

# EDUCATION PROGRAMMING GUIDE

# ABOVE AND BEYOND<sup>SM</sup>

THE ULTIMATE INTERACTIVE FLIGHT EXHIBITION

PRESENTED BY  **BOEING**



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ABOVE AND BEYOND—THE ULTIMATE INTERACTIVE FLIGHT EXHIBITION is made possible by Boeing. The exhibition is produced by Evergreen Exhibitions in association with Boeing, in collaboration with NASA and the Smithsonian's National Air and Space Museum.

Content for this Education Programming Guide is created by TurnKey Education, Inc., for Evergreen Exhibitions. NASA is a collaborator to the exhibition.

Education resources and programming for ABOVE AND BEYOND are made possible by Boeing in celebration of its centennial and its ongoing commitment to prepare and inspire the next generation to dream, design, and build something better for the next century. Boeing Centennial education collaborative partners include The Documentary Group, WGBH, PBS LearningMedia, Iridescent, and Teaching Channel. The Museum of Flight is an education collaborator.

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# I. WELCOME TO ABOVE AND BEYOND!

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**ABOVE AND BEYOND** is a 5,000-square-foot, multisensory, flight and aerospace exhibition that invites visitors to experience what it takes to make the “impossible” possible, in and above the sky. This unique learning opportunity is brought to you by The Boeing Company, and developed in collaboration with a host of renowned aviation specialists, aerospace experts, historians, archivists, teachers, and educational programming professionals.

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## WELCOME TO ABOVE AND BEYOND!

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**ABOVE AND BEYOND offers direct access to immersive simulations, interactive design challenges, iconic historical touchstones, visionary concepts for the future, and inspiring stories from game-changing innovators past and present.**

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Looking back at the history of flight, one thing is abundantly clear: The sky was never the limit. From the time humans first got off the ground, the race was on to go above and beyond. Faster . . . farther . . . higher . . . smarter! ABOVE AND BEYOND creates an uplifting and memorable experience that encourages all visitors to aim high and push past the limits in their lives. This exhibition is designed to ignite a passion for humankind's greatest adventure: our journey of flight in the air and space. In doing so, it honors past world-changing innovations in flight, while looking ahead to what's next, and demonstrating the impact of aerospace in our everyday lives. The exhibition also serves to inspire children and young adults to imagine future careers in aerospace, and support educators in building STEAM awareness and skills among K-12 students.

As a companion to the educational experience at ABOVE AND BEYOND, you have access to standards-compliant teacher's guides for both

elementary school and middle school. Each of these guides contains original, accessible, STEAM-related classroom lesson plans for you to use and share.

This programming guide summarizes special programs that align with themes and content in the exhibition. These programs are developed as part of a larger educational initiative made possible by Boeing to commemorate their centennial anniversary. Boeing teamed up with several leading educational partners to cocreate K-12 resources that celebrate the science and engineering behind aerospace innovation and prepare students, families, mentors, and educators with skills for the next century. These resources are readily available to you in support of the learning initiatives in ABOVE AND BEYOND.

Take your students above and beyond in this communitywide celebration of flight!

# II. GO BEYOND: BOEING CENTENNIAL PARTNERS

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Boeing teamed up with several leading educational partners to cocreate K-12 resources that celebrate the science and engineering behind aerospace innovation and prepare students, families, mentors, and educators with skills for the next century. These resources are readily available to you in support of the learning initiatives in ABOVE AND BEYOND.

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*Learn more about ABOVE AND BEYOND at [www.AboveAndBeyondExhibition.com](http://www.AboveAndBeyondExhibition.com)*

\*Please note these complementary resources are included for awareness and consideration. Additional funding may be required to apply these resources and tailor programs to museums and their particular needs.

**CURIOSITY MACHINE:  
ENGINEERING DESIGN  
CHALLENGES FOR STUDENTS  
AND FAMILIES**

**TEACHING CHANNEL:  
TEACHER PROFESSIONAL  
DEVELOPMENT**

**WGBH/PBS LEARNINGMEDIA:  
AEROSPACE ENGINEERING  
COLLECTION**

**NASA: "MUSEUM IN A BOX"**



## ENGINEERING DESIGN CHALLENGES FOR STUDENTS AND FAMILIES

[www.curiositymachine.org](http://www.curiositymachine.org)

Select a Design Challenge for you and your family, and work together to create fun inventions—using the same process used in the real world—and with live guidance and assistance from real scientists and engineers.

