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4-H AEROSPACE PROGRAM



FLYING

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## On The Cover

Thousands of people are flying today, both for business and pleasure. Aviation offers something for everyone. Youth can learn about flying by using this publication and enrolling in a 4-H aerospace program through a local 4-H Club or special interest 4-H group. (Photograph by Stephan Wilkinson, courtesy of "Flying" magazine.)

## Introduction

Flying is an adventure. Perhaps you have already had this adventure by building flying model airplanes. Now you are ready for bigger adventure, learning about full-scale aircraft.

There is much to learn! Men have been designing and flying airplanes for centuries. Some men and women have devoted their lives to making airplanes.

Aviation can grow into a career for you, or it can always be a hobby. That's the nice part about aviation — there is something for everyone.

Is it really for me? Will I fit into the picture? Why not? Everyone is affected by aviation. Airplanes carry people, mail, freight, and food. You may fly for business, pleasure, or work. You may be part of a ground team to keep airplanes flying. Remember, aviation is an opportunity waiting for you!

### Things You Can Do:

Exercises at the beginning of each chapter will challenge you to further interests and study. The exercises are not difficult. Don't be discouraged if they are not possible in your area. Do all you can, and have fun.

### 4-H Aviation Project Flight Level 01 The History Of Flight

#### Things You Can Do:

1. Study and tell about one of the following airplanes:

Fokker D-7	DC-3 (Douglas Skytrain)
"Spirit of St. Louis"	Zero
Sopwith Camel	Spitfire

2. Study and tell about one or more of the following people:

Orville and Wilbur Wright	Charles Lindberg
Curtis Langley	"Hap" Arnold
Amelia Earhart	Jacqueline Cochran
Admiral Byrd	

3. Other suggested activities:

- Build a model of an early airplane or a series of famous warplanes.
- Name five manufacturers of airplanes.
- List several "firsts" in the aviation field — such as the first flight across the English Channel.
- Make a poster showing the history of flight.

One of the earliest airplane designers was Leonardo da Vinci, the 15th century artist. Da Vinci designed gliderlike airplanes, but he never built them. In fact, it was almost 400 years later that the first glider was built.

Those late 18th century glider flights must have been frustrating! Men such as Germany's Otto Lilienthal barely got their gliders into the air before the gliders were grounded again.

Frustration was common for men experimenting with powered flight. One pioneer, Samuel Langley of Washington, D.C., built two successful

flying machines. Neither was big enough to carry a man. When he built a passenger-size plane in 1903, it crashed at takeoff.

But frustration didn't keep these men from trying.

The first big success was in 1903 when Orville and Wilbur Wright flew their invention at Kitty Hawk. The plane flew 120 feet while Orville lay in the lower wing. That small distance was a big move ahead.

In 1907, the U.S. Army bought a plane from the Wright brothers. By 1918, the Post Office was using air-

planes. Two years later, passengers were flying between Florida and Cuba. In 1927, Charles Lindberg flew across the Atlantic Ocean — nonstop and all by himself. The air age had begun!

The wood and fabric airplanes of World War I have been surpassed by generations of fighters, transports, and space vehicles. World War I's famous "Jennies" and "Fokkers" have given way to jumbo and supersonic jets.

Power plants have improved from the 30-horsepower engines of the early 1900's to today's jets providing thousands of pounds of thrust.

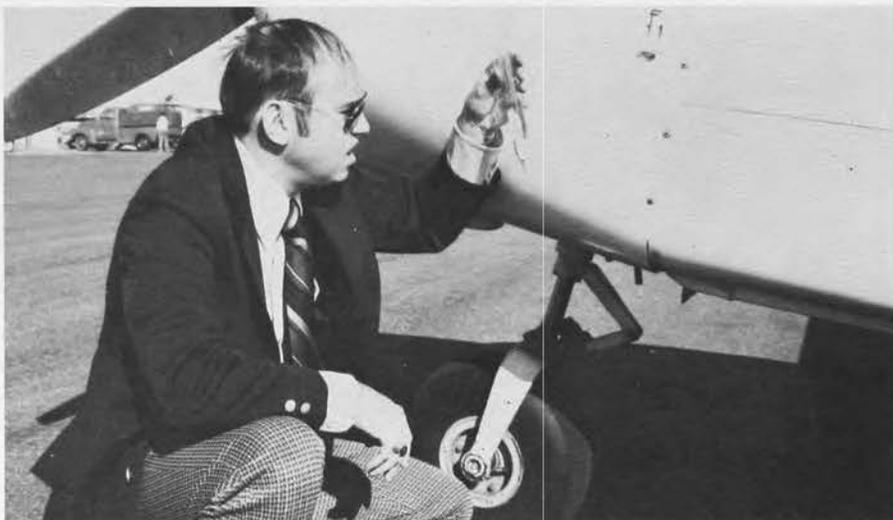


The DC-3 was one of the early airplanes that helped establish the commercial airlines. The first models were used in the 1930's. This airplane is still being used today in many developing nations.

## 4-H Aviation Project Flight Level 02 How Safe Is Private Flying?

### Things You Can Do:

1. List recent aircraft improvements that insure safer flying.
2. Study an aircraft flight manual and report on what a pilot looks for in a preflight check.
3. There are three pieces of information (manuals or certificates) that must be kept in the airplane. What are they?
4. What are some safety items checked during an aircraft's annual inspection?
5. All pilots must have medical examinations. Learn and report on pilots' physical requirements for various pilot licenses.



Preflight inspection requires many safety checks before the pilot even climbs into the cockpit. Above, the pilot is checking a sample of the fuel for dirt and water. For this check, a special drain is provided at low points in the fuel system. Below, the pilot is inspecting control surfaces and attachments.



Safety is one of the first considerations for anyone thinking about learning to fly. The real story of general aviation safety lies not in statistics, but in recent changes in airplanes and fliers.

Safety contributions include:

- EXTENSIVE DESIGN IMPROVEMENTS that have made airplanes easier to fly.
- IMPROVEMENTS IN EQUIPMENT that have made the pilot's job simpler and safer.
- BETTER INSTRUCTION METHODS AND PILOT AIDS that have improved pilots' capabilities.

The Federal Aviation Administration (FAA) originated "safety watch" guard. "Safety watch" begins at factories where airplanes are designed and built. Each plane must meet safety requirements. Airports, pilots, mechanics, navigational aids, and aviation researchers are all checked by the FAA.

FAA makes sure all pilots can control airplanes properly. Students must pass a written and flight examination to receive their private pilot's licenses. Before they receive their licenses, students must spend 35 hours in the air in a FAA approved flight school or 40 hours under the supervision of a certified flight instructor not associated with an approved school. Pilots must also pass a physical examination. Private pilots must pass a



Most aircraft manufacturers today put tricycle landing gear on their airplanes. Most pilots feel that tricycle landing gear, with a wheel under each wing and the turning wheel under the nose of the airplane, is safer and easier to control than older conventional gear having two main wheels and a small tail wheel or skid. (Top photograph by Stephan Wilkinson, courtesy of "Flying" magazine.)



physical examination every 2 years. Other pilots, such as commercial, military, business, and executive pilots, have examinations more frequently.

