



CAPSTONE INSTRUCTOR:  
PROFESSOR RAJEEV NAIR

# MOBILE PUMP NOZZLE RETENTION SYSTEM



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## Background

- Capstone project group has been tasked with developing a retention device for holding the gas nozzle to better protect it from the elements.
- It has been noted on several occasions the nozzle is not used by consumers due to the nozzle falling out or not safely being retained within the housing unit.

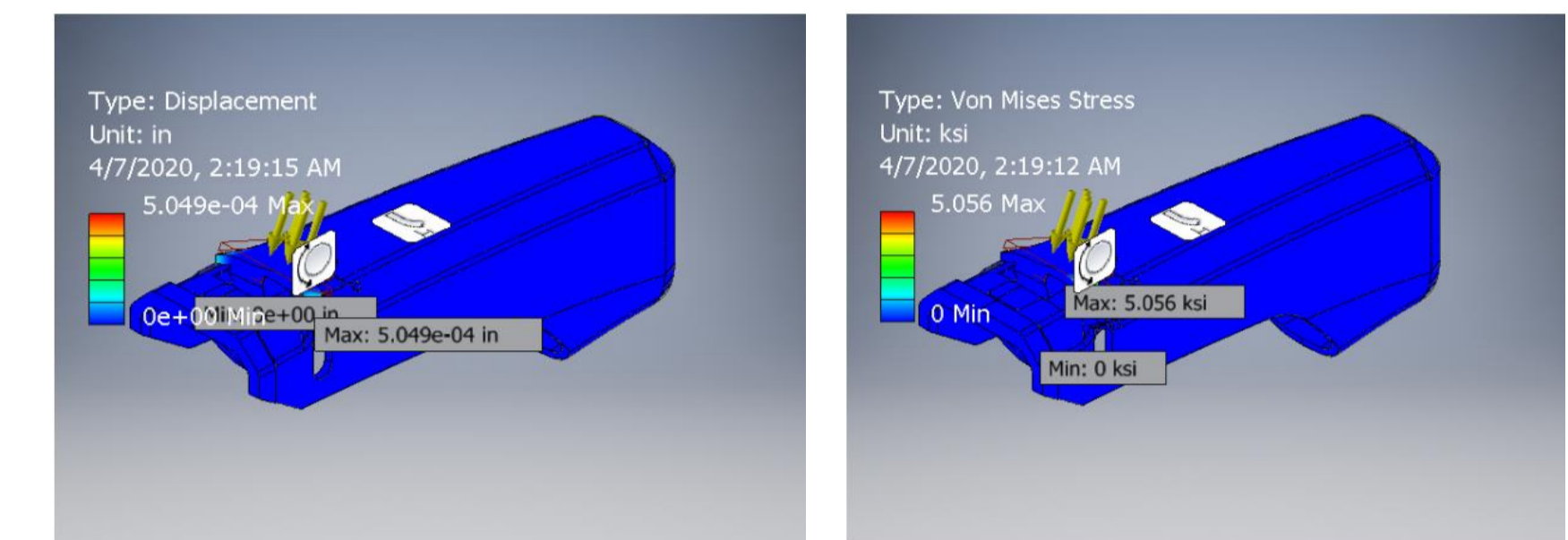
## Problem Statement

- The capstone team must create a holster system to retain the nozzle from falling inside during transit. It is easily bumped out if a force is exerted up anywhere.
- The goal is to appeal to the consumers to use the housing.
- Make sure the shut-off valve isn't closed while the nozzle swings around in the bed of the truck.

## Proposed design



## FEA Analysis

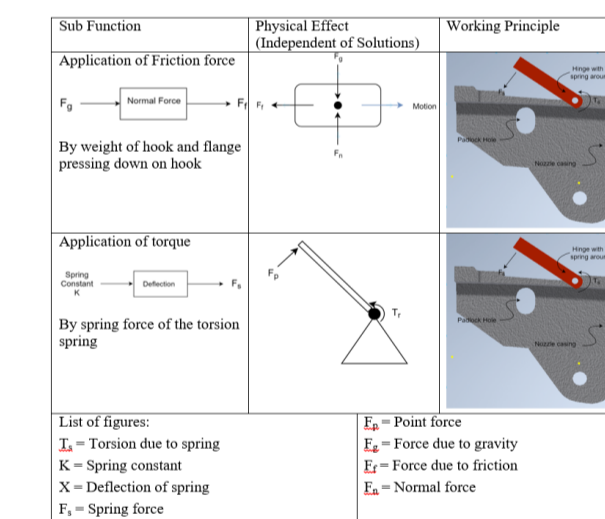


## Testing methods

- Manufacturability Test
  - Line worker will attempt to assemble product
  - Poka Yoke opportunities to be decided on
- Durability/Transit Test
  - Determines if it can be stepped on
  - Determines if during transit it will fall out
- Computer Aided Stress and Force Analysis

