Custom Low-Profile Vacuum Valve

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Mechanical Engineering CAL POLY

AUTOMETRIX PRECISION CUTTING SOLUTIONS

Background

Autometrix Inc. manufactures gantry-style cutting tables that use vacuum pressure to hold soft materials. Currently, they lack a modular method to isolate vacuum zones in these tables. Our project addresses this gap by designing a low-profile, electronically actuated valve to segment vacuum plenum channels.

Design Process

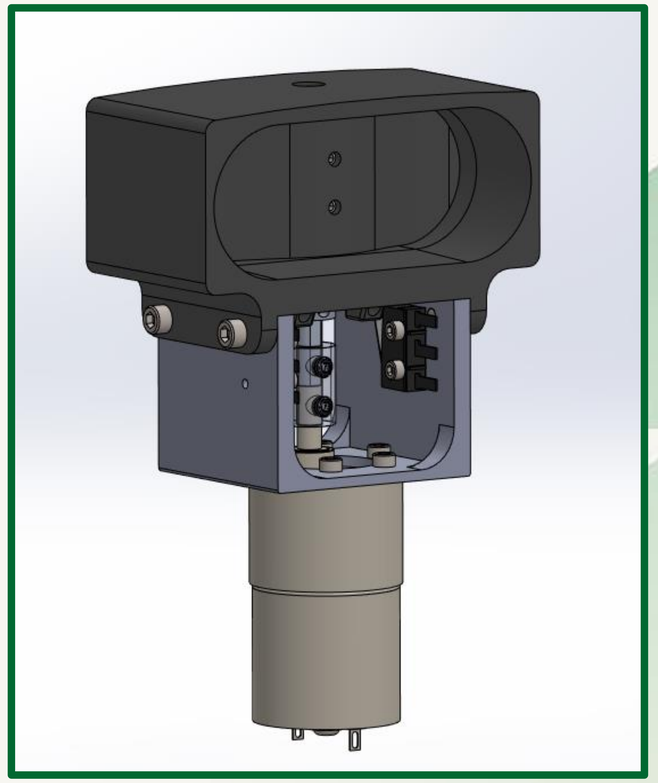
- Explored multiple valve types and evaluated using Pugh matrix
- Chose off-center butterfly valve for simplicity and pressure-assisted sealing
- Designed for SLS 3D printing using Autometrix's in-house capabilities

Design evolution included:
- Nylon valve body and door with O-ring seal
- D-shaft + set screws for torque
- Motor-based direct actuation

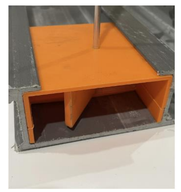
Final Design & Manufacturing

- Valve body and door: SLS-printed nylon (PA12)
- Sealing: Single nitrile O-ring in continuous groove
- Actuation: 24V Brushed DC motor with direct shaft coupling
- Installation: RTV sealed into vacuum channel

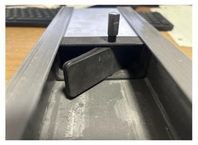
- Custom bushings, shaft, and servo mounts
- Minimal internal fasteners
- Built for reliability & integration with Autometrix tables



Model 1



Model 2



Model 3

Bill of Materials

Assembly	Part Name	Qty	Price (USD)
Valve Assy	Valve Assembly	1	3.96
	O-ring	1	0.83
	1/4 – 20 x .500 Cap Screw	4	0.57
Shaft Assy	1/4 x 2in S-Steel Shaft	1	0.26
	#8 – 32 Set Screw	2	0.27
	1/4 x .125" Flange Bushing	2	1.72
Actuation Assy	Brushed DC Motor	1	18.95
	Shaft Coupling	1	2.54
Electronics	ProtoBoard	1	2.49
	Relays (SPDT 2A 24V)	2	1.33
	Limit Switches (3A, 30V)	2	1.06
	#8 – 32 x .375 Cap Screw	4	0.37
Total		$ 41.55	

Testing & Results

Test	Specification	Result
Torque Test	< 7 in-lbf	Passed
Leakage Test	< 0.5 psi/sec	Failed
Actuation Time	< 1 sec	Passed
Dimensional Tolerance	± 0.005 in	Passed
Cycle Life	>10,000 cycles target	In Progress

Conclusion

Our valve meets all major requirements and is low-cost, easy to manufacture, and reliable. It successfully segments vacuum zones and integrates into Autometrix's cutting tables.

Next Steps & Acknowledgements

- Finalize DC Motor selection after extended testing
- Perform long-cycle validation
- Deliver design documentation for integration

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