### The Airplane

Today's private aircraft bears little relationship to its older brothers which were designed primarily for the skilled pilot who was interested in sport flying and acrobatics.

However, the entire concept of the private airplane has changed. Today's private airplanes have a new mission: cross-country flying and transportation of people or cargo.

Private airplanes are now more stable, safe, comfortable, and simplified. Contrary to public belief, flying today requires little more physical skill than driving an automobile. Major design improvements include:

**TRICYCLE LANDING GEAR** – This is now standard on most airplanes. It has done more than any other design change to make flying easier and safer. Tricycle landing gear makes ground handling easy, provides positive steering with the nose wheel, and improves

directional control during takeoff and landing.

**STABILITY AND CONTROL** have been greatly improved. Controls respond quickly and easily.

**BETTER ENGINES** offer greater reliability and more power. The FAA requires aircraft engines to be inspected at specified intervals.

### Pilot Aids

All pilots have many aids which contribute to safe flying:

**WEATHER BRIEFINGS** are available at almost any airport. These give current weather conditions at hundreds of places throughout the country. With reasonable accuracy, weather forecasts also predict conditions within the next few hours.

**FLIGHT SERVICE STATIONS**, operated by the FAA, continually serve pilots. These stations accept flight plans filed by pilots. They broadcast current weather for airborne pilots and may be contacted anytime by telephone or radio for flight, airport, and weather information.

**RADIO NAVIGATIONAL AIDS** are almost always within range of an airplane. These make navigation possible almost any place in the country using only basic navigational aids for directional reference.

**DETAILED MAPS** of the United States and other countries show towns, cities, railroads, major roads, rivers, prominent landmarks, and other navigational aids.

**IMPROVED INSTRUCTIONAL METHODS** help students learn to fly and obtain advanced training.

### The Future

Safety is important to airplane manufacturers and pilots. Manufacturers work closely with the FAA whose duties include establishing safety standards for aircraft production and operation.

The risks inherent in flying will never be eliminated. However, a well-built and well-maintained airplane in the hands of a competent and prudent pilot makes flying as safe as any other form of transportation.

## 4-H Aviation Project Flight Level 03 What Is An "Airplane?"

### Things You Can Do:

1. Collect and display pictures of airplanes. High wing, low wing, twin engine, etc.
2. Report on one or more airplane manufacturers and name some of the airplanes they manufacture.
3. Build and fly a model airplane.
4. Visit a local airport and ask the fixed base operator to show the parts of an airplane and explain their functions.
5. See if your airport has the following:

- Wind Sock
- Beacon
- Hangar
- Runway lights
- Fueling facilities
- Tie downs



### Airplane Design — A Challenge

Airplanes have to be carefully designed. The design must balance the forces of weight, lift, drag, and thrust. Designers have many options when they create a new airplane. Where should the wing be placed? What should it be made of? What shape should the fuselage be? To answer such questions, the designer must understand airplanes and the forces of flight.

Airplane builders begin with the fuselage, the part that carries the pilot, cargo, controls, instruments, and passengers. All other parts of the plane are attached to this fuselage.

The wings are attached to the fuselage with heavy aluminum or steel fittings. The wings provide lift, but wings can do more than that. Wings can carry fuel and engines, house landing gear, and support the de-icing system. The designer selects the right wings for his airplane. He may use one of the thousands of designs that have been developed, or he may design a new kind of wing. (Note: In aviation language, each wing "section" may be called a "wing," i.e., right wing, left wing.)

Most designs include one wing section on each side of the fuselage. Together these make one full wing. Such planes are called monoplanes. Planes with two full wings are called biplanes. Monoplanes may have the wing attached on top of the fuselage, near the middle of the fuselage, or at the bottom of the fuselage. This gives them their titles of high-wing, mid-wing, or low-wing monoplanes.

The horizontal and vertical stabilizers are also attached to the fuselage. The horizontal stabilizer extends from both sides of the fuselage. It may be one piece or in separate sections. The vertical stabilizer extends upward from the top of the aircraft. It includes the rudder which assists turning.

The designer must also decide where to mount the engines. Sometimes it is best to mount an engine on the fuselage. Other times engines are mounted on the wings.

Most small planes have either conventional or tricycle landing gear. Airplanes sitting with their noses tilted upward have conventional landing gear — two main wheels and a tail wheel. Tricycle landing gear has the third wheel under the nose. Planes with this landing gear are level when they rest.

### Aircraft Engines

The throttle controls the airplane engine, and the engine provides thrust. Because the engine moves the plane forward, pilots call the engine the propulsion system.

Many early flights failed because airplanes did not have enough propulsion. Today there are several types of airplane engines. These are:

- The reciprocating engine turning a propeller.
- The turbine engine called a turbojet.
- The turbine engine turning a propeller and called a turboprop.

Let's take a look at each engine to see how it provides thrust:

The reciprocating engine is a piston-type engine similar to that in a car. Such an engine is used in most light airplanes having propellers.

The reciprocating engine is popular for small aircraft, but jet engines have advantages for larger airplanes. Jet engines are lighter and simpler for the same horsepower rating. Jet engines have less vibration, although they make much greater noise. Turboprops and turbojets are jet engines.

Turbojets are best for high speed and high altitude. A turbojet engine has only three main parts: the compressor; the combustion chamber; and the turbines. There are fewer moving parts compared to those in reciprocating engines. Jet engines give the



This is a high-wing monoplane which means it has the wing attached to the top of the fuselage. Other monoplanes may be mid-wing or low-wing. (Photograph by Stephan Wilkinson, courtesy of "Flying" magazine.)

plane thrust the same way a fired rifle kicks back against your shoulder or a balloon moves when you let out its air. This kick is caused by gases pushing against the gun barrel or the sides of the balloon. The atmosphere has nothing to do with the force of the kick.

Air enters the jet from the front. The air pressure is increased in the compressor. This compressed air is forced into the combustion chamber where it mixes with fuel and burns. Hot, expanding gases are created.

These hot gases flow to the turbine, making it revolve at high speed to turn the compressor. The hot gases escape through the exhaust nozzle at the back of the engine.

Turboprop engines work much like turbojet engines. However, turboprop engines turn propellers for thrust. About 90 percent of these engines' energy operates the propellers.

The propeller is another part of the propulsion system. Propellers are most commonly two-bladed. Larger engines will have three- and four-bladed propellers. Most general aviation aircraft use a fixed-pitch propeller — one



**This four cylinder reciprocating aircraft engine develops up to 150 horsepower. Inspection and maintenance standards for airplane engines are much greater than for automobile engines.**

that cannot be adjusted. Larger engines need variable pitch propellers. These allow the pilot to change pitch as needed to provide greater efficiency at cruise speeds. Variable pitch propellers are common on larger aircraft and smaller planes with larger engines.

