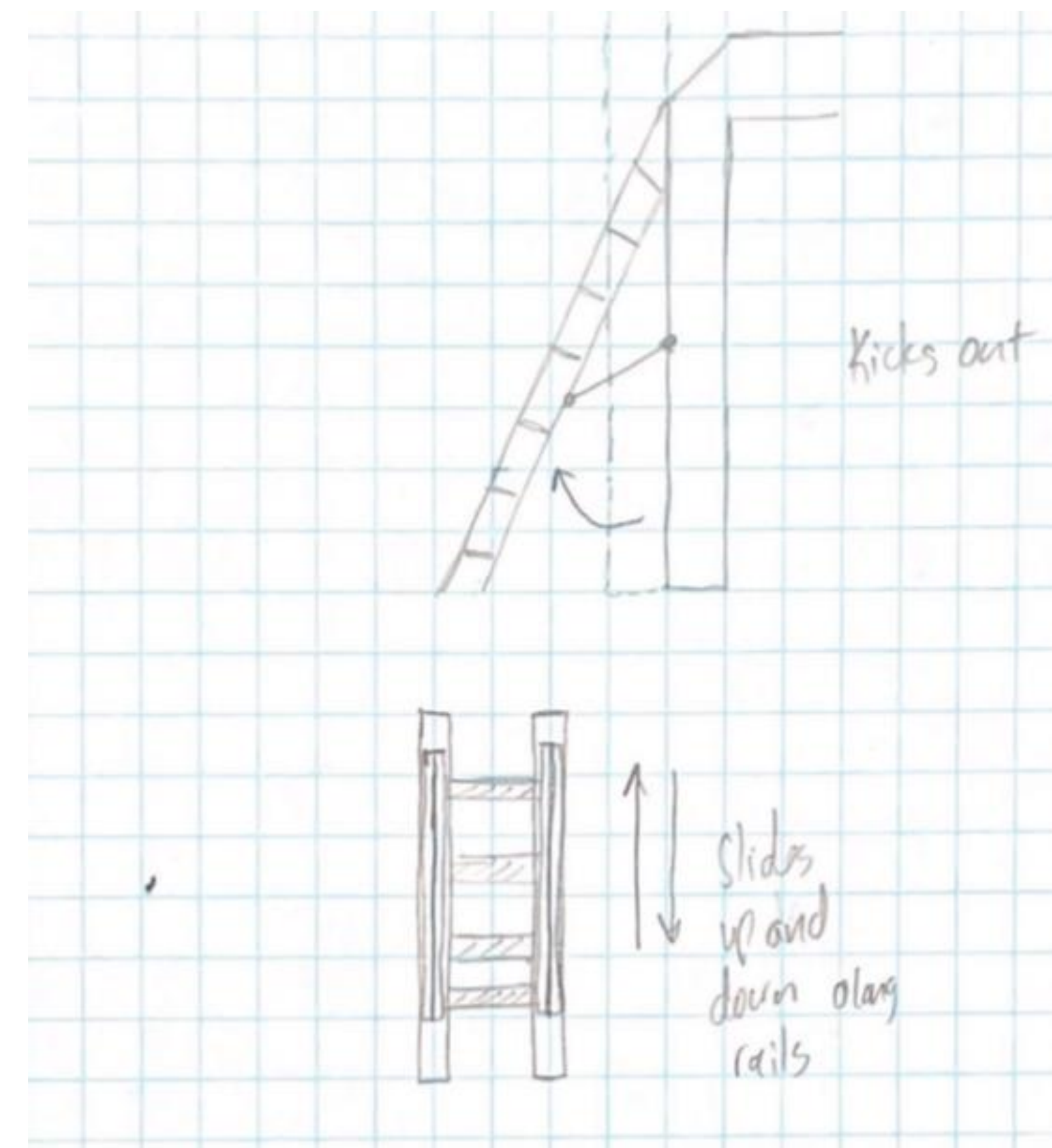
RESEARCH/BACKGROUND

- Average age of farm producers in 2017 was 57.5 (USDA, 2019)
- Colorado State reports individuals over 25 can lose 50% of their muscle mass (Tracy, 2021).
- Henderson Combine Ladders sells a retrofit staircase kit which requires a power source.
- Lifelyft sells a hydraulically powered elevator lift designed for a combine.

