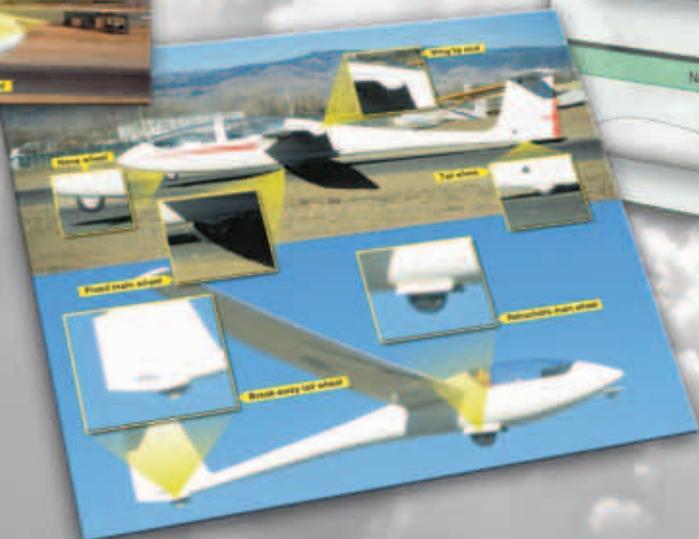
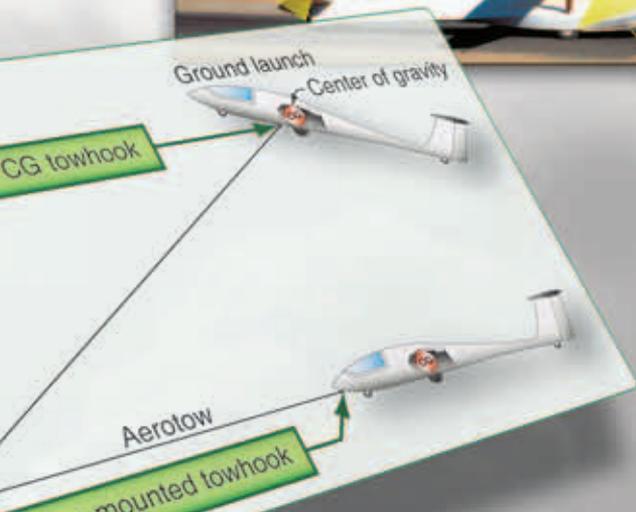
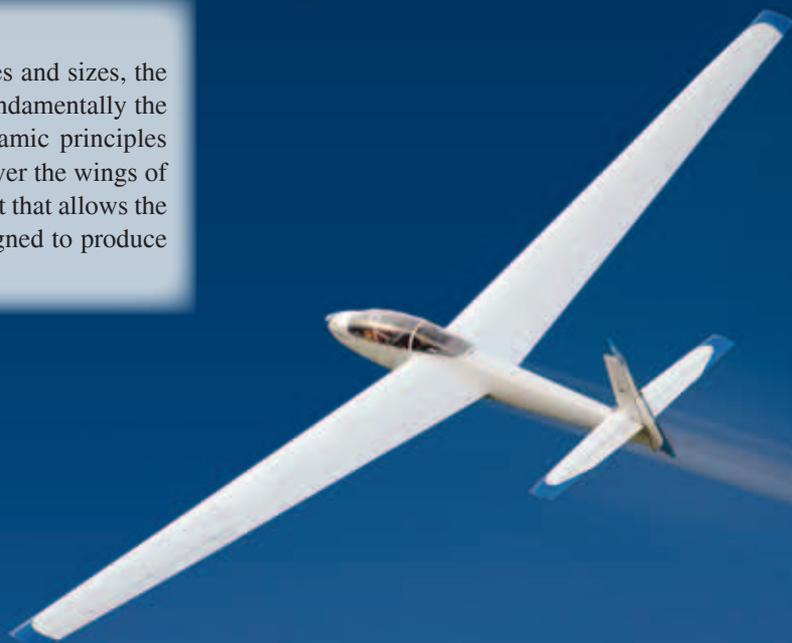


Chapter 2

Components and Systems

Introduction

Although gliders come in an array of shapes and sizes, the basic design features of most gliders are fundamentally the same. All gliders conform to the aerodynamic principles that make flight possible. When air flows over the wings of a glider, the wings produce a force called lift that allows the aircraft to stay aloft. Glider wings are designed to produce maximum lift with minimum drag.