**CAUTION:** Propellers are dangerous. Do not stand near a turning propeller or near an aircraft while the pilot is starting his engines. Be safety conscious around airports and moving aircraft. Jet intakes are extremely dangerous, as is jet exhaust.

## FLYING TERMS

- Autopilot . . . . . An electronic device which automatically flies the airplane on a course and altitude selected by the pilot.
- CFI . . . . . Certified Flight Instructor — the person who will be your instructor when you begin flying.
- Cockpit . . . . . Sometimes called the “cabin” or “front” of an aircraft. This is where the pilot and other crew are located.
- Cross Country . . . . . A flight away from the airport’s immediate area.
- Dual Instruction . . . . . Flying with an instructor. You are required to have a certain number of hours of dual instruction before you can receive a pilot’s license.
- Gear . . . . . The “wheels and their axles.” Gear may be fixed or retractable.
- “Hangar Flying” . . . . . Talking about your flying experiences.
- IFR . . . . . Instrument Flight Rules. Pilots are required to have a special rating and training for bad weather or certain controlled flying conditions. To fly through clouds, an instrument rating is required.
- “Mags” or magnetos . . . . . The ignition system used on most light aircraft.
- Nav aids . . . . . Electronic systems used in aircraft to aid pilots in flight. Means “navigational aids.”
- Panel . . . . . Contains instruments and other aids for airplane operation like the dashboard of a car.
- Pilot-In-Command . . . . . The pilot of the airplane.
- Pattern . . . . . The system of approaches and exits used when taking off and landing at airports.
- Preflight Inspection . . . . . A walkaround inspection to visually check your aircraft before each flight to see if everything is safe and in proper order.
- Run-up . . . . . Accelerating the engine to test the many electrical and engine systems and also an instrument check to see if the airplane is ready to take off.
- Sectional . . . . . An aviation map showing many landmarks and airports. It is similar to a road map used in driving.
- Solo . . . . . Your first flight alone in an airplane or a term used to indicate you are the lone pilot. No copilot or instructor is along.
- Taxi . . . . . Maneuvering the airplane on the ground before lining up on the runway for takeoff.
- Taxiway . . . . . “Lanes” used for taxiing to or from the runway.
- Trim Tab . . . . . A control in the cockpit which aids the pilot in flying the airplane. It allows him to change the pressure on the controls so he does not have to exert so much force to fly the airplane.
- VFR . . . . . Visual Flight Rules — those that govern a pilot flying in visual contact with points of reference outside the airplane. A VFR flight is not permitted through clouds.

**4-H Aviation Project  
Flight Level 04  
Why Does It Fly?**

**Things You Can Do:**

1. Tilt your hand at different angles in front of a fan or other air source. Describe this experience in regard to lift and drag.
2. Inflate a balloon. Record your observations of the balloon when you release it, letting the air out. Describe its action in terms of thrust.
3. Construct a rubber band powered model airplane.
  - a. Wind the propeller, let the propeller go, and feel the thrust produced.
  - b. Wind the propeller in the other direction, let it go, and note the reverse thrust.
  - c. Wind the propeller and release the model. Observe its flight characteristics in regard to lift, gravity, thrust, and drag. Observe and record the results of your experiment.
4. Draw five different wing designs.
5. Collect pictures of airplane engines and propellers.

What made the Wright brothers successful when so many others had failed? Perhaps it was because Wilbur and Orville Wright studied flight scientifically. Before they began building full-scale airplanes, they spent years studying birds and experimenting with model gliders.

Today, although aviation is an important part of our lives, many people do not understand what makes airplanes fly.

Airplanes are held up by air. This may surprise you because you can't see air, but the air that surrounds you is heavy and strong. It pushes in on you equally in all directions. You don't feel air pressure because it

pushes so evenly. Without air pressure, airplanes could not fly.

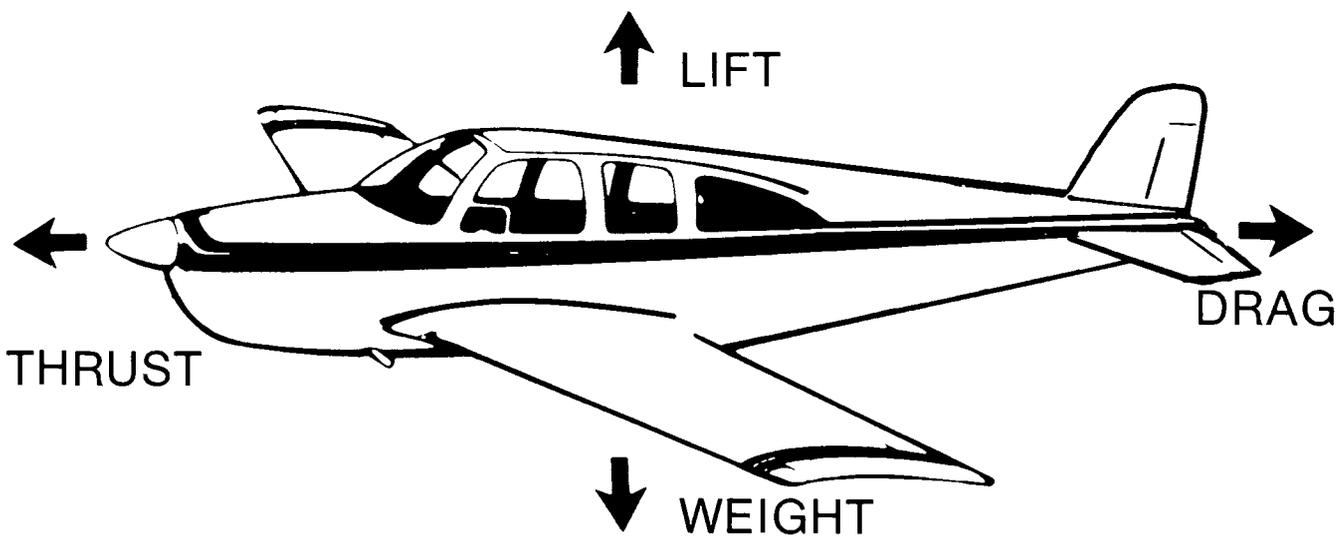
Air pressure alone will not make planes fly. Four forces affect airplanes in the air:

**WEIGHT** is the total load of the airplane. Because airplanes have weight, gravity pulls them downward just like it pulls you back to the ground when you jump. How does an airplane overcome the force of gravity? By lift.

**LIFT** is created by air flowing over the wings. This air lifts the airplane upward. You can see lift at work. Hold a strip of paper in front of your mouth and blow across the top of it. The paper will rise.

**DRAG** is air friction which pulls the plane back. When you ride a bicycle as fast as you can, you feel air blowing into your face. This is because you are pushing through the air, disturbing its position. This air keeps you from going faster. Drag has the same effect on an airplane as the plane rushes through the air.

