



CAMP INVENTION FLIGHT LAB™



INNOVATION EXPLORATION KIT™,
ELEVATE SERIES



Let LINK be your guide as you discover the
principles of flight and soar into invention!





Read prior to using the product.

SAFETY AND HYGIENE

 **Warning: Choking hazard—small parts.
Not for children under 3 years.**

- All activities require adult supervision.
- Ages 5+.
- Read and follow all instructions.
- Only use screwdrivers with an adult present.
- When using tools, like screwdrivers, safety glasses should be worn at all times.
- For safety and hygiene purposes, please be sure all children wash their hands after each activity.
- Demonstrate how to properly hold and use scissors. Do not run with scissors.
- Do not allow children to put materials in or near anyone's eyes, mouths, and ears.
- Do not play with or place plastic bags near the face or mouth.
- Ventilate the room when using markers.
- Batteries are only to be installed under adult supervision.
- Insert batteries with the correct polarity.
- Remove the batteries during long periods of non-use. Always remove exhausted batteries from the robot. Battery leakage and corrosion can cause damage.
- Never short-circuit the battery terminals.
- Do not mix old and new batteries. Do not mix different types of batteries: alkaline, standard (carbon-zinc), or rechargeable (nickel cadmium).
- Remove all batteries prior to taking apart a robot.
- Dispose of batteries safely. Do not dispose of batteries in fire. The batteries may explode or leak.
- Do not hold the robot's propeller near anyone's hair. Use hair bands to pull hair back as needed.
- If anyone has an allergy, remove any materials that may trigger an allergic reaction for them.
Note: The feathers can be allergenic.

MATERIALS

- AA batteries
- Classic Paper Airplane sheets
- Classic Paper Airplane Instructions sheet
- Feathers
- Flight Inductee Book
- HandCopter
- Inventor Log
- LINK accessory stickers
- LINK robots
- Masking tape
- Pencil
- Safety glasses
- Scissors
- Screwdriver
- Straws
- Washi tape

Camp Invention Flight Lab™ experience page:
invent.org/Elevate/Flight-Lab

Password: **link**

Need help? Please reach out
to our Customer Relations
Department at 800-968-4332.



TAKING FLIGHT

MATERIALS

- AA batteries
- Inventor Log
- Pencil
- Flight Inductee Book
- LINK robots

MEET LINK, YOUR FLIGHT TRAINING ROBOT

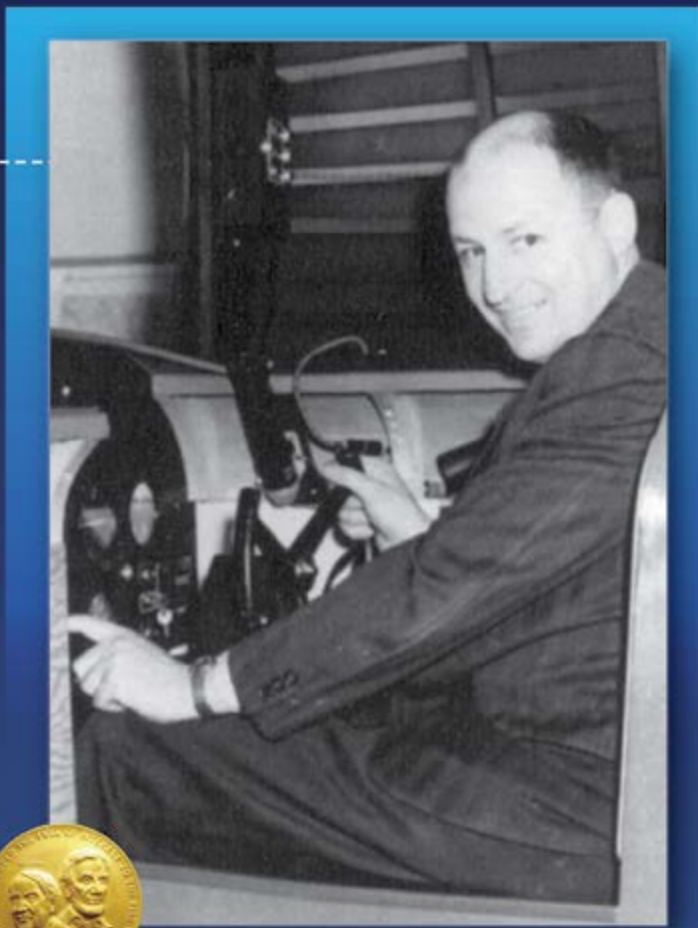
Your robot LINK is named after **Edwin Link**, the **National Inventors Hall of Fame® (NIHF) Inductee** who invented the first Flight Simulator that allowed student pilots to safely train on the ground!

