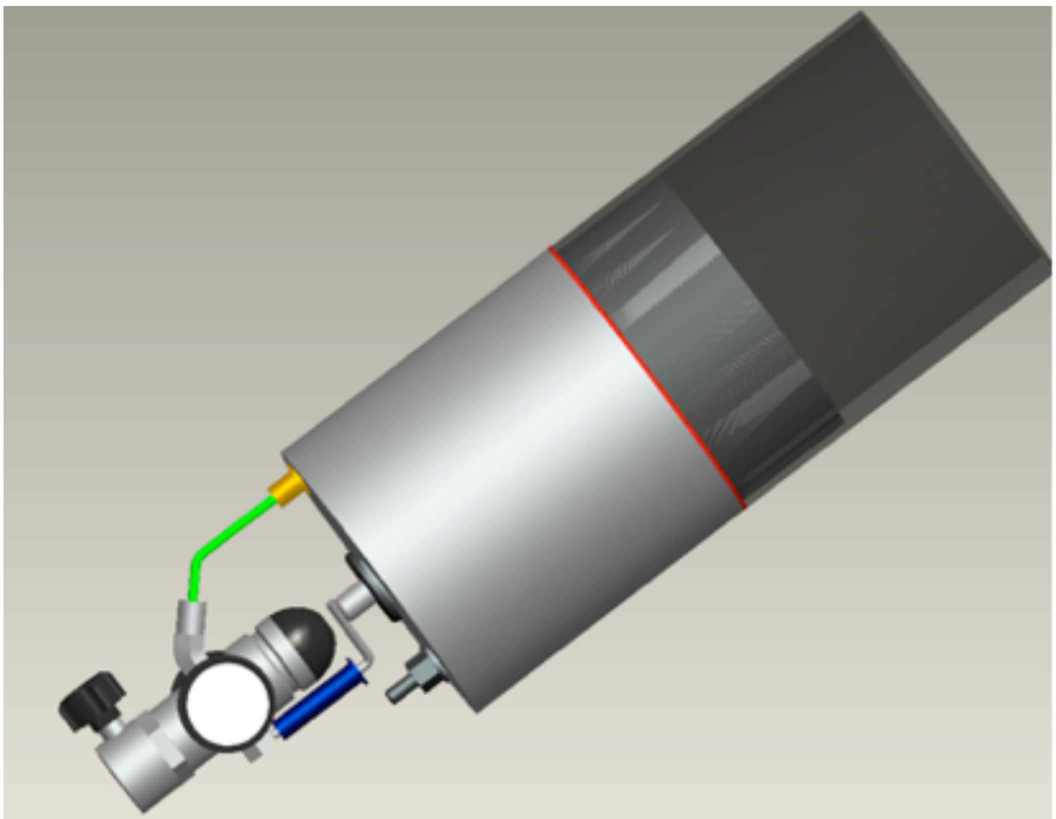
Compact Pneumatic UAV Launcher

Spring Proposal



Sponsored by Eglin AFB

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Overview

In this spring proposal, the team will address the events to take place this spring semester. It will include a detailed timeline, identify the manufacturer and vendors, and provide information on the tests to be performed.

Manufacturing Parts

The parts to be manufactured are the launch tube and the carriage that will propel the UAV forward. All of the other parts will be purchased from vendors. Since the sponsor has not yet provided the team with adequate dimensions of the UAV, no orders can be placed. The team feels that they could better optimize the design and dimension the rest of the launch system appropriately once the dimensions are known.

Launch Tube –

After talking with many companies, Nim-Cor was the company that the launch team chose to manufacture the launch tube. There were many reasons for choosing Nim-Cor. In an effort to reduce the weight of the overall design, carbon fiber was chosen as the material to be used for the launch tube. It has mechanical properties that compare to aluminum, but with two thirds of the weight. Many companies did not have the tools or machines for the dimensions the team was looking for. Because of this, some changes had to be made to the inner and outer diameters of the launch tube. Once these changes were made, a quote was given by Nim-Cor. They specialize in carbon fiber tube fabrication. It was explained to the team that carbon fiber, unless it is molded, cannot be woven onto flat surfaces. Carbon fiber can only be woven onto convex surfaces and would not be able to be woven in a way that it closes the back of the tube. In order to achieve this, an aluminum mold would have to be placed into the tube and bonded with the carbon fiber with a space grade adhesive. This would give the end of the tube a convex shape on which they could weave the carbon fiber. This adds weight and complexity due to the curve of the aluminum where the pin would be inserted. The team opted to mold an aluminum piece with a flat back and adhere it to the inside of the carbon fiber tube. This would mean that there would not be carbon fiber on all surfaces of the tube, but the aluminum backing would give a better working surface and help increase the safety on the charge chamber. Once the team is given the dimensions of the UAV, a work order will be placed and the timeline will better established. The team is still awaiting an estimate from Nim-Cor for fabrication time. The group will assume it will take a month to be manufactured.