Glider Design

The earlier gliders were made mainly of wood with metal fastenings, stays, and control cables. Subsequent designs led to a fuselage made of fabric-covered steel tubing glued to wood and fabric wings for lightness and strength. New materials, such as carbon fiber, fiberglass, glass reinforced plastic (GRP), and Kevlar® are now being used to develop stronger and lighter gliders. Modern gliders are usually designed by computer-aided software to increase performance. The first glider to use fiberglass extensively was the Akaflieg Stuttgart FS-24 Phönix, which first flew in 1957. [Figure 2-1] Fiberglass is still used because of its high strength to weight ratio and its ability to give a smooth exterior finish to reduce drag. Drag has also been minimized by more aerodynamic shapes and retractable undercarriages. Flaps were installed when technology improved and are fitted to the trailing edges of the wings on some gliders to minimize the drag and to allow lower landing speeds.



Figure 2-1. The Akaflieg Stuttgart FS-24 Phönix, made in Germany, was first flown on November 27, 1957.

Most high-performance gliders are built of composites, instead of metal or wood, with a gel-coat finish. The gel coat is susceptible to damage from exposure to ultraviolet (UV) radiation from the sun, as well as prolonged exposure to moisture. At some soaring sites, pilots can keep the glider assembled in a hangar, but the composite glider is more frequently rigged before flying and derigged after flying. The transition to high-performance gliders necessitates development of checklists and discipline during glider assembly and disassembly. Other considerations for gel-coat care include extreme cold soaking. There is evidence that flying a composite glider with a gel-coat finish to very high and cold altitudes followed by a quick descent to warmer levels can seriously reduce the life of the gel coat. Composite gliders appear to be more susceptible to flutter than metal gliders. Flutter is a function of true airspeed. The GFM/POH of composite gliders sometimes presents a table of the indicated V_{NE} for different heights. For instance, a popular two-seat composite glider shows 135 knots as the sea level V_{NE} , 128 knots at 10,000 feet MSL, 121 knots at 13,000 feet MSL, etc. Read the GFM/POH carefully and obey the limitations set forth in the manual.

With each generation of new materials and development and improvements in aerodynamics, the performance of gliders has increased. One measure of performance is glide ratio. A glide ratio of 30:1 means that in smooth air a glider can travel forward 30 feet while only losing 1 foot of altitude. Glide ratio is discussed further in Chapter 5, Glider Performance.

Due to the critical role that aerodynamic efficiency plays in the performance of a glider, gliders often have aerodynamic features seldom found in other aircraft. The wings of a modern racing glider have a specially designed low-drag laminar flow airfoil. After the wing surfaces have been shaped by a mold with great accuracy, they are highly polished and painted with a gel coat (light fiberglass spray/sealer). Some high performance gliders have winglets installed at the ends of the wings. These winglets are computer designed to decrease drag and improve handling performance. [Figure 2-2] To continually ensure the best in aerodynamics, manufacturers use specially designed seals in the vicinity of the flight controls (i.e., ailerons, rudder, and elevator) to prevent the flow of air in the opposite direction through the control surface gaps, which causes turbulence over the area.



Figure 2-2. Schmepp-Hirth Ventus-2 glider with factory winglets installed.

Additional high-technology designs include such items as bug wipers. These are very similar to a car windshield wiper. They may be installed to wipe the wings while in flight and remove insects that are disturbing the smooth flow of air over the wing by sliding back and forth along the leading edge of the wing. [Figure 2-3] Bug wipers can be operated by small electrical motors or by aerodynamics.

Modern competition gliders carry water ballast that can be jettisoned. This water acts as ballast in the wings and sometimes in the vertical stabilizer. The extra weight provided by the water ballast is advantageous if the lift is likely to be strong, and may also be used to adjust the glider's center of gravity (CG) during flight. Moving the CG toward the rear by carrying water in the vertical tail section reduces some



Figure 2-3. Mechanical bug wipers can be installed to slide back and forth along the leading edge of the wing.

of the required down force from the horizontal stabilizer aerodynamics and the resultant drag from that down force. Although heavier gliders have a slight disadvantage when climbing in rising air, they achieve a higher speed at any given glide angle. This is an advantage in strong conditions when the gliders spend only little time climbing in thermals. The pilot can jettison the water ballast before it becomes a disadvantage in weaker thermal conditions. Another use of water ballast is to dampen air turbulence that may be encountered during ridge soaring. To avoid undue stress on the airframe, gliders may jettison any water ballast before landing. [Figure 2-4] This is discussed further in Chapter 5, Glider Performance.



Figure 2-4. Sailplane dropping water ballast before landing.

