MachWorks

2024-25 SPONSORSHIP PACKET

ICARUS 2024

ABOUT US

MachWorks is an undergraduate Student Engineering Design Team at Virginia Tech. We have a single question:

> What does it take to break the speed of sound?

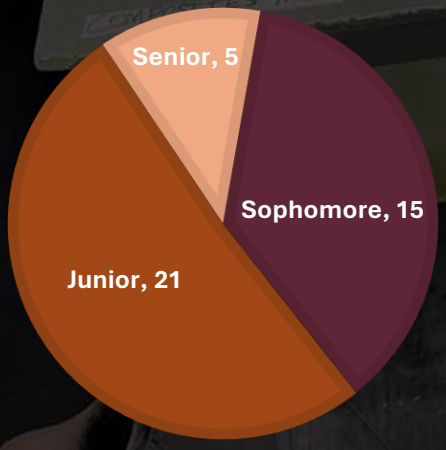
A lot. But we think we can do it. Our team's ultimate goal is to break the sound barrier under the following conditions:

- > Using only air-breathing engines
- > On a craft we design and build ourselves
- > Under autonomous control

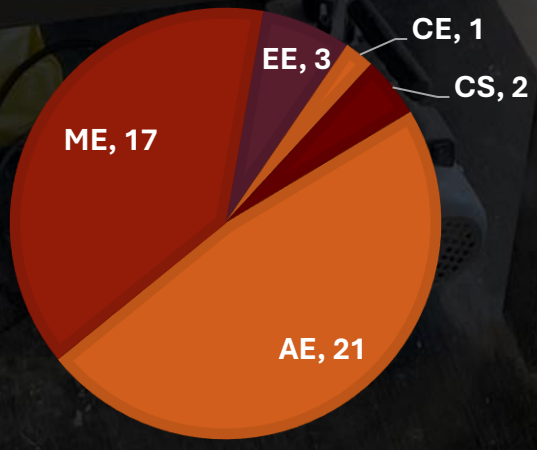
Originally formed in January 2022, we are a team of 46 students pursuing the first-ever collegiate level supersonic flight of a fixed-wing UAV. We are united by our relentless pursuit of speed, passion for aerospace, and desire to realize our goal. We are proudly located in Virginia Tech's Aerospace Engineering Design Laboratory.

We aim to create an environment for undergraduate engineers to develop their skills through challenging projects, real responsibility, and risk of failure. We structure our projects carefully to ensure that every member of the team has an essential role. We believe that by providing students with the opportunity to work on a problem that has been reserved only for corporations until now, we can shape the future of our students – and aerospace technology - for the better.

