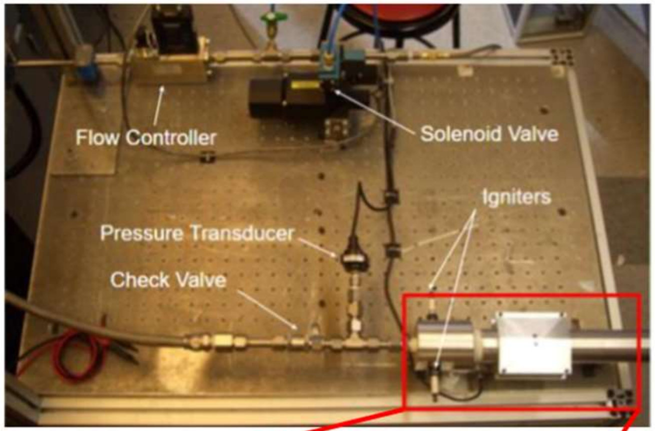
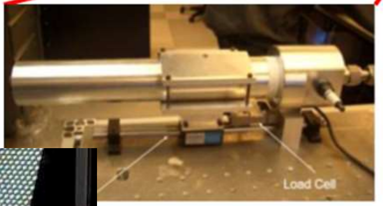
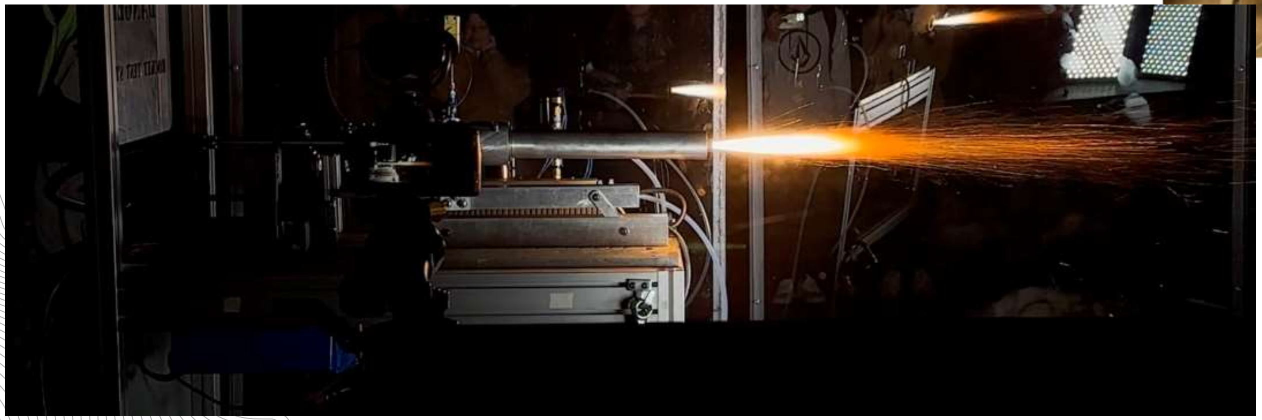
Graham Avers Portfolio

Hybrid Rocket Motor Design and Testing

- Achieved 10 lbf thrust using HTPB fuel and GOX oxidizer within constraints, showcasing advanced engineering skills
- Applied regression rate, mass flow rate, O/F ratio, and thrust equations with NASA CEA to determine appropriate nozzle throat area to achieve desired performance.
- Demonstrated precise thrust, pressure, and flow rate control, with impressive correlation between predicted and experimental results
- Gained invaluable practical experience, enhancing theoretical knowledge in rocket propulsion

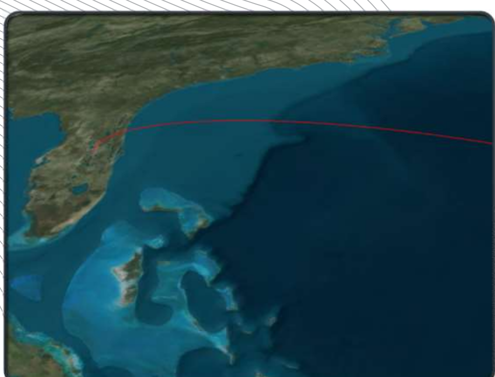






Trajectory and Performance Optimization of Hypothetical GTO and LEO Mission

- Developed the AA1 rocket to deliver 5000 kg to GTO and 15,000 kg to LEO, supporting asteroid mining and satellite deployment missions.
- Executed complex mission sequences, including precise burns and coasts, leveraging Cape Canaveral's infrastructure and using STK for orbit creation, optimization, and targeting.
- Utilized RP-1 and LH2 fuels with strategic material choices to balance performance and cost, demonstrating robust engineering principles.



