UNIVERSITY of VIRGINIA

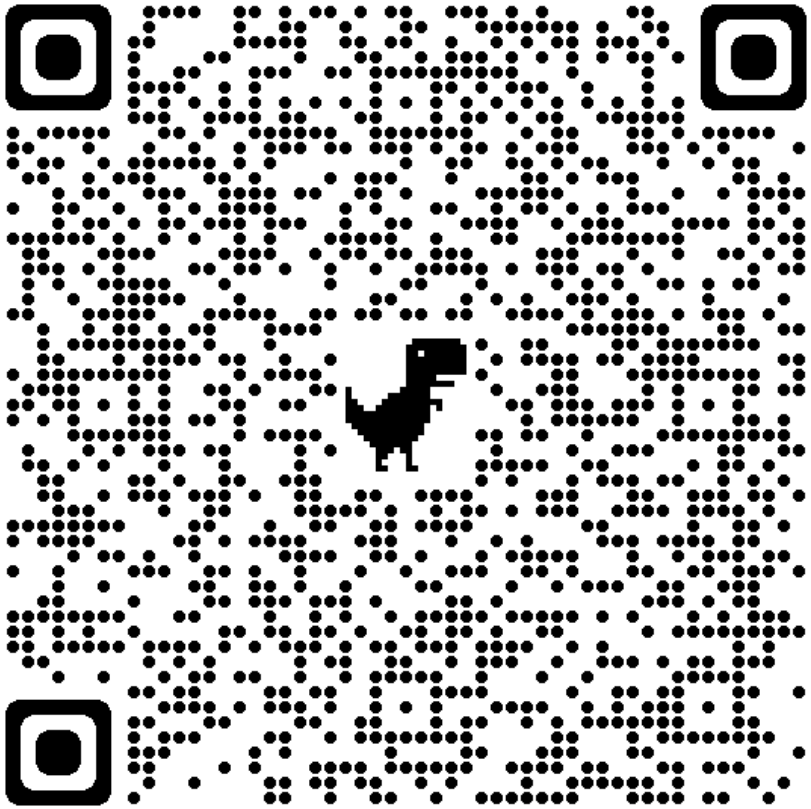
-Major's Night- 2024

Aerospace Engineering

UNIVERSITY of VIRGINIA

ENGINEERING

Department of Mechanical and Aerospace Engineering



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UNIVERSITY of VIRGINIA ENGINEERING

Contents

- The Core

  Curriculum; Capstone design; Double major
- The Fun

  Clubs, Internships, Summer research
- The Next Steps

  UVAccelerate; Graduate program
- The Flash Talks
- The Q/A's

https://www.youtube.com/watch?v=hI9HQfCAw64

SpaceX catches Starship rocket booster in historic test launch

>30 faculty members in MAE

Continuous growth in the years to come

Aerospace Engineering Curriculum

2nd Year

THIRD SEMESTER				FOURTH SEMESTER		
		credits				credits
APMA 2130	Ordinary Differential Eq.	(4)		APMA 3140	Applied Partial Differential Eq.	(3)
MAE 2030	Intro to Aerospace Engr	(2)		MAE 2100	Thermodynamics	(3)
MAE 2040	Computer Aided Design	(1)				
MAE 2300	Statics	(3)		MAE 2310	Strengths of Materials	(3)
PHYS 2415	General Physics II	(3)		MAE 2320	Dynamics	(3)
PHYS 2419	General Physics II Workshop	(1)		MAE 2330	Mechanics Laboratory	(2)
STS 2XXX/3XXX	STS Elective[4]	(3)		_____	Unrestricted Elective 1[5]	(3)
	Total	(17)				(17)

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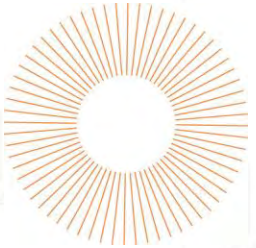
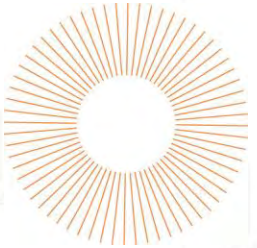


3rd Year

FIFTH SEMESTER				SIXTH SEMESTER		
		credits				credits
APMA 3110	Applied Statistics & Prob	(3)		MAE 3010	Astronautics	(3)
MAE 3210	Fluid Mechanics	(3)		MAE 3220	Aerodynamics	(4)
MAE 3230	Thermal Fluids Laboratory	(2)		MAE 3730	Flight Vehicle Dynamics	(3)
MAE 3310	Aerospace Structures	(3)		MAE 3820	Aerodynamics Lab	(2)
MAE 3610	Aerospace Materials	(3)		MAE 3420	Computational Methods	(3)
_____	Unrestricted Elective 2[5]	(3)				
	Total	(17)				(15)



4th Year

SEVENTH SEMESTER				EIGHTH SEMESTER		
		credits				credits
MAE 4xxx	Aerospace Design I[6]	(3)		MAE 4xxx	Aerospace Design II[6]	(3)
STS 4500	STS and Engineering Practice	(3)		STS 4600	Engineer, Ethics, Prof. Resp.	(3)
MAE 4120	Propulsion	(3)		_____	Math-Science/Tech Elective 2[7]	(3)
_____	Math-Science/Tech Elective 1[7]	(3)		_____	HSS Elective 3	(3)
_____	HSS Elective 2	(3)		_____	Unrestricted Elective 3[5]	(3)
	Total	(15)				(15)

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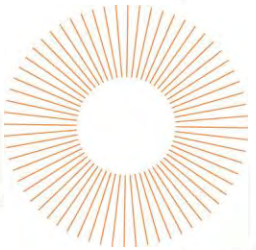


4th Year Aero Design Projects

The Design Challenge is based on the annual AIAA Aircraft Design Technical Committee's (TC) Design Competition Request for Proposals (RFP)
https://www.aiaa.org/get-involved/students-educators/Design-Competitions

