



UNIVERSITY  
*of* VIRGINIA

# Major's Night Aerospace Engineering

**AERO**  
ENGINEERING



*Rich Kent*

*MAE Department Chair*

*Co-founder for UVA Center for Applied  
Biomechanics (CAB)*



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# Introduction

# ENGINEERING

Department of Mechanical and  
Aerospace Engineering

- **Aerospace engineers design, develop, test, and produce aircraft, spacecraft, propulsion systems, satellites, missiles, and related systems and equipment, and solve problems in advancing atmospheric and space flight, with two major and overlapping branches: aeronautical engineering and astronautical engineering. They develop leading-edge technologies and integrate them into aerospace vehicle systems used for transportation, communications, exploration, and defense applications.**
- **Examples of career opportunities: Aerospace engineers work primarily in the aerospace industry, at systems and software suppliers, corporate labs, government labs, and universities. The skill set of aerospace engineers is extremely broad and multidisciplinary, and the experience of aerospace engineers as systems architects and engineers allows them to make contributions in many diverse sectors.**



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## Our Mission

# ENGINEERING

Department of Mechanical and  
Aerospace Engineering

- Our curriculum provides a broadbased education in the core disciplines and integrative systems of aerospace engineering, including aerodynamics, structures, propulsion, dynamics and controls, computation and software.
- We combine comprehensive coursework, extensive hands-on, practical experiences, and team projects to emphasize learning and discovery, ethics, leadership, and communication skills.
- Students also gain valuable fundamental knowledge about emerging fields such as unmanned air systems and autonomous vehicles, hypersonics, aerospace materials, and wind energy.
- Our graduates are trained to become future leaders in an ever-evolving, critical industry, and who will go on to make a positive impact on global society and contribute to programs of national importance.



