SMART SPIN
Encyclopedias as Adventures

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Aviation Smarty

How did we conquer the skies? From early flying toys to Leonardo da Vinci's dreams; from lighter-than-air experiments to the Wright brothers' historic flight; from unmanned drones to space rockets… Aviation has been one of humanity's greatest adventures, and we're still going strong. Let's learn about the origins and principles of air travel, the aircrafts that take us there and the heroes that fly them.

TO THE COLLECTION >

Smarties are inspirational guides for educational activities. Click on the red button below to know more about them.

Smarties are complemented by our **Smart Spin** online encyclopedia. Click on the green button below to explore it.

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   Books, films and games about aviation, matching the topics in the collection.

1. Paper Airplane

One of the best ways to learn about the principles of flight is with paper airplanes. In fact, paper airplanes were used by engineering pioneers to design and improve powered aircrafts. Instruct and join your learner in making some planes out of paper and see what you can learn along the way.

★ Paper Plane

Resources

Here are some websites and articles that can guide and instruct you on how to build paper airplanes:

- Scientific American invites you to experiment with different models of paper airplanes with different drag, and learn about aerodynamics in the process. There are also instructions for a wingless ("hoopster") paper airplane.
- Fold 'n Fly offers guides for a wide variety of paper planes, arranged by types of flight and difficulty of folding. Each guide comes with an instructional video.
- Fun Paper Planes goes a step further and offers printable templates. They also have some nifty tips on how to make your planes even better.
- Paper Airplanes HQ is another great resource for a variety of plane models, with video folding demonstrations for each step!
- WIRED features the current distance world record holder for a paper plane (the "Paper Airplane Guy") who shows how to fold winning airplanes (video).
- DIY network describes how to make 5 classic paper planes - The Dart, The Stealth, The Bumble, The Hunter, The Bullnose.

Books

Here are some recommendations for books that teach how to make paper airplanes. Some of them even include materials and tools to help you through the process.

- *The New World Champion Paper Airplane Book: Featuring the World Record-Breaking Design, with Tear-Out Planes to Fold and Fly*
  - by John M. Collins (the “Paper Airplane Guy”)

- *The Gliding Flight: Simple Fun with a Sheet of Paper-Make and Fly 20 Original Paper Airplanes Using No Glue or Cutting*
  - by John M. Collins

- *Klutz Book of Paper Airplanes Craft Kit*
  - 10 different planes with 40 sheets of custom-designed paper. Very cool!

- *The World Record Paper Airplane Book*
  - by Ken Blackburn and Jeff Lammers

- *The Ultimate Guide to Paper Airplanes*
  - by Christopher Harbo

To Consider

While you are building your airplanes, try to think about how you might build them to perform better knowing the following...

There are 4 main forces that act on a paper airplane (or a real airplane for that matter) while it is flying:

- *Lift* is the force that keeps the airplane in the air. Without lift the plane would not fly. Lift can be a very complicated force to explain, but here are two basic models to give an intuitive understanding.
    - *Bernoulli's Principle* (named after Swiss Physicist Daniel Bernoulli): If you ever look closely at the wings of an airplane from the side, you will notice that they are not flat. The wing has a curved shape to it. This shape is called an airfoil. Airfoils are specially designed to produce lift. To understand how Bernoulli's principle causes lift, we must first understand that air usually presses equally on all sides of an object. Suppose that as the plane flies forward, the approaching air splits up when it hits the leading (front) edge of the wing and rejoins at the trailing (back) edge of the wing. The airfoil shape causes the air to go farther over the top of the wing than under the bottom, both in the same amount if time. This means the air on top of the wing must move faster. When air speeds up, its pressure gets lower. Since the air pressure on top of the wing is lower than the air pressure on the bottom of the wing, the wing produces lift! This phenomenon is called Bernoulli's principle.
    - *Newtonian Explanation:* Isaac Newton stated in his famous third law that "for every action, there is an equal and opposite reaction." Newtonian lift largely depends on the tilt of the wing or "angle of attack". If the leading edge of the wing is pointing upward, the bottom surface is deflecting oncoming air downward. When this air bounces off the bottom surface of the wing (action), it pushes the wing upward (reaction)...or produces lift.
- *Gravity* is a force that we are all familiar with. It's what causes any object you throw into the air to come back to the ground. Gravity is also what keeps us on the ground. Without gravity, we would all float away into space! With airplanes, gravity works against lift by pulling the airplane toward the ground.