Stage 1		
Propellent Mixture Ratic	2.56	
Fuel Mass	66,527.08	kg
Fuel Density	0.81	kg/liter
Volume of Fuel	82,132.19	liters
Fuel Fill Volume %	95%	
Fuel Tank Volume	86,238.80	liters
Diameter	4	m
Side Length	8.20	m
Surface Area	102.99	m^2
Fuel Tank Thickness	0.005	m
Tank Metal Density	2710	kg/m^3
Tank Skin	1,398.17	kg
Stringer/Isogrid	349.54	kg (25%
Inter-Tank Structure	349.54	kg (25%
Fuel Tank Mass	2,097.25	kg
Oxidizer Mass	170,309.32	kg
Oxidizer Density	1.141	kg/liter
Volume of Oxidizer	149,263.21	liters
Fill Volume %	95%	
Oxidizer Tank Volume	156,726.37	liters
Diameter	4	m
Side Length	13.8052213	m
Surface Area	173.48	m^2
Oxidizer Tank Thickness	0.005	m
Tank Metal Density	2710	kg/m^3
Tank Skin	2,354.47	kg
Stringer/Isogrid	588.62	kg (25%
Inter-Tank Structure	588.62	kg (25%
Oxidizer Tank Mass	3,531.70	kg

Pre Design Analysis Tool

- Created Excel Spreadsheet for determining various orbital maneuver delta V requirements
- Launch Azimuth Calculations
- Burnout Impact Point Calculation
- Vehicle mass breakdown depending on delta V, payload mass, ISP, propellants used
- Available for download on my GitHub

Initial Conditions	Units	Case 1	Case 2	Case 3	Case 4
Altitude	km	140	50	80	110
Velocity	m/sec	4500	2200	2600	5000
Angle	deg	25	45	30	22
Downrange at Burnout	km	1000	60	120	300

Results					
Horizontal Velocity	m/sec	4078.39	1555.63	2251.67	4635.92
Vertical Velocity	m/sec	1901.78	1555.63	1300.00	1873.03
Max Increase in Height	km	184.34	123.34	86.14	178.81
Time to Max Height	secs	193.86	158.58	132.52	190.93
Distance to Ground	km	324.34	173.34	166.14	288.81
Time to Ground	secs	257.15	187.99	184.04	242.65
Total Time burnout to Impact	secs	451.01	346.57	316.56	433.58
Horizontal Distance	km	1839.39	539.13	712.78	2010.06
Total DwnRng (Ls to Impact)	**km**	**2839.39**	**599.13**	**832.78**	**2310.06**
Vacuum Impact Velocity	m/sec	2523	1844	1805	2380
With Earth Curve Correction					
Height Error	km	160.0	7.0	13.6	105.5
Distance to Ground	secs	484.35	180.38	179.74	394.27
Time to Ground	secs	314.24	191.77	191.43	283.52
Total Time burnout to Impact	secs	508.10	350.35	323.95	474.45
Horizontal Distance	km	2072.236	545.0091	729.4192	2199.494
Total DwnRng (Ls to Impact)	**km**	**3072.236**	**605.0091**	**849.4192**	**2499.494**
Vacuum Impact Velocity	m/sec	3083	1881	1878	2781
Delta Descent Time	**secs**	**57.09**	**3.78**	**7.39**	**40.86**
Delta Down Range	**km**	**232.85**	**5.88**	**16.64**	**189.43**
Percent Down Range Change	**%**	**8%**	**1%**	**2%**	**8%**

	Kg/L
Lox Density	1.141
H2 Density	0.071
Rp1 Density	0.81

+ 3% propellent mass for unusable propellent

Propellent Breakdown					
Ox Ratio	Stage 2	Weight (kg)	Liters	Volume (m^3)
6	Lox	38,804.73	34,009.40	34.01
	LH2	6,467.46	91,090.92	91.09
2.56	Stage 1			
	Lox	170,309.3	149,263.21	149.26
	Rp1	66,527.1	82,132.19	82.13

Thrust To Weight		
Stage 1		
Needed	3,289,961.44	Newtons
Engine Thrust	1,960,000.00	Newtons
Engines Needed	2	
Stage 2		
Needed	<0	Newtons
Engine Thrust	850,000.00	Newtons
Engines Needed	1	

Tank Wall Thickness S1	0.005	m		
Tank Wall Thickness S2	0.004	m	Al Density	2710 kg/m^3

Tank Volume and Weight								
	Radius	Diameter	Tank height	Total Height	Volume (m^3	Wall Thickness Vol	Tank Mass (kg)	Ms/Mp
Stage 2					+5% volume for back pressure			
LOx	2	4	0.18	4.175034853	35.71	0.21	854.75	
LH2	2	4	4.94	8.944557358	95.65	0.45	1,830.28	
Stage 1						**Total**	**3,335.03**	8%
LOx	2	4	9.81	13.80522131	156.73	0.87	3,531.70	
RP-1	2	4	4.20	8.195999314	86.24	0.52	2,097.25	
						Total	**8,828.95**	4%

Mass includes +50% for Stringers/Isogrid Stru

Mass and Height Breakdown Of Rocket

Stage 1	Mass (kg)	Height (m)	Notes	Stage 2

○ Altitude	◉ Radius	Gravity Const	6.6743E-11	g_0	9.81
		mu	398600	j2	0.001082636
	2	EarthMass	5.9722E+24	Earth Radius	6378

