

# Whitewings®

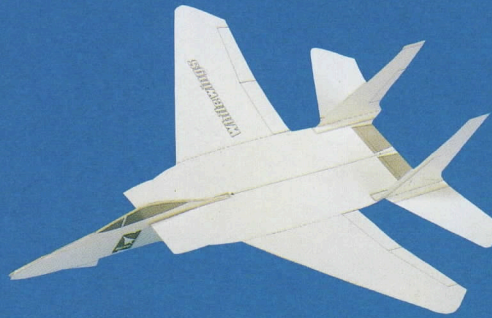
ASSEMBLY INSTRUCTIONS

FLIGHT INSTRUCTIONS

GUIDELINE FOR WHITEWINGS COMPETITION

INTRODUCTION TO PAPER PLANE DESIGN

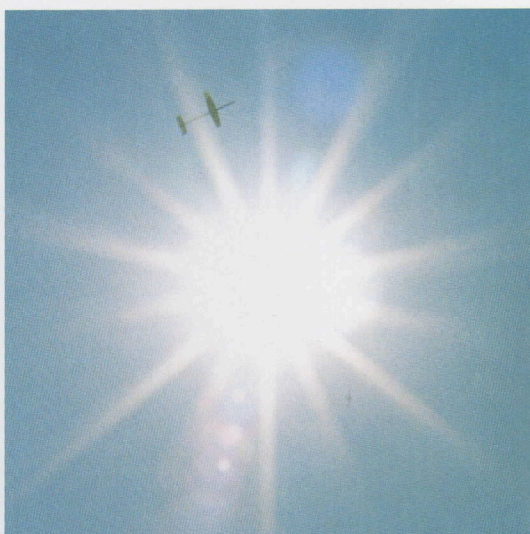
HOW TO BUILD "WHITEWINGS"



**HISTORY OF JET FIGHTERS SERIES**



Flight through the sky has long captivated men's imaginations. Today, air travel has become as simple for the average person as boarding a jumbo commercial airliner. If, however, we really want to experience, at first hand, the "joy of flight", I believe it's far more exciting to fly a miniature plane that you've made by your own efforts or to soar through the air on a hang glider. So that as many people as possible may readily get a taste of this fascinating experience, I would like to highly recommend that you make and fly your own paper airplanes.



# Fly into the Sky with Jet Fighters

When you hear the word "paper airplane" you may think of a child's folded plane made of a piece of paper. If you use a somewhat thicker and better quality paper, and cut and glue several layers of paper together, you can design and build structurally sound and aerodynamically high-performance paper planes. As the name of this kit "History of Jet Fighters Series" indicates, 10 representative profile models from the earliest jet planes to the most recent fighters have been selected.

In addition to these, this kit also includes high performance racer models and two new models featuring the triangular long fuselage. All the parts are printed on excellent quality drawing paper so you need only a minimum of tools such as scissors and glue. You can easily build a plane with excellent flying capability. The completed Whitewings will fly much better than you probably ever imagined a paper plane could fly. In order to maximize the Whitewings flying performance, you must follow the points listed below.

- Read the instructions carefully and thoroughly.
- Apply sufficient glue over the entire surface of each part to be glued to ensure a sturdily constructed plane.
- After the plane is assembled, make sure that the glue is completely dry. (Allow at least one day.)

Learning how to fly your paper plane is of primary importance. It is as important as building the plane.

- Test fly repeatedly until you can make your plane fly smoothly and straight forward.
- And then, practice making it fly to a higher altitude.

You should practice the above steps with care and patience.

There are many profile models of jet planes which fly at high speed. Therefore, when you fly your plane, it is important to remember the following:

- **Make sure you are in an area where there are no passing cars.**
- **Fly your plane in a large, open space, away from people who might get hit.**
  - Don't use too strong a rubber band in the catapult.
  - Before you have made your final adjustments, launch the plane by pulling the catapult lightly. As you have made the proper adjustments, fly the plane up higher gradually.
  - Examining the flying sphere of your plane, pay particular attention not to do people harm.
  - Don't try to give an extra hardness to the nose of the plane.

**DON'T FORGET THESE PRECAUTIONS!**

Now you're ready to give it a try.  
Take-off, WHITEWINGS!

Now you're ready to give it a try.  
Take-off, WHITEWINGS!

August, 1992

*Yasuaki Ninomiya*

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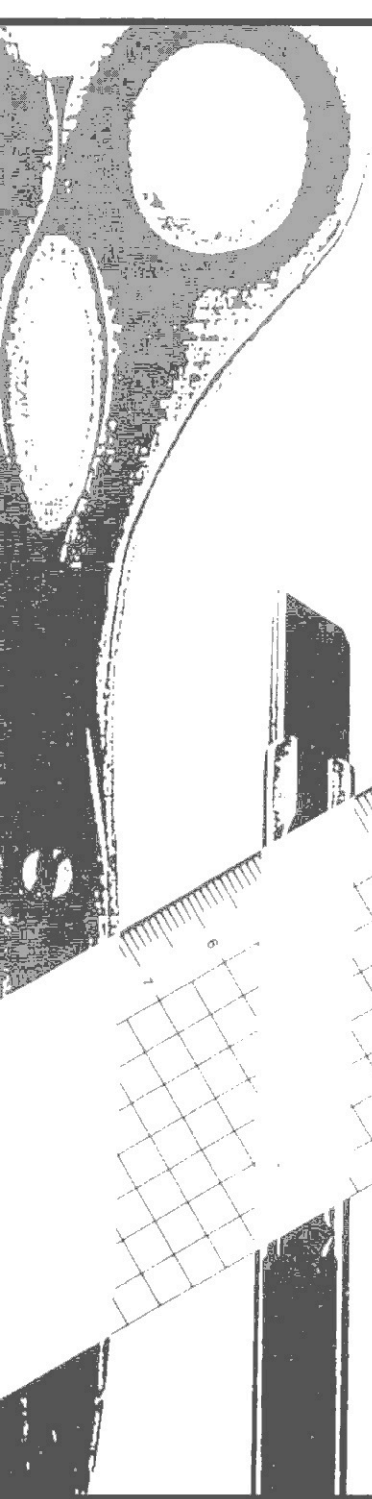
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Read And Follow Instructions.

### WARNING

Fly your Whitewings only in an area large enough for unobstructed flight, never near traffic or where it might hit someone. Whitewings airplanes are carefully designed for optional performance, do not alter your Whitewings or use catapult rubber bands other than those provided. Never launch your Whitewings directly at another person. Failure to follow these warnings could result in personal injury.



## **ASSEMBLY INSTRUCTIONS**

- Tools & Materials
- Airplane Parts
- Cutting Out the Parts
- Gluing
- Finishing Touches

## **FLIGHT INSTRUCTIONS**

- Test Flight
- How to Pilot
- Achieving Altitude
- How to Catch Rising Air Currents
- Repairs
- Storage
- Enjoy Displaying Your Airplanes
- Transporting Your Plane Safely

## **GUIDELINE FOR WHITEWINGS COMPETITION**



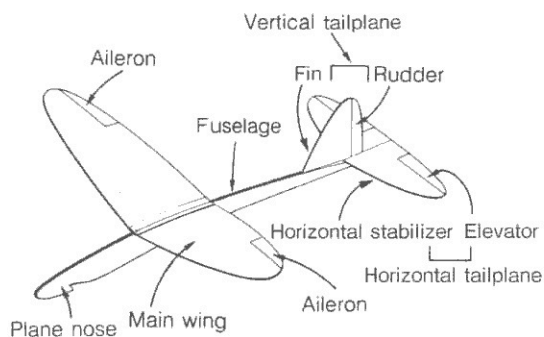
## TOOLS & MATERIALS

- **SCISSORS:** A pair of scissors that cuts well (Dressmaker's or tailor's are excellent).
- **CUTTER: (X-ACTO KNIFE):** This is used for cutting out the holes. Any small knife that can cut with its tip is suitable.
- **RULER:** Used to fold pieces and make creases accurately.
- **COMMON ORDINARY TABLE KNIFE:** Used for making the creases in the triangular long fuselage.
- **CLIPS:** Approximately ten clips are required for the construction of the triangular long fuselage. Clothespins may be used in place of clips.
- **TWEEZERS:** Used for checking the center of gravity and assembling the smaller pieces.
- **GLUE:** A clear, fast drying glue is most suitable; for instance, Dupont's "Seal All" or Bond Corporation's "527 Cement". These can be bought at your local drugstore, hardware, or stationery store.
- **RUBBER BAND AND ROD:** Used for making a rubber band catapult.
- **STRAIGHT PIN:** Used for making pin holes.
- **PIN:** This is used for the propeller shaft on the TriLinear 705.

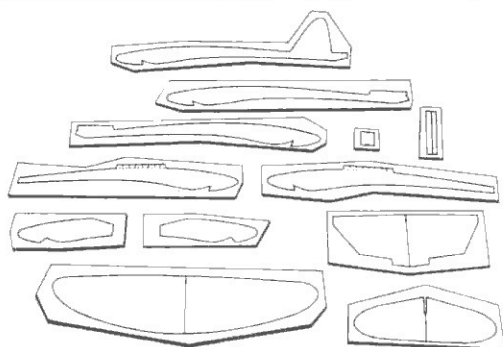


## AIRPLANE PARTS

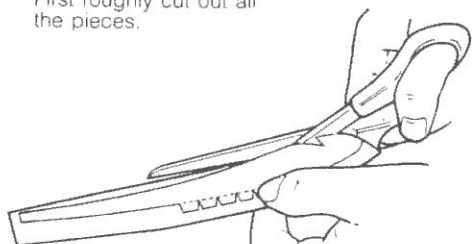
Figure shows a plane's parts and what they are called.



## ASSEMBLY INSTRUCTIONS

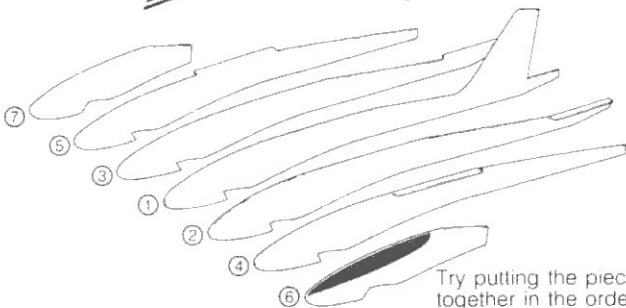
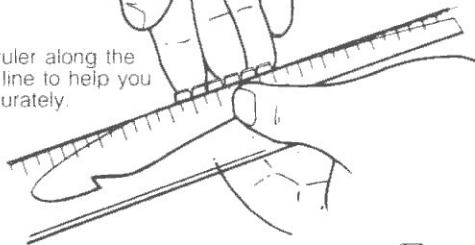


First roughly cut out all the pieces.



Cut precisely on the lines.

Hold a ruler along the dashed line to help you fold accurately.



Try putting the pieces together in the order shown before gluing.

## CUTTING OUT THE PARTS

Roughly cut out each piece taking care not to cut into adjacent pieces.

Trim each piece to size by cutting precisely on the line. However, don't cut on the lines of the front and back of the main wing backing. Leave a 2-3 mm margin on these edges, as described in the gluing instructions.

Bend the tabs for the main wing and stabilizer before gluing the fuselage (plane body) together. Bend the tabs along the dashed lines using a ruler to make sure that tabs are neatly folded.

## GLUING

Try putting the pieces together before gluing, according to the gluing instructions and explanatory figures for each model, to make sure everything is ready and in order.

After all the details have been satisfactorily worked out, you are now ready for the actual gluing. Following the gluing instructions precisely, glue the pieces together in the proper order.

(Note: To build a straight solid body, first glue ①, ② and ③ together and let dry on a flat surface. Then glue the rest of the body parts, in order, to this center section.)



Apply the glue evenly and quickly, making sure that the assembled pieces do not slip out of position.

If the glue is insufficient, the pieces will not be firmly glued together, resulting in weak construction and poor flying performance.

In order to assemble a sturdy fuselage, after gluing on each piece, place the assembled pieces inside a folded piece of scrap paper and press out the excess glue with your fingers.

Use a blank piece of scrap paper and make sure that no print on the paper comes into contact with the glued parts. Since glue has the power to dissolve printing ink, the ink could smear onto the assembled plane.

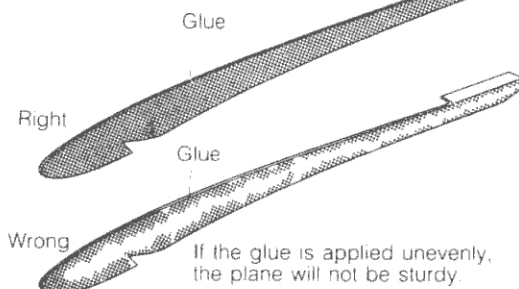
Spread several layers of large scrap paper over a desk or other flat surface for protection. Set the newly glued main wing and fuselage on the papers to dry for at least 5 - 6 hours.

Or, for speedier drying, place "stands" of folded paper under the glued parts as shown in the figure. This permits improved air circulation to the underside of the glued parts.

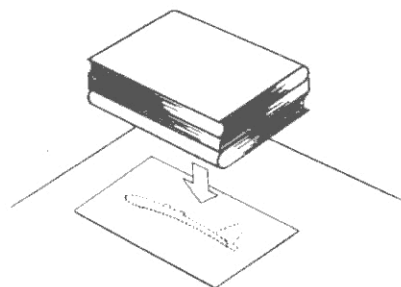
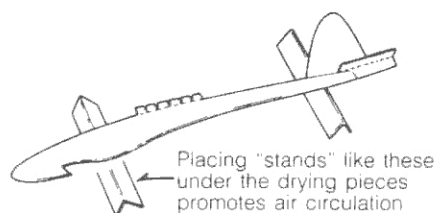
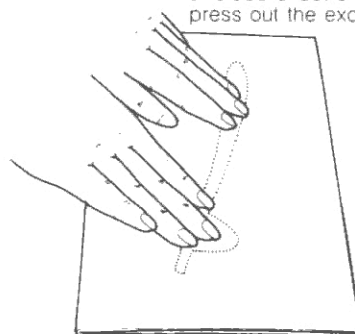
When building a layered fuselage, it is helpful to place books on top of the fuselage as a weight after gluing in order to maintain a solid and uniform body.

The assembly instructions for the triangular fuselage are located on pages 42 and 43.

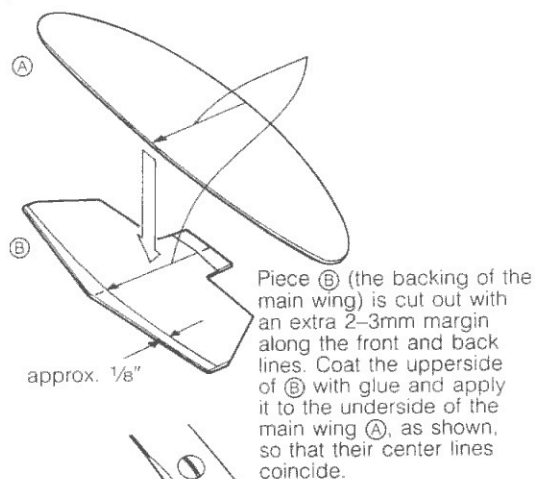
Spread glue evenly over the entire surface to be glued.



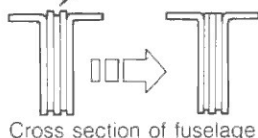
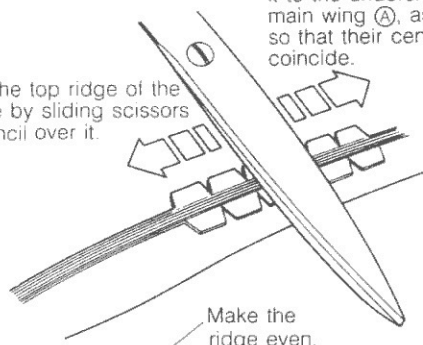
Place the glued parts inside a folded sheet of paper to press out the excess glue.



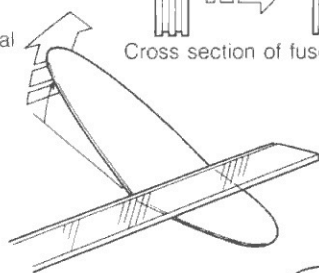
## ASSEMBLY INSTRUCTIONS



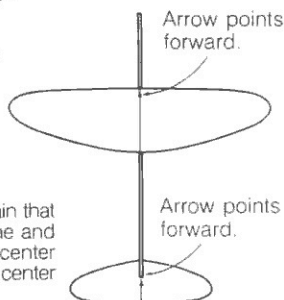
Flatten the top ridge of the fuselage by sliding scissors or a pencil over it.



Dihedral angle



Before gluing make certain that the main wing center line and the horizontal stabilizer center line are aligned with the center of the fuselage.



When "assembling the main wing" is mentioned, we are referring to gluing the reinforcement piece B to the main wing A.

The center line for piece B extends about 3 mm (1/8") in front and in back of the cutting lines. When cutting out piece B, you will notice in the figure that the left and right edges are cut right on the lines, but the front and back edges extend 2 ~ 3 mm outside the lines. Apply glue evenly to the upper surface of piece B, and gently fit piece A on top of piece B. Because piece B's center line extends out from the front and back of piece A, it is easy to line up the center lines of pieces A and B accurately. After the glue is dry, you can cut off the protruding portions of piece B.

In order to glue the main wing precisely and securely to the body, the part of the fuselage to which it will be glued must be smoothed flat with scissors or a pencil, before applying the glue, as shown in the figure.

Place a ruler along the center line of the main wing, and bend the wing slightly upward (called a dihedral angle) as shown in the figure. Since the dihedral angles vary from model to model bend the wing upward until the angle is identical to the angle indicated in the assembly instructions for that particular model.

When gluing the main wing and horizontal stabilizer to the fuselage, make sure that the center line is properly aligned lengthwise with the center of the fuselage. You will find that if you glue the stabilizer onto the fuselage before gluing the main wing onto the fuselage, assembly will be much easier.



The importance of gluing the main wing firmly to the fuselage cannot be overemphasized. In order not to leave any gap between the main wing and the body, press down firmly on the center of the main wing about 5-6 minutes after gluing. After gluing the main wing and stabilizer onto the fuselage, let it dry thoroughly for 3-4 hours.

## FINISHING TOUCHES

To make a truly high performance plane, it is important that the cross section of the main wing be curved in such a fashion as to minimize drag, or air resistance, and maximize lift, the upward draft of air.

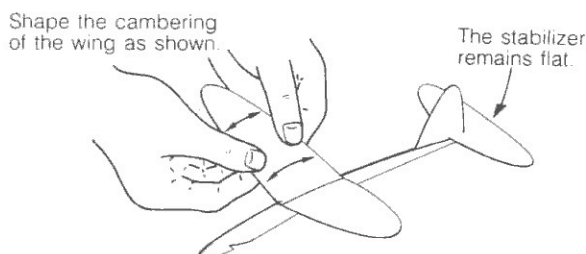
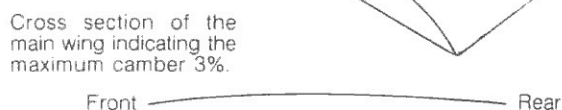
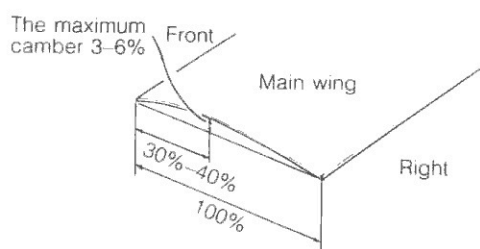
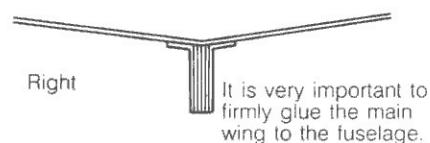
To make the proper curve, bend the main wing slightly in the manner shown in the figure (this is called cambering the wing). This shape is necessary for top performance.

Use the figure on the right as a guide to give an appropriate camber to the main wing.

The maximum camber point should be between a distance of 30% and 40% from the front edge of the main wing.

Only the main wing is to be cambered. The stabilizer should be left flat.

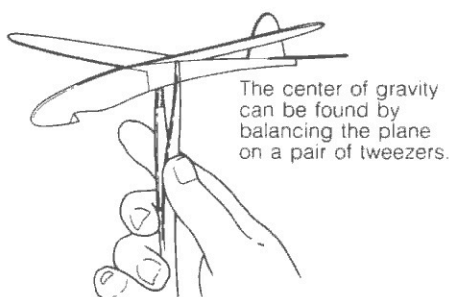
Placing the dihedral angle gauge on the middle of the wing, once again make sure that the dihedral angle is the required one.



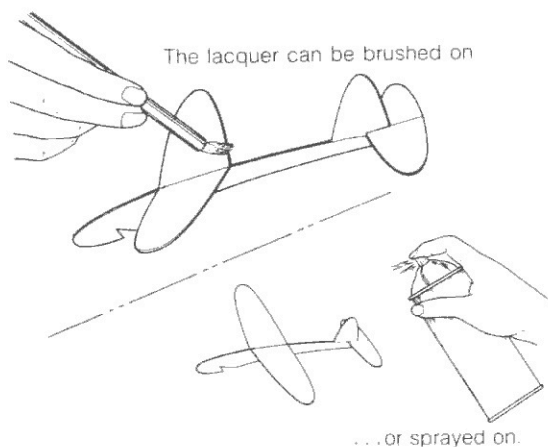
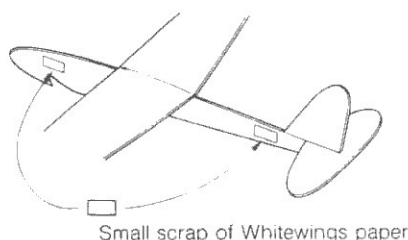
# Whitewings

## ASSEMBLY INSTRUCTIONS

## FLIGHT INSTRUCTIONS



Adjusting the location of the center of gravity.



To test to see if the center of gravity is properly aligned or not, take an open pair of scissors or tweezers and balance the plane on the two tips at the ▲ mark as shown in the figure.

All of the planes in this Series are designed to have the center of gravity located at the ▲ mark. In some cases, however, due to an excess of glue or lacquer on the plane, you may find that the center of gravity is not properly located at the ▲ mark. When this happens, it becomes necessary to add some additional weight. To do so, attach a small scrap of the remaining Whitewings paper lightly to either side of the plane nose or the rear of the fuselage and secure it temporarily with a small amount of glue.

Vary the position or size of the attached paper until the center of gravity is located properly and then glue the attached paper firmly to the fuselage. The center of gravity should be located within 1 mm (1/24") of the ▲ mark.

If your paper plane is coated with lacquer, it will become water resistant. Therefore when it lands on wet grass, if you quickly wipe the water off with a soft cloth, you're ready for another flight.

For preserving the beauty of the white paper, clear lacquer is good, but if you want your plane to be a different color, you can use colored lacquer. It doesn't matter whether you spray it on or paint it on with a brush, but in order to keep the plane light and preserve its balance and center of gravity, be careful to coat the plane as thinly and evenly as possible.



## FLIGHT INSTRUCTIONS

One of the secrets of flying a paper plane well is to view the plane closely from a head-on position and straighten out all warps, bends or twists with your fingers.

