

HARTZELL'S SECOND GENERATION ADVANCED
STRUCTURAL COMPOSITE TECHNOLOGY.

OPTIMIZED DESIGN FOR OPTIMIZED PERFORMANCE.





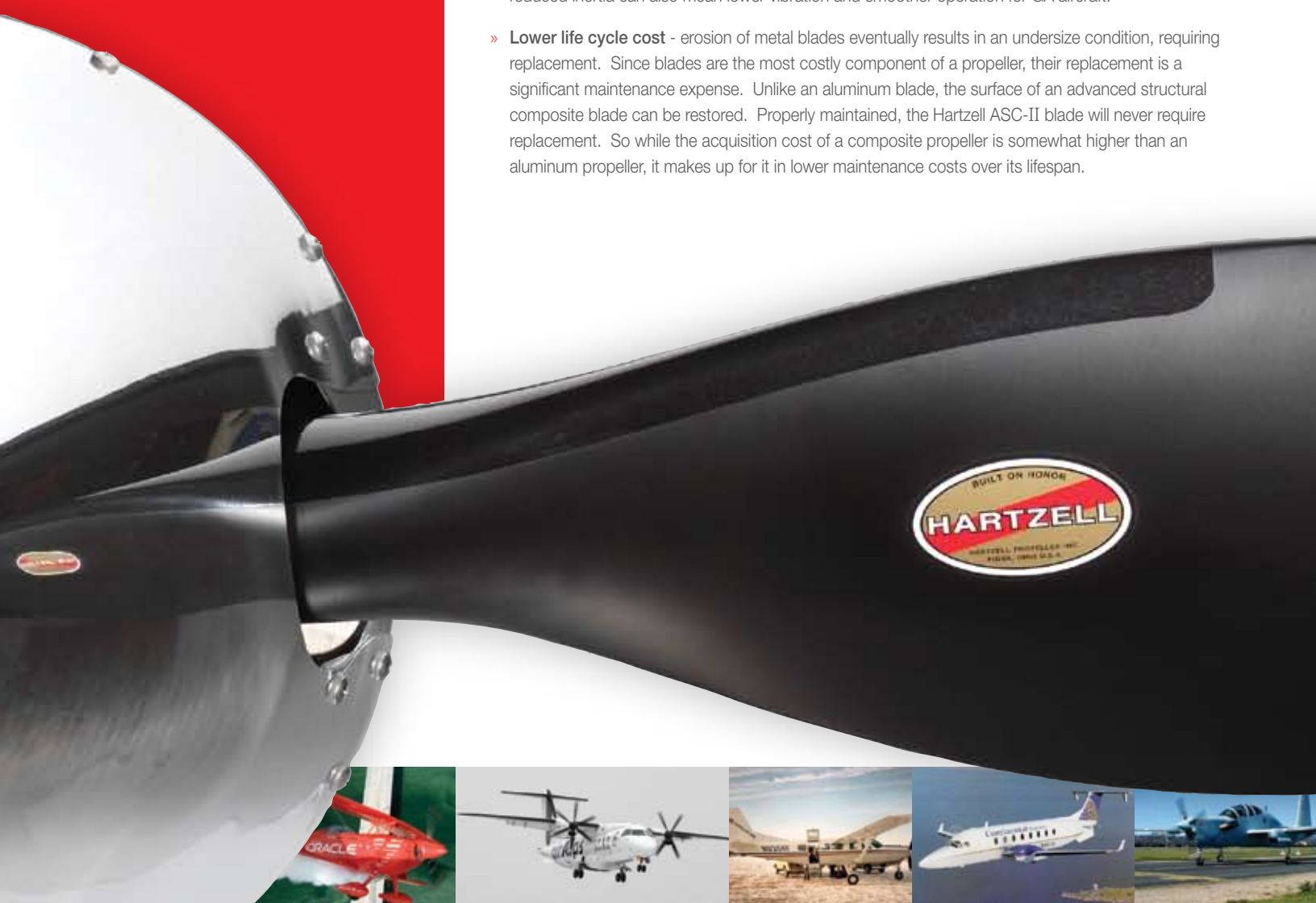
THE FIRST CERTIFIED ADVANCED STRUCTURAL COMPOSITE PROPELLER SPECIFICALLY DEVELOPED FOR GENERAL AVIATION.