Most gliders are built in Europe and are designed to meet the requirements of the European Aviation Safety Agency (EASA), similar to the United States Federal Aviation Administration (FAA). The EASA Certification Specification CS-22 (previously Joint Aviation Requirements (JAR)-22), defines minimum standards for safety in a wide range of characteristics such as controllability and strength. For example, it must have design features to minimize the

possibility of incorrect assembly (gliders are often stowed in disassembled configuration with at least the wings being detached). Automatic connection of the controls during rigging is the common method of achieving this.

Throughout the years, flying gliders has not only been a recreational past time but are built and used for sport as well. Many glider pilots take part in gliding competitions that usually involve racing. Modern gliding competitions now comprise closed tasks; everyone races on an aerial route around specified turnpoints, plus start and finish points that bring everybody back to base. The weather forecast and the performance of the gliders, as well as the experience level of the pilots, dictate the length of the task. Today, most of the points are speed points, and the rule is to set the task so all pilots have a fair chance of completing it.

With the advent of global positioning systems (GPS), new types of tasks were introduced, such as speed or distance tasks within assigned areas and speed or distance tasks with pilot-selected turn points. Despite the use of pilot-selected turn points made possible by GPS, tasks over a fixed course are still used frequently. The Fédération Aéronautique Internationale (FAI), the world's air sports federation, is a nongovernmental and nonprofit international organization with the basic aim of furthering aeronautical and astronautical activities worldwide. The FAI Gliding Commission is the sporting body overseeing air sports at the international level so that essentially the same classes and class definitions are followed in all countries.

The following is an overview of the seven classes of gliders that are currently recognized by the FAI and are eligible for European and World Championships:

1. Standard class—no flaps, 15 meter (49.2 feet) wingspan, water ballast allowed.
2. 15 meter class—flaps allowed, 15 meter (49.2 feet) wingspan, water ballast allowed.
3. 18 meter class—flaps allowed, 18 meter (59 feet) wingspan, water ballast allowed.
4. Open class—no restrictions on wingspan, except a limit of 850 kg (1,874 pounds for the maximum all-up weight). Open classes may have wingspans in excess of 85 feet or more. [Figure 2-5]
5. Two-seat class—maximum wingspan of 20 meters (65.6 feet), also known by the German name of Doppelsitzer. [Figure 2-6]
6. Club class—this class allows a wide range of older, small gliders with different performance. The scores must be adjusted by handicapping. Water ballast is not allowed.



Figure 2-5. The Schempp-Hirth Nimbus-4 is a family of high-performance Fédération Aéronautique Internationale (FAI) open class gliders.



Figure 2-6. The DG Flugzeugbau DG-1000 of the two-seater class.

- World class—the FAI Gliding Commission, which is part of the FAI and an associated body called Organization Scientifique et Technique du Vol à Voile (OSTIV), announced a competition in 1989 for a low-cost glider that had moderate performance, was easy to assemble and handle, and was safe for low-hours pilots to fly. The winning design was announced in 1993 as the Warsaw Polytechnic PW-5. This allows competitions to be run with only one type of glider.

Glider airframes are designed with a fuselage, wings, and empennage or tail section. Self-launching gliders are equipped with an engine that enables them to launch without assistance and return to an airport under engine power if soaring conditions deteriorate.

The Fuselage

The fuselage is the portion of the airframe to which the wings and empennage are attached. The fuselage houses the cockpit and contains the controls for the glider, as well as a seat for each occupant. Glider fuselages can be formed from wood, fabric over steel tubing, aluminum, fiberglass, Kevlar® or other composites, or a combination of these materials. [Figure 2-7]

Wings and Components

Glider wings incorporate several components that help the pilot maintain the attitude of the glider and control lift and drag. These include ailerons and lift and drag devices, such as spoilers, dive brakes, and flaps. Glider wings vary in size and span from 12.2 meters (40 feet) to 30 meter (101.38 feet).