Inspect your plane thoroughly from the front:

- (1) Is the fuselage bent?
- (2) Are both the right and left main wings straight, perfectly matched, and are both inclined at the same angle?
- (3) Are the horizontal stabilizer and front wing warped or bent?
- (4) Is the vertical stabilizer warped or bent?

Check for these irregularities and straighten out any bent or warped areas gently and carefully.

Inspect your plane from the rear and check for irregularities in the same manner as above.  
Check the plane from both sides also.

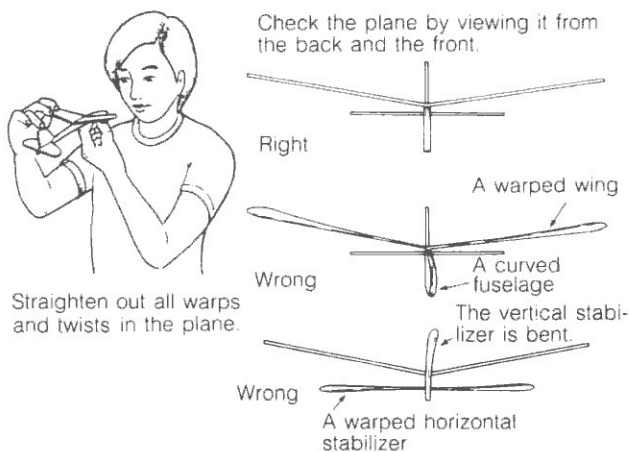
- Do the inclinations of both the near and far wing tips match?

If they don't this is proof that the main wing is warped, so straighten it out with your fingers until the wing tips line up perfectly.

## TEST FLIGHT

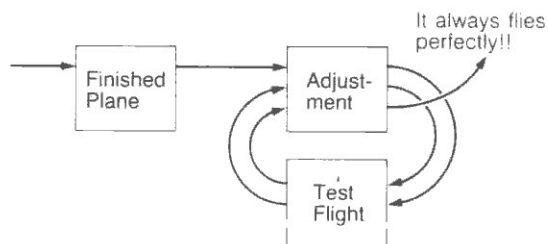
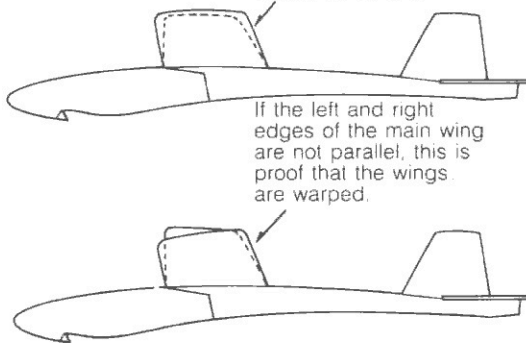
The reason most model airplanes don't fly well is that they have not been properly adjusted. After finishing your plane, the importance of following the test flight and adjustment instructions carefully cannot be overemphasized!!

If you continuously repeat the test flight and adjustment procedures, adjusting your plane slowly but surely, you will finally arrive at a point where your plane will always glide smoothly and in a straight line. A perfect flight every time!

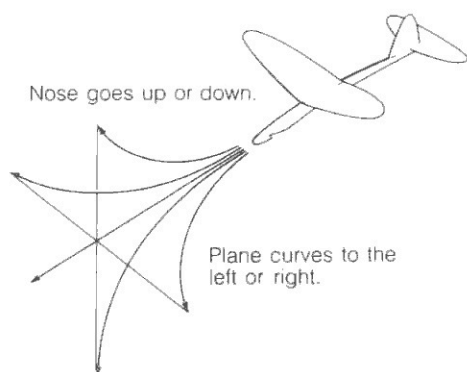
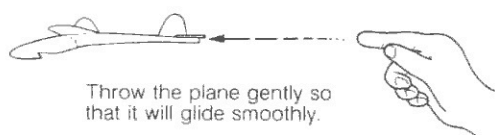


Side view of  
the plane

If the main wing is not warped, the edges of the left and right wings should be parallel.



## FLIGHT INSTRUCTIONS



Try to test fly your plane when there is as little wind as possible. If there is a breeze, always throw your plane straight into the wind. When test flying your plane indoors, always try to throw it toward a curtain to ensure safety.

Do not throw the plane upward. Aim it horizontally or slightly downward and toss it gently forward to make the plane glide smoothly.

The adjustment procedures for the Test Flight are based on the How to Pilot instructions.

Therefore, read the How to Pilot instructions which will better help you to understand these adjustments.

How to adjust your plane:

- When it curves to the left or right
- When the nose goes up or down

If you know how to adjust your plane to correct these two faults, your plane will be able to fly well. I will explain how to correct each of these faults with the proper adjustment.

The first thing to look for when test flying your plane is whether it flies to the left or right. If so, perform the following adjustments and your plane will fly straight.

If a paper plane curves to the left or right, it is always because there is a bend or a warp somewhere on the plane. Therefore, the first step is to examine the plane again thoroughly, and straighten out the affected parts with utmost care. If the plane still curves to the left or right, bend the trailing edges of the wing tips (ailerons) and vertical stabilizer (rudder) in the appropriate directions, according to the instructions in the figure on pages 13, in order to correct this fault and ensure straight flight.

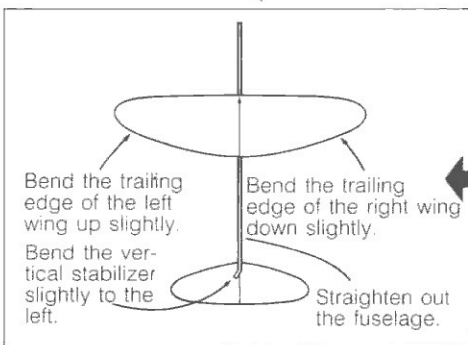
The second thing to test for is to see whether or not the nose gradually goes up and the plane loses speed; also watch if the plane's nose rises up, then suddenly dips down. This is known as stalling. If the glider does this, a smooth flight pattern can be assured by adjusting the back ends of the horizontal stabilizer (elevators).



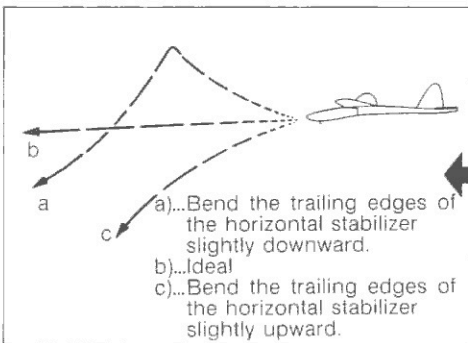
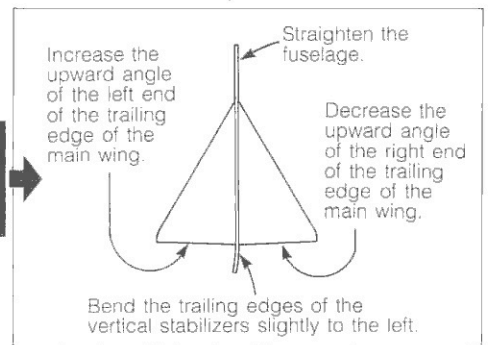
To ensure a straight flight, make the following adjustment.

### Regular Planes

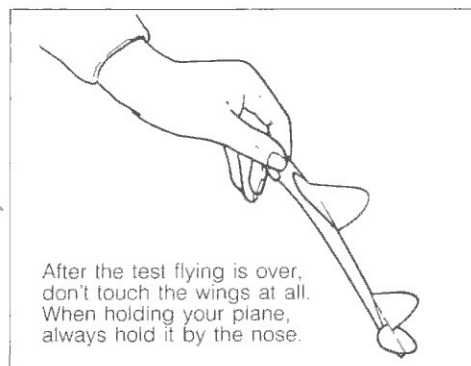
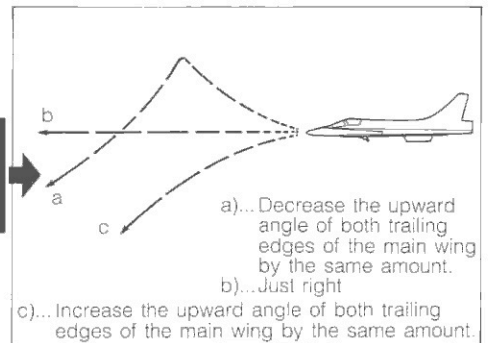
### Delta Planes



How to adjust when the plane curves right (If it curves left, make the reverse adjustment.)



How to adjust when the nose goes up or down.



## HOW TO PILOT

After finishing test flight and adjustment, the point for the excellent and advanced flight performance of paper airplane is how to pilot, that is, to know how bending a portion on a wing changes a flight pattern. In most cases, paper airplanes will fly well if you follow the adjustments mentioned below.

- The adjustment for circular flight to the right or left
- The adjustment for ups and downs of the nose

First of all, here is the explanations how to pilot the regular planes.

### Regular Planes

#### Circular Flight

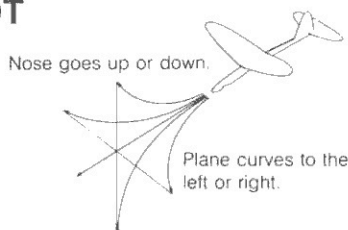
When you want to curve the regular plane, bend the both ends of the trailing edges of the main wing and the trailing edge of the vertical stabilizer as shown.

#### Another method for circular flight

For the regular planes, you may tilt the horizontal stabilizer instead of using the above-mentioned method for circular flight. The regular planes in this kit are designed so that the lift is produced on the horizontal stabilizer. So, when you tilt the horizontal stabilizer to the right, the nose curves to the left by the force of horizontal direction from the left to right. If it isn't easy to tilt the horizontal stabilizer structurally, try to tilt the main wing instead of the horizontal stabilizer in the opposite direction, for example, to the left in this case. Either way is effective for the curve.

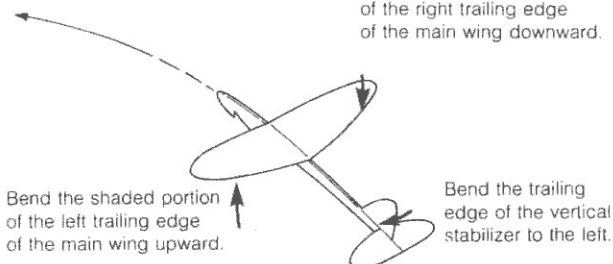
#### Ups and downs of the nose

The ups and downs of the nose depend upon the control of the horizontal stabilizer as shown.

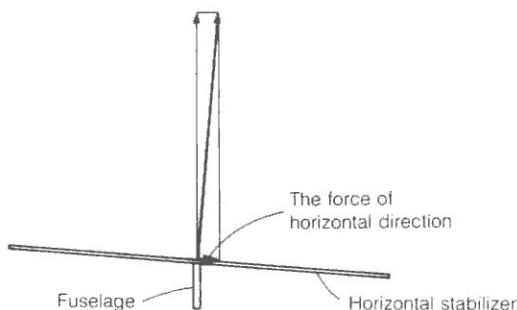


#### If you want your plane to curve to the left:

Bend the shaded portion of the right trailing edge of the main wing downward.

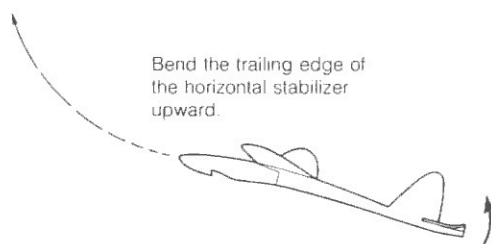


\* If you want your plane to curve to the right, make the reverse adjustment.



#### If you want the plane's nose to point up:

Bend the trailing edge of the horizontal stabilizer upward.



\* Conversely, if you want the plane's nose dip down, bend the trailing edge of the horizontal stabilizer downward.

## HOW TO PILOT

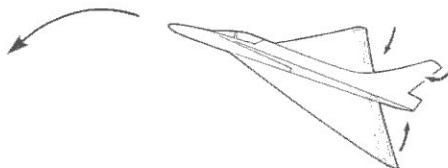
### Delta Planes

#### Circular Flight

When you want to curve the delta planes, bend both ends of the trailing edges of the main wing and the trailing edge of the vertical stabilizer as shown.

**If you want your plane to curve to the left:**

Bend both trailing edges of the vertical stabilizers slightly to the left.



Decrease the upward angle of the shaded portion of the right trailing edge of the main wing.

Increase the upward angle of the shaded portion of the left trailing edge of the main wing.

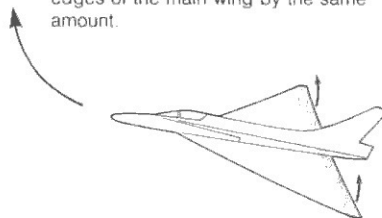
\* If you want your plane to curve to the right, make the reverse adjustment.

#### Ups and downs of the nose

The ups and downs of the nose depend upon the increase or decrease in the upward angle of the both ends of the edges of the main wing.

**If you want your plane's nose to point up:**

Increase the upward angle of the shaded portions of both trailing edges of the main wing by the same amount.



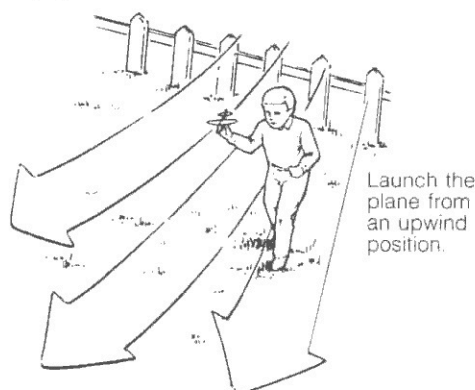
\* Conversely, if you want your plane's nose to dip down, decrease the upward angle of the shaded portions of both trailing edges of the main wing by the same amount.



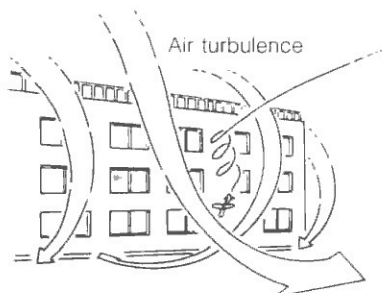
## FLIGHT INSTRUCTIONS



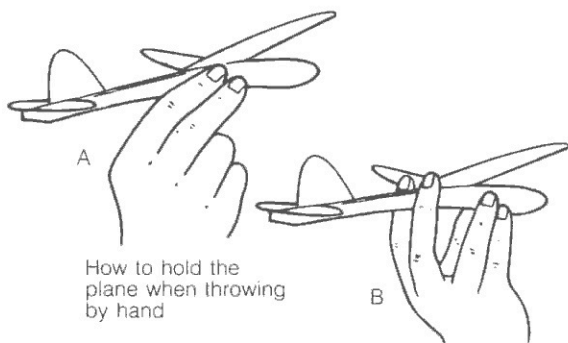
Arrows indicate wind direction.



Launch the plane from an upwind position.



Air turbulence



How to hold the plane when throwing by hand

### ACHIEVING ALTITUDE

Now that the test flying is over, let's go outside to a wide open space to fly your plane! To protect your plane from wear and tear, it's best that you fly it in a field of soft grass. When you get out into the field, the first thing to do is to determine the wind direction. To do this, pull a few blades of grass and toss them into the air, or, if a chimney is nearby, note the direction in which the smoke rises.

If you are flying your plane outside with a wind blowing and want to keep your plane's flight pattern within a limited area, it is best to throw your plane with the wind from an upwind position. Always be sure to return to the original upwind position for launching in order to prevent the plane from gliding beyond the confines of the flying area.

It's not good to fly your plane if the wind is too strong. When a strong wind is blowing, great turbulence is created in the vicinity of large buildings such as apartment houses or schools. In such places, you will never be able to fly your plane successfully when the wind is strong, so it's best to wait for a day when the wind is gentle.

To throw your plane high, there are two ways to hold it, as shown in the figure, either by grasping the body with your fingertips, or by placing your index and middle fingers behind the main wing, on both sides of the fuselage. Use whichever method you find easiest and most natural.

If you hold the plane horizontally, and throw it up and forward, it will "loop the loop" and dive down, so it is very difficult to get it to glide at a high altitude.

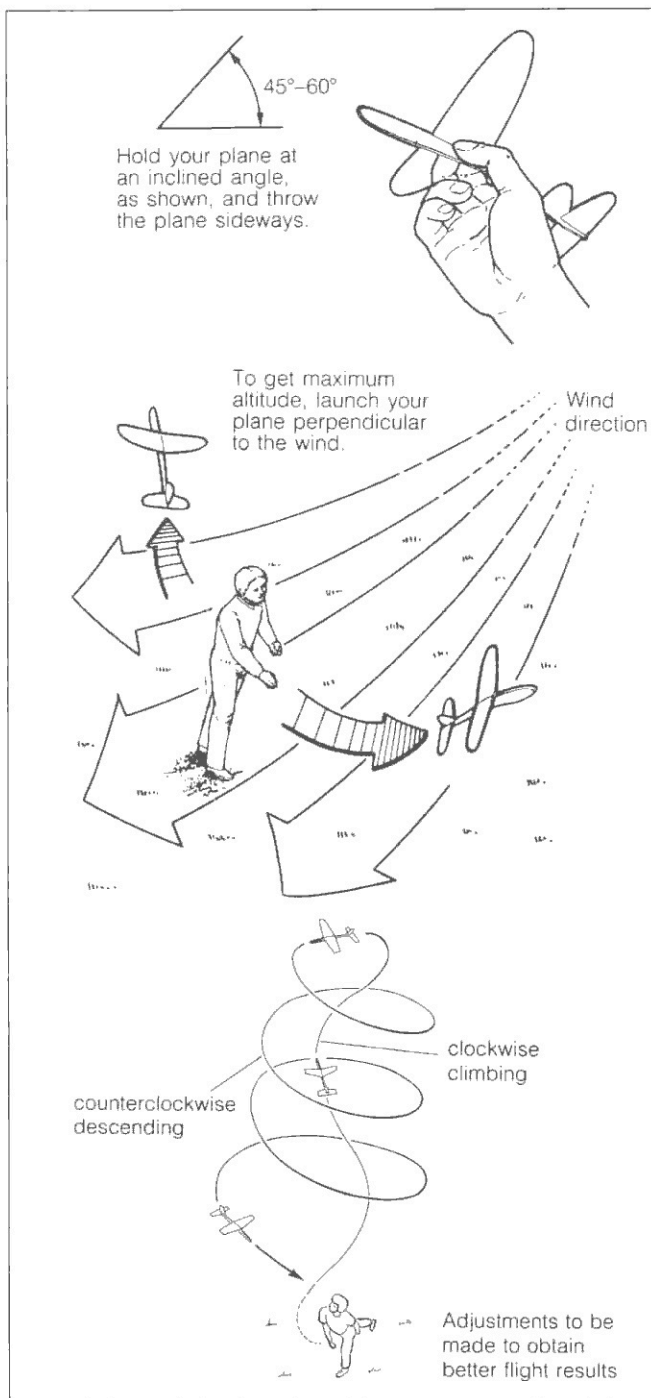
In order to overcome this difficulty, tilt the plane at a  $45^\circ - 60^\circ$  angle to the side when throwing.

Your plane will curve outward as it gains altitude, then it will gradually level off and glide on a straight course. If the plane still tends to loop the loop, adjust it in the same manner you would for making the nose go down according to the How to Pilot instructions for each type of plane.

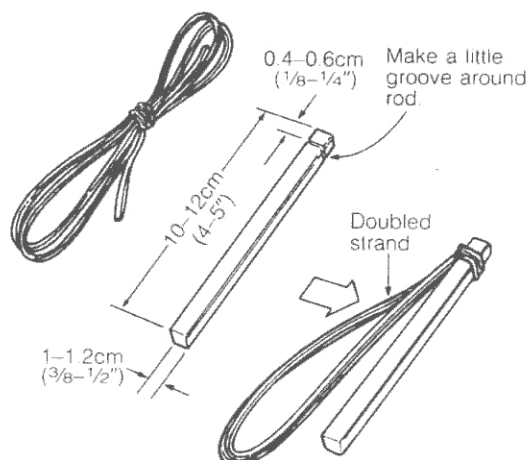
This adjustment will serve to discourage this looping tendency.

Contrary to test flying instructions, it's great to launch your plane perpendicular to the wind when "high-flying" it. The reason for this is that when throwing your plane upwind the plane has a tendency to loop; conversely, when throwing your plane downwind, the plane has a tendency to stall, due to the decreased relative airspeed over the wings. When throwing the plane perpendicular to the wind, none of these faults are apparent, so it is easier to obtain good flight results.

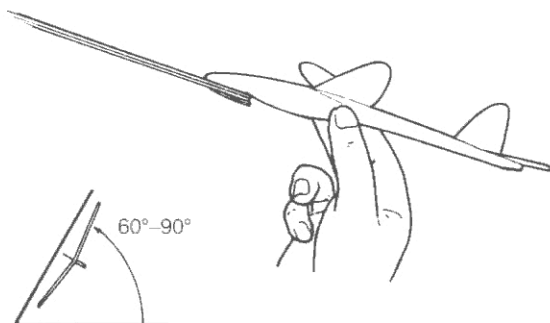
If an especially large wide open space is available, it's good to fly your plane in the following manner: before launching your plane, adjust the main wing and vertical stabilizer in the direction necessary for a left turn. Then, take the plane in your right hand, incline it at  $60^\circ - 90^\circ$  angle to the side and launch it to the up into the sky at almost a right angle. If you do this, the plane will climb in a clockwise fashion until it has obtained a considerable altitude, then it will go into a glide in a counterclockwise fashion, which resembles a corkscrew pattern, for its descent. If your plane has been well adjusted, it will remain aloft for at least 10 - 15 seconds. (The same manner is applicable to launching by catapult.)



## FLIGHT INSTRUCTIONS



How to make a rubber band catapult



How to hold a plane when you launch it by the rubber band catapult

If you use a rubber band catapult, you will be able to fly your plane at a high altitude for a long time. Another advantage of using the catapult is its ability to maintain the desired position of the plane, as at launching, and thereby ensure a proper flight course.

A catapult can be made easily from the included wooden rod and rubber band. Make a groove at the place shown in the figure and fasten the rubber band tightly onto the rod at the groove, making a double strand.

When launching by catapult, suspend the rubber band on the hook, holding the fuselage securely with tip of your fingers as shown in the figure. If you use more than just your fingertips, you may sometimes damage the horizontal stabilizer when the plane is launched. Pull the plane back, being careful not to bend the fuselage. You may pull back as far as you can but if you use a stronger rubber band than the one included in the kit, too much tension on the band will cause wing flutter. On a real plane, flutter will cause disintegration in mid-air. Flutter is occurring when your paper plane makes a vibrating sound. To avoid this problem, try not to put as much tension on the rubber band.

When using a catapult, as when hand launching your plane, use the ground as a horizontal plane of 0° and incline the plane at 60° - 90° angle to avoid loops. The adjustment for making the nose go down according to the How to Pilot instructions for each type of plane will also serve to discourage this looping tendency.

- ☆ Launch your plane in a wide open area.
- ☆ Since the catapult-launched plane will fly at a high speed, take precautions to avoid hitting people in the area.

When considering the proper inclination that your plane should have when catapulting it, you must remember if you have a plane that tends to curve to the right, the more you incline it with the right wing downward (as in Figure A), the more the plane will tend to plunge down to the ground. If you try reversing this inclination and incline the left wing downward (as in Figure B), you will obtain better flight results.