Carriage Material –

The carriage will be under both high impact force and high pressure forces; therefore, the team has opted to let Nim-Cor manufacture the carriage as well as the launch tube. The combination of carbon fiber and aluminum that Nim-Cor can provide is important because the weight of the carriage is crucial to the overall weight of the launcher as well. Basically, the less the carriage weighs without sacrificing performance; the better. Also, if the carriage is lighter, less pressure will have to be loaded into the charge chamber. The back of the carriage will experience the bulk of the forces, and will be made of aluminum. In order to reduce weight, the aluminum will be bonded to the inside of a carbon fiber tube, similar to the design for the launch tube. Aluminum is a very workable metal and it will be easier to drill and thread the appropriate holes for the pin receiver and threaded wire connectors. With Styrofoam inserts holding the wings in place, the UAV will sit in the carbon fiber tube upon being launched. The team is still awaiting an estimate from Nim-Cor for fabrication time. The group will assume it will take a month to be manufactured.

Vendors

Prototype Design -

Below is a list of vendors and the parts the team will be purchasing for a prototype testing design.

Lowe's –

Lowe's hardware store will receive the bulk of the P.O. for the prototype testing. The store is located within a short driving distance of the FAMU/FSU College of Engineering; therefore, parts delivery time will take approximately a week.

McMaster-Carr –

This vendor is an online resource that distributes a large range of products for commercial and industrial use. McMaster will provide the team with a few of the desired parts for the prototype testing. If the items that the team requests are in stock, the delivery time would be approximately insert time.

Jergens –

This vendor is not listed on the parts list for the prototype design; however, the team will be using the Jergens listed in the final design parts list for prototype testing.

Item	Vendor	Quantity	Total Price
8oz PVC Cleaner	Lowes	1	4.94
8oz PVC Primer	Lowes	1	2.52
8oz PVC Clear Cement	Lowes	1	3.48
TF Yellow Gas Tape	Lowes	1	2.63
4"x2' PVC Sch 40 Solid Pipe	Lowes	1	4.97
4"x2" PVC Coupling	Lowes	1	4.93
1" PVC Ball Valve Socket	Lowes	1	5.17
2"x2' PVC Sch 40 Solid Pipe	Lowes	1	2.53
2"x1" Sch 40 Bushing	Lowes	1	1.76
4" Cap PVC	Lowes	2	10.88
5"x36"x1/4" Acrylic Tube	McMaster-Carr	2	219.72
5" diameter 1" thk Polyurathane	McMaster-Carr	1	8.23
1/32" thick Neoprene rubber film	McMaster-Carr	2	30.76
		Total Cost	**302.52**

Final Design -

Pending any major changes to the proposed design, the group has chosen a list of vendors to purchase the parts that will make up the final product to present to the customer. Purchase and work orders will not be placed until proper testing takes place. Every nut and bolt is accounted for.

<u>McMaster-Carr –</u>

This vendor will be used for the prototype design and the final product. McMaster will provide the team with the bulk of the desired parts for the final product. If the items that the team requests are in stock; the delivery time would be approximately one week.
Address: 200 Aurora Industrial Pkwy, Aurora, OH 44202-8087
Phone: 330-995-5500

<u>E-Paintball –</u>

This vendor specializes in distributing aftermarket paintball products. Since the team chose to use a carbon fiber paintball tank as a reservoir, the lightest tank on the market was supplied by E-Paintball.
Address**:** e-Paintball, 811 TX State HW 62, Buna, TX 77612
Phone: 409-994-9818

<u>Cabela's –</u>

The team needed a reliable way to trigger the push button of the pin that releases the carriage, and found a hydraulic trigger release made by Hyskore. Cabela's has both online and physical stores that specialize in outdoor sporting goods. The product of interest in this case is a trigger release for a rifle. The

team plans on using this to provide the user a safe distance between them and the UAV launcher. Cabela's offers regular shipping as well as 3 day and overnight.
Address:
Phone: 1-800-237-4444

Sak World Paintball –

Since some of the parts must be compatible with aftermarket paintball supplies, it was easy to find high pressure lines and a pressure regulator that would fit the application. Sak World is also another aftermarket paintball accessory retailer. The vendor has stated that it will take 5 days for any order to be delivered.
Address: SAK World Paintball Supply and Service, L.L.C., North Andover, MA 01845
Phone: 877-725-9675

Jergens –

This company manufactures a range of different products mainly for heavy duty industrial use. The items that the team requires are for heavy lifting and are items that Jergens keeps in stock. They will not have to be specially made. This will reduce the time it will take to receive the parts we need, which will take up to one week if the parts are in stock.
Address: Jergens Inc.15700 South Waterloo Rd., Cleveland, OH 44110
Phone: 800-537-4367

*The parts circled below are custom manufactured parts that will be provided by Nim-Cor and are mentioned earlier in the report.