Curiosity Machine is a community of scientists, engineers, children and their families who create, invent, and engineer together. The website is an initiative of the science education nonprofit Iridescent, and hosts design challenges that are open-ended and appropriate for children in grades K-12. With the support of a parent or mentor, even your youngest family members can navigate the Curiosity Machine website. There, they can watch inspirational videos that showcase the work and strategies of Boeing aerospace engineers. The videos are accompanied by related design challenges for children to build. Children will follow the Engineering Design Process with the support of a trained online mentor who guides and encourages them to persist through failure and bring their ideas to reality. The website guides children through the engineering design process, encouraging them to document their building steps using videos and pictures.

The activities on Curiosity Machine are appropriate for on-site programs and events for children and families. Families work together using simple, low-cost materials to complete design challenges and master key concepts based on current engineering research and work. These challenges are ideal for family fun days, summer STEM camps, after-school engineering clubs, and Scout sleepovers.

### Using this online program:

- *Students and families watch an inspiring video featuring a scientist or engineer explaining a concept they apply in their real work every day.*
- *Students and families explore an open-ended aerospace design challenge related to the scientific topics covered in the video presented.*
- *Students follow the engineering design process—Inspiration, Planning, Build-Test-Redesign, and Reflection—while working through each challenge.*

• *Students plan, build, test, and redesign their solution to the challenge, uploading videos, pictures and/or text demonstrating their inventions.*

• *Mentors provide one-on-one feedback to students and their families throughout their process of designing, building, and inventing solutions.*

In collaboration with Iridescent, Boeing engineers and scientists have helped to create hands-on design challenges based on the work they do every day as aerospace innovators. Try them all!

TO GET STARTED, GO TO  
[WWW.CURIOSITYMACHINE.ORG](http://WWW.CURIOSITYMACHINE.ORG).



**NOTE:** Check the site often, as projects are updated and new challenges are added.



## AEROSPACE

- **Deploy a Satellite:** Build a satellite with a 6-inch-square body that can deploy its own solar wings and antennae, and can fit inside a 9-inch-diameter tube.
- **Build a Plane Powered by Stored Energy:** Build a plane that is powered by stored energy from a rubber band, balloon, or spring. The plane should be able to fly straight for 5 feet.
- **Make a Wave Machine:** Make a device that will carry a wave and record the wave's movement.
- **Engineer an Air-Powered Spinning Machine:** Build an air-powered spinning machine inspired by the Boeing CST-100.

Visit the Curiosity Machine often to find more than 20 new Boeing-inspired challenges that will be added during the next year.

Check out these additional aerospace-related challenges you can also find on the Curiosity Machine (you'll need to register if new user):

- **Engineer a Balloon Helicopter:** Build a balloon helicopter that can fly at least 3 feet from the ground. (<https://www.curiositymachine.org/challenges/45/>)
- **Design a Powerful Bird Wing:** Design and build a powerful bird wing that can spin you around in an office chair when you flap it. (<https://www.curiositymachine.org/challenges/22/>)
- **Control a Microraptor's Flight:** Make a microraptor and then control its flight with attached strings. (<https://www.curiositymachine.org/challenges/64/>)
- **Engineer a Landing Device:** Build a device that will slow down your payload as it falls so it lands gently when dropped from 8 feet high. (<https://www.curiositymachine.org/challenges/13/>)

## TEACHING CHANNEL: SCIENCE AND INNOVATION 5TH - 8TH GRADE

<https://www.teachingchannel.org/engineering-curriculum-boeing>

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**Teaching Channel enables shifts in teacher practice by engaging educators in communities of practice that integrate real-world examples in curricula designed to align with globally competitive standards.**

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Teaching Channel is a thriving online community where educators can watch, share, and learn diverse techniques to help every student grow. It is a nonprofit video showcase of inspiring and effective teaching practices. Teaching Channel resources provide a unique opportunity to offer professional learning to you as an educator as part of your experience at ABOVE AND BEYOND.