ACADEMIC YEAR



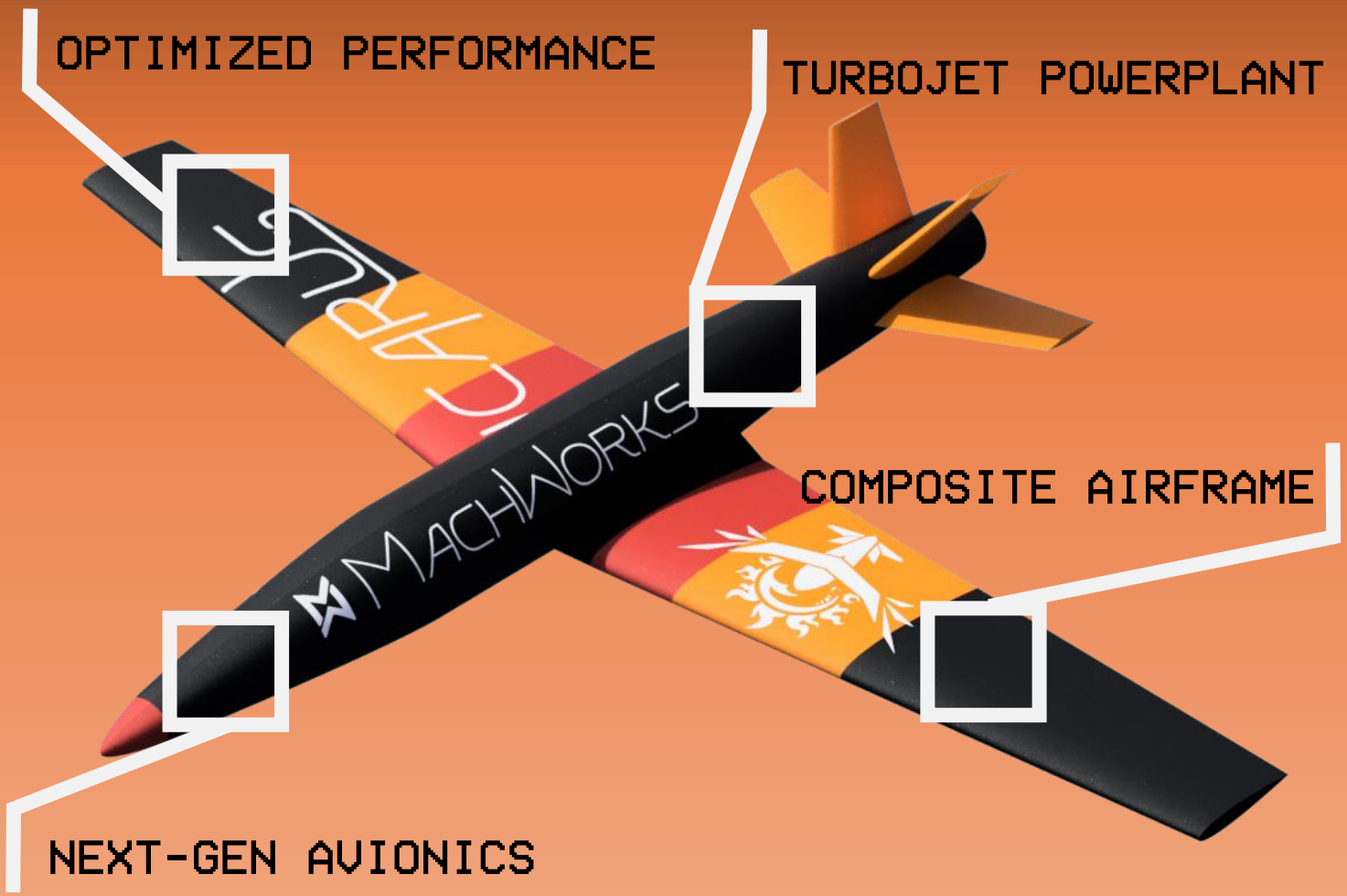
MAJOR DISTRIBUTION



ICARUS

Meet ICARUS, MachWorks' first aircraft. Supersonic flight cannot be achieved overnight, and so we are taking things one step at a time. The first step is to conquer the incompressible region, or under Mach 0.3.

ICARUS is the aircraft to do it. ICARUS will allow us to prove our systems, demonstrate our capabilities, and develop our technology in a safe, relatively low-speed environment. We plan to implement a number of advanced features and fly in January 2025.



MTOW	**12.6kg**	**Powerplant**	**JetCat P80-SE**
Top Speed	**Mach 0.3 230mph**	**Cruise Altitude**	**1000ft AGL**
Flight Time	**20 mins**	**Thrust to Weight**	**0.78**

JANUARY 2025

FAQ

WILL THE FAA LET US FLY?

Under Part 107 regulations, we can fly up to 100 mph, under 500 feet, with an aircraft under 55lbs. We have some members become Part 107 certified pilots to understand the regulations. Using waivers obtained through local partnerships, we can exceed those restrictions. Through relationships with local airfields, detailed flights plans approved by experienced faculty, and a professional approach to flight we can safely follow the necessary procedures.

DOES THIS PROJECT FALL UNDER GOVERNMENT REGULATION?

The ICARUS project does not fall under ITAR regulations. Initial research into regulations for a future supersonic aircraft indicates the project will not be under ITAR but will be subject to additional FAA regulations requiring communication with local government.

IS A SUPERSONIC UAV EVEN POSSIBLE?

There are many technical challenges involved with supersonic flight. To address this, MachWorks is taking an iterative approach by constructing aircraft with increasingly difficult flow regimes: subsonic, transonic, and finally supersonic. ICARUS will fly in low subsonic – Mach 0.3. Our next aircraft, currently dubbed Prometheus, will aim for transonic speeds – Mach 0.7. After those two aircraft, we can tackle a supersonic aircraft. Our initial feasibility studies indicate a small scale supersonic aircraft is possible.