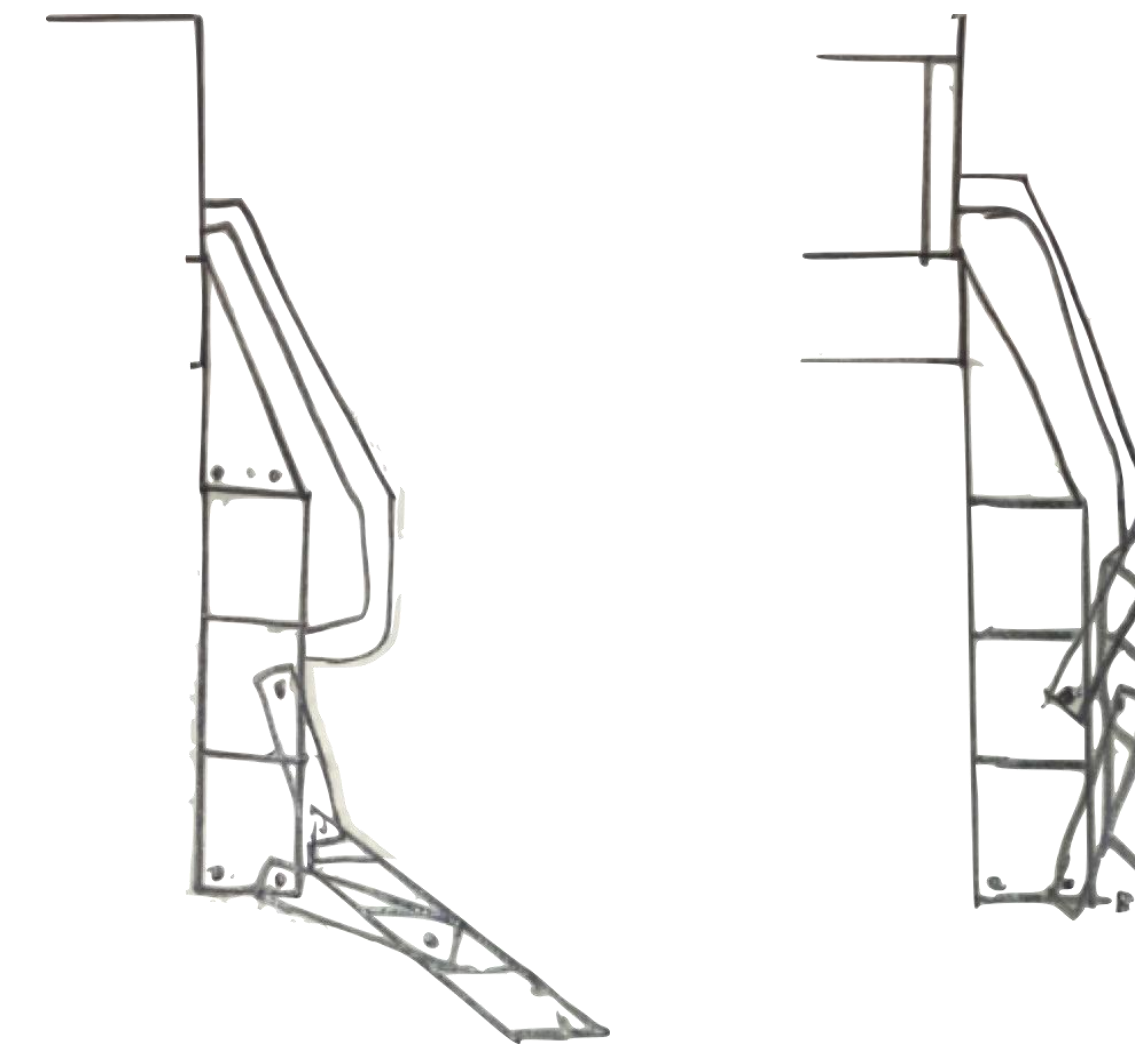
LADDER CHARACTERISTICS

- Improve mobility and mount/dismount time
- Simple
- Universal fit on John Deere or CNH combines
- Improve operator safety
- Reliable power source
- Product cost \$1,200

POTENTIAL DESIGNS



A sliding ladder design which lowers closer to the ground and provides a better climbing attack angle.