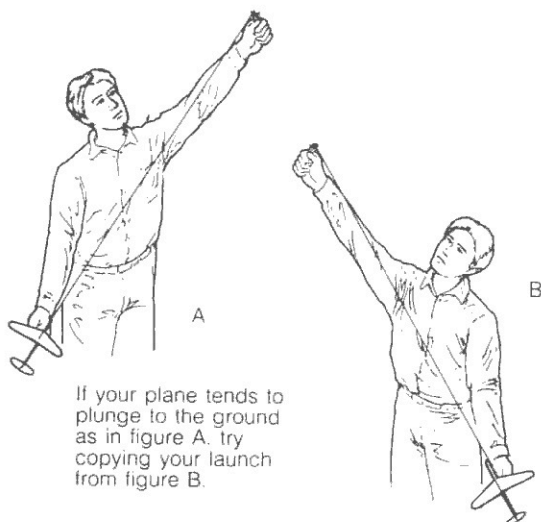
All the models in this Series can be launched by a double strand rubber band catapult. Flutter will not be a problem if all parts are securely glued.

When you want your plane to spiral upwards in the way mentioned on page 17 by hand or catapult, launch it tilted away from you at a  $70^\circ - 80^\circ +$  upward angle.

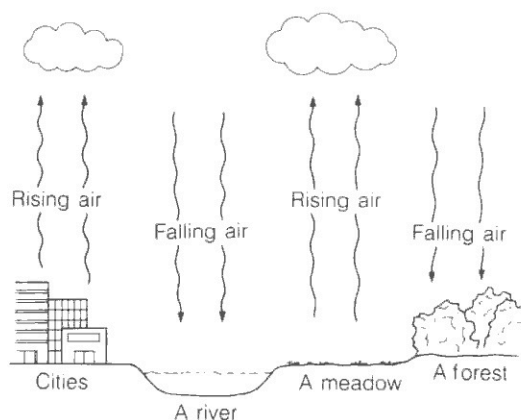
## HOW TO CATCH RISING AIR CURRENTS

In order for a paper plane to stay aloft for over 30 seconds, it must make use of rising air currents. Rising air currents can be of two kinds; those resulting from the flow of wind over an inclined surface, and "thermals", which are rising columns of warm air. Paper planes fly well in thermals. "Thermals" originate when the earth's surface is heated by the sun. They usually originate over city streets, deserts, and plains with short grass. Lakes, rivers, and forests, however, are difficult to heat up, so these areas favor the formation of downdrafts, or descending air currents. You will be most able to make use of "thermals" if you fly your plane over wide open grassy areas or concrete lots.

To enable your plane to make best use of these thermals, it's best to adjust it to fly in a circular pattern, then launch or throw it as high as you possibly can. Although invisible to the naked eye, there are what can be called "bubbles" of rising air, like that shown in the accompanying figure, over patches of heated ground. Therefore, if you

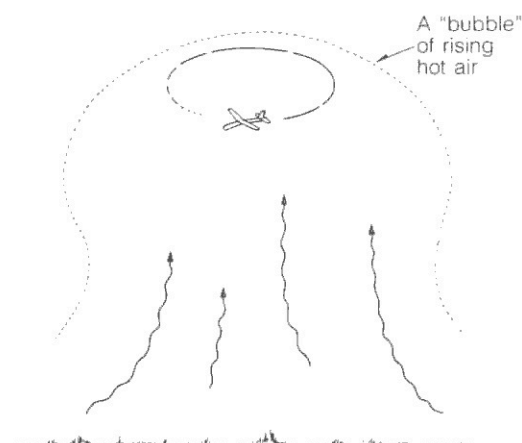


Launching by the catapult



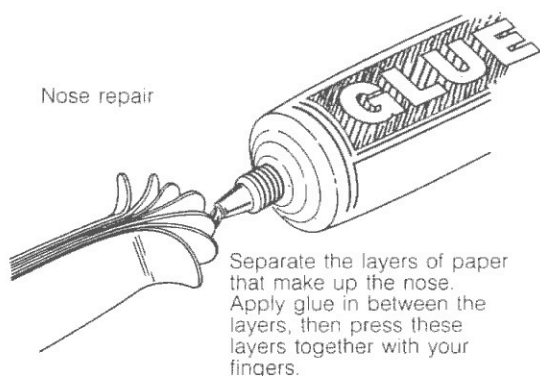
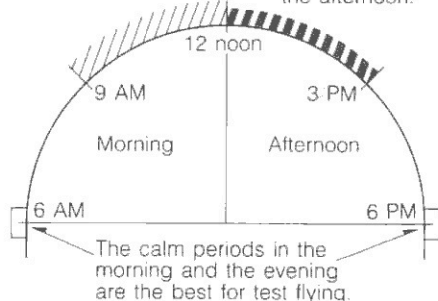


## FLIGHT INSTRUCTIONS



9 AM–noon is the best time to make use of thermals.

Winds get strong in the afternoon.



Separate the layers of paper that make up the nose. Apply glue in between the layers, then press these layers together with your fingers.

throw your plane as stated above and get it to go around in circles and the plane enters one of these "bubbles", its chances for remaining inside this "bubble" for a considerable length of time are increased.

All the racer models included in the kit are designed to fly over one minute in rising air currents if adjusted carefully.

The best time to make use of thermals is between 9 AM and 12 noon on days when the skies are clear and the winds are gentle. Although the strength of thermals increases during midday (9 AM – 4PM) when the sun is shining most strongly and the highest temperatures are reached, in the afternoon, when thermals are strongest, gusty surface winds also get stronger, often making it difficult to fly paper planes.

Actual atmospheric conditions will not always occur at the above-mentioned times however, so always keep an eye out for chances to fly your plane.

## REPAIRS

Even if your plane becomes damaged, if you repair it, you should be able to fly it again and again.

When paper planes dive to the ground or crash into a wall, the nose is especially vulnerable to damage. If any dirt or pebbles are imbedded in the nose, remove them with a pair of tweezers or a knife. Separate the various layers of paper as shown in the figure and coat all the inner surfaces with glue. Then press the layers together from the outside and, pressing hard, squeeze out all the excess glue, just as you did during assembly. Let the glue dry thoroughly.

If the wings or fuselage are bent or torn, reinforce the damaged parts from the outside by gluing on small pieces of paper, as shown in the figure.

These small pieces of paper should preferably be pieces of scrap paper left over from building your plane. These pieces of paper are bend-resistant in the direction of the wing tips so be sure to cut out and apply them in the proper direction. (Bend-resistant direction of the paper is indicated

by an arrow in the lower right hand corner of each model sheet.)

## STORAGE

If your paper planes are well made, you should be able to preserve them with minimum care, thus enabling you to fly them for many years.

For storing a large number of planes when not in use, you should stretch a piece of wire between two hooks and fasten the planes by their noses with clothespins. Let them hang vertically as shown in the figure. This has the advantage of taking up only a small amount of space, and also of minimizing the accumulation of dust on the wings.

## ENJOY DISPLAYING YOUR AIRPLANES

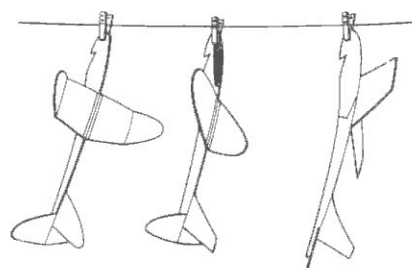
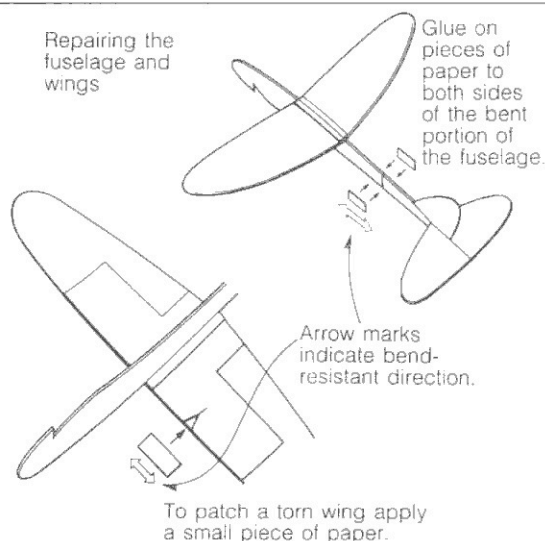
You can enjoy airplanes not only by flying them, but also, for example, by viewing them on a stand on your desk. The sleek lines of the plane's body will set your imagination off. A paper stand, that can be made very easily, is quite useful as a support for displaying an airplane.

- 1) Prepare 4cm (1½") square piece of paper.
- 2) Fold it in half.
- 3) Make an incision with a width of approximately 1.5 – 2mm (1/16") at the center of the piece of paper.
- 4) Insert the fuselage between the cut.

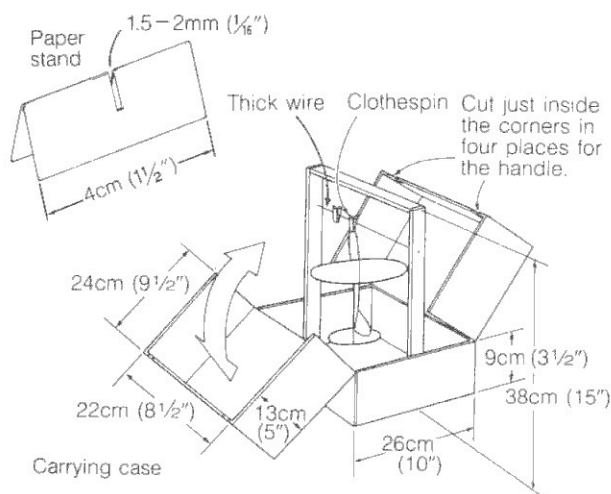
## TRANSPORTING YOUR PLANE SAFELY

In order to transport your paper planes safely from your home to an open area, I recommend using a carrying case. You may make it yourself from a carton or a light wooden box.

The carrying case should be large enough to accommodate each plane in its own space without overlapping with the others and so the planes are ready to fly with only a little adjustment. Here is one example of a carrying case I have made.



Stretch a wire across an open space and hang your planes on it with clothespins.



## GUIDELINE FOR WHITEWINGS COMPETITION

Once you have learned to build and fly your Whitewings plane well, you may want to compete with your friends in flight performance and hold your own paper plane competitions. It will encourage you to further improve your building and flying skills.

Up to now, the main competition categories have been flying distance, time aloft, aerobatics and aesthetic design. The first two - flying distance and time aloft - are the main activities related to measurable performance capabilities.

The flying distance category, however, has a number of problems. Certain designs should not be included in competition. For example, designs similar to stones or arrows may need to be excluded. Other problems are how to factor for wind conditions, how to measure the landing point precisely (because planes often side on the ground after landing), and so on.

The time aloft category, on the other hand, is much more interesting and challenging. It requires a steep ascent and a very gradual gliding descent. To attain this, the plane needs to be not only structurally sound but also light and aerodynamically designed. In addition, a high level of flying technique is also necessary.

For this reason, it is a type of competition that measures total design and flying performance capabilities of the plane. Timing is easily done with only a stopwatch.

Thus, I'd like to recommend you begin with a time aloft competition. In holding such a competition, some of the things you'll need to keep in mind are as follows:

### SPACE-

It is ideal to have an open area of approximately 300 x 300m (900 x 900 ft.). If it is not possible, 100 x 100m (300 x 300ft.) is acceptable.

### WEATHER-

No wind or just a breeze is best for flying paper planes. It is better to hold a competition in the morning since there is usually less wind. In a strong wind paper planes will drift or go out of control due to wind turbulence.

### COMPETITION-

#### ● Launching:

You may have competitions by hand launch, by catapult launch, or both. When there is limited space or if you are indoors, you should compete only by hand launch.

#### ● Timing:

Each competitor should be timed 3 to 10 times during the competition. Even if there are many competitors, try to time each one at least 3 times.

Clock the period consisting of when the plane leaves the hand and when it lands. If the plane is stopped by a wall or tree, stop timing the flight. A flight of less than three seconds should not be counted because it might be a mislaunching. If the person fails a three second flight by the third attempt, then you should count it.

One entrant may be allowed to use more than 2 models.

If a plane disappears from sight after circling up into the sky, or is hidden behind something, stop timing the flight.

#### ● Recording:

You may decide the winners using all the recorded times or by using the best five of ten recorded times.

To have a constant flight performance competition, even flights of over 60 seconds should be recorded at a maximum of 60 seconds. This method eliminates a competitor who has one very lucky long flight and rewards consistent, medium length flight.

	Actual flight time	Recorded time
Entrant#1	82 sec.	60 sec.
	30	30
	26	26
	<hr/> 138	<hr/> 116

Entrant #2	47 sec.	47 sec.
	34	34
	45	45 sec.
	126	126

☆ This entrant has consistently longer flights.

Outstanding records, however, should also be awarded in some way.

The above-mentioned methods of competition are only guidelines. You can make modifications as required according to the space available, number of competitors, and the number of staff members available to oversee the competition. If there are so many competitors that it becomes impractical to clock each several times, 10 to 20 persons could fly their planes at the same time as an eliminatory competition and the 5 people with the best times could compete with each other using the method mentioned earlier.

### Time aloft competition

Date \_\_\_\_\_

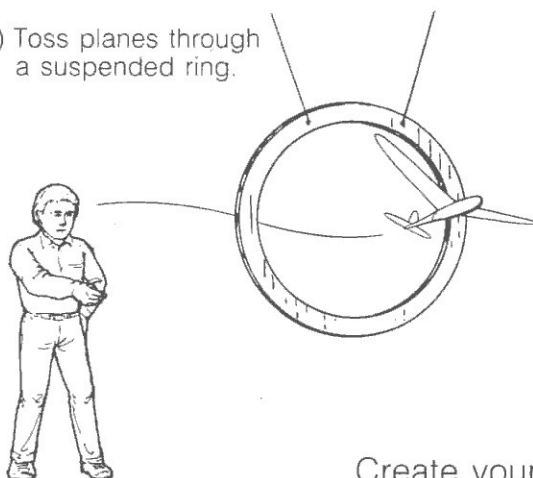
Location \_\_\_\_\_

Entrant's name	1st	2nd	10th	Total of best five
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	sec.
	sec.	sec.	sec.	sec.

An example of record sheet

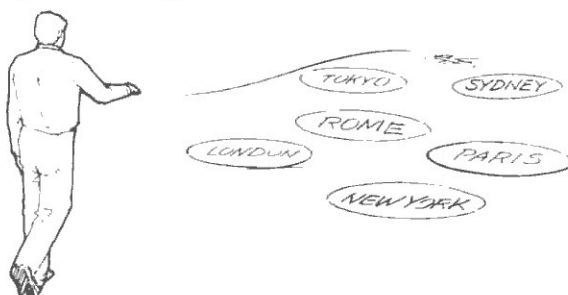
### You can also enjoy playing games using Whitewings planes:

- 1) Toss planes through a suspended ring.



The 2nd Great International Paper Airplane Contest (Seattle, U.S.A., May 1985, by Toyo Yamamoto, MAINICHI-GRAHP)

- 2) Aim for targets.



Create your own games!



The image features a white paper airplane on the left side, set against a black background with a white grid. The airplane is oriented vertically, with its nose pointing upwards. Two curved lines represent its flight path, starting from the bottom left and arching upwards and to the right. The text 'INTRODUCTION TO PAPER PLANE DESIGN' is located in the upper right quadrant, followed by a bulleted list. The grid lines are thin and evenly spaced.

## INTRODUCTION TO PAPER PLANE DESIGN

- How to Make Your Plane Fly Well
- How to Improve Flying Performance
- How to Improve Stability
- Elementary Design Method

## HOW TO MAKE YOUR PLANE FLY WELL

To make a paper plane fly its best, two conditions are very important.

- 1) Since a paper plane is a glider it must have good gliding performance. This will be explained more later, but basically, this means that the glide ratio is high and the rate of descent is low.
- 2) The plane must have good stability. This means that it must be able to correct itself and maintain a good flight after tilting or turning.

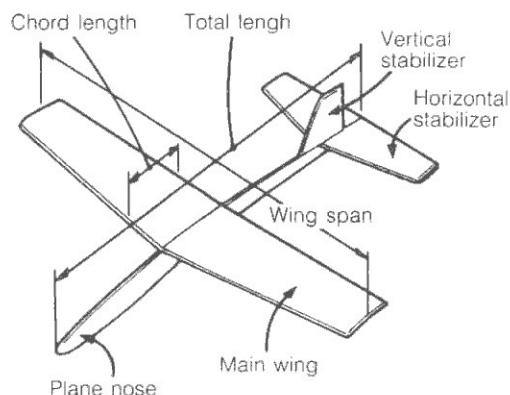
If your plane has these two qualities, when you throw it high into the air it will glide smoothly for a long distance even when there is slight air turbulence.

## HOW TO IMPROVE FLYING PERFORMANCE

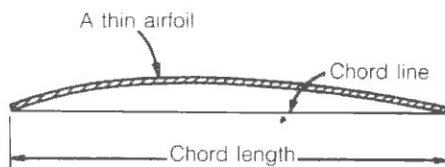
Figure 1 shows an airplane's parts and what they are called.

The most important part of a glider is the main wing. Its job is to support the plane in mid-air. The shape of a wing's cross section is called a wing section or airfoil. The chord line shown in the figure is the base line of the airfoil. Its length is called the chord length.

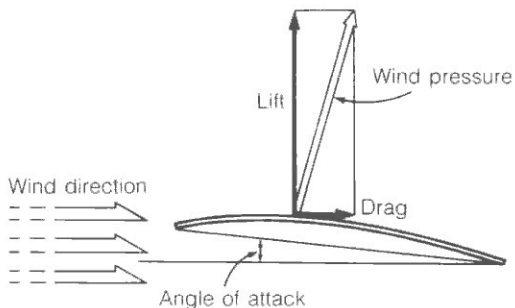
In Figure 3, we can see that the angle made by the chord line and wind direction is called the angle of attack. When the fuselage is designed, a base line is drawn across the body to assist in drawing and construction. The angle formed by this base line and the chord line is called the angle of setting. The angle of setting does not change on a plane's body, but the angle of attack changes as the plane's vertical direction changes (Fig. 4).



**Fig.1 Plane parts and special terms**



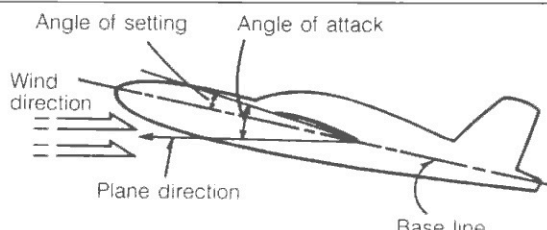
**Fig.2 Cross section of a thin airfoil**



**Fig.3 Angle of attack and forces on wing**

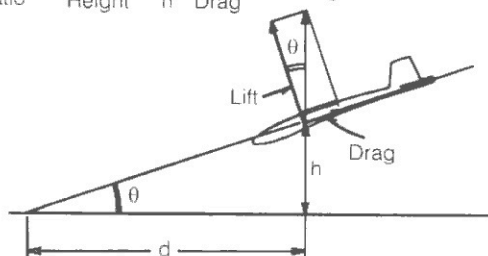
# Whitewings

## INTRODUCTION TO PAPER PLANE DESIGN

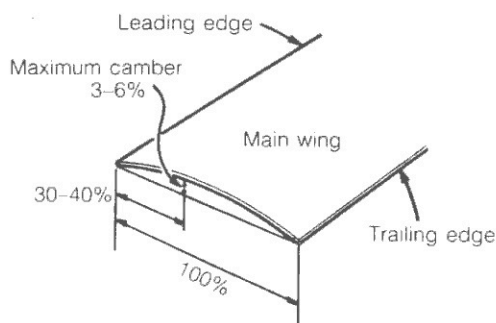


**Fig.4 Angle of attack and angle of setting**

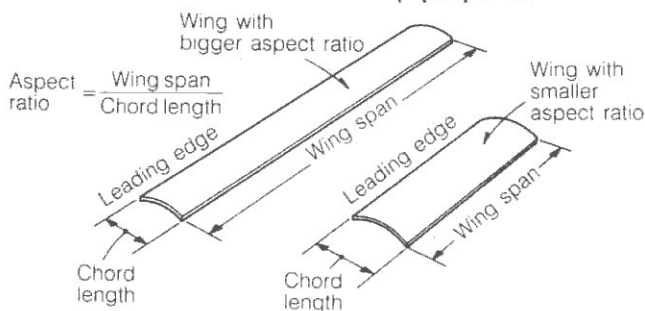
$$\text{Glide ratio} = \frac{\text{Distance}}{\text{Height}} = \frac{d}{h} = \frac{\text{Lift}}{\text{Drag}} = \text{Lift/drag ratio}$$



**Fig.5 Glide ratio and lift/drag ratio have the same value.**



**Fig.6 A thin airfoil is easy to make and suitable for paper planes.**



**Fig.7 Aspect ratio**

When the plane is gliding, wind pressure creates two forces on the wing as shown in Figure 3. One force is the upward draft of air (called lift) and the other force on the wing is called air resistance or drag. The ratio of these forces is called the lift/drag ratio. The higher the ratio of the wing (strong lift and little drag) the better the plane will fly.

As shown in Figure 5, the ratio between the distance a plane will glide and its altitude is called the glide ratio. A plane with a high glide ratio will fly farther than a plane with a lower glide ratio. The glide ratio has the same value as the lift/drag ratio of the entire plane so for long flights the lift/drag ratio must be as high as possible.

In order to have a high lift/drag ratio you must choose a good wing shape. A wing that is easy to make with a high lift/drag ratio is shown in Figure 6. As described in the chapter "Assembly Instructions", this thin type of wing is easily made by cambering the wing carefully with your fingers.

It is very important to decrease the air-drag by slimming the fuselage or by omitting parts which jut out such as the landing gear, struts, etc. as much as possible. A special ratio used to decrease drag on the wing is called the aspect ratio.

The aspect ratio is found by dividing the wing span by the chord length. The greater the aspect ratio the more slender the wing will be. As the aspect ratio of the main wing becomes larger, the less the drag on it. Real gliders and planes designed for long distance flights have long slender wings for less drag and greater lift. On a paper plane, however, which has a small body and flies at low speeds, there is no need to make the wing too slender. Rather it is best to build a light and sturdy main wing with an aspect ratio of about 5 or 6.

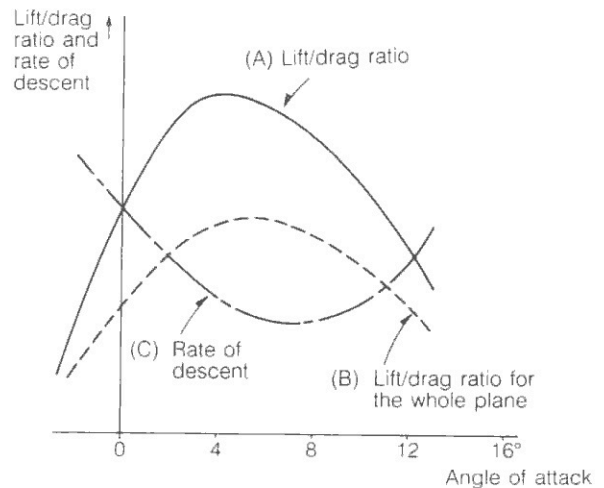
The lift/drag ratio changes with the glider's angle of attack. Figure 8 shows the changes. Line (A) shows the lift/drag ratio for the main wing. A  $3^\circ$  or  $4^\circ$  angle of attack is most desirable. Line (B) shows the lift/drag ratio of the whole glider. Since there is more drag on the entire glider, a  $5^\circ$  or  $6^\circ$  angle of attack is best.

