Emily Howell Warner made aviation history multiple times throughout her career including being the first woman to pilot a scheduled U.S. carrier and being the first woman to be an airliner captain.

EMILY HOWELL WARNER

FIRST WOMAN PERMANENT PILOT OF A SCHEDULED U.S. PASSENGER AIRLINE

OBJECTIVES

- List three "firsts" Emily Warren achieved as a female pilot.
- Describe Warren's accomplishments before becoming a pilot for Frontier Airlines.
- Discuss Warren's early life before becoming a flight instructor.
- Build the MU2.

STANDARDS

NGSS

SCIENCE

- MS-PS2-1
- MS-PS2-2
- MS-PS3-1
- MS-ETS1-1
- MS-ETS1-2
- MS-ETS1-3

ELA/LITERACY

- RST.6-8.1
- RST.6-8.3
- RST.6-8.7
- RST.6-8.9
- WHST.6-8.7
- WHST.6-8.9

MATHEMATICS

- 6.RP.A.1
- 6.RP.A.2
- 7.RP.A.2
- 8.EE.A.1
- MP.2

NCSS

- IV.f.
- V.c.
- X.e.

Emily Hanrahan Howell Warner had hit a wall, or, rather, a glass ceiling.

The year was 1973. For five years, Warner, a flight instructor, had applied unsuccessfully to become a pilot at Frontier Airlines, a Denver-based U.S. passenger airline, in a time when there were no U.S. women passenger airline pilots. She had turned 30 in 1969 and saw her own former flight school students, who were all male, being hired. But in January 1973, Frontier made Warner the first woman to be named permanent pilot for a scheduled U.S. passenger airline. Previously, in 1934, aviation pioneer Helen Richey had been the first woman to pilot a commercial airline on a regularly scheduled run.

On Feb. 6, 1973, Warner served for the first time as second officer on a Frontier Airlines Boeing 737-300. The flight departed from Denver and went to Las Vegas, St. Louis, and back. Within six months, Frontier discontinued its use of second officers, and Warner was named a co-pilot. In 1974, she became the first woman to be a member of the Air Line Pilots Association (ALPA). In 1976, she became the first woman to be a captain on a U.S. scheduled airline, flying a Twin Otter. In 1986, she commanded the first all-female flight crew in the U.S.

In addition to piloting for Frontier, Continental Airlines, and United Parcel Service, Warner was a flight school instructor and manager in Denver, Colorado. In 1991, she began working for the Federal Aviation Administration (FAA) as a flight designated flight examiner holding multiple ratings.

Her career has been recognized by the National Aviation Hall of Fame and National Women's Hall of Fame. Her Frontier pilot's uniform is on display at the Smithsonian's National Air and Space Museum.

HER STORY

Emily Hanrahan was born October 30, 1939, in Denver, Colorado.

Her parents taught her and her siblings (four brothers and a twin sister) to believe they could achieve anything. But her family could not afford to send her to college. So, instead, after graduating from high school, she began working in retail sales at the May Company store in Denver.

As she worked, occasionally flight attendants would come into the store, and she began considering a career as a flight attendant. As a teenager, she did not meet the flight attendant minimum age requirement, put in place because attendants served alcohol to passengers. Still, she'd never flown before, and decided to take a flight to see if she liked it.

"I bought a ticket on Frontier Airlines in a DC-3," she said of her first flight to Gunnison, Colorado, in 1958, reports *Airport Journals*. During the flight, she was able to see the cockpit.

"I looked out that front window, and it just hit me," she recalled in a *Denver Post* interview. "It's so beautiful looking out that front window instead of looking out of the sides." Noticing how excited Warner was, one of the pilots suggested she take flying lessons. Warner remembered her response: "I said, 'Gee, can a girl take flying lessons?'"

It was not long before she began taking those flying lessons at Clinton Aviation, housed at Stapleton Airport in Denver. It cost her about $13 per lesson. She left the May Company to become a receptionist at Clinton and continued obtaining multiple pilot license ratings. At 21, she was a full-time flight instructor with her own airplane provided by Clinton Aviation, a Cessna 150.

Warner had read about Turi Wideroe, a Norwegian pilot who, in 1961, had become the first woman documented as an airline pilot outside the Soviet Union with Scandinavian Airlines System. Warner wanted to pursue a career as an airline pilot.

Her flight training business was thriving as returning troops sought flight training. Many of the men whom she had trained accrued flying time and then left for commercial jet pilot jobs.

In 1968, she began applying for a position at Frontier Airlines, as well as Continental Airlines and United Airlines. By 1973, she had thrived in the aviation industry for 15 years. She had accrued 7,000 flight hours and multiple FAA certificates and ratings: private pilot, commercial, instrument, multi-engine, instructor and Airline Transport pilot. Her resume also included chief pilot, air taxi and flight school manager, and FAA pilot examiner. She was in charge of the United Airlines Contract Training Program for Clinton Aviation.

A friend who worked with Frontier introduced her to the vice president of flight operations there. She was not offered a job immediately, but Warner persisted until she was hired in January of 1973.