The Teaching Channel community is all about getting better together, through the use of standards-compliant video and tools designed for teachers. With support from Boeing, 20 Boeing engineers and scientists and 10 teachers collaborated to create 10 science units for grades 5-8 that align with the exhibition content and the educational themes featured in ABOVE AND BEYOND. To access the curricular guides for the 10 units, each with 10 scaffolded lessons,

the teacher ancillary resources, and accompanying video, visit: [https://www.teachingchannel.org/engineering-curriculum-boeing.](https://www.teachingchannel.org/engineering-curriculum-boeing)

Teachers can download any of the 10 two-week units for free at [teachingchannel.org](https://www.teachingchannel.org) and/or encourage their district to join *Teaching Channel Teams*, an interactive collaboration platform for professional learning communities where teachers, coaches, and mentors can reflect and collaborate to improve teacher practice together with individual or group *Learning Plans*.

Observe these engineering design challenge lessons in action in the classroom and share DBL (Design-Based Learning) at its very best! Use these video best practices to engage your neighboring schools before, during, and after you host ABOVE AND BEYOND. Each theme represents a two-week unit of instruction emphasizing NGSS engineering design standards and science standards.



## POLYMERS FOR THE PLANET

This unit revisits the physical science properties of matter: mass, volume, density, boiling point, melting point, and solubility. Students are then introduced to polymeric materials and their properties with hands-on activities that explore types and uses of plastics and reinforced plastic composites.

## CUBESATS

This unit explores very small satellites sent out into space. These satellites are 10-centimeter cubes and carry a variety of payloads. The unit will embed lessons on volume, mass, and density; the common uses of satellites; how satellites function; and their orbits as well as force and motion in space.

## SPY GLIDERS

In this unit, students will explore glider design with a special emphasis on kinetic energy, conceptual models, small-scale models, and observations and data collection. Throughout the lessons, they will conduct research on how kinetic energy translates to distance traveled and how models can be used to learn the basics of flight.

## DESIGN A QUIETER CABIN

This project blends several important disciplines, including science, math, architectural design, industrial processes, and music, as students work to design a quieter cabin. Students are introduced to ultrasonics, electroacoustics, aeroacoustics, architectural acoustics, sonic boom creation and reduction, sound suppression, and sonification.

## THE SOFT LANDING: EGG ENGINEERING

This unit explores the core challenge of protecting an astronaut during a landing. Science concepts that are organic to the project include gravity, force, shock, material science, and impulse momentum theorem (increase time of impact to soften the blow) as well as electricity in parallel circuits.

## ALTERNATIVE ENERGY

This unit addresses wind as an alternate energy option. It features building an initial prototype, testing it, and then using backwards design analysis to prepare an improved turbine design. Students explore how lift, drag, and airfoil can be altered via design choices.

## BIOSUITS

The essential challenge in this unit focuses on biosuit construction. The suit must address biological necessities and ensure that its user can survive multiple environments while completing key tasks. Students will examine the relative differences between local and extreme environments and review different environmental effects on the body.

## MISSION TO MARS

Students will simulate a launch sequence for a manned mission to Mars. The unit will encourage deeper understanding of gravitational forces and how direction, friction, mass, and air pressure affect the force necessary to launch objects.

## BOLT CATCHER

This unit engages students in an engineering design challenge to create reusable crew capsules. The core project helps students learn the importance of force and motion in the area of space science, as well as ways these concepts are applied to other areas of science and life, including the necessary interests, aptitudes, and programs of study to pursue a career in engineering.

To access these Science and Innovation units, visit: <https://www.teachingchannel.org/engineering-curriculum-boeing>

*Science and Innovation Special Offer from Teaching Channel:*

*Teaching Channel Teams is an award-winning, video-enabled, professional learning platform for educators to interact in a professional learning community. Teaching Channel offers a variety of teacher professional development options to schools and districts interested in supporting teacher engagement and understanding of the Science and Innovation units through Teaching Channel Teams. The Learning Plans in Teaching Channel Teams prepare teachers to authentically implement the Science and Innovation units in their classrooms. Professional learning options range from one to three days of on-site professional development, with all options including a one-year site-based subscription to Teaching Channel Teams and virtual support from Teaching Channel.*

Contact Teaching Channel at [teams@teachingchannel.org](mailto:teams@teachingchannel.org) for Teaching Channel Teams information.

# WGBH/PBS LEARNINGMEDIA: AEROSPACE ENGINEERING COLLECTION

## DOCUMENTARY FILM SERIES

### THE AGE OF AEROSPACE (Coming Soon)

Driven by the galloping pace of technological innovation, the last 100 years have seen more changes in the way we live than any previous century in human history. There has been no greater driver of this transformation than the cascade of invention inspired by the Wright Brothers that brought us air travel, the Jet Age, space exploration, and satellites—man-made celestial bodies orbiting the earth—

that literally affect almost every moment of our lives.