	Radius (km)	Altitude (km)									
								Velocities			
Orb1P	5801	413	SMA1	6296	km	Ener1	-31.65501906	km^2/sec	8.60898042	km/s	Periapsis Velocity
Orb1A	6791	422	Ecc1	0.07862135		Per1	4971.738756	sec	7.35395309	km/s	Apopapsis Velocity
Incl1	28.5		hOrb1	49940.6954	km^2/sec						
Orb2p	50000	30000	SMA2	50000	km	Ener2	-3.986	km^2/sec	2.82347304	km/s	Periapsis Velocity
Orb2A	50000	30000	Ecc2	0		Per2	111266.9613	sec	2.82347304	km/s	Apopapsis Velocity
Incl2	40		hOrb2	141173.652	km^2/sec						
Orb1P	5801		SMAT	27900.5	km	EnerT	-7.143241161	km^2/sec	11.0967608	km/s	Periapsis Velocity
Orb1A	6791		hOrbT	64372.3092	km^2/sec	PerT	46379.83514	sec	1.28744618	km/s	Apopapsis Velocity
Orb2p	50000		EccT	0.79208258							
Orb2A	50000					ΔIncl1	1.34	deg	13.7818659	km/s	Transfer Perigee
						ΔIncl2	10.16	deg	-2.40286015	km/s	Transfer Apogee

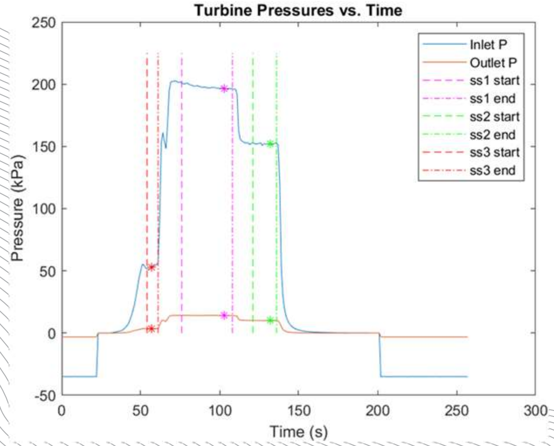
Time of Flight Evaluation for Orbit 1	
True Anomaly	220
Eccentric Anomaly	3.891901727
Time of Flight (min)	52.03318674

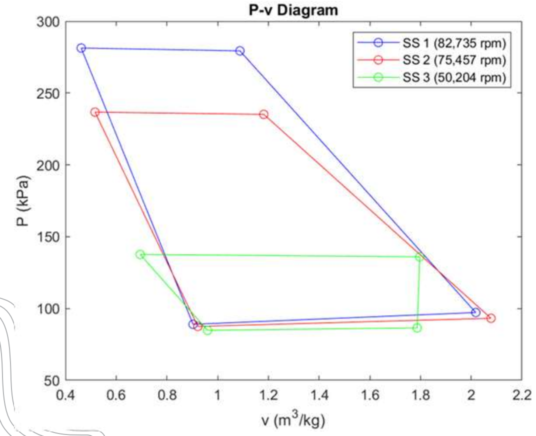
Co-Apsidal Hohman			Radii
Initial Orbit Perigee Velocity	8.609	km/s	5801
Initial Orbit Apogee Velocity	7.354	km/s	6791
Initial Orbit Energy	-31.655	K^2/s^2	
Initial Orbit Angular Momentum	49,941	K^2/s	
Initial Orbit Period	82.86	min	
Final Orbit Perigee Velocity	2.823	km/s	50000
Final Orbit Apogee Velocity	2.823	km/s	50000
Final Orbit Energy	-3.986	K^2/s^2	
Final Orbit Angular Momentum	141,174	K^2/s	
Final Orbit Period	1854.45	min	
Transfer Orbit Perigee Velocity	11.097	km/s	
Transfer Orbit Apogee Velocity	1.287	km/s	
Transfer Orbit Energy	-7.143	K^2/s^2	
Transfer Orbit Angular Momentum	64,372	K^2/s	
Transfer Orbit Time of Flight	386.50	min	
Min Delta V Burn 1 SMA only	2.488	km/s	
Min Delta V w/ΔIncl1	2.498	km/s	
Min Delta V Burn 2 SMA only	1.536	km/s	
Min Delta V w/ΔIncl2	1.573	km/s	
Total Delta V SMA only	4.024	km/s	
Total Delta V w/ΔIncl	4.071	km/s	

Circular to Circular Orbit

Brayton Cycle Jet Engine

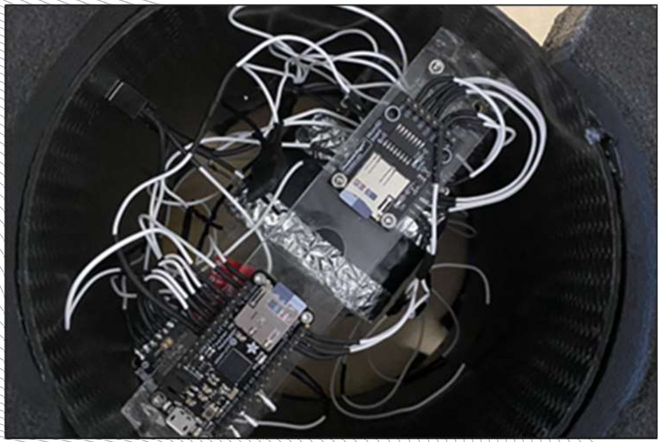
- Operated Brayton Cycle and analyzed compressor and turbine efficiency
- Utilized Pitot tube at system inlet and outlet to compute Mass flow rate, fluid speed specific Mach number and volumetric flow rate to create T-s and P-v diagrams for the cycle
- Data collection in LabVIEW