UNIVERSITY of VIRGINIA

University of Virginia Engineering
Dept. of Mechanical & Aerospace Engineering

Capstone Design Team | Aerospace Engineering | May 2021

Aircraft Design: Project Kestrel

The Millennium Falcons: Robbie Sorrentino, Riley Assaid, Alfredo Basile, Ben Hamer, Ryan Hughes, Andrew Kraemer, Caleb Mallicoat advised by Prof. Jesse Quinlan

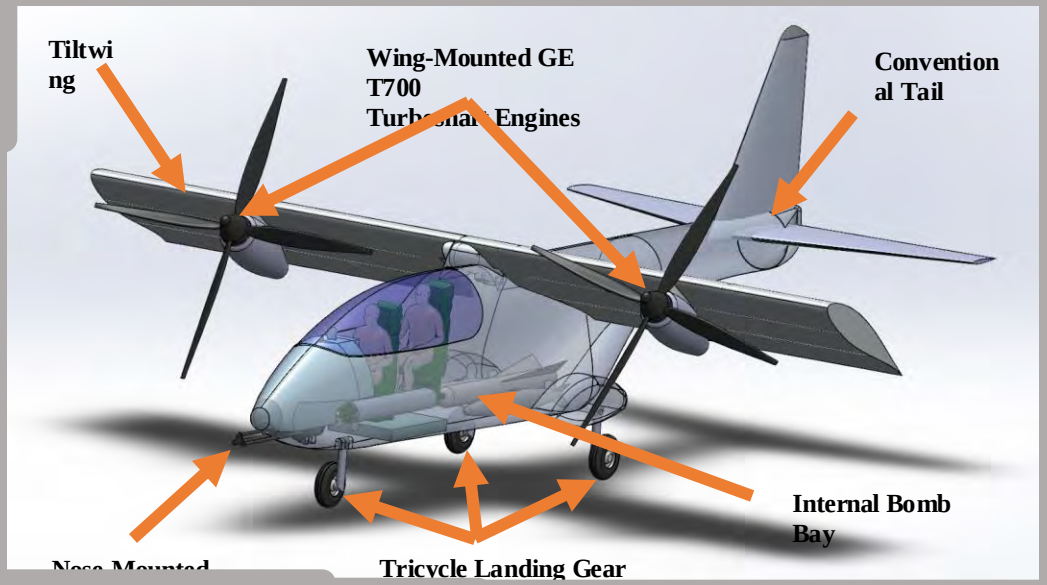
2021 AIAA Undergraduate Design Competition

The objective of the project is to design an affordable light attack aircraft that can operate from short, austere fields near the front lines to provide close air support to ground forces at short notice and complete some missions currently only feasible with attack helicopters. The intended entry-into-service is 2025.

Design Requirements

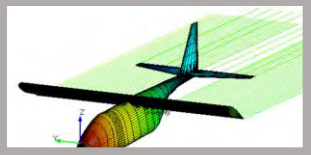
Criteria	Kestrel
Takeoff and Landing ≤ 4000 ft	Takeoff Distance = 708.9 ft Landing Distance = 496.2 ft
Survivability	redundancy, countermeasures, etc.
Payload	3000 lbs of armament
Weapon Provisions	missiles, rockets, 500 lb bomb
Integrated Gun	M-197 Gatling
Service Life	> 15,000 hours over 25 years
Service Ceiling ≥ 30,000 ft	38,816 ft
Crew	Two, both with ejection seats

Final Design

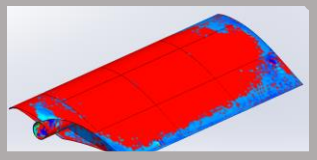


Design Approach

The A-29 Super Tucano and AT-6 Wolverine already meet the requirements and are in production. The door is open for a new and unique light attack aircraft that offers greater versatility and mission flexibility. A concept down-select led to a tiltwing configuration as the preferred concept. Custom Matlab scripts implementing methods from aircraft design textbooks were used to perform sizing analysis. Aerodynamics was assessed with NASA's VSPAero software and DARcorporation's FlightStream. Propulsion was modeled using GasTurb and structures was modeled using SolidWorks. Mission performance was analyzed with NASA's Flight Optimization Software (FLOPS). Estimates of cost were generated with DARcorporation's Advanced Aircraft Analysis (AAA). The engines were sized for vertical takeoff and landing (VTOL) at only 60% payload



FlightStream Simulation



SolidWorks Fatigue Analysis

GE T700 Engine (1870

Key Performance Parameters

Gross Weight	14,169 lbs
Operating Empty Weight	9156 lbs
Block Fuel Burn	1795 lbs
Block Time	5.01 hours
Wing Area	245 ft^2
Maximum Lift-to-Drag Ratio	12.9
Top Speed	393.7 mph
Specific Fuel Consumption	0.43 lbm/hp/hr
Acquisition Cost	$25.75 M
Operating Cost	$3601/hr
Life-Cycle Cost	$3.987 B

University of Virginia Engineering
Dept. of Mechanical & Aerospace Engineering

Capstone Design Team | Mech. and Aero. Eng. | Spring 2021

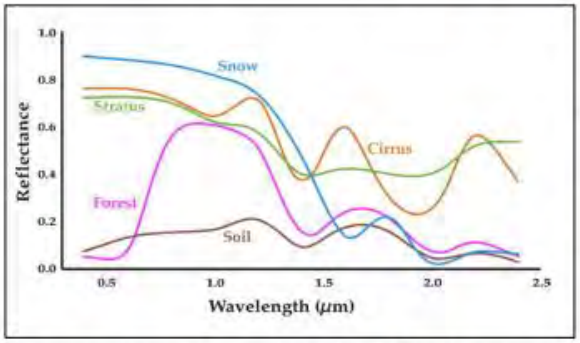
Spacecraft for Snow and Ice Detection on Roadways

Students of MAE 4690/4700 Spacecraft Design I/II
advised by Professor Chris Goyne

Primary Mission Objectives

1. Detect and identify snow-covered, ice-covered or dry roadways in Virginia via remote sensing
2. Effectively distribute measured data to roadway users, first responders, and roadway managers in order to improve roadway efficiency and safety

Weather Impacts on Virginia's Roadways



Comparison of wavelengths of light needed to detect road accumulation of snow compared to background.