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Rankings

ENGINEERING

Department of Mechanical and  
Aerospace Engineering

■ **US News**

- #24 in Aerospace/Aeronautical/Astronautical Engineering

■ **Best-engineering-colleges.com**

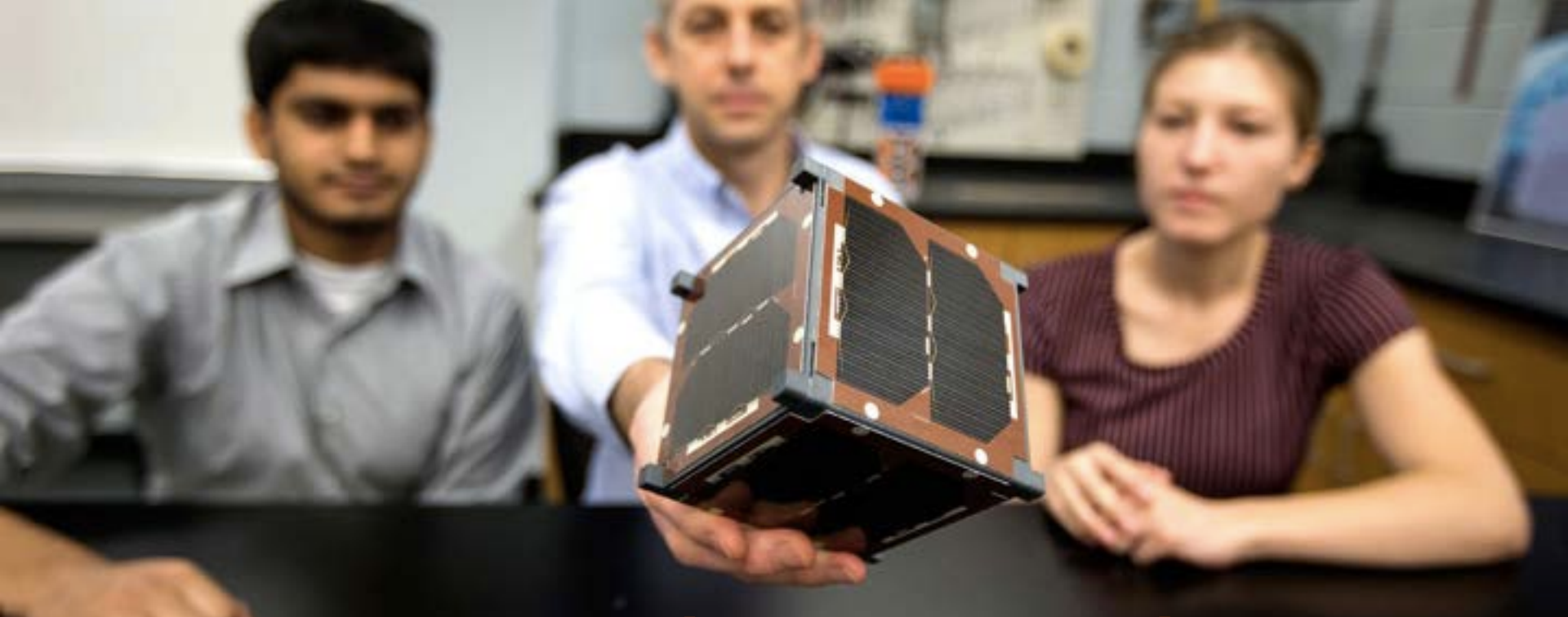
- # 12 in Aeronautical Engineering

# Six National NASA Aircraft Design Championships



# Design Build Fly: 1<sup>st</sup> in the Nation & 3<sup>rd</sup> in the World (2019)





**Impacting our world**





# ME & AE Curriculum Focus

- Fluids & Thermal Transport
- Structures & Materials
- Dynamics & Control
  
- Experimental & Computational Method
- Probability and Mathematical Analysis
  
- Systems Level Design
- Mechatronics (ME)
- Flight Vehicles (AE)
- Research & Development



# AE Societies and Clubs



**HOOS FLYING/AERO  
DESIGN TEAM**



**UVA AVIATION CLUB**

# Center for Engineering Career Development

Heather Palmer (hrr5j@virginia.edu)

**Find us in Thornton Hall, A-Wing**  
[engineering.virginia.edu/careers](http://engineering.virginia.edu/careers)

**Advising appointments with a knowledgeable career advisor (schedule using Handshake)**

Resume/cover letter reviews | Career exploration | Deciding on a major | Networking (Alumni & Employers) | Interview prep | Job/Internship Search Strategies | Career Design | LinkedIn profile review | Grad school application planning | Evaluating and negotiating offers

**Drop-in Advising (Thornton A114, A115, A116)**

Mondays and Thursdays (1:30-3pm) | Tuesdays and Wednesdays (10-11:30am)

