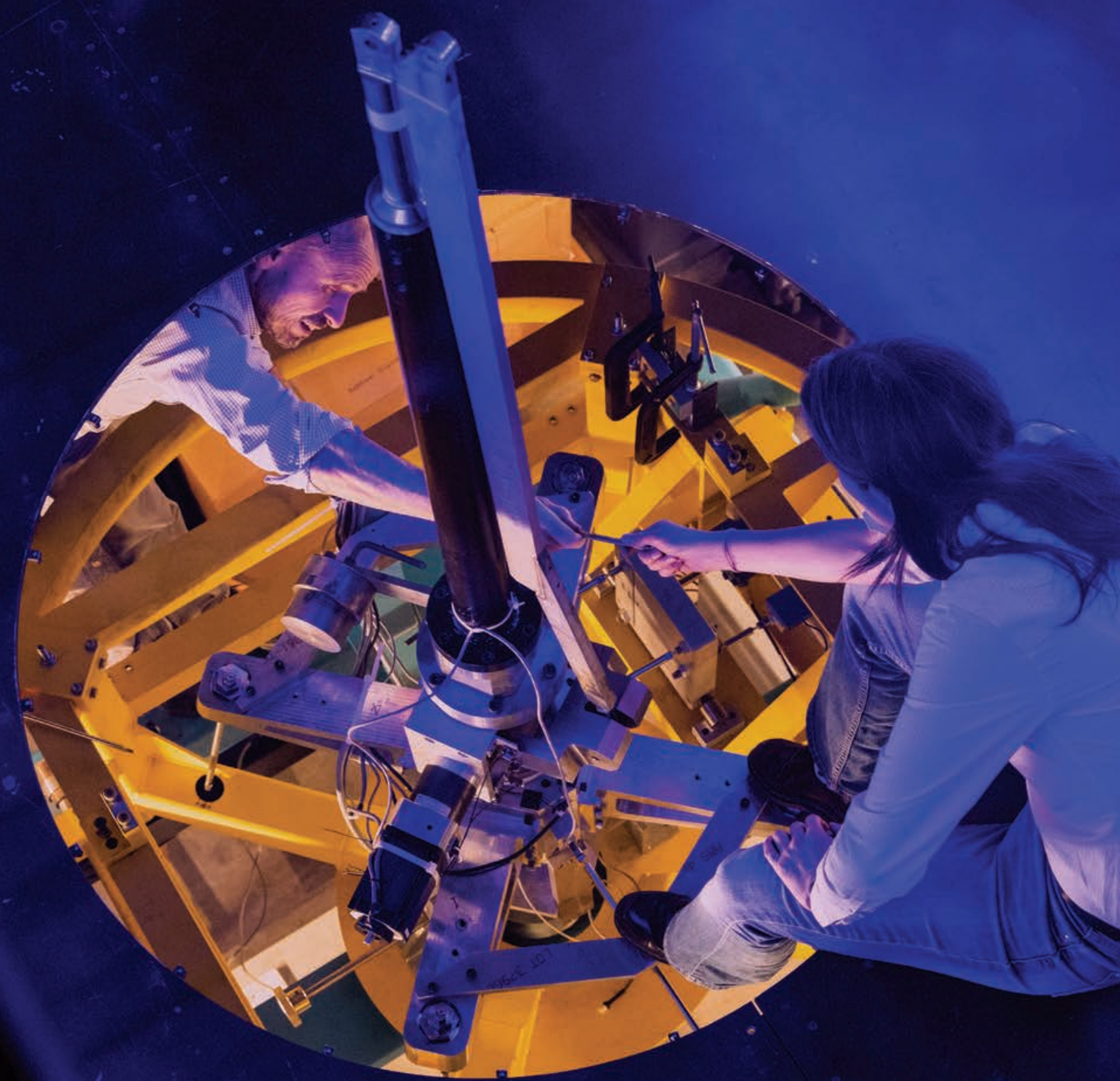
MIT AEROASTRO



STRATEGIC PLAN 2026

TO LOOK AHEAD, LOOK UP

For over 100 years

MIT has led the world in research, education, and innovation in aerospace. As the oldest program of its kind in the United States, our department has a rich tradition of technical excellence and academic rigor, and we continue to push the boundaries of what is possible to shape the future of air and space transportation, exploration, communications, autonomous systems, national security, and education.

In developing the Department's strategic plan, the aim is to identify and address the critical challenges for the aerospace field over the next 5–10 years. These challenges guide how we can best invest our resources in research and education to lead the aerospace community, leverage the unique academic environment at MIT, and continue to have a positive real-world impact.

The 2026 Strategic Plan was developed as a collaborative effort across the Department, with input and insights from dozens of industry, government, and academic leaders. It will serve as a guide to help our Department lead during a period of tremendous change and growth in aerospace.

Research from graduate student Palak Patel arrives at the International Space Station.

Photo credit: NASA astronaut Michael Fincke '89

A Renaissance in Aerospace

KEY DRIVERS OF THE STRATEGIC PLAN

Rise of artificial intelligence

Artificial intelligence is redefining what is possible in aerospace. With rapid advances in LLMs, agentic AI, digital twins, predictive modeling, and more, over the past 5 years, AI has emerged as a broad array of capabilities that will be integrated into design and engineering workflows, autonomous systems, manufacturing processes, and operational decision-making.

Commercialization of space and dramatic increase in launches and satellites

The space industry has commercialized rapidly. The number of active satellites in orbit has increased from 2,200 in 2020 to 14,252 in 2026, and constellations like Starlink are demonstrating viable business models.