She had crashed the glass ceiling for women commercial pilots. The term

Continued on PAGE 15

©Smithsonian Institution

Achievements include

- Was the first woman hired as a pilot by a U.S. commercial airline (1973)
- Was the first woman to become a member of the Air Line Pilots Association (ALPA) (1974)
- Was the first woman to be a U.S. airline captain (1976)
- Inducted into Colorado Aviation Hall of Fame (1983)
- Commanded the first all-female flight crew in the United States (1986)
- Inducted into the Women in Aviation International Pioneer Hall of Fame (1992)
- Name entered in the International Forest of Friendship (1993)
- Inducted into the National Women's Hall of Fame (2001)
- Inducted into the Colorado Women's Hall of Fame (2002)
- Selected as one of the 100 most influential women in the aviation and aerospace industry. Nominated by Women in Aviation International (2003)
- Inducted into the National Aviation Hall of Fame (2014)

> "I still love it (flying). You don't lose that – looking out and seeing that world in a different way." — **Emily Howell Warren**

HER STORY (continued from Page 14)

"glass ceiling" is in reference to an intangible barrier that prevents women or minorities from obtaining upper level positions. This door-opening achievement is just one piece of the long flying career Warner experienced. After flying for Frontier, Continental, and United Parcel Service, she began working for the FAA as an inspector.

What did the woman who opened doors for so many other women have to say about the current climate for women in aviation?

Even as recently as 2014, Warner still was frustrated by inequities women encounter in aviation. When women are not given the same opportunities as men, Warner told the *Denver Post*, the U.S. and all countries are "only using half of their manpower." As she put it, "If they only use men, they're losing a lot."

Additionally, at the time of her 2014 induction into the National Aviation Hall of Fame, Warner was aware of the challenges women still faced pursuing a career in aviation. "Not as many women are learning how to fly, and you've got to build your flight time," she told the *Post*, "and if you have a family, it's tough."

And still, when she was 74, she loved the view that had captivated her as a teenager. "I still love it (flying)," she said to the *Post*. "You don't lose that – looking out and seeing that world in a different way."

Warner died July 3, 2020, at the age of 80. When she was asked once how she hoped to be known, as aviatrix or female pilot, she replied, "Captain will be just fine."

QUICK BOX

Overcoming Barriers

On her second flight as a commercial airline pilot, the captain told her: "Don't touch ANYTHING on the flight." She recalls that it took about a year to feel acceptance from other pilots. The attitude change began with a high-ranking Frontier captain. "You get that acceptance, and it gets around, and everybody accepts you."

Source: Airport Journals and The Denver Post

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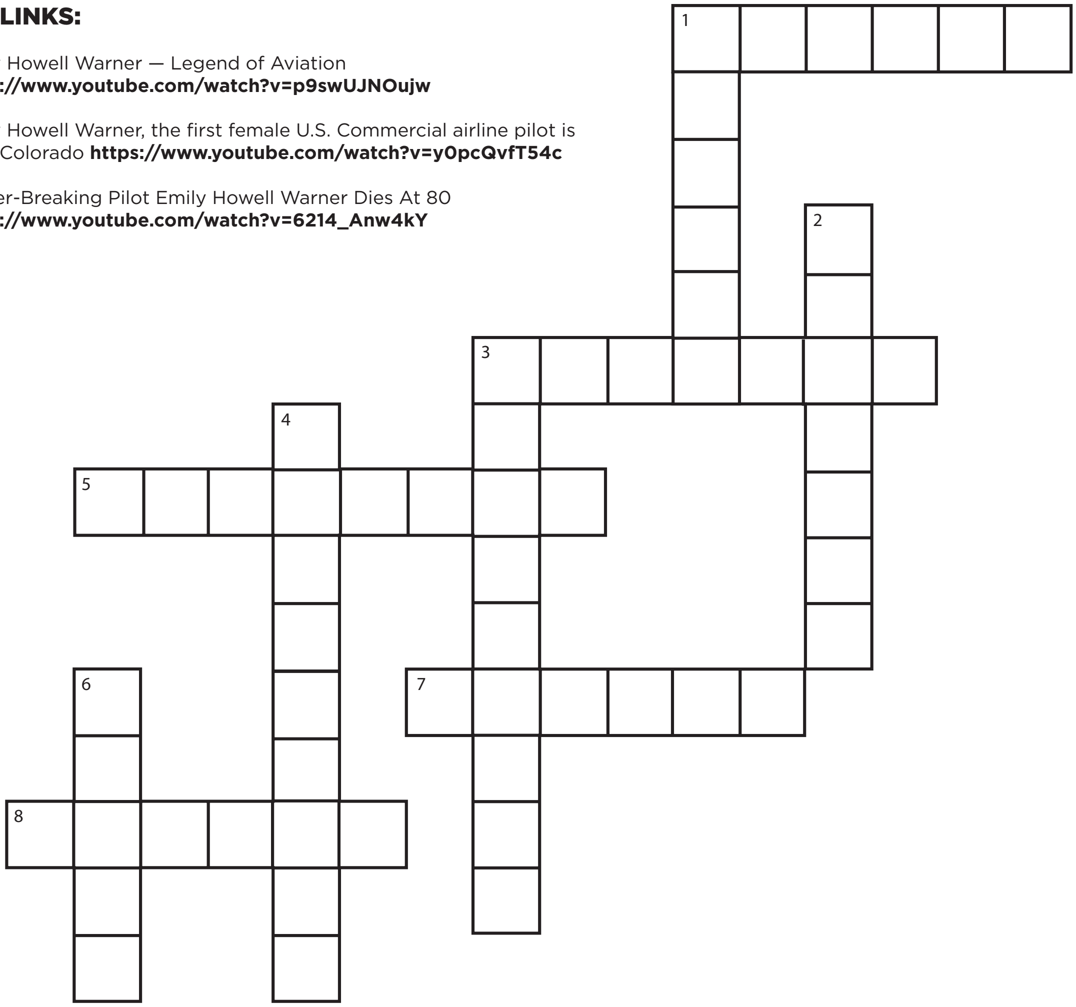
EXTENSION CROSSWORD PUZZLE