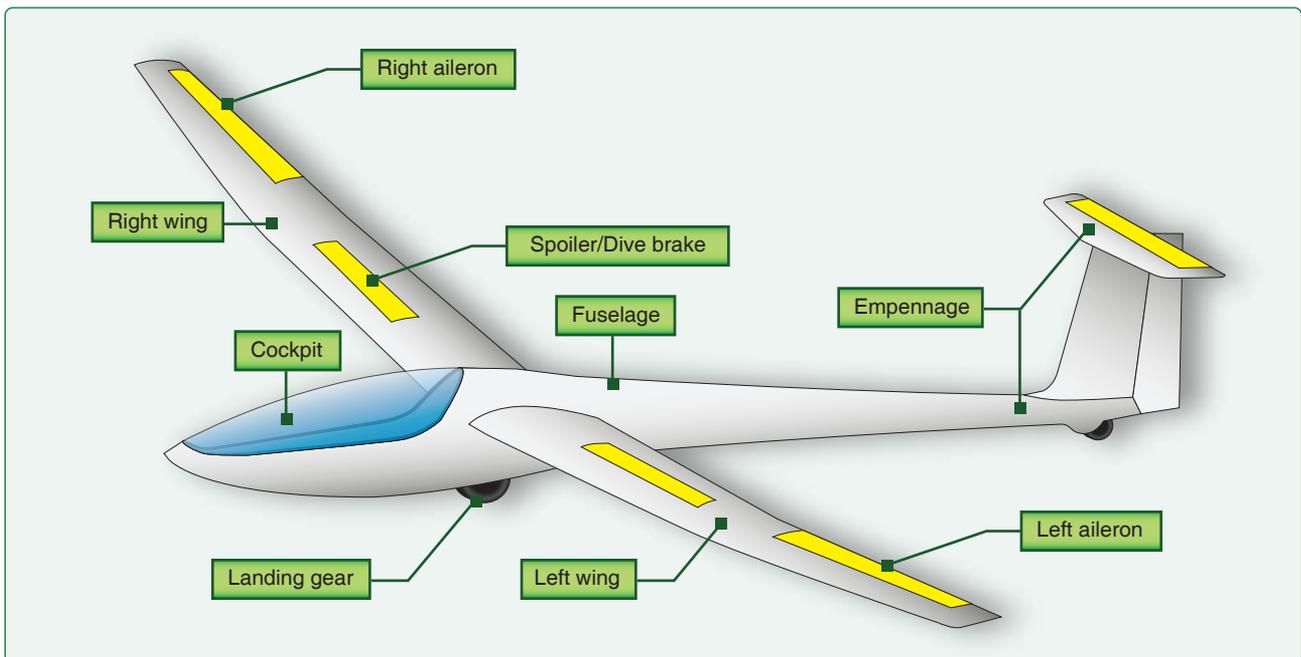


Figure 2-7. Components of a glider.

A wing may consist of a single piece attached to the fuselage to as many as four pieces (on one side).

The ailerons control movement around the longitudinal axis, known as roll. The ailerons are attached to the outboard trailing edge of each wing and move in opposite directions.

Moving the aileron controls with the control stick to the right causes the right aileron to deflect upward and the left aileron to deflect downward. The upward deflection of the right aileron decreases the effective camber (curvature of the wing surface), resulting in decreased lift on the right wing. [Figure 2-8] The corresponding downward deflection of the left aileron increases the effective camber, resulting in increased lift on the left wing. Thus, the increased lift on the left wing and decreased lift on the right wing causes the glider to roll to the right.

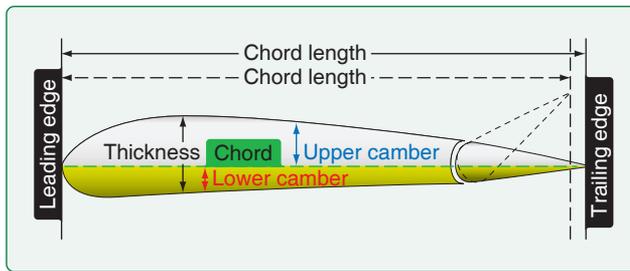


Figure 2-8. The wing camber remains the same physically, but the ailerons change the “effective” camber of the wing and increase or decrease lift to change lift vectors to affect turns.

Lift/Drag Devices

Glifters are equipped with devices that modify the lift/drag of the wing. These high drag devices include spoilers, dive brakes, and flaps. Spoilers extend from the upper surface of the wing, interrupting or spoiling the airflow over the wings. This action causes the glider to descend more rapidly. Dive brakes extend from both the upper and lower surfaces of the wing and help to increase drag.

Flaps are located on the trailing edge of the wing, inboard of the ailerons, and can be used to increase lift, drag, and descent rate. [Figure 2-9] Each flap type has a use depending on aircraft design. When the glider is cruising at moderate airspeeds in wings-level flight, the flaps can sometimes be set to a negative value (up from trail or level) for high speed cruising in some high efficiency gliders. When the flap is extended downward, wing camber is increased, and the lift and the drag of the wing increase.

Glifters are generally equipped with simple flaps and these flaps can generally be set in three different positions which are trail, down or negative. [Figure 2-10] When deflected downward, it increases the effective camber and changes the wing’s chord line, which is an imaginary straight line drawn from the leading edge of an airfoil to the trailing edge. Both of these factors increase the lifting capacity of the wing.

