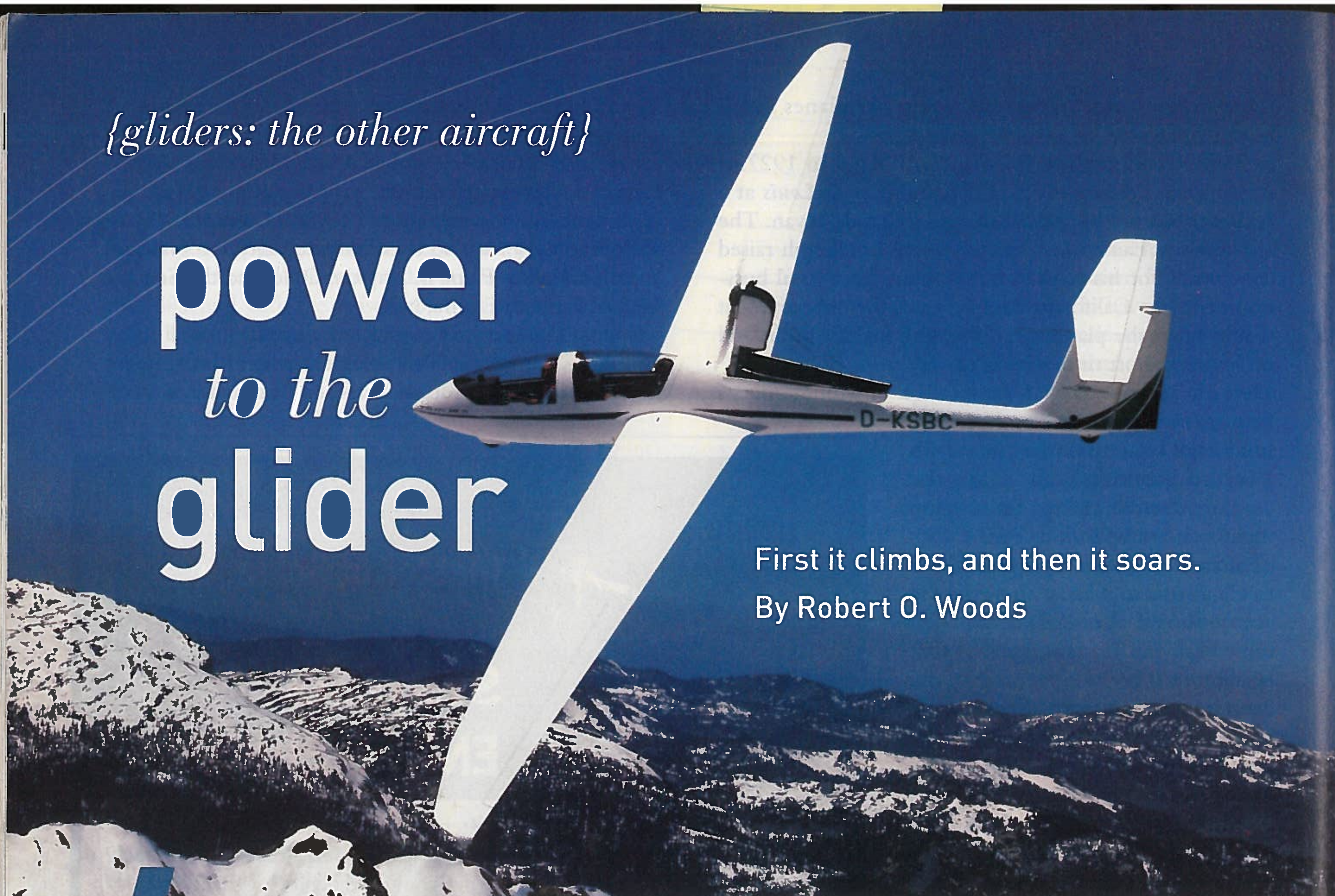
{gliders: the other aircraft}

power *to the* glider

First it climbs, and then it soars.

By Robert O. Woods



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The art of glider building, which began in carpenter shops and initially produced airframes that were nothing more than very large model aircraft, has advanced to a position on the cutting edge of aeronautical technology. The sport of soaring, placing as it does an emphasis on ever-evolving design, has opened a world of challenges to mechanical designers. High-performance gliders—usually referred to as sailplanes—place a premium on sophisticated engineering. Every part of a glider must be light in weight, compact, and reliable. Failures can put human life in jeopardy.