VIDEO LINKS:

- Emily Howell Warner — Legend of Aviation
  https://www.youtube.com/watch?v=p9swUJNOujw
- Emily Howell Warner, the first female U.S. Commercial airline pilot is from Colorado **https://www.youtube.com/watch?v=y0pcQvfT54c**
- Barrier-Breaking Pilot Emily Howell Warner Dies At 80
  https://www.youtube.com/watch?v=6214_Anw4kY



ACROSS

3. In 1958, Warner purchased a plane ticket for the first time and flew to this city in Denver.
4. In 1976, Warner became the first woman to be a captain on a U.S. scheduled airline, flying the Twin ___________.
7. Airline that named Warner the first woman permanent pilot for a scheduled passenger airline.
8. Before Warner was a pilot, she worked retail for this company.
9. Emily Warner broke through a commercial pilot ______________ ceiling, the term for an intangible barrier that prevents women or minorities from obtaining upper level positions.

DOWN

1. Birthplace of Warner.
2. Her uniform is on display here.
5. Norwegian female pilot who was an inspiration to Warner.
6. Taught flying lessons with this plane at age 21.
7. Worked as a flight designated flight examiner for this organization.

ANSWER KEY: **ACROSS:** 3. Gunnison 4. Otter 7. Frontier 8. May 9. Glass
DOWN: 1. Denver 2. Smithsonian 5. Turi 6. Cessna 7. FAA

Created using the Crossword Maker on TheTeachersCorner.net.

EXTENSION SPEED ACTIVITY — PART ONE

Airplanes were developed with a primary goal: to take their occupants across the skies at speeds never before imagined. For thousands of years, before the invention of the wheel, humans were limited by the speed of their legs.

In the following laboratory activity, students and cadets will determine their walking speed using an inquiry approach. Although some students might be familiar with the relationship speed = distance/time, most will not know where that relationship comes from. Instead of directly applying the equation, students will plot their distance at various waymarks, as well as the time it takes them to get to those points. Students will find that the slope of their graph has a meaning: namely, their speed. Students can compare their own graph to their classmates' graphs. More advanced students can use the simple linear equation to derive the relationship between distance and time: distance = (speed) * time. In Activity Part Two, students will use a web-based real-time flight viewer and maps to apply the equation derived in Activity Part One, in order to estimate the current speed of an actual plane in the air.

Source: NASA

Goal: Collect distance and time data to determine each student's natural walking speed.

Key Concepts: Distance, Time, Speed, Graphs, Linear Relationships

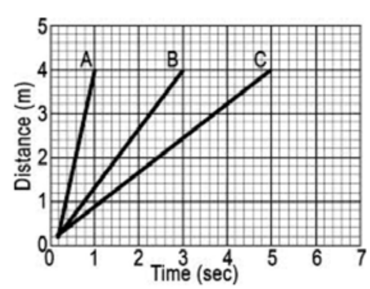
Grade Level: 5-12

Subjects: Math, Physical Science, Physics

Materials: large classroom/ gym/outdoor area, meter stick or tape measure, tape or cones (to mark distances), timer, graph paper, calculator (optional)

1. Ask a few students to stand against a wall, and to walk – at a normal pace – to the other side of the classroom. Ask the remaining class what the difference is between each student's motion. Students are likely to respond that some students walk faster than others.

2. Discuss how speed could actually be quantified – what things must someone know in order to fairly determine one's speed? (Guide students to recognize that both distance and time of travel must be known for each student.) Split students into pairs or small groups, and ask students to collect data on each individual's distance and the time it took them to get to that distance. Students should collect at least five different distance and time data sets. In order to make a graph, teachers may provide students with a data table with required distances, or allow students to choose their own distances. (Caution: Some students might want to only do multiple trials of the same distance. To make a proper graph, students must have a wide variety of distance and time values, although multiple trials of the same value are also encouraged to increase accuracy. Also, ensure that students have chosen wide enough distances to get reasonable time values. For example, it would be unreasonable to measure the time it takes for a student to walk one meter. Students should aim for a range of data between five and twenty (or more) meters.)



