



MIT Beaver Works Summer Institute 2025

HIGH SCHOOL PROGRAM

Draper



Autonomous
RACECAR
Grand Prix



Autonomous
Air Vehicle
Racing



Autonomous
Cognitive
Assistant



Remote Sensing
for Disaster
Response

AFFOA



E-Textiles
Wearable
Technology

RTX Project



UAS-SAR



Serious Game Design
and Development
with AI

MITRE Project



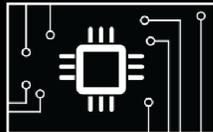
Embedded
Security and
Hardware Hacking



Data Science for
Health & Medicine

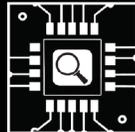


Cyber Operations



Microelectronics
and Hardware
Development

MITRE Project



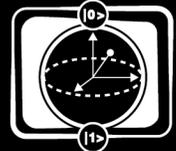
Basics of ASIC

MOL Mitsui O.S.K. Lines, Ltd.



Autonomous
Underwater
Vehicle Challenge

MITRE Project



Quantum
Software



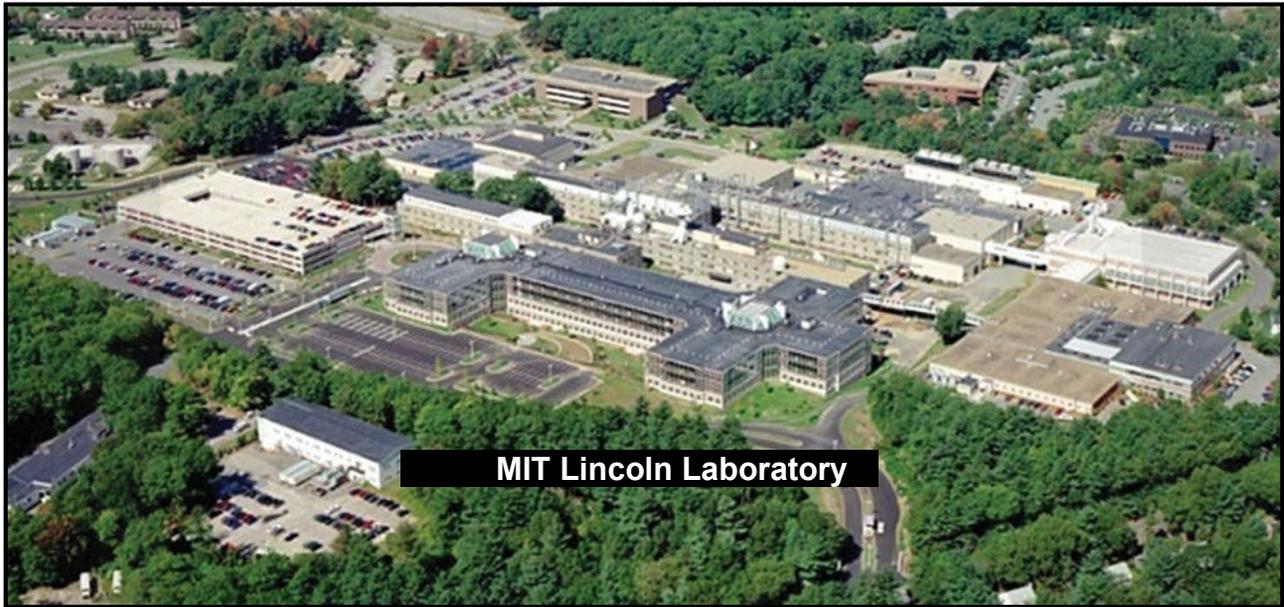
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Massachusetts Institute of Technology



MIT Lincoln Laboratory



MIT Lincoln Laboratory / School of Engineering Beaver Works

Pioneering STEM Education for Tomorrow's Innovators

The MIT Beaver Works Summer Institute (BWSI) is redefining STEM education for talented high school students, offering an immersive, hands-on learning experience designed to spark curiosity and ignite passion for cutting-edge technologies. Beyond its renowned four-week summer program, BWSI engages students year-round through Fall and Spring Saturday sessions and two national STEM challenges.