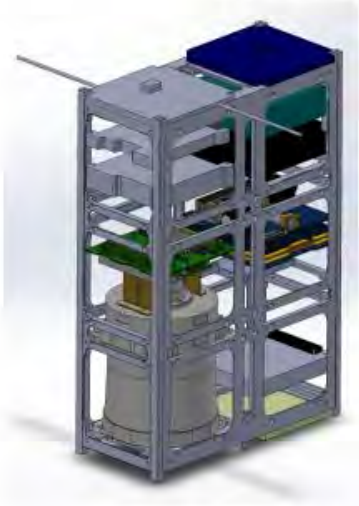
Inclement Weather:

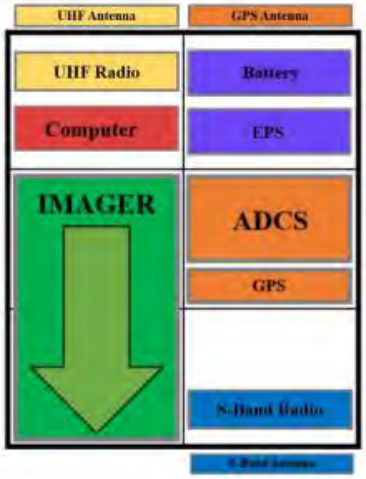
- Few traffic navigation devices include weather data in routing [1]
- Real time data (via road signs) helped reduce accidents in Oregon [2]

Wet Pavement and Precipitation:

- Highest proportion of weather-related accidents [3]
- Rain intensity positively correlated with traffic slowdowns [4]
- Snow varies greatly between the coast and mountains [5]

6U CubeSat Concept





Impact

- A spacecraft design to observe road conditions to improve safety and reduce costs of roadway monitoring
- Multi-disciplinary collaboration as part of MITRE's University Innovation Exchange (UIX)
- Student experience in program management, design, and defining customer needs

Acknowledgements

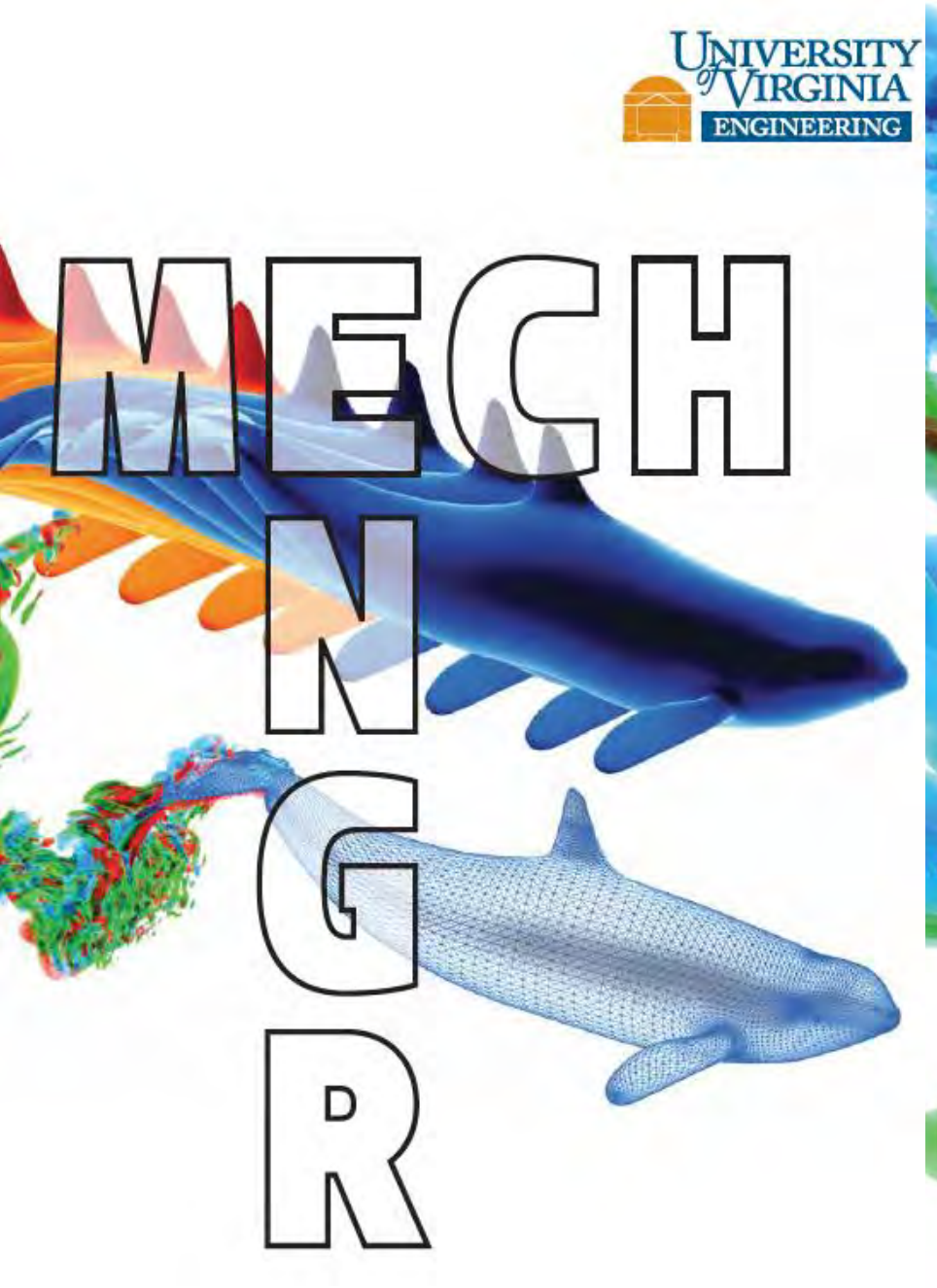
Subject Matter Experts:
Michael Fontaine of VDOT, Prof. Venkataraman Lakshmi at UVA, Mike McPherson of KQ9P and W4UVA