When a plane is gliding and slowly losing altitude, this is called the rate of descent. It is measured in meters per second. For a long duration flight you must decrease the rate of descent. In Figure 8, line (C) shows the rate of descent. When the angle of attack is a little larger, (i.e.  $1^\circ - 2^\circ$  greater than that for the best lift/drag ratio), the rate of descent is the smallest.

The weight of the whole plane, divided by the surface area of the main wing, is called the wing loading. A heavy plane with small wings will have a large wing load. The Lockheed F-104 is an example of this principle. Planes with high wing loads glide faster and so their rate of descent is high.

On an actual light plane or glider the surface area of the main wing is relatively large, and because the plane is light, the wing loading is small. Due to these factors, the rate of descent is low. Accordingly they can glide, cruising for long periods of time.

When designing paper planes for long duration flights, it is best to have a low wing load by making a large wing area with a body as light as possible so your plane will fly for a long time.



**Fig.8 Lift/drag ratio and rate of descent depending on angle of attack**



# Whitewings

## INTRODUCTION TO PAPER PLANE DESIGN

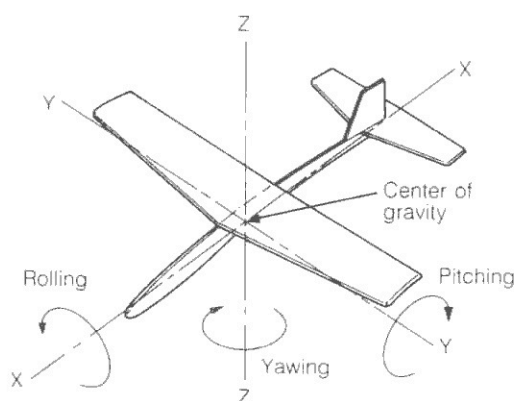


Fig.9 In-flight motion

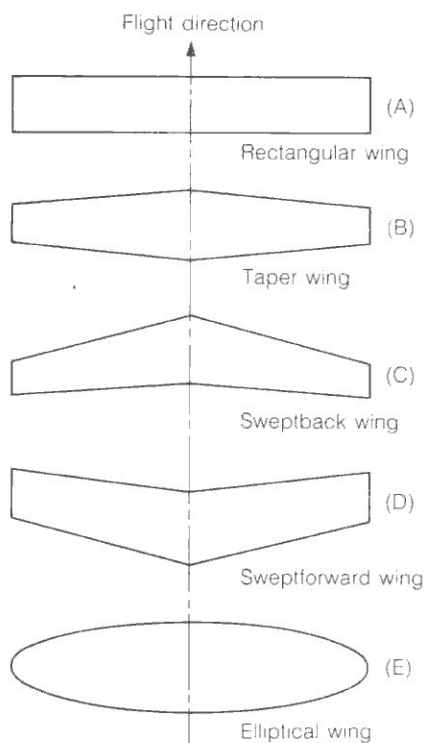


Fig.10 Wing shapes

## HOW TO IMPROVE STABILITY

For a plane to fly well, it must be stable. Figure 9 shows the movements of a plane in flight. The parts which control stability are:

- HORIZONTAL STABILIZER
  - controls pitching
- VERTICAL STABILIZER
  - controls yawing
- DIHEDRAL ANGLE ON MAIN WING
  - controls rolling

For a stable plane all of these must be designed and attached properly as described in the next chapter.

## ELEMENTARY DESIGN METHOD

### 1. Designing the Main Wing

The plane's gliding speed and rate of descent depends a lot upon the wing loading. You must decide on the wing area that is best for the plane you are building.

- When you design a plane for a long, slow buoyant flight, give it a large wing area.
- When you design a high-speed, sleek jet plane, make the wing area small.

However, be careful not to make the wing loading too small. Although it will decrease the rate of descent, the plane won't go up very high when thrown into the air, resulting in a short flight. A wing span of less than 30cm (12") is recommended considering the strength of the paper.

## 2. Main Wing Surface Shape

You can choose the wing shape you like best from the shapes in Figure 10. If the wing is either too narrow (high aspect ratio) or too wide (low aspect ratio) the plane will not be stable nor fly well. For a good flying airplane, try to avoid odd shaped wings.

The sweptback wing tends to cause "tip stall" which sends the plane into a spin, so it is best to avoid a wing with a large sweptback angle.

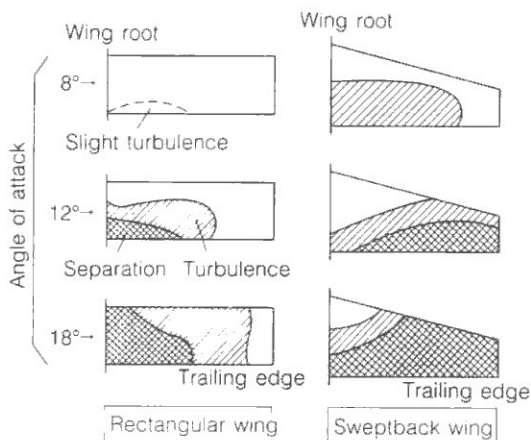
Figure 11 shows the relationship between the angle of attack and stalling on the rectangular wing and the sweptback wing. On the rectangular wing, air turbulence affects the central part of the wing, while on the sweptback wing, turbulence affects the wing tip which sends the plane into "tip stall." When tip stalling, the plane suddenly loses its lift.

Differences in the effect of air turbulence and bends or warps in the wings cause differences in wing lift. This will result in stalling (Fig. 12).

The sweptback wing plane will go into a "spin" when it stalls. And so although the sweptback wing looks quite good its design does present some problems.

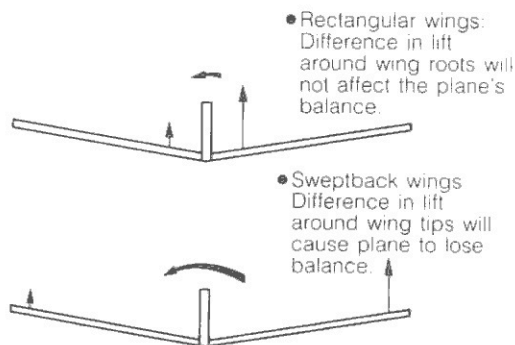
As mentioned in Fig. 13, both a bending-up force and warping force affect the main wing during flight. When a plane flies at a high speed after being launched powerfully by a rubber band catapult, a thin main wing with a reinforcement backing has less strength to withstand a warping force than to withstand a bending-up force. This condition will often lead to deformation or perhaps even destruction of the main wing.

In the light of this, the sweptforward wing (in Fig. 10 D on page 28) has a tendency to increase or diverge warps while the sweptback wing (in Fig. 10 C on page 28) has a tendency to decrease or converge warps.

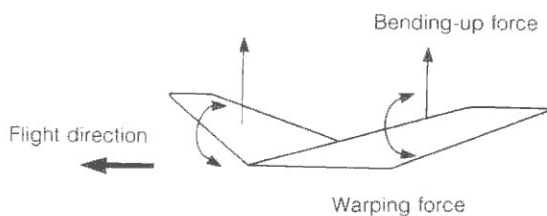


**Fig.11 Occurrence of stalling differs for planes with rectangular wings and those with sweptback wings.**

(From "Report and Memorandum No. 1976 of the Royal Aircraft Establishment")



**Fig.12 Difference in stall on rectangular wings and sweptback wings**



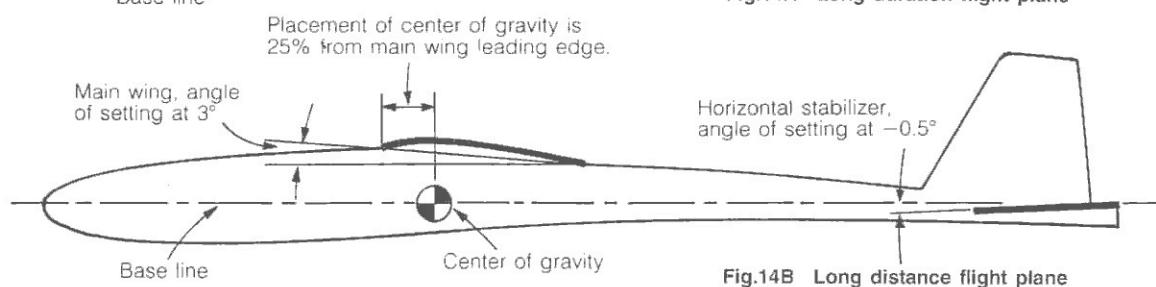
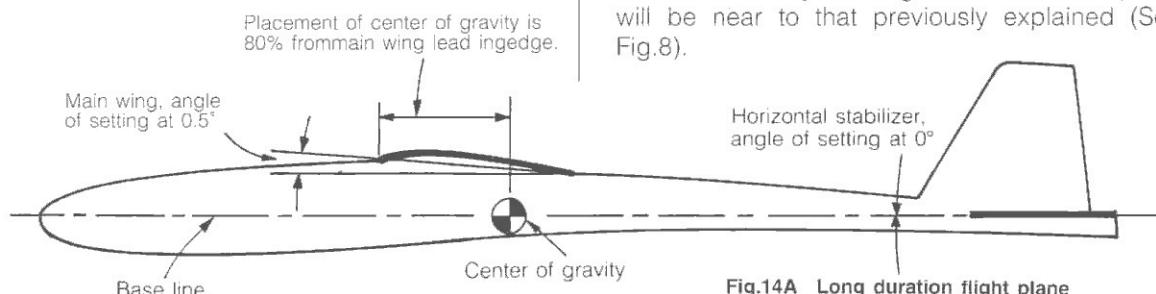
**Fig. 13 The force against a wing during flight**

# Whitewings

## INTRODUCTION TO PAPER PLANE DESIGN

### 3. Center of Gravity and Wing Angle of Setting

The angle of attack must be determined according to the type of glider you choose, whether it is for a long duration flight or a long distance flight. The placement of the center of gravity and the angle of setting for the main wing and horizontal stabilizer for these two types of gliders are shown in Figures 14A and 14B. When the wings are positioned in this way, the angle of attack of the plane will be near to that previously explained (See Fig.8).



In the case of long duration flight planes, as shown in the formula for long duration flights on page 32, make the surface area of  $S_H$  bigger than long distance flight planes. Additionally, place the center of gravity further back so that this design has the effect of making the plane climb up higher without looping at high speed when launched. \*

When the wings and the center of gravity are placed according to the guidelines, then the fuselage can be designed according to what glider type you choose. The horizontal stabilizer setting might have to be adjusted to get good balance but this can be done after the test flight.

#### 4. Center of Gravity on Non-Rectangular Wing Planes

In Figures 14A and 14B, the center of gravity of the airplane is placed at a point 25% or 80% of the chord length from the main wing's leading edge.

For the rectangular wing (Fig. 10-A) the chord length is the same for every part of the wing so it is easy to find the center of gravity. In the other wing shapes, the chord length changes at different places on the wing. The center of gravity on these wings depends upon the average chord length which represents the aerodynamic characteristics of the wing. This chord length is called the Mean Aerodynamic Chord (MAC) and it is easy to find. The shaded parts in Figure 15 are half the main wing (from center to wing tip).

Make a sketch of the wing in which  $T_t$  is the chord length at the wing tip and  $T_r$  is the chord length at the wing root. Extend line  $T_t$  the distance of line  $T_r$  and extend line  $T_r$  the distance of line  $T_t$ . Connect the two points ( $T$  &  $R$ ) at the end with a dotted line. Find  $1/2 T_r$  and  $1/2 T_t$  and divide the wing with another dotted line. These two lines form point  $M$ . Draw a line parallel to the plane's body through  $M$ . This line will be the Mean Aerodynamic Chord length of the wing.

The center of gravity should be placed at a point 25% or 80% of the MAC as seen in Figure 16.

#### 5. The Dihedral Angle

The reason a plane can recover from temporarily rolling to either side while in flight is because of the dihedral angle placed on the main wing.

As shown in Figure 17 the dihedral angle should be  $5^\circ - 15^\circ$  on a highwing glider and  $15^\circ - 25^\circ$  on a low wing glider.

The sweptback wing of the jet plane serves the same function as a dihedral angle. On jet planes with sweptback wings, a smaller dihedral angle than the values listed in Figure 17 is used.

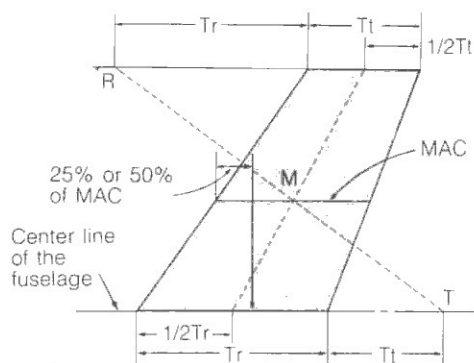


Fig.15 How to find Mean Aerodynamic Chord (MAC)

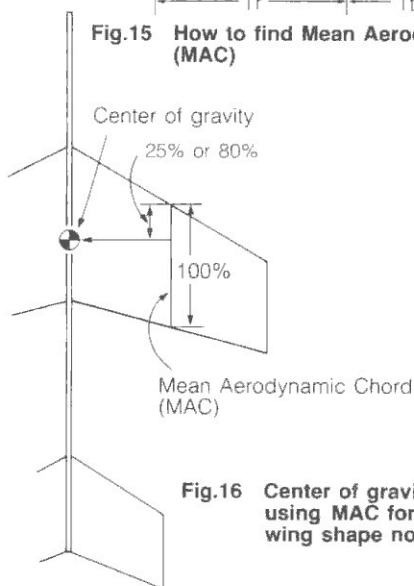


Fig.16 Center of gravity is decided using MAC formula for any wing shape not rectangular.

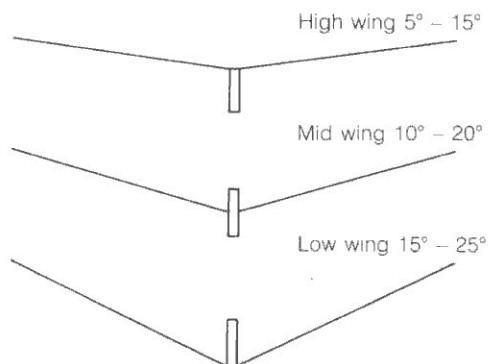
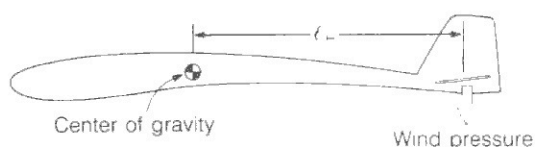


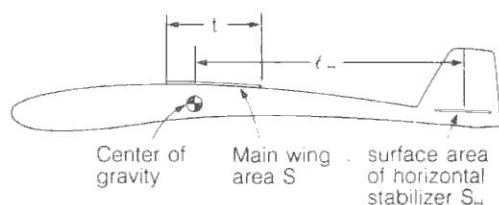
Fig.17 Wing position and suitable dihedral angle

# Whitewings

## INTRODUCTION TO PAPER PLANE DESIGN



**Fig.18** Stabilizer works as a lever with center of gravity as a fulcrum.



**Fig.19** How to find surface area of the horizontal stabilizer

### 6. The Horizontal Stabilizer

The horizontal and vertical stabilizers act independently as levers supporting the center of gravity. The distance ( $\ell$ ) between the center of gravity and the horizontal and vertical stabilizers is very important. By multiplying the size of the stabilizers by this distance ( $\ell$ ) we can find how well the stabilizers work. This product is called the tail volume.

To find the best surface area for the horizontal stabilizer ( $S_H$ ) the following formula is used.

#### ■ Long duration flight

$$S_H = 1.2 \frac{S \times t}{\ell_H}$$

#### ■ Long distance flight

$$S_H = 0.6 \frac{S \times t}{\ell_H}$$

$S$  = Main wing surface area ( $\text{cm}^2$ )

$t$  = Chord length (cm) or MAC for any wing shape not rectangular.

$\ell_H$  = Distance from center of gravity to horizontal stabilizer (cm)

The surface area of  $S_H$  as determined by the above formula is bigger in Figure 14A than in Figure 14B. This is because the further back the center of gravity, the more unstable the plane will be. Therefore, a large surface area on the horizontal stabilizer is necessary.



## 7. The Vertical Stabilizer

$$S_v = 0.05 \frac{S \times b}{l_v}$$

$S$  = Main wing surface area ( $\text{cm}^2$ )

$b$  = Main wing span (cm)

$l_v$  = Distance from center of gravity to vertical stabilizer (cm)

The surface area of the vertical stabilizer is found using the above formula. This figure is only an estimate of the stabilizer's size. For a more precise figure the surface area of the plane body and main wing dihedral angle must also be taken into consideration.

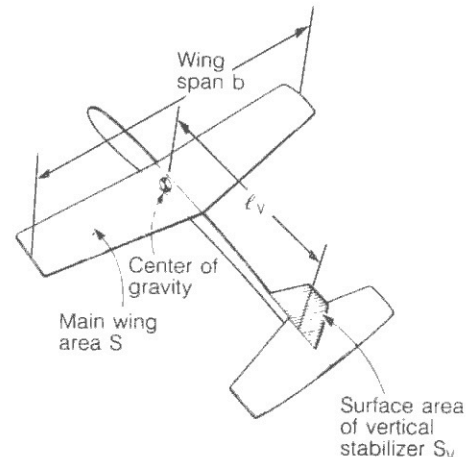
If the vertical stabilizer is too big, or too small, the glider will not fly well. If the stabilizer is too large, the glider will tend to go into a spiral descent. If it is too small the plane will tend to spin. To find the best size for the vertical stabilizer, make it slightly larger than the size you figured in the above formula. During test flights trim it until the back end begins to sway slightly from side to side. It's fun to practice this method, so give it a try!

As long as the size of the horizontal and vertical stabilizers is right, then you may choose whatever shape you like.

## 8. Test Design

Let's design a paper plane now using the aforementioned explanations. We will design a rectangular winged plane for long duration flying. If we make the main wing span 22cm, and the chord length 4cm, then the main wing surface area calculation is:

$$S = 22 \times 4 = 88\text{cm}^2$$



**Fig.20** How to find surface area of the vertical stabilizer

# Whitewings

## INTRODUCTION TO PAPER PLANE DESIGN

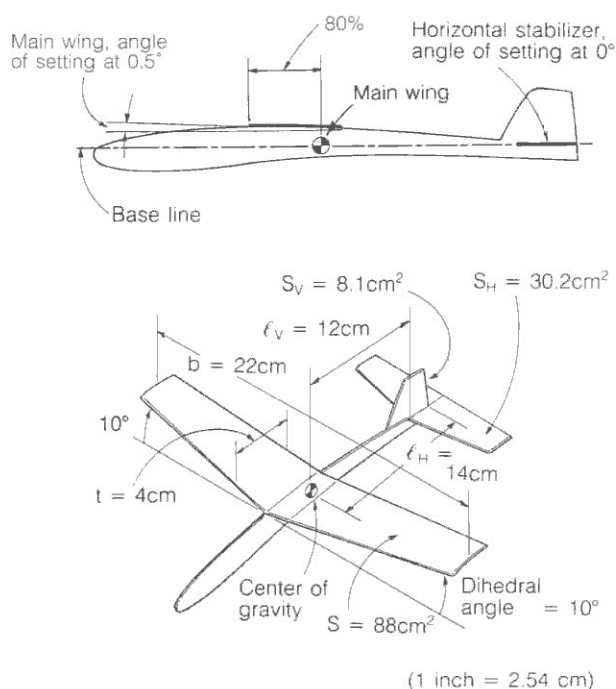


Fig.21 Test design for long duration flight

Layering the nose increases strength.

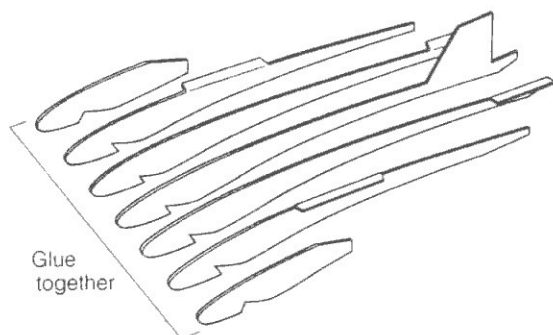


Fig.22 Composition of the fuselage

If we put the center of gravity 80% back from the main wing's leading edge (See Fig. 14A) and make the distance from the center of gravity to the horizontal and vertical stabilizers respectively  $l_H = 14\text{cm}$  and  $l_V = 12\text{cm}$ , we can calculate  $S_H$  and  $S_V$  using the following equations (See Fig. 19 and Fig. 20).

$$S_H = 1.2 \frac{88 \times 4}{14} = 30.2\text{cm}^2$$

$$S_V = 0.05 \frac{88 \times 22}{12} = 8.1\text{cm}^2$$

When deciding the distance from the center of gravity to nose tip, choose a length similar to that of one of the Whitewings models. If the distance is either too long or too short, the plane will fly poorly. You can, however, design the shape as you like.

From the above values your design will be similar to the glider in Figure 21. I have made a test model of this plane and I have found that it flies very well. Enjoy designing one for yourself!

## 9. Plane Body Construction

When throwing the glider by hand or by catapult, the wings must be able to withstand extreme wind pressure. Also, the plane must be sturdy so it will not bend or rip when it hits the ground or walls.

For a top quality glider, some parts are designed for strength while others need to be as light as possible. The shape of the glider should be designed with the following conditions in mind. It must be easy to launch by hand, simple to repair when damaged, and it must have little wind resistance.

To meet these requirements, the actual construction of the plane body, as shown in Figure 22, is made up of layers of heavy paper. There are more layers in the nose for added strength. In Figure 23, the dashed lines show where the glider tends to bend easily. To prevent this, parts (A) and (B) extend past the arrow marks for reinforcement.

As shown in Figure 24, a backing is glued to the underside of the wing's center in order to keep the main wing from bending and twisting due to wind pressure. Further, to obtain better performance, the wing should be slightly cambered as in Figure 6. This type of main wing is also easy to repair.

## 10. Layers of Paper and Bending Strength

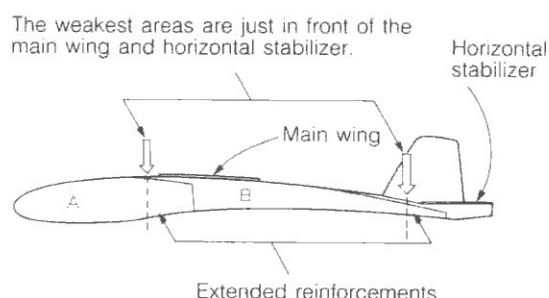
One of the main reasons why paper planes don't fly well is that the midsection, the part of the body between the main wing and the tail, tends to bend from side to side. When this happens, the plane spirals down sharply after it is launched. It is thus important to try to design your planes so that they don't bend in this section.