# 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

# 1<sup>st</sup> post-graduation jobs of UVA Aerospace students

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

Atolla

Bell

Boeing

Booz Allen Hamilton

Defense Intelligence Agency

FAA

GE

Johns Hopkins Applied Physics

Laboratory

Lockheed Martin

Millennium Space Systems

MITRE

NASA

NAVAIR

Naval Air Warfare Center Training  
Systems Division

Naval Sea System Command

Northrop Grumman

Perspecta

SAIC

TriMech

WillowTree



**New Partnership with McIntire  
School of Commerce**

# Awesome Combination

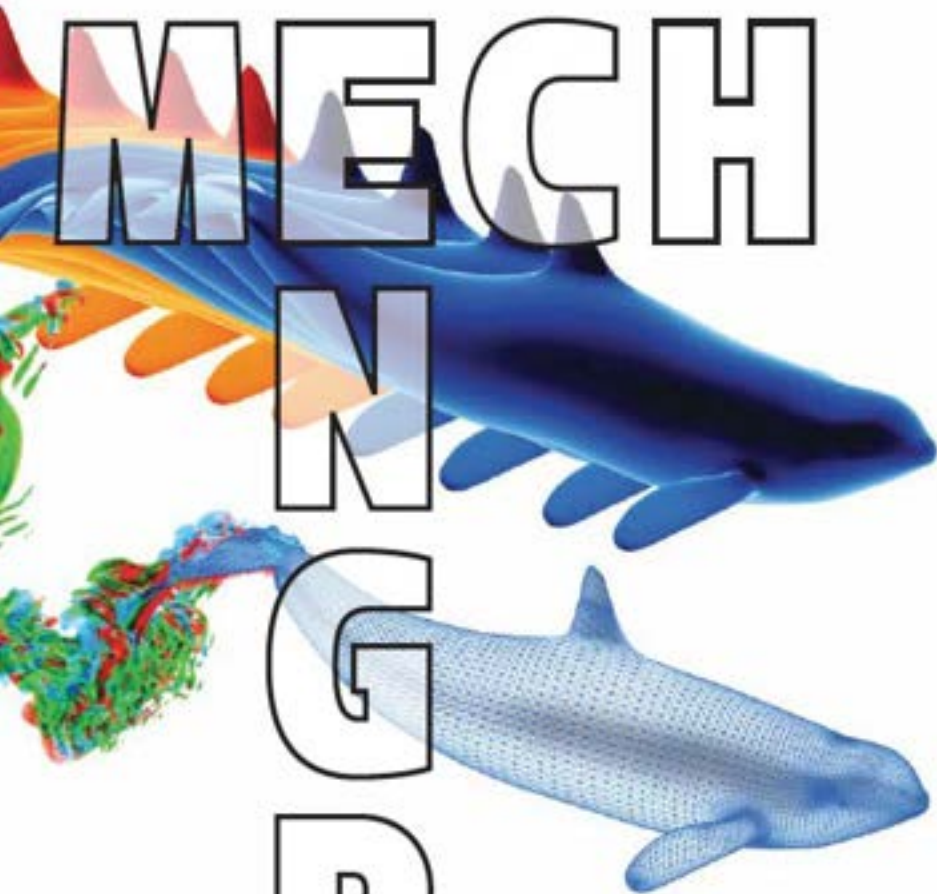


MECH

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AERO

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# MAE Summer UG Research 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.**

# MAE Summer UG research program

## Examples of research topics from Summer 22

- ✓ **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**



# Aerospace Engineering Curriculum

# 2<sup>nd</sup> 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 <sup>4</sup>	(3)	_____	Unrestricted Elective 1 <sup>5</sup>	(3)
	Total	(17)			(17)



# 3<sup>rd</sup> 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 <sup>5</sup>	(3)			
	Total	(17)			(15)



# 4th Year

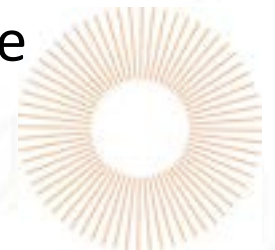
SEVENTH SEMESTER			EIGHTH SEMESTER		
		credits			credits
MAE 4xxx	Aerospace Design I <sup>6</sup>	(3)	MAE 4xxx	Aerospace Design II <sup>6</sup>	(3)
STS 4500	STS and Engineering Practice	(3)	STS 4600	Engineer, Ethics, Prof. Resp.	(3)
MAE 4120	Propulsion	(3)		Math-Science/Tech Elective 2 <sup>7</sup>	(3)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



# 4th Year Design Projects

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- Synthesize learning to design, build, and test an aircraft or spacecraft
- Emphasis on learning and applying state-of-the-art conceptual aircraft design tools
  - NASA: Open Vehicle Sketch Pad (OpenVSP); Flight Optimization Performance System (FLOPS)
  - MIT: XFOIL; XROTOR; Athena Vortex Lattice (AVL)
  - FlightStream; GasTurb; AAA; SolidWorks, etc.
  - Additional tools depending on design challenge