Since its inception in 2016 with a single course, BWSI has grown into a thriving global program. What began with 46 students in the RACECAR course—where teams programmed autonomous robotic cars to navigate racetracks—has blossomed into a diverse curriculum. By 2025, the program featured 14 summer courses, including autonomous systems, chip design, microelectronics, and advanced engineering topics. This year saw record participation, with over 400 students from 275 high schools nationwide, and 42% of admitted students identifying as female—a reflection of our commitment to increasing diversity in STEM.

BWSI has continued to grow by shifting both virtual and in-person formats, we are able to expand access as we continue to create new courses. Today, students complete online prerequisite courses on our elearning platform, powered by OpenEdx, enabling them to explore topics like AI, robotics, and programming before selecting their summer course. This ensures students are both prepared and genuinely excited about their chosen fields of study.



Beyond summer, our Fall and Spring Saturday programs introduce students to foundational concepts, with the Fall program focused on encouraging young women in STEM. These sessions serve as gateways to STEM, covering topics from aerodynamics to artificial intelligence. Meanwhile, our national challenges—The CRE[AT]E Challenge and the Build a CubeSat Challenge—allow students across the U.S. to collaborate on real-world projects, from assistive technology to space-based research missions.

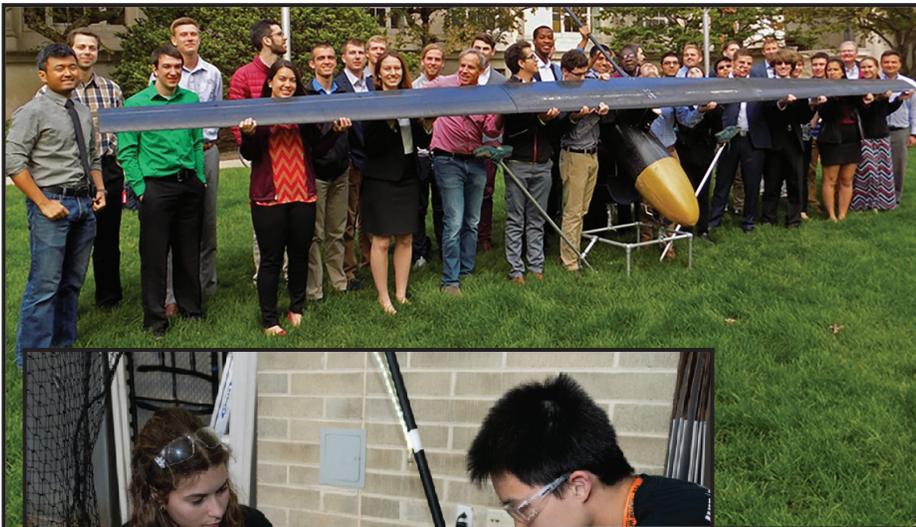
Looking ahead, BWSI is determined to expand its reach and impact. We're continuously developing new courses in emerging areas like data science, autonomous technologies, and advanced engineering. Our vision is ambitious: a global network of programs inspired by BWSI, empowering educators and schools worldwide to adopt our project-based approach. By sharing our resources and ideas, we aim to transform STEM education and prepare the leaders of tomorrow.

Join us in shaping the future of learning. To bring BWSI's innovative curriculum to your school or organization, contact us at bws-admin@mit.edu.

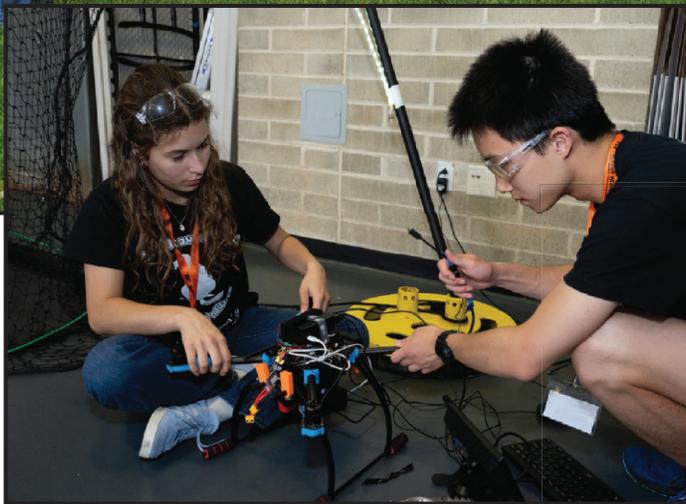
Beaver Works and BWSI: Two Programs, One Shared Vision – What is Beaver Works?