*The Age of Aerospace* is a multipart documentary series that tells the story of how this happened through the lens of an aerospace giant, The Boeing Company, which today is the largest aerospace company in the world, having acquired or merged with many of the most important

aerospace companies of the last century: McDonnell, Douglas, North American Aviation, Rockwell, Piasecki/Vertol, and Hughes Satellite Systems. The story of these companies is the story of men and women whose intelligence and imagination were focused on engineering the future and thereby transforming our lives.

## DOCUMENTARY SERIES EDUCATIONAL CONTENT

### AEROSPACE ENGINEERING

Collection on PBS LearningMedia™

[www.pbslearningmedia.org/collection/aeroeng/](http://www.pbslearningmedia.org/collection/aeroeng/)

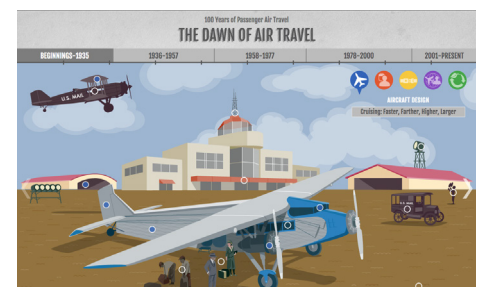
In addition to the documentary series, the producers of *The Age of Aerospace*, The Documentary Group, have partnered with WGBH Boston to create a suite of educational resources that will be distributed on PBS's educational service, PBS LearningMedia. Using video and interactive media, these resources will give students a window into what it takes to make something fly, the scientific concepts that make flight possible, and the history of aviation, while introducing them to some of the people who build the machines

that take us into the sky. These resources support the middle and high school Engineering Design ideas and practices of the Next Generation Science Standards and state standards.

**Mini-documentary:** A 3- to 5-minute excerpt from an episode of the documentary series that exhibits a major milestone or theme of aerospace engineering. Mini-documentaries are surrounded by essays, relevant primary sources, additional media, and links to related resources on PBS LearningMedia, all of which allow students to further explore concepts and themes

discussed in the videos.

**Interactive:** A student-guided interactive examination of major ideas of aerospace. These resources allow students to explore a subject at their own pace and through their own path. In one interactive, experience the engineering design process as an aerospace engineer assigned

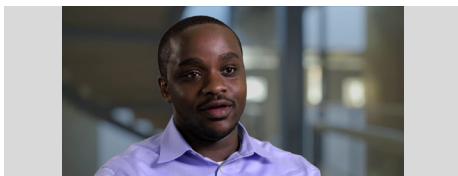


to design and test an airplane. In the other, immerse yourself in five illustrated scenes, each depicting an era of passenger flight, and explore the changes that have occurred in passenger air travel since the dawn of commercial aviation, in an interactive graphic timeline.

The screenshot shows the PBS LearningMedia interface for the 'Challenge of Flight' resource. At the top, there's a navigation bar with 'PBS LearningMedia', 'WGBH', and 'LOG IN'. Below that is a search bar and 'BROWSE BY OPTIONS'. The main content area features a 'Challenge of Flight' section with a star rating and a description: 'Examine the physical forces that act on a plane in flight, the motions a pilot controls, and the design process engineers follow to develop planes that meet a business mission and manage these flight conditions, in this interactive produced by WGBH and The Documentary Group. The first part of the interactive uses videos, still images, and diagrams to explain the four forces of flight (lift, thrust, drag, and weight) and the three vectors a plane experiences in flight (roll, pitch, and yaw). The second part explores the four primary steps of the design process and the tools today's aerospace engineers use in their work.' Below this is a grid of interactive elements: 'Introduction', 'Design', 'Testing', '21st Century Tools', 'Constraints', and a 'LAUNCH' button. To the left, there's a sidebar with 'Info', 'Grades 5-12', 'Permitted Use: Stream, Download and Share', '125 Favorites', '2234 Views', and 'Credits Funded By BOEING'. Below the grid, there's a 'Support Materials' section with a 'Background Essay' and 'You might also like' recommendations including '100 Years of Passenger Air Travel', 'Higher and Faster', 'Profile: Simon', and 'Profile: Victoria'.

**Exploration:** A multimedia presentation of specific concepts of aerospace and relevant physics. These resources use short videos, images, graphics, and text to guide students through concepts from various perspectives.