WHAT IS OUR SAFTEY AND RISK MANAGEMENT PLAN?

Jet engines, high speeds, and a significant manufacturing project create a hazardous situation which needs to be monitored and controlled. To mitigate risks, MachWorks has four strategies.

1) Follow NASA guidelines for engineering and tracking risks.
2) Develop extensive documentation that will ensure our designs are approved by experienced faculty and industry partners.
3) Create dedicated positions with our organization to ensure compliance with safety protocols and continually mitigate risks to personnel.
4) Build in redundancies for critical systems and emergency recovery systems. For example, ICARUS will feature an extensively tested parachute system.

OUR PLAN

SUBSONIC INCOMPRESSIBLE

Below the speed of Mach 0.3, the effects of air compressibility can be ignored. This vastly simplifies the level of aerodynamic proficiency required to safely traverse this range, and will allow us to test our avionics and safety systems in a lower stakes environment.

However, this speed is still not within the speed limit of unmanned aircraft that do not require waivers from the FAA. Without an additional waiver, we are allowed to fly at 100 mph and 400 ft above ground level. ICARUS's first several test flight will operate well within the 100 mph and 400 ft speed and altitude limits, until we are comfortable attempting higher speed flight.

SUBSONIC COMPRESSIBLE

When an aircraft surpasses the speed of Mach 0.3, air compressibility effects begin to become noticeable. Through very careful review of data and methodology from our first aircraft, we aim to gain confidence in our aerodynamic design, and begin to conquer this challenge.

With the lessons learned from success and failures of ICARUS, all of PROMETHEUS's subsystems will be redeveloped and improved to handle a more adverse environment. We plan to improve propulsion through more powerful engines and improve avionics through better hardware and software. We also hope to incorporate better manufacturing methods for composites and other structures, as well as higher quality materials.

Throughout ICARUS's operational lifetime, we will also work with Virginia Tech's Mid Atlantic Aviation Partnership, which works closely with the FAA. After we reach the limits of FAA regulation, we will pursue a relationship with Edwards Air Force base, to permit very high speed flight.

May 2024

ICARUS

May-24 - Sep-24
SUBSYSTEM DEVELOPMENT
PAGE 6

Sep-24 - Dec-24
INTEGRATION AND TESTING

Dec-24 - Jan-25
FLIGHT TESTING

PROMETHEUS

Jan-25 - May-25
SUBSYSTEM DEVELOPMENT

May-25 - Aug-25
INTEGRATION AND TESTING

Aug-25 - Oct-25
FLIGHT TESTING

Oct-25 - Dec-25
TRANSONIC TESTING

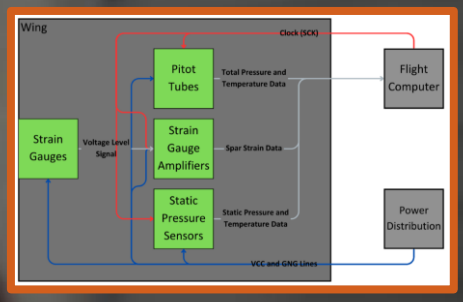
Jan-26 - Jul-26
FUTURE PLANS

August 2026

OUR TEAMS

AVIONICS

No person can manually operate an RC-scale aircraft remotely past 250mph. Our avionics team leverages advanced frameworks such as ROS2 and MavLink, and advanced sensor fusion and optimal control techniques to safely and autonomously pilot our aircraft. Safety is our top priority.

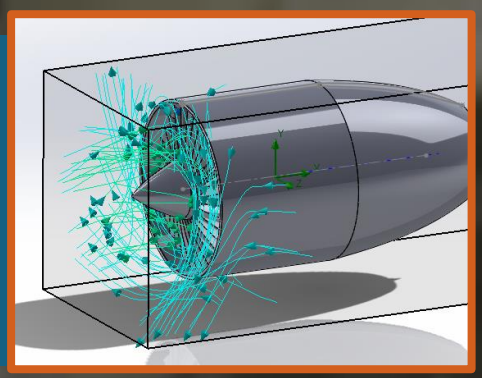


STRUCTURES

Meeting the competing demands of all the other subteams and manufacturing the vehicle, Structures uses careful analysis and testing. Improving composite manufacturing, aero-structural analysis, and managing the weight of the craft are among Structures' responsibilities.