Increased focus on venture-backed startups and entrepreneurship in aerospace

Both the aviation and space industries are experiencing a broad shift toward private companies, private funding, and venture capital-backed startups. Startups are prioritizing technologies that enable scalable production and rapid certification pathways, changing manufacturing paradigms and challenging existing infrastructure. This surge of innovation requires aerospace engineers and leadership who are agile in adapting to change and confident in managing and securing integrated complex systems.

Growing need for sustainability

As the Earth grapples with the effects of a changing climate, the aerospace field should play a central role in addressing this challenge as well as other sustainability issues, ranging from the growth of commercial aviation to space debris and Earth observation for the betterment of the planet. This is a global responsibility and an economic imperative.

A shifting geopolitical landscape

Government funding and direction remain essential to the success of aerospace companies and global industries. As the current surge of innovation and commercialization adds technological and operational complexity, the department and its graduates must be able to navigate the needs of both government and industry. At the same time, global competition and evolving national security priorities are driving shifts in defense investment and demanding new approaches to rapid prototyping, autonomous systems, and resilient supply chains. The convergence of commercial space capabilities with defense requirements creates both opportunities and challenges that will shape the sector's evolution over the coming decade.

Vision & Mission

VISION

The vision of the MIT Department of Aeronautics and Astronautics is to push the boundaries of the possible in aerospace to ensure a lasting positive impact on our society, economy, and environment while creating a diverse and supportive community.

MISSION

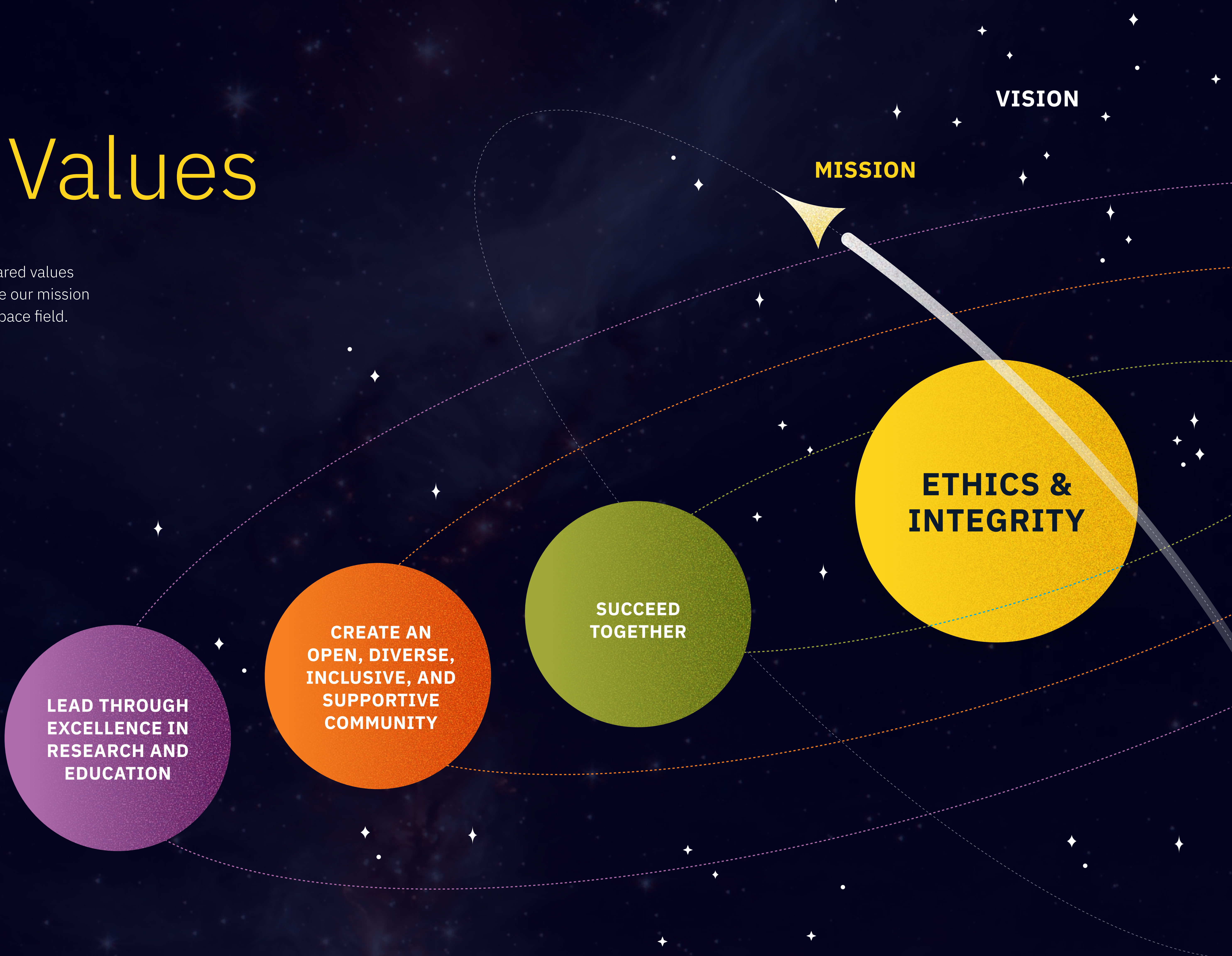
In the MIT Department of Aeronautics and Astronautics, we look ahead by looking up. We lead innovation in aerospace systems and technologies that have world-changing impact. Educating the next generation of leaders, researchers, engineers, and entrepreneurs who will shape the future of aerospace, we foster a diverse, creative, and international community built on technical excellence and integrity. Working together with the public and private sectors, we aim to expand the benefits of aerospace to preserve our environment, strengthen global security, contribute to a thriving economy, and explore other worlds in the service of the nation and for the betterment of humanity.

