

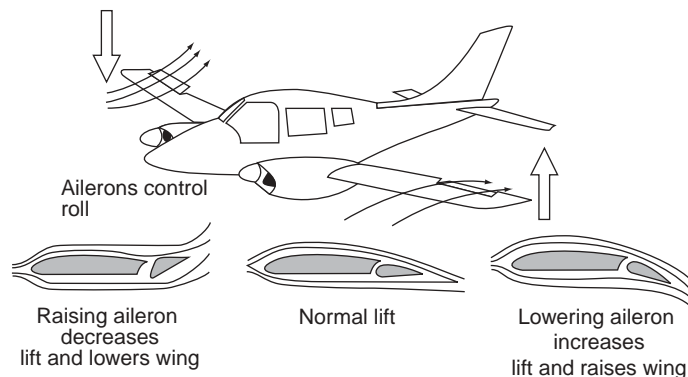
G l o s s a r y



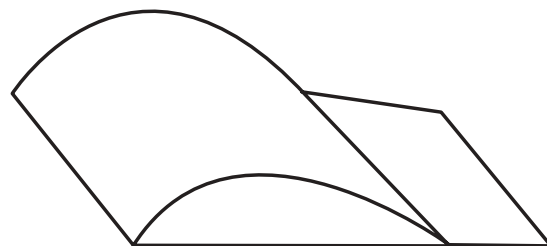
Aeroelastic Divergence: Aeroelasticity is the science that studies forces causing structural bending and flexing of aircraft components such as wings. When a forward-swept wing produces lift, structural bending causes the forward edge of the wing to increase incidence (it bends upward). This in turn further increases the aerodynamic lift until at some speed (or value of lift) the aerodynamic forces overcome the structural restoring forces of the wing. This is called aeroelastic divergence and causes the wing to bend up until it breaks.

Afterburner: On some jet engines, a tailpipe section aft of the turbine where additional thrust is produced. Afterburner operation is not continuous but can be selected by the pilot, normally by moving the throttle lever forward through a detent to the afterburner position. Additional fuel is then injected into the hot exhaust gases and combustion significantly increases the thrust compared to that of the basic engine. Unfortunately, fuel consumption is even further increased. Also “reheat” [UK], “augmented thrust,” or “max thrust.”

Aileron: A movable section on a wing used for controlling the roll attitude of the airplane. Ailerons are normally located on the outboard trailing edges of each wing and are interconnected so as to move in opposite directions. Downward aileron movement on one wing increases that wing’s lift while a corresponding upward aileron movement on the opposite wing decreases lift; the unbalanced forces cause a roll towards the wing with upward aileron deflection. Ailerons are controlled by the pilot’s control stick or wheel, which is moved in the direction of desired roll. (From “aleron,” French for “wing tip.”)

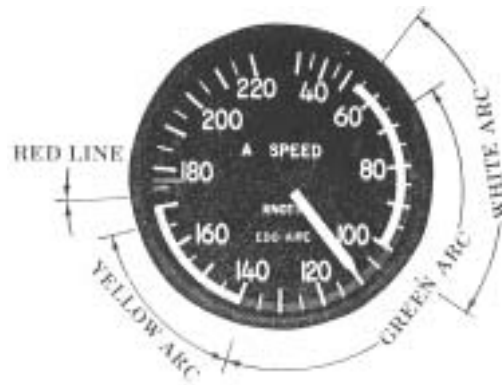


Airfoil: A solid surface designed to move through air and obtain a useful force called lift. Examples are wings, sails, propeller blades, and helicopter rotor blades. In the study of aerodynamics, “airfoil” usually refers to the cross-sectional shape obtained by the intersection of the wing with a perpendicular plane.

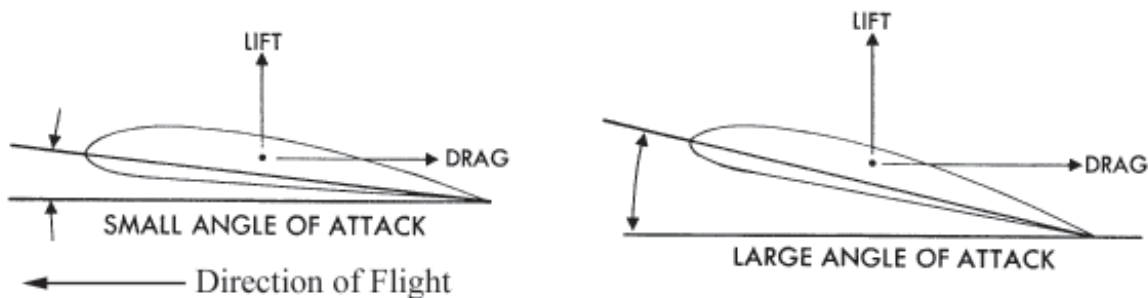


Airspeed: The speed of an airplane relative to the surrounding air (“groundspeed” would be the airplane’s speed relative to the ground; the two would be equal in the absence of wind). Airspeed is usually measured by a “Pitot-static system,” which reacts to air pressure caused by movement of the airplane through the air.

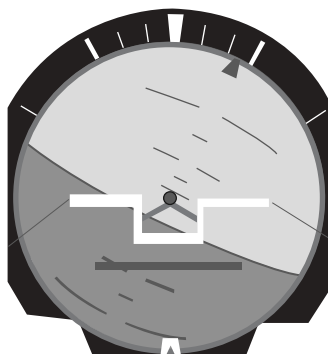
Airspeed Indicator: An instrument in the pilot’s cockpit giving continuous indication of airspeed. Usually, airspeed indicators show the speed in units of knots (1 knot = 1 nautical mile per hour where 1 nm = 6000 feet). However, many of the smaller airplanes have airspeed indicators calibrated in mph (1 mph = 1 statute mile per hour where 1 sm = 5280 feet).