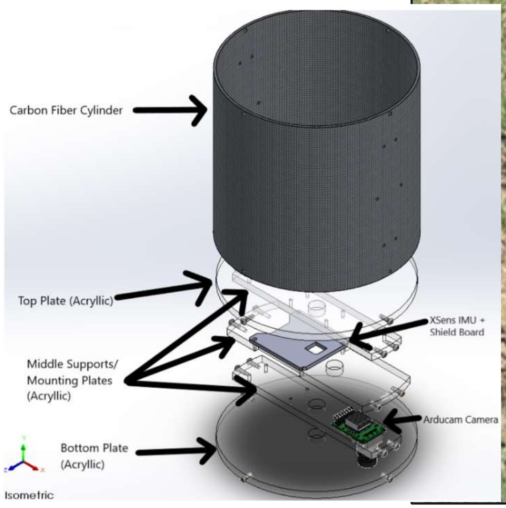




NASA Inertial Positioning System

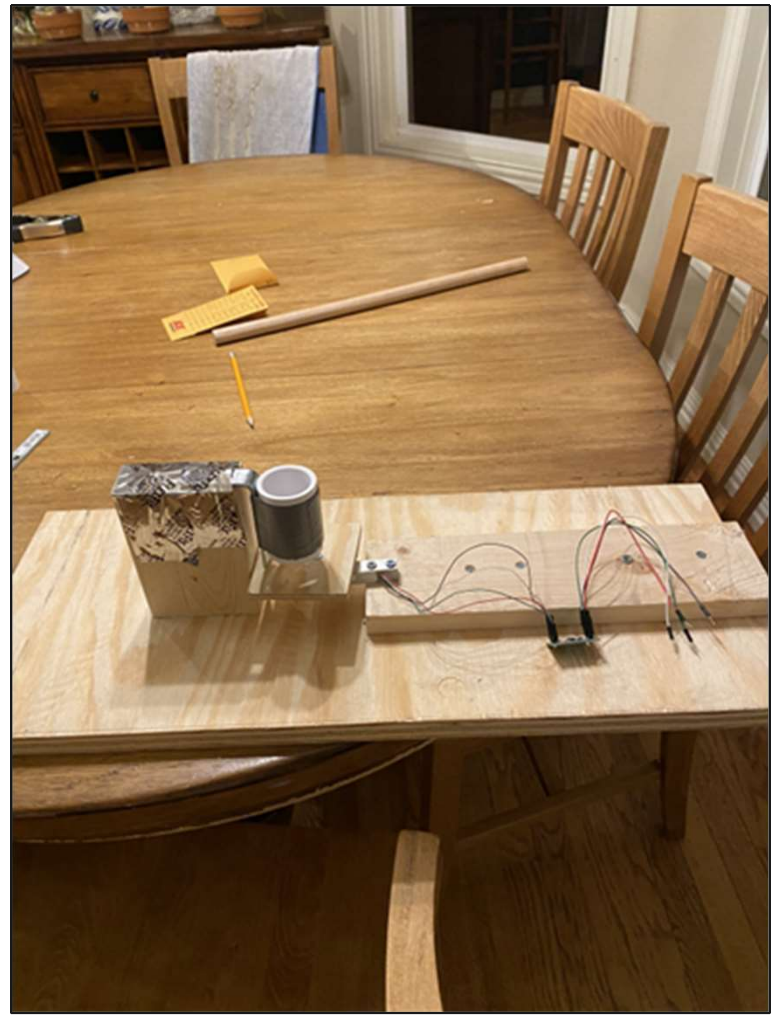
- Designed, Created, and Tested a positioning system that required zero external communication and was flown to space.
- Created a payload with the ability to survive the harsh environment of space while staying below weight and size requirements.
- Created a MATLAB program to process and visualize data using the google elevation API with the MATLAB mapping toolbox.
- Performed thermal simulations and testing to ensure mission success.
- Asked to speak and present findings at one of NASA's research symposiums