Project Sponsors:
MITRE, University of Virginia Department of Mechanical and Aerospace Engineering

Acronyms:

1 Effective Traffic Flow

Awesome Combination of 2 Majors in 1 Department



For Double Majoring in AE + MECH

The regular AE curriculum + these 5 Mech courses: Intro to Mech, Mech Systems, Machine Elements & Fatigue, Mechatronics, Heat & Mass Transfer.

"Prioritize the AE classes in your 3rd year and take whatever remaining Mech classes you need in the 4th year – this is because you will have to do the Aero capstone and need the core Aero classes to be prepared." Advice by Prof. Natasha Smith

AE Clubs @UVA

Aero Design Team

Aviation Club

Cubeset Design Club

MARS

Rocketry

Aero Design Team at UVA

Hoos Flying

University of Virginia | ENGINEERING

Why join a design team?

Academics

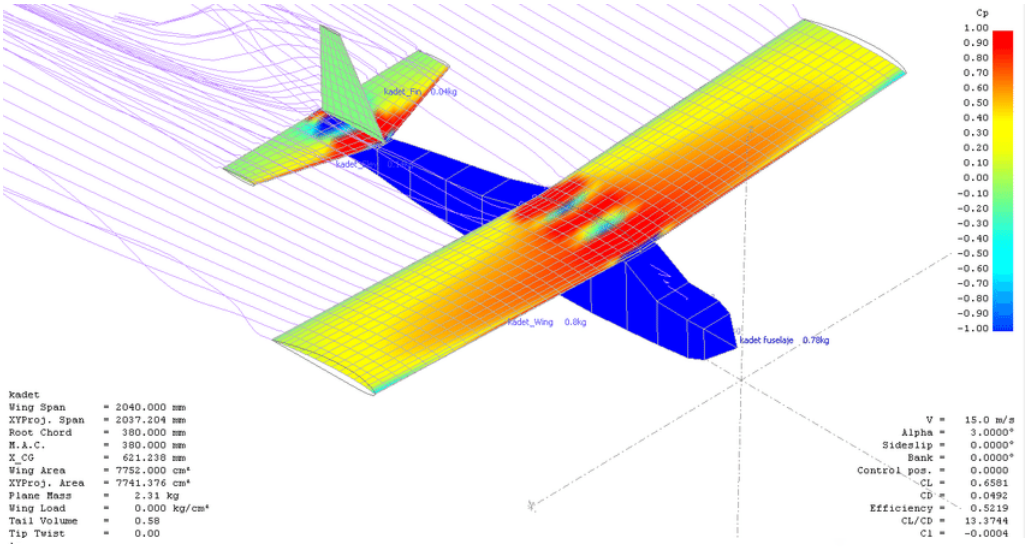
- Real world application of course curriculum
- Improved performance in 3rd year major classes
- Develop a strong community within the MAE department

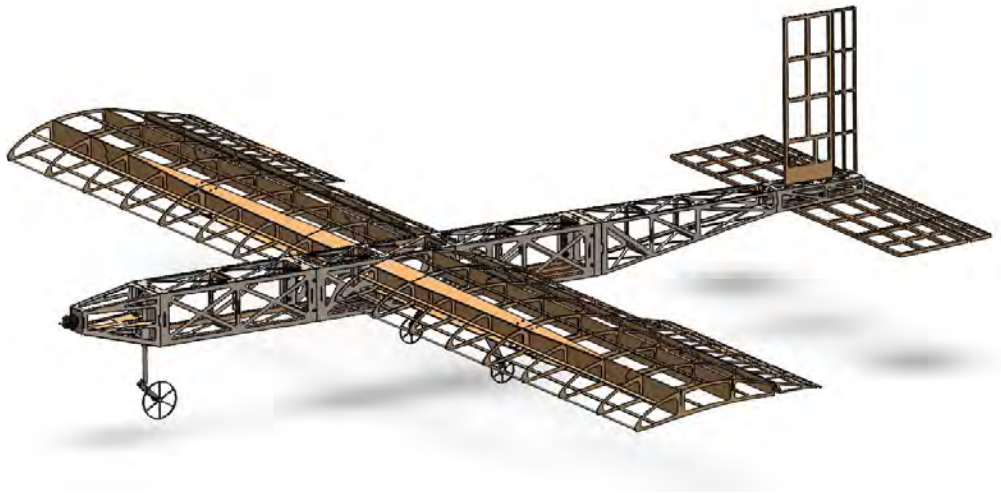
Career

- Increased access to internship opportunities
- Major green flag on resume

Design

- Conceptual Design
- Analyze Ruleset
- Test and discuss aircraft configurations
- XFLR5 – stability, sizing, and weight
- Design Reviews: CoDR, PDR, CDR
- SolidWorks CAD of full aircraft





Build

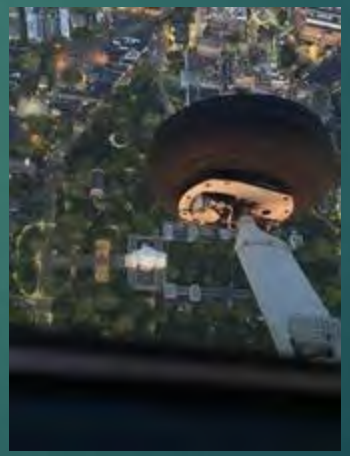
- Waterjet, CNC, Laser Cutter
- Lacy Hall build sessions
- Wood construction techniques: superglue, epoxy, mechanical linkages
- Monokote wrapping
- Integration & Assembly