Prof. Jon How and students watch their projects fly an obstacle course in the Kresa Center for Autonomous Systems.

Photo credit: Lillie Paquette/In Short Media

Our Values

Our department's shared values guide how we execute our mission and lead in the aerospace field.



Department Structure

RESEARCH SECTORS

Computing

- Aerospace computational engineering
- AI-integrated aerospace engineering
- Autonomous systems
- Communications and networks
- Control systems
- Human-autonomy collaboration

Space

- Astrodynamics
- Engineering systems
- Humans in aerospace
- Nuclear Technologies
- Space Propulsion
- Space and Satellite Systems

Air

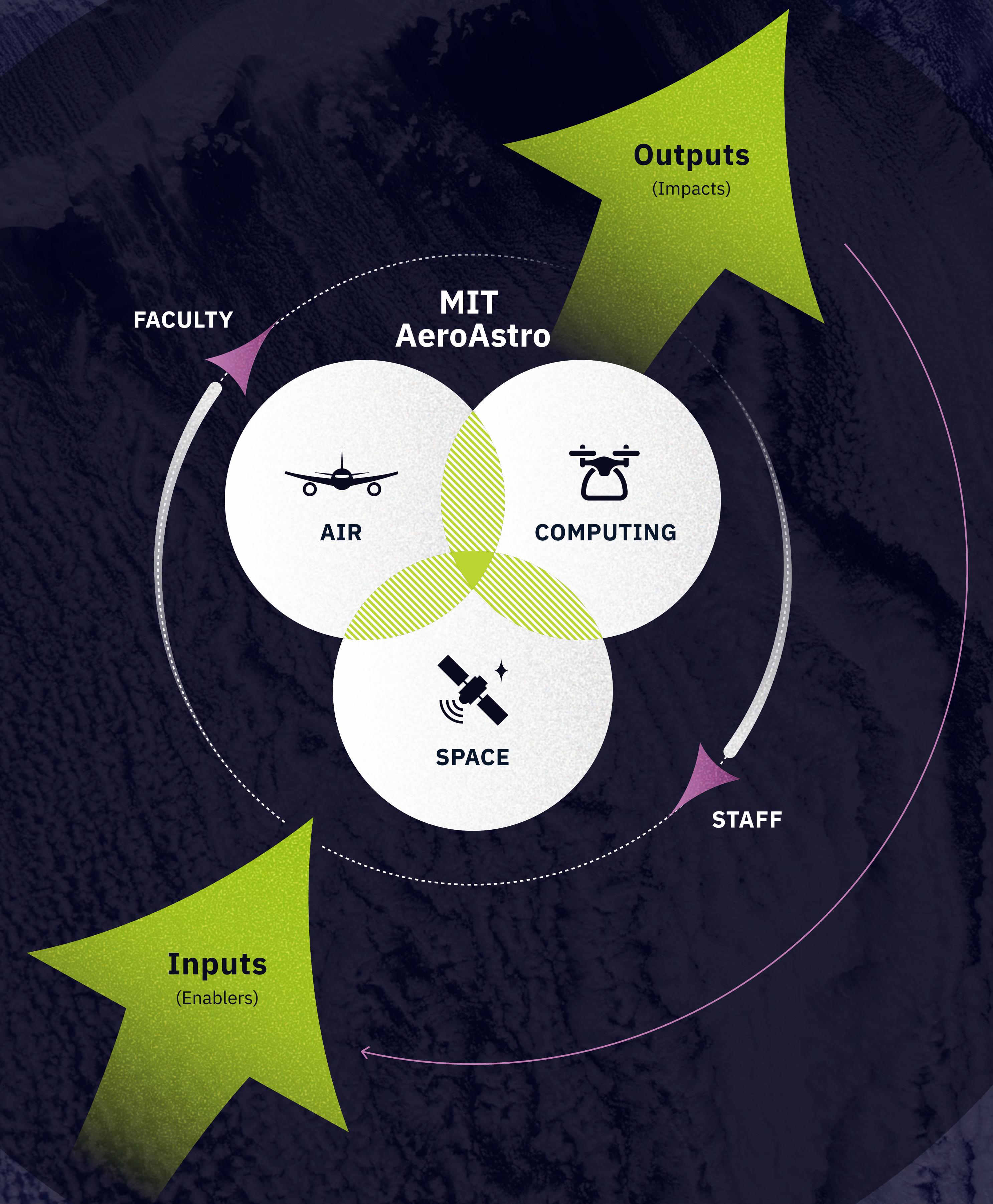
- Air-breathing propulsion
- Aircraft systems engineering
- Air transportation systems
- Aviation, energy & environment
- Hypersonics
- Materials and structures
- Plasma physics

Inputs (enablers)

- Faculty hires
- Funding
- Government engagement
- Graduate students
- Industry collaborations
- Undergraduate students

Outputs (impacts)

- Alumni
- Concepts & ideas
- Expertise & influence
- Methods & tools
- Patents & technologies
- Publications
- Spinoffs & startups



Core Competencies

Grad student Sam Austin works with fabrication tools in the machine shop inside the Arthur and Linda Gelb Laboratory.

Photo credit: Jake Belcher

The Department's core competencies are essential for research and teaching in the field, and form the basis on which the Department can undertake cross-cutting strategic priorities and pivot to new areas as necessary.