It is for this reason that Whitewings paper airplanes are designed to be 5 to 7 layers thick in the midsection of the fuselage. As you can see in Figure 25, the bending strength is proportionate to the cube of the width ( $w$ ) times the height ( $m$ ):

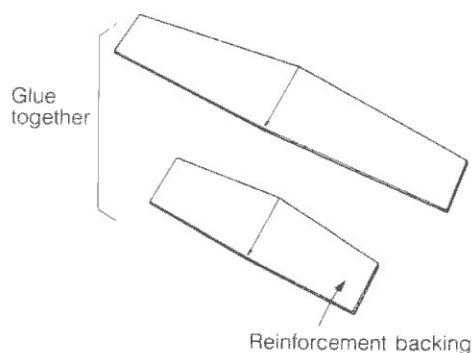
$$\text{Bending strength} \propto (w^3 \times m)$$

Taking the thickness, and thus the strength, of one piece of paper as a constant, we can substitute the number of layers of paper ( $n$ ) for the width ( $w$ ) as follows:

$$\text{Bending strength} \propto (n^3 \times m)$$



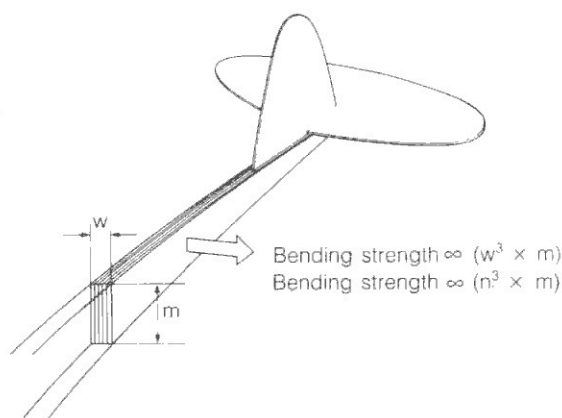
**Fig.23 Reinforcement of easily bendable parts**



**Fig.24 Composition of the main wing**

# Whitewings

## INTRODUCTION TO PAPER PLANE DESIGN



**Fig.25** Dimensions of the fuselage and bending strength

If we compare the use of six layers of paper with five layers of paper, we find that six layers of paper leads to about 1.73 times the strength.

$$\frac{6 \text{ layers}}{5 \text{ layers}} = \frac{6^3 \times m}{5^3 \times m} = \frac{216}{125} \approx 1.73$$

One other thing that becomes clear is that it is much more effective to increase the number of layers of paper than it is to increase the height of the body in order to increase strength and reduce bending. If too many layers of paper are used, however, the plane becomes too heavy.

At the same time, it is important to make sure that the several layers of paper are glued together securely. If the gluing is incomplete, then the bending strength is  $n \times m$  rather than  $n^3 \times m$ , leading to a much reduced strength.

The racer type planes included in this Whitewings kit consist of both 5 to 7 layer designs. When you fly them you will feel a slight difference between the two. While you'll need to be much more careful about how you fly the five layer ones, you'll see that they have a lighter and spirited feeling to their flight. I hope that you'll try constructing, flying, and comparing the performance of both types to see for yourself how different they are.

This concludes my explanation of simple design methods. You can now use this knowledge to help you design your own gliders.

**Good Luck and Good Flying!**

## HOW TO BUILD "WHITEWINGS"

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Racer 532 Dragonfly



P. 39

Racer 533 Sparrowhawk



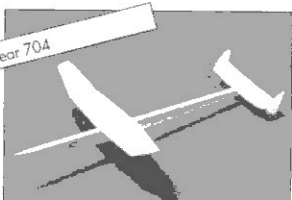
P. 40

Racer 534 Heron



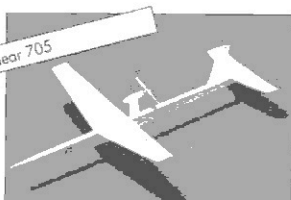
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TriLinear 704



P. 46

TriLinear 705



P. 48

Me-262



P. 50

VAMPIRE



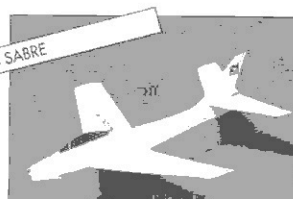
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P-80 SHOOTING STAR



P. 54

F-86 SABRE



P. 55

F-4 PHANTOM II



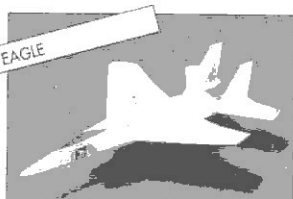
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HARRIER



P. 58

F-15 EAGLE



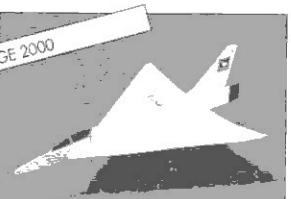
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F-16 FIGHTING FALCON



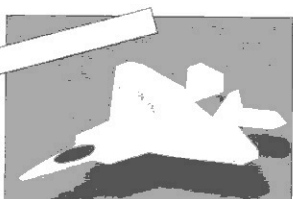
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MIRAGE 2000



P. 63

F-22



## Racer 532 Dragonfly

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

3.

Glue ⑨ to the underside of ⑧. When dry, cut off the protruding portions.

2.

Aligning the noses flush, glue ① through ⑦ together in the order shown.

4.

Glue the horizontal stabilizer ⑩ to the fuselage.

1.

Fold all tabs outward.

5.

Place a ruler along the center line of the main wing (⑧ + ⑨), bend each side up individually to make a dihedral angle of approximately 15° for both sides of the main wing. Then, glue the main wing (⑧ + ⑨) firmly to the fuselage.

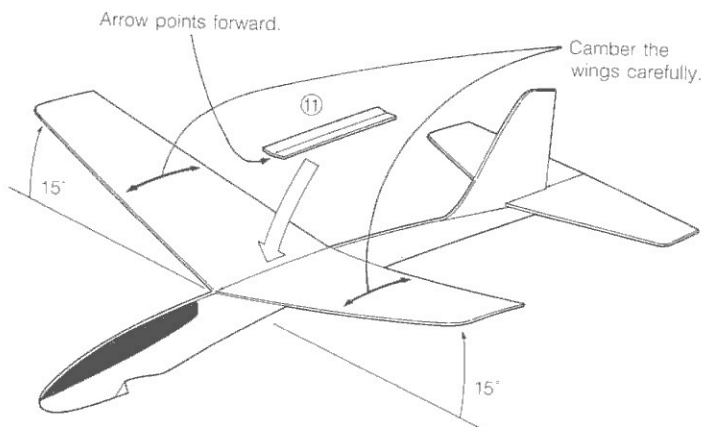
### FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.

6. Camber the main wings carefully with your fingers.
7. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 15°.
8. Fold ⑪ up slightly along the center line and glue it onto the center of the main wing.
9. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

### TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.

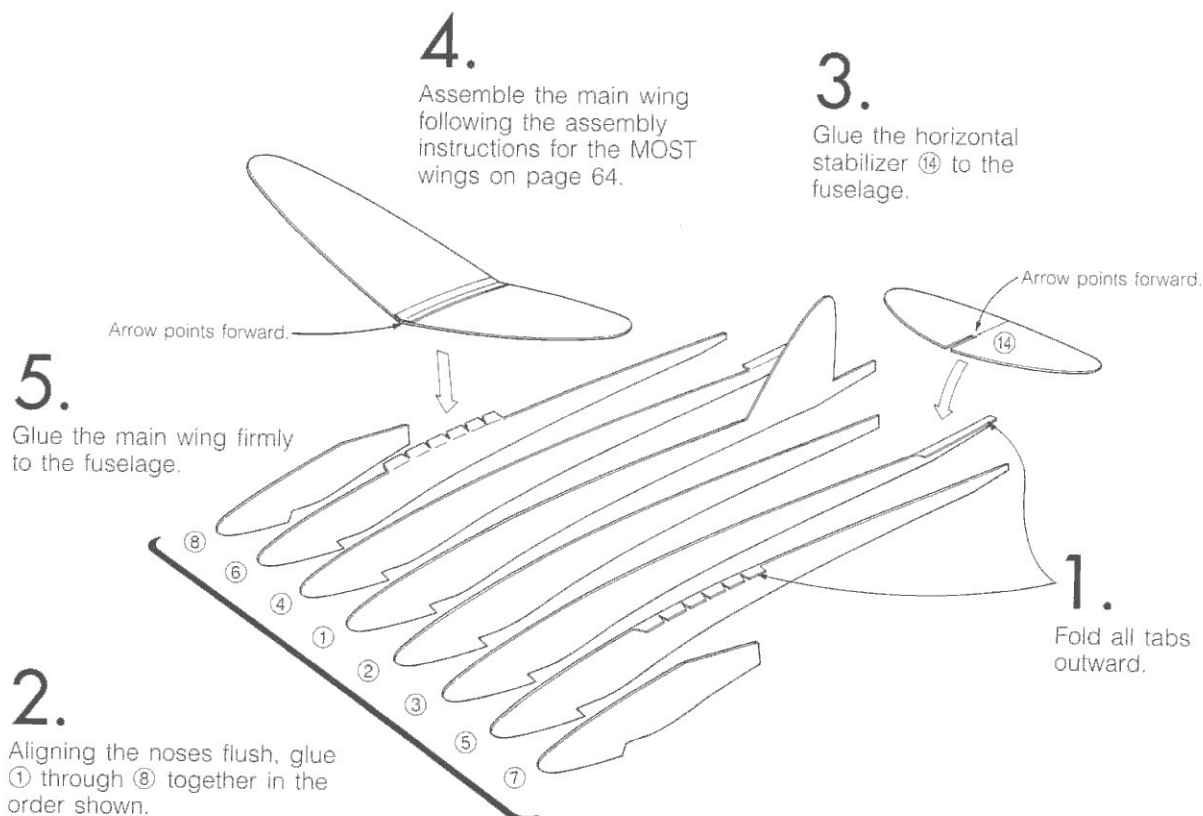




## Racer 533 Sparrowhawk

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

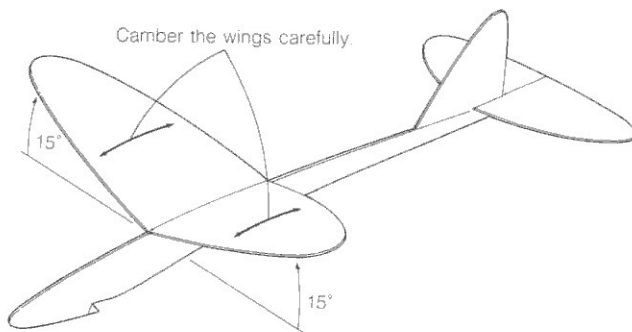


### FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 6. Camber the main wing carefully with your fingers.
- 7. Using the dihedral angle gauge make sure the dihedral angle for the main wing is 15°.
- 8. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

### TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on page 11 to 13.



## Racer 534 Heron

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

**4.**

Assemble the middle part of the wing with ⑨, ⑩, ⑪, ⑫ and ⑬ following the assembly instructions 0. 1.....7. on page 64 starting with step 0. The dihedral angle, however, must be 5°. Be careful as the part numbers for the main wing are different from those listed on page 64.

**5.**

Glue the middle part of the main wing firmly to the fuselage.

**3.**

Glue the horizontal stabilizer ⑮ to the fuselage.

Arrow points forward.

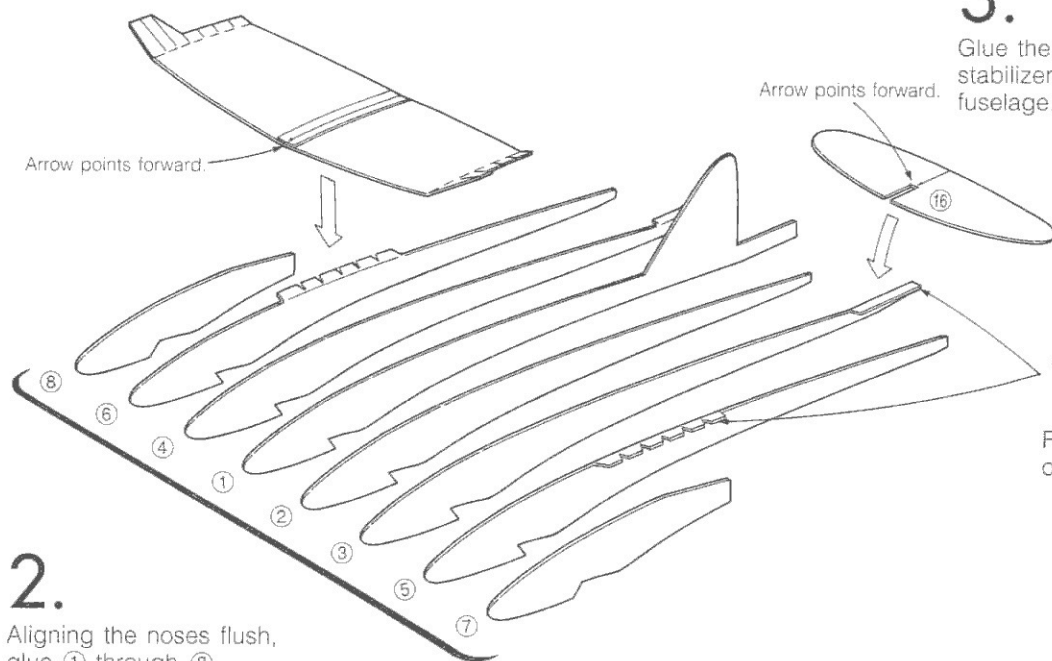
Arrow points forward.

**1.**

Fold all tabs outward.

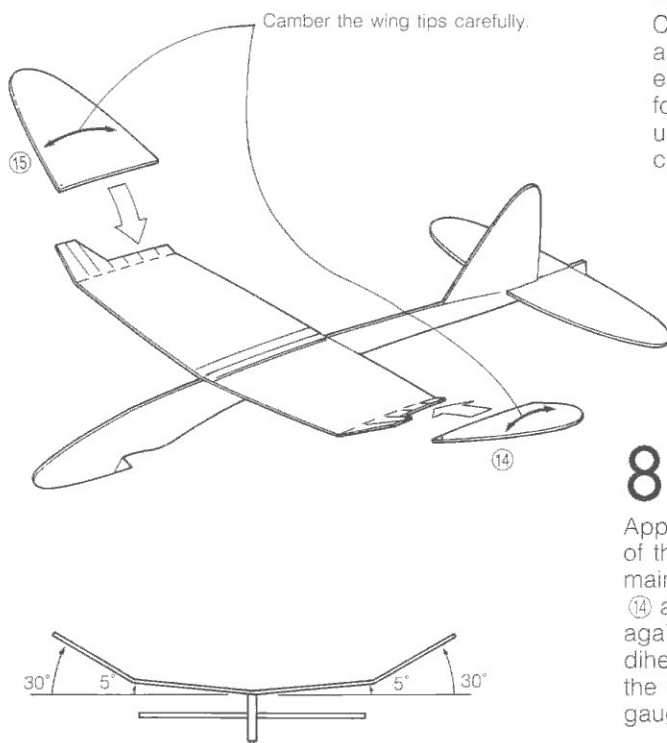
**2.**

Aligning the noses flush, glue ① through ⑧ together in the order shown.



# 6.

Place the dihedral angle gauge on the main wing to make sure the dihedral angle is  $5^\circ$ .



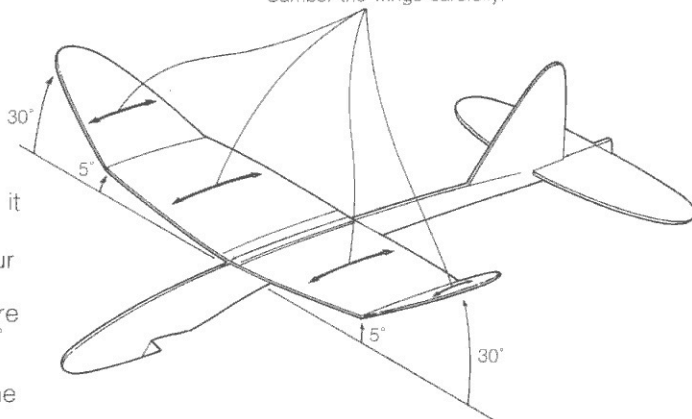
# 7.

Camber both wing tips ⑭ and ⑮. Fold tabs on both ends of the main wing to form a  $30^\circ$  dihedral angle using the gauge and then camber them as well.

# 8.

Apply glue to the top surface of the folded tabs of the main wing. Attach wing tips ⑭ and ⑮ respectively. Once again, check that the dihedral angle at the tip of the wing is  $30^\circ$ , using the gauge.

Camber the wings carefully.



## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 9. Camber the main wings carefully with your fingers.
- 10. Using the dihedral angle gauge make sure the dihedral angle for the main wing is  $5^\circ$  and for the wing tips  $30^\circ$ .
- 11. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

## TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on page 11 to 13.

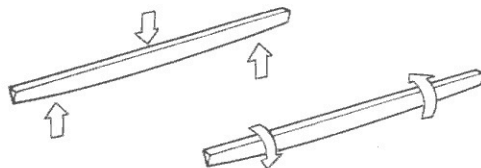
# Whitewings

## ASSEMBLY INSTRUCTIONS FOR THE TRIANGULAR LONG FUSELAGE

A truly high performance paper plane is light, sturdy, and has little air resistance or drag.

This is especially true of larger paper airplanes. That is why I have spent some time researching and designing a fuselage that accomodates the body construction of a large paper airplane.

The result of theses efforts was the invention of the triangular long fuselage which is resistant to bending and twisting. Its aerodynamic performance makes it worthy of the Whitewings' name.

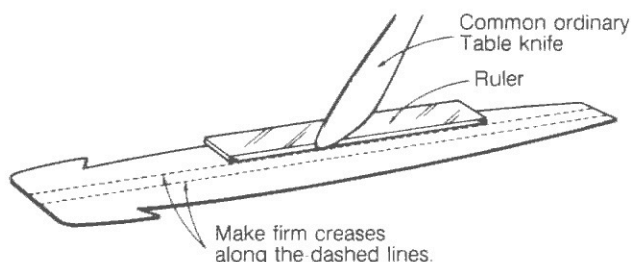


The triangular long fuselage is resistant to both bending and twisting.

1.

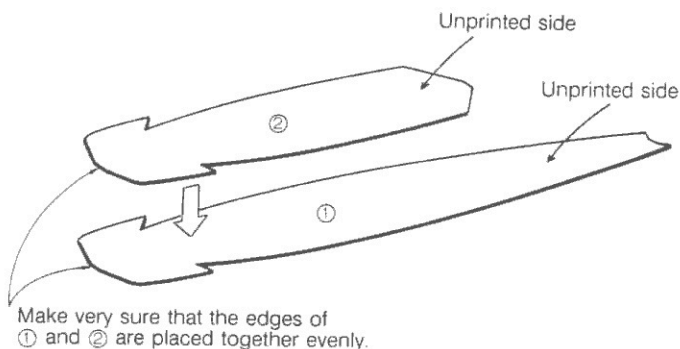
Make firm creases along the dashed lines of fuselage pieces (① & ②) using a common ordinary table knife (blunt knife) and a ruler as a guide.

Avoid cutting through the dashed lines.



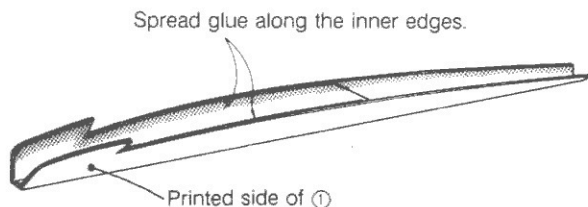
2.

Spread glue evenly over the entire surface of printed side of ②. Apply ② to the unprinted side of ①. Make very sure that the edges of ① and ② that form the plane nose are placed together evenly, or flush, as shown in the diagram.



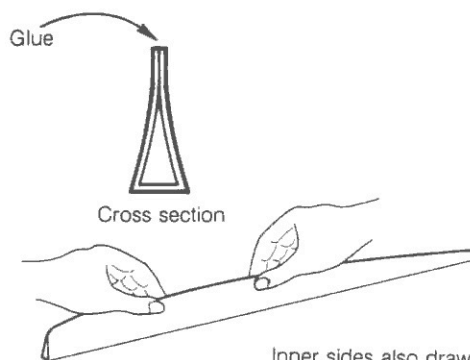
3.

Before the glue dries, fold ① and ② along the creased dashed lines having ② face inward. Then spread glue along the inner edges as shown.



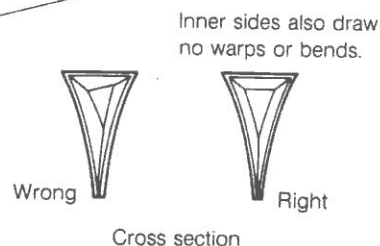
4.

Glue the inner edges together to complete the formation of the cross section as shown.



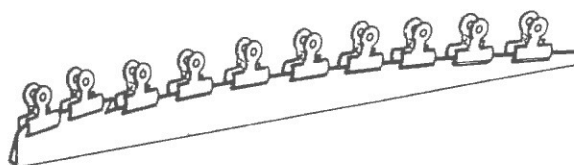
5.

View the fuselage closely from both the front and back carefully straighten any warps or bends before the glue dries. Look inside of the fuselage to make sure the inner side also draw no warps or bends.



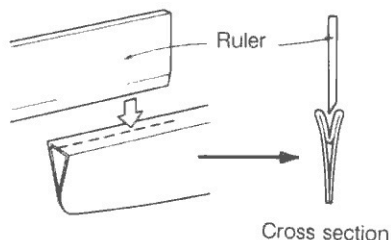
6.

Let the fuselage dry completely by attaching clips or clothespins on the glued edges as shown. It takes at least 2 hours to dry.



7.

Make a groove along the thick dashed line at the plane nose by carefully pressing down upon it with a ruler. The groove must be deeper at the tip of the plane nose than at any other part. The remaining area of the top of the fuselage, except for the thick dashed line, should remain flat.



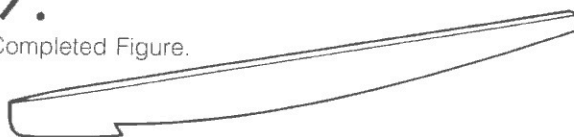
8.

Put glue into the groove at the tip of the plane nose and both inner sides of the plane nose and glue together. Let it dry thoroughly (at least 2 hours) using a clip to keep the tip of the nose in place.



9.

Completed Figure.



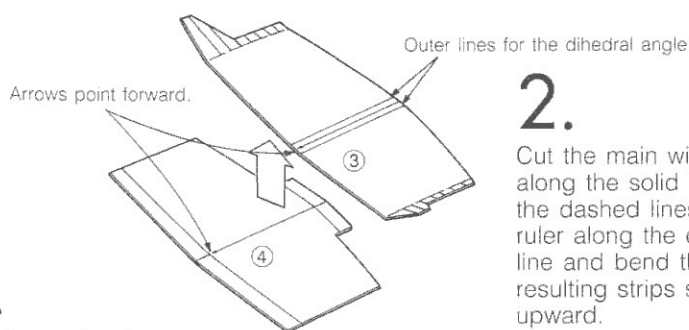
## TriLinear 704

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

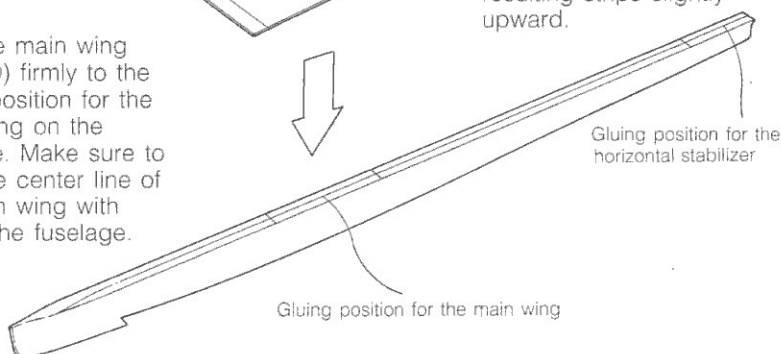
**3.**

Glue ④ to the underside of ③. When dry, cut off the protruding portions.