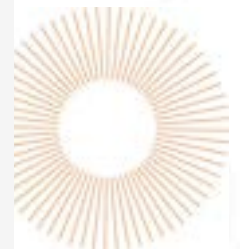
# 4th Year Aero Design Projects

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>



The screenshot shows the AIAA website's "Design Competitions" page. The header features the AIAA logo with the tagline "INSPIRING THE FUTURE OF AEROSPACE" and navigation links for "EVENTS & LEARNING", "GET INVOLVED", "PUBLICATIONS", "NEWS", "ADVOCACY", "CAREERS", and "MEMBERSHIP". The main heading is "Design Competitions". Below this, a breadcrumb trail reads "Home / Get Involved / University Students". The main content area includes a paragraph: "The AIAA Foundation sponsors design competitions every year. These competitions offer a great opportunity for students to participate in a simulated real-world problem, allowing students to gain experience and receive useful and constructive feedback from technical experts who sit on AIAA Technical Committees." To the right of this text is a photo of a team of students in formal attire, with a caption: "Team Aerospace Excellence at Miami, 3rd Place Graduate Team Aircraft Design, 2020". Below the main text is another photo of a team standing in front of an aircraft, with a caption: "Team Space Aerial Blue (University of Hawaii), 2nd Place Graduate Team Aircraft Design." To the right of the main text is a section titled "In This Section" with a list of links: "Student Branches", "Scholarships & Graduate Awards", "Careers in Aerospace", "Student Conferences", "Design Competitions", "Design/Built/Fly Competition", "Diversity Scholars Program", and "Spaceport America Cup".







### 2021 AIAA Undergraduate Design Competition

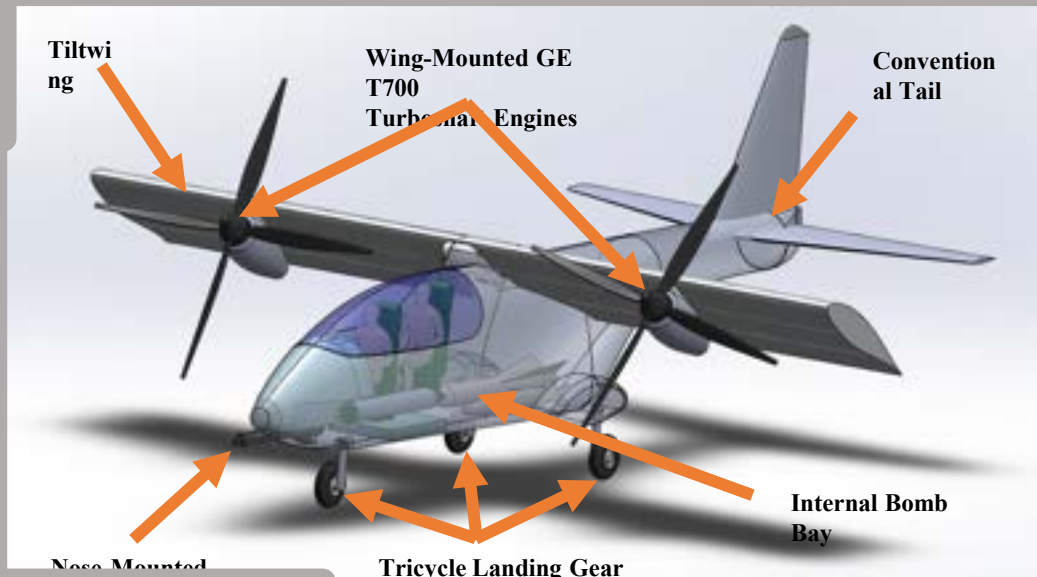
The objective of the project is to design an affordable light attack aircraft that can operate from short, austere fields near the front lines to provide close air support to ground forces at short notice and complete some missions currently only feasible with attack helicopters. The intended entry-into-service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

### 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 tilting 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

### Final Design

### Key Performance Parameters

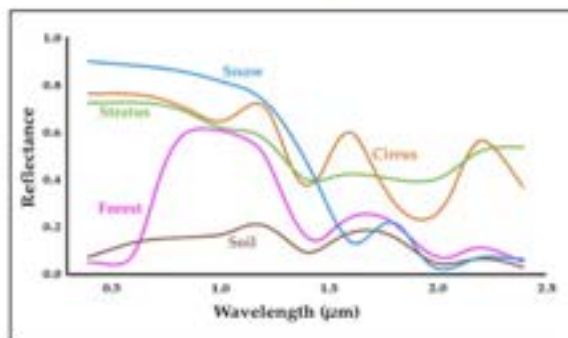
Gross Weight	14,169 lbs
Operating Empty Weight	9156 lbs
Block Fuel Burn	1795 lbs
Block Time	5.01 hours
Wing Area	245 ft <sup>2</sup>
Maximum Lift-to-Drag Ratio	12.9
Top Speed	393.7 mph
Specific Fuel Consumption	0.43 lbm/hp/hr
Acquisition Cost	\$25.75 M
Operating Cost	\$3601/hr
Life-Cycle Cost	\$3.987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