Distance (m)	Time (s)
5	4.7
10	9.5
15	15.3
20	21
25	24.9

3 Ask students to each create a dot plot of distance (y-axis) versus time (x- axis) for their own data. (Caution: Ensure that students use a dot plot. Many young students tend to make bar graphs, which are typically appropriate for data categories, not for quantitative data on both axes.)

4 Ask students to compare their graphs, and notice any differences. If necessary, either provide students with axes values to ensure a fair comparison, or ask students to plot their data on a single graph, using a particular color to denote their own data points and best-fit line. Students should notice that although the line goes upward to the right, that the angle (slope) at which it does this is different for some students. Students with significant differences in their slope should be asked to demonstrate their walk. Students should find that students with a steeper slope have a higher natural walking speed.

5 Ask students to quantify how fast each student walks. As students see that the angle (slope) is equivalent to the speed of the walker, students can now determine the slope of their own graph.

6 For more advanced students, students can be asked to determine the relationship – from the graph – between distance and time, using the following method (using C's data from the graph):

a) General Equation of a Line: y = mx + b
b) Substitute Axes Variable Names: Distance = (m) Time + b
c) Substitute Slope (with Unit): Distance = (0.8 m/s) Time + b
d) Substitute Y-Intercept (with Unit): Distance = (0.8 m/s) Time + 0. (Note: Some students might not get an intercept of 0! This is an important data analysis concept. Students can be asked to describe the meaning of the y-intercept, in this lab (it should represent the starting point). Because students likely assumed that they started at 0 m at 0 s, this value should be 0. If it is not, it is likely the result of experimental error. Leaders can help students discuss possible causes and sources of experimental error.)
e) Generalize the equation for each student to a single equation for the whole class: Distance = (Speed) Time.

7 Apply the new equation to a variety of relevant questions such as:

a) Convert speed (in m/s) to km/hr, then use that speed to solve the following problem.
b) How much time would it take to walk to a favorite distant destination (over 200 miles away) assuming no stops were made?

EXTENSION SPEED ACTIVITY — PART TWO

Source: NASA

Goal: Use the equation derived from Activity Part One, Distance = (Speed) Time, to estimate the speed of an airplane as it travels between any two points across the globe.

Key: Distance, Time, Speed

Grade Level: 5-12

Subjects: Math, Physical Science, Physics

Materials: computers or mobile devices with internet access (and possibly a map and marker), timer

1 Direct students to go to the following website:
https://planefinder.net

2 Ask students to browse the page and to note the greatest concentration of air flights around the world. Students may be provided a map and asked to mark the countries and areas where there is the most flight activity.

3 Discuss potential reasons for air flight concentrations being where they are. Consider:

a) Economics
b) Population density
c) Geography (locations of deserts, mountain ranges, remote areas)
d) Weather (locations of storm systems, hurricanes)
e) Time of day (consider that it is night time on the other side of the world)
f) Cultural holidays

4 Ask students to zoom in to a particular area where there is a regular amount of air traffic. The goal at this point is to identify an aircraft that is moving from one notable location to another (such as a city, interstate intersection, lake, etc.), so that speed may be determined. (Note: If students zoom in very close to an aircraft, they can get the airline, flight number, origin and destination airports, as well as the speed in knots, or KTS: 1.15 miles per hour, or 1.85 kilometers per hour. However, most students will not recognize KTS. This value can be used to evaluate the calculated speed, but should not be used directly for this activity.)

5 Choose one aircraft and time it as it goes from one point of interest to the other. Students should choose a range of time somewhere between 1 and 5 minutes to ensure that enough time is collected for accurate calculations. (Caution: Students should not choose planes traveling in significantly curved paths, or near airports, where speeds change.)

6 Make sure that students choose recognizable points of interest because students will next need to determine the distance crossed by relocating and measuring the distance between the two points using Google Maps.

7 To measure the distance between the points, follow the example procedure below:

a) Go to **www.google.com/maps** to get to Google Maps.
b) As an example, a student might have observed a plane go from Holtwood, Pa. to Whitehall, Md. in a period of 2.387 seconds.
c) Students should find, on Google Maps, the initial point of the plane's status.
d) Right-click on the initial location to get a menu. Choose "Measure distance." The second point of interest can be clicked, and an estimate given for the distance between the two points. (In the 7b example, the distance is 22.58 miles.)
e) To make speeds more relevant, it is suggested that students convert time in seconds to hours. Using a simple conversion, students can find that 2.387 s is equivalent to 0.03978 hr.
f) Using the equation derived from Activity Part One, Distance = (Speed) Time, and rearranging for speed, students can get Speed = Distance/Time. In this example, Speed = 22.58 mi / 0.03978 hr, which is equal to 567.6 mi/hr. This is a very reasonable estimate! Most commercial airplanes cruise at about 550 mi/hr.