LINK will help you explore many things about flight, including lift, thrust, and airplane mechanics.

If possible, watch the LINK video.



1. Let's see what LINK can do! Set aside the "Take Apart" LINK and use the LINK with no sticker. Have an adult help you open the battery compartment on the back and insert three AA batteries.
2. Find an open space on a smooth, non-carpeted surface. Place LINK on this surface and slide the switch to the On position. Discover LINK's features, moves, and mechanics!



Edwin Link

If you need to create a smooth surface, gather large, flat pieces of cardboard where LINK can move.

Be careful not to spin or push the propeller on LINK since it may cause the robot to malfunction.

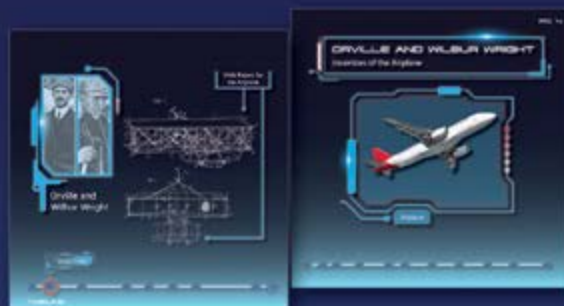
3. Have a flight trainee dance party! Let LINK inspire your most aerodynamic dance moves as you show off your propeller-like spins and smooth, gliding steps.