Beaver Works is a dynamic partnership between MIT Lincoln Laboratory and the MIT School of Engineering, serving as a catalyst for research, innovation, and education. Designed as an incubator for cutting-edge ideas, Beaver Works embodies MIT's commitment to project-based learning by bringing together the expertise of MIT faculty, students, researchers, and Lincoln Laboratory staff to tackle real-world challenges and foster cross-institutional collaboration.

Located in Cambridge, Massachusetts, Beaver Works is more than a workspace—it's a vibrant environment for innovation. Beaver Works was created by collaboration for collaboration! The facility features collaborative brainstorming areas, workshops equipped with tools for prototyping, and classrooms for immersive learning. By engaging students in hands-on projects, Beaver Works provides an exceptional platform for teaching complex engineering concepts and addressing real-world problems and issues.



Beaver Works supports research and educational initiatives, including capstone courses, research projects, and UROP internships. These programs challenge students to solve real-world problems while gaining practical skills and invaluable experience under expert mentorship of researchers.



At its core, Beaver Works thrives on collaboration and creativity, empowering students to push the boundaries of innovation and engineering excellence.



2025 MIT Beaver Works Summer Institute (BWSI) Showcase Ceremony.

CELEBRATE INNOVATION, DEDICATION, and INSPIRE THE FUTURE.

Join us as we celebrate the remarkable accomplishments of over 420 outstanding high school students from across the country! These talented young minds have spent the summer tackling real-world engineering and computer science challenges—and now it's time to show off what they've achieved.

What to Expect:

- Thrilling races, demos, and final project presentations
- Insight into cutting-edge STEM education
- Meet the dedicated instructors and mentors behind the scenes
- Celebrate the future of innovation—BWSI Class of 2025!

All Showcase events—both in-person and virtual—will be streamed at:

<https://web.mit.edu/webcast/beaverworks/sum25/>

From this single page, you can tune in to the live broadcast of Saturday's in-person event and Sunday's virtual presentations. Don't forget to bookmark the link!

We're excited to share the incredible accomplishments of the BWSI Class of 2025 with you!

Full schedule for both days is below and all times are listed in Eastern Daylight Time (EDT).

All in-person events are held on the MIT campus and will be live-streamed for remote attendees.

Agenda

August 2 In-Person

August 3 Virtual

11:00 AM - 11:30 AM

Opening Remarks

11:30 AM - 2:30 PM

Autonomous RACECAR Time Trials (W34 - Johnson Ice Rink)

11:30 AM - 1:30 PM

Unmanned Air System-SAR (W20 - Stratton Student Center, Lobdell)

11:30 AM - 1:30 PM

E-Textiles and Wearable Technology (W20 - Stratton Student Center, Lobdell)

11:30 AM - 1:30 PM

Embedded Security (W20 - Stratton Student Center, Lobdell)

11:30 AM - 1:30 PM

Autonomous Underwater Vehicle (W20 - Stratton Student Center, Lobdell)

11:30 AM - 2:00 PM

Autonomous Drone Racing (UAV; W35 - ZeSiger Sports Center, Mac Court)

2:30 PM - 2:45 PM

Break

2:45 PM - 3:00 PM

RACECAR Grand Prix - (W34 - Johnson Ice Rink)

RACECAR Grand Prix Virtual Race (Johnson Ice Rink) - This will be the final event of the day. Everyone is invited to join us for the final race and closing ceremonies.

3:00 PM - 3:15 PM

Closing Remarks

Agenda

August 2 In-Person

August 3 Virtual

11:00 AM - 11:25 AM

Opening Remarks

11:30 AM - 12:55 PM

Session 1

Cyber Operations; Quantum Software; Medlytics, Serious Games for AI

1:00 PM - 2:30 PM

Session 2

Basics of ASCIS; MicroElectronics; Autonomous Racecar; Remote Sensing; Autonomous Cognitive Assistant

2:30 PM - 2:45 PM

Break

2:45 PM - 2:55 PM

Dr. Bob Berman Award for Disruptive Engineering

2:55 PM - 3:00 PM

You Belong In STEM Essay Contest Awards

3:00 PM - 3:30 PM

Team Awards and Class Thank You's

3:30 PM - 4:00 PM

Closing Remarks

MIT Beaver Works Summer Institute

Summer Program: Course Overview

BWSI Summer program consisted of the following courses. Courses are offered both virtually and in-person on the MIT campus located in Cambridge Massachusetts. For more information on each course specifically, please see <https://bws.mit.edu>.