8 Take a broader look at the flight path across the United States.

a) Are any patterns for eastward or westward flights noticed?
b) How do flight paths change upon entering or leaving airports?

HANDS ON

BUILD THE MITSUBISHI MU-2

Learners will build a paper model catapult-launched aircraft used by airlines and corporations. The MU-2 is a turbo-jet aircraft typical of those used all over the world for civil and military uses. Student pilots working on their commercial licenses like Emily Warner would have trained on a plane like the MU-2, Beech 1900, or an Embraer EMB-120 Brasilia before moving on to a Boeing 727 airliner. This model is a Mitsubishi MU-2 catapult-launched paper (cardstock) glider. Most catapult-launched paper gliders are designed with card stock or 3mm foam board in mind. All A.S. Paper Aircraft Laboratory model airplanes fly very well with a simple loose rubber band, hand-made Popsicle stick catapult launcher. See Page 11 for instructions. For these paper aircraft, lots of thrust is not needed.

U.S. Air Force/Airman 1st Class Bailee A. Darbasie

ABOUT THE PLANE

GENERAL CHARACTERISTICS

- **Crew:** 1-2 pilots, up to 7 passengers
- **Length:** 33 ft 2 in (11.95 m)
- **Wingspan:** 39 ft 2 in (11.94 m)
- **Height:** 13 ft 8 in (4.17 m)
- **Wing area:** 178 ft² (16.55 m²)
- **Empty weight:** 6,350 lb (2,880 kg)
- **Engines:** AiResearch TPE-331-25A Turboprop (each 605 ehp)
- **Max Takeoff Weight :** 9,920 lb (4,490 kg)

PERFORMANCE

- **Cruise speed:** 317 mph (510 km/h)
- **Range:** 1,200 miles (1,900 km)
- **Service ceiling:** 26,500 ft (8,075 m)

BACKGROUND

The Mitsubishi MU-2 is a high-wing, light twin-engine turboprop transport aircraft. It made its maiden flight on September 14, 1963, and was produced until 1986. In 2000, there were over 500 MU-2 aircraft still flying as corporate transports. It is one of postwar Japan's most successful aircraft, with 704 manufactured in Japan and the United States.

This aircraft represents a twin-engine turbo-prop commercial aircraft. While it is not a Boeing 737 like Emily Warner piloted, it does represent a typical small airliner that can be found worldwide flying commuter feeder routes. These aircraft would include the MU-2, Embraer EMB-121, Let L-410 Turbolet, and DHC-6 Twin Otter, to name a few. Commercial airline pilots, after getting their basic and twin-engine certificates,usually begin their airline careers flying these type aircraft for smaller commuter airlines before moving up to ATR 42, ATR 72, Air Bus A319/A320, or Boeing 737 airliners.

When the MU-2 was designed, it was designed for speed and the result was a smaller wing area and a very clean aircraft. With full-span double-slotted Fowler flaps, the aircraft increased the effective wing area by nearly 30 percent – giving the MU-2 the best of both worlds – high lift for low-altitude low-speed operations and a highly loaded low-drag wing to optimize highspeed performance at altitude. Although production ceased in 1986, this airplane is still interesting to look at, and is still carrying passengers and doing work worldwide.

Between 1968 and 1991, a total of 61 MU-2 aircraft were delivered to the Japan Self Defense forces, of which four MU-2Cs (1971) and 16 MU-2Ks (1972-1974) were delivered to the Japanese Army as LR-1s for the liaison and reconnaissance role. Another 29 MU-2Es were delivered to the Japanese Air Force for search and rescue duties, as well as photo reconnaissance. These MU-2Es had an extended "thimble" nose cone (radome), increased fuel capacity, bulged observation windows, and a sliding door for dropping rafts. All Japanese MU-2 aircraft were retired by 2016.

There are eight MU-2s that have supported the Air Battle Manager (ABM) training at Tyndall AFB, FL since 2006. They are currently flown under government contract at Tyndall AFB, Florida, by the Air1st Aviation Company providing U.S. Air Force undergraduate ABM students with their initial experience controlling live aircraft. Students must control eight MU-2 missions before they can progress to controlling high-performance aircraft such as F-15s or F-22s.

PROCEDURE — Building the MU-2

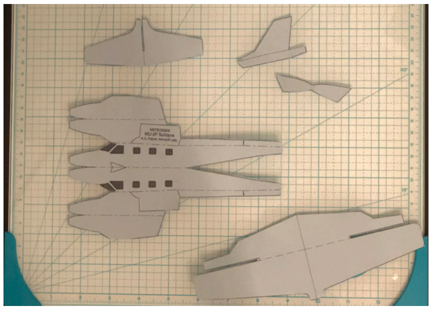
MATERIALS

- Cardstock for templates
- Flat, level, stable, and easily cleaned surface to work on
- Binder clip or clothespin to hold glued parts in place to dry
- Sharp-pointed (“X-acto”-type) hobby knife; ALWAYS cap it when not in use
- Sharp, precision sewing-type scissors
- A ruler or any other (truly) straight edge
- Toothpicks, round (and flat, if available)
- Aleene’s Fast Grab Tacky Glue, Elmer’s glue, or super glue
- Eyebrow-type tweezers, having a straight edge of comfortable angle
- Stylus of some kind, to make indented lines for folds
- Some old books or similar object to act as a weight/press to keep the airplane parts completely flat while drying
- A trash can nearby to be neat