Cost Analysis

	Number of Parts	Vendor	Manufacturer	Part Number	Cost	
Resevoir Tank	1	E-Paintball.com	Guerrilla	100992	154.95	
Tank Regulator	1	Sakworld Paint	Sak Paintball	144891330	99.95	
Pin Washers	2	McMaster	McMaster	98783A033	12.32	Pack
Wire Connector Washers	4	McMaster	McMaster	93783A029	7.93	Pack
O-ring	1	McMaster	McMaster	4061T153	14.88	Pack
Launch Tube	1	Nim-Cor	Nim-Cor	Custom	360	
Carriage	1	Nim-Cor	Nim-Cor	Custom	175	
Push Pin	1	Jergens	Jergens	806493	55.3	
Pin Reciever	1	Jergens	Jergens	845103	29.18	
Pipe Sealant	1	Lowe's	Oatey	23535	1.83	
Cable	1	McMaster	McMaster	3459T72	19.3	
Self Sealing Nuts 1/4-28	4	McMaster	McMaster	91339A135	12.84	
Self Sealing Nuts 1/2-20	2	McMaster	McMaster	91339A170	8.52	
Cable Connector	2	McMaster	McMaster	3475T29	83.02	
High pressure line	1	Sakworld Paint	Sak Paintball	N/A	10	
Remote trigger release	1	Cabela's	HySkore	IJ-226084	19.99	
Hose Fittings	1	McMaster	McMaster	53485K71	10.65	
Protection Rods	3	McMaster	McMaster	6516K23	26.22	
				Total:	**1101.88**	

Anticipated Test Plan

Our group plans to assemble a small scale prototype UAV launcher to test the finalized design. The prototype will be constructed mostly of PVC and acrylic tubing, as it is readily available in several sizes and configurations.

The team plans to test the exit velocity of our simulated UAV using either light or contact-sensing transducers. Also, the pressure difference along the barrel will be measured by installing multiple pressure ports with pitot-static probes. The safety and reliability of our quick-release pin will be tested. Lastly, the valve design will be tested as a possible alternative to our quick-release pin method.

The group will utilize a few methods of calculating the exit velocity of our simulated UAV. Our first method involves the light-sensing or contact-sensing transducer setup. The sensors will be placed on the barrel at a set distance apart. As the simulated UAV travels through the barrel, both sensors will be tripped, and there will be a short time-delay between the sensor readings. The set distance between the sensors and the time difference will allow the calculation of an average velocity over that distance. The most favorable method of measuring velocity uses a high-speed camera setup. The high speed camera would allow a highly accurate time measurement between set points marked on a backdrop. Similar to our sensor setup, the exit velocity could then be calculated.

The equipment used in these tests is incumbent on our testing methods. The first method would utilize two infrared sensor and receiver pairs. These pairs would be offset by a set distance past the 18” mark on our launch barrel. The sensors would be internally conditioned and LabVIEW-compatible. The sensors would then connect to a National Instruments Data Acquisition laptop card. When the infrared beams are broken, LabVIEW would record the time difference. The other method using this concept is slightly simpler. Two circuits would be constructed with two wires running across the barrel. The LabVIEW program would be manually started at the time of launch. When the circuit is broken by the simulated UAV, LabVIEW would be able to record the time difference. The other method involves the use of a high speed camera and a backdrop. The backdrop would simply be a drywall board with set markings from the barrel end to a set distance past the barrel. As the prototype launches, the high speed camera would allow the launch to be slowed down to obtain accurate time stamped markings. Also, any unexpected oscillations or failures could be reviewed accurately.

The pressure measurements would be recorded using pitot-static probes placed along the barrel. The probes convert the pressure difference into a voltage output, which then passes through a signal conditioner before being recorded by LabVIEW.

Clearly, this list of equipment far exceeds the group budget of $1500, so the group will attempt to use existing equipment purchased by the mechanical engineering department. Dr. Alvi, our team advisor, will be able to source a laptop-compatible data acquisition card, signal conditioner, pitot-static pressure probes, and possibly a high speed camera.

The team also plans to test the instantaneous acceleration experienced by the UAV during the launch process. This will be done using shock packs were. The shock packs will rupture if the instantaneous acceleration exceeds 200g's. This will not provide the team with accurate information if the maximum instantaneous g's was higher than 200gs, but our calculations show the UAV should experience accelerations lower than 200gs. However, the calculations do not account for any vibrations experienced by the UAV during the launch process. Peak and instantaneous acceleration could be measured using a piezoelectric or piezoresistive accelerometer attached to our prototype UAV. The accelerometers convert instantaneous acceleration to a voltage output. There are a few issues with this method, however. It requires signal conditioning, as the accelerometers pick up background "noise" that can corrupt reading. It is wired through a signal conditioner and recorded by LabVIEW. Also, a wired accelerometer would become disconnected when launched. Our group has not finalized a design for measuring the exact peak acceleration, as it leads to complications and exceeding our budget.