Autonomous Air Vehicle Racing

This course provides a holistic introduction to Unmanned Aerial Vehicles, more commonly known as drones. Throughout the course you will be challenged to think deeply about the complexities of software systems needed to operate an autonomous platform. The course begins with an introduction to UAVs. We examine the electrical, software, and aerodynamic characteristics of our platform and discuss the tradeoffs involved in building systems suited for a variety of use cases. You will

gain experience in building and debugging code using cutting-edge robotics software and simulation. Building on that knowledge, we'll then venture into the field of computer vision. We leverage on-board sensors to process visual cues from the world around our drones. We'll need this to detect and avoid obstacles as well as read QR codes. Underlying all of this is the mathematics of stable flight. We'll dive into a bit of control theory and write code that will be used to guide the UAV toward goals in a challenging environment. All these topics converge into a single challenge - a choose your own adventure project - where each team will have the opportunity to show off what they've learned.



Autonomous Cognitive Assistant

The Autonomous Cognitive Assistant course, CogWorks, uses project-based learning to immerse students in exciting applications of modern machine learning and data science. It was created in 2017 and is a course at the MIT Beaver Works Summer Institute (BWSI). The class consists of three distinct modules, which focus on applications of machine learning in the domains of audio, vision, and language, respectively. These modules bring students in contact with critical

foundational concepts in applied mathematics, science, and machine learning via compelling capstone projects that have important, real-world applications. The central ethos to this course is that all of these impressive projects can be completed without depending on any “mystery boxes” to do so.

Students in Cog*Works will be immersed in a hands-on environment, where all lectures are paired with detailed Python-based exercises that incorporate both applied mathematics and basic algorithms. The capstone projects are completed by teams of students, who will learn to use tools like git and VSCode to work together in a highly collaborative environment.



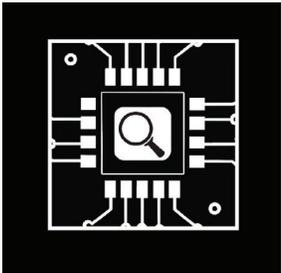
Autonomous RACECAR Grand Prix - Draper Project

Beaver Works Summer Institute will offer students, each with its own MIT-designed RACECAR robot, the opportunity to explore the broad spectrum of research in autonomy; learn to collaborate, and demonstrate fast, autonomous navigation in a Mini Grand Prix to *Move... Explore... Learn...Race!*



Autonomous Underwater Vehicles Challenge - MOL Project

This course will introduce students to the challenges faced by real-world ocean engineers in designing, building and programming autonomous underwater autonomous vehicles (AUVs). The culmination of the summer course will be an exciting test of true autonomy – the student AUVs will autonomously navigate a simulated underwater obstacle course, applying real-time decision making based on feedback from onboard sensors.



Back To bASICs – MITRE Project

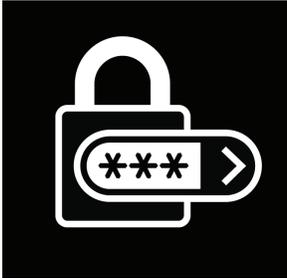
Beaver Works Summer Institute will offer a brand-new course on open source semiconductor design and fabrication this summer. This course will give students a fundamental and working knowledge of *the* building blocks of today's electronic world—knowledge that will benefit the student no matter what they decide to pursue academically. Students will receive hands-on experience on how to design and arrange semiconductors on a nanometer scale to perform a specific function. Students will start with a

blank canvas (silicon substrate) and learn how to take a specification through the entire design process—including foundry manufacturability. Once complete, the student's design will be sent to a foundry for fabrication. Six months later we'll host a class reunion and the students will be provided a dev kit with their custom design permanently etched in silicon—a milestone to be treasured for a lifetime!