Fly

- Motor/propellor thrust testing
- RC servo flight integration
- Test flights at Milton Airfield
- Test crashes at Milton airfield

Aviation Club @ UVA

- Expose members aviation avenues
- Teach basic concepts of flight
- Provide resources to aspiring and prospective pilots
- Foster a community of aviators and aviation lovers



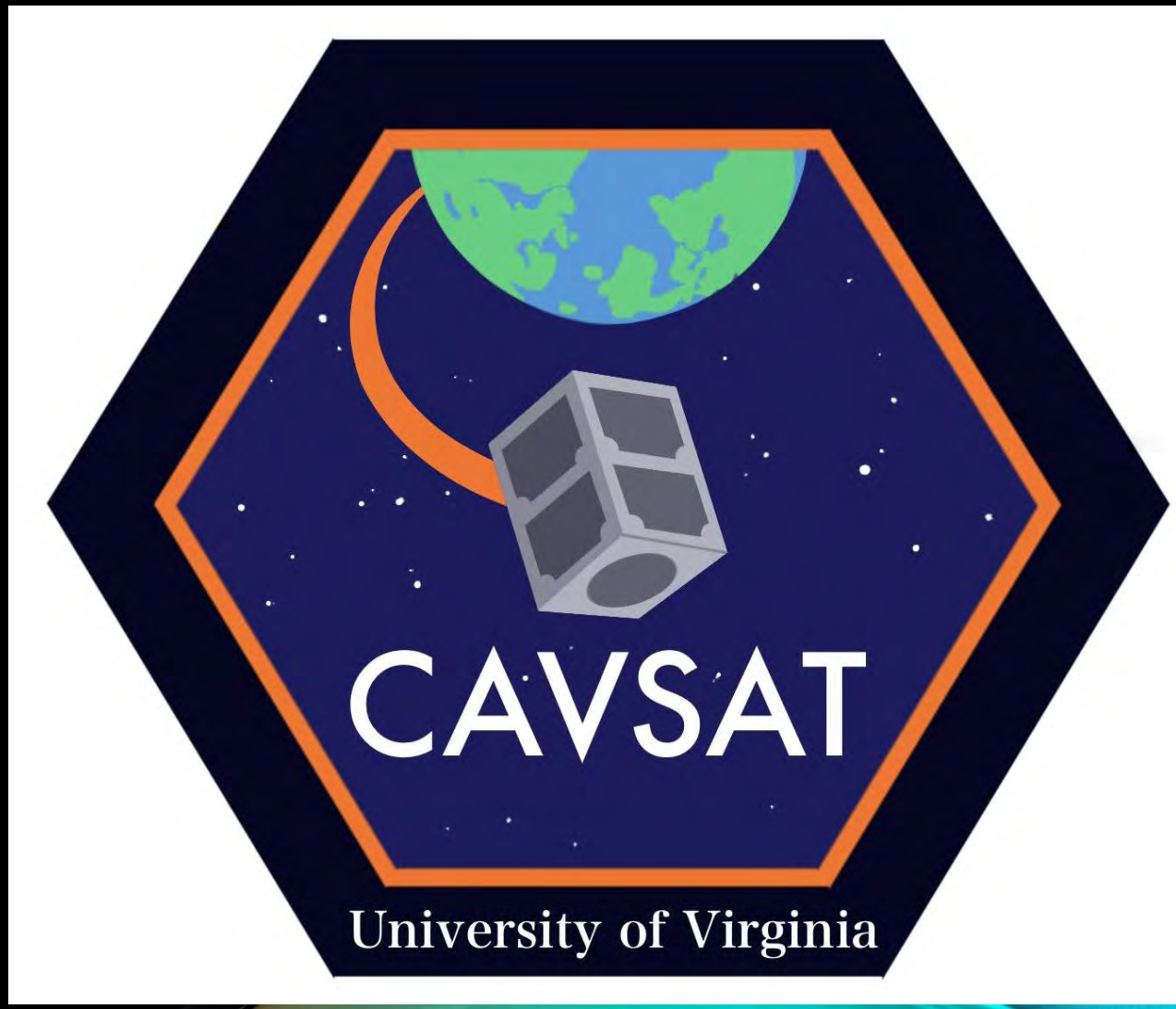
What to Expect from Joining?

- Instructional flight simulator sessions
- Aircraft Pre-Flight Demonstration Event (C'Ville Airport)
- Field Trips:
  - Air shows
  - Museums
- Guest speakers from the aviation industry

Looking Ahead

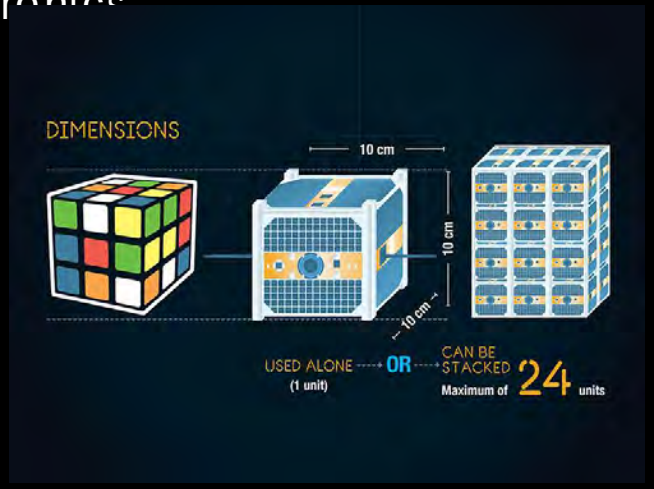
- Join our Discord!
- Lookout for ground training and flight simulator classes in the future
- Flight sim sessions!!