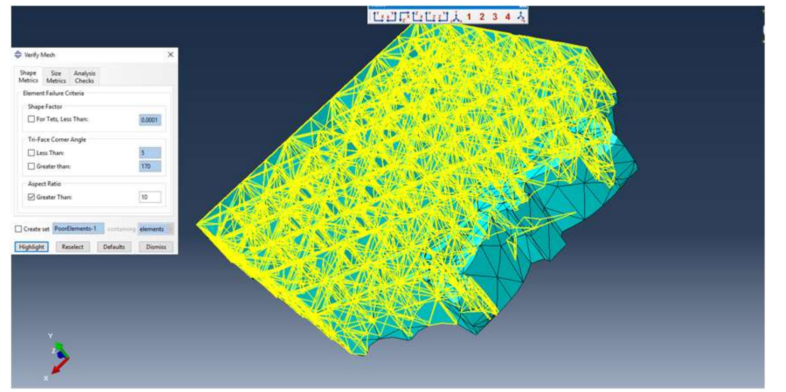
Rocket Test Bench

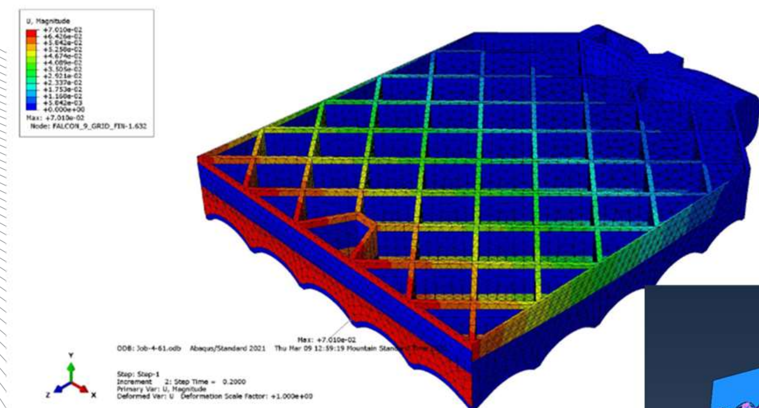
- Created loadcell based test bench to measure thrust output of homemade solid rocket motors
- Used Arduino and MATLAB for data acquisition and post processing
- Measured thrust variation based off varying Nozzle diameters

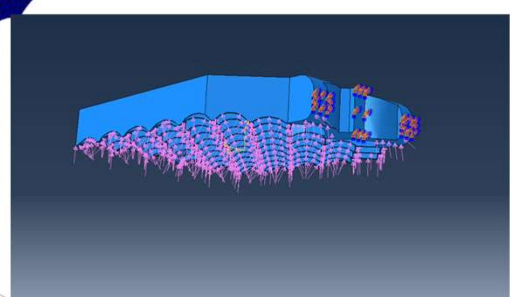


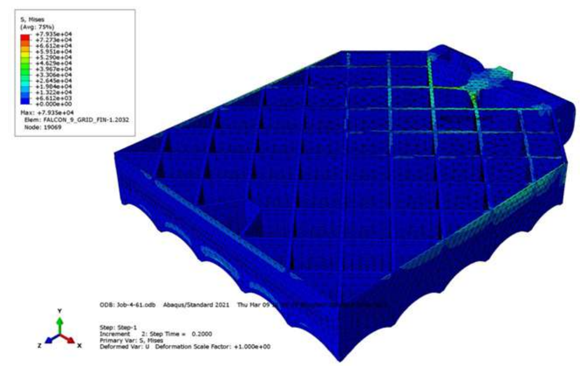
A Finite Element Analysis of SpaceX Falcon 9 Grid Fins

- Determined total deformation of SpaceX's falcon 9 booster's grid fins during reentry
- Performed FEA using Abaqus
- Learned to seed high complexity geometry

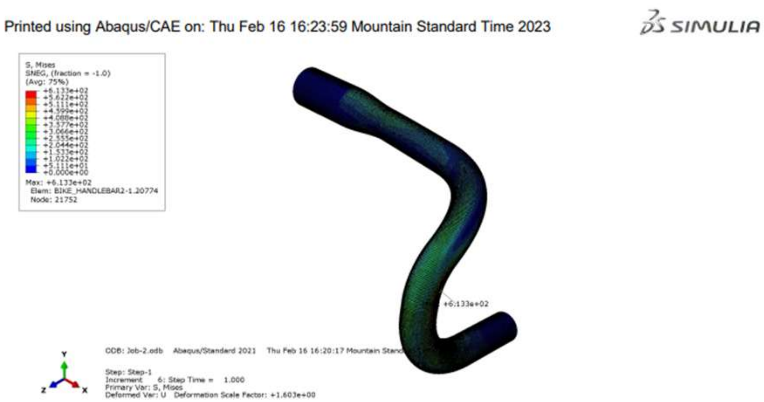








More FEA



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+5.622e+02
+5.111e+02
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+3.577e+02
+3.066e+02
+2.555e+02
+2.044e+02
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+1.022e+02
+5.111e+01
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Max: +6.133e+02
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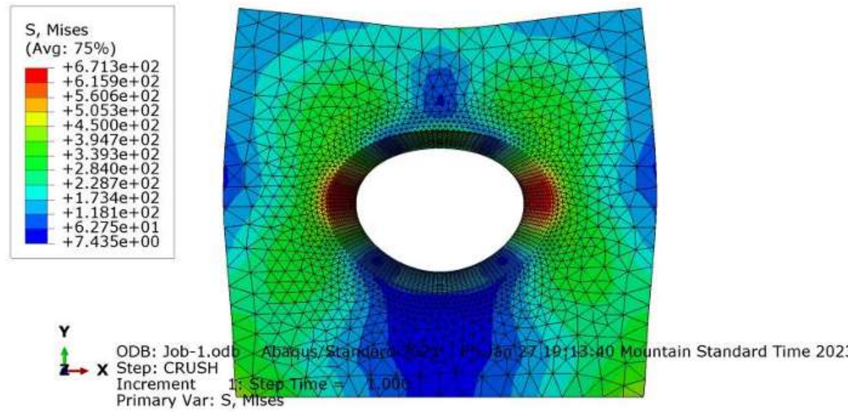