Cyber Operations

Beaver Works Summer Institute will help students learn and understand a variety of techniques and environments relevant to cybersecurity. The topics will include, but are not limited to: networking, system administration, cyber threat intelligence, network defense, basic and advanced cryptography, software / malware analysis, and side-channel analysis. The course will also touch on challenges unique to non-traditional computing platforms (e.g. satellites). After dining on this smorgasbord, students finish the course by applying much of their new knowledge in a weeklong capstone activity.



Embedded Security and Hardware Hacking – MITRE Project

Beaver Works Summer Institute will cover several cybersecurity topics with a focus on threats that are especially concerning for embedded systems. These topics include cryptography, embedded systems, software security, side-channel analysis, and fault-injection. This background will help prepare students for the summer course, during which they will design and perform security assessments of multiple implementations of an embedded system. They will learn the basics of embedded security and hardware hacking by designing a secure system and performing security assessments of classmates' designs to see who can find and fix the most security flaws.



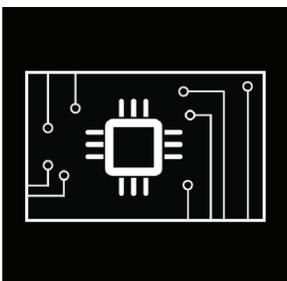
E-Textiles and Wearable Technology – AFFOA Project

Wearable technology is a growing field in which we bring technology closer and closer to the human to solve problems or take measurements where being next-to-skin is paramount. Whereas today the field of wearable tech is primarily dominated by smart watches and other similar “hard” wearables where encasing the electronics is fairly straightforward, in the not-to-distant future (and in some senses, now) we will see more wearable tech that is embedded seamlessly into the textiles that make up our clothing. However, there are many challenges the field currently faces to make these technologies commercially available, including washability and ensuring that hard-to-soft component connections are robust.



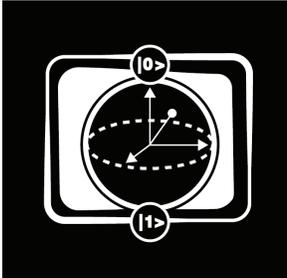
Medlytics (Data Science for Health & Medicine)

Beaver Works Summer Institute will give students a chance to explore the exciting intersection of data science and medicine. Students will build a solid foundation in the fundamentals of probability and statistics, and learn the basics of coding and machine learning techniques through a series of online teaching modules. During the summer, students will work in groups to gain hands-on experience applying advanced machine learning and data mining to solve real-world medical challenges.



Microelectronics and Hardware Development

Beaver Works Summer Institute will offer a brand-new course on microelectronics and hardware development this summer. This course will provide students with an overview of how microchips, PCBs, and hardware systems are made and how they run the world. Students will receive hands-on experience on how to design and implement hardware systems using microcontrollers and develop useful electronics that can impact our daily lives. At the start of the summer, students will receive a basic hardware kit and can ask for additional items to be purchased so they can implement their own unique designs. No prior experience with hardware is necessary, and we encourage novices to participate.



Quantum Software - MITRE Project

Beaver Works Summer Institute will offer students a chance to learn about quantum computing and algorithms. Students will learn fundamentals of quantum mechanics that make qubits unique and important to solving hard computational problems and develop algorithms that make use of qubit properties like superposition and entanglement. Students will be able to use quantum computing simulators to test their ideas and algorithms and explore the incredible opportunities with this technology.



Remote Sensing for Disaster Response

Beaver Works Summer Institute Remote Sensing program will offer students the opportunity to explore the exciting intersection of data science and disaster response. The program consists of two components: (1) online course from February to May 2023, open to all interested and committed students; and (2) a four-week virtual summer program. During the course, the students will learn to understand the basics of Python, Git, GIS, machine learning, and image processing through a series of online teaching modules. Students will explore real world datasets featuring disaster imagery from both satellites and aerial platforms. Students in this course will develop experience in an area of data science that is poised to play a critical role in understanding our world.