1. The disciplines central to the design of aerospace vehicles (fluids, gas dynamics, structures, energy conversion, materials, dynamics)
2. The discipline of real-time aerospace information sciences (guidance and navigation, estimation and control, autonomy, sensing, communications, networks)
3. Advanced computation methods to support design and decision-making (numerical simulation, high-performance computing, uncertainty quantification, inference)
4. The disciplines essential to human-system collaboration (human-machine systems, human factors, collaborative autonomy, biomechanics, life support, habitation)
5. Earth and space sciences and how they inform aerospace systems (environmental impact of aviation, environmental monitoring, space weather, remote sensing, space exploration)
6. The design, implementation, and operation of complex aerospace systems (system architecture, safety, optimization, logistics, engineering economics)

Building on Success

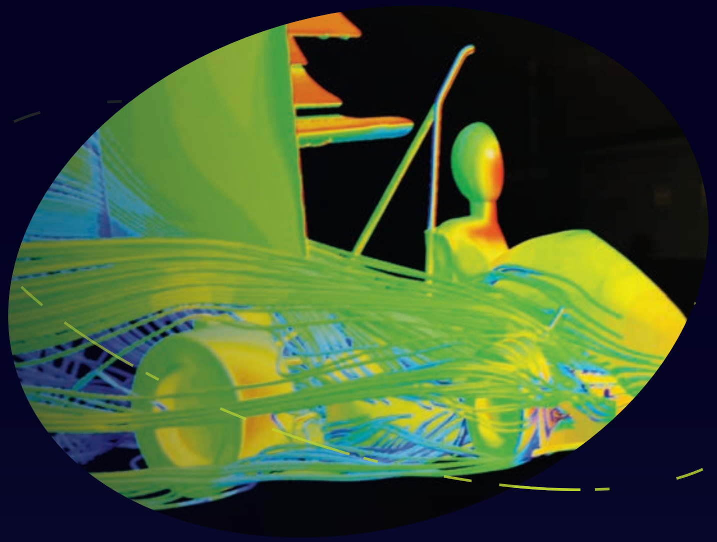
Building on these core competencies, AeroAstro has maintained world-class teaching and research in the fundamentals of aerospace engineering while working at the frontier of innovation in new technologies, novel approaches, and pure and applied research.

Hands-on, project-based learning

- Conceive Design Implement Operate (CDIO)
- Design-build paradigm
- Student teams

Pioneering research topics in aerospace

- Systems engineering and space systems
- High-performance computing, machine learning, and modeling
- Robotics and automation
- Quantum technologies
- Climate and sustainability



Undergraduate students prepare for the first flight of Surge1, a StolSURGE uSTOL demonstrator aircraft, as part of 16.821: Flight Vehicle Development.

Photo credit: Mark Drela

Prof. Zachary Cordero and students building a laboratory-scale electric turbopump in 16.811 (Advanced Manufacturing for Aerospace Engineers).

Photo credit: Lillie Paquette/In Short Media

A student inspects his drone hardware as it prepares for the final mission in 16.85 (Design and Testing of Autonomous Vehicles).

Photo credit: Lillie Paquette/In Short Media

A virtual model of the aerodynamics of the MIT Motorsports team's MY25 Formula One style race car.

Photo credit: Rachel Ornitz

Unique classroom experience

- 16.811 Advanced Manufacturing for Aerospace Engineers
- 16.85. Design and Testing of Autonomous Vehicles (Capstone)
- 16.678 Designing Virtual Worlds

Prof. Masha Folk and undergraduate students participate in the “Jet Joe” lab in 16.004 (Thermodynamics), part of Unified Engineering.

Photo credit: Pam Fradkin

A student in 16.851 (Intro to Satellite Engineering) experiences a Falcon 9 rocket launch at a 1:1 scale using a custom-built virtual reality simulation developed by graduate student Mollie Johnson.

Photo credit: Mollie Johnson

Cutting-edge facilities and experimental capabilities

- Wright Brothers Wind Tunnel
- Small Satellite Collaborative
- Kresa Center for Autonomous Systems
- Neumann Hangar and Gelb Lab

Researchers from SPARK Lab test high-speed aerial grasping using a soft drone with onboard perception.

Photo credit: Adam Glanzman

Tamara Hinderman ’25 testing the aerodynamics of a model in the Wright Brothers Wind Tunnel.

Photo credit: Jake Belcher

Findings and Trends

INNOVATION FOCUS AREAS ACROSS THE AEROSPACE INDUSTRY

In dozens of interviews with leaders and experts from mature companies to startups to government agencies, consulting firms, and academic peers, we gained valuable insights about the most exciting avenues for research and innovation across the industry over the next decade. We also gained a deeper understanding of current challenges and pain points where the department has an opportunity to lead.

AI-enabled design, engineering, and integration

Artificial intelligence has emerged as a transformative force across aerospace and defense industries, with companies consistently highlighting AI integration as both a current necessity and future strategic imperative. The industry consensus indicates that AI will enable small teams to tackle increasingly complex aerospace challenges; however, there remain many questions and concerns about trust and safety, certification, and security.

Air traffic control and advanced air mobility

The United States is falling critically behind in air traffic control (ATC) modernization while other nations lead innovation efforts in airspace management. Aging infrastructure and staffing shortages are impeding operations while slowing the development of capabilities for managing increasingly complex airspace. The emerging market for Unmanned Aerial Vehicles (UAVs), increasing frequency of space launches through commercial airspace, and integration challenges between new and legacy systems—all of these are complex systems challenges that require dedicated research solutions. The technology integration challenges involve developing communication protocols, real-time data sharing capabilities, and AI-supported operations that can safely manage the complexity of mixed autonomous and human-operated aircraft in shared airspace.