**8.**

Glue the main wing (③ + ④) firmly to the gluing position for the main wing on the fuselage. Make sure to align the center line of the main wing with that of the fuselage.



**1.**

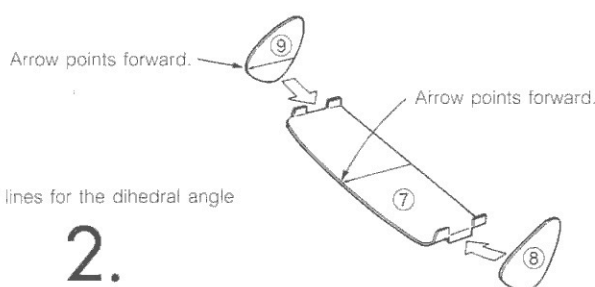
Assemble the fuselage following the assembly instructions for the triangular fuselage on pages 42 and 43.

**7.**

Place a ruler along each of the outer lines of the main wing and bend each side up individually to make a dihedral angle of approximately 5° for both sides of the main wing.

**4.**

Fold both tabs of the horizontal stabilizer ⑦ as shown.



**2.**

Cut the main wing ③ along the solid lines up to the dashed lines. Place a ruler along the dashed line and bend the resulting strips slightly upward.

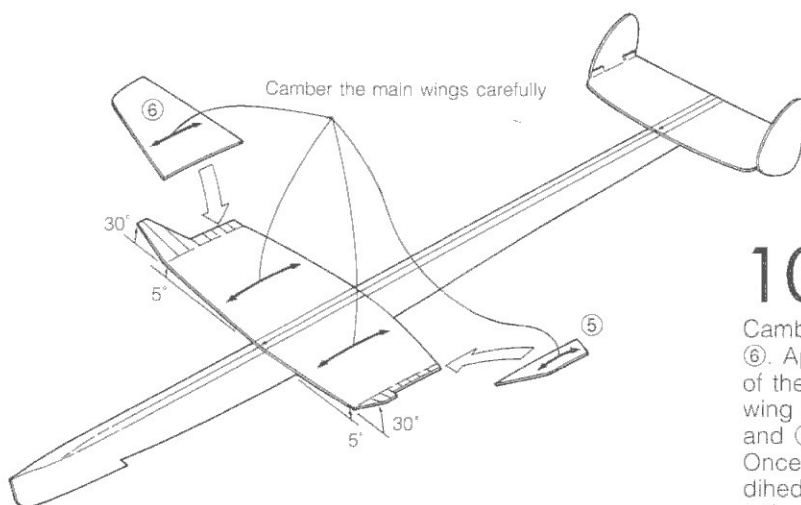
**5.**

Glue the vertical stabilizers ⑧ and ⑨ to the tabs of the horizontal stabilizer ⑦ aligning the arrows on ⑧ and ⑨ with the folded tab lines of ⑦.

**6.**

Glue the horizontal stabilizer (⑦ + ⑧ + ⑨) firmly onto the gluing position for the horizontal stabilizer on the fuselage top. Make sure to align the center line of the fuselage with that of the horizontal stabilizer.



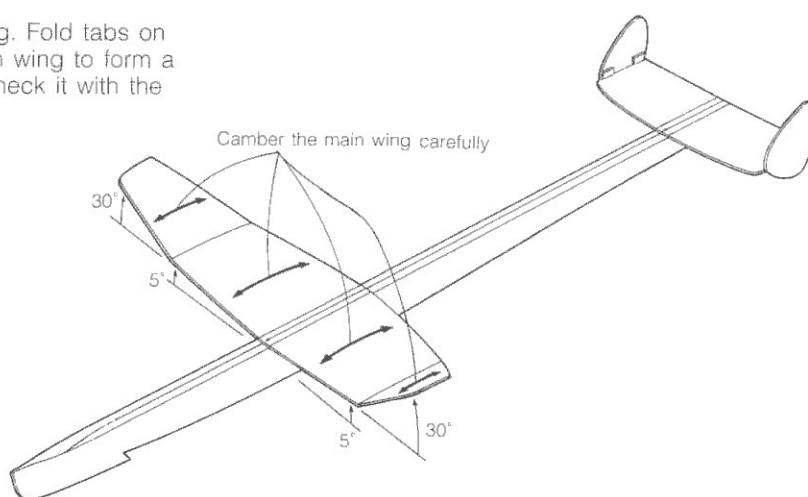


10.

Camber both wing tips ⑤ and ⑥. Apply glue to the top surface of the folded tabs of the main wing and attach the wing tips ⑤ and ⑥ respectively as shown. Once again, check that the dihedral angle at the wing tip is 30° using the gauge.

9.

Camber the main wing. Fold tabs on both ends of the main wing to form a 30° dihedral angle. Check it with the gauge.



## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 11. Make the camber on the main wing even with your fingers.
- 12. Using the dihedral angle gauge, make sure the dihedral angle of the main wing is 5° and for the wing tips 30°.
- 13. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

## TEST FLIGHT

- Test fly the plane according to the test flight instructions for Regular Planes on pages 11 to 13.

## TriLinear 705

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

# 7.

Place a ruler along the outer lines of the main wing and bend each side up individually to make a dihedral angle of approximately 15° for both sides of the main wing.

# 5.

Fold the tab of the vertical stabilizer (6). Glue (7) to the other side of the vertical stabilizer (6).

# 6.

Glue the vertical stabilizer (6 + 7) to the gluing position for the vertical stabilizer on the fuselage. Make sure to align the folded tab line of the vertical stabilizer with the center line on the fuselage.

# 2.

Glue (4) to the underside of (3) aligning their center lines. When dry, cut off the protruding portions.

# 4.

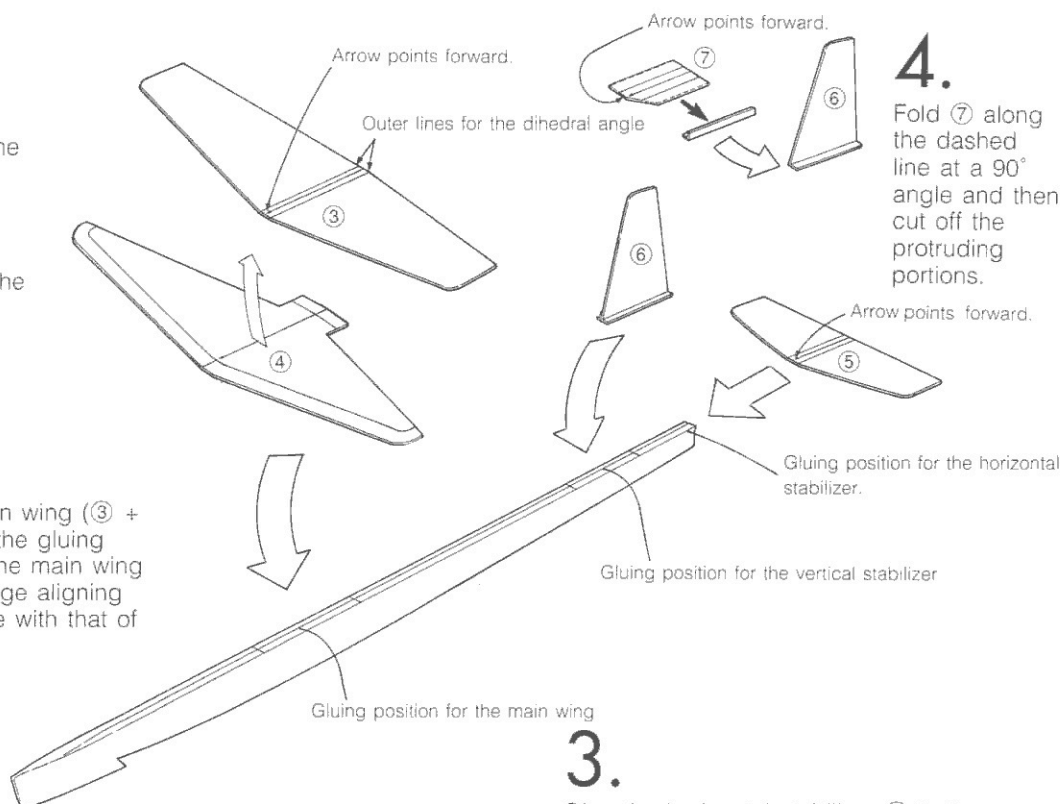
Fold (7) along the dashed line at a 90° angle and then cut off the protruding portions.

# 8.

Glue the main wing (3 + 4) firmly to the gluing position for the main wing on the fuselage aligning its center line with that of the fuselage.

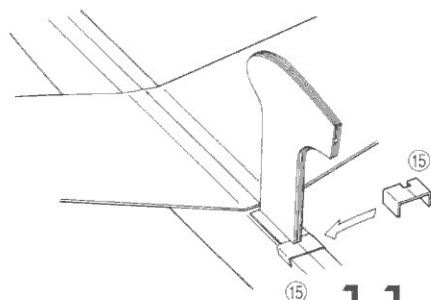
# 3.

Glue the horizontal stabilizer (5) to the gluing position for the horizontal stabilizer on the fuselage.



# 9.

Fold the tabs on ⑩ and ⑪. Make the engine by gluing together ⑧, ⑨, ⑩ and ⑪. Insert a pin into the slots of ⑧ and ⑨ when gluing, then remove it after the glue dries.



# 10.

Glue the engine (⑧ + ⑨ + ⑩ + ⑪) to the gluing positions for the engine on the fuselage. Then fold ⑮ as shown and glue ⑮ to the fuselage top so that it surrounds the base of the engine as shown.

# 11-4

After inserting the pin with the propeller into the back end of the engine, trim the propeller blades so that both blades are of equal length. Make sure the propeller revolves smoothly.

# 11.

Assemble the propeller.

# 11-1

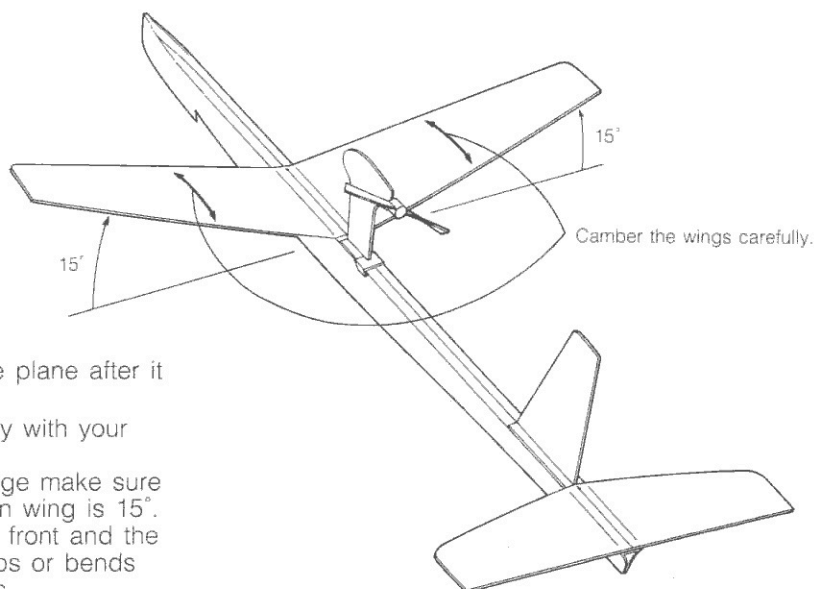
To make the propeller hub (the part which the propeller shaft passes through), wrap the ribbon ⑫ around the pin applying glue on the ribbon. After making sure that the hub around the pin revolves smoothly, pull the pin out temporarily.

# 11-2

Curve the end of both propeller blades (⑬ and ⑭) to fit around the hub as shown. Wrap the blades around the hub and glue on.

# 11-3

When dry, carefully twist the propeller blades in opposite directions as shown.



## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 12. Camber the main wing slightly with your fingers.
- 13. Using the dihedral angle gauge make sure the dihedral angle of the main wing is 15°.
- 14. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

## TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.

# Whitewings

## Messerschmitt Me-262

= The First Practical Jet Fighter in the World =

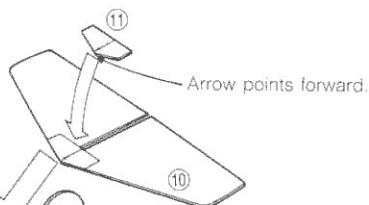
The first jet plane in the history, Heinkel He-178 (Germany, First Flight in 1939) and Gloster E28/39 (UK, First Flight in 1941) were experimental planes or akin to them. In the latter part of World War II, Messerschmitt Me-262 (Germany, First Flight in 1941) were mass-produced and utilized as a fighter and bomber. Those days in Germany, the study of a sweptback wing with small drag at sonic speed had been carried forward and put into practical use in the Me-262 prior to any other country.

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

4.

Glue ⑪ to the printed box on the top of the horizontal stabilizer ⑩



5.

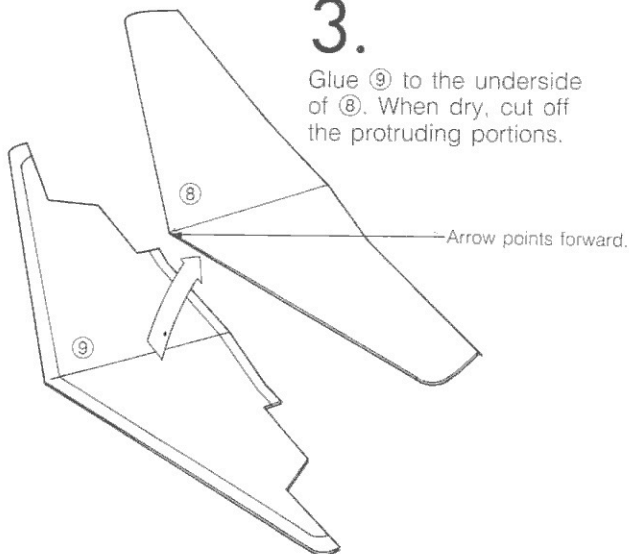
Glue the horizontal stabilizer (⑩ + ⑪) to the fuselage.

1.

Fold all tabs outward.

3.

Glue ⑨ to the underside of ⑧. When dry, cut off the protruding portions.



2.

Aligning the noses flush, glue ① through ⑦ together in the order shown.

6.

Placing a ruler along the center line of the main wing (⑧ + ⑨), make a dihedral angle of approximately 10°. Then, glue the main wing to the fuselage aligning their center lines. (Refer to [NOTE].)

### [NOTE]

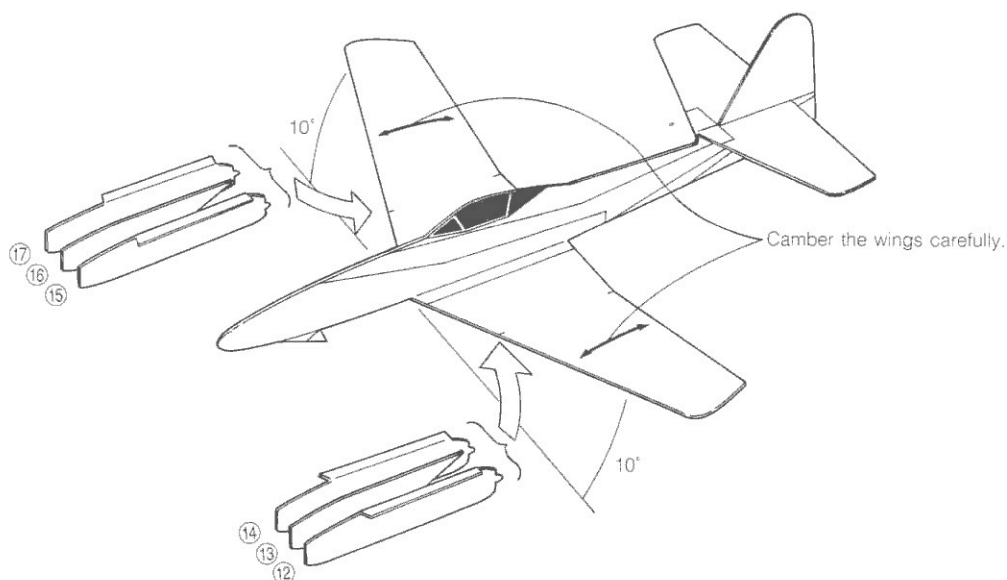
In the case of a low-wing plane, the fuselage prevents you from finding the printed center line of a main wing. In order to align the center line of both a main wing and a fuselage, therefore, take the following measure. Make pinholes at both ends of the center line on the top side of the main wing. Turn the main wing over. Link the pinholes together with a ruler and draw a center line on the unprinted side of the main wing.

# 7.

After folding the tabs, glue together ⑫, ⑬ and ⑭ to make the left engine and ⑮, ⑯ and ⑰ for the right engine.

# 8.

Using the engine installation lines on the upside of the main wing as a guide, glue the two engines to the underside of the main wing.

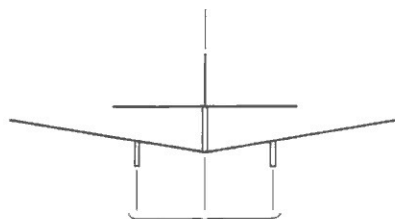


## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 9. Camber the outer sides of the main wing from the engines carefully with your fingers.
- 10. Place the dihedral angle gauge at the underside of the main wing and make sure the dihedral angle for the main wing is  $10^\circ$ .
- 11. Fix the engines to ensure the vertical fuselage line and the engines are parallel when viewed from the front.
- 12. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

## TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.



Make the three parallel.

## De Havilland VAMPIRE

= The Jet Fighter with twin fuselage =

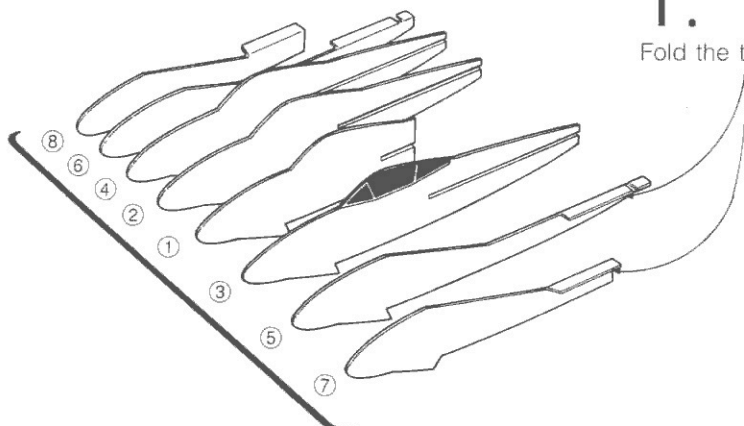
DH100, the prototype of VAMPIRE, had its first flight in 1943. In that period, searching for the most effective way to equip planes with newly developed jet engines was underway. In order to minimize thrust loss, the jet-exhaust-pipe and the front fuselage carrying the jet engine are shortened in this VAMPIRE. The result is the twin fuselage on the rear part of the plane.

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

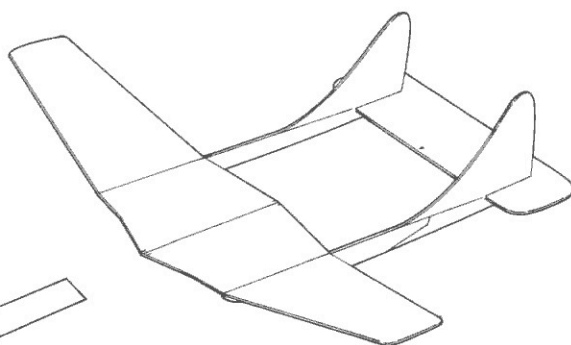
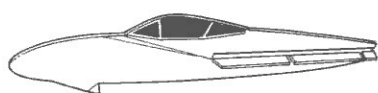
1.

Fold the tabs outward.



2.

Aligning the noses flush, glue ① through ⑧ together for the front fuselage in the order shown.

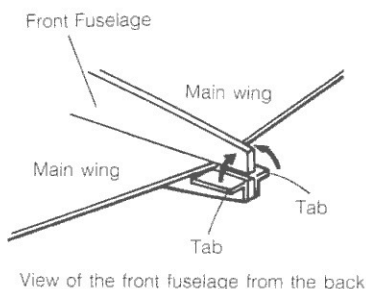


11.

Insert the main wing into the end of the slit of the front fuselage. Glue the front tab of the front fuselage to the underside of the main wing to fix them. As the fuselage prevents you from finding the center line of the main wing, install the fuselage using the center guidelines on the main wing.

12.

Referring to the figure, glue the rear tabs of the front fuselage to close the slit.





9.

Using the installation lines for left and right fuselages as a guide, glue both the rear -left and rear -right fuselages to the underside of the main wing.

7.

Aligning the noses flush, glue ⑬ through ⑯ together for the rear - right fuselage in the order shown.

5.

Aligning the noses flush, glue ⑨ through ⑫ together for the rear - left fuselage in the order shown.

3.

Glue 18 to the underside of ⑰. When dry, cut off the protruding portions.

8.

Placing a ruler along the installation lines for left and right fuselages on the main wing, make a dihedral angle of approximately 15° for both sides of the main wing. (Use a dihedral angle gauge.)

10.

Bridging the horizontal stabilizer ⑲ between left and right rear fuselages, glue it to the fuselages.

4.

Fold the tabs outward.

6.