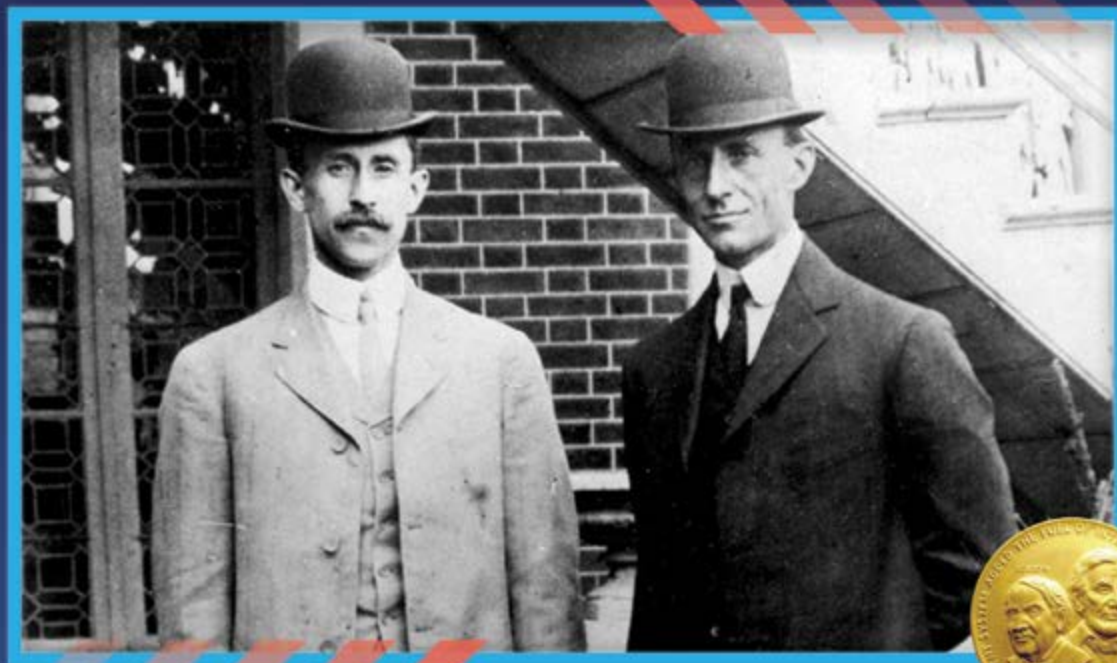
MEET THE HALL OF FAMERS



When people first dreamed about flying, they looked to the skies for inspiration from nature. **The Wright Brothers, NIHF Inductees** who invented the first airplane, figured out how to control and steer a plane by studying how buzzards tilted their wings.



Check out the Flight Inductee Book to discover NIHF Inductees who helped take aviation to new heights.



Orville and Wilbur Wright



DISCOVER YOUR AVIATOR CALL SIGN

Verbal communication over the radio is very important to pilots, but talking without seeing the person they are talking to can create confusion! For example, sometimes pilots have the same name. In order to quickly identify themselves to other pilots and Air Traffic Control, pilots can use Aviator Call Signs instead of their names.

Check out the **Aviator Call Sign** page in your Inventor Log to figure out your call sign!

MORE TO EXPLORE

There are many different jobs that involve flight. One of these jobs is called an Air Traffic Controller. They help planes safely take off, fly, and land. Becoming a fully qualified Air Traffic Controller takes years of intensive training. They must be excellent at concentrating and multitasking.

A controller may have to look after several planes at any one time as they listen to pilots, coordinate with fellow controllers, and make computer entries. Do you think you would like to assist pilots in this way?



UP, UP, AND AWAY

Complete flight training to achieve liftoff!

LET'S GET READY FOR HIGH-FLYING FUN!

While you explore the science of flight, the most important discoveries you make will be the ones with your eyes and hands as you experiment with the HandCopter and paper airplanes.

MATERIALS

- HandCopter
- Inventor Log
- LINK robot
- Pencil
- Safety glasses

HOW DO FLYING OBJECTS LIFT INTO THE AIR?

Bernoulli's Principle helps explain how a big heavy object, like an airplane, can fly. Due in part to an airplane wing's shape, air flows faster above the wing than below it. As the speed of air increases, air pressure decreases. Since high-pressure air moves toward low-pressure air, it causes the airplane to lift. When lift is greater than weight, the airplane can fly!



Check out the Bernoulli poster.

BERNOULLI'S PRINCIPLE

So how do flying objects lift into the air?

Bernoulli's Principle helps explain how a big heavy object, like an airplane, can fly. Due in part to an airplane wing's shape, air flows faster above the wing than below it. As the speed of air increases, air pressure decreases. Since high-pressure air moves toward low-pressure air, it causes the airplane to lift.

Low air pressure

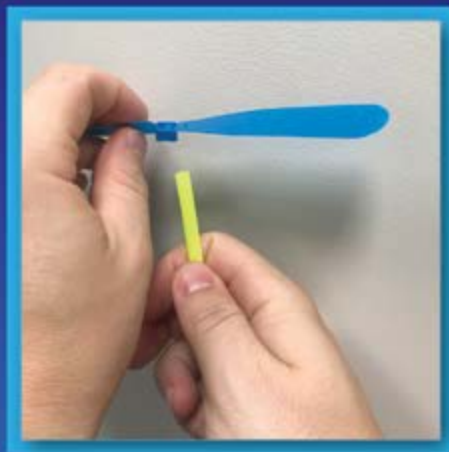
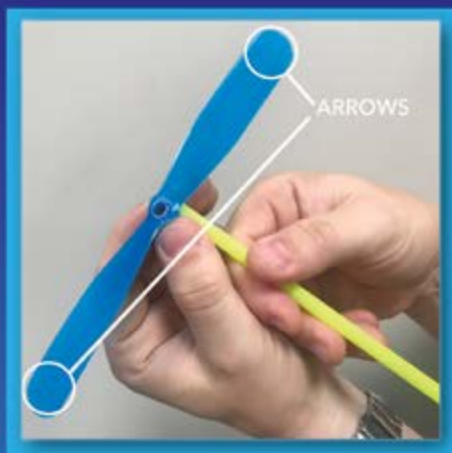
High air pressure

AS AIR MOVES FAST

When lift is greater than weight, the airplane can fly!