CUBESAT DESIGN CLUB AT UVA

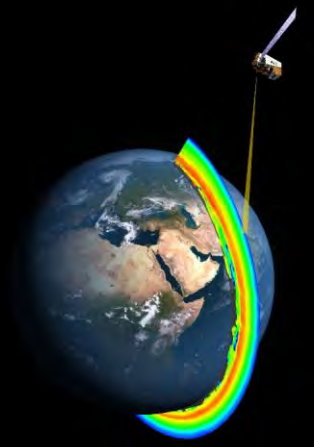


ABOUT THE CLUB

- CubeSat design and interest club
- Includes multiple forms of engineering in the design of CubeSats
  - Aerospace, mechanical, electrical, computer engineering/programming
- Catered towards those interested in long-term conceptual / physical design of satellite components and electronics



LONG-TERM PROJECT
6U CUBESAT DESIGN



- Preliminary & conceptual design for CubeSat
  - Mission Objectives:
    - Develop / Design a 3 to 6 unit CubeSat by combining structural and electronic components necessary for lower-Earth orbit
    - Monitor ozone depletion over major cities subject to high travel volume through usage of hyperspectral imager (HSI)
  - Main Deliverables for 2024-2025:
    - Conceptual Design Review
    - Preliminary Design Review
    - Critical Design Review
  - Hopeful Deliverables for 2024-2025:
    - Conceptual model via CAD software

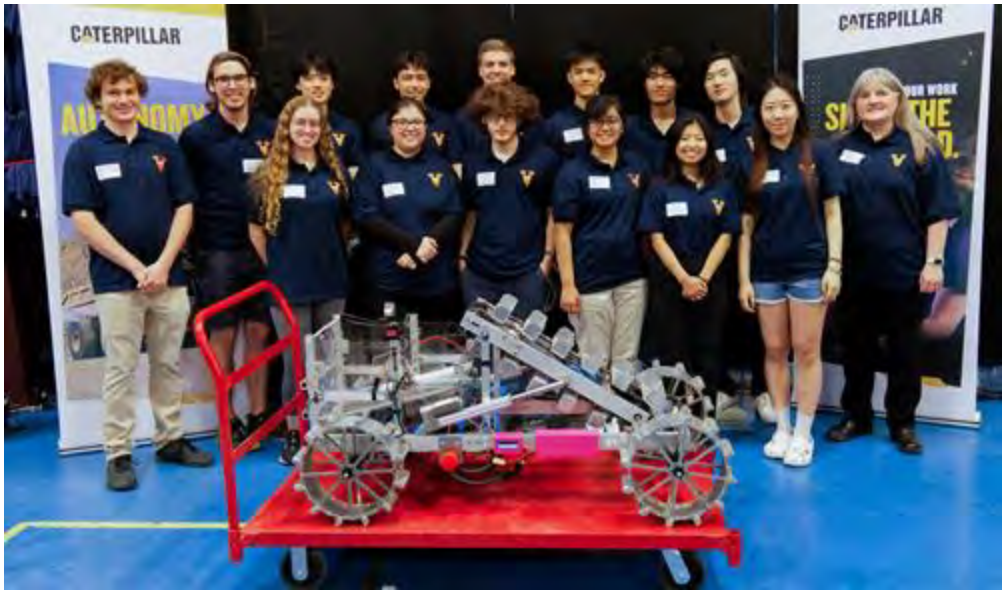
CONTINUED WORK POST 2024-2025 SCHOOL YEAR

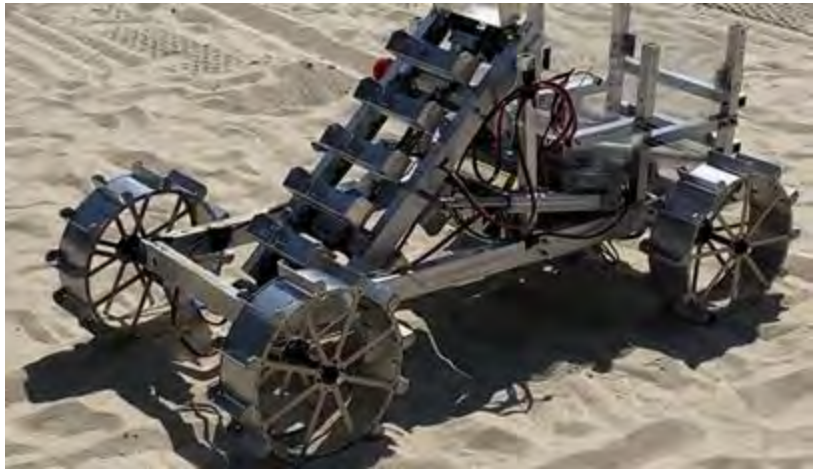
- Finalize conceptual model via CAD software
- Obtain approval from NASA through CubeSat Launch Initiative
- Obtain physical and electronic components to assemble physical CubeSat model
- Test components / structural integrity + prototype
- Launch and deploy CubeSat into orbit!

MARS

Mechatronics and Robotics Society

- Compete in NASA Lunabotics Competition
- Build a lunar mining and construction robot
- Used to support Artemis missions (going back to the moon)