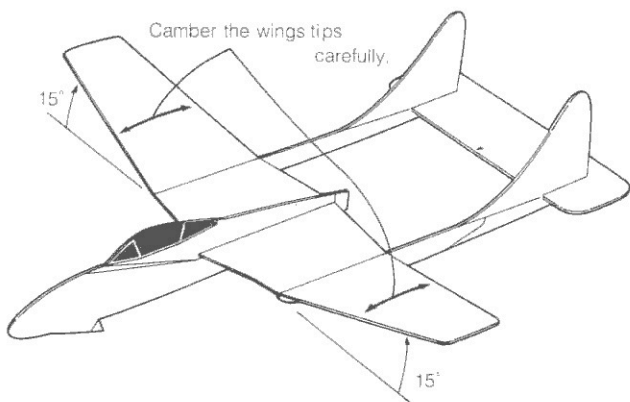
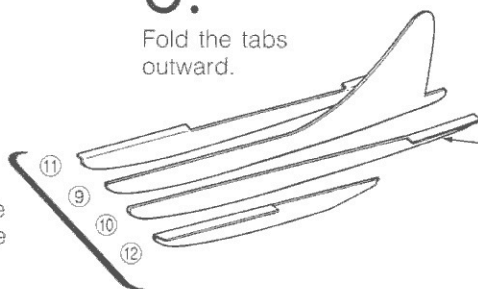
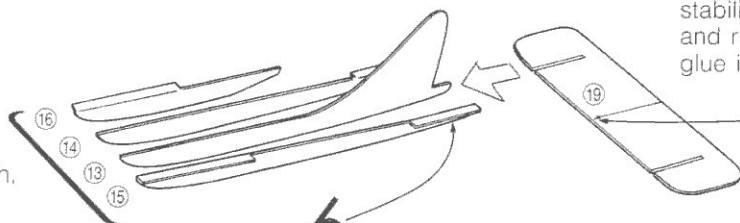
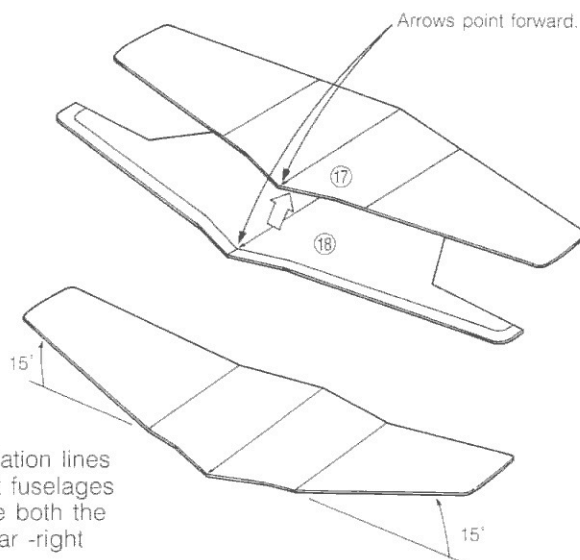
Fold the tabs outward.

## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 13. Camber the wing tips carefully with your fingers.
- 14. Using the dihedral angle gauge, make sure the dihedral angle of the outer of the main wing tips are both 15°.
- 15. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

## TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.



## Lockheed P-80 SHOOTING STAR

= The First Practical Jet Fighter in the US =

Lockheed P-80 is the first practical Jet fighter in the United States. (First Flight in 1944) This plane has a jet engine at the center of the fuselage and the air intakes opened at both sides of the fuselage body. With the development of this plane, the standard form of jet planes using a single jet engine was established. The streamlined objects at the ends of the main wing tip are the fuel tanks and constitute a characteristic feature of P-80.

T-33 Jet Trainer Plane which is now being used is the two-seat plane based upon P-80.

### GLUING INSTRUCTIONS

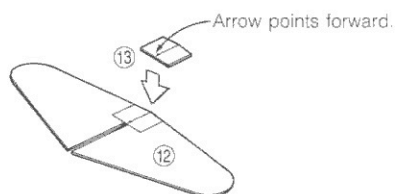
Glue the parts together in the order indicated.

7.

Glue the horizontal stabilizer ⑫ to the fuselage.

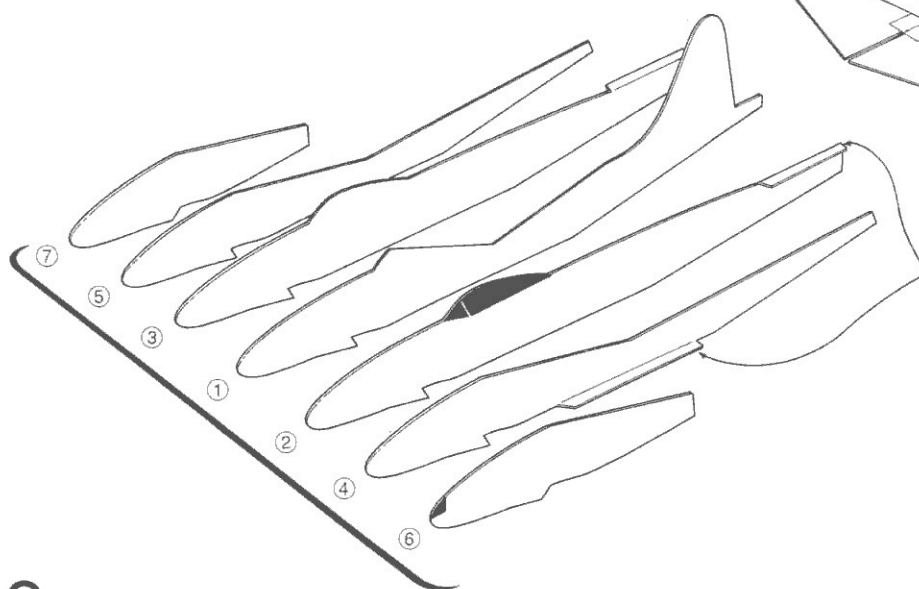
8.

Glue ⑬ to the printed box on the top of the horizontal stabilizer ⑫.



1.

Fold all tabs outward.

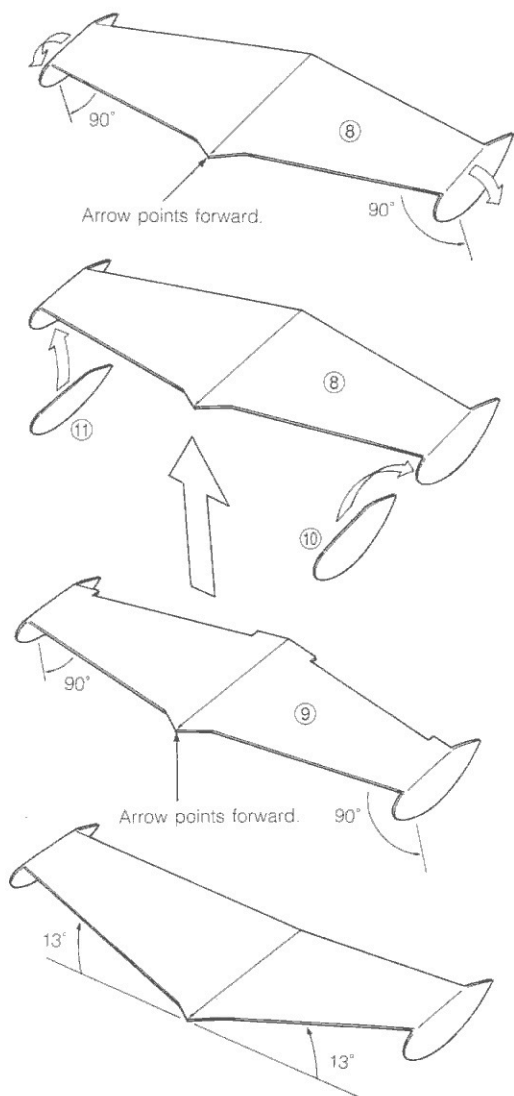


2.

Aligning the noses flush, glue ① through ⑦ together in the order shown.

9.

Place a ruler along the center line of the main wing (⑧ + ⑨), make a dihedral angle of approximately 13° for both sides of the main wing. Then, glue the main wing to the fuselage aligning their center lines. (Refer to [NOTE] on page 48.)



### 3.

Bend the tip tanks of the main wing ⑧ downward 90°.

### 4.

Glue parts ⑩ and ⑪ respectively to the inside of the tip tanks of the main wing ⑧.

### 5.

Bend the tip tanks of ⑨ (the backing of the main wing) downward 90°.

(For this P-80, it is easier not to cut ⑨ out with on extra 2 – 3mm margin along the front and back lines.)

### 6.

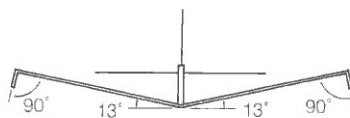
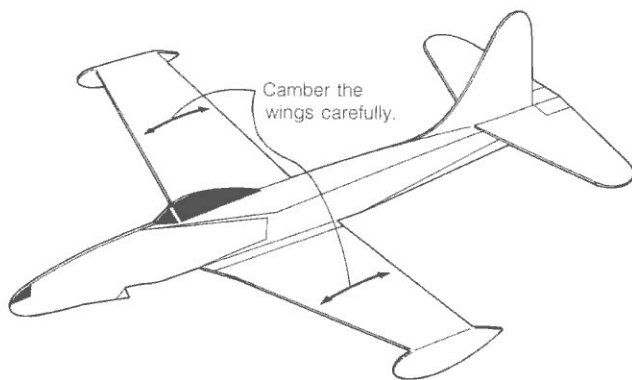
Spread glue entirely on the printed side of ⑨ including the tip tanks. Then, glue ⑨ to the underside of the main wing ⑧ and let it dry thoroughly.

## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 10. Camber the main wing slightly with your fingers.
- 11. Place the dihedral angle gauge at the underside of the main wing and make sure the dihedral angle for the main wing is 13°.
- 12. Make sure the tip tanks are bent at 90° to the main wing.
- 13. View the plane from the front and the back and straighten any warps or bends in the fuselage and the wings.

## TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.



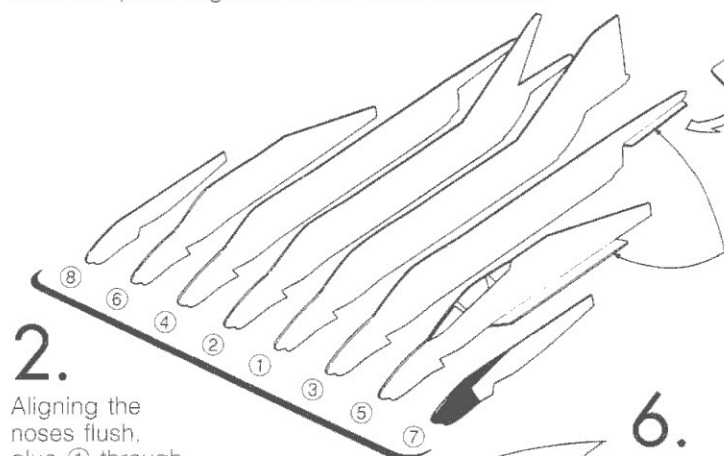
## McDonnell Douglas F-4 PHANTOM II

= The Large-sized All-around Fighter =

F-4 PHANTOM II was developed as a fighter for an aircraft carrier. Being appraised as omnipotent, this plane was adopted not only by the U.S. Air Force and the U.S. Marine Corps, but also by other countries in the West. The total quantity of production reached more than 5,000. Although F-4 is a large-sized plane whose gross weight is beyond 20 tons, it is capable of an air combat, a ground attack and has a long cruising range. After the appearance of this fighter, the notion that a large-sized plane with twin engines is effective as a multi-purpose fighter was established. Its first flight was in 1958.

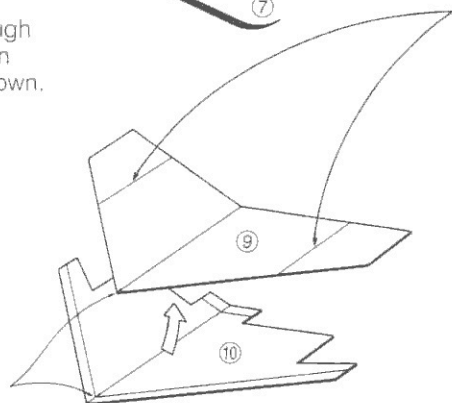
### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.



2.

Aligning the noses flush, glue ① through ⑧ together in the order shown.



Arrows point forward.

1.

Fold all tabs outward.

6.

Placing a ruler along the lines on the wing tips, make a dihedral angle of approximately  $23^\circ$ . Then, glue the main wing firmly to the fuselage aligning their center lines. (Refer to [NOTE] on page 48.)

5.

Turn the horizontal stabilizer ⑩ upside down and glue it firmly to the fuselage.

4.

Place a ruler along the center line of the horizontal stabilizer ⑪ and make a dihedral angle of approximately  $12^\circ$ .

3.

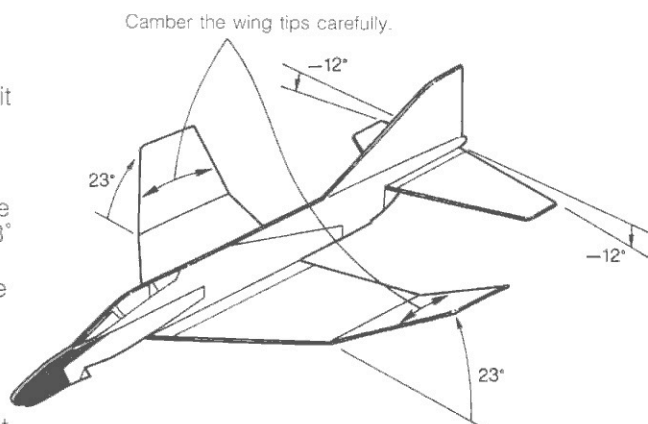
Glue ⑩ to the underside of ⑨. When dry, cut off the protruding portions.

### FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 7. Camber the wing tips carefully with your fingers.
- 8. Using the dihedral angle gauge make sure the dihedral angle for the wing tips are  $23^\circ$  and for the horizontal stabilizer minus  $12^\circ$ .
- 9. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

### TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on page 11 to 13.



## Hawker Siddeley HARRIER

= The first fixed wing VTOL plane in the world which was successfully put to practical use =

In the UK, the Pegasus jet engine with a vectored thrust was developed and utilized for the HARRIER, the fixed wing VTOL (vertical take-off and landing) plane.

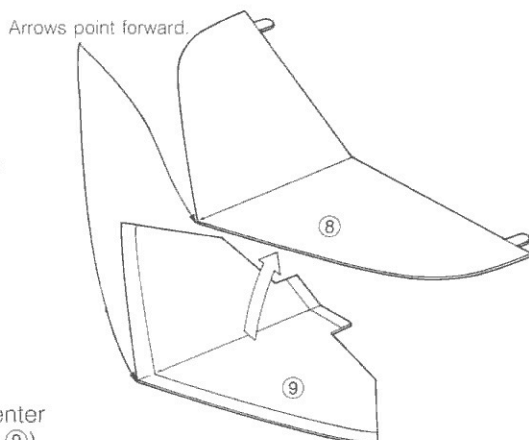
Hawker P-1127 had its first flight in 1957 and it is the prototype of the HARRIER (First Flight in 1960). Although it took a long time to make it practical, the HARRIER was completed and became the first and most successful S/VTOL fighter in the world.

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

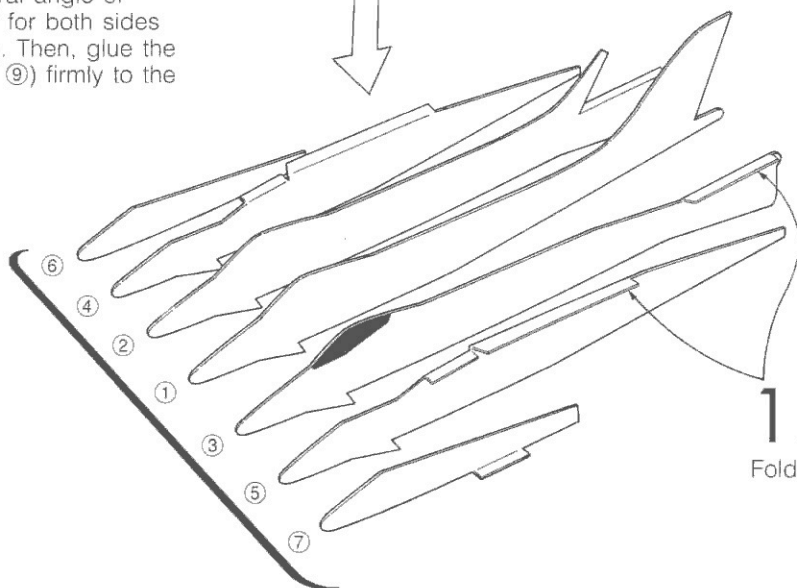
3.

Glue ⑨ to the underside of ⑧. When dry, cut off the protruding portions.



6.

Placing a ruler along the center line of the main wing (⑧ + ⑨), bend each side up individually to make a dihedral angle of approximately 5° for both sides of the main wing. Then, glue the main wing (⑧ + ⑨) firmly to the fuselage.



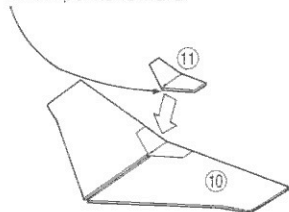
1.

Fold all tabs outward.

2.

Aligning the noses flush, glue ① through ⑦ together in the order shown.

Arrow points forward.

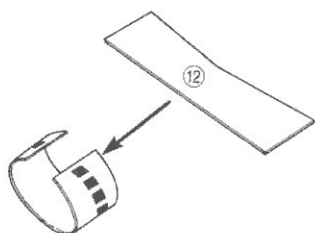


4.

Glue ⑪ to the printed box on the top of the horizontal stabilizer ⑩.

5.

Glue the horizontal stabilizer (⑩ + ⑪) to the fuselage.

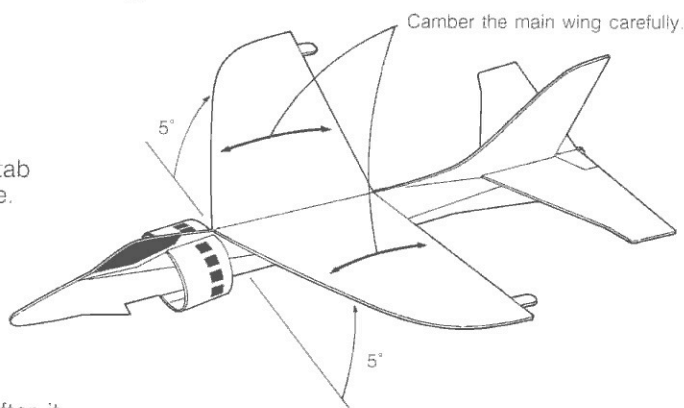


7.

Roll up ⑫ with your fingers in advance keeping the printed side of ⑫ facing outward. Then glue ⑫ to the tab of the lower part of the fuselage aligning the center line of ⑫ with the center of the fuselage.

8.

Glue both edges of ⑫ to each tab of the upper part of the fuselage.



## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 9. Camber the main wings slightly with your fingers.
- 10. Using the dihedral angle gauge, make sure the dihedral angle for the main wing is 5°.
- 11. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wings.

## TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.

## McDonnell Douglas F-15 EAGLE

= The Large-sized Fighter with an excellent performance for air combat =

F-15 is the leading fighter developed mainly for air-combat. In order to augment the faculty for an air combat, this plane was designed with small wing loading and large thrust/weight ratio. Using expensive titanium for lightening the weight and the engine with a large thrust, the engine thrust almost achieves exceeding the weight of the plane. This has become the general objective in the design of fighters since this development. Its first flight was in 1972.

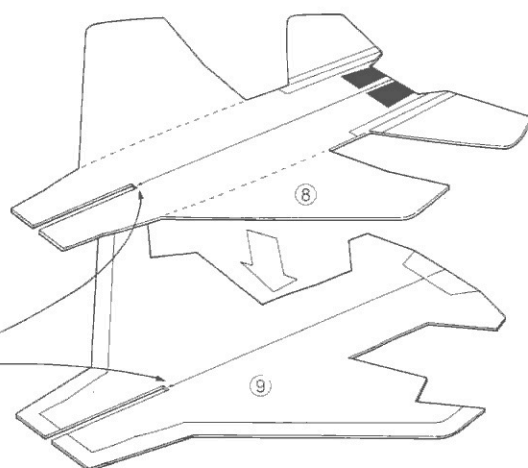
### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

3.

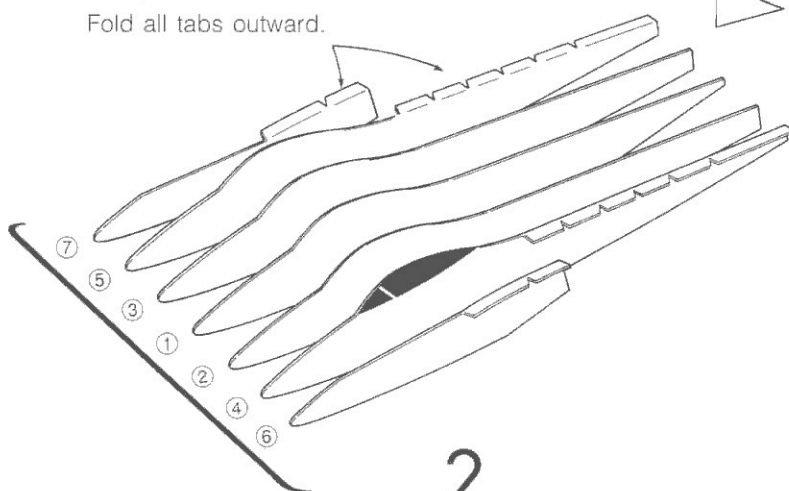
Glue ⑨ to the underside of ⑧.  
When dry, cut off the protruding portions.

Arrows point forward.



1.

Fold all tabs outward.



2.

Aligning the noses flush, glue ① through ⑦ together in the order shown.

4.

Glue ⑧ + ⑨ firmly to the fuselage.

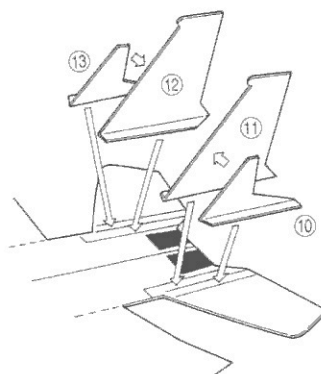


# 5.

Glue ⑪ and ⑫ to the horizontal stabilizer, aligning the rear edges.

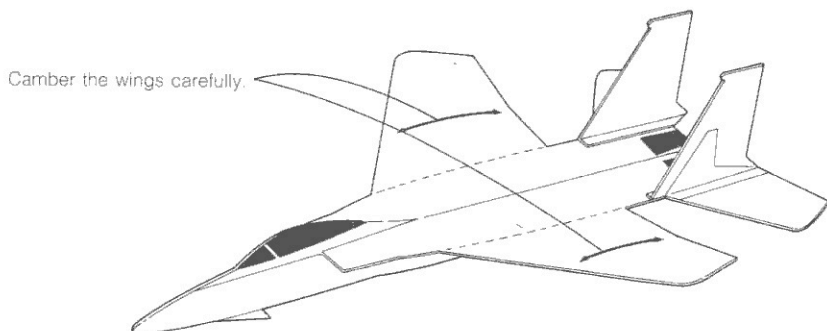
# 6.

Next, glue ⑩ to the side of ⑪ and ⑬ to the side of ⑫.



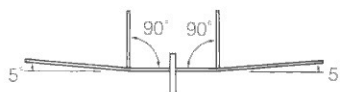
# 7.

Placing a ruler along the dashed line, bend the main wing slightly upward to make a dihedral angle of approximately  $5^\circ$ .



## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 8. Camber the main wings carefully with your fingers.
- 9. Using the dihedral angle gauge, make sure the dihedral angle for the main wing are  $5^\circ$  and the vertical stabilizers  $90^\circ$ .
- 10. View the plane from the front and the back and straighten any warps or bends in the fuselage and wings.



## TEST FLIGHT

- Test fly the plane according to Test Flight instructions for Regular Planes on pages 11 to 13.

# Whitewings

## General Dynamics F-16 FIGHTING FALCON

= The representative of Lightweight Fighter =

In comparison with the large-sized and expensive F-15, the U.S. Air Force had a try at a Lightweight Fighter Project in order to develop a more economical plane. This resulted in the birth of this representative of the contemporary lightweight fighter, F-16. It has the fly-by-wire control system and is controlled with a side-stick. As F-16 is small-sized, light, inexpensive and excellent in an air combat performance, more of these are in commission than F-15 and more countries employ this plane. Its first flight was in 1974.