BUSINESS

Business oversees team administration which includes setting up team events, documenting team progress, communicating with sponsors, and overseeing finances. They ensure the team is well positioned to take on engineering challenges through management of human and other resources.

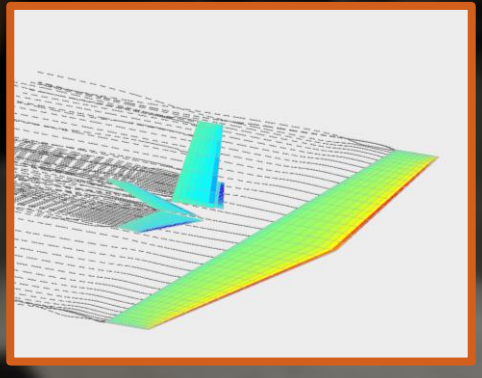


PROPULSION

Propulsion uses commercial scale jet engines, and handles augmentation, upgrades, and airframe integration. Carefully managing heat, air supply to the engine, and fuel delivery is critical to flight safety and performance. Propulsion also hopes to test custom ramjet engines in the future as we go faster.

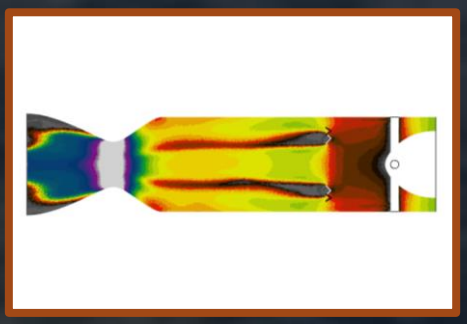
AERODYNAMICS

Aerodynamics is responsible for the design of the outer mold line of the aircraft. Using analytical and computational methods, Aerodynamics optimizes airfoils, planforms, and control surfaces to meet mission and stability and control requirements. They are also responsible for creating and managing the aerodynamic database used for controls modeling.



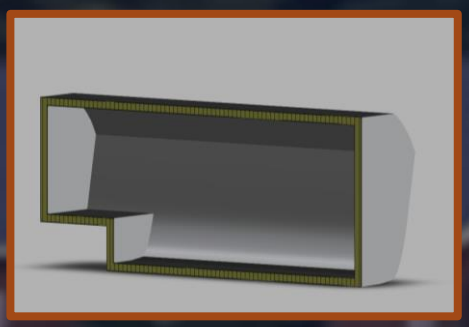
FEATURED PROJECTS

AFTERBURNER



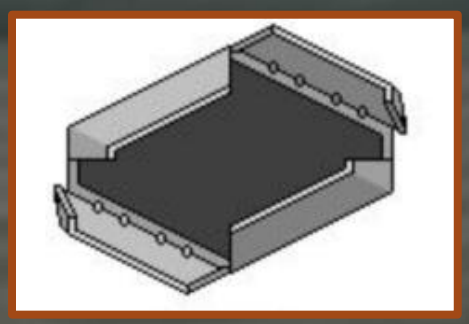
We currently have a team working on developing an aftermarket custom afterburner for our JetCat P80-SE. We hope to place the system on ICARUS and allow it to push up to speeds of Mach 0.5. It will also assist with takeoff and landing. We plan to continue to develop engine augmentations.

FUEL SYSTEM



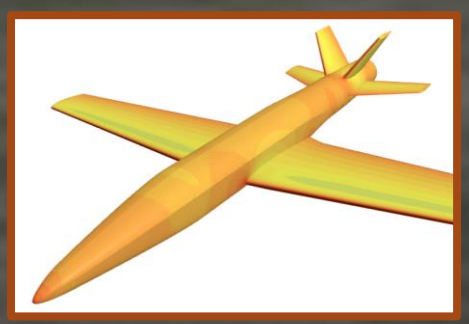
To meet the demands of ICARUS' performance, we are developing a Selective Laser Sintered Nylon 12 fuel tank. It will also serve as a major structural component. We will outfit it with optimized baffles, a robust level sensing system, and a hopper tank to provide consistent delivery in adverse conditions.