Gliders have always involved ancillary mechanical components, such as control linkages, landing gear, and instrumentation, but only recently have engines and a host of supporting structures been added to what was previously a class of relatively simple aircraft.

Taken literally, the term "powered glider" was an oxymoron. Until recently, a glider by definition did not have an engine. Today, the term applies to a new class of aircraft that take off under their own power and then, with the powerplant stopped and streamlined, behave as true sailplanes.

Putting an engine and propeller on an airframe is nothing new, but to achieve the aerodynamic performance required in soaring, the powerplant must be stowed in such a way as to add the least drag to the aircraft. This usually involves sophisticated retracting mechanisms for the engine and propeller, or a means of grossly reducing the drag of the propeller alone if it is left out in the airflow.

A two-seat Astir manufactured by Grob Aerospace of Switzerland and Germany. The engine is mounted in what might be called a "classic" configuration. Since the propeller is a tractor, i.e., in front of the engine and pulling, the region behind the engine is free and allows the use of cables to take the thrust.

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Clearing the Ground

The various means by which unpowered machines have been gotten into the air have evolved through a number of generations.

During the early days of soaring, gliders were launched using what amounted to huge slingshots. An elastic cord (bungee or shock cord), 30 feet or more in unstretched length, was arranged in a vee with the glider—initially a very primitive one—at the apex. Two crews of volunteers would run with the free ends as far as they could, and the glider would then be released by others who held it back until it was ready to fly. This arrangement worked only when flight was taking place on the slope of a hill that was steeper than the plane's glide angle. A bungee launch could give the glider only enough airspeed to allow it to zoom a few feet above the point of departure before starting down the slope.

This technique of using gliders was perfected in Ger-

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many during the 1930s because details of the Versailles Treaty drastically limited the amount of powered aviation the Germans were allowed. It was a popular state-supported youth activity. Pilots who had learned the rudiments of flying in gliders later became the nucleus of the Luftwaffe. This ostensibly sporting approach to aviation was taking place at the same time that Germany, being limited as to aircraft production, was developing aircraft engines under the guise of automobile racing.

The next development in launching was the winch or car tow. The glider ascends exactly like a kite. In order to get the greatest altitude from a line that is at least several hundred meters in length, it is necessary to climb at a very steep angle. This puts the pilot in serious danger because a rope break or winch failure can release the glider at an exaggerated angle of attack, flying slowly, and close to the ground. The risk can be reduced by proper piloting technique.

When done according to protocol, the pilot will climb gradually to a recoverable altitude before rotating to a high angle of attack. He must always be acutely conscious of altitude and airspeed. If he is alert, a pilot can recover from a rope break, but only if he is quick enough. Rope breaks have been the source of numerous accidents.

Winch and car towing have been largely phased out in favor of air towing behind a powered plane. If it is done properly, this is no more hazardous than any other general light aviation maneuver. The great majority of glider flights are now launched by air tows. The operation has been reduced to a well-defined set of rules and is done thousands of times each year.

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In the Carat, the 60-hp engine is nicely cowled in the manner common to single-engine aircraft. The design is unique in that the propeller folds forward to reduce drag when not running.

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It does have some features that can be improved upon. In particular, air towing a glider is a team effort. At the very least, it involves an additional pilot to fly the tow plane. Also, since gliders, almost without exception, have only a single wheel to minimize landing gear weight, a third person is usually involved in running with a wingtip. The crewman runs the wing until the glider is moving fast enough to give aileron control and thus allow the pilot to balance on the single wheel.

Since the greatest attraction of soaring for most pilots is the freedom they feel in being completely alone with nature, the fact that soaring is a team effort is mildly disappointing. Pilots would be happier if they could come and go without having to organize a team. There is a growing movement in soaring to make this possible. Self-launched, or powered, gliders are becoming more and more common.

They pose a number of interesting design challenges beyond the questions common to powered planes or other gliders. Almost unique in powered sailplanes is the question of stowing the powerplant or at least reducing the drag of a stationary propeller when the aircraft goes from powered to gliding flight. This requirement was first studied to any real extent shortly after World War II when lightweight target drone engines became available as surplus.