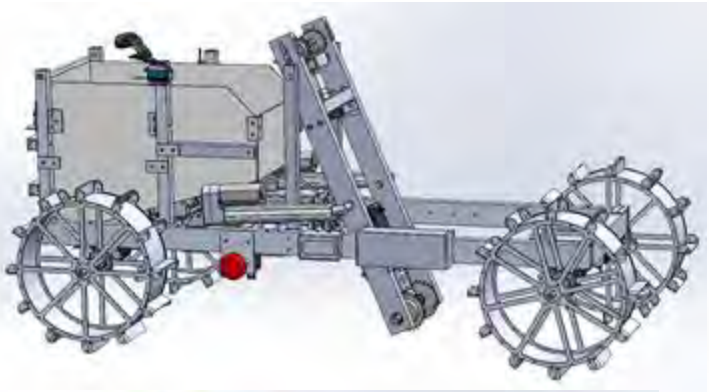
NASA's Artemis Mission

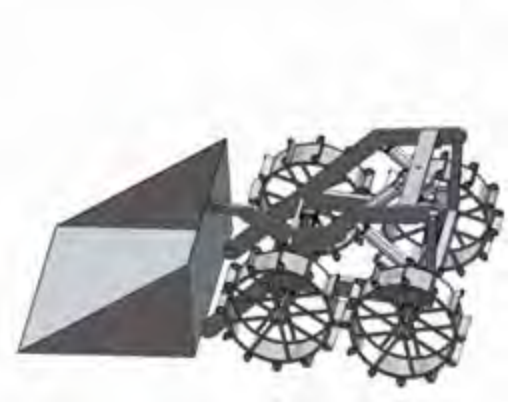
- NASA's plan to **return to the Moon**
  - Goal is to land the first woman and person of color on the Moon by 2026
  - Landing in South Pole region
- NASA is returning to the Moon to stay
  - This requires permanent settlements and technology to support that — where this competition comes in!
- **All of this will support future missions to Mars**

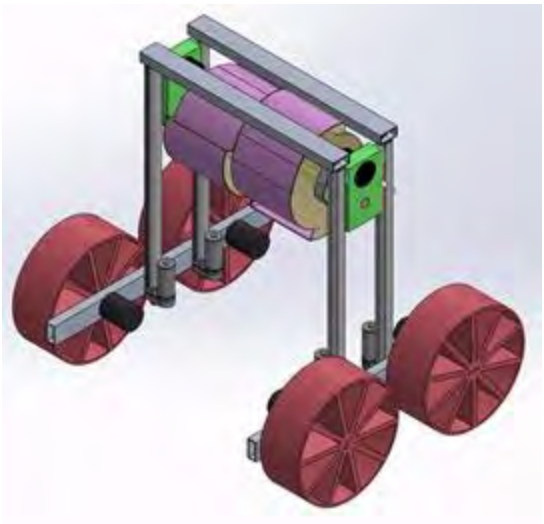
The Competition Arena

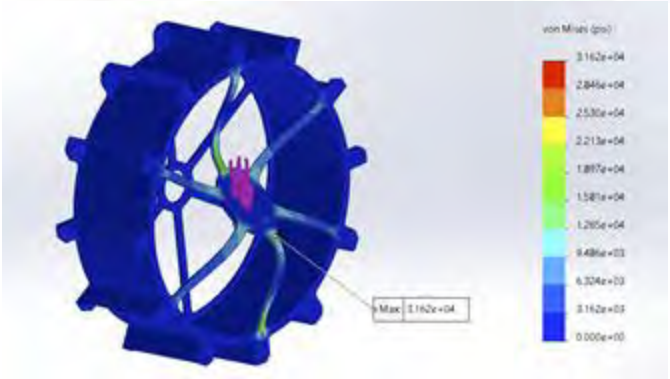
Designing and Prototyping

CAD and FEA





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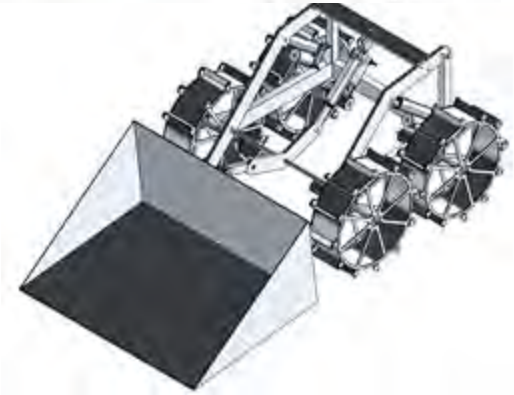
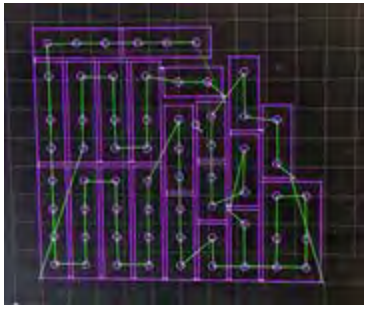
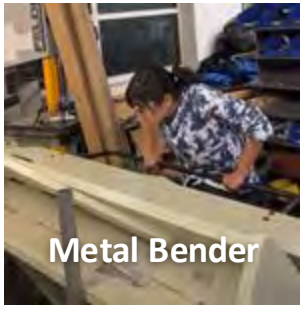
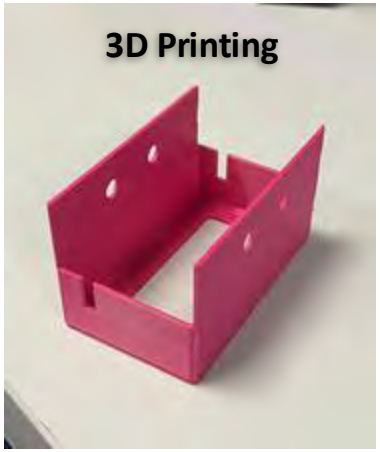
2.846e+04
2.530e+04
2.213e+04
1.897e+04
1.581e+04
1.265e+04
9.486e+03
6.324e+03
3.162e+03
0.000e+00
Max: 3.162e+04



Manufacturing







Assembling

At Competition

Driving Around

Excavating

Constructing

UVA Rocketry

AE Major Night
2024

Overall Team Structure

IREC Competition Team	Research and Development	Tripoli L1 Certifications	Club Level Leads
• Design, build, fly! • Goal: Sabre II • Three Sub-Teams • Compete in June!	• Design, build, test! • Goal: Hybrid Fuel Motor Development	• Build and fly your own Rocket at our local TCV launch site! • Goal: Lots of new L1 Certifications	• Safety • Finance • Business Development