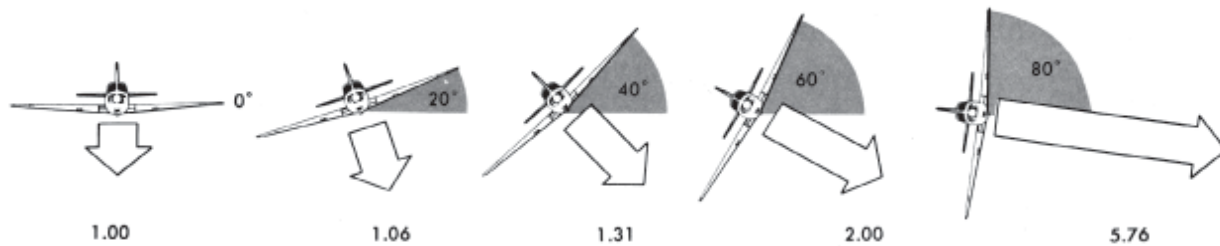
Angle-of-Attack (AOA, alpha, α): The angle of incidence of the airplane’s wing (or other reference) with the airflow direction. The airflow direction relative to the airplane is often termed the “relative wind.”



Attitude: An airplane’s pitch, roll, and/or yaw angle relative to the Earth’s horizon or another reference. Attitude is displayed to the pilot on an instrument called an “attitude indicator.”



Bank Angle: Airplane's angle of bank relative to the Earth's horizon (see **roll**).



Bleed Air: Air under pressure that is bled from a jet engine for purposes other than producing thrust. These uses include cockpit or cabin pressurization and air conditioning or, in the case of the Harrier, air to power the “puffer jet” reaction control system.

Canard: A horizontal control surface mounted in front of the wing. Also, “foreplane.”

Control (or Command) Augmentation System (CAS): An electrical circuit between the pilot's controller (stick, wheel, sidestick) and the control surface, which essentially boosts the pilot's initial control force and makes flying the airplane easier and more precise; “power steering.” Sensors in the CAS circuit provide feedback signals (typically load factor, pitch rate, or roll rate) to a computer, which compares them to the pilot command signal to make the airplane respond as desired. In this manner, aircraft response is consistent over most of the flight envelope, and unwanted motions are heavily damped.

Center of Gravity (CG, c.g.): Point through which the force of gravity acts and about which the airplane is balanced. An airplane's longitudinal, lateral, and vertical axes intersect at the c.g. The location of the c.g. is normally given in inches from a datum or expressed in terms of the wing's mean aerodynamic chord (%MAC).

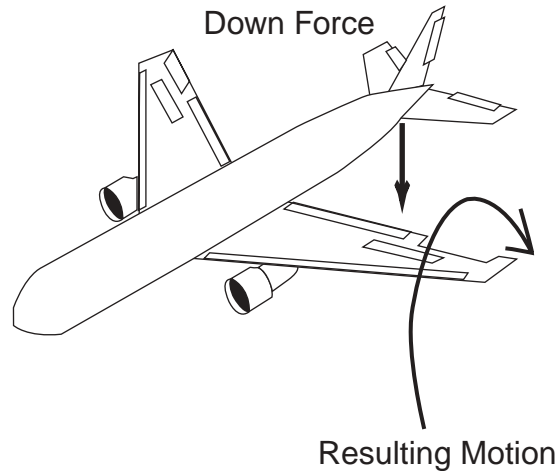
Compressibility: Phenomenon of air moving over a curved aircraft surface at speeds close to local sonic speed, where air can no longer be considered as incompressible (as it is assumed to be for most subsonic aerodynamics applications). Effects include the appearance of shockwaves, rapid increase in drag, rearward shift of the lift forces, and, for improperly designed aircraft, stability and control problems.

Control Laws: The sequence of calculations an electronic flight control system uses to control aircraft response to pilot inputs and external disturbances such as wind gusts.

Damper: An electrical circuit in a flight control system that senses uncommanded motion and moves a control surface to stop unwanted oscillations. Typically, pitch, roll, and/or yaw dampers are used. (See **Stability Augmentation System**.)



Drag: Retarding force acting upon an airplane parallel to the direction of motion. “Parasite drag” is caused by the friction of the air moving over the airplane. The other basic type of drag is related to the wing’s production of lift and is called “induced drag.” Induced drag is affected by the wing’s shape, the angle at which the air strikes the wing, and the speed and density of the airflow.

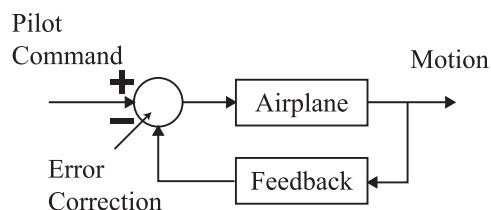


Dynamic Stability: An airplane’s response over time to a disturbance from the trim condition (a state of equilibrium). The response may diverge from the trim condition, converge back to trim, or oscillate about trim. An oscillatory response may continue to increase in amplitude, stay about the same, or decrease in amplitude (“damp out”).