## 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.

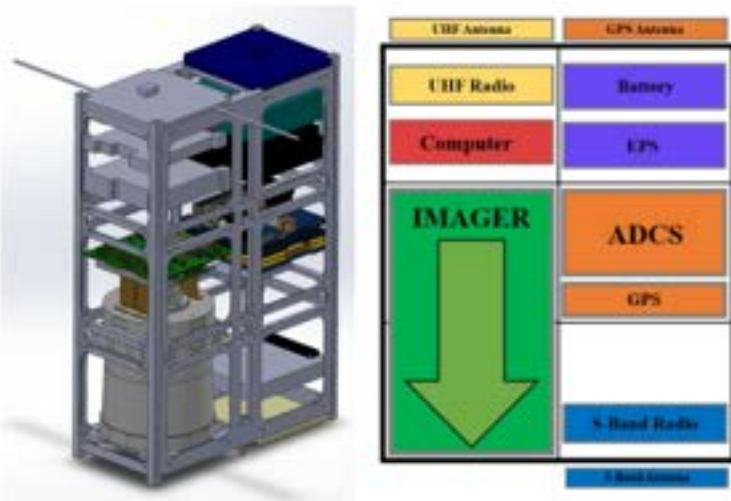
### Inclement Weather:

- Few traffic navigation devices include weather data in routing <sup>1</sup>
- Real time data (via road signs) helped reduce accidents in Oregon <sup>2</sup>

### Wet Pavement and Precipitation:

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

## 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

**Danielle Ashbahian**

4th Year Aero, AIAA Student Chapter President  
Hoos Flying Design team leader

**Miriam Elizabeth**

3<sup>rd</sup> Year Aero, Sigma Gamma Tau President

**Sean Jolly**

Hoos Flying Design team

**Alex Poley, Miles Beam, Christopher Recuperero**

UVA Aviation Club

# Aero Design Team 2022-2023

## Majors Night



ENGINEERING

## Who are we?

- Design, Build, Fly custom RC aircraft
- Compete in SAE AeroDesign
  - Competitive ruleset and guidelines
  - Takes place in Texas or Florida!
- We strive to be exciting, innovative, and performance-driven!

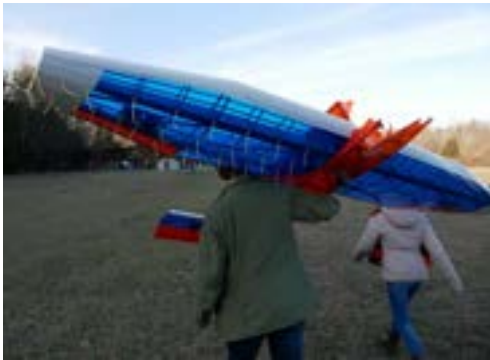


SCHOOL of ENGINEERING  
& APPLIED SCIENCE



# Project Breakdown: Design, Build, Fly

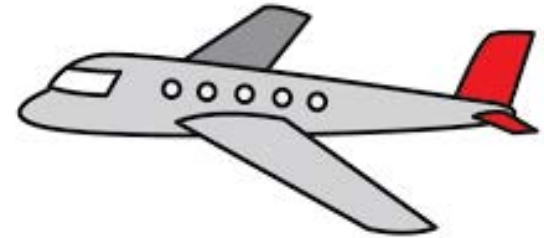
- Design
  - Using classroom knowledge, computer-aided design, computational analysis and real life experimentation to design the best possible airplane while adhering to competition rules
- Build
  - Using advanced machinery and tools to build a high fidelity airplane.
- Fly
  - Understanding the airplane and making appropriate changes to increase the airplane's performance