EXPERIMENT WITH LIFT

1. Get ready for takeoff! Assemble the HandCopter by inserting the stick into the hole on the underside of the propeller, beneath the propeller arrows. Ensure the arrows at each tip of the propeller blades are facing up.



2. Put on your safety glasses and make sure your hair is pulled back and out of the way.
3. To achieve lift, start with the stick against the heel of your left palm. Keep both hands flat as you swiftly slide your right hand forward, away from your body, releasing the HandCopter.



How high did your HandCopter fly?



To gauge height, look at a nearby tall object such as a wall, tree, or building. Write down your estimate on the **Flight Lab Notes** page in your Inventor Log.



You are exploring altitude! For pilots, knowing their aircraft's altitude, or how high up they are, is an essential piece of information.

MEET A HALL OF FAMER

NIHF Inductee **Paul Kollsman** invented a tool for measuring altitude—the Altimeter—so pilots can easily see the height of their plane in the cockpit control panel. An Altimeter uses air pressure to measure the height of an airplane from sea level. It is an important tool for pilots because it helps them stay at a safe altitude above the ground.



Paul Kollsman

PROPELLER: A WING WITH A TWIST!

1. Investigate the HandCopter and LINK. What do you notice that is similar?
2. Record your observations on the **Flight Lab Notes** page in your Inventor Log.



Check out the Propeller poster.



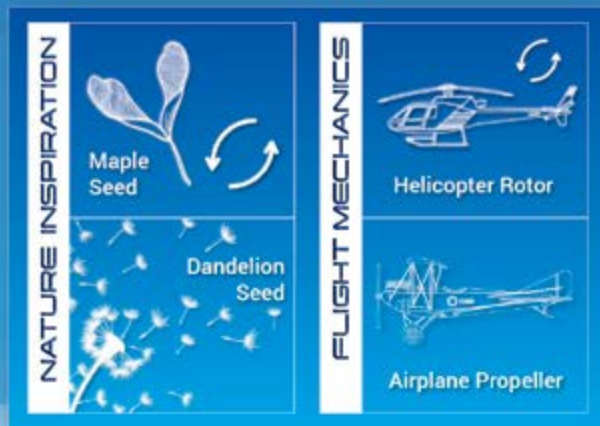
Propellers help create lift and can be found on helicopters and airplanes.

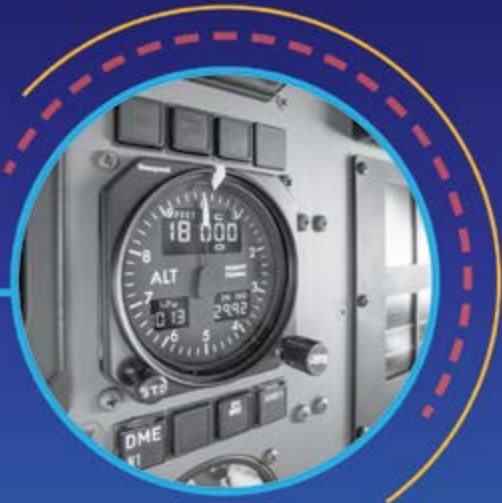


Can you think of any examples in nature that move like the HandCopter or LINK's propeller?



After watching maple seeds twirl in the air as they fell from a tree, Leonardo da Vinci was inspired to make his first sketch of a helicopter-like vehicle.





