Autoliv — Head Drop Airbag Demonstration

Breakneck Engineering
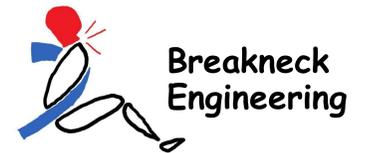
Project Description:

The Autoliv head drop airbag apparatus is designed for demonstration to audiences ranging from K-12 STEM fairs to professional career fairs.

The purpose of this project was to update and improve the existing system to streamline and simplify the demonstration process

Sub-systems:

Lever Arm System:

All components related directly to the physical drop of the head
- Lever bar
- Head form
- Accelerometer
- Electromagnet
- Limit switch and mount
- Spring neck system

Pressure System:

All components connected to the compressive system
- Compressor
- Hoses
- Valves and hard connectors
- Solenoid
- Pressure sensor
- Airbag
- Printed caps

Frame:

Hardware and components of external frame
- T-bar
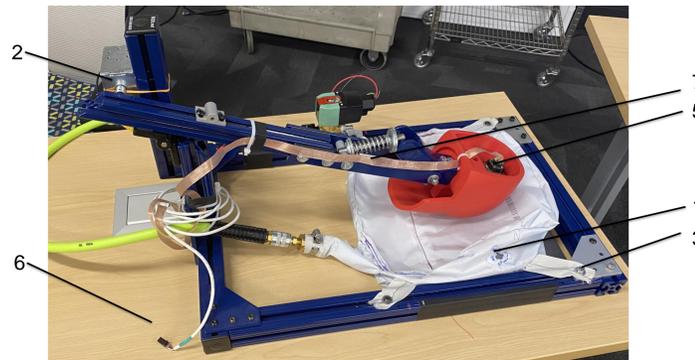- Steel plate
- Dampening Foam
- Cap holder
- Rubber feet

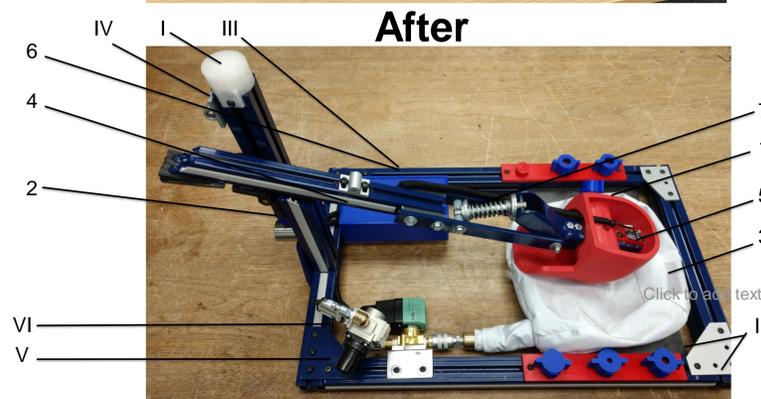**Electronics:**

The electrical system of the apparatus
- Arduino
- H-bridge
- Wiring
- LED light
- Computer
- Code

Design Description:

Before

After

Physical Changes:
1. Airbag Venting
2. Release Mechanisms
3. Airbag Fastening
4. Processor to Arduino
5. Accelerometer and Mount
6. Physical Plugin Complexity
7. Wire Routing & Consolidation
8. Pressure Storage/Inflation System

Computerized Changes:
1. Arduino Code
   - Airbag fill time stabilization/customizability
   - Reliability
2. Graphical User Interface
   - Improved display
   - 'Demonstration' menu

Features Added:
I. Expressive Light Display
II. Sound Suppression
III. Processor Case/Mount
IV. Backwards Compatibility
V. Pressure Valve
VI. "Hard Path" Pressure System

Conclusion:

Improvements Made:
- Simplification
- Professional Looking
- Halved connection points
- Durability
- Aesthetics
- Interactive interface and display
- Repeatability
- Reliability
- Improved venting and changeability
- New accelerometer
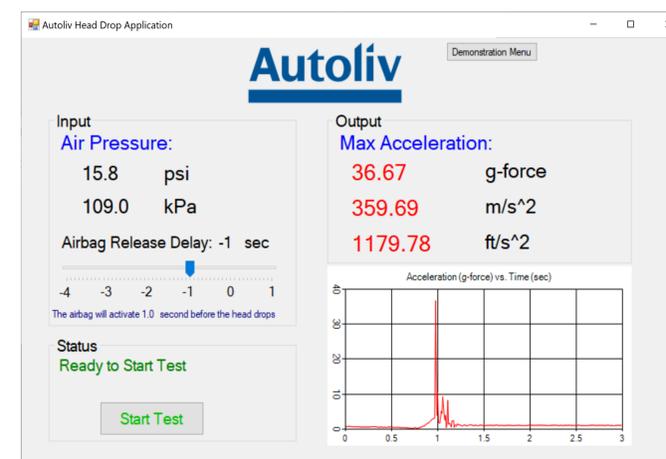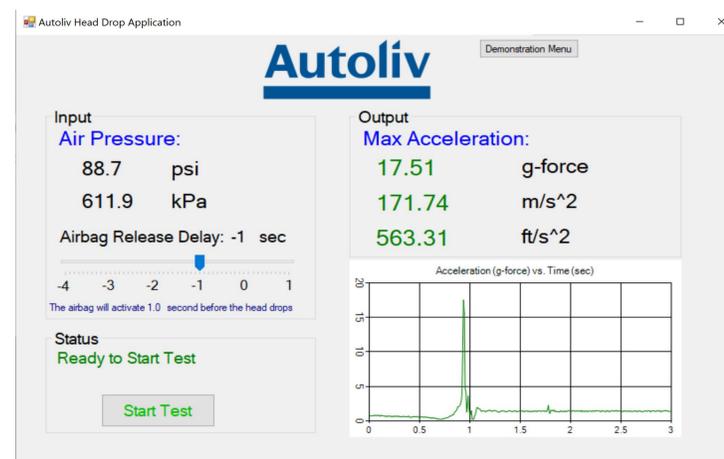- Compressor implementation
- Decreased vibration and impact

Future Work:
- Electronic pressure valve
- Head cover
- Carrying Case
- T-slot brackets
- Additional indicators (audio & visual)

Takeaways:
- Documentation matters for future success (including code comments)
- Team communication is crucial
- Sometimes the solution is to start over
- Not all project requirements are created equal
- Projects change and evolve with time, so should the design

Performance & Testing:

Autoliv Head Drop Application — Demonstration Menu

Input — Air Pressure: 88.7 psi / 611.9 kPa
Airbag Release Delay: -1 sec
The airbag will activate 1.0 second before the head drops
Status: Ready to Start Test — Start Test
Output — Max Acceleration: 17.51 g-force / 171.74 m/s^2 / 563.31 ft/s^2
Acceleration (g-force) vs. Time (sec)

Autoliv Head Drop Application — Demonstration Menu

Input — Air Pressure: 15.8 psi / 109.0 kPa
Airbag Release Delay: -1 sec
The airbag will activate 1.0 second before the head drops
Status: Ready to Start Test — Start Test
Output — Max Acceleration: 36.67 g-force / 359.69 m/s^2 / 1179.78 ft/s^2
Acceleration (g-force) vs. Time (sec)

Test #	Input		Output
	Time Delay (s)	Pressure (psi)	Max Accel (G)
1	-1	32.9	26.64
2	-1	32.9	27.25
3	-1	32.9	26.69
4	-1	32.9	29.87
5	-1	32.9	26.07
6	-1	32.9	25.73
7	-1	32.9	25.26
8	-1	32.9	26.97
		Mean	26.81
		Std. Dev.	1.401152587

Testing:
- Head drop testing throughout design process
- Code debugged based on head drop test results
- Testing for output consistency under constant test conditions

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