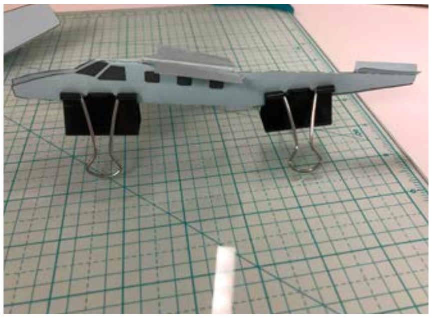
1 Print the Mitsubishi MU-2 plans onto cardstock.

2 Set up work area with materials and tools. Be sure to work on a craft cutting board, or cardboard, or other scratch-resistant surface so as not to damage the tabletop.

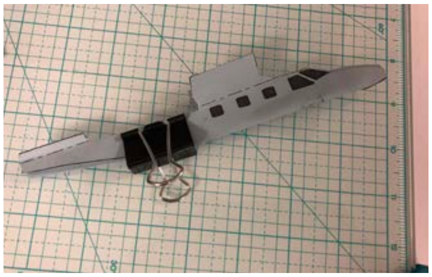
3 Read all the instructions on the plan. Instructions should tell where to glue, cut, and fold/bend. Some plans are more detailed than others.



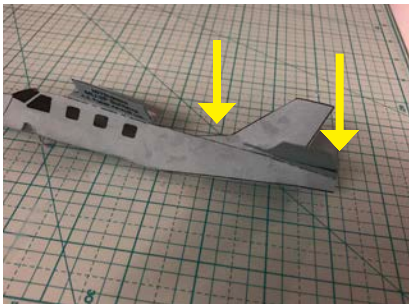
4 Start with the body (Part No. 2). Cut on solid lines, slowly and carefully. There are two airplane body halves, and each half has two nose sections that fold into the center. Glue sections A and B together. Glue sections C and D together. Fold A/B into E and glue into place. Fold C/D into F and glue into place. Clip with binder clips or clothespins to hold glued parts in place and let dry.



5 Fold the long thin tabs (Tab G) inside along the top of the body/fuselage. Fold the shorter tabs (Tab H) out to support the horizontal stabilizer



6 Stick the vertical stabilizer, or tail fin (Part No. 1), inside the body. Then spread the glue/adhesive inside the body and refold.



7 The vertical stabilizer will set into the fuselage and the line at the bottom of the on the vertical stabilizer will line-up on the top of the fuselage. DO NOT glue the two tabs on the rear of the fuselage; they are what the horizontal stabilizer will sit on when that is placed in a later step. The yellow arrows show the whole part being pushed down into the fuselage.

8 Fold nose cover (Part No. 3) over nose of body and attach with glue.

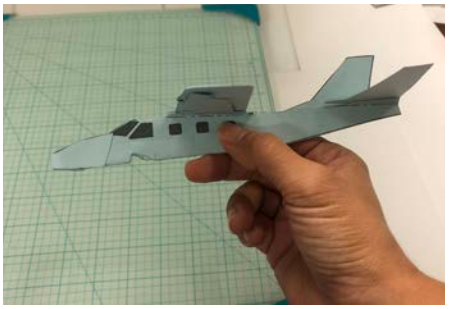
9 The tab on the wing (Part No. 4) should point to the tail. Fold the frontal, smaller, portion of the wing underneath the main wing to work as a wing support. Glue the support to the main wing.

10 Glue has a tendency to warp the parts glued together, and so it is a good idea to use a book or something heavy and flat to press the part(s) flat.