Altimeter

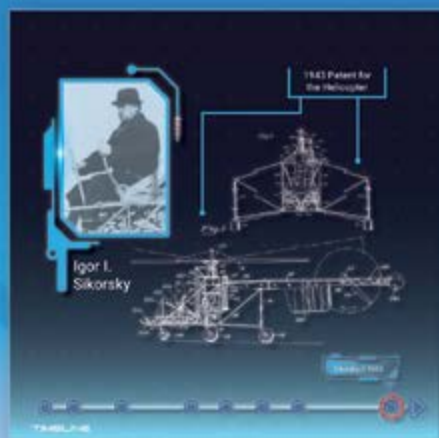
3. Explore the HandCopter's ability to lift straight up into the air, achieving vertical flight just like a helicopter.
4. Experiment with how weight affects lift by taping small objects from around the home onto your HandCopter near the top of the stem.

What do you notice?

Weight and lift are opposite forces involved in flight. Lift pushes a plane up. Weight pulls a plane down.

MORE TO EXPLORE

The helicopter was invented by **NIHF Inductee Igor Sikorsky**. Unlike airplanes, helicopters have the ability to hover and fly backwards and side-to-side, and they can take off and land vertically!



Check out the Sikorsky page in the Flight Inductee Book to see his patent for the helicopter.





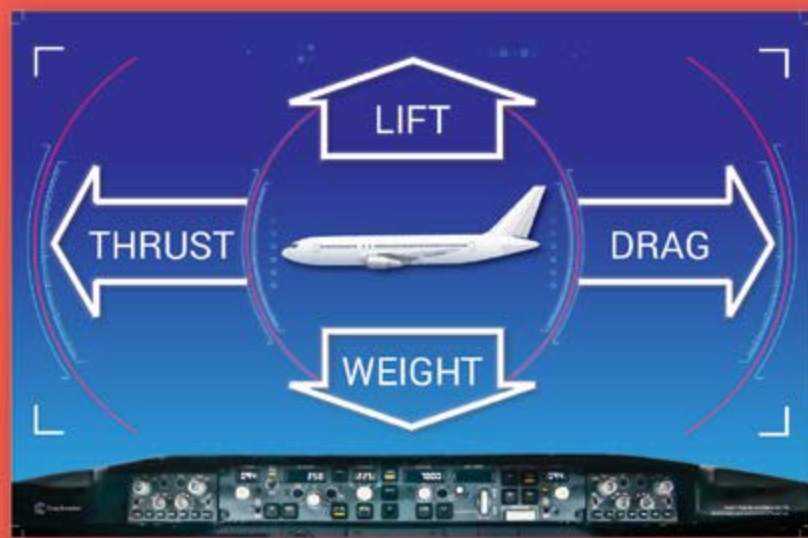
WINGING IT

Explore wings and the power of thrust in flight!

EXPERIMENT WITH THRUST

Thrust pushes a plane forward. Drag pushes against the plane and is what slows a plane down.

A simple way to think about thrust is to imagine air being pushed suddenly in a specific direction, like blowing air onto a pinwheel blade to make it spin.



Check out the Flight Forces poster.



MATERIALS

- Classic Paper Airplane sheets
- Classic Paper Airplane Instructions sheet
- Feathers
- Inventor Log
- LINK robot
- Straws

1. If you have tissue paper or streamers, tape a few strips to the edge of a table so that they hang down.
2. Tilt LINK's propellers towards the strips and observe how it moves them.
3. Use a piece of paper to make your own propellers, tape them to the top of LINK's propellers, and test them to see what you can discover!



What happens when you slightly bend the paper propellers or change the angle of the blades?

MORE TO EXPLORE

Scientists study birds and other animals that fly for many reasons, including to explore their behavior and to discover how they fly. Some engineers build new types of aircraft inspired by what others discover from animals about flight. For example, biologists and engineers are working together to make an aircraft with wings that can change shape and fly without a pilot!