IREC

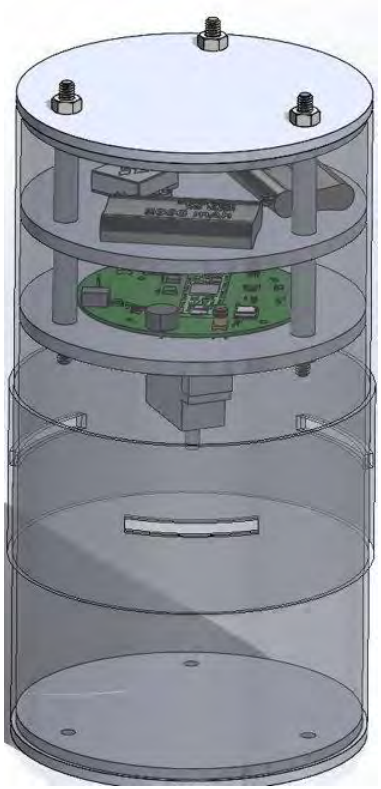
- World's Largest Intercollegiate Rocketry Competition
- 10K COTS Category
- Design, Build, and Fly!
- Weeklong trip out west!

Competition Team Structure

Structures: Focused on the mechanical design and construction of the rocket

Flight Performance: Focused on characterizing the performance of the rocket during all stages of flight

Electronics: Focused creating COTS and SRAD avionics systems (both software and hardware) that support airbrake and parachute deployment



Interested?
Join our Discord

UVAccelerated Program

-Accelerate your time to completion of a non-thesis Master's degree-

Professor Peter Griffiths, Program Director

UVAccelerate

Non-thesis Master's of Engineering degree:

- More interesting and challenging job opportunities, accelerated career advancement, and higher earning potential throughout your career.
- UVA Engineering graduate students report an average starting salary $30,000 higher than bachelor's graduates.
- https://engineering.virginia.edu/undergraduate-study/current-undergrads/uvaccelerate

APPLICATION & DEADLINES

- Online application: https://applycentral.virginia.edu/apply/
- Apply during 3rd year.
- Opens December 1st , closes March 1st, and decision within 30 days.
- No application fee, optional GRE, & one letter of recommendation for UVA Engineering students

COURSE REQUIREMENTS

30 credit hours of 5000 or 6000 level classes

- Minimum of 18 credit hours of MAE classes
- Up to 12 hours outside the department for engineering, math, or science related courses
- No more than 9 credit hours from 5000 level classes
- No more than 6 credit hours from 5000 level MAE classes
- MAE 7510 – Research Seminar only required class
- Part of Cardinal Education program

TRANSFER CREDITS

Up to 15 credit hours can be transferred towards degree

- Cannot have been counted towards undergraduate degree
- Charged at undergraduate rate before graduation

Summer UG Research Program
&
Graduate Program

Professor Haibo Dong, Program Director

MAE Summer UG research program

- ✓ **The MAE department offers 8-10 weeks Summer Undergraduate Research Program (SURP) experience for undergraduates wanting to build their skills as young researchers.**
- ✓ **As a summer research assistant, you will be immersed in research opportunities. You'll gain valuable experience in the lab and work closely with your mentor on a research project designed specifically for summer students.**
- ✓ **Applications: February – March each year**

MAE Summer UG research program

Examples of research topics from Summer 24

- ✓ **Multi-Camera Imaging of Biomechanical Analysis**
- ✓ **Composites for Electric Vehicles (EVs)**
- ✓ **Bio-inspired underwater robotic systems with flexibility and schooling interaction**
- ✓ **Computational Propulsion**
- ✓ **Bio-inspired system design and experiment**
- ✓ **Scramjet Propulsion Research**
- ✓ **Floating Wind Energy and Energy Storage**
- ✓ **Optical Diagnostics for Reacting Flow Systems**
- ✓ **Aerodynamic Laboratory Design and Testing**
- ✓ **Biomechanical evaluation and measurement of microstructural bone characteristics**
- ✓ **Tibia Injury Criteria Development**
- ✓ **Kinematic and Injury Response of Reclined Small Females and Crash Test Dummies**
- ✓ **Flow Measurement via Particle Tracking Velocimetry in the Towing Tank Facility**

MAE Summer UG research program

Examples of research topics from Summer 23

- ✓ **Applied biomechanics**
- ✓ **Autonomous drones**
- ✓ **Human Robot Collaboration for Assembly Work**
- ✓ **Bio-inspired design and flow physics**
- ✓ **Scramjet design for highly maneuverable hypersonic vehicles**
- ✓ **Thermal imaging and image processing**
- ✓ **Design and modeling of a Tesla turbine**
- ✓ **Wearable Textile Systems for Health Monitoring and Human-Robot Interaction**

Where have Aerospace majors spent their summers?

Sample internships from student survey responses. This is not an exhaustive list.

NASA
Aerojet Rocketdyne
Air Force Research Laboratory
American Energy Society
Bell Flight
Boeing
Collins Aerospace
Deloitte
Department of Defense
Northrop Grumman
Lockheed Martin
National Ground Intelligence Center
Commonwealth Center for Advanced Manufacturing
Quartus Engineering
Raytheon
Rolls-Royce
Solis Applied Science
Strategic Systems Programs
Various research labs at UVA

Center for Engineering Career Development

Heather Palmer, Assistant Director

Find us in Thornton Hall, A-Wing
engineering.virginia.edu/careers

How our team supports undergraduate students:

- Exploring careers
- Gaining experience
- Crafting job and internship search strategies
- Creating strong resumes and cover letters
- Applying to graduate school
- Learning how to navigate employer and alumni events
- Networking and interviewing
- Evaluating options and making decisions

RESEARCH FLASH TALKS

Dr. David Brown

Dr. Xinfeng Gao

Dr. Chen Cui

[UVa Researchers Engineer Safety for the Football Field (wmra.org)]

UVA Center for Applied Biomechanics (CAB)

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