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# Learning Opportunities

- As a member of this club, you will learn important industry skills such as:
  - Solidworks
  - FEA/analysis
  - MDO
  - How to design
  - Manufacturing





***SHAPING THE FUTURE OF AEROSPACE***



# What is the AIAA

- American Institute of Aeronautics and Astronautics is a professional society for the field of Aerospace Engineering
- Holds annual design competitions to provide real-world design experience for engineering students
- Hosts many conferences and smaller events



# AIAA Chapter at UVA

- AIAA takes part in community activities such as Aero Day and UVA Engineering Open House
- Worked within the local Aerospace Community to write papers for submission at national conferences
- We plan other events (such as social events) to generate a better community within AE



# Sigma Gamma Tau

NATIONAL HONOR SOCIETY IN AEROSPACE ENGINEERING



**Spring 2022**

# CURRENT OFFICERS



- **FACULTY ADVISOR: Professor Chris Goyne**
- **PRESIDENT: Miriam Morse**
- **VICE PRESIDENT: Aaron Osborne**
- **TREASURER: Jason Nguyen**
- **SECRETARY: Dylan Tran**

# ABOUT



- **NATIONAL AEROSPACE HONOR SOCIETY**
- **OBJECTIVES**
  - **TO RECOGNIZE AND HONOR THOSE INDIVIDUALS IN THE FIELD OF AERONAUTICS AND ASTRONAUTICS WHO HAVE, THROUGH SCHOLARSHIP, INTEGRITY, AND OUTSTANDING ACHIEVEMENT, BEEN A CREDIT TO THEIR PROFESSION**

# WHO IS ELIGIBLE?



- **DISTINGUISHED SCHOLARSHIP**
- **MUST HAVE COMPLETED AT LEAST 3 SEMESTERS OF WORK TOWARDS A BACHELOR'S DEGREE**
- **REQUIREMENTS**
  - **TOP 1/3 OF 4<sup>TH</sup> YEARS**
  - **TOP 1/4 OF 3<sup>RD</sup> YEARS**
  - **TOP 1/5 OF 2<sup>ND</sup> YEARS**

# WHAT DO WE DO?



- **UVA AIAA A.E.R.O. DAY (AEROSPACE ENGINEERS REACHING OUT)**
- **2<sup>ND</sup> YEAR AEROSPACE ENGINEERING INFO SESSION**
  - **PROVIDED OPPORTUNITY FOR 2<sup>ND</sup> YEARS TO MEET AERO MAJORS AND ASK QUESTIONS ABOUT MAJORING IN AEROSPACE ENGINEERING**
- **MAE TUTORING PROGRAM**
  - **PROVIDE TUTORS FOR 2<sup>ND</sup> AND 3<sup>RD</sup> YEAR AEROS**
- **COFFEE FOR MAE LOUNGE**
- **MAE Student Council**

# REASONS TO JOIN



- **IT'S AN HONOR: YOU REPRESENT THE TOP OF YOUR CLASS**
- **ABILITY TO FORM CONNECTIONS WITH CLASSMATES AND PROFESSORS**
- **ONCE YOU JOIN, YOU ARE A MEMBER FOR LIFE**
- **EXCLUSIVE SCHOLARSHIP OPPORTUNITIES**
- **LEADERSHIP OPPORTUNITIES AND RESUME-BOOSTER**





# The Aviation Club at the University of Virginia

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Alex Poley, Christopher Recupero, Miles Beam



# Meet the Board



# Our Goals

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



# What Can You Expect from Joining?

- Use of the flight simulator lab
- Movie screenings and facilitated discussions
- Guest speakers from the aviation industry



# What Can You Expect from Joining?

- Field trips to local airports and airshows
- Ground schools for FAA Private Pilot and Instrument Rating written exams (planned for next semester)





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# ENGINEERING

Department of Mechanical and  
Aerospace Engineering

## Questions? Contact:

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[jlt4uy@virginia.edu](mailto:jlt4uy@virginia.edu)

### Danielle Ashbahian

4<sup>th</sup> Year Aero, AIAA Student Chapter President  
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### Miriam Elizabeth

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