## Structure Design

Selection Criteria	Weight	Concepts									
		Wheel Rating	Wheel Weighted Score	Maze Rating	Maze Weighted Score	Toggle Rating	Toggle Weighted Score	L Rating	L Weighted Score	Hook Rating	Hook Weighted Score
One handed	20%	5	1	5	1	3	0.6	4	0.8	3	0.6
Cost	15%	3	0.45	4	0.6	4	0.6	4	0.6	4	0.6
Nozzle Compatibility	5%	4	0.2	3	0.15	4	0.2	4	0.2	4	0.2
Ease of assembly	10%	4	0.4	5	0.5	4	0.4	4	0.4	4	0.4
Durability	5%	3	0.15	4	0.2	4	0.2	3	0.15	4	0.2
Ease of use	20%	5	1	4	0.8	4	0.8	3	0.6	4	0.8
Design for manufacturability	5%	3	0.15	4	0.2	4	0.2	4	0.2	4	0.2
Retention	20%	5	1	3	0.6	5	1	3	0.6	5	1
Rank		1	32	4.35	32	4	29	3.55	32	4	
Continue			X			X					



- No interference between surfaces
- Added thickness to top surface
- Hook cut-out length was increased
- Cost was kept under \$2 for the addition of the toggle, spring, and shaft.

## Cost Analysis

Production Details		#Prior USA	#Prior USA
VPE	Sheet Metal	Stock Machining	
Process Group			
Annual Volume	5,000	5,000	
Batch Size	416	416	
Production Life	5	5	
Total Planned Volume	25,000	25,000	
Routing	Material Stock / Punching / Forming / 3 Axis Mill	Material Stock / Band Saw / 4 Axis Mill / Bulk Milling	
Material Details		Aluminum, Stock, ANSI 3103	Aluminum, Stock, ANSI 3103
Material	8.131	9.959	
Material Rate (Currency / kg)	0.014	0.014	
Finish Mass (kg)	0.035	0.055	
Rough Mass (kg)	0.035	0.055	
Utilization	41.13%	26.1%	
Cost Details			
Material Cost	0.28	0.54	
Labor Cost	0.09	3.42	
Direct Overhead	0.04	1.18	
Amortized Batch Setup	0.14	0.30	
Logistics	0.00	0.00	
Material Overhead	0.01	0.01	
Expensible Tooling	0.05	0.02	
Additional Direct Costs	0.00	0.00	
Extra Costs	0.00	0.00	
Other Direct Costs	0.06	0.02	
Total Variable Costs	0.62	5.46	
Labor Overhead	0.08	1.29	
SG&A	0.06	0.54	
Margin	0.00	0.00	
Piece Part Cost	0.76	7.29	
Hard Tooling (Amortized)	0.00	0.00	
Fixture Cost (Amortized)	0.00	0.01	
Programming Cost (Amortized)	0.01	0.02	
Additional Amortized Investments	0.00	0.00	
Total Amortized Investments	0.02	0.03	
Fully Burdened Cost	0.77	7.32	

Item Number	Part Description	Cost Per Piece, \$	Quantity	Total Cost, \$
1	Toggle Switch	.77	1	.77
2	180° .515lb-force torsionalspring	.60	1	.60
3	Attachmentpin	.20	1	.20
Total				\$1.57

## Conclusion

- Developed of a working solution
- Followed safety protocols; UL Compliance
- Created a simplistic and cost-effective design
- Addressed all Sponsor's concerns
- Manufacturing cost totaled to \$1.57 for all components

## References

- Power-Operated Pumps for Petroleum Dispensing Products. UL 79:2020. Northbrook, IL : Underwriters' Laboratories.
- Electric Motors and Generators for Use in Hazardous (Classified) Locations. UL 674:2013. Northbrook, IL: Underwriters' Laboratories.
- Neibling, M. (2020, April 2). Personal Advisement.
- "Fuel Transfer Pumps and Meters - GPI." Great Plains Industries, gpi.net/.

## Objective and Design Parameters

Changes	D	W	Requirements	Process
Yes	D	W	<b>Geometry: Desired sizing considerations</b> Fixture retain original design aspects No additional changes are made to the pump handle if necessary	CAD Modeling
Yes	D	W	<b>Kinematics: Motion Requirements</b> Components will withstand many cyclic functions	Met
Yes	D	W	<b>Safety:</b> D Must follow UL safety standards D Protects against environmental factors W Follow internal safety standards	Met
No	W	D	<b>Materials:</b> W Die cast or other inexpensive process D Manufacturing process stays within a 2-dollar additional manufacturing cost	Met
No	W	D	<b>Quality Control</b> W Must fit multiple brand designs D Components must withstand various degrees of motion and forces	Met
Yes	W	D	<b>Ergonomics:</b> W Easy pinning and unpinning D Only hook up fittings and unhook fittings once W Using a single hand motion	Not Entirely Met
No	W	D	<b>Production:</b> W Protective casing will be made from a single part	Met
No	D	W	<b>Costs:</b> D Up to \$2 increase if meets requirements.	Met
Yes	W	D	<b>Assembly:</b> W Polka Yoke manufacturing parts D Must be completed on existing Assembly line without new machinery	Not Met