**THRUST** is the forward pull of the engine. It is this thrust that overpowers drag. Let's suppose you are riding your bicycle and drag is holding you back. What do you do? You pedal harder to get more thrust. The thrust overpowers the drag, and you move forward.



An airplane in flight is the center of a continuous tug-of-war among four forces: lift; weight; thrust; and drag.



Air rushing over the curved surface of this paper causes air pressure to decrease on top of the paper, creating lift from the bottom.

### Using the Forces of Flight

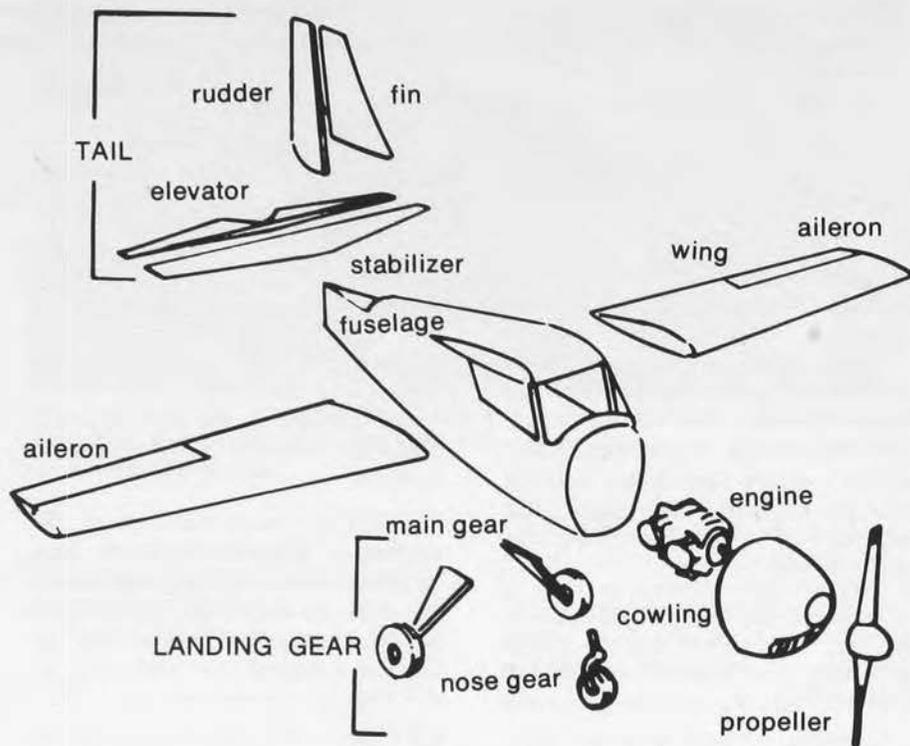
The Wright brothers' plane and every airplane since was designed to work with the four forces of flight. For example, early wings were designed to give lift. Today's wings are still designed to provide lift.

How is lift created? The front or leading edge of the wing is rounded. The back edge, or trailing edge, is pointed and thinner. The underside of the wing is almost flat, and the top is curved. As the wing pushes through the air with its leading edge first, it pushes air out of its way. Some of the air sweeps across the curved top, and some air rushes past the flat underside. The air meets again at the wing's trailing edge. The air moving across the top of the wing has to move farther and faster. It has little time to press down on the wing. The air under the wing, moving a shorter distance, has more time to push up on the wing. With this difference in air pressure, the wing lifts the airplane as it moves through the air.

An airplane must move through the air fast enough so difference in wing air pressure occurs. Lift is the result. As the blades whirl around on a propeller-driven airplane, they cut into the air and push it back. This pushed-back air gives a kick forward, thrusting the propeller and airplane forward.

In the same way, the jet produces thrust as gases are released at the rear of the jet. Released gases thrust the engine and airplane forward through the air.

Actually, every part of the airplane puts the forces of lift, weight, thrust, and drag to work. When lift and thrust overcome weight and drag, the airplane flies steadily — either climbing or descending, speeding up or slowing down.



Parts of an airplane.

### Controlling the Forces of Flight

The pilot has controls to help him change direction and speed of the airplane. The wing, fuselage, and tail help keep the plane stable.

The tail has several parts, each with a different job:

- The horizontal stabilizer is a small wing at the back of the airplane. It is stationary and keeps the plane from pitching or tipping forward and backward.
- The elevators are hinged to the horizontal stabilizer as a door is hinged to a wall. These are controlled from the cockpit. When the elevators are moved up or down, the plane moves up or down. The elevators control pitch (up and down movement).
- The vertical stabilizer is the fin that sticks up between the horizontal stabilizer. It keeps the plane from yawing (rolling from side to side). Some aircraft have two or more, but most only have one vertical stabilizer. The

rudder is hinged to the vertical stabilizer and can swing to the left or right. It helps the plane turn.

Part of each wing's trailing edge is hinged. These hinged sections are ailerons. The pilot uses them to make a turn. Planes turn, in part, because the wing on one side of the fuselage is raised and the wing on the other side is lowered. Ailerons control this banking (raised and lowered movement). When the wings are tipped, balance is thrown off. The lift on each wing is no longer equal. Therefore, the plane banks in the direction of the lowest wing.

We have talked about the elevators, the rudder, and the ailerons. These are called surface controls because they change the shape of the airplane's surfaces, directly affecting the forces of flight. But there is another basic control. It's the throttle.

The throttle affects the airplane's thrust. Pushing the throttle speeds the engine. Pulling the throttle slows the engine. The throttle operates the same as does the accelerator pedal of a car.

## 4-H Aviation Project Flight Level 05 All About Instruments

### Things You Can Do:

1. Draw a circle and mark it North, South, East, and West together with the number of degrees at each of the four points.
2. Using a compass, plot a course from your house to a friend's house.
3. Observe the cockpit of an airplane and identify the instruments.
4. Draw three pictures of an altimeter, showing needle positions at 1,000 feet, 1,700 feet, and 2,350 feet.

A pilot needs more than controls and an engine to fly his airplane. He also needs instruments to tell him how the plane is flying. Is the airplane too high? Is it going too fast? Does it have enough fuel? Instruments can tell the pilot these things and more.