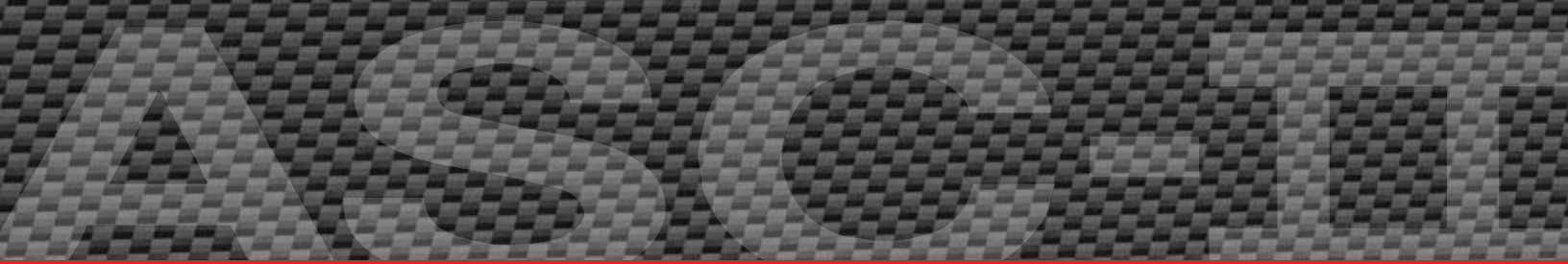
Hartzell's second generation Advanced Structural Composite technology (ASC-II™) is the latest evolution of Hartzell's nearly 30 year experience in the design and manufacture of composite propellers. Developed with the general aviation market in mind, the Hartzell ASC-II is an optimized design mated to a proprietary, Hartzell-developed manufacturing technology. The result is an advanced structural composite propeller that delivers all the advantages of its first generation progenitor - low weight, low inertia, and low life cycle costs - while minimizing the major disadvantage - the high cost manufacturing process.

ADVANTAGES OF COMPOSITES

Hartzell propellers with forged aluminum blades are the industry standard, providing market leading performance at the most economical cost. While forged aluminum blades set the standard, composites generally have several inherent advantages over metal blades:

- » **Less weight** - Hartzell's ASC-II blades weigh 30% less per blade than comparable metal blades which translates directly to greater useful load and moves the aircraft center of gravity toward the opposite end of the aircraft, which can provide more versatile loading capability.
- » **Lower inertia** - important for aerobatic aircraft to minimize the gyroscopic effects of the propeller, reduced inertia can also mean lower vibration and smoother operation for GA aircraft.
- » **Lower life cycle cost** - erosion of metal blades eventually results in an undersize condition, requiring replacement. Since blades are the most costly component of a propeller, their replacement is a significant maintenance expense. Unlike an aluminum blade, the surface of an advanced structural composite blade can be restored. Properly maintained, the Hartzell ASC-II blade will never require replacement. So while the acquisition cost of a composite propeller is somewhat higher than an aluminum propeller, it makes up for it in lower maintenance costs over its lifespan.





HARTZELL ASC-II VS. OTHER COMPOSITE PROPELLERS

Beyond the advantages composites offer over metal blades, the technology in the Hartzell ASC-II propeller is more robust than other composite propellers available in the GA market, including our own first generation advanced structural composites.