THRUST VECTORING



High-speed performance sacrifices low-speed maneuverability. Our thrust-vectoring team is working on solutions using exhaust deflection or fluidic vectoring. We hope to improve our control, maneuverability, takeoff and landing performance by leveraging vectoring in the control loop.

STALL SENSORS



Our advanced sensor package will include embedded pressure sensors to validate our CFD results, create a robust stall detection system, and enable advanced feedback control. We hope to gather data during test flight to improve our ability to model our aircraft flight dynamics.

PARACHUTE RECOVERY

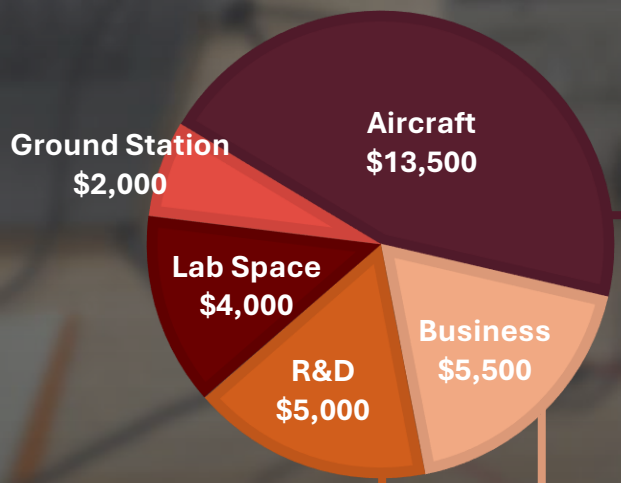
Safety is our top priority. Due to the experimental nature of our aircraft, we will outfit them with a dual-deploy parachute system, as well as fully redundant failure detection using electrically isolated avionics systems. Custom landing gear is our primary method of takeoff and recovery.

BUDGET

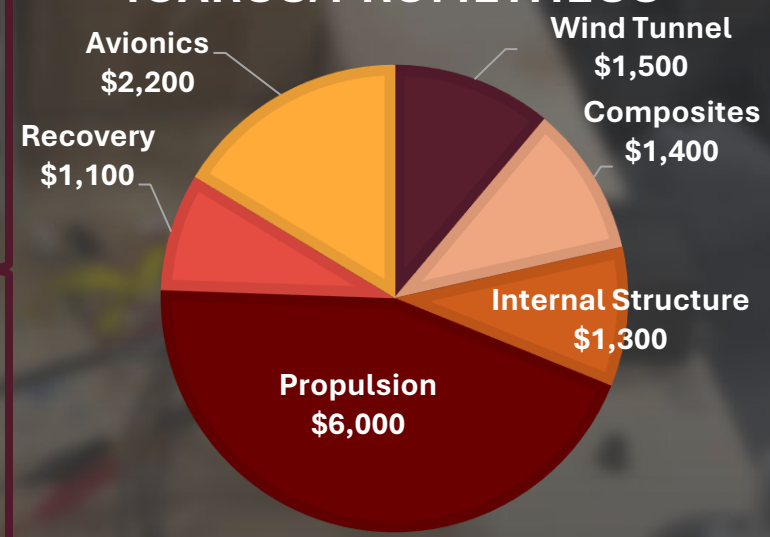
Below, we have outlined our anticipated budget requirements for the 2024-25 year which will support the full development cycle of ICARUS, outfitting our new AEDL lab space, a host of ambitious technology research projects, and specific support towards our members for skill development and professional experience.

