Steering Decision Presentation

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Overview

- Decision
- Functional Design
- FMEA
- Calculations
- Manufacture
## Pitman Arm Vs Rack and Pinion Steering System

<table>
<thead>
<tr>
<th>Pitman Arm</th>
<th>Rack and Pinion</th>
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</thead>
<tbody>
<tr>
<td>• Higher turning ratio</td>
<td>• Requires 3-4 complete revolutions from lock to lock</td>
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<tr>
<td>• Less Sensitive to Errors in assembly</td>
<td>• Possible Slippage</td>
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<tr>
<td>• Less complex parts</td>
<td>• System of Gears</td>
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<tr>
<td>• Ease of machining</td>
<td>• Need to be ordered or specially designed</td>
</tr>
</tbody>
</table>
Pittman Arm Steering System
## FMEA

### Failure Modes

RPN = (SEV) * (OCC) * (DET)

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>RPN</th>
<th>SEV</th>
<th>OCC</th>
<th>DET</th>
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</thead>
<tbody>
<tr>
<td>Mounting Issues</td>
<td>24</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Weld Fracture</td>
<td>160</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Removal of lubricant</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Loose Fittings</td>
<td>30</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Peg Failure</td>
<td>30</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>
FMEA

Weld Fracture (RPN=160)

RPN = (SEV)*(OCC)*(DET)

SEV = 8  Significant danger depending on circumstances
       May work but almost useless

OCC = 2  Very small chance of occurrence
       Forces in steering system are not very significant

DET = 10 No chance to detect and avoid

One possible solution is to add set screws
Approximating the Steering Column Length

The steering column length should be approximately 31 inches long.
Calculating Wheel Angle

The minimum requirement for turning radius is 10 ft.
In order to prevent understeer this will be used for the maximum turning radius.

To calculate the corresponding wheel angle:

Law of Sines

\[
\frac{r}{\sin(90)} = \frac{\text{Wheelbase}}{\sin(\theta)}
\]

\[
\theta_{req} = \sin^{-1}\left(\frac{\text{Wheelbase}}{r}\right) = \sin^{-1}\left(\frac{4.625 \text{ ft}}{10 \text{ ft}}\right) = 27^\circ
\]
Calculating Shaft Angle

At current maximum wheel turn of $20^\circ$, the peg which regulates the tire angle is stopped at $30^\circ$.

$$\theta_{column} = \left(\frac{\theta_{column,\text{max}}}{\theta_{tire,\text{max}}}\right) \times \theta_{req} = \left(\frac{30^\circ}{20^\circ}\right) \times 27.5^\circ = 41^\circ$$
Manufacture of Steering Assembly

Base

1"x1/8" Flat Bar
1020 Low carbon steel
Bent to 45° angles using Hossfeld Universal Bender

1" round Bar
1020 Low carbon steel
Machined using lathe and milling machine

Design to be finalized based on prototype
Manufacture of Steering Assembly, cont.

Steering Column

- Shaft can be 1.33” round bar
- Pitman arm can be machined from 3/4” plate
- Lower shaft can be machined from a 1” round bar
- Pin can be machined from a small round bar
Questions???