» **Stronger** - Any component made up of two or more separate and distinct materials can literally be characterized as a composite. The term Advanced Composites has been used to distinguish the use of high strength materials such as carbon fiber, Kevlar®, and S-glass, from other “non-advanced” materials such as wood laminates and even common fiberglass. The Hartzell ASC-II uses carbon and Kevlar® materials to make the structural part of the blade, creating an extremely high strength advanced structural composite blade that is stronger than other composite propeller blades.

» **More Durable** - Hartzell’s first generation advanced structural composite propellers have been used extensively in regional airline service on aircraft such as the Beech 1900, CASA 212, Cessna Caravan, Dornier 328, and Shorts 360. These propellers have withstood millions of hours of service in all weather and operating conditions, including gravel runways! The strength of the blade and the laminate thickness allow for substantial surface damage to be incurred before repair is necessary, and, even then, most repairs can be done on wing. This is not a delicate propeller. These blades can perform in the same tough operating environment as metal blades. The construction features that provide this level of durability were intentionally retained in the development of the second generation Hartzell ASC-II blades, but the ASC-II design goes a step beyond with the use of a stronger and maintenance free stainless steel shank, which is also used as the bearing surface to increase blade thrust bearing life.

» **Intensively Tested** - In order to achieve FAA certification, composite blades must pass an extensive battery of tests. It’s not easy. If it were easy, all composite propellers available today would be certified. They’re not. We take certification very seriously, since our customers’ ultimate safety depends upon the integrity of our propeller. The Hartzell ASC-II propeller has lived through simulated encounters with 4 pound birds under the worst possible flight condition, taken a direct hit of over 200,000 amps of electricity to prove that it can survive any possible encounter with lightning and withstood a direct pull of 132,000 pounds reaching the limit of the test fixture without failing – 6.8 times the normal Cf load – to demonstrate a safety margin in the event of an engine overspeed. This is in addition to passing normal fatigue and endurance tests to demonstrate that it will have a good useful life as well as flight tests to ensure stress levels fall within allowable limits for safety. The result was that Hartzell was awarded certification by the FAA for the first ASC-II model on July 11, 2006.

Note: The requirement for bird and lightning strikes are that the propeller be able to continue safe flight, but may require retirement of the blade.



HARTZELL PIONEERS COMPOSITES

Hartzell’s second generation Advanced Structural Composite technology (ASC-II) is the result of the company’s pioneering efforts in composite propellers, which were first certified in 1977. Since then, Hartzell composite propellers have logged millions of flight hours in demanding commercial airliner service, as well as on special high performance applications such as the Pilatus PC-21 advanced turboprop trainer and Boeing’s record setting high altitude Condor.



BIRD STRIKE TESTING

As a certified propeller, Hartzell's ASC-II has passed demanding bird strike testing which is designed to simulate a collision with a 4 pound bird at rotation.

COMPOSITE DESIGN - OPTIMIZED

Hartzell's first generation advanced structural composite propellers were an excellent solution for applications where payload earns its name, but, due to their use of expensive pre-preg materials and labor intensive lay-up processes, were too expensive for most general aviation applications. The design goal for the Hartzell ASC-II was to make an affordable, advanced structural composite propeller for general aviation without sacrificing any of the benefits of our earlier designs.

The next generation Hartzell ASC-II blades use an optimized design for reduced parts count in combination with a new, automated resin infusion process with minimal secondary post curing operations. The proprietary design and manufacturing process reduces both labor and material costs, allowing the Hartzell ASC-II to set a new value standard for general aviation composite propellers.

Hartzell's proprietary process allows the carbon fiber and Kevlar® plies to be quickly and easily laid up over a lightweight foam core, ensuring optimized fiber direction and ply alignment for strength and rigidity. The use of a high strength carbon and Kevlar® laminate takes advantage of the benefits of both materials – carbon for stiffness and Kevlar® for damping. While Hartzell's first generation blades were made primarily of Kevlar®, the use of carbon in addition to the Kevlar® permits a thinner monocoque structure that results in a thinner airfoil profile at the blade tips. Thin airfoil sections, particularly at the tip, are a