Elevator: A movable control surface hinged to the trailing edge of a horizontal stabilizer that is connected to the pilot’s controls (stick, wheel, sidestick). Aft motion of the pilot’s control causes the elevator to deflect and produce a nose-up pitch response; forward control motion causes a nose-down pitch response.

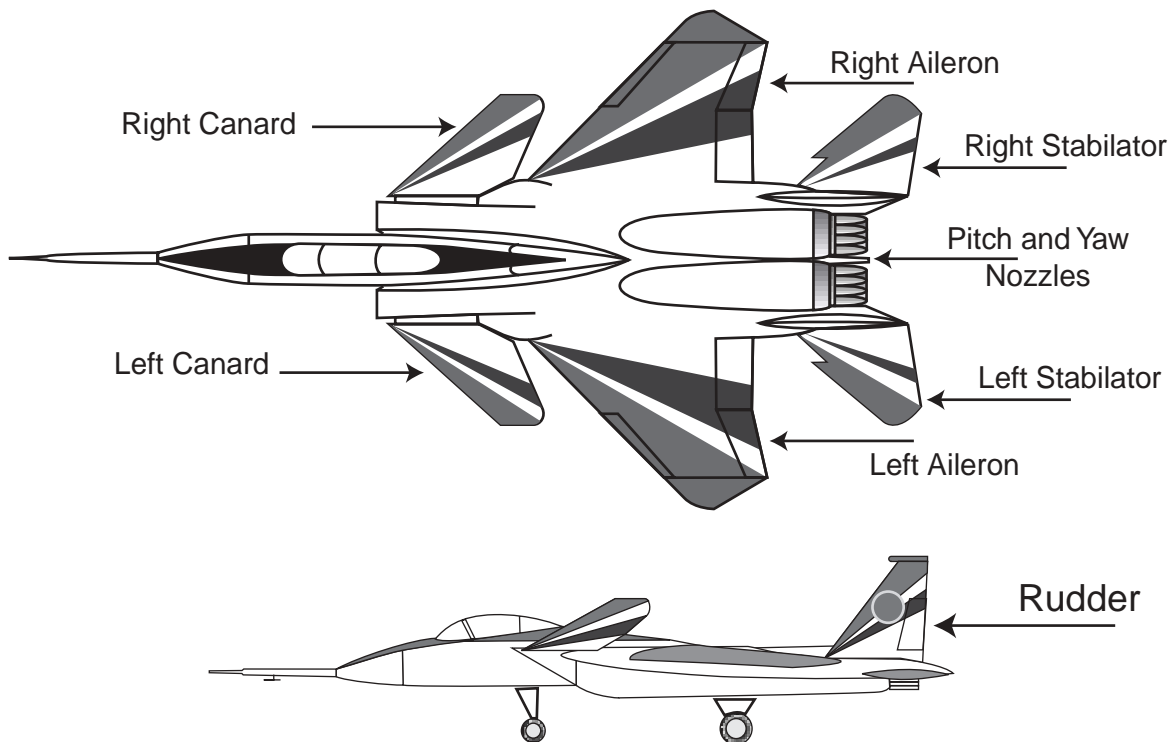
Elevons: A hinged control surface on the trailing edge of a wing that is connected to the pilot’s controls combining the functions of elevators and ailerons. Elevons are often used on delta-wing aircraft.

Feedback Control System: Circuit of a flight control system that regulates aircraft response through feedback compensation techniques. The pilot’s control input becomes the system’s command; resultant aircraft motions are measured, transformed into electrical signals, and then conditioned and amplified for summing with the input command. This forms a closed loop, illustrated below. The error between the output and input signal becomes an electrical command to the flight control surfaces until output equals input.

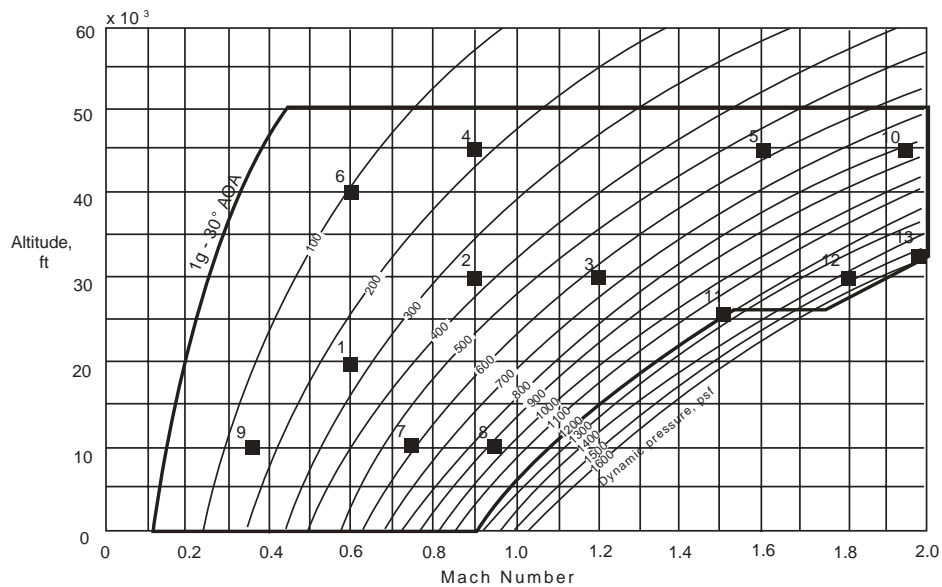


Flight Controls: Devices the pilot uses to steer and control the trajectory of an airplane; also refers to the external surfaces responding to the pilot’s flight control movements or inputs. The pilot’s controls, the external surfaces, and all mechanical and electrical linkages, computers, and sensors in between make up the flight control system. Pilot’s controls usually include a center stick, control wheel, or sidestick; flap lever; speed brake handle or actuation button; and nozzle angle position lever in the case of the Harrier.