Serious Games Development with Artificial Intelligence

SGAI provides students with an introduction to game design and artificial intelligence by allowing them to create their own modifications to a game. These games are known as “Serious Games” and rather than being designed for entertainment serve the purpose of allowing us to better understand various real world situations such as disease spread, self driving cars and more! Once students are taught the basics of game design, team work, coding and others, they will begin working with their groups to develop a mod for the game we provide them to investigate a research question of their choosing. Artificial intelligence is used to investigate how a computer will handle the moral dilemmas it is put into and see just how well computers are able to compare to humans in the complex environments in the real world that these serious games are meant to reflect.



Unmanned Air System – Synthetic Aperture Radar - RTX Project

Beaver Works Summer Institute will introduce students to Synthetic Aperture Radar (SAR) imaging as they build and fly a radar on a small Unmanned Aerial System (UAS) and use it to image scenes around campus. Students will work in small teams alongside their instructors to gain hands-on experience building, integrating, and processing data from a radar to generate SAR images. Teams will compete to create the UAS-SAR capable of producing the clearest images possible.

BWSI 2025 Seminar Series

July 8 (Tuesday): Prof. Luca Carlone, MIT AeroAstro

Title: Spatial AI for Robots and Autonomous Systems

July 9 (Wednesday): Prof. Darcy McRose, MIT CEE

Title: Fascinating (and Sometimes Forgotten) Microbial Ecosystems

July 10 (Thursday): Prof. Ariel Furst, MIT ChemE

Title: Microbial Engineering for Human and Environmental Health

July 11 (Friday): Michaye (Hannah) Ledford, MIT Admissions

Title: Getting into College by Doing What You Love

July 14 (Monday): Hazem Mahmoud, Patrick J. McGovern Foundation

Title: Power and Responsibility: AI & Technology's Impact on Society

July 16 (Wednesday): Prof. Dava Newman, MIT AeroAstro

Title: Leading Innovation: Exploring Optimistic Futures

July 17 (Wednesday): Dr. Eli Niewood, US Air Force

Title: System Analysis of an Engineer's Career (8 Things I Wish I had Known Before I Started My Career)

July 21, 2025 (Monday): Prof. Hamsa Balakrishnan, MIT AeroAstro (in-person)

Title: Whole New Worlds: Multi-Agent Systems for Advanced Air Mobility, Aerial Sensing, and More

July 22 (Tuesday): Dr. Jerry Wohletz, Draper

Title: Perspectives on Leadership ... and My Journey

July 23 (Wednesday): Dr. Hosea Siu, MIT LL, Annie Katz, BWSI Alum

Title: The CRE[AT]E Assistive Technology Challenge

July 24 (Thursday): Melissa Choi, MIT Lincoln Laboratory Director

Title: MIT Lincoln Laboratory Overview

July 28 (Monday): Haley Wahl (Moderator), Adriana Dady, Allison Chang, Allister Azagidi, David Pierre, Maggie McLeod, Stephanie Shen

Title: You Belong in STEM panel

July 29 (Tuesday): Dr. Dana (Keoki) Jackson, Senior Vice President, General Manager, MITRE National Security

Title: Engineering for Impact: From Hawaii to High Stakes in National Security

July 30 (Wednesday): Dr. Mary Knapp, MIT Haystack Observatory

Title: Exploring the last spectral frontier: Great Observatory for Long Wavelengths Satellite Constellation (GO-LoW)

July 31 (Thursday): Nobuyuki Onishi, Mitsui O.S.K. Lines, Ltd.

Title: Update on Wind Challenger – Innovation of Wind Propulsion of Ships: May the “Wind Force” be with You

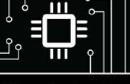
BEAVER WORKS

MIT Lincoln Laboratory MIT School of Engineering



Beaver Works Summer Institute 2025

HIGH SCHOOL PROGRAM

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 <p>Medlytics</p> <p>Data Science for Health & Medicine</p>	 <p>Cyber Operations</p>	 <p>Microelectronics and Hardware Development</p>	 <p>MITRE Project</p> <p>Basics of ASIC</p>	 <p>MOL Mitsui O.S.K. Lines, Ltd.</p> <p>Autonomous Underwater Vehicle Challenge</p>	 <p>MITRE Project</p> <p>Quantum Software</p>	 <p>AFFOA</p> <p>E-Textiles Wearable Technology</p>

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