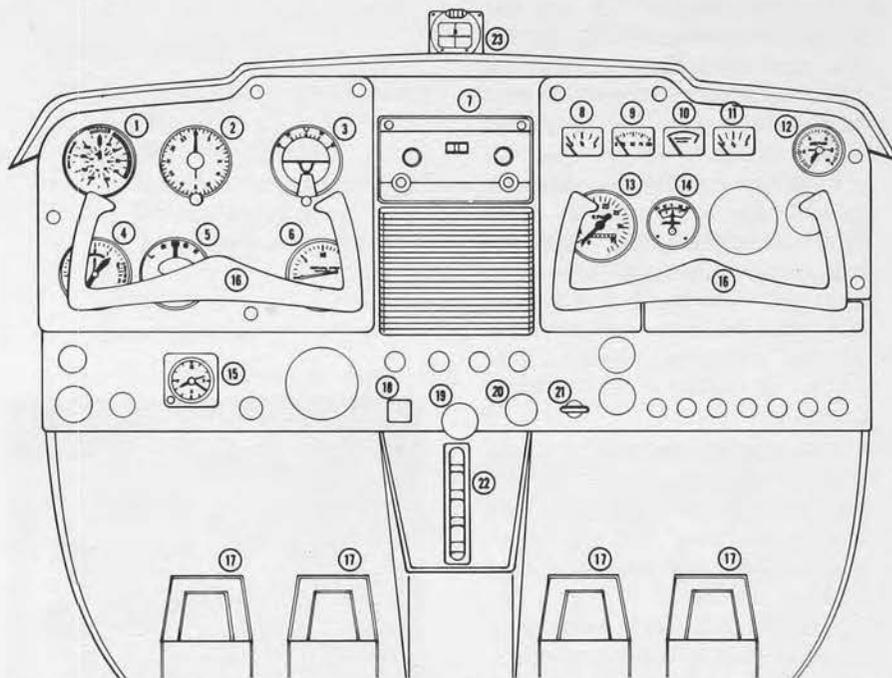
The plane's instrument panel may look complicated at first, but many of these instruments are similar to those in a car. There are two main sets of instruments. The first group tells the pilot what is happening inside the engine. The second group indicates how the airplane is flying.

### Engine Instruments

**Tachometer** – Measures engine speed by telling engine revolutions per minute (rpm).

**Fuel gauge** – Tells how much fuel is in the tanks. There is one gauge for each tank or a master switch allows you to check each individual tank. A pilot does not rely entirely upon this gauge. Before flight, he makes a physical and visual check of the fuel.

**Oil pressure gauge** – Shows the pressure of oil supplied to engine parts. All these instruments are colored differently in their various ranges. The pilot can readily see if the engine is operating at the correct level.

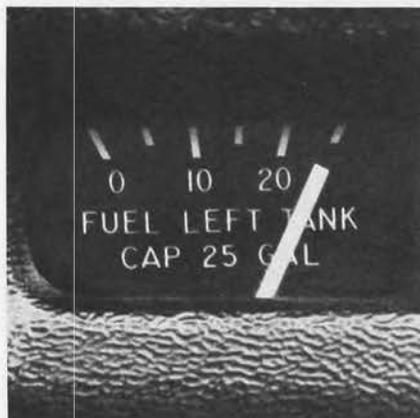


A pilot uses many instruments and controls to fly an airplane. This drawing shows the locations of several instruments and controls found in smaller aircraft.

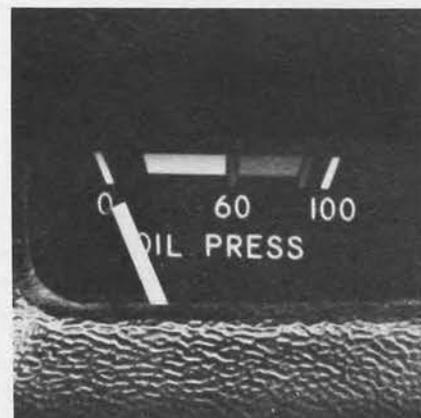
- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Air speed indicator</li> <li>2. Directional gyroscope</li> <li>3. Artificial horizon</li> <li>4. Altimeter</li> <li>5. Turn-and-bank indicator</li> <li>6. Vertical speed (rate of climb-descent) indicator</li> <li>7. VHF navigation-communication radio</li> <li>8. Fuel gauge (left tank)</li> <li>9. Oil pressure gauge</li> <li>10. Oil temperature gauge</li> <li>11. Fuel gauge (right tank)</li> <li>12. Suction indicator (run by vacuum pump, activates gyroscopic instruments)</li> </ol> | <ol style="list-style-type: none"> <li>13. Tachometer</li> <li>14. Battery-alternator indicator</li> <li>15. Clock</li> <li>16. Control wheel (dual)</li> <li>17. Rudder pedals</li> <li>18. Carburetor heat control</li> <li>19. Throttle control</li> <li>20. Fuel-air mixture control</li> <li>21. Wing flaps control</li> <li>22. Trim tab control</li> <li>23. Magnetic compass</li> </ol> |
|---|---|



Tachometer



Fuel Gauge



Oil Pressure Gauge

## Flight Instruments

The artificial horizon helps the pilot keep the plane straight and level. If the plane is level, the wings illustrated on the instrument touch the horizon line; or if these wings go above or below the instrument's horizon line, the plane is either climbing or diving, respectively.

The air speed indicator tells how fast the plane is moving through the air. The pilot must make calculations from this indicator to determine his ground speed (how fast he is moving in relation to the ground). An airplane flying 100 miles an hour air speed facing a 25 mile per hour head wind would have a 75 mile per hour ground speed. With the same speed tail wind, his ground speed is 125 miles per hour. Colored areas on the instrument indicate safe speeds for different flight operations.

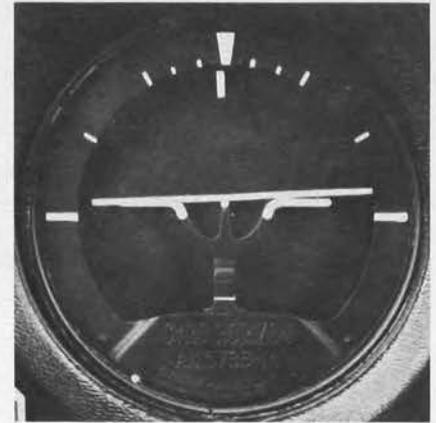
The altimeter shows how high the plane is flying above sea level. This looks like a clock with two hands. The smaller hand indicates thousands of feet, and the larger hand indicates hundreds of feet. The pilot must thoroughly understand the altimeter's principle of operation and the effect of barometric pressure and temperature on this instrument. Further study and research on this will make an interesting project area.

The directional gyroscope and magnetic compass tell the direction the airplane is flying. Most aircraft are equipped with both these instruments.

The magnetic compass is difficult to read under certain conditions, but it is a reliable instrument. In plotting a course and during some flight conditions, a pilot must make calculations or corrections on the magnetic compass.

The directional gyroscope is not magnetically oriented. It must be set to the magnetic compass. On this instrument, the numbers in the window are heading indicators and represent numerical directions similar to that on a compass. When the airplane changes direction, the numbers on the directional gyro and magnetic compass will change to continuously show you the airplane's direction.

Here are several flight instruments found on an airplane instrument panel. Each provides vital information the pilot needs to fly safely.



Artificial Horizon



Air Speed Indicator



Altimeter



Magnetic Compass



Directional Gyroscope

**4-H Aviation Project  
Flight Level 06  
Map Reading And Navigation**

How can a pilot tell which way to go in the roadless sky?