Flight Control Surfaces (or Effectors): The external surfaces that respond to pilot inputs to control the airplane’s trajectory. Primary surfaces produce direct response in pitch, roll, and yaw. These include elevators, stabilators, canards, elevons, tailerons, ailerons, rudders, and thrust vectoring nozzles. Secondary flight control surfaces augment the primary surfaces by modifying the lift and drag characteristics of the wings and airplane. These include wing flaps (usually on the trailing edge but sometimes used on the leading edge), wing slats, spoilers, and speed brakes (UK = “air brakes”). The recent terminology for primary flight controls is “flight control effectors,” as the effector may not be a conventional control surface. For example, NASA’s F-15 ACTIVE research aircraft is said to have nine flight control *effectors*: left and right canards, left and right ailerons, rudder (the two rudders move together and are treated as one effector), left and right stabilators, and pitch or yaw TV (thrust vectoring).



Flight Envelope: The boundaries of speed, Mach, altitude, load factor, and angle-of-attack within which a particular airplane design can sustain flight. A typical flight envelope is presented as a two-dimensional plot with altitude on the y-axis and speed/Mach on the x-axis.



ACTIVE envelope

Fly-By-Wire: The generally accepted terminology when the pilot’s control commands are processed by a computer and sent to the flight control surface actuators with electrical signals (or fiber-optic signals, sometimes called “fly-by-light”) rather than mechanical linkage. NOTE: “power-by-wire” is a recent term for flight control surface actuators that are electrically powered, as opposed to the conventional hydraulic-powered actuator.

g Loading (load factor, g, n, Nz): The increase in apparent weight of the pilot and aircraft when an airplane is maneuvered in flight, caused by inertia forces. Load factors are measured in reference to the vertical (Z) axis by accelerometers and expressed in “g” units. In level flight with no turning, the load factor is at 1g and the load on the structure is equal to the weight of the structure. If the aircraft turns or pulls up at 2 gs, the load on the structure and pilot is twice their weight. Since wing lift must be increased to effect a turn or other maneuver, it can be shown that the load factor equals the ratio of lift to weight: $n = L/W$.

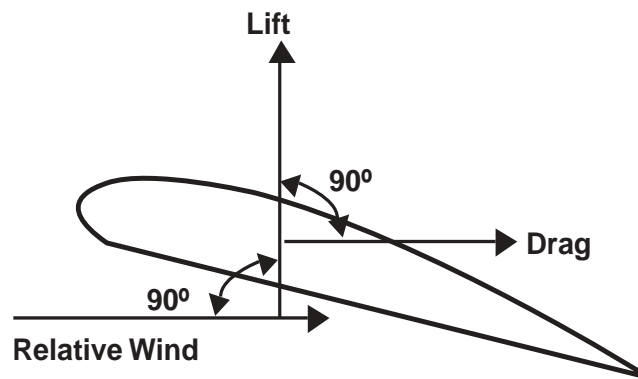
Head-Up Display or Heads-Up Display

To improve flight safety and reduce pilot workload in high-performance aircraft, critical parameters such as aircraft attitude, altitude, airspeed, and navigation information are viewed directly by the pilot via a plasma display embedded into the windshield or canopy of the aircraft. This reduces the need for the pilot to divert his attention to the instrument panel inside the cockpit, especially for those parameters he views directly on the windshield.



Horizontal Stabilizer: A horizontal airfoil at the rear of an airplane providing stability in pitch. The stabilizer may be fixed or have a small angular adjustment for trim only. Elevators may be mounted on the back. In some designs, especially supersonic airplanes, the entire stabilizer is pivoted and moves for pitch control. Also, tailplane.

Lift: The useful force produced by a wing as air flows over it. Air travels faster over the curved upper surface than along the bottom, which creates lower pressure on the top and higher pressure on the bottom. The pressure differential creates a “vacuum” suction on the upper surface, tending to lift the wing. The pressure differential can be represented by a single force acting at a location called the “center of pressure” and perpendicular to the relative wind. The amount of lift is affected by the shape of the wing, the angle at which the wind strikes the wing, and the speed and density of the airflow.



Mach Number: Ratio of aircraft’s airspeed to the speed of sound: $M = V/a$ where V is true airspeed and a is the speed of sound which varies with air temperature. At Mach 2, an aircraft is traveling at twice the speed of sound. The term is named after Ernst Mach (1838-1916), an Austrian physicist.