11 Glue the wing onto the supports on the fuselage.

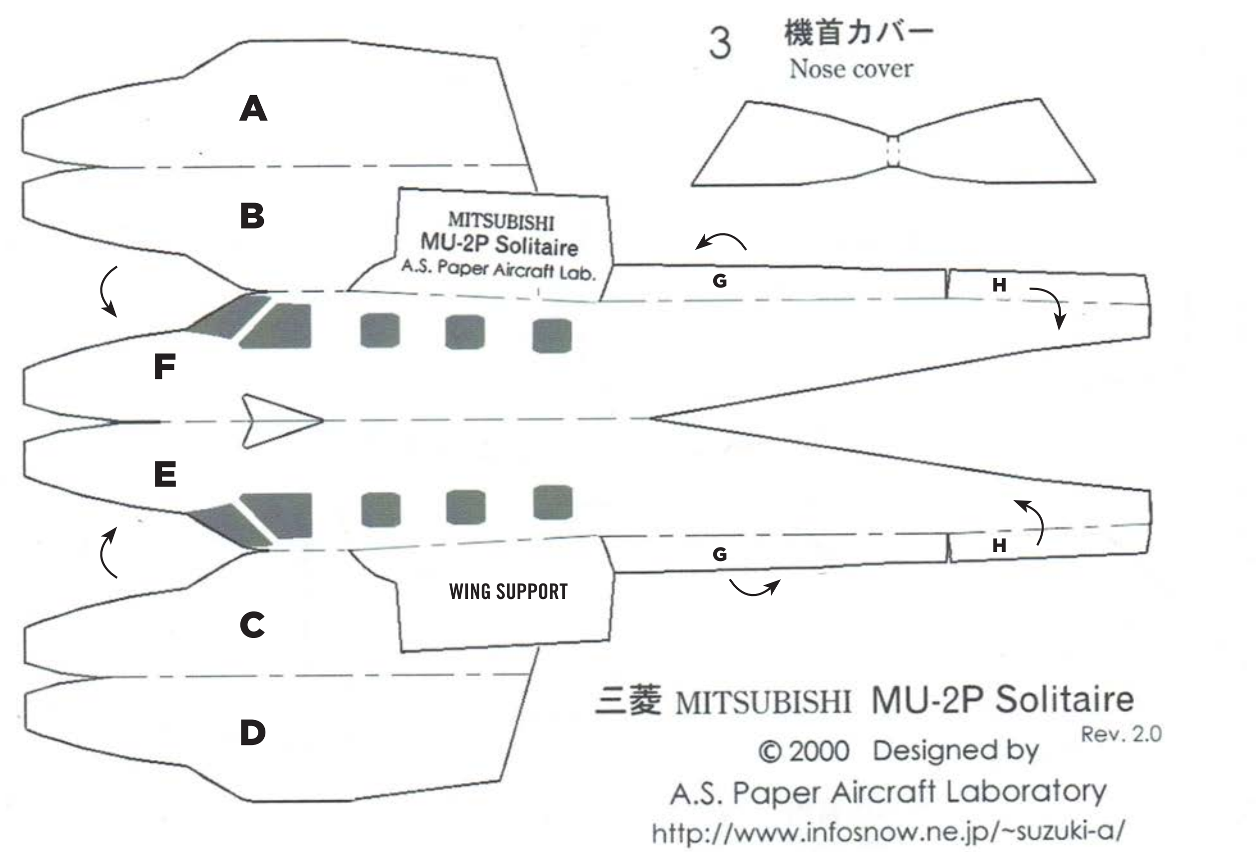
12 Slide the horizontal stabilizer (Part No. 5) into place and glue it onto the supporting tabs of the fuselage.

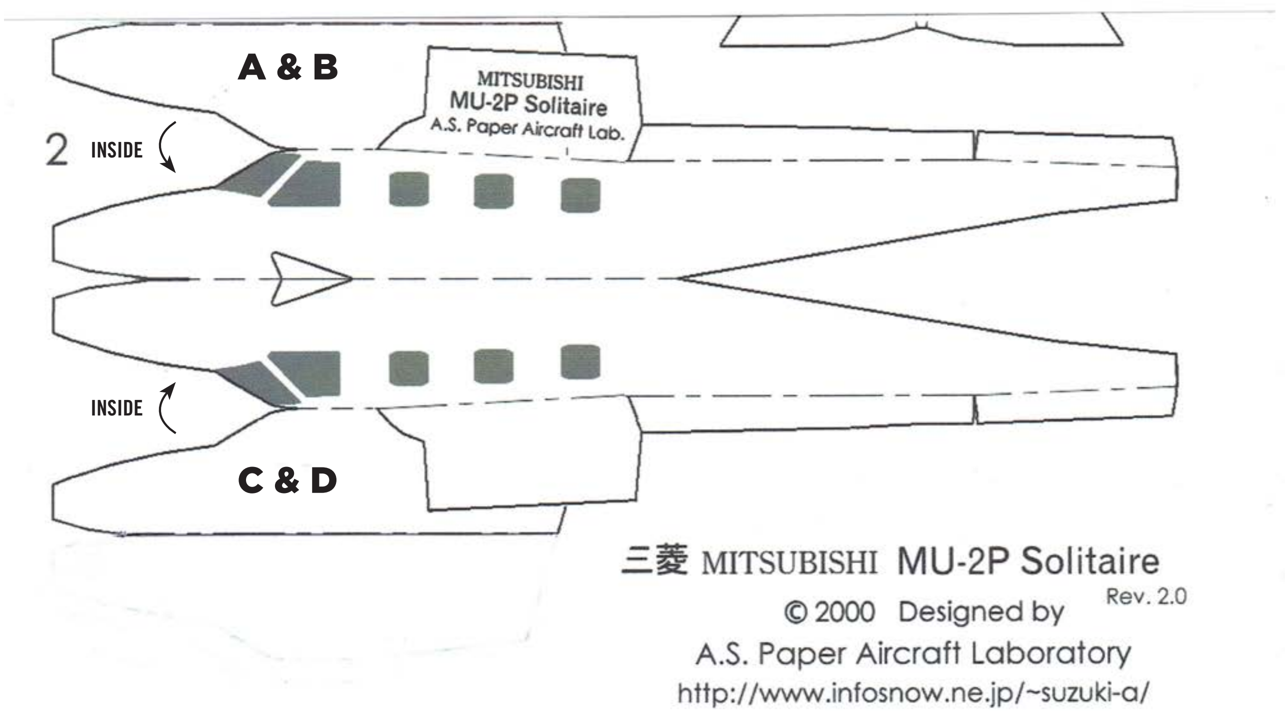
13 Cut out the launching notch under the nose with the X-Acto knife.