EXPLORE WING POWER

1. Let's experiment with wings and flight by folding paper airplanes and aiming them at your robot flight trainer, LINK! **Fold a Classic Paper Airplane sheet**, following the steps on the Instructions sheet. Ask an adult to help you fold.
2. Ready...aim...throw! Turn on your LINK and notice the red, illuminated target that LINK projects onto the floor. Aim your airplane to land in the target.
3. Now, modify your paper airplane and test its flying abilities.
 - What happens if you add paper clips to the nose of your plane?
 - What happens if you bend the wing tips up, or down, or one up and one down?
4. Build a giant city out of recyclables like cardboard boxes and other objects from around your home.
5. Launch your airplanes above the city and watch them soar!

Animal wings, the arms on LINK, and the wing flaps and landing gear on an airplane are all levers that can move up and down. Flapping wings is one way of providing thrust, giving the force needed to move flying objects forward after liftoff.



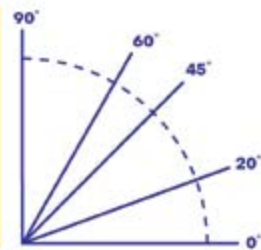
- If possible, watch the Wings video to find out more about wings and flight.



Check out the Levers poster



Understanding wing angle in relation to the oncoming air is important for pilots. Changing the angle of the wings helps pilots land the plane softly and safely. The ideal "angle of attack" allows for a smooth flight, balancing lift and drag. Experiment with the angle of attack as you test.



LAUNCH YOUR DREAMS

1. See the forces of thrust and drag in action as you let your dreams soar! Start by sliding a straw into one of LINK's hands to use as a launcher.
2. Insert the tip of a feather into the front end of the straw launcher.
3. Think about your dreams!

- What would you like to be when you grow up?
- Where would you like to go?
- What do you hope to make or do in the next year?

4. Once you have your dream in mind, blow into the straw and watch your dreams take flight!

If you have cotton swabs, try launching them with LINK's straw. A cotton swab is more aerodynamic than a feather!



LOOK INTO LINK

Check out LINK's mechanics by taking a look inside LINK, and then add your personal touches to take LINK to the next level!

MATERIALS

- Feathers
- LINK accessory stickers
- Scissors
- Inventor Log
- Masking tape
- Screwdriver
- LINK robots
- Safety glasses
- Washi tape

INVESTIGATE LINK

1. Turn on LINK and watch it move on the table or floor as you explore your curiosities.

I Wonder...

- How LINK moves and functions.
 - What is making LINK's arms and legs move up and down.
 - How LINK's stabilizer and propellers spin.
 - How LINK's arms, legs, and head are connected to his body.
 - How LINK's lights are powered.
2. Record your thoughts on the **Flight Lab Notes** page in your Inventor Log.

CAREERS THAT TAKE FLIGHT

Have you ever wanted a job that would bring you close to airplanes? Just like the variety of flight paths your aircraft can take, there are many career paths in aviation that go beyond being a Pilot, Flight Attendant, or Air Traffic Controller. Many of these jobs require you to know how all of the pieces and parts of the aircraft fit together and work!



BECOME A FLIGHT MECHANIC

1. To observe LINK's inner workings, you can open your "Take-Apart" LINK by removing the shell. Ask an adult for supervision.

2. Before beginning:

- Review how to safely use the tools with an adult.
- Wear safety glasses at all times.
- To loosen a screw, turn the screwdriver to the left (counterclockwise). To tighten a screw, turn the screwdriver to the right (clockwise).