S, Mises
(Avg: 75%)
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+6.159e+02
+5.606e+02
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+4.500e+02
+3.947e+02
+3.393e+02
+2.840e+02
+2.287e+02
+1.734e+02
+1.181e+02
+6.275e+01
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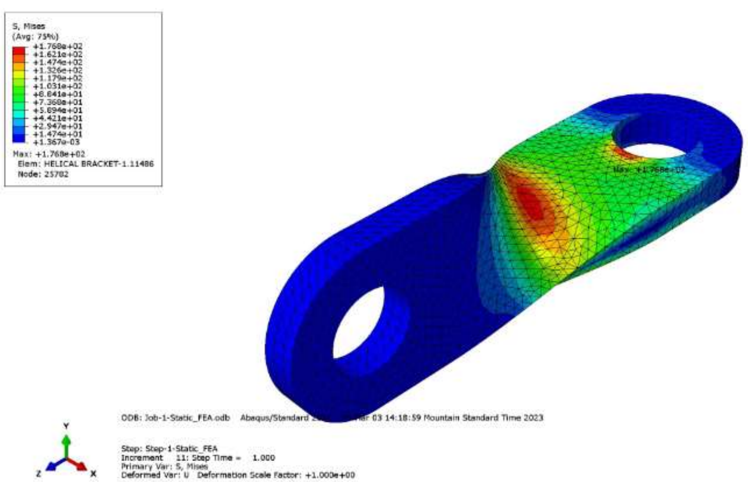
Primary Var: S, Mises



S, Mises
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Max: +1.768e+02
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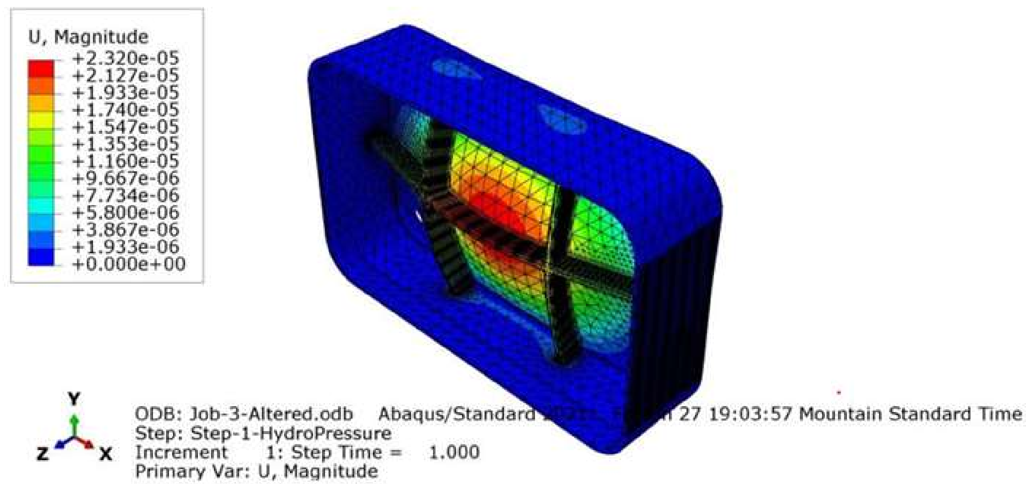
Deformed Var: U Deformation Scale Factor: +1.000e+00



U, Magnitude
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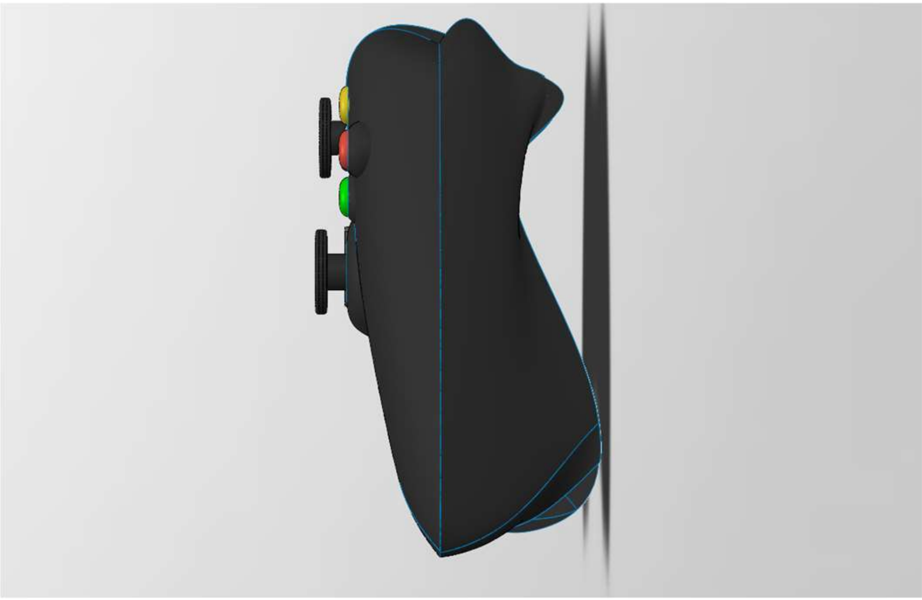
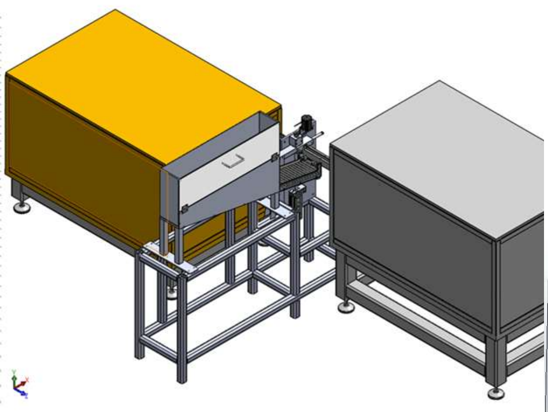
Solidworks Surfacing Porject

