SENIOR CAPSTONE/
SENIOR DESIGN EXPERIENCE
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Central Tire Inflation System

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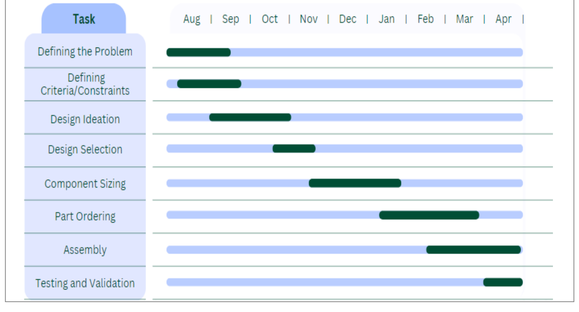
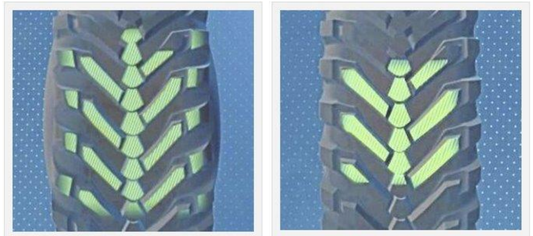
Executive Summary

Efficient tire pressure management is vital for agricultural combines, impacting traction, fuel consumption, and equipment longevity. Current methods lack adaptability, leading to inefficiencies and downtime during harvests. To address this, a system comprising a two-stage air compressor, a 30-gallon air tank, and hydraulic motor-driven components has been developed. Controlled via a cabin-mounted interface, this system adjusts tire pressure on-the-fly, optimizing traction and reducing fuel consumption. Pressure sensors ensure precise inflation, preventing over or underinflation. Farmers, agricultural service providers, and the environment stand to benefit from improved harvest efficiency, reduced runoff, and sustainability gains. Testing validates system efficacy, showing a 34% increase in traction with reduced tire pressure. Future speed testing will further validate system performance. The full-system would cost roughly $3500 to make.

PROJECT TIMELINE

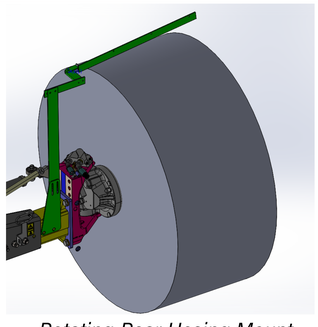




https://agtiretalk.com/variable-inflation-system-tire-performance-impact-tire-manufacturers-answer/

RESEARCH AND CONTEXT

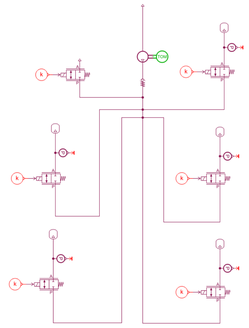
Using correct tire pressure increases tire footprint and contact area by upwards of 30%, reduces tire wear, and can save up to 10% on fuel consumption per year. Currently, there is no efficient way for farmers to increase or decrease tire pressure for combines on the fly. By varying pressure based on road or field conditions, combines will run more efficiently, decreasing equipment downtime and increasing overall efficiency of harvests.



Rotating Rear Hosing Mount

SOLUTION GENERATION

The team considered three viable options when it came to generating a solution. The first idea was a tankless design. The second solution was using tanks within the design. The third option was to have individual compressors for each tire. Through a weighted design matrix and sponsor input, the team ultimately chose solution two.



System Pneumatic Diagram

DESIGN AND DEVELOPEMENT

The constraints were that it must be operated through the cabin, have a working prototype by the end of the year, and must be able to be installed on any combine. The criteria were that it cost less than $5,000 to make, go through the center of the hub, inflate and deflate in a reasonable time, and be as nonintrusive as possible

The final design solution involves a system consisting of a two-stage air compressor capable of outputting 15 cubic feet per minute and a 30-gallon air tank to efficiently inflate and deflate tires. The compressor is driven off a hydraulic motor that is driven from the onboard hydraulics of the combine. Air hoses run from the compressor and tank over the tires through an arm guide where they connect to a rotary union spinning with the tire. From there, another air hose connects the rotary union to the valve stem of the tire. A controller that is positioned in the cabin allows the operator to adjust tire pressure with the push of a button. When the tires need to be deflated, dump lines open until the desired tire pressure is reached. During inflation, the air compressor and tank lines open, filling each tire to their respective pressure. Pressure sensors in the system continuously read and send signals to control valves, ensuring that tires will not be under or overinflated.

Project Sponsor

VALUE PROPOSITION

The main beneficiary from this project are farmers, but the benefits also extend to agricultural service companies and the environment. Better traction will lead to longer lasting field conditions, decreasing runoff and increasing efficiency during harvest. Our sponsor, Terra Drive Systems, will also receive a new product to market.

TESTING AND FEEDBACK

Validating the tire inflation system included 3 individual tests: footprint, speed, and accuracy. The footprint tests were a way of providing numerical data to support the increase in tire footprint and thus traction when operating a combine with lower tire pressures. The team found that the decrease in tire pressure from 35 to 12 psi resulted in a 34% increase in footprint. Due to not using the compressor and tank that the system was designed for, speed for inflation wasn't performed as it wouldn't be representative of the full system. The team was able to determine that the system would successfully hold air pressure, even while the wheels spun.

Tire Footprints from Testing

The team would like to thank Dr. John Lumkes, Tyler Finley, and TJ Wiegman for their support of the project.

The team would also like to express our gratitude to Terra Drive Systems and Daniel Skelton for sponsoring the project.