OUR FUNDRAISING GOAL: $30,000

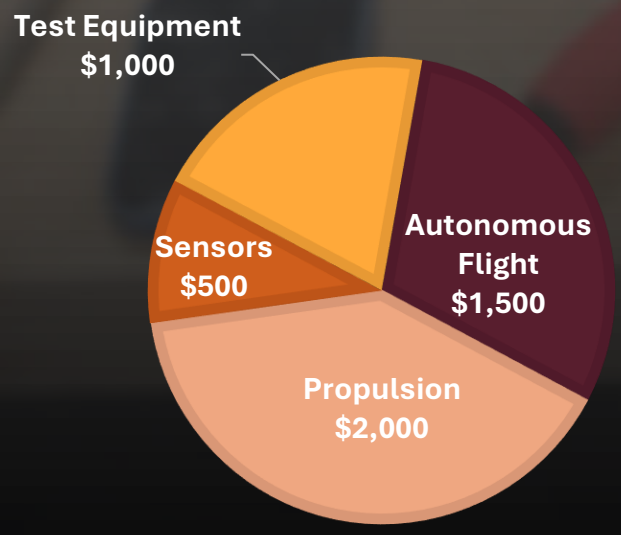
2024-25 BUDGET



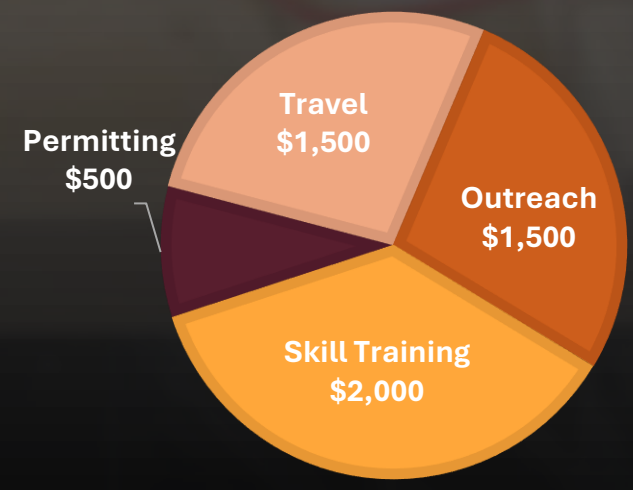
ICARUS/PROMETHEUS



R&D



BUSINESS



SPONSORSHIP

We rely on the generous support of companies, Virginia Tech, and our community

WHY SPONSOR US?

- Invest in future engineers by providing valuable, hands-on engineering experience and leadership opportunities
- Connect and interact with passionate students able to take on complex challenges
- Enable our team to develop exciting technologies, advance high-speed aviation, and inspire others
- Associate your brand with innovative, high-quality projects
- Share your organization's mission with our team
- Donations are tax-deductible as VT is a non-profit institution

	SUBSONIC <$1k	TRANSONIC $1k -$ 5k	SUPERSONIC $5k - $10k	HYPERSONIC >$10k
Receive Newsletter	X	X	X	X
Logo on Website & Aircraft	Small	Medium	Large	Large
Logo on Apparel & Banners		X	X	X
Social Media Post		X	X	X
Invitation to Flight		X	X	X
Access to Resume Book			X	X
Invitation to Design Reviews			X	X
Access to Flight Data				X
Recruiting Event				X

*Sponsorship level depends on monetary value of donation or equivalent value in products, goods, or services
*Sponsorship level is maintained for one year from the date of the required donation value
*Virginia Tech is a registered 501(c)(3) non-profit organization which enables tax deductible donations. Supporting documentation available upon request

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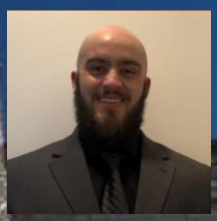

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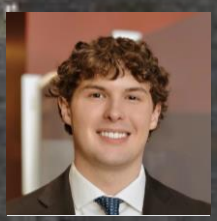

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http://www.mwvt.org

https://www.linkedin.com/company/machworks

HOW TO SUPPORT US

TWO WAYS TO DONATE:

Online

This is the quickest way to support the team. Simply navigate to https://giving.adv.vt.edu/gift and select 'College of Engineering' for the area and 'Other' for fund location. For the destination enter 'Mach Works – 878622'.

Check

For those wishing to support the team via a check, please make all checks payable to 'Virginia Tech Foundation'. In the memo section, please write '878622 - Mach Works'.

MachWorks at Virginia Tech
Virginia Tech-Aerospace and Ocean Engineering Dept.
1600 Innovation Drive Room 241G
Blacksburg, VA 24060

**Note: Please be sure to include personal information on donation forms and checks to ensure relevant IRS charitable donation tax deduction information can be properly sent out*

**We also accept support in the form of discounts, products, or services! Regardless of the form of support, you as a sponsor will receive the relevant support tier equal to your donation*

**For product donations please reach out to us directly*

THANK YOU!