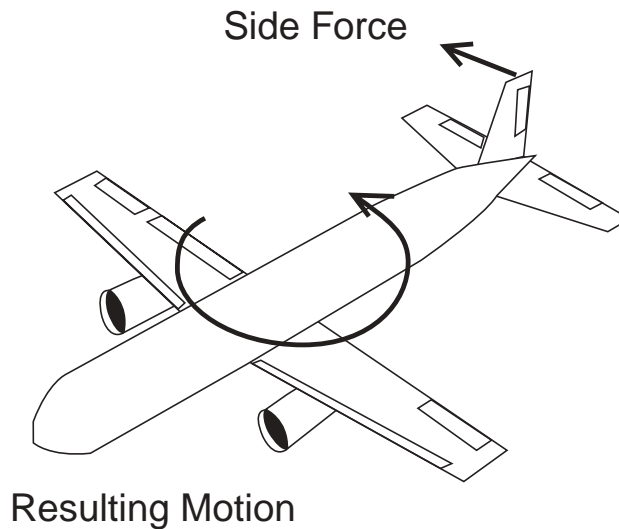
Maneuverability: The ability of an aircraft, as commanded by its pilot, to change trajectory. A pilot must be able to hold an airplane in a maneuver, and the designer has to provide adequate flight control effectors appropriate to the role of the aircraft. Maneuverability is opposed by stability; that is, the less stable an airplane, the more maneuverable it is. However, some degree of stability is required in order for the pilot to maintain the desired trajectory.



Nozzles: The aft section of a jet engine tailpipe through which the exhaust gases escape. Usually, the nozzle is designed with interleaved metal sections (nozzle leaves), which allow the nozzle exit area to be varied. If the nozzle exit area is decreased, the exhaust velocity is increased by the relationship $V_2 = (A_1/A_2) V_1$. A nozzle controller continuously varies the exit area to provide optimum exhaust gas velocity and internal tail pipe temperature. Recent nozzle design provides the ability to vary the nozzle and exhaust gas angular direction to provide thrust vectoring.



Pitch, Pitch Attitude: Angular rotation about the airplane’s lateral (Y) axis, usually termed “nose up” or “nose down.” The angle between the airplane’s longitudinal (X) axis and the Earth’s horizon is called pitch attitude. Pitch is produced by the elevators (or canards, or pitch thrust vectoring).

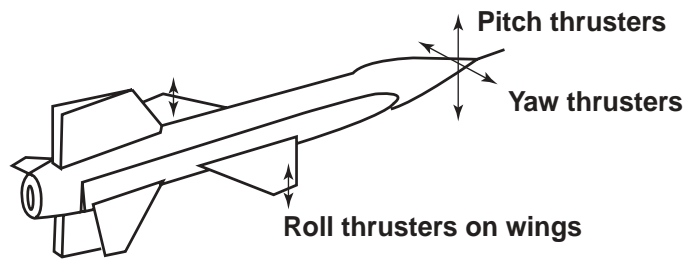


Positive Static Stability: The level of static stability of an airplane is determined by the relationship or location of the aerodynamic center of pressure (ac) with respect to the airplane’s center of gravity (cg). Typically the more forward the center of gravity from the aerodynamic center, the more positive static stability an airplane will have. This means that following application and removal of a disturbance, the airplane will return to its initial undisturbed equilibrium position relatively quickly.

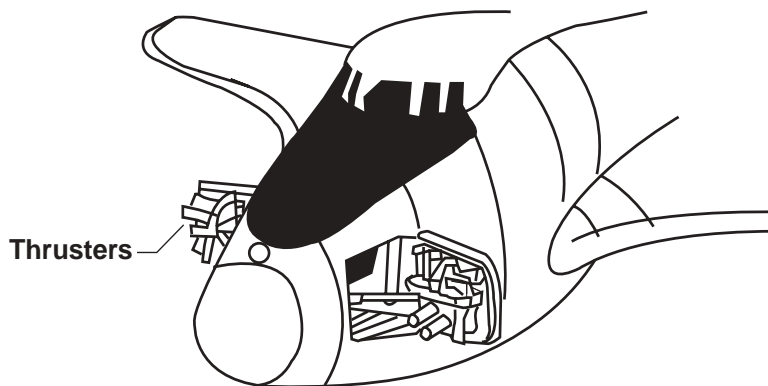


Quadraplex: To provide security in the event of certain critical complex airplane system failures, such as a flight control computer, four (*quadraplex*) computers are utilized to perform similar simultaneous functions. Each computer checks on the others to verify that they all agree by comparing output commands. If one computer or system command output is found to differ, it can then be deactivated or ignored and the others will continue their normal function, thus avoiding the possibility of a catastrophic situation.

Reaction Control System: In the absence of atmospheric aerodynamic pressure acting on a space plane's control surfaces (elevator, ailerons, or rudder), to change its attitude or position with respect to another object, such as the Earth, another means must be employed. Such a system must be utilized in space where no aerodynamic force can be produced. In the vacuum of space, small on/off rocket motors (thrusters) must be used by a spacecraft to produce the force to change vehicle attitude or position. The jet thrust of small reaction engines (thrusters) is developed by ejecting a substance, such as a stream of gases, from burned fuel (see diagram below). This type of *reaction control system* (RCS) is controlled by a pilot or computer and is usually either on or off; variable levels of thrust are usually not available. The density of the atmosphere decreases as a function of altitude. Approximately 50 percent of the Earth's atmosphere is below 18,000 feet (5,486 m). As altitude increases the number of molecules or mass per unit volume



(a) X-15 reaction controls



(b) Space Shuttle reaction controls

Examples of reaction controls



decreases, resulting in a decrease in atmospheric pressure. As altitude increases, aerodynamic pressure on aircraft control surfaces decreases to a point where reaction control thrusters must be blended with aerodynamic control to maintain adequate control. As altitude increases further, aerodynamic controls must be phased out and reaction controls phased in. Once out of the atmosphere, reaction control thrusters are then the sole means of orienting or maneuvering the vehicle. In the return to Earth, the control system must phase out the thrusters and phase in aerodynamic control.