At that time, there were still a few prewar airframes available and it was inevitable that designers would try to mate them with engines. This led to the creation of a few sailplanes designed specifically for power. Some of them were moderately successful, although the wooden airframes typical of the time were not well suited to power. Early postwar gliders were typically very light by today's standards—usually weighing in the vicinity of 300 pounds or even less. With such gossamer structures the added weight of an engine, which was at least 75 pounds, was almost out of the question.

Developments in airframe design have changed the picture. Glider airframes push structural engineering to its limit today. Metal sailplanes are made, but the majority of them are heavy enough to be most successful as trainers or general utility aircraft. Very few are contest quality.

Something better is needed and fiberglass has been found to be ideally suited to sailplane construction. Fiberglass was adopted immediately when the technology became available. It is lighter and stronger than wood and building a structure is usually less labor intensive.

One of the most successful fiberglass designs, the Libelle by Glasflügel, was introduced in the '70s and is still the standard by which fiberglass airframes are judged. This design was followed by a host of others, which further evolved the technology, and have led to present-day structures of carbon fiber and even more exotic materials.

The result has been an increasing number of aircraft made of what were once unknown materials, and aircraft of increasing size and weight. Wingspans on the order of 20 meters are no longer unusual. With technology advanced to the current degree, the addition of an engine is no longer a quantum jump. In addition, the interest in contest soaring has exploded and more money is available. It is a very competitive sport and those who can afford it are willing to pay considerable sums to gain an edge. Airframes costing nearly $200,000 and weighing around 800 kilograms are not unheard of. In this climate, creating a powered design becomes feasible. It provides a new world of challenges for mechanical designers.

The propeller blades of the S10-VT made by Stemme AG fold up inside the nose cone when they stop turning. The nose cone can be retracted to streamline the fuselage. The blades are held open by centrifugal force.

Design Solutions

Retracting an engine and propeller can eliminate drag. A common approach to doing that is to mount a propeller on a folding pylon, which can be enclosed in the fuselage after powered flight ends. Mounting a motor at the top of a pylon involves putting a large mass at the end of a light structure. To simplify the problem, the engine is most often mounted at the base of the pylon, near the hinge, and drives the propeller remotely. This is usually done using an elastomeric belt. (Bicycle chains went out with the Wright brothers.)

Electric motor and battery technology have made great advances in recent years; this has made it possible to make an electric motor light enough to place it at the top of the pylon without requiring a prohibitively heavy structure. This is unusual, but it avoids the complication of driving a propeller at a distance from a motor.

Great ingenuity has been displayed in the case of engines mounted in the fuselage rather than on pylons. In such cases, the engine can be well cowled to minimize drag and the challenge becomes that of reducing the drag of a stationary propeller. One solution is to rotate the propeller blades until they are parallel to the airflow (feathering). This is an almost traditional solution, but it still leaves the blades out in the airflow producing some drag.

The problem has been treated in a number of ways. In one design, the Carat manufactured by AMSFlight in Lubljana, Slovenia, the propeller blades actually fold forward, giving an appearance that is unconventional on the ground but which is nevertheless an efficient means of drag reduction.

In one highly sophisticated design, a two-blade propeller folds up and can be enclosed in the nose cone. In this aircraft, the S10-VT made by Stemme AG in Strausberg, Germany, the engine is mounted behind the cockpit and drives the propeller via a carbon-fiber shaft. The nose cone moves forward to create a gap in which the propeller spins. Centrifugal force holds the propeller open while it is driven by the engine. The blades fold into a compact diameter when the rotation stops. The pilot can retract the nose cone to close the gap and streamline the craft.

The Next Generation

The advent of radio control has allowed model aviation to progress to an almost unbelievable degree. In this context, there are now small turbojet engines commercially available that weigh a little over 5 pounds and deliver 40 pounds force of thrust. An airshow demonstration pilot and skilled engineer, Robert Carlton of Albuquerque, N.M., has mated two of these engines to a conventional powered sailplane and has shown that such an arrangement is entirely practical.

His innovation is currently in the developmental stage, but it has proven to be well suited for the specialized application of performing at airshows. Jet propulsion clearly demonstrates the future direction of powered sailplanes. ■

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