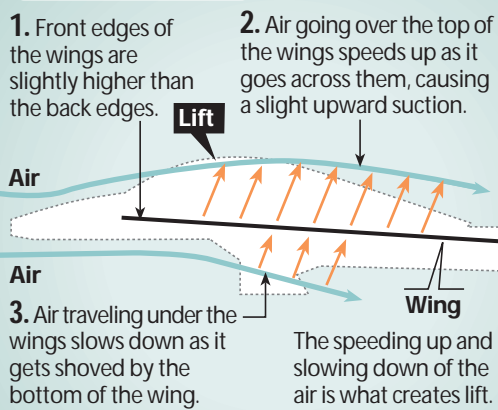


Aerodynamics of paper airplanes

Whether you have a cut-and-paste paper plane or a simple folded plane, there are four forces affecting its flight — lift, drag, weight and thrust.

1 LIFT
Lift is generated mostly by the wings of the plane as it moves through the air. In order for the plane to fly straight and level, it must generate enough lift to oppose its weight.

HOW LIFT WORKS



4 THRUST
To generate lift, the thrower must create enough thrust to help the plane overcome the drag and its own weight. Because paper planes don't have the constant thrust of an engine, drag slows the plane down until it can no longer generate enough lift to oppose its weight.

3 WEIGHT
If lift pulls harder than weight pulls down, the airplane begins to rise. If weight pulls harder, the plane falls.

STABILITY

There are two points on a plane that determine if it will be stable in flight:

Center of pressure is the point along the length of the plane where aerodynamic forces of lift are equal on either side.

Center of gravity is the point where the weight of the plane is equal on either side.

If the center of gravity is forward of the center of pressure, the tail elevators must be adjusted up to compensate.

The results: A center of gravity at or in front of the center of pressure will likely make for a stable flight. A center of gravity behind the center of pressure is more unstable.

The rudder helps the pilot turn the plane left or right (yaw).

2 DRAG

Air hitting the surfaces of the plane slows its forward motion. Drag is generated by every part of the plane and also by lift. Lift never pulls directly up, but rather tugs up and a little back, and that backward pull also contributes to drag.

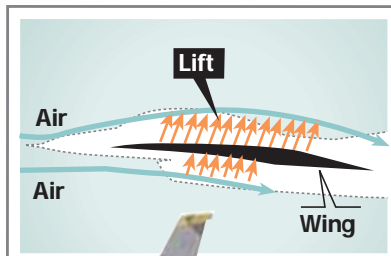
Elevators help the pilot change the plane's angle of attack and control whether the plane goes up or down (pitch).

Flaps are used in traditional airplanes to create extra lift during takeoff and landing. But they also can add extra drag.

Ailerons are used to turn the plane (roll) and keep it level.

Comparing it to the real thing

The F-16 Fighting Falcon uses many of the same techniques to fly as the paper airplane, but with a few exceptions. Real jet wings have more mass and the top has a slightly curved shape to create more lift.



1. Extra lift is also created by a set of flaperons on the wings' trailing edge. They maintain lift at high angles of attack.



2. Drag also can be increased by the moving flaps, which slow down the plane for landing.



3. Weight (42,500 lbs.) and center of gravity can change after a missile is launched or fuel is spent, so the pilot or plane must constantly adjust the controls to keep it balanced.



4. Thrust compensates for the weight through a turbofan engine with afterburner capable of producing speeds of up to 1,500 mph.

Flying tips

Based on the forces of lift, drag, weight and thrust, here are some suggestions to help your airplane make a turn or fly on a straight path:

PROBLEM: Too much rapid lift causing a stall.

PROBLEM: Twisting motion.

PROBLEM: Too little lift causing a plunge.

Maneuver

LEFT TURN: Bend the back edge of the right main wing (aileron) down, and bend the back edge of the rudder to the left.

To correct a bad flight path

SOLUTION: Bend down the rear edge of the tail wings (elevators) to create more drag.

SOLUTION: Make sure the body and wings of the plane are not twisted.

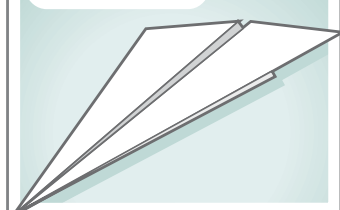
SOLUTION: Bend up the rear edge of the tail wings (elevators) to create more lift.

Build your own Air Force

You can perform your own aerodynamic experiments using easy-to-build paper airplanes. Cut-and-paste planes, such as the one on this page, are designed to look like real airplanes. The weight of the plane is distributed for optimal aerodynamic stability. Traditional paper airplanes, such as the classic dart, differ in that they don't have a tail and only require folding. Yet they follow the same aerodynamic rules that all airplanes do.

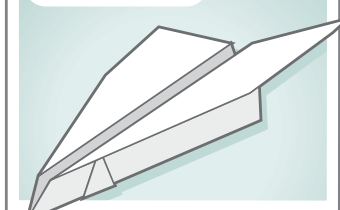
CUT-AND-PASTE F-16

CLASSIC DART



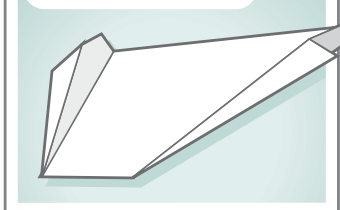
Usually flown by bored people in offices, lectures and classrooms the world over. Seven folds and throw — there isn't anything difficult in making this plane.

FAST FLYER



Shorter than the classic dart and a little harder to make, with a total of 12 folds. Glides smooth and far. This flyer looks more complicated than it is.

GLIDING WING



Nice, wide plane with an unusual triangular fold on the bottom that requires a tucking step. The gliding wing lacks a central crease but glides smooth and far.

Models online

Print the patterns to build these planes and more in our online Paper Airplane Garage. Pick your own color schemes and design at sun-sentinel.com/theedge