- *Thrust* is the force that causes the plane to move forward through the air. In a real airplane, this is produced by the turning propellers or jet engine. With a paper airplane, the thrust is produced when you throw the plane into the air. Without thrust, planes could not produce lift.
- *Drag* is the force that tries to slow the airplane down. Drag is produced when air flowing over the plane causes friction. When the plane is flying, it must push oncoming air out of the way. As this air is pushed around the plane, it bumps into other air molecules. Air close to the surface of the airplane also wants to try to stick to it. All of this causes friction. Have you ever ridden your bike on a windy day? The wind hitting you in the face that makes it hard to keep moving is drag.

Lift and *thrust* help to keep a plane flying. *Gravity* and *drag* work against it. We can't do anything to change gravity, but we can try to minimize drag and increase lift and thrust. This will make a paper airplane fly well.

You might also want to watch the following videos to learn more about the principles of flight:

- How airplanes fly
- How to make airplanes fly faster
- How wings work
- History of wings
- Why wings are angled backwards
- How winglets work
- How bird wings work

Criteria

Paper planes are typically judged (in competitions), based on:

- *Distance* - how far the plane landed relating to where it was thrown.
- *Time* - how long the plane was in the air before touching the ground.

- ➔ *Aerobatics* - what maneuvers the plane performed (e.g. looping).
- ➔ *Stability* - how stable the plane was while in the air (kind of the opposite of aerobatics).
- ➔ *Decoration* - how cool the plane looks.

When designing, building and testing your plane, think about:

- ❏ Is it a plane that's going to excel at *distance* or is it a plane that can stay for a long *time* in the air? Are you designing it for doing *aerobatic* tricks or testing it in order to perfect its *stability*?
- ❏ What type of paper are you using? Is it heavy but sturdy or light but flimsy?
- ❏ Are you *decorating* your plane, such as painting it or using special printed paper? Do any of the decorations affect the plane's flying performance?
- ❏ How will you be launching your plane? Are you going to gently guide it upwards in a 45 degrees angle, or are you going to forcefully throw it forward as fast as you can? Are you going to do it yourself, ask a tall or strong friend, or use a launcher?
    - ❏ Check out the following videos on how to make a launcher:
        - ❏ DIY Semi-Automatic Paper Plane Launcher
        - ❏ DIY Mini Popsicle Paper Airplane Launcher
    - ❏ You can also buy a ready-made one, such as the "Science Museum Paper Plane Launcher" or "The Ultimate Paper Plane Launcher Shooter".

Note: You may choose to do this activity for building aircrafts that are not made out of paper, or are not planes. Here are some examples:

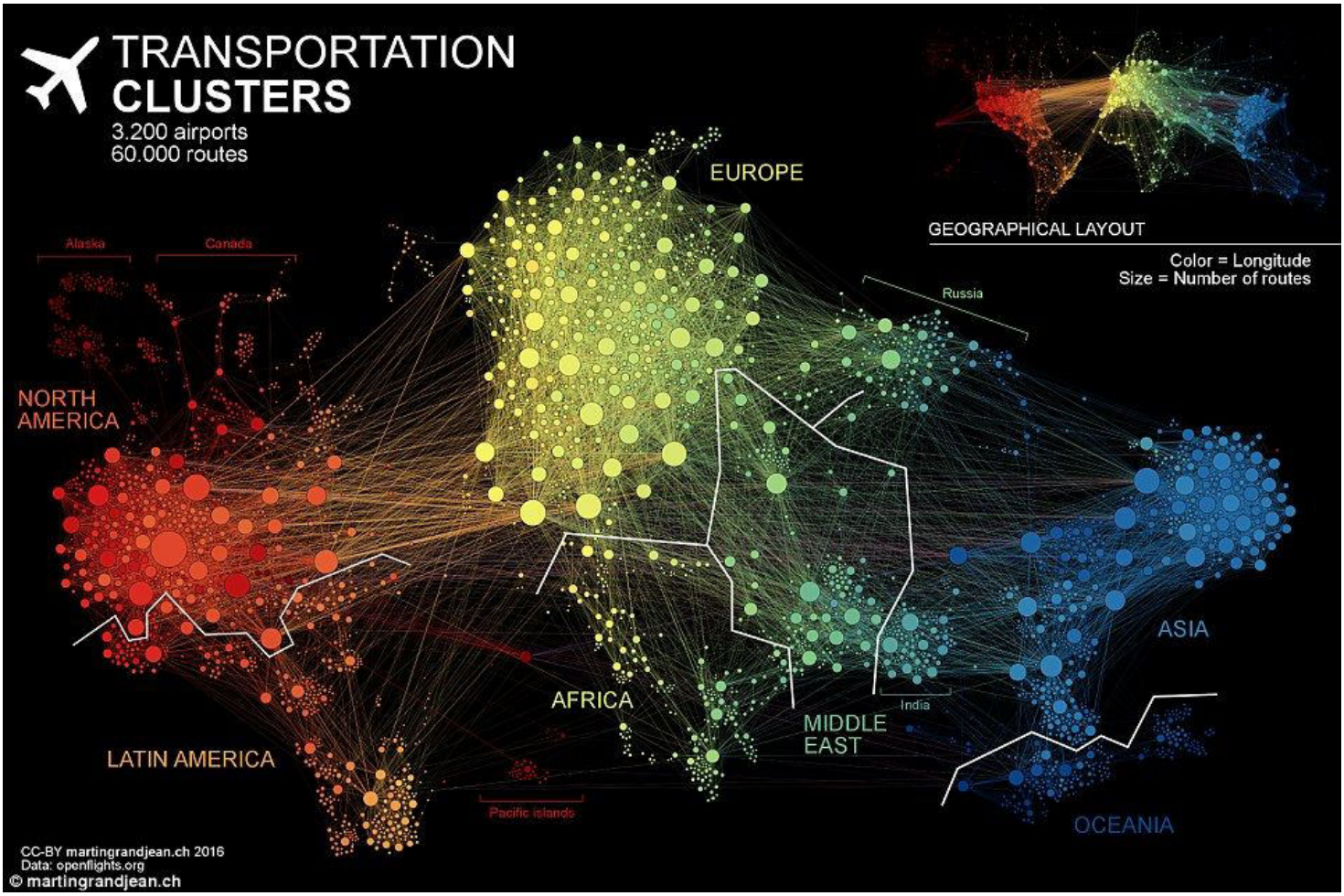
- ❏ Foam glider airplane
- ❏ Rubber band helicopter
- ❏ Bottle rocket
- ❏ Sky Lanterns

2. World Travel

SOMETHING TO LEARN

In this fascinating map, which you are invited to present to your learner, world travel is visualized in a vivid way.

Check out this cool map:



It shows the visualization of 3,200 airports and 60,000 routes between the different countries around the world.

- As people increasingly take to the skies to travel around the world, air traffic has grown to become a ‘tangled’ global network.
- The colour-coded data shows just how cluttered the skies really are when the routes are considered at once, pulsating to reveal the geographic locations that correspond with these networks.
- In the map, longitude is represented by different colours, while the number of routes are indicated by size.
- The map was created using a force-directed layout algorithm on a graph of 3,275 airports from OpenFlights.org data.
- Notice:
  - Europe is extremely dense, and the dots (airports) are hard to differentiate.
  - India is more connected to the Middle East than it is to South and East Asia, and Latin America is strongly divided between South and Central America clusters.
- Fun facts:
  - Hartsfield–Jackson Atlanta International Airport has been the world's busiest airport every year since 2000. More than 100 million passengers pass through it each year. It is followed by Beijing Capital International Airport (95 million passengers). Next are airports in Dubai and Tokyo.
  - With all airports combined London has the world's busiest city airport system by passenger count.
  - As of 2017, seven countries have at least two airports in the top 50; the United States of America has 15, Greater China has 10, and the United Kingdom, Japan, Germany, India and Spain have two airports each.
  - There are about 44,000 airports in the world.
  - In 2016 there were an average of 9,728 planes — carrying 1,270,406 people — in the sky at any given time.