Cost and rate, manufacturing, and automation

Driven by economic pressures and new market demands, companies across commercial aviation, defense, and space sectors are investing in increasing production of aerospace systems with a focus on affordability. Startups in particular are driving a fundamental shift toward rapid iteration, often in place of traditional exquisite engineering approaches.

Digital design, engineering, testing & certification

Industry demand for digital engineering capabilities is rapidly accelerating across aerospace sectors, driven by the need for more complex and advanced autonomous systems, reduced hardware testing costs, and faster certification timelines for vehicles with no legacy information. The convergence of autonomous systems, advanced manufacturing, and regulatory challenges has created an urgent need for new digital approaches.

Human spaceflight

Human spaceflight represents a key driver of innovation in the aerospace industry, with many companies investing heavily in technologies that will enable long-duration human presence in space. From space stations and lunar habitats to Mars exploration and space tourism, industry leaders view human spaceflight as both an immediate commercial opportunity and a long-term strategic imperative that will drive the next generation of aerospace innovation. Human spaceflight also represents a convergence point for multiple technical disciplines, with ample opportunity for scientific and technological innovation in areas ranging from partial gravity research and advanced propulsion systems to closed-loop life support, power-to-X technologies, and space-based manufacturing.

Student team members in the Space Resources Workshop work on the Walking Oligomeric Robotic Mobility System (WORMS). The project has received numerous awards since its development in 2022.

Photo credit: Jake Belcher

Students gain hands-on engineering experience driving a full engineering cycle in 16.811 (Advanced Manufacturing for Aerospace Engineers).

Lillie Paquette/In Short Media

Todd Billings, Senior Technical Instructor, works with a lathe in the machine shop.

Photo credit: Rachel Ornitz

Integrated, complex system of systems challenge

The aerospace industry's evolution toward more complex, integrated systems requires substantial update in how engineers are educated. Companies are seeking graduates who can think across traditional disciplinary boundaries, understand system interactions at multiple levels, and contribute immediately to integrated product development teams. AeroAstro is already known for both research and education in complex systems, and has significant opportunities to lead in this area through curriculum innovation, hands-on project experiences, and research collaborations that address the real-world challenges of complex aerospace systems integration.

Materials, hypersonics, and re-entry

Companies ranging from defense contractors to commercial space companies and aerospace startups are actively conducting research and seeking partnerships to advance reusable rockets and hypersonic applications. Hypersonic vehicles are also central to next-generation national security strategy. Research priorities include fundamental scientific investigations that inform the description of the hypersonic environment, including plasma, gas, and solid interactions, to enable technological innovations across sensors, automated design optimization, and advanced materials.

Nuclear technologies

Nuclear propulsion is essential for next-generation space missions, particularly for Mars exploration and sustained lunar operations. Both nuclear thermal and nuclear electric propulsion as well as nuclear surface power systems are viable options for future missions. Industry experts emphasize the development of renewable and sustainable solutions specifically designed for deep space missions, with particular attention to safety, thrust capabilities, and sustainable system architectures for long-duration operations. MIT's unique position with both top-ranked aerospace and nuclear programs, combined with the MITR-II research reactor, creates a competitive advantage.

Quantum technologies

Quantum technologies represent a significant emerging opportunity in aerospace, with companies expressing strong interest in quantum sensing applications for alternative Position, Navigation, and Timing (PNT) systems, while exploring novel approaches to quantum communication and computing. The defense sector leads investment and application development, particularly for military needs where GPS denial is a major concern.

Satellite systems, operations, and constellations

The small satellite sector represents a critical transformation in space technology, with major industry players driving demand for cost-effective, scalable manufacturing solutions. Companies are shifting from traditional aerospace approaches to automotive-style production, while simultaneously addressing fundamental challenges in thermal management, battery optimization, and space situational awareness. Educational gaps center on the need for foundational research in manufacturability and cost optimization rather than purely ambitious end-goal projects. The sector faces policy constraints around access to military-grade debris modeling data, outdated MMOD (micrometeoroid and orbital debris) models, and the challenge of scaling optical communications systems, while international competition adds strategic urgency to American small satellite development programs.