Relaxed Static Stability: As the location of the center of gravity (c.g.) with respect to the airplane's aerodynamic center of pressure (a.c.) is decreased, as the case when the c.g. is allowed to move aft, the airplane's static stability will be *relaxed* or decreased. This means that following application and removal of a disturbance, the airplane will return to its initial undisturbed equilibrium position less quickly. If the c.g. is allowed to move aft of the a.c., the airplane will become unstable (*negative static stability*). This is the situation in which, when disturbed from a condition of equilibrium by some force, the airplane will not return to its initial undisturbed position or attitude following removal of the disturbance force, but will continue to diverge from that position.

Roll, Roll Attitude, Bank Angle: Angular rotation about the airplane's longitudinal (X) axis, usually called "right/left roll" or "right/left bank." The angle between the aircraft's vertical (Z) axis and the Earth's vertical is the roll attitude or bank angle. Roll is produced by the ailerons (or spoilers, tailerons, or elevons).

Roll Coupling: "Coupling" is what happens when a motion about one axis causes a motion about another axis. Roll coupling is a divergence in pitch or yaw during rolling maneuvers. It is caused by a complicated interaction of inertial and aerodynamic properties and can lead to loss of control or structural failure. Many high-performance aircraft with fly-by-wire flight control systems incorporate a roll rate limiter to avoid roll coupling.

Rudder: A movable flight control surface hinged to the back of the vertical stabilizer, providing yaw control. The rudder is connected to a set of pedals operated by the pilot's feet; the right pedal moves (yaws) the nose to the right, and left pedal moves the nose left. This yawing motion pivots the airplane about the vertical (Z) axis. Since the directional stability of an airplane is necessarily very high, full rudder deflection normally produces small angular displacements compared to pitch or roll capability, perhaps 15° or less yaw angle at normal cruise speed.

Shockwave: The air pressure waves ahead of a supersonic airplane bunch, because the speed of propagation of the pressure waves is finite (the speed of sound), and form a surface of discontinuity where the flow changes from subsonic to supersonic. The shockwave forms a three-dimensional conical surface, sometimes called a Mach cone. Shockwaves cause a change in the airflow pressure patterns around an aircraft. This will ultimately change its maneuverability, stability, and control characteristics.



Sideslip: When an airplane is not flying straight but has an angle between the fuselage and the direction of motion (flight path, or relative wind), it is said to be in a “sideslip.” This causes additional drag.

Spin: A dangerous maneuver in which the aircraft has stalled and entered a sustained yawing rotation about the vertical axis and a near vertical descent.

Spoiler: A small control surface on the top of a wing that decreases (spoils) the wing’s lift by deflecting the airflow over the wing. This drag is used to augment roll control when spoilers on one wing only (the down-going wing) deflect or to provide quick airspeed reduction when spoilers on both wings deflect. The latter function is called a speed brake (UK: “air brake”), which the pilot controls by a speed brake extension lever. These may also be extended after landing to aid deceleration and reduce landing distance.

Stability: The property of a body, as an aircraft or rocket, to maintain its attitude or to resist displacement, and if displaced, to develop forces and moments tending to restore the original condition.

Stability Augmentation System (SAS): An auxiliary system to the basic manual vehicle control system, whereby response of the control surfaces to inputs by the pilot can be adjusted to give a preselected vehicle response by selection of certain fixed gains in a standard feedback loop on control-surface output.

Stabilator: Single-piece horizontal tail control surface used as primary pitch control, especially on supersonic aircraft where shockwaves might reduce the effectiveness of an elevator type control. Also “stab” and “slab.”

Static Stability: The tendency of an airplane (or body), when disturbed from a undisturbed position or attitude, following removal of the disturbance force. Airplanes possess a delicate and important balance between aerodynamic and gravitational forces. A more stable airplane is more difficult to move using controls, so if ease of maneuverability is desired, then decreasing or relaxing its stability will achieve this objective.

Stall: A flight condition that occurs when the angle-of-attack becomes so high that the air flowing over the top of the wing no longer flows smoothly, but breaks away (stalls), causing a rapid loss of lift. The associated angle-of-attack is called the “stall angle-of-attack” and is always the same angle for a given wing shape.

Stick: A control *stick* is a pilot cockpit control and is a primary flight control device (a control wheel may also be used in larger airplanes). A pull or push on the stick controls the airplane pitch attitude. Push results in nose down and pull results in nose up. Left stick or wheel deflection rolls the airplane left, and right stick rolls to the right.

Swept Wing: The term for wings that are inclined towards the back of the airplane. Also called sweepback, and the angle between the longitudinal axis and the wing leading edge (or other reference such as the quarter-chord line) is the “sweepback angle.”



Taileron: A stabilator design where the left and right halves can move in unison for pitch control or differentially to produce roll; may produce both pitch and roll simultaneously. Also, differential tail.

Tricycle Landing Gear: Landing gear, or wheels of an airplane, consisting of two main wheels and a nose wheel that provide support for the airplane while on the ground.

Thrust: The pushing or pulling force of an aircraft engine that gives it the forward motion through the air to create lift. In a jet engine, air flows in through the front of the engine and is mixed with fuel and compressed. A spark plug makes the fuel mixture burn, expand, and rush out through the exhaust nozzle at the back of the engine to make the airplane go forward.

Thrust Reverse (Reverse Thrust): The simplest and most general use of thrust vectoring is *reverse thrust*. This is typically used on large jet airliners to a stop in short distances. Propeller blades may also be reversed on some airplanes to achieve the same objective. Reverse thrust engines are equipped with a mechanism that turns the normal rearward thrust force 180° to a near-forward direction.