Pilots use many navigational aids to stay on course. If a pilot is familiar with the land below the airplane, he looks for landmarks. If he doesn't know the territory, a pilot uses aeronautical charts – the road maps of the sky. These maps show checkpoints which can be spotted from the air.

Before taking off, the pilot plots his course, selecting checkpoints he will watch for from the air. He may watch for certain towns, highways, lakes, or railroad tracks.

Control towers, control centers, and flight service stations all help the pilot find his way. These are located across the United States. They can be reached by radio whenever there is a need.

Every pilot must be able to read aeronautical charts. These are similar to automobile road maps. The legend on the margin on the chart identifies aeronautical and other symbols including those used for highways, railroads, cities, and rivers. Other easily recognizable landmarks are shown, such as race tracks, highways, open air theaters, and obstructions such as radio and television towers. When shown on the chart, many of the items are exaggerated in size to be easily seen. All these checkpoint features may be useful to the pilot to maintain his course in the air.

Other valuable information on the margin of each sectional chart includes

**Things You Can Do:**

1. Locate and identify the following on the sectional chart below:
  - An Airport
    - Name of airport?
    - Length of longest runway? Does the runway have a hard surface?
    - Is the airport lighted?
    - Does it have a control tower? If so, what radio frequency is used?
  - River
  - Railroad
  - Main highway
  - High structure and height of this structure
  - Small town and large town
  - Airway
2. Plot a course between an airport and a VOR.
3. Locate a very high frequency omni range radio station.





Sectional maps show landmarks, airports, and other information which help pilots plan trips and navigate. Here a pilot is planning a flight. He is using a plotter to mark his course. The computer (lower right corner) is used to calculate ground speed, time enroute, true air speed, and other factors affecting his flight. The form at the bottom center is used to file a flight plan. The other form is used to record check points, time, fuel, ground speed, and other flight data for planning and flying a safe trip.

prohibited, restricted, caution, and warning areas.

With a firm knowledge of the map or chart, a pilot is ready to navigate where he wants to go. Perhaps the easiest way is the course he marks on the map before he takes off. He chooses checkpoints to help maintain heading (direction of flight). Checkpoints can be towns, rivers, lakes, and other prominent features on the ground. This method of following checkpoints, point to point, is called navigating by pilotage or "dead-reckoning." If he uses it regularly, the pilot learns to navigate easily and maintain a steady course.

On the charts, airports are indicated. Information about them is included in boxes beside their symbols. This gives all the information needed to plan a trip and to contact the airport for up-to-the-minute information or landing instructions.

Under the name of each airport are two groups of numbers. The first is its elevation in feet above sea level. The second, with two zeros omitted from the end, is the length of its longest runway.

Careful preflight planning cannot be emphasized too strongly. FAA regulations say the pilot "shall familiarize himself with all available information appropriate to the intended operation. Preflight action for flights away from the vicinity of an airport . . . shall include a careful study of available current weather reports and forecasts, taking into consideration field requirements . . ." Careful planning enables the pilot to make his flight with greater ease and safety.

Suggested steps to be used in flight planning are: Assemble materials needed on the flight such as current sectional charts and other charts for the planned route. Also, take along

charts which adjoin those for the route of flight. These help if it's necessary to go around bad weather or if you inadvertently fly off the planned course. Draw the planned course on the chart and study the terrain. Select appropriate checkpoints. Consider any caution, restricted, or prohibited areas. Study airport information such as number and direction of runways, maintenance facilities, and refueling stops. Review weather forecasts, current weather reports, winds aloft forecast, pilot weather reports, and similar information. Check the current airman's information guide and any other information about the flight area. Prepare and file a flight plan. (It is possible to get weather information by telephone or by radio from the airport. However, it is recommended that a personal visit be made to your nearest national weather station or flight service station to gather this information before the flight.)



Control towers are designed so personnel can see all the airplane traffic on and above the airport.



Airport control tower personnel keep radio contact with pilots taking off, landing, and taxiing. Many safety precautions are taken to avoid accidents and to reduce traffic congestion.

#### 4-H Aviation Project Flight Level 07 Communications

##### Things You Can Do:

1. Learn the function of an aircraft control tower and arrange a visit to a tower.
2. Learn the function of a Federal Flight Service Station and arrange a visit to one of these facilities.
3. Invite a pilot or aircraft controller to visit your group and explain the use of aircraft radios.
4. Practice radio communication terminology. Learn the international phonetic alphabet and the Morse Code.
5. Listen to aircraft communications on a radio having a frequency range of 108 to 135 MHz. Determine the frequencies used in your area for towers, ground control, emergencies, etc.

“Ground Control this is Cessna 9902 Lima ready to taxi.”

“Cessna 9902 Lima this is Ground Control, you may taxi to runway 29 left and hold. Watch Braniff 727 taxiing to left side of main terminal. Upon reaching holding point, contact control tower on 119.5. Over.”

“Ground Control this is Cessna 9902 Lima, taxiing. Will contact control tower on 119.5. Out.”

Aviation communications take on an entirely new dimension. Visual signals, words, and a special language are used. Control towers and ground radios give a pilot information for beginning a trip, in flight, and finishing a trip. Instrument flying and visual flying require communication equipment and special skills. Communications in the aviation field is an extremely interesting field of study for indepth, self-determined project work.

The pilot communicating above has used the radio to receive direction and

information to begin flight. The control tower allows the airplane to take off and enter the air space. Communications will be available for the pilot during the flight, during landing, and during taxiing to the airplane's parking place. Not all airports offer communications with control towers or ground control operations. However, the FAA urges all aircraft to be equipped with basic communication aids.

Pilots are concerned with low-frequency (LF), very high-frequency

(VHF), and ultrahigh-frequency (UHF) communication. Light general purpose aircraft and business planes largely use VHF for command and control. UHF, a standard in military and commercial communication, is rapidly finding its way into general purpose aviation. Weather broadcasts and some weather beacons operate in HF range. The primary difference among these is the equipment and range of possible coverage. Many commercial radio stations operate on amplitude modulation (AM). This is high-frequency with long-range coverage. FM or frequency modulation is another commercial radio frequency. Such stations operate on a line-of-sight principle. (This does not mean they only reach as far as you can see. Instead, if there is nothing blocking the distance between the transmitter and a receiver, radio waves with enough power can travel that distance.) Line-of-sight distance varies according to altitude also. If you are 1,000 feet high and in line with the transmitter, you can receive communication 45 miles distant; 3,000 feet, 80 miles; 5,000 feet, 100 miles; 8,000 feet, 140 miles. These are averages and can only give you a basic guide.

Electronic navigational aids are many and varied. They range from a simple radio compass to complex radar and distance measuring equipment. When flying under instrument conditions, the navigational aids are required.

Many small aircraft are used near fields without airport control towers. These airplanes rely upon the UNICOM radio system for air-to-ground information about traffic, weather, and air-to-air conversation with other aircraft.