Negative flap is used at high speeds at which wing lift reduction is desired to reduce drag. When the flaps are

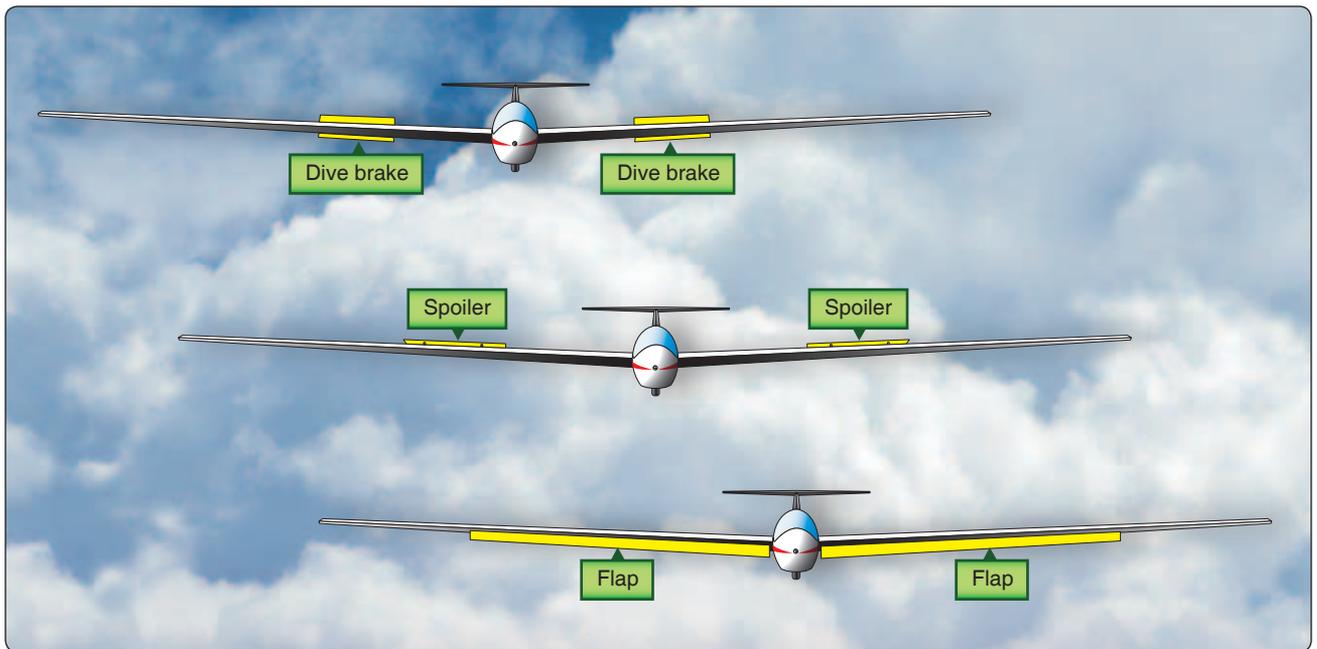


Figure 2-9. Types of lift/drag devices.

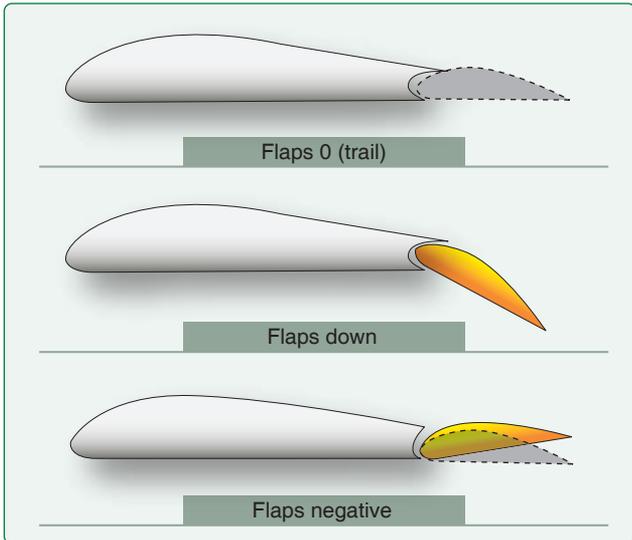


Figure 2-10. Flap positions.

extended in an upward direction, or negative setting, the effective camber of the wing is reduced, resulting in a reduction of lift produced by the wing at a fixed angle of attack and airspeed. This action reduces the down force, or balancing force, required from the horizontal stabilizer.