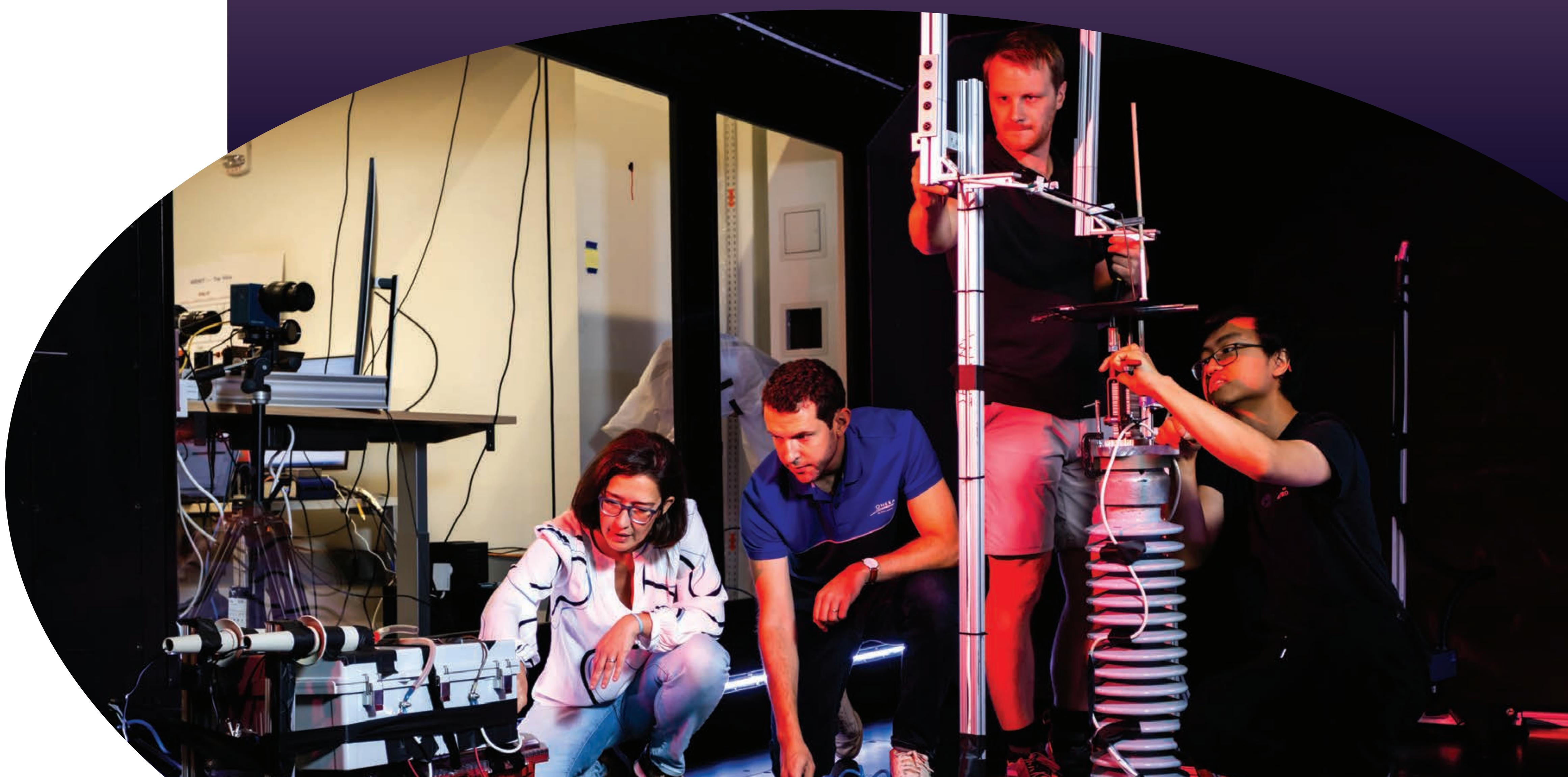
Strategic Priorities

Strategic priorities are high-level initiatives pursued in tandem with our core capabilities. They support the mission and vision and align with our shared values. We have identified eight strategic priorities, across Innovation Areas, Education, and Culture & Leadership, that represent emerging areas of opportunity where we are uniquely positioned to lead and achieve major impact.

These priority areas focus on long-term trends rather than specific systems. They build upon our strengths while anticipating future changes as the aerospace field continues to evolve. Each area requires specific, dedicated resources and effort while developing synergies with the others. Together, they allow us to develop our strengths to best address the nation's greatest challenges and opportunities in aerospace.

Graduate student Lanie McKinney working in the Aerospace Plasma Group.

Photo credit: Jake Belcher



Prof. Carmen Guerra-Garcia's group and European collaborators set up an experiment measuring lightning strikes in the Wright Brothers Wind Tunnel.

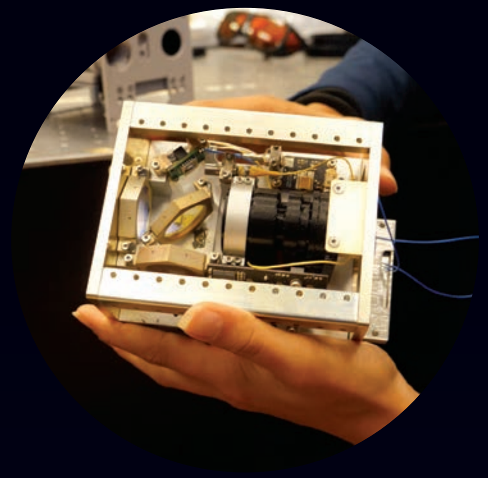
Photo credit: Jake Belcher

INNOVATION AREAS

The Department has identified a number of key research areas where we are well-placed to lead the aerospace field. These areas build on our core strengths—engineering fundamentals, complex systems, a culture of excellence—and will allow us to expand the Department's domain expertise to meet the needs of the evolving aerospace industry.

With the rapid advances and widespread adoption of AI technologies, we have a once-in-a-generation opportunity to position our Department at the forefront of this emerging domain in aerospace. AI is a cross-cutting priority that will underpin our investments and initiatives across all other innovation areas and pedagogy.

Some of these efforts are already underway, while others are at early stages of investment by the Department; all will be the focus of intensive efforts across multiple tracks during the next 5–10 years.



Prof. Julie Shah and Christopher Fourie PhD '24 test robots designed to work alongside humans as highly effective teammates as part of their research in the Interactive Robotics Group.

Photo credit: Gretchen Ertl

PRIORITY ONE

AI-Enabled Aerospace Design and Operations

Advance MIT AeroAstro as the premier institution for certifiable, safety-critical AI in aerospace by pioneering methods that integrate a wide range of AI capabilities across digital design, materials, manufacturing, and operations, and by educating AI-native graduates who can seamlessly leverage and embed artificial intelligence across aerospace systems.