Communication plays an important role. Voice communications give instructions, directions, guidance, plane-to-plane contact, and code identifiers for signaling and navigation. The very high frequency omni range (VOR or VORTAC) is an instrumented navigation system most commonly used in light aircraft. This system depends upon radio range together with a compass dial and a needle indicator telling whether the airplane is going toward or away from the station. This omni range system is known as VOR or OMNI.



This pilot is requesting landing instructions from control tower personnel. Smaller aircraft usually use VHF radio communication.

On this aircraft radio, the frequency designated on the left is used for voice communication. The frequency on the right is tuned to a VOR station for instrument navigation and for weather and other flying advisories.



### ICAO International Phonetic Alphabet (International Morse Code)

A	..	Alfa (Al-fah)	N	..	November
B	....	Bravo (Brah-voh)	O	---	Oscar
C	....	Charlie (Char-lee)	P	....	Papa
D	...-	Delta	Q	---.	Quebec (Keh-beck)
E	..	Echo	R	..-	Romeo
F	....	Foxtrot	S	...-	Sierra (See-air-rah)
G	--.	Golf	T	-..	Tango
H	....	Hotel	U	...-	Uniform
I	..	India	V	....	Victor
J	....	Juliatt (Jew-lee-ett)	W	...-	Whiskey
K	-.-	Kilo (Key-loh)	X	...-	X-ray
L	....	Lima (Lee-mah)	Y	....	Yankee
M	--	Mike	Z	....	Zulu (Zoo-loo)

### Numbers

1	(Wun)	6	(Six)
2	(Too)	7	(Seven)
3	(Tree)	8	(Ait)
4	(Fo-wer)	9	(Nin-er)
5	(Fi-yuv)	0	(Zero)

### 4-H Aviation Project Flight Level 08 Weather

#### Things You Can Do:

1. Record weather observations for a 7-day period and check the following:
  - Cloud type, whether cumulus, stratus, cirrus, alto, etc.
  - Amount and kind of precipitation.
  - Wind direction and velocity.
  - Temperatures, highs, lows, and averages.
  - Barometric pressure.
2. Sketch the different cloud types. Tell how they may be recognized, what are their characteristics, and what they mean.
3. Visit a Federal Flight Service Station or National Weather Service Station. These may be located at or near an airport.

**Good weather provides excellent visibility and safe flying conditions. However weather changes rapidly, and pilots must keep constant vigil for unsafe conditions.**



Air movement, heating and cooling of the earth's surface, and the earth's rotation on its axis create "weather."

This section tells common weather terms and patterns related to visibility, turbulence, and icing that occur during flight. Despite new devices and improvements in aircraft design, power plants, radio aids, and navigational techniques, flight safety is still subject to various weather conditions.

No amount of instruction can take the place of flying experience during various weather conditions. But this section will help you understand clouds, winds, weather fronts, and their effects. A full understanding would take much more space than is available here. Weather can be an excellent self-determined study for a club or group project.

If a pilot makes a mistake and flies into the wrong kind of weather, he can endanger himself, his passengers, and his airplane. Even model airplane fliers should observe weather.

Listening to the weatherman is not enough. Weather changes rapidly. The weather can change shortly after the

weather report. Pilots need more information than a television weatherman usually gives. Pilots also need to understand the weather well enough so they know what to do if the weather changes during a flight.

Pilots can get detailed weather information at Federal Flight Service Stations or at many airport weather stations operated by the National Weather Service. Local weather observations together with national observations, satellite pictures, and pilot reports combine to give many pictures of present and future weather. A pilot cannot change the weather, but he can use it to his best advantage. Through study beyond what is presented here, you will be able to better understand weather.

### Clouds

By the early 1900's, nearly all types of clouds had been identified and cataloged. Almost all kinds of weather are associated with certain cloud formations.

There are four basic cloud types:

- The cirrus, which look like wisps of hair floating in the sky.
- The stratus, which appear as large cloud blankets spread out across the sky.
- The nimbus, which are the grey, low hanging, rain clouds.
- The cumulus, the huge clouds boiling up into the sky. They often become large thunderheads.

Height also determines cloud classification. The term "alto" means clouds between 5,000 and 20,000 feet high. The amount of moisture in the air generally determines cloud cover in the sky.

Low clouds are of great importance to the pilot because they create low ceilings and low visibility. They change rapidly and often drop to the ground, forming complete blankets over landmarks and airfields. Cumulus clouds are extremely turbulent. This extreme turbulence creates dangerous high



These are stratocumulus clouds. The fuzzy cloud bases indicate that showers are falling. Some of the precipitation is virga (rain not reaching the ground). (Photograph by Craig Sanders, National Weather Service.)

Opposite page, upper left: This is a cumulonimbus cloud with a small "anvil." It's a thunderstorm and turbulent cloud which means danger to airplanes. Upper right: These are fair weather cumulus clouds with cirrus clouds above. Fine weather for flying. Lower left: These are cumulonimbus clouds with showers. Flying in such cloud cover is dangerous because of severe turbulence and lack of visibility. Lower right: Here are two levels of stratocumulus clouds over a mountain range. The lower deck is of special concern to pilots because it is obscuring the mountain tops. The darker, smaller clouds are scud clouds. (Photographs by Craig Sanders, National Weather Service.)

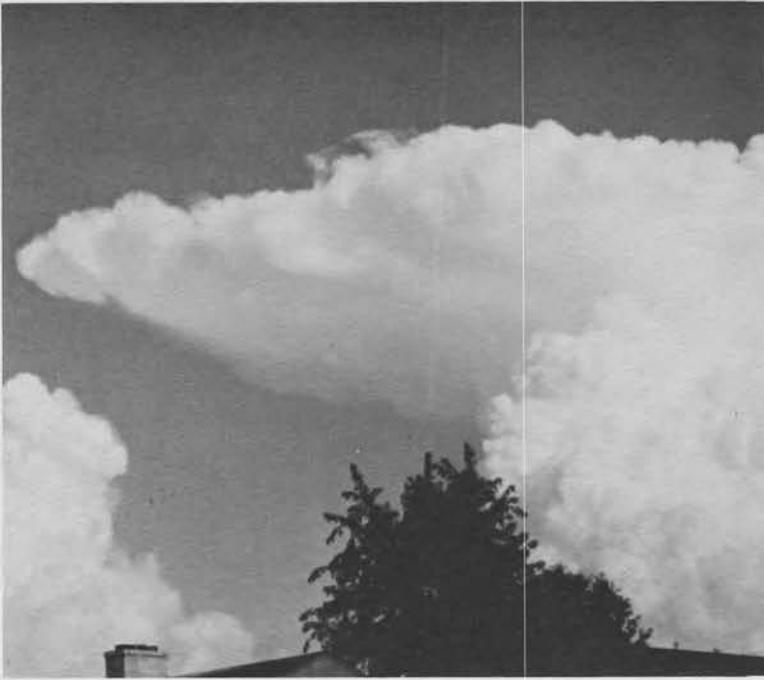
winds and is a storm-making factory. Caution is needed when flying near cumulus cloud formations.