Empennage

The empennage includes the entire tail section, consisting of the fixed surfaces, such as the horizontal stabilizer and vertical fin, and moveable surfaces such as the elevator or stabilator, rudder and any trim tabs. These two fixed surfaces act like the feathers on an arrow to steady the glider and help maintain a straight path through the air. [Figure 2-11]

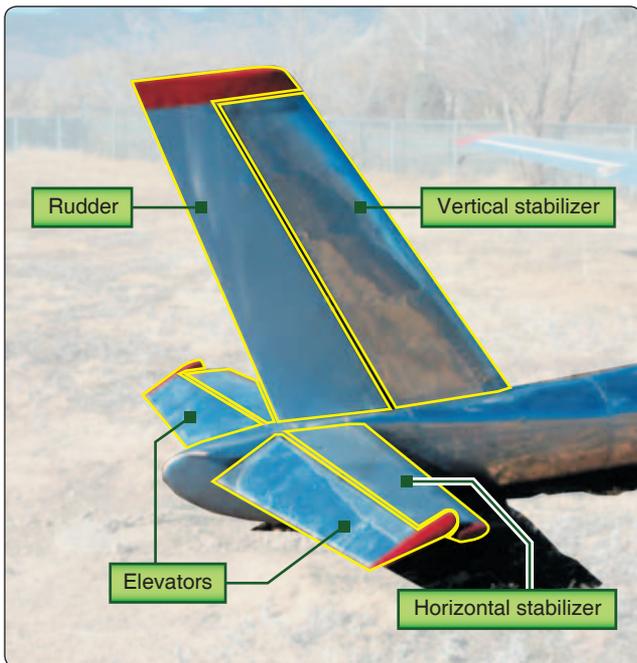


Figure 2-11. Empennage components.

The elevator is attached to the back of the horizontal stabilizer. The elevator controls movement around the lateral axis. This is known as pitch. During flight, the elevator is used to move the nose up and down, which controls the pitch attitude of the glider. The horizon is the primary pitch reference for a glider pilot. The elevator is primarily used to change or hold the same angle of attack of the glider. The trim tab, normally located on the elevator of the glider, lessens the resistance felt on the flight controls due to the airflow over the associated control surface.

The rudder is attached to the back of the vertical stabilizer. The rudder controls movement about the vertical axis. This is known as yaw. The rudder is used in combination with the ailerons and elevator to coordinate turns during flight.

Some gliders use a stabilator, which is used in lieu of an elevator and horizontal stabilizer. The stabilator pivots up and down on a central hinge point. When pulling back on the control stick, the nose of the glider moves up; when pushing forward, the nose moves down. Stabilators sometimes employ an anti-servo trim tab to achieve pitch trim. The anti-servo tab provides a control feel comparable to that of an elevator.

Trim devices reduce pilot workload by relieving the pressure required on the controls to maintain a desired airspeed. One type of trim device found on gliders is the elevator trim tab, a small, hinged, cockpit-adjustable tab on the trailing edge of the elevator. [Figure 2-12] Other types of elevator trim device include bungee spring systems and ratchet trim systems. In these systems, fore and aft control stick pressure is applied by an adjustable spring or bungee cord.

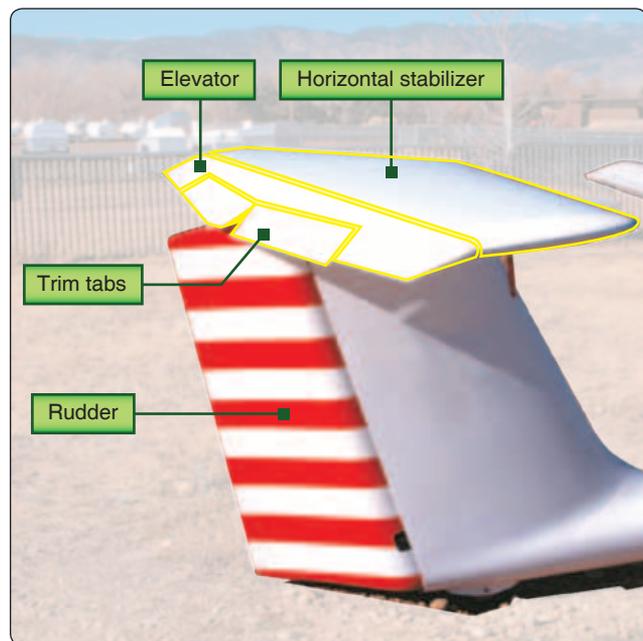


Figure 2-12. Additional empennage components.

Primary flight controls (aileron, elevator, and rudder), assisted by the trim devices, reduce control loading and provide positive feedback to the pilot. The trim tab is either servo or anti-servo. [Figure 2-13] Anti-servo tab movement is opposite to the control surface providing a positive feedback (or feel) to the pilot. Servo tabs move in the same direction as the control surface and allow the pilot to remove (or lighten) control load, reducing fatigue during flight and providing aerodynamic trim.