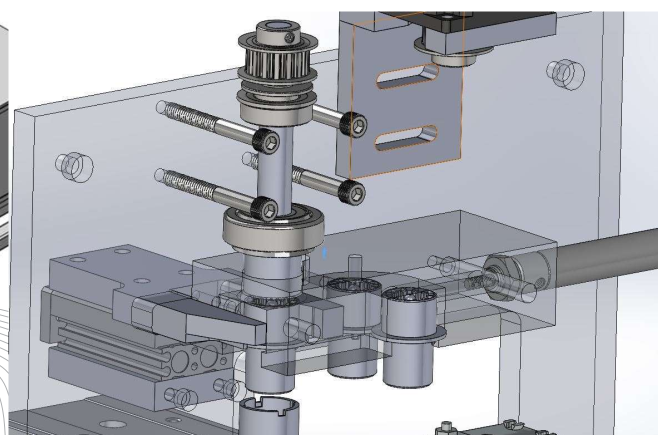
- Created Xbox 360 controller using only surfacing techniques in Solidworks

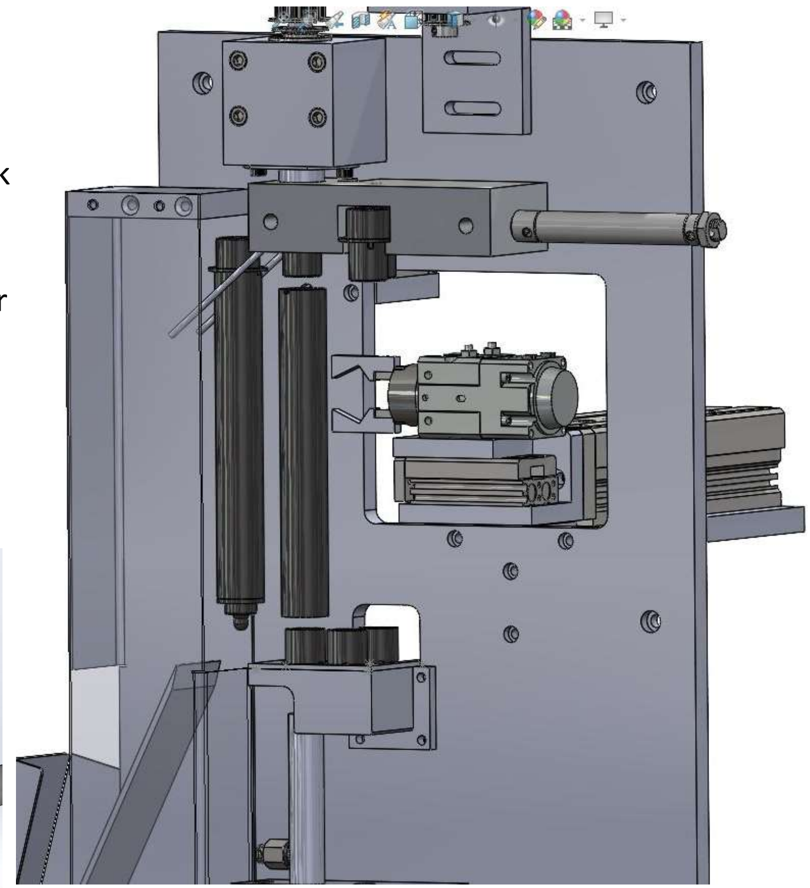


Senior Design Project

- Worked on team that designed an assembly automation project for Kodak Alaris
- 13’x8’x5’ footprint
- Utilized Vibratory bowl feeders, Custom 3 axis pneumatic gripper, stepper motors, and more to achieve complete mechanical assembly