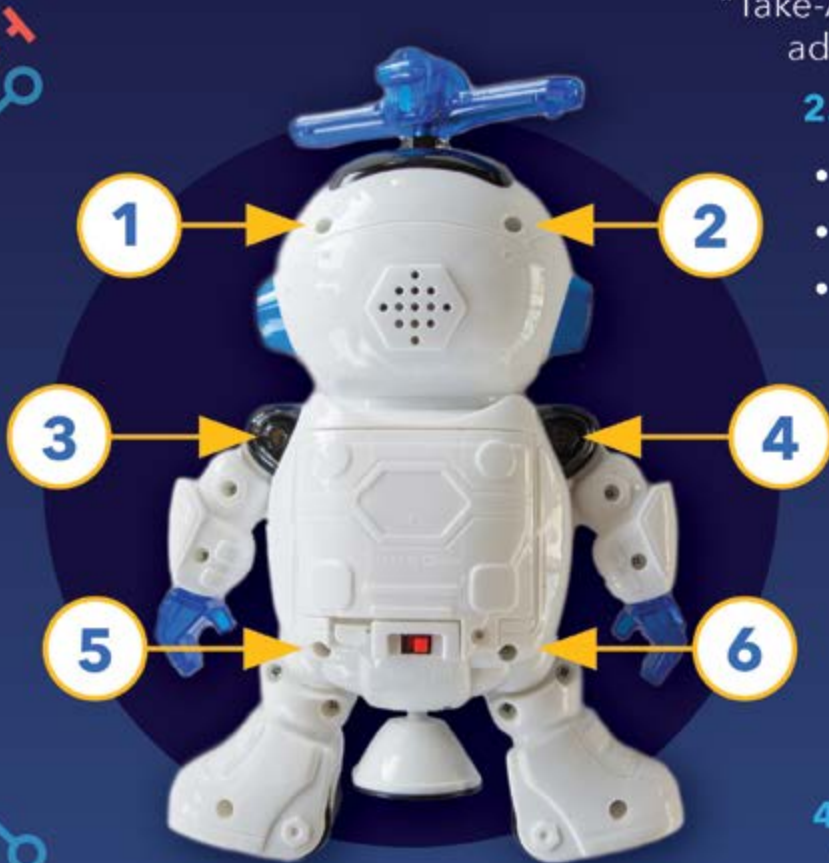
Check to make sure that batteries have not been installed in the robot before taking it apart.

3. Use the screwdriver to remove the six screws holding the shell together.

4. Continue taking apart your LINK and exploring the parts and pieces!

5. Check out the **LINK's Flight Mechanics** page in your Inventor Log to compare the components found inside LINK with those in an actual aircraft.

If possible, watch the Flight Mechanics video to explore all of the pieces and parts that make LINK light up and move.





What does the inside of LINK look like? Does it remind you of anything you have seen before?



What surprised you about what you found inside LINK? What did you find most interesting?



Write down or sketch your discoveries on the **Flight Lab Notes** page in your Inventor Log.



Beatrice Hicks

MEET A HALL OF FAMER

Many NIHF Inductees tell stories about taking apart machines, watches, radios, and other devices when they were children. Taking devices apart is called reverse engineering. It sometimes feels like finding pieces of a puzzle. Engineers must be good puzzle and problem solvers.

NIHF Inductee Beatrice Hicks was one of the first women to pursue an engineering degree. She put the puzzle pieces together to make a gas density sensor that was used in the Apollo moon missions and Boeing 707™* aircraft.

*Boeing 707 is a trademark of The Boeing Company.

ONE-OF-A-KIND LINK

1. Customize your working LINK robot (with batteries) using the LINK accessory stickers, feathers, washi tape, and fun recyclables and materials from your home, such as stickers, patterned paper, or permanent markers.
2. Create accessories or a carrying case for LINK to take your flight training robot to the next level.
3. Turn on LINK and celebrate!



CONGRATULATIONS!

You have earned your Wings of Innovation!



Now that you have explored the principles of flight and navigated your way through flight training, the sky's the limit for your inventive imagination. What challenges will you soar through next? Might you design and build a Flight Simulation Lab or a light-up Launch Tower? Aim high as you turn your ideas into the next big thing!



LINK 2-0-2-0... OVER AND OUT!



National Inventors
Hall of Fame®



Camp Invention®

**Camp Invention is an educational program from
the National Inventors Hall of Fame.**

Learn more at [invent.org](https://www.invent.org)

978-1-61823-114-7

© 2020 National Inventors Hall of Fame, Inc.