Figure 2-13. Additional empennage components.

Over the years, the shape of the empennage has taken different forms. Early gliders were most often built with the horizontal stabilizer mounted at the bottom of the vertical stabilizer. This type of tail arrangement is called the conventional tail. Other gliders were designed with a T-tail, and still others were designed with V-tail. T-tail gliders have the horizontal stabilizer mounted on the top of the vertical stabilizer, forming a T. V-tails have two tail surfaces mounted to form a V. V-tails combine elevator and rudder movements. This combination of elevator and rudder are referred as ruddervators.

Towhook Devices

An approved towhook is a vital part of glider equipment. The towhook is designed for quick release when the pilot exerts a pulling force on the release handle. As a safety feature (on most of the bellyhooks (CG hook)), if back pressure occurs from either getting out of position during the tow or overrunning the towrope, the release automatically opens. Part of the glider pilot's preflight is ensuring that the towhook releases properly with applied forward and back pressure.

The glider may have a towhook located on or under the nose and/or under the center of gravity (CG), near the main landing gear. The forward towhook is used for aerotow. The CG hook is used for ground launch. A glider with only a CG hook may be approved for aerotow in accordance with the Glider Flight Manual/Pilot's Operating Handbook. [Figure 2-14]

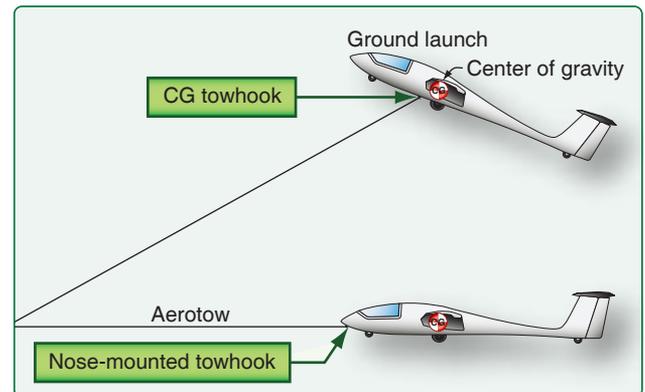


Figure 2-14. Towhook locations.

Powerplant

Self-Launching Gliders

Self-launching gliders are equipped with engines powerful enough to enable them to launch without external assistance. The engines may also be used to sustain flight if the soaring conditions deteriorate. Self-launching gliders differ widely in terms of engine location and type of propeller. There are two types of self-launching gliders: touring motor gliders and high-performance self-launching gliders.

Touring motor gliders are equipped with a fixed, nose-mounted engine and a full feathering propeller. [Figure 2-15] Touring motor gliders resemble an airplane to the untrained eye. They do have some basic airplane characteristics but are not certified as an airplane. On other types of self-launching gliders, the engine and propeller are located aft of the cockpit. High-performance self-launching gliders generally are seen with engines and propellers mounted behind the cockpit that completely retract into the fuselage for minimal drag in the soaring mode. [Figure 2-16] Propellers may fold or may simply align with the engine and retract completely. This configuration preserves the smooth low drag nose configurations important for good soaring efficiencies. When the engine and propeller are not in use, they are retracted into the fuselage, reducing drag and increasing soaring performance. These types of self-launch engines are usually coupled to a folding propeller, so the entire powerplant can be retracted and the bay doors are closed and sealed.



Figure 2-15. A Grob G109B touring motor glider.

Sustainer Engines

Some gliders are equipped with sustainer engines to assist in remaining aloft long enough to return to an airport. However, sustainer engines do not provide sufficient power to launch the glider from the ground without external assistance. These sailplanes are launched by either aerotow or ground launch. [Figure 2-17] A more detailed explanation of engine operations can be found in Chapter 7, Launch and Recovery Procedures and Flight Maneuvers.

Landing Gear

Glider landing gear usually includes a main wheel, a front skid or wheel and a tail wheel or skid, and often wing tip wheels or skid plates. Gliders designed for high speed and low drag often feature a fully retractable main landing gear and a small breakaway tailwheel or tail skid. Breakaway tail skids are found on high-performance gliders, and are designed to break off when placed under side loads. [Figure 2-18]

For safety reasons, the main landing gear remains extended during the launch process. If there is a tow break or early release, the pilot needs to focus on a safe return. The pilot's



Figure 2-17. A Schleicher ASH 26e motor glider with the sustainer engine mast extended.

normal landing checklist provides a landing gear check, but during a low-altitude emergency, important items could be skipped on any checklist. Therefore, it is good practice to leave the main gear extended until reaching a safe altitude.