3. Fly With Me

Your learner (and you as well) may spin through the collection (and sub-collections), to spur a discussion based on the following questions.

Spin through the **Aviators** sub-collection:

- ➔ Who is your favorite aviator and why? Is it the aviator with the most impressive accomplishment or the most important contribution to aviation? Is it the one with the best piloting skills or one that performed the most daring flights?
- ➔ Did they accomplish something no one else did? Were they the first to do it? Did they win anything?
- ➔ Did they contribute to progress in aviation? How did they do that?
- ➔ What was their craft of choice? Was it instrumental to their achievements?
- ➔ Can you think of questions you'd like to ask them, if you were to interview them?

Spin through the **Aircrafts & Spacecrafts** sub-collection:

- ➔ What is your favorite aircraft or spacecraft?
- ➔ What's special about it? Does it have an interesting story behind it? Does it feature a technological breakthrough you appreciate?
- ➔ Did a famous aviator fly it? Did they use the aircraft or spacecraft for a historic flight? What were the challenges and dangers of flying it?
- ➔ Can you imagine yourself flying it, designing it or building it?
- ➔ What is your favorite type of craft? Is it powered or unpowered? Is it an aerostat & aerodyne? A fighter jet or an experimental design?

- ➔ What is your favorite part of any craft? Is it the rotor? Is it the engine? The wings? The controls? The tail? The fuel tank?! Some crafts have parts that others don't, so choose the favorite part among all the crafts you know, even not all of them have it.
- ➔ Can you imagine your dream aircraft or spacecraft? Can you try and design it, such as with a drawing, or describe it in words? Can you try and build a model?

Spin through the **Aviation** collection:

- ➔ What do you think is the most important or groundbreaking advancements in aviation history? When did they happen or were made? Who were responsible for these breakthroughs? What did they do to achieve them? Who else contributed to these achievements?
- ➔ What advancements do you think the future holds? Can you imagine what kind of breakthroughs might be achieved in the years to come? Is it going to be faster airplanes, safer ones or more fuel-efficient ones? Are planes going to fly higher or carry more travelers? Is it going to be in the field of unmanned flight (drones) or flight simulators? What about new types of aircrafts?

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4. Timeline to the Sky

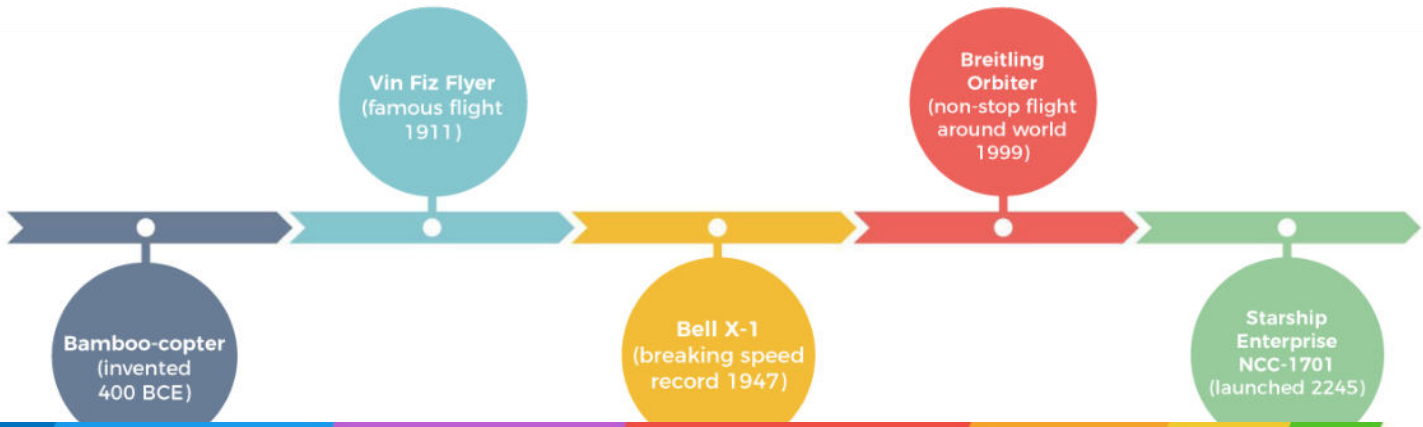
Your learner may want to place the famous aircrafts and spacecrafts of history (and fiction!) along a timeline, to get a visual overview of the history of aviation.

