Introduction

Problem Definition
➢ A local farmer needs a suspension system installed on his farm wagon that will prevent damage to produce during transport and from selling points.

Background Information
➢ Payloads range from 3000 lbs when hauling sweet corn to 30 lbs at the end of the day.
➢ Damaged produce reduces customer satisfaction and is a financial loss for the farmer.
➢ Estimated losses are $20 a day.
➢ Farmer has 8 wagons that he uses to sell produce.

Constraints and Criteria
➢ Must dampen when fully loaded and empty
➢ Must attach to current wagon
➢ Must be towable behind truck
➢ Minimal cost
➢ Ease of installation
➢ Easily replicated

Design Matrix
➢ Matrix developed to determine optimal solution
➢ Scoring and criteria based on desired outcome
➢ Highest scoring design used in finished product
➢ Similar design matrix used to determine location for suspension system

Final Design
➢ Double eye trailer leaf springs with a 1250 lb. capacity mounted above the axle to frame of the bed.
➢ Shock absorbers to dampen leaf spring oscillations.
➢ Ride height will be increased by 7.75" unloaded and 6.75" when fully loaded.

Economic Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>Specifications</th>
<th>Quantity</th>
<th>Unit Cost ($)</th>
<th>Total Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf Springs</td>
<td>US-1041 1250 lbs. Capacity</td>
<td>4</td>
<td>33.95</td>
<td>135.80</td>
</tr>
<tr>
<td>Shock Absorbers</td>
<td>Magnum 65177 Gas Shock</td>
<td>4</td>
<td>50.00</td>
<td>200.00</td>
</tr>
<tr>
<td>Mounting Brackets</td>
<td>1018 Steel</td>
<td>N/A</td>
<td>62.58</td>
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</tr>
<tr>
<td>U-Bolts and Nuts</td>
<td>1/2-20, 2” inside width, 6” leg</td>
<td>8</td>
<td>5.95</td>
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<td>Shackles</td>
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<tr>
<td>Shackles Bolts</td>
<td>9/16”-12, 3” Long, w/Locknut</td>
<td>12</td>
<td>5.71</td>
<td>68.52</td>
</tr>
<tr>
<td>Total Cost</td>
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Accelerometer Testing
➢ Wagon was tested before suspension was installed and after suspension was installed with an accelerometer.
➢ Tested both empty and loaded with 3000 lbs to simulate real conditions.
➢ Tested in gravel parking lot by ADM at 10 mph to replicate roughest conditions the farmer sees.
➢ Saw a 25% average reduction in peak G loading in the vertical direction.

Alternative Designs
➢ Airbags with Lateral Stabilization
➢ Coilovers
➢ Magnetic Adjustable Shocks
➢ Hydraulic Shocks
➢ Torsion Bar
➢ Stabilization In Bed

FEA Analysis
➢ Ran finite element analysis on leaf spring hangers to validate design.
➢ Analysis was run with a 5000 lb vertical load on the bolt holes representing a 4g shock loading in a fully loaded condition, twice what was encountered in test.
➢ The max Von Mises Stress from the analysis was 24,000 psi.
➢ Brackets manufactured using 1018 steel which yielded a factor of safety of 8.
➢ This maximum stress was below the fatigue limit of 1018 steel of 27,000 psi.

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