Wheel Brakes

The wheel brake, mounted on the main landing gear wheel, helps the glider slow down or stop after touchdown. The type of wheel brake used often depends on the design of the glider. Many early gliders relied on friction between the nose skid and the ground to come to a stop. Current glider models are fitted with drum brakes, disk brakes, and friction brakes. The most common type of wheel brake found in modern gliders is the disk brake, which is very similar to the disk brake on the front wheels of most cars. Most glider disk brakes are hydraulically operated to provide maximum braking capability. Wheel brake controls vary from one glider type to another.



Figure 2-16. A DG-808B 18-meter high-performance glider in self-launch.

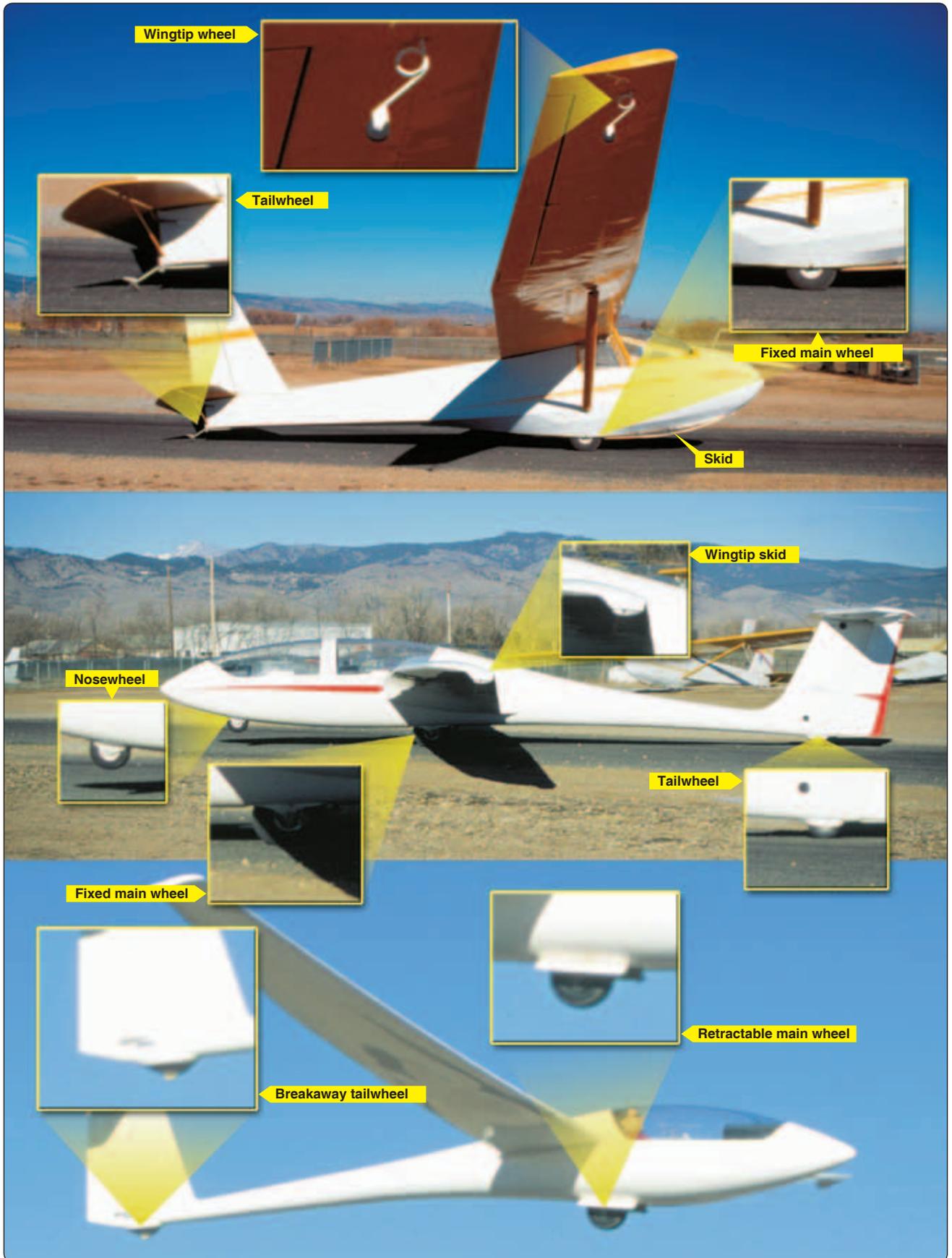


Figure 2-18. Landing gear wheels on a glider.