Spin through the **Aircrafts & Spacecrafts** sub-collection:

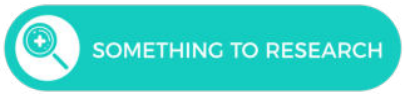
TO THE COLLECTION >

For each craft you find, can you place it along a timeline?

- You can place the date of its famous flight and/or the date it was built or invented. You may also choose any other significant date associated with the craft.
- You may try to include even fictional aircrafts & spacecrafts.
- You may add to the exercise, on the same timeline, by including noteworthy dates from the Aviators sub-collection, as well as topics from the main collection.
- The timeline can be a simple chronological order, or you can try and be more precise with the scale (for example, leave a large gap between Bamboo-copter (400 BC) and Vin Fiz (1911) than between Vin Fiz and Bell X-1 (1947)).
- If you are preparing the timeline to scale, can you notice interesting trends in the history of aviation? Was there a turning point (or period) when the field of aviation seemed to progress faster? What breakthrough contributed to it? For example, the Orteig Prize may have encouraged a rush of development of new aircraft technology. You may research more important dates in aviation (in the collection or other resources) to include more data points on the timeline, for more insights.
- What else can you learn from examining the timeline? Can you extend it by imagining the flight of future crafts (and other aviation developments) and when (roughly) they might happen (for example, the first unmanned commercial plane).
- See example:



5. Aviation Fails



Unfortunately, along with many successes and great progress in aviation, there are also quite a few disasters, such as the Hindenburg disaster (see also the famous photo, and about Zeppelins). We can learn from them as much as we can from successes.

Have your learner search for 3 more aviation disasters (in the collection, or in any other resource). These need not be a fatal or catastrophic disasters; they may include incidences such as failed experiments and disappointments. These may include ***mysterious disappearances****. We made a special sub-collection for these:*

For each disaster, find out:

- ➔ What happened? What went wrong? Was it a technical fault or human error?
- ➔ How was it investigated? If you were to investigate it, how would you go about it? How would you collect information and analyze it (e.g. use computer algorithms to scan through satellite footage)? Who would you interview, how would you search for clues? What tools would you use (e.g. sonar, drone flights)?
- ➔ What aircrafts (or spacecrafts) were involved?
- ➔ Did it involve any notable aviators? Did they survive? Who else was involved?
- ➔ Could this disaster have been prevented? How?
- ➔ What should have been done differently in hindsight? What was learned, or what can be learned, from this disasters?

For each disaster, you may want to prepare a “report”, covering the available information about the disaster, and providing conclusions and guidelines for correcting errors and faults.

6. Drone Traffic Controller

In this exercise, your learner will consider air traffic by assuming the role of a drone traffic controller, and a designer of flight algorithms.

A Drone Traffic Controller is a professional responsible for monitoring and directing the traffic of unmanned aerial vehicles (UAVs). Currently there aren't many drones up there, so this this is more of a future job, yet drones are expected to populate our skies in much greater numbers sooner than we might think.

- ➔ Can you propose 5 traffic laws that govern the use of UAVs in public spaces (such as inside cities)?
  - ◆ Can you think of laws that relate to the owners of these vehicles, their pilots, their manufacturers? For example, laws that specify the safety measure that a pilot must take in order to prevent collisions, or the quality assurance protocols that manufacturers must follow to prevent malfunctions.
  - ◆ What about laws that relate to the general public, such as obligations to report drones that violate privacy, or what to do when encountering a lost one?

Some UAVs are not controlled by pilots but by a computer that follows algorithms. These algorithms are essentially sets of rules that describe what the UAV should do in different situations. For example, how high they must fly relative to the top of buildings and in certain weather conditions, or what to do if it gets too close to another UAV, or what if a person suddenly stands in their way.

- ➔ Can you think of a series of such rules that optimize the efficiency of UAVs' flights and maximize safety of their operation?

