Airbag Inflator Automated Test Set-Up
Khaled Almutairi, Logan Diekmann, Martin Grasic, Kristen Stewart
Advisor: Dr. Sanford Meek

Introduction
As part of safety factor testing, airbag inflators are tested to failure by plugging diffuser holes. Upon deployment, an inflator ignites gas generating tablets which create gas to fill the airbag. Autoliv wants a remote process that automates all test technician handling of inflators with plugged holes to eliminate any risk while running this test.

Problem Statement
The objective of this project is to design an automated fixture that will remotely plug one or more diffuser holes of an airbag inflator to eliminate human exposure during the setup and running of the test.

Design

FEA of Top Plate

• No significant stresses on bottom of plate connecting to stepper motor
• Factor of Safety of 2 in bolt holes where highest stresses occur

Metrics

<table>
<thead>
<tr>
<th>Specifications/Metrics</th>
<th>Desired Values</th>
<th>Achieved Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug all holes along one row on diffuser</td>
<td>6 plugged holes</td>
<td>6 plugged holes</td>
</tr>
<tr>
<td>Precision</td>
<td>Screw aligned within 0.5mm of hole center</td>
<td>Screw aligns within 0.26 mm of hole center</td>
</tr>
<tr>
<td>Size</td>
<td>L &lt; 46.5 in W &lt; 46 in H &lt; 46 in</td>
<td>L=16 in W=10.75 in H = 17 in</td>
</tr>
<tr>
<td>Drill Travel</td>
<td>&gt; 1 in to allow for reloader design to work</td>
<td>1.25 in of travel</td>
</tr>
</tbody>
</table>

Axle Design

• Roller bearings used to reduce friction during inflator holder rotation
• Shoulder bolt allows axle to adapt to shaft coupler on stepper motor

Motor Selection

Needed to ensure that the stepper motor selected to rotate the steel inflator holder would provide sufficient torque with enough precision to reach all six holes on a row of the inflator.

Stepper Motor Resolution | 400 steps
Rotation Time per Hole | 1 second
Rotation | 67 steps/s
Angular Acceleration | 5.6 rad/s²
Torque Required from Motor | 1.8 N-m

Screw Reloader

Full System Integration

• Stepper motor attaches to axle to rotate inflator holder
• Pneumatic actuator provides horizontal actuation to insert screws
• Screw reloader allows for multiple holes to be plugged in one test
• Drill motor provides torque to insert screws
• Frame is robust to withstand forces during insertion test
• Motors are controlled by Arduino

Testing & Results

Inflator Holder Rotation Test

Procedure:
• Initially align first diffuser hole to drill motor
• Program stepper motor to rotate 60 degrees to next diffuser hole and observe accuracy of one rotation

Results:
• Motor would not have torque necessary to move metal inflator. (Needed to select new motor)
• Coupling between main axle and motor was slipping. (Needed redesign)

Screw Insertion Test

Procedure:
• Vary air pressure for pneumatic actuator to determine force to insert screw
• Test rotation speed so threads catch inside diffuser hole

Observations:
• Pneumatic actuator provides sufficient force to insert screw
• Actuator travelled far enough to work along with screw feeder design

Final Prototype

Results:
• Autonomously plugged entire row of holes
• Inflator rotates 1/16" off its center axis causing issues with hole spacing and contact sensor
• Setup requires technician to measure hole spacing when in inflator holder
• Successfully tested contact sensor that can autonomously locate the holes

Conclusions & Future Work

The system effectively plugs the holes along one row of an inflator. This design only requires a technician to insert an uncompromised inflator into the holder and align the first diffuser hole with the drill.

The next step would be to integrate the contact sensor into the full design. This design can be modified to add a vertical actuator to reach both rows of diffuser holes. Additionally, the top plate can be adjusted so it can fit other circular inflator styles that Autoliv manufactures.