Thrust Vectoring: Thrust is a force and as such has both magnitude and direction, which makes it a *vector* quantity. Normally, the thrust of an airplane cannot be changed except by turning the vehicle. If, however, some mechanism is provided to turn, deflect, or rotate an airplane's thrust vector, with respect to the vehicle, it is capable of *thrust vectoring*. This type of system is used to enhance maneuvering.

Trim: That state of airplane flight where all forces and moments are in balance and little, if any, control is required to maintain the condition.

Triplex: Similar to a quadraplex system except the number of complex systems is only three (triplex) rather than four.

Variable Geometry: Some highly specialized airplanes such as the B-1, F-111, and F-14 have the ability to change wing sweep in flight. These are referred to as variable geometry airplanes due to their ability to change shape as flight conditions dictate. Typically they have low sweep (wing forward) at low speed and high sweep (wing aft) at high speed.

Variable Stability: Some experimental airplanes have complex computer systems installed so that their stability and or flight characteristics can be artificially altered in flight based on some predetermined plan. These systems allow the simulation of increased or reduced (*variable*) stability or duplicating the flight characteristics of other airplanes for study or pilot familiarization purposes.

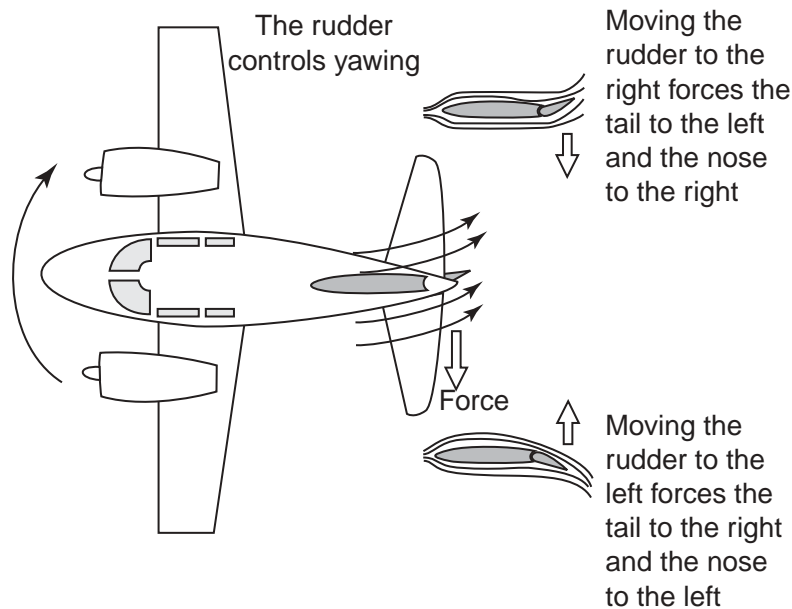
Vertical Fin (Vertical Stabilizer): A fixed vertical airfoil surface usually at the rear of an airplane that provides directional stability. Rudder controls are hinged to the back of the vertical stabilizer. In some supersonic designs, the entire vertical stabilizer can move, similar to a horizontal stabilator. Also, "fin."



Wing: The airfoil surface that produces the main source of lift for an airplane. The front of a wing is termed the leading edge while the back is called the trailing edge. The intersection of the wing and fuselage is called the wing root.

Wing Warping: During the development of the airplane the Wright brothers determined that the ability to control or steer an airplane was as important as the wing's ability to generate lift. The construction of the first airplanes was of wood, wire, and linen fabric. The Wright brothers determined that if they pulled down and twisted (warped) the outboard trailing edge of a wing, the airplane would roll or bank in the opposite direction. That is, the right wing trailing edge down the airplane would roll left, and vice versa. This method literally distorted or warped the wing (hence the term wing warping). Without the ability to bank an airplane, it is virtually impossible to accomplish a turn. Modern airplanes use ailerons to accomplish banked turns and roll maneuvering, and the wings cannot typically be warped.

Yaw: Angular rotation about an airplane's vertical (Z) axis. Yaw is produced by the rudder. Undesired yaw may also be produced by the use of ailerons or other roll controls for banking. This is called "adverse yaw" if the nose moves opposite the direction of roll and "proverse yaw" when the nose moves in the same direction. This undesired yaw is an example of coupling (motion about one axis causing motion about another axis) and is due to the lift vectors of the up-going and down-going wing being inclined at different angles during a roll. Therefore, a pilot of a conventional airplane must often use the rudder simultaneously with the ailerons to prevent undesired yaw. This is often termed coordinating a turn.



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<http://www.wff.nasa.gov/~WVC/ERC.htm>

Regional Educator Resource Centers offer more educators access to NASA educational materials. NASA has formed partnerships with universities, museums, and other educational institutions to serve as regional ERCs in many states. A complete list of regional ERCs is available through CORE, or electronically via NASA Spacelink at <http://spacelink.nasa.gov/ercn>.

NASA's Education Home Page serves as the education portal for information regarding educational programs and services offered by NASA for the American education community. This high-level directory of information provides specific details and points of contact for all of NASA's educational efforts, Field Center offices, and points of presence within each state. Visit this resource at the following address: <http://education.nasa.gov>.