- For example, you can think of how the drone should behave when taking of and landing, or how to fly through heavy winds, or how to switch between sensors depending on changing conditions (such as when visibility is low). You can think of what a drone should do when its battery is low (to prevent a crash), for a more specific example.
- Try to think of extreme situations that might be difficult for a drone to navigate in, such as when it is surrounded by other drones from all sides (the best strategy in this case might be to maintain a 1 meter distance from each other drone until there is a clear path to fly away through), or when the drone's sensors shut down (the best strategy in this case might be to either keep hovering at the same position and try to signal an error message to the owner or flight controllers, or it might be to immediately land directly below their current position).
- Of these rules that you thought of, which do you think human pilots follow when they fly airplanes? These might not be exactly the same rules, but similar ones, or similar principles that any flying vehicle should follow.

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7. Recommendations

Films

- ➔ **Documentary: "Amelia Earhart: The Price of Courage" (1993)**
- ➔ **Docudrama: "Amelia Earhart: The Final Flight" (1994)**
- ➔ **Film: Amelia (2009)**
  - ★ *Related topics:* Amelia Earhart

➔ **Film: The Spirit of St. Louis (1957)**
- ★ *Related topics:* Charles Lindbergh
- ★ *Related topics:* Spirit of St. Louis

➔ **Film: The Aviator (2004)**
- ★ *Related topics:* Howard Hughes
- ★ *Related topics:* Spruce Goose
- ★ *Related topics:* Hughes H-1 Racer

➔ **Film: Wings of Courage (1995)**
➔ **Biopic: Saint-Ex (1996)**
- ★ *Related topics:* Antoine de Saint-Exupéry

➔ **Documentary: “Black Sky: The Race For Space” (2005)**
- ★ *Related topics:* SpaceShipOne

➔ **Documentary: One Six Right (2005)**
- ★ *Related topics:* Paul Poberezny

➔ **Film: The Right Stuff (1983)**
- ★ *Related topics:* Chuck Yeager
- ★ *Related topics:* Bell X-1

➔ **Documentary: Flying the Feathered Edge (2014)**
- ★ *Related topics:* Bob Hoover

➔ **Film: The Red Baron (2008)**
- ★ *Related topics:* Red Baron
- ★ *Related topics:* Fokker Dr.I

➔ **Film: The Rocketeer (1991)**
  ★ *Related topics:* Jet Pack

➔ **Film: Sole Survivor (1970)**
  ★ *Related topics:* Lady Be Good

➔ **Documentary: 'The Farthest' (PBS)**
  ★ *Related topics:* Voyager 1

Books

➔ **Memoir: “The Fun of It”, by Amelia Earhart**
  ★ *Related topics:* Amelia Earhart

➔ **“The Big Jump - Lindbergh and the Great Atlantic Air Race”, by Richard Bak**
➔ **“One Summer: America 1927”, by Bill Bryson**
➔ **Biography: “Lindbergh”, by A. Scott Berg**
  ★ *Related topics:* Charles Lindbergh
  ★ *Related topics:* Spirit of St. Louis

➔ **The Little Prince, by Antoine de Saint-Exupéry**
  ★ *Related topics:* Antoine de Saint-Exupéry

➔ **A Man on the Moon, by Andrew Chaikin**
➔ **Biography: First Man, by James R. Hansen**
  ★ *Related topics:* Neil Armstrong

➔ **Poberezny: The Story Begins, by Bonnie Poberezny and Chuck Parnall**
  ★ *Related topics:* Paul Poberezny

➔ **The Right Stuff, by Tom Wolfe**
- ★ *Related topics:* Chuck Yeager
- ★ *Related topics:* Bell X-1

➔ **Novel: Five Weeks in a Balloon (Jules Verne)**
- ★ *Related topics:* Breitling Orbiter 3

Video Games

➔ **Video game: Lunar Lander**
- ★ *Related topics:* Lunar Module

➔ **Video game: Kerbal Space Program**
- ★ *Related topics:* Single-stage-to-orbit
- ★ *Related topics:* Lunar Module
- ★ *Related topics:* Space Shuttle

Space

➔ **"The Origin of the Space Shuttle" MIT course**

➔ **NASA's Space Shuttle website**
- ★ *Related topics:* Space Shuttle

➔ **"Spot the Station" interactive tracker by NASA**

➔ **"Get to Know the Space Station" NASA resources**
- ★ *Related topics:* Space Station