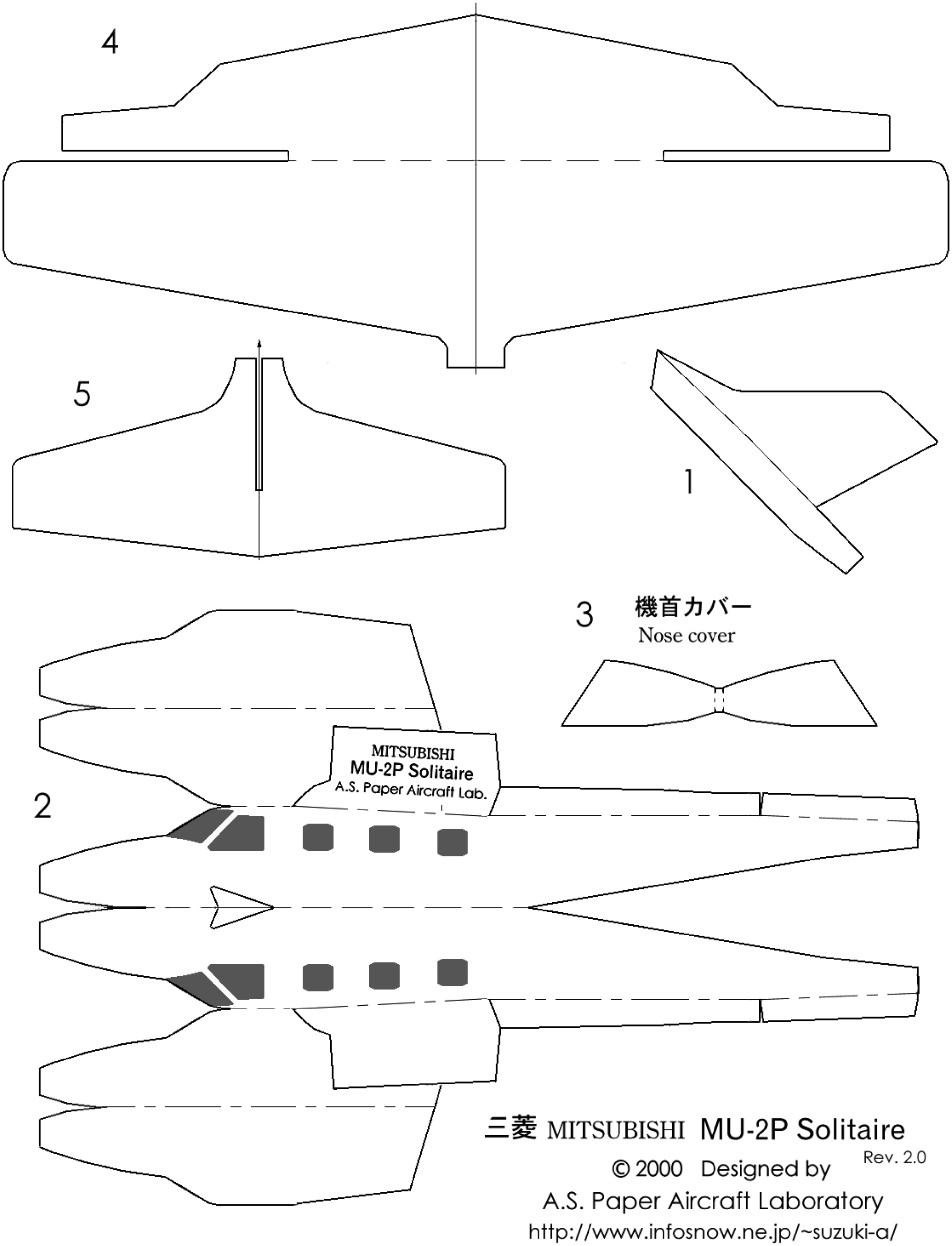


Activity Credit: Credit and Permission to Reprint – The A.S. Paper Aircraft Laboratory has made these aircraft model plans freeware and downloadable from their website especially for educational purposes. Therefore, they have given the Civil Air Patrol permission to reprint many of the paper aircraft model plans at their website. One such plan is presented here. Other A.S. Paper Aircraft Laboratory Plans can be found at **www.infosnow.ne.jp/~suzuki-a/**. Over 20 airplane plans can be viewed and downloaded from this website.

Below is the labled template that shows how to fold the airplane to create a Mitsubishi MU-2






4
5
1
3
機首カバー
Nose cover
2
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