Capstone Senior Design Project

Large Hose Cutting Machine

Final Design Presentation
Project Team Members and Advisor

Mohsen Almohammed
Mechanical Engineering

Julio Hernandez
Mechanical & Mecatronic Engineering

Brett Karr
Mechanical Engineering

Kelly Womack
Mechanical Engineering

Webster Johnson
Mechanical Engineering
Project & Sponsor Background

- Fab-in-house fuel system products
- Local company
- Build 10,000 fuel systems annually
- Use hundreds of thousands of rubber hose per year
Current Machine

Current Hose Cutting Machine

- Works with spooled hose
- Cuts smaller diameters
Current Problem

- Problem
  - Poor edge finish
  - Inconsistnet Edge Finish
  - Permanent Deformation

- Debris
- Time Consuming
- Employee Injury
## Project Specifications

<table>
<thead>
<tr>
<th>Must Do</th>
<th>Should Do</th>
<th>Would Be Nice</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Cut ¾-3” diameter hose</td>
<td>✓ Setup time &lt;5 min</td>
<td>✓ No hardware change</td>
</tr>
<tr>
<td>✓ Clean cut- burr size &lt; .15in</td>
<td>✓ Drive hose 1 in/sec</td>
<td>✓ Indicator light for</td>
</tr>
<tr>
<td>✓ Smooth- frays &lt; 1.5mm</td>
<td>✓ Accommodate All hose sizes</td>
<td>system stages</td>
</tr>
<tr>
<td>✓ Perpendicular cut- angle ± 5°</td>
<td>✓ Off-the-shelf parts</td>
<td>• Magazine Feeder</td>
</tr>
<tr>
<td>✓ Maintain 2% length accuracy</td>
<td></td>
<td>• Download job specs</td>
</tr>
<tr>
<td>✓ No Debris</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Meet OHSA safety standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Use Mach 3 G-Code</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Safety Factor &gt; 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TFI Hose Cutting Work Center Design Solution

- **Drive System**
  - 2 Stepper Motors
  - 1 Pneumatic Actuator

- **Compression System**
  - 1 Stepper Motor

- **Cutting Mechanism**
  - 1 Pneumatic Actuator
Design Solution

Drive Mechanism
- Roller velocity at .5in/s
- 2 NEMA 23 motors at 233 in-oz
- 1.5” Actuator supplying 21lb force
Design Solution

Cutting and Compression
- Cutting 4” actuator- ~1200lb Force
- Compression NEMA 23 w/ 450 in-oz Torque
Design Solution

Safety Cover
Testing

- Setup Time
- Cutting
- Edge Fray
- Debris
- Perpendicularity
- Length Accuracy
Testing-Setup Time

Specification:
Setup Time <5min

Test parameters
• Load Program
• Enter Data

100% Design Compliance

Specification Met
Testing-Cutting

Specification:
Cut? (yes/no)

Test parameters
- Run test fully automated
- All hose types

100% Design Compliance

Specification Met
Testing-Edge Fraying

Specification:
Fray Edge <1.5mm

Test parameters
- Run test fully automated

100% Design Compliance

Specification Met

By Default:
Debris Specification Met
Perpendicularity Testing

Specification:
Angle ± 5° for ≤ 1”
Angle ± 2° for >1”

Test parameters
• Run test fully automated

Degree of design compliance
96% for hoses ≤1” ID
94% for hoses >1” ID @ ± 5°
16% for hoses >1” ID @ ±2°

Specification Met
Testing - Length Accuracy

Specification:
5% length Accuracy \(\leq 3''\)
(2.85 min and 3.15 max)

Test parameters
• Run test fully automated

97% Design Compliance

Specification Almost Met
Reflection and Design Suggestion

Linear slide
- Ball screw binding
  - Max force 56 lb
  - Max torque 15 in-oz
- Decreased compression plate size
TFI Project Thanks

Todd LaPant
Director of Engineering

Joseph Baldi
Mechanical Engineering

John Buss
Mechanical Engineering

Chris McClurg
Research and Development

Ignasio Sucedo
Maintenance Supervisor
Final Budget $58,000

TransferFlow Project Budget

- Purchased Parts, $3,500
- TFI Custom Parts, $1,300
- Donated Labor, $35,000
- TFI Labor, $18,000
Conclusion & Questions

This machine is:
- Safe
- Versatile
- Repeatable
- Robust
- Modular
- Off-the-shelf
- Fully automated

<table>
<thead>
<tr>
<th>Specification</th>
<th>Spec Met</th>
<th>% Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut Hose</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Fray Length</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Burr Size</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Perpendicularity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle ± 5° for &lt;=1&quot;</td>
<td>Almost</td>
<td>96%</td>
</tr>
<tr>
<td>Angle ± 5° for &gt;1&quot;</td>
<td>Almost</td>
<td>94%</td>
</tr>
<tr>
<td>Length % Accuracy</td>
<td>Almost</td>
<td>96%</td>
</tr>
<tr>
<td>Debris</td>
<td>Yes</td>
<td>100%</td>
</tr>
<tr>
<td>Setup Time &lt;5min</td>
<td>Yes</td>
<td>100%</td>
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