- Certifiable, safe AI and autonomy for mission critical settings
- AI-accelerated design, engineering, manufacturing, and test certification
- Human-AI teaming, collaborative autonomy, and human-in-the-loop and on-the-loop
- AI-driven efficiencies and climate mitigations

PRIORITY TWO

Aviation for the Next Century

Strengthen MIT AeroAstro's position as a world leader in next-generation aircraft, airspace management, and aviation systems modernization to address the critical infrastructure, systems integration, and carbon emissions challenges that are constraining aircraft deployment and limiting U.S. competitiveness in airspace modernization.

- Air traffic control (ATC) of the future
- Aircraft design, including autonomy, sensing, and AI integration
- Advanced propulsion systems and next generation energy carriers
- Unmanned aerial vehicles (UAVs), urban air mobility, drones

PRIORITY THREE

Leading-Edge Satellites and Systems

Position MIT as the preeminent institution for innovation in small satellite systems, constellations, and operations by advancing technologies that enable novel sensing, communications, and operations for constellation-scale deployment.

- Sensing and high bandwidth communications
- Hardware including edge computing in space
- Onboard autonomy
- Space situational awareness and space traffic management

PRIORITY FOUR

Long-Duration Space Exploration

Lead the field in enabling sustainable human activity beyond Earth through integrated innovation in advanced aerospace systems for launch, aerocapture, reentry, and propulsion, space-based manufacturing, cislunar operations, and human life support and health technologies that reduce costs, enable long-duration missions beyond low Earth orbit, and deliver transformative applications for life on Earth.

- Reusable launch vehicles and hypersonics
- Human health and productivity in space
- Nuclear technologies for surface power and in-space propulsion
- In-situ resource utilization and manufacturing

The Wright Brothers Wind Tunnel's fan and motor assembly, which drives the tunnel's airflow.

Photo credit: Adam Glanzman

STAR Lab's CLICK-A project, a technology demonstration of low size, weight, and power CubeSat optical communication terminals for downlink and crosslinks.

Photo credit: Rachel Ornitz

Prof. Lonnie Petersen floats in microgravity aboard a parabolic flight, testing a wearable lower body negative pressure device developed in the Aerospace Physiology Lab.

Photo credit: Laurent Theillet

EDUCATION

AeroAstro has been named the top aerospace engineering program in the world for well over a decade. Alumni and industry leaders consistently recognize Course 16's excellence in preparing both undergraduates and graduate students for a wide variety of careers through an education that focuses on strong fundamentals, systems engineering, and creative problem solving.

Advances in technology and shifting industry trends reveal several emerging needs in education where the Department is well-placed to lead the field. Across sectors there is a growing need for graduates with a firm understanding of new technologies and an ability to adapt to new approaches.

The Department's approach to education must evolve to maintain our core competencies while future-proofing our graduates in a changing industry. Our curriculum and pedagogy will empower students with the skills to look ahead and lead through change.

PRIORITY ONE

AI-Native Aerospace Engineers

AI-native graduates are critical to leading the future of the aerospace industry. AeroAstro students will master using a variety of AI methods in their learning and their work. They will also understand the limitations of AI, validate outputs, and maintain the critical thinking skills that are essential alongside AI capabilities.

Goal: Advance MIT AeroAstro as the premier institution for AI-native aerospace engineers who combine rigorous fundamental knowledge with advanced AI and digital engineering capabilities, producing graduates who can lead industry transformation.

- AI-enabled research labs: teaching students to use AI to their benefit and to push the boundaries of their work.
- Digital engineering and AI for physical systems: students will learn to apply generative and agentic AI and digital engineering technologies to real-world aerospace tasks.
- Emphasis on safety-critical systems in aerospace: students will learn to incorporate AI in ways that are appropriate for the unique safety requirements of aerospace.

16.85 (Design and Testing of Autonomous Vehicles) asks students to design, implement, deploy, and test a full software architecture for autonomous flying systems.

Photo credit: Rachel Ornitz

PRIORITY TWO

Design-build-test

Companies across all aerospace sectors emphasize the critical importance of experience with hands-on manufacturing, project teams, and understanding of the full engineering lifecycle. MIT is well known for its dedication to hands-on, project-based learning which fully embodies "Mens et Manus"; AeroAstro has an opportunity to further enhance this experience, building on the foundation of our Conceive-Design-Implement-Operate (CDIO)-based curriculum.

We are committed to training graduates who combine theoretical excellence with outstanding hands-on experimental competency, systems thinking, and an iterative design mindset.