NASA Spacelink is one of NASA's electronic resources specifically developed for the educational community. Spacelink serves as an electronic library to NASA's educational and scientific resources, with hundreds of subject areas arranged in a manner familiar to educators. Using Spacelink Search, educators and students can easily find information among NASA's thousands of Internet resources. Special events, missions, and intriguing NASA Web sites are featured in Spacelink's "Hot Topics" and "Cool Picks" areas. Spacelink may be accessed at: <http://spacelink.nasa.gov>.

NASA Spacelink is the official home to electronic versions of NASA's Educational Products. A complete listing of NASA Educational Products can be found at the following address: <http://spacelink.nasa.gov/products>.

NASA Television (NTV) features Space Station and Shuttle mission coverage, live special events, interactive educational live shows, electronic field trips, aviation and space news, and historical NASA footage. Programming has a 3-hour block—Video (News) File, NASA Gallery, and Education File—beginning at noon Eastern and repeated four more times throughout the day. Live feeds preempt regularly scheduled programming.

Check the Internet for programs listings at: <http://www.nasa.gov/ntv>

For more information on NTV, contact:

NASA TV

NASA Headquarters - Code P-2

Washington, DC 20546-0001

Phone (202) 358-3572

NTV Weekday Programming Schedules (Eastern Times)

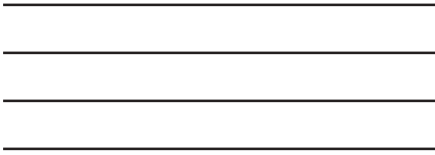
<i>Video File</i>	<i>NASA Gallery</i>	<i>Education File</i>
12-1 p.m.	1-2 p.m.	2-3 p.m.
3-4 p.m.	4-5 p.m.	5-6 p.m.
6-7 p.m.	7-8 p.m.	8-9 p.m.
9-10 p.m.	10-11 p.m.	11-12 p.m.
12-1 a.m.	1-2 a.m.	2-3 a.m.

How to Access Information on NASA's Education Program, Materials, and Services

(EP-2002-07-345-HQ) This brochure serves as a guide to accessing a variety of NASA materials and services for educators. Copies are available through the ERC network, or electronically via NASA Spacelink.

Please take a moment to evaluate this product at http://ehb2.gsfc.nasa.gov/edcats/educational_wallsheet. Your evaluation and suggestions are vital to continually improving NASA educational materials. Thank You.





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Exploring the Extreme - Educator's Guide

EDUCATOR REPLY CARD

To achieve America's goals in Educational Excellence, it is NASA's mission to develop supplementary instructional materials and curricula in science, mathematics, and technology. NASA seeks to involve the educational community in the development and improvement of these materials. Your evaluation and suggestions are vital to continually improving NASA educational materials.

Please take a moment to respond to the statements and questions below. You can submit your response through the Internet or by mail. Send your reply to the following Internet address:

http://ehb2.gsfc.nasa.gov/educats/educator_guide

You will then be asked to enter your data at the appropriate prompt.

Otherwise, please return the reply card by mail. Thank you.

1. With what grades did you use the educator's guide?

Number of teachers/faculty:

- | | | | |
|---|--|-----------------------------------|--|
| <input type="checkbox"/> K-4 | <input type="checkbox"/> 5-8 | <input type="checkbox"/> 9-12 | <input type="checkbox"/> Community College |
| <input type="checkbox"/> College/University | <input type="checkbox"/> Undergraduate | <input type="checkbox"/> Graduate | |

Number of students:

- | | | | |
|---|--|-----------------------------------|--|
| <input type="checkbox"/> K-4 | <input type="checkbox"/> 5-8 | <input type="checkbox"/> 9-12 | <input type="checkbox"/> Community College |
| <input type="checkbox"/> College/University | <input type="checkbox"/> Undergraduate | <input type="checkbox"/> Graduate | |

Number of others:

- | | | |
|---|---------------------------------------|--|
| <input type="checkbox"/> Administrators/Staff | <input type="checkbox"/> Parents | <input type="checkbox"/> Professional Groups |
| <input type="checkbox"/> General Public | <input type="checkbox"/> Civic Groups | <input type="checkbox"/> Other |

2. a. What is your home 5- or 9-digit zip code? _____

b. What is your school 5- or 9-digit zip code? _____

3. This is a valuable educator's guide.

- Strongly Agree Agree Neutral Disagree Strongly Disagree

4. I expect to apply what I learned in this educator's guide.

- Strongly Agree Agree Neutral Disagree Strongly Disagree

Fold along line and tape closed.

5. What kind of recommendation would you make to someone who asks about this educator's guide?

- Excellent Good Average Poor Very Poor

6. How did you use this educator's guide?

- | | |
|--|---|
| <input type="checkbox"/> Background Information | <input type="checkbox"/> Critical Thinking Tasks |
| <input type="checkbox"/> Demonstrate NASA Materials | <input type="checkbox"/> Demonstration |
| <input type="checkbox"/> Group Discussions | <input type="checkbox"/> Hands-On Activities |
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| <input type="checkbox"/> Lecture | <input type="checkbox"/> Science and Mathematics |
| <input type="checkbox"/> Team Activities | <input type="checkbox"/> Standards Integration |
| <input type="checkbox"/> Other: Please specify: _____ | |

7. Where did you learn about this educator's guide?

- NASA Educator Resource Center
 NASA Central Operation of Resources for Educators (CORE)
 Institution/School System
 Fellow Educator
 Workshop/Conference
 Other: Please specify: _____

8. What features of this educator's guide did you find particularly helpful?

9. How can we make this educator's guide more effective for you?

10. Additional comments:

Today's Date: _____