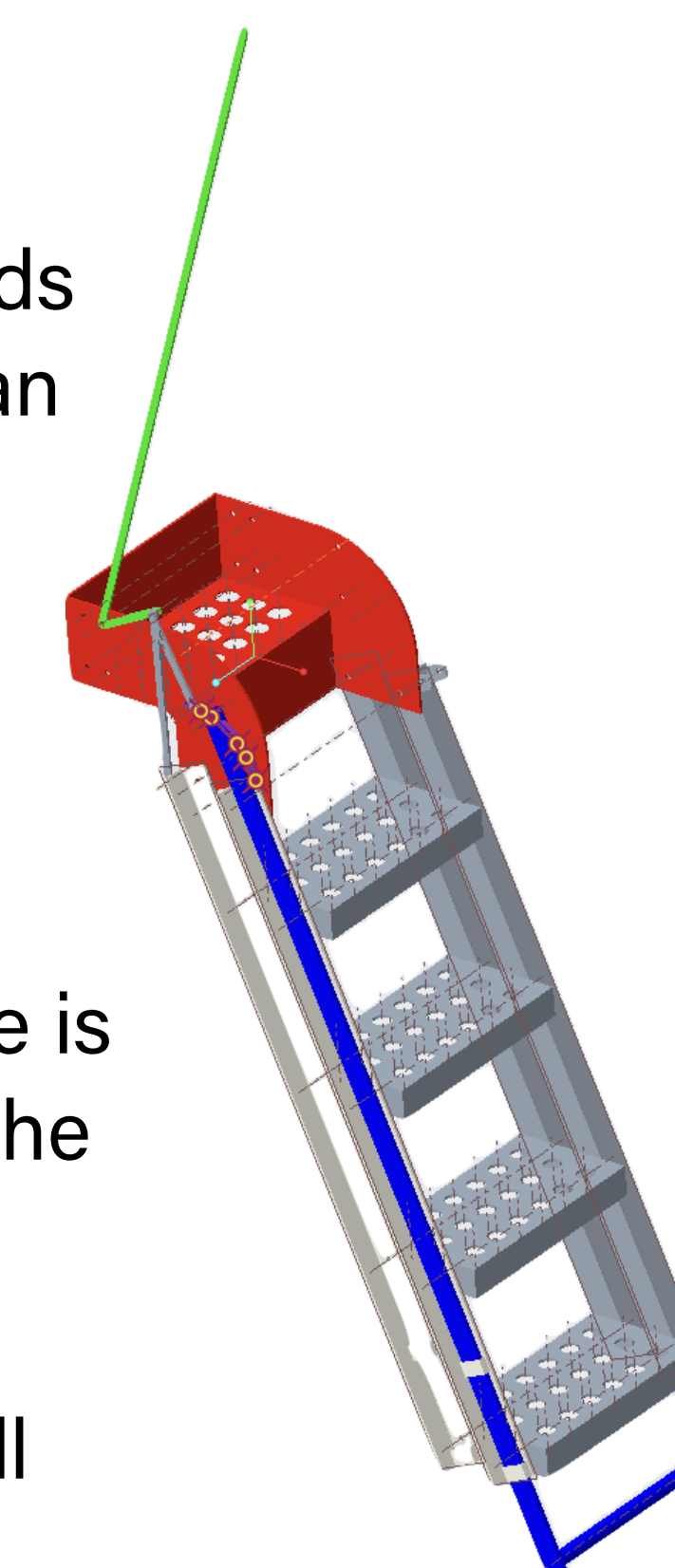
A scissor stair design with three bottom steps which lower to the ground with parallel arms.

VALUE PROPOSITION

A ladder that allows more farmers to easily access their combine benefits the operators, manufacturers, and retailers. More farmers can operate their equipment with this new tool, increasing the market for such equipment. Retailers can profit off of this new system by providing it on their equipment. With an increased market, manufacturers may see an increased demand. Overall, adopting this ladder will align manufacturers closer with farming communities.

FINAL DESIGN

A retractable staircase with an extendable bottom rung was chosen as the final design. By pulling a lever, the ladder extends into the staircase position and an additional step lowers closer to the ground. A second lever is pulled to lock it into place. The mechanical advantage lever allows any operator to easily engage the ladder. The staircase is a stable, secure climbing tool. The staircase design keeps the operator's weight in front of his feet, preventing a backwards fall unlike the traditional ladder styles.



Two group members testing the prototype's weight capacity.

TESTING AND FEEDBACK

The ladder supported the minimum of 300 pounds through several iterations of testing. The sponsor provided positive feedback when operating and climbing the ladder. Agriculture industry professionals complemented the ladder's ease of climb and comfortable retraction and extension.

ECONOMIC ANALYSIS

Inputs	Projected cost /unit	Return	
Material	\$ 178.94	Sales Price	\$1,200.00
Production	\$ 450.00	Competiton	\$4,250.00
Marketing	\$ 100.00		
Total	\$ 728.94		
		Profit	\$ 471.06

PROJECT IMPACT

Already, there is interest from other farmers for similar ladders on their combines. This will require scaling up the manufacturing of the ladder. It would be beneficial to create detailed plans of manufacturing and assembly for mass production. In order to maximize the benefit this ladder provides, effective marketing is required. Thus, generating marketing plans or consulting with professionals would be beneficial. Finally, a completely refined prototype should be constructed.

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