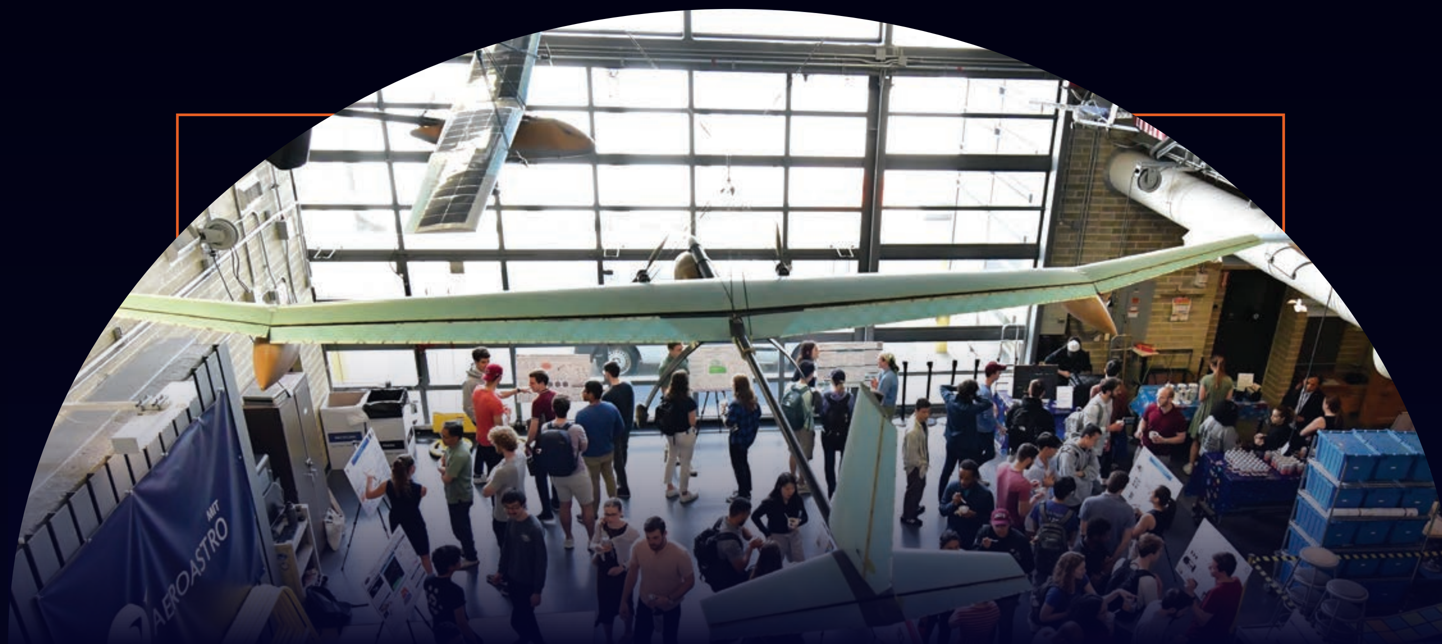
Goal: Enhance MIT AeroAstro's undergraduate curriculum and graduate research opportunities to integrate substantial design-build-test experiences throughout students' time in the department.

- Earlier, sustained projects that incorporate design-build-test experiences through a complete build cycle, from their first days in the department through graduation.
- Emphasis on compliance with industry standards and regulations.
- Leverage faculty expertise, research infrastructure, alumni affiliations, and industry relationships to deepen real-world project context for CDIO in more classes.

Joseph Chiapperi PhD '26 works in the Gas Turbine Laboratory.

Photo credit: Adam Glanzman

CULTURE & LEADERSHIP



PRIORITY ONE

Cultivate an environment of excellence

AeroAstro has made a concerted effort over several decades to make our community and the aerospace field a welcoming place for people from across the world, of all backgrounds, to do their best work. We recognize that we can only realize the full potential and impact of our teaching and learning, research, innovation, and service when inclusion and collaboration are core principles.

Through the Department's leadership efforts and the initiatives we undertake, we commit to making sure everyone at AeroAstro can contribute and succeed. We will uphold excellence, rigor, and integrity in an environment where all individuals are supported without prejudice.

PRIORITY TWO

Industry collaborations and startup ecosystem

The Department has a long history of collaboration with government and industry to solve pressing challenges and innovate at the cutting edge of aviation, spaceflight, autonomy and computing. With the aerospace field experiencing a renaissance of entrepreneurship, led by venture-backed startups and characterized by rapid innovation, AeroAstro leadership remains committed to exploring collaborations with both traditional and new research partners and training students for the dynamic field they will enter.

The Department will enable sustained engagement to:

- Take on grand challenges and hard problems that are critical to industry leaders and cultivate strategic collaborations.
- Establish innovative partnership models that are mutually beneficial to the Department, the students, and the companies.
- Support students' growth as aerospace entrepreneurs and leaders in emerging technologies and applications across the industry.

Students in NEET: Intro to Autonomous Machines have the opportunity to design, build, and deploy mechanical systems, software, and autonomy algorithms for real-world autonomous machines and robots.

Photo credit: Jake Belcher

The 2025 AeroAstro Master's Thesis Showcase in the Gerhard Neumann Hangar.

Photo credit: Rachel Ornitz

As we look ahead to the future, we embrace our challenges and opportunities to shoot for the stars.

Cadence Payne PhD '24 and colleagues flying in microgravity as part of Aurelia Institute's Horizon Zero Gravity Flight program.

Photo credit: Blaga Ditrow / ZERO-G

This strategic plan positions the Department well for the next phase of aerospace evolution by responding to key drivers across the field. It outlines a robust roadmap for research, education, and cultural leadership in aerospace.

Together with our remarkable students, alumni, faculty, and staff, we will shape the future of air and space transportation, exploration, communications, autonomous systems, national security, and education. This is our blueprint for the future.

ACKNOWLEDGMENTS

This strategic plan is the product of the entire faculty of the Department of Aeronautics and Astronautics. Particular thanks go to the faculty who served on the steering committee led by Department Head Julie Shah: Luca Carlone, Zachary Cordero, Olivier de Weck, Eric Evans, Jon How, Carmen Guerra-Garcia, Richard Linares, Eytan Modiano, and Zoltán S Spakovszky, with staff support from Janine Liberty and Kate Reynolds.

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Prof. Mark Drela and Alejandra Uranga PhD '10 working together on the Wright Brothers Wind Tunnel.

Photo credit: Adam Glanzman