**Profiles:** Videos that show students how aerospace engineers work and think by hearing from engineers themselves. Each profile



features an engineer from across the aerospace industry, from satellites to commercial airplanes to the next rocket to Mars, talking about his or her experience as an engineer. By meeting working aerospace engineers, students will learn what it takes to build something that flies, from the people who actually make it happen.

### About PBS LearningMedia:

PBS LearningMedia ([www.pbslearningmedia.org](http://www.pbslearningmedia.org)), a partnership of PBS and WGBH, provides Pre-K–12 educators with access to free digital content for their classrooms, designed to improve teacher effectiveness and student achievement. The service offers more than 100,000 standards-aligned digital resources from 205 trusted media partners. Currently, 1.7 million educators have registered access to PBS LearningMedia content. PBS LearningMedia is offered locally by 155 PBS licensees, representing 356 stations in 55 U.S. states and territories.

### Partners:



**The Documentary Group** produces work based on a very simple principle: have faith in the intelligence, taste, curiosity, and integrity of the audience. The Documentary Group was founded in 2006 by the core members of PJ Productions

following the death of legendary broadcaster Peter Jennings. The producers and directors, who were for many years the team behind Jennings' documentaries at ABC News, are dedicated to continuing the tradition of smart and innovative filmmaking while enthusiastically embracing the modern and expanding media landscape. An independent production company, with offices in New York and Los Angeles, The DocGroup produces long-form and short-form films for the major commercial networks, public television, and cable, as well as for the educational market, digital distribution, and theatrical release. <http://thedocumentarygroup.com/>



**WGBH Boston** is America's preeminent public broadcaster and a major contributor to PBS LearningMedia, which was built using WGBH's digital resource website Teachers' Domain as a foundation. WGBH is the largest producer of PBS content for TV and the Web, including *Frontline*, *Nova*, *American Experience*, *Arthur*, and *Curious George*. WGBH also is a major source of programs for public radio (producing PRI's *The World*<sup>®</sup>) and a pioneer in technologies and services that make media accessible to hearing and visually impaired audiences. Find more information at [wgbh.org](http://wgbh.org)

## NASA: "MUSEUM IN A BOX"

[www.aeronautics.nasa.gov/mib.htm](http://www.aeronautics.nasa.gov/mib.htm)

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The "Museum in a Box" program brings the physical sciences of flight to students in grades Pre-K–12. These self-contained activities provide hands-on/minds-on lessons with an aeronautics theme to inspire future scientists, mathematicians, and engineers.

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This group of exercises provided by NASA is perfectly suited for expanding your in-classroom exploration of the themes in ABOVE AND BEYOND.

The following lessons, listed with their recommended grade levels, are available to download from [www.aeronautics.nasa.gov/mib.htm](http://www.aeronautics.nasa.gov/mib.htm)

**NOTE:** Please check the supply list for each activity. All materials must be provided by the user.

## DRESSING FOR ALTITUDE

Why Do We Really Need Pressure Suits? (5-12)

## HISTORY OF FLIGHT

Designing an Aeronautics Museum Gallery (5-12), First Flyers (PK-4), If These Airplanes Could Talk (5-12)

## PARTS OF AN AIRPLANE

Getting on an Airplane (K-2), Parts of an Airplane (K-4, 5-8, & 9-12)

## PRINCIPLES OF FLIGHT

Axes/Control Surfaces (K-4 & 5-12), Bernoulli's Principle (K-4 & 5-12), Foam Wing (K-12), Four Forces (K-4 & 5-12), Kites (K-4 & 5-12), Principles of Flight in Action (9-12)

## STRUCTURES AND MATERIALS

Composites (K-12), Space Shuttle Tiles (2-4, 5-8, & 9-12), Space Shuttle Tires (K-4 & 5-12), Space Shuttle Tires Supplemental Lessons (K-12)

## PROPULSION

Ball Launcher (5-12), Rockets Away (K-12), Wind Power (9-12)

## FUTURE FLIGHT

Aerolab (5-12), Fuel Cell Activity (5-12), Solar Power (5-12)

## CAREERS IN AERONAUTICS

Careers in Aeronautics (5-12)

## AIRSPACE

Contrails (K-12), Noise: Good Vibrations (K-8 & 9-12), Noise: Quieting the Popper (5-12), Noise: Seeing Sound (K-8), Noise: Speed of Sound (9-12), Pollution: Making Oxygen and Carbon Dioxide (K-12), Weather to Fly By (K-8)