Here are tips to do your own weather forecasting. Check these over a period of time to see how accurate they can be. Keep a record of cloud types and see if you are able to forecast weather.

### Winds

A combination of changes in pressure and temperature (which are occurring daily) create weather. Heating and cooling creates winds and changes in their flow and direction. Heated air rises, and cool air descends. This warm and cool air is, in turn, affected by the earth's rotation and forms "high" and "low" pressure areas. The winds rotate counterclockwise in a low-pressure area and clockwise in a high-pressure area. Though it is not always the case, usually a high-pressure area means good weather, and low-pressure usually means bad weather.

Cloud Condition	Forecast
Sharply defined clouds	Wind
Soft, ragged, scud cloud	Rain
Movement of high cloud in a different direction than surface wind	Change of wind toward direction of high cloud
Increasing cloudiness	Bad weather
Small, soft, white high cloud	Fair



## Weather Fronts

“Weather fronts” are created when warm and cold air try to replace one another. As one air mass moves away from an area, it is replaced by another. This creates a moving front. If warmer air is replacing the colder air, the front is called warm. If colder air is replacing the warmer air, the front is called cold. A cold front moves in unannounced and makes a complete weather change within a few hours. Then it passes on. A warm front creates a much slower and more gradual change.

## Characteristics of a cold air front:

Type of clouds: Cumulus  
 Ceilings: Generally unlimited (except during precipitation)  
 Air: Unstable, pronounced turbulence at lower levels  
 Visibility: Excellent (except during precipitation)  
 Occasional thunderstorms or showers: Can be hail, sleet, or snow flurries

## Characteristics of a warm air front:

Type of clouds: Stratus with possible fog or haze  
 Ceilings: Generally low  
 Air: Smooth, little or no turbulence  
 Visibility: Poor, smoke and dust held in lower levels  
 Precipitation: Drizzle

Commercial airlines need thousands of employees performing hundreds of different jobs. In addition, aviation jobs are available in the military, government, and in private industry. Here is the cabin crew of a large commercial airliner.

#### 4-H Aviation Project Flight Level 09 Something For Everyone

Aviation can be a hobby now and grow into a career later. Or it can always be a hobby. That is the nice part about aviation. There is something for everyone.

Many skilled private pilots call themselves hobbyists. They fly because it is fun! They think it is exciting to take pictures from the air, to beat the heavy vacation traffic, to take a sightseeing tour by air, to take the family to a sports event, or to visit relatives. Some private pilots belong to clubs and organizations which help them get the most enjoyment out of flying at the lowest possible cost.

Others are commercial pilots. Some spray farmers' fields, fight forest fires, conduct aviation research, or fly for commercial airlines or private companies.

Aviation leaders predict that there will always be a need for corporation pilots, agricultural pilots, air traffic controllers, control tower operators, mechanics, and service personnel. Vocational schools, technical training centers, and apprenticeships with airlines are goals to think about now as you finish your high school years. Both boys and girls can find a place in passenger airlines. The pay is good, and so are the chances of going where you want to live in the United States or in a foreign country. Some positions require college; some require a special vocational or technical school. Most require at least a high school diploma.

How will you fit into the picture? Remember aviation is an opportunity waiting for you.



#### Careers

There are many career options available in this exciting field:

**Airline operations:** Ground mechanics; flight crews; station personnel; counter ticket personnel; stewards and stewardesses; tower operators; security personnel; etc.

**Aircraft manufacturing:** All vocational trades are needed, ranging from the intricate work of communications and instrumentation to airframe and engine specialists. There is also need for sales and office personnel.

**Agricultural operations:** This can be a part of a fixed-base operation or a complete operation in itself. Pilots, mechanics, and field men all are part of the teams involved here.

**Government aviation (nonmilitary):** The FAA has authority for all air operations. Many careers are possible as control tower operators,

Federal Flight Service Station attendants, the National Weather Service, and in communications. These jobs are for both men and women.

**Military aviation:** Boys can become aviators in the Army, Navy, Marines, and Air Force, if they can pass the physical and mental requirements. Girls are also beginning to train as pilots for noncombat operations. Flight attendants, station personnel, and tower and radar personnel can include women. Many fields of work are associated with military aviation, such as communications, maintenance, and supply.

Therefore, both professional and semiprofessional fields of aviation need skilled, dedicated young people.

Whatever your future goals, there are many interesting and well-paying jobs available which can challenge and offer satisfying rewards.

## 4-H Aviation Project Flight Level 10 On The Ground

You should now have a basic understanding of the many elements of flying, from the basic airframe to the complex weather systems, from communications and navigational aids to possible careers.

Some flight levels have been written to interest you so you will want to delve further into the topic. Your leader may not always have been able to assist you, but this should motivate you for individual work in a self-determined project.

The following bibliography lists sources for further information, photographs, films, slides, publications, and career information.  
**HAPPY FLYING!!!!**



The minimum age to receive a pilot's license is 16. However, younger 4-H'ers can learn about flying now in anticipation of the time when they can fly. Others may not want to learn to fly themselves but enjoy learning about a mode of transportation which affects everyone.

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1. Flying Weather Forecast
2. Ice on Aircraft
3. Jet Stream
4. Turbulence — Its Causes and Effects
5. Mountain Wave
6. Storm Detection Radar
7. Thunderstorms
9. Flying Weather Information
10. Ceiling
12. Tips on Weather VFR Flight
13. Fronts
17. Severe Weather Forecast
18. Altimeters — How the Readings Are Affected by Temperature

Available from Supt. of Documents, Government Printing Office, Wash., D.C.

*Career Opportunities Booklets* (several titles) General Aviation Manufacturers Association, Suite 1200-A, 1025 Connecticut Ave. N.W., Wash., D.C. 20036.

*Pictures, Pamphlets and Packets for Air/Space Education.* National Aerospace Education Council, 806 15th St. N.W., Wash., D.C. 20005. (50¢)

#### Audio-Visual Materials:

Films, filmstrips, slides, and other material lists may be available through:

- a. County Cooperative Extension Office (4-H Agent).
- b. State Dept. of Aviation (or Dept. of Aeronautics).
- c. College, university, vocational schools, high school instructional materials centers, audio visual centers, or libraries.
- d. Federal Aviation Agency, Office of General Aviation Education, Wash., D.C. 20590.
- e. Local fixed-base airport operators.
- f. National Aerospace Education Council, 310 Shoreham Bldg., 806 15th St. N.W., Wash., D.C. 20005.



**PERFECT LANDING** — The pilot is watching the runway strip to bring his airplane down to the ground. He has already received landing instructions from the control tower and knows the runway is being reserved for his use. This publication is about flying, an exciting career or hobby which 4-H'ers can prepare for by enrolling in a 4-H aerospace program.

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