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

1.

Glue ① and ② together and dry it thoroughly.

2.

Cut out the two slits into which the main wing and the horizontal stabilizer will be inserted.

4.

Aligning the folded tab lines of ③ and ④ with the upper edges of two slits on (① + ②), glue ③ and ④ onto each side of the fuselage (① + ②) so that the slits are not covered by parts ③ and ④.

8.

Insert and glue the main wing to the fuselage in the same way as the horizontal stabilizer except this time, with printed side down. The logo should be visible when the plane flies. Again, use the pinholes as the guide to the center line.

5.

Glue ⑫ to the underside of ⑪. When dry, cut off the protruding portions.

Slit for horizontal stabilizer

Slit for main wing

3.

Place a ruler along the dashed line of ③ and fold the tab outward. Do the same with part ④.

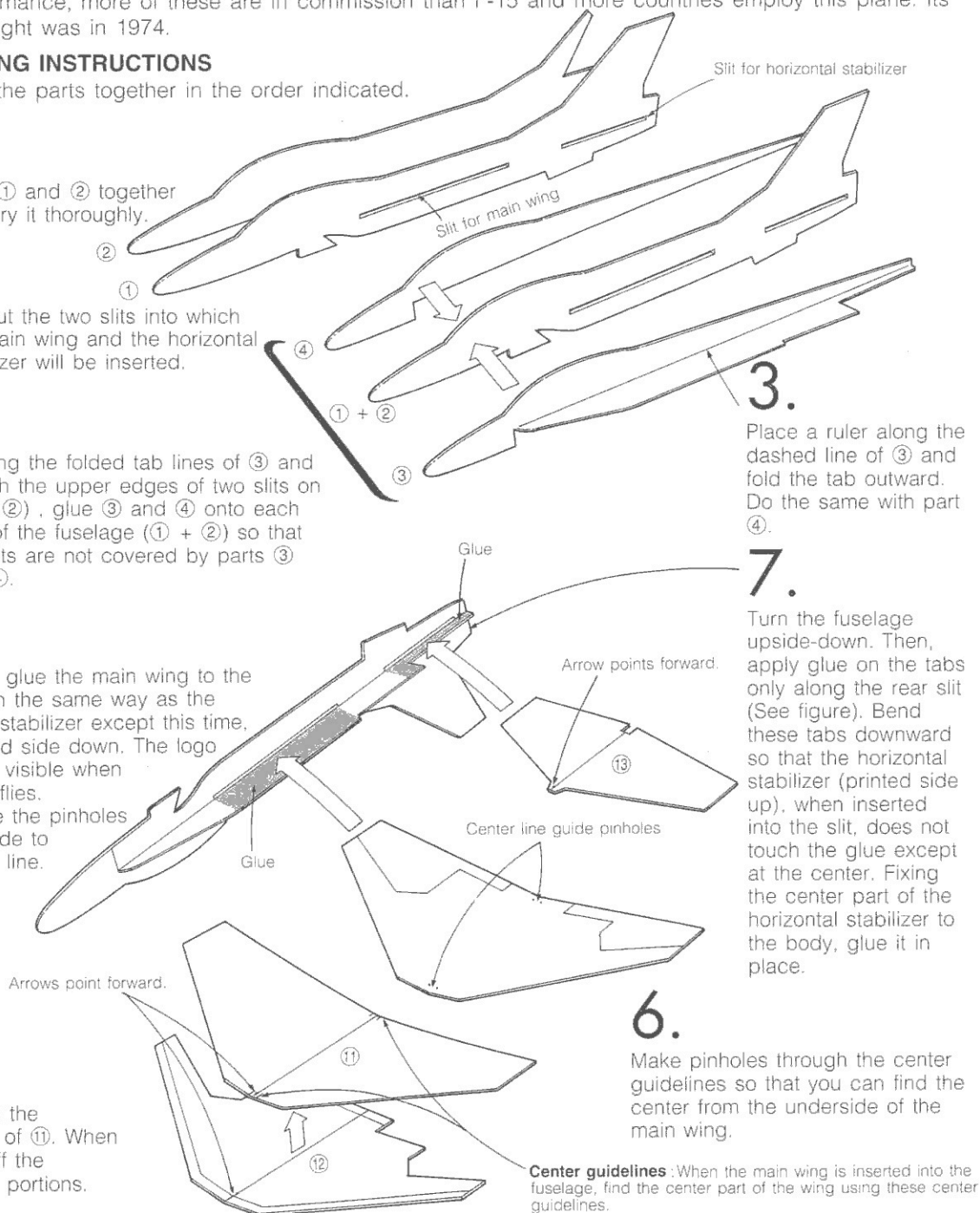
7.

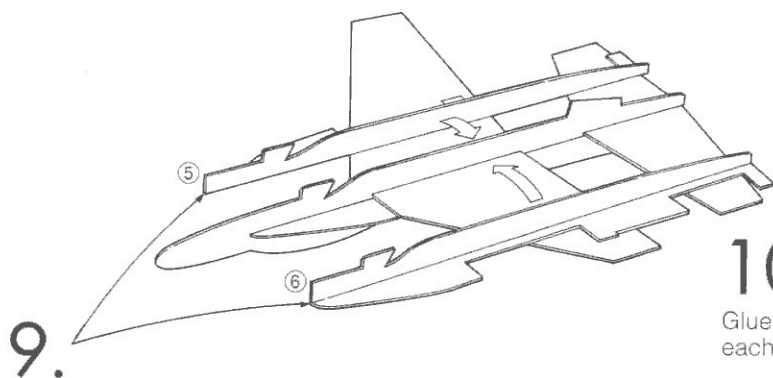
Turn the fuselage upside-down. Then, apply glue on the tabs only along the rear slit (See figure). Bend these tabs downward so that the horizontal stabilizer (printed side up), when inserted into the slit, does not touch the glue except at the center. Fixing the center part of the horizontal stabilizer to the body, glue it in place.

6.

Make pinholes through the center guidelines so that you can find the center from the underside of the main wing.

**Center guidelines:** When the main wing is inserted into the fuselage, find the center part of the wing using these center guidelines.



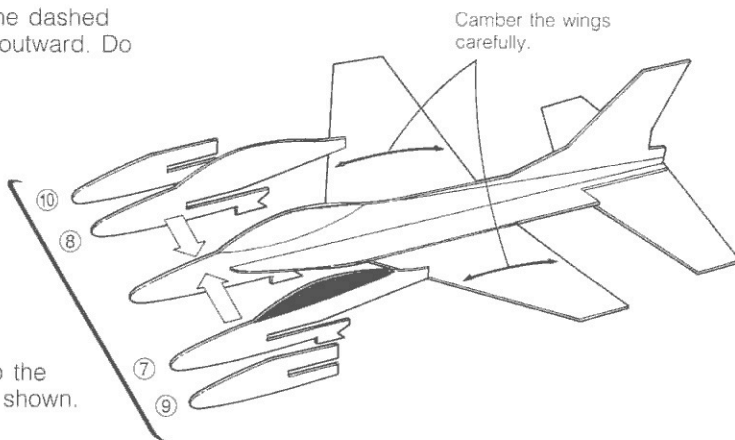


9.

Place a ruler along the dashed line of ⑤ and fold it outward. Do the same with ⑥.

10.

Glue ⑤ and ⑥ respectively to each side of the fuselage.



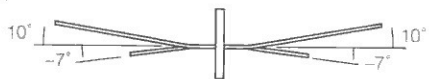
11.

Glue ⑦ through ⑩ to the fuselage in the order shown.

## FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.

12. Using a ruler, make the dihedral angle of  $10^\circ$  on the main wing at the end of the flat tab where it is not glued. Make a dihedral angle of minus  $7^\circ$  on the horizontal stabilizer in the same manner. Place the dihedral angle gauge on them to check that the dihedral angles have been properly made.



13. Camber the main wings slightly with your fingers.

14. **Bend both trailing edges of the horizontal stabilizer upward by approximately 1 – 2 mm (1/16"). Do not forget to do this, or the plane won't fly!**



15. View the plane from both the front and the back and straighten any warps or bends in the fuselage and wings.

## TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.
- If your plane tends to dive down or if it flies upside - down when going upward, the reason might be insufficient bending on the trailing edges of the horizontal stabilizer. Keep bending the part just a fraction more until you get a straight flight.

# WhiteWings

## Dessault MIRAGE 2000

### = Delta Wing Fighter =

Dessault in France had been improving Delta wing fighters repeatedly and succeeded in the first flight of MIRAGE III fighter in 1967. The most advantageous point of Delta wing plane is to be constructed lightly. Additionally, the activity in the Middle East War proved its maneuverability as a fighter. In MIRAGE 2000 (First Flight in 1978), the introduction of fly-by-wire system adds an improvement to the air-combat performance. The paper airplane of a Delta wing plane can be assembled lightly, also. The weight of this MIRAGE 2000 model is about 6g (0.2oz), two-thirds of other profile models. Generally, Delta wing plane has an excellent roll performance. In the case of a paper airplane, however, this advantage can be a reason to cause awkward flights. While learning the test flight instructions of Delta wing plane, make adjustments patiently so that you can fly the model of MIRAGE 2000 well.

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.

2.

Aligning the noses flush, glue ① through ⑥ together in the order shown.

4.

Spread glue on the tabs on the fuselage. Then, glue the fuselage to the main wing ⑦ inserting both the hook for the catapult and the rear projection into the slits. In order to glue the main wing accurately, draw the center line on the underside of the main wing and glue the main wing to the fuselage aligning the center line of the main wing with that of the fuselage. (Refer to [NOTE] on page 48.)

6.

Glue folded ⑧ to the underside of the main wing covering the rear projection of the fuselage.

1.

Fold the tabs outward.

3.

Cut out the two slits on the main wing ⑦. (Use a cutter.)

5.

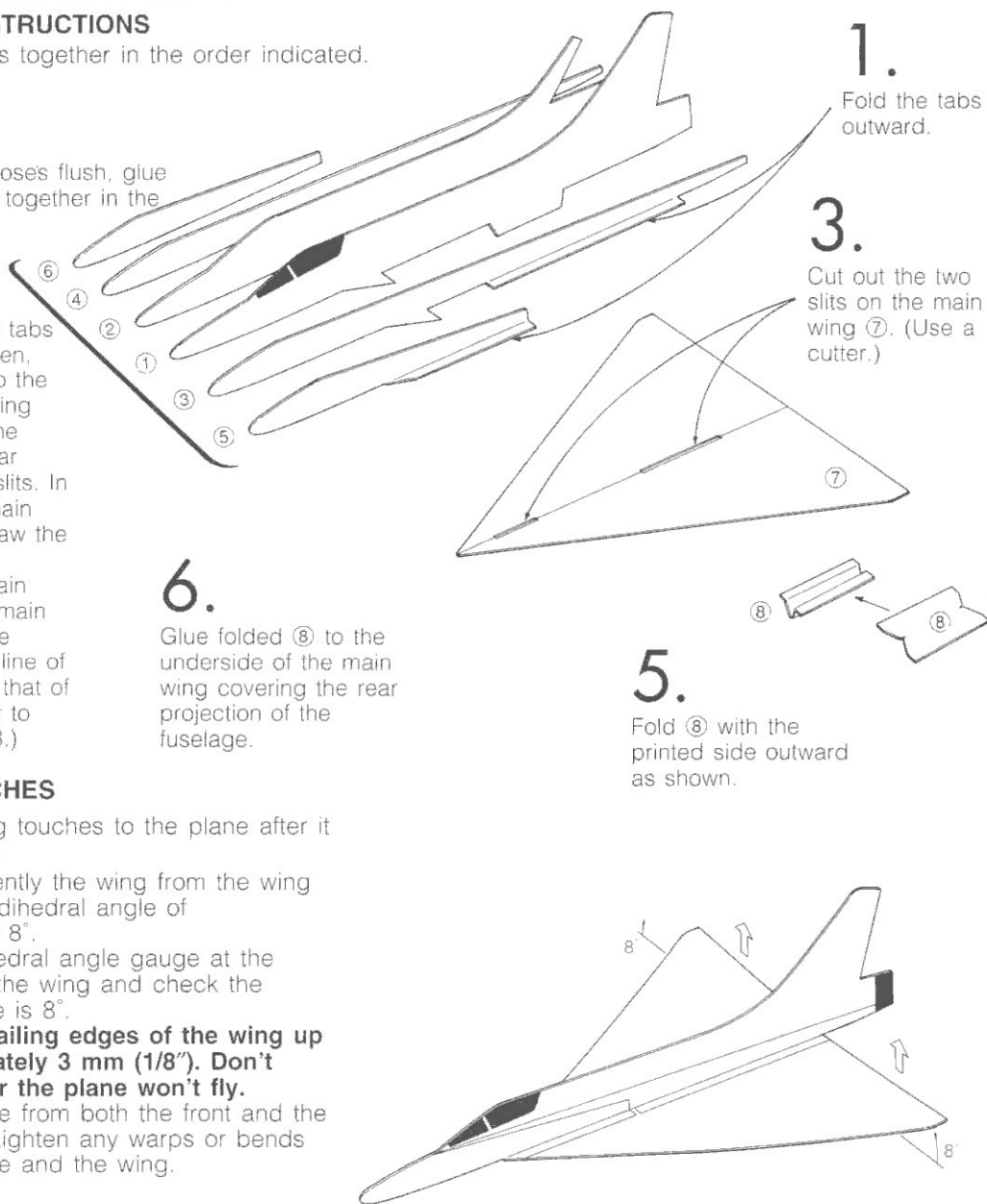
Fold ⑧ with the printed side outward as shown.

### FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.
- 7. Turning up gently the wing from the wing root, make a dihedral angle of approximately  $8^\circ$ . Place the dihedral angle gauge at the underside of the wing and check the dihedral angle is  $8^\circ$ .
- 8. **Bend both trailing edges of the wing up by approximately 3 mm ( $1/8''$ ). Don't forget this, or the plane won't fly.**
- 9. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the wing.

### TEST FLIGHT

- Test fly the plane according to the Test Flight instruction for Delta wing plane on page 13.



# WhiteWings

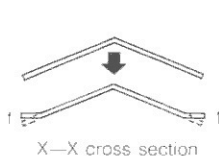
## Lockheed F-22

=Super-cruise Fighter=

F-22 was developed in accordance with the Advanced Tactical Fighter Project through which the U.S. Air Force tried to design a successor to its leading Fighter F-15. The prototype, YF-22 had its first flight in 1990. F-22 is the stealth plane which has an efficiency to enable a supersonic cruise that has never before been realized in war planes. Its mass production is expected in the late 1990's.

### GLUING INSTRUCTIONS

Glue the parts together in the order indicated.



5.

After the cockpit ⑩ dries thoroughly, press its fringe down carefully with your fingers. Refer to the figure of x-x cross section.

6.

Spread glue around the bottom edge of the cockpit ⑩. Apply it to the printed oval shape on the upper side of the wing ⑦. Press it down with your fingers for a few minutes until it dries.

2.

Aligning the noses flush, glue ① through ⑥ together in the order shown.

4.

Fold the "cockpit" ⑩ slightly inward along its center. (Use the short center line as a guide.) Swell the whole of the cockpit into a curve to complete its oval shape. Then, glue the tab as shown.

7.

Fold the tabs of the vertical stabilizer ⑧ and ⑨. Then, glue them to their gluing positions on the upper side of the wing ⑦.

1.

Fold all tabs outward.

3.

Glue the wing ⑦ to the fuselage aligning the center line of ⑦ with that of the fuselage.

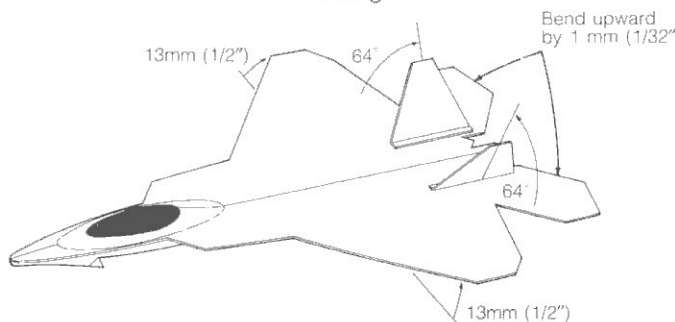
### FINISHING TOUCHES

- Give the finishing touches to the plane after it dries thoroughly.

8. Bend the right and left trailing edges of the main wing slightly upward 13 mm (1/2"). Refer to the figure.
9. Bend both trailing edges of the horizontal stabilizers upward by 1 mm (1/32"). Refer to the figure.
10. Tilt the two vertical stabilizers respectively outward (64°). Put the gauge between the vertical stabilizers to make sure of the angles.
11. View the plane from both the front and the back and straighten any warps or bends in the fuselage and the main wing.

### TEST FLIGHT

- Test fly the plane according to the Test Flight instructions for Regular Planes on pages 11 to 13.



## HOW TO ASSEMBLE THE MOST WINGS

Two of the racer type planes in this History of Jet Fighter Series have a high performance main wing featuring a uniform camber along the length of the wing. Because the shape of the central part of the wing resembles a so-called saddle shaped surface in math, I call this type of wing a MOST (Modified Saddle Type) wing. It is constructed as follows.

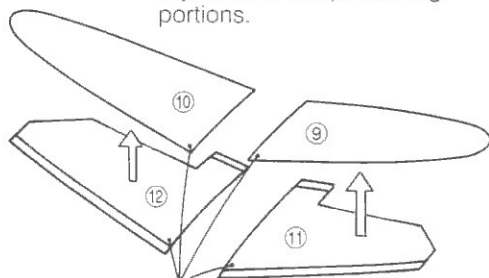
### CAUTION 1

The parts numbers used below are for the Racer 533. As the part numbers and dihedral angle may change according to the model, be careful when you use these instructions for other models.

### CAUTION 2

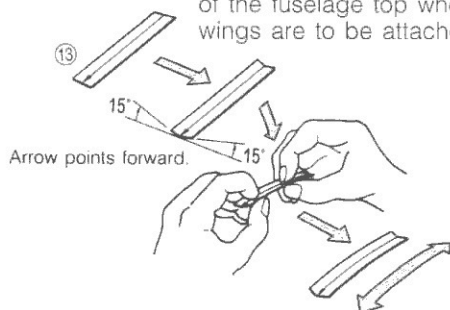
When constructing the Racer 534, start with step 0.

1. Glue parts ⑪ and ⑫ to the undersides of parts ⑨ and ⑩ respectively. When dry, cut off the protruding portions.



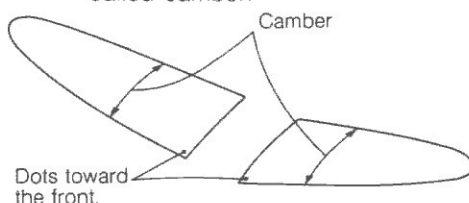
Dots toward the front.

2. Using a ruler along the center line, fold part ⑬ from the center line to make a 15° angle on both sides. Then curve it carefully with your fingers to fit the curved edge of the fuselage top where the main wings are to be attached.

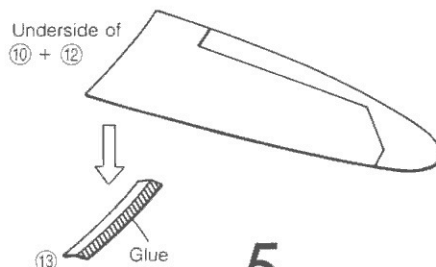


Arrow points forward.

3. Curve the main wings, ⑨ + ⑪ and ⑩ + ⑫ respectively, in the manner shown in the figure on page 9. This curve is called camber.



4. Apply glue on half of the underside of ⑬ and glue onto ⑩ + ⑫ (The arrow should point toward the dot.)



5.

In the same manner as in 4 attach ⑨ + ⑪ to the other side of ⑬

6.

Placing the dihedral angle gauge on the main wing check that the dihedral angle is 15°.

Glue

7.

Putting folded stands under the main wing will be conducive to fast and thorough drying.

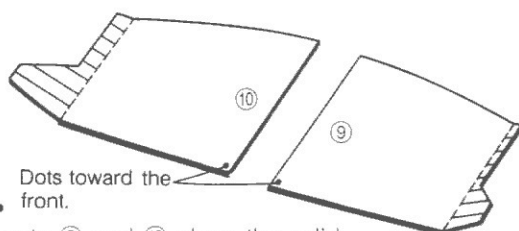


Folded paper stands

0.

Dots toward the front.

Cut parts ⑨ and ⑩ along the solid lines up to the dashed lines. Then placing a ruler along the dashed line, bend the resulting strips slightly upward.



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## DESIGNER'S PROFILE

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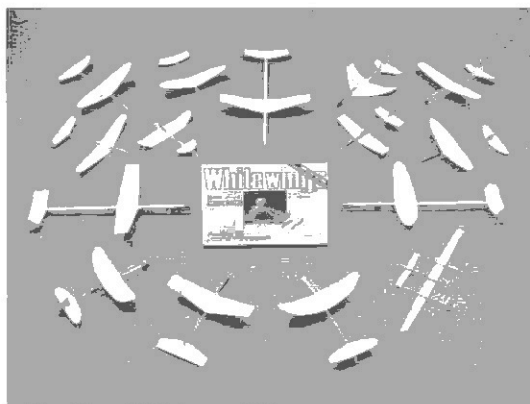
**Dr. Yasuaki Ninomiya**, born in 1926, has been fascinated by airplanes since early childhood, an interest which later developed into his present hobby and business of designing and building paper airplanes.

He received his doctorate in 1962 in the field of microwave measurement theory. He is recognized as a pioneer in microwave communications engineering from his work as a leading researcher at the Electrical Communications Laboratory of the Nippon Telegraph and Telephone Corporation from which he retired in 1984. At the invitation of the Iranian government, he served as principal advisor of the joint Japan-Iran Electronic Communications Research Center from 1975 to 1977. He is currently a member of the Japan Industrial Designer's Association and has been a member of the Good Design Committee of the Ministry of International Trade and Industry.

Drawing upon this distinguished background and expertise, Dr. Ninomiya designs aviationally sound and sleek, high performance paper planes based upon principles of industrial design and mechanical functionality. Convincing evidence of his talent is his garnering of the grand prizes in the Duration Flight and Distance Flight categories of the 1st International Paper Plane contest (Pacific Basin Division) in San Francisco in 1967. He later served as a judge in the 2nd Great International Paper Plane Contest, held in Seattle, Washington in May 1985.

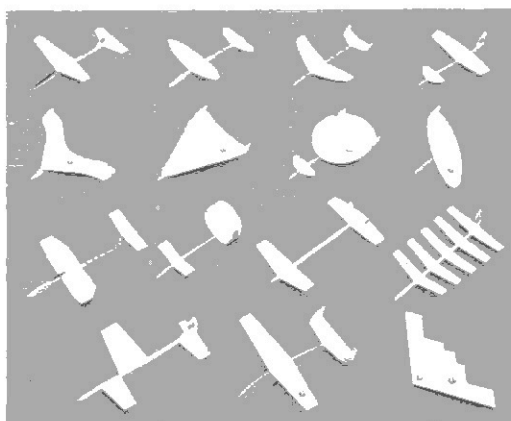
Dr. Ninomiya is widely recognized as a respected authority on paper planes. He has designed a wide variety of planes ranging from racer type models to profile models. He also holds a private plane operator's license and tries to get into the pilot's seat of his Cessna 182 whenever his busy schedule permits.





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