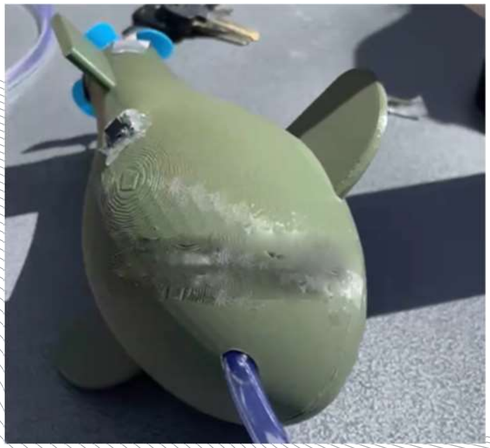


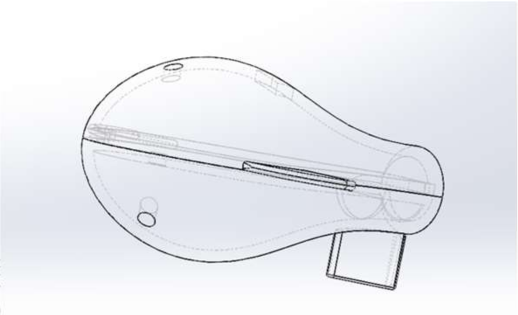


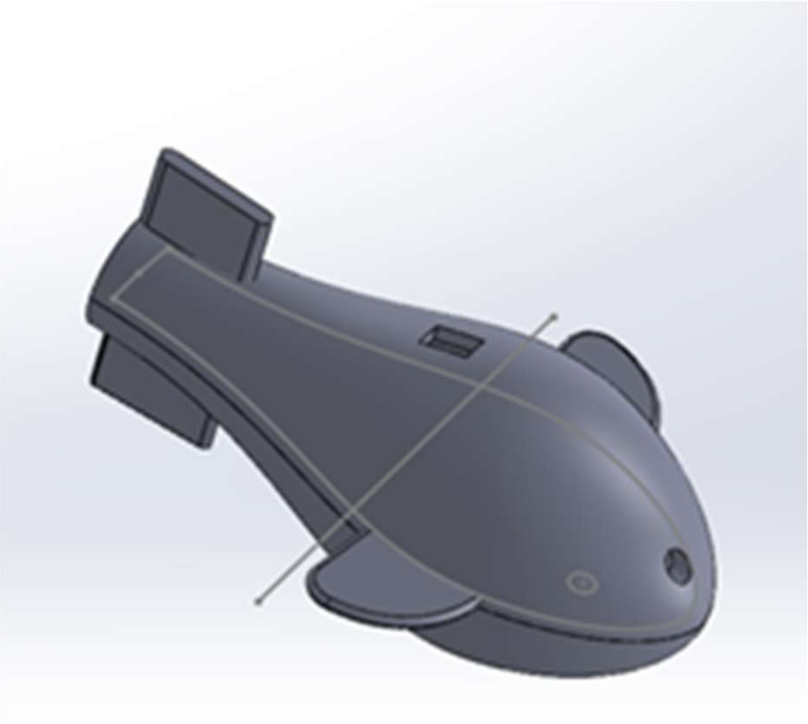


Submarine Competition

- Created submarine to compete in school competition
- Placed 3rd
- Disqualified because we let our submarine flood and sink as our method of submergence

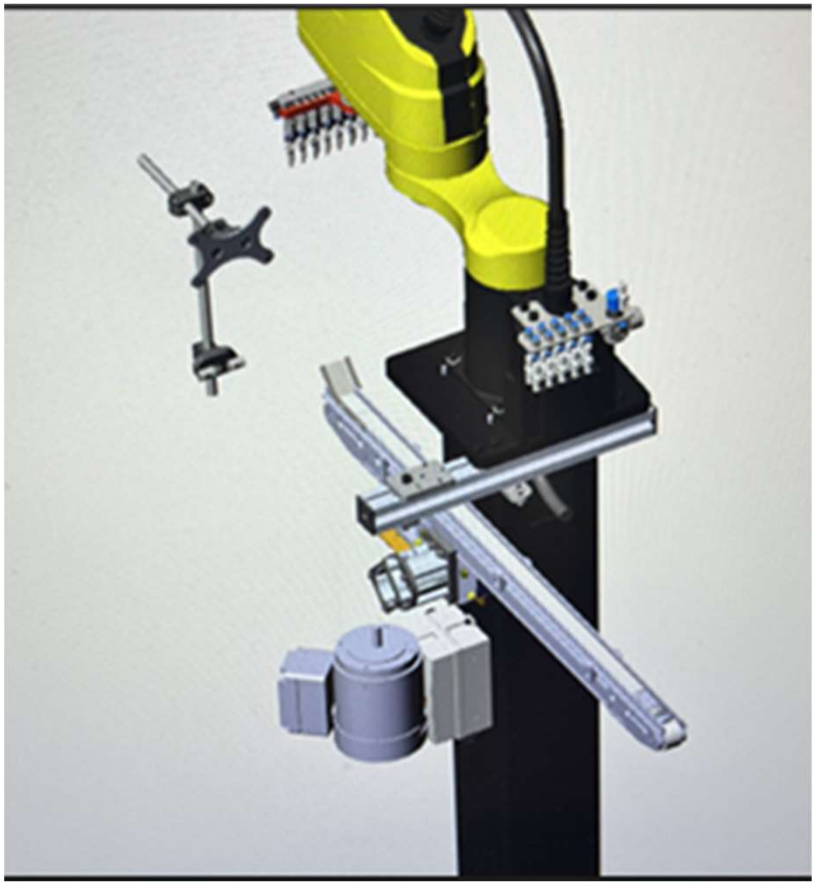






Custom Automation Projects With Complete Solution Robotics

- Unable to show most of work as it is proprietary / confidential
- Created custom automation solutions for multiple industries
- Created custom joint rolling robot utilizing a custom fluidized vat for appropriate coating of joints
- Large Scale Palletizing operations
- Programmed and utilized Fanuc robots
- Large scale SolidWorks assemblies
- Created parts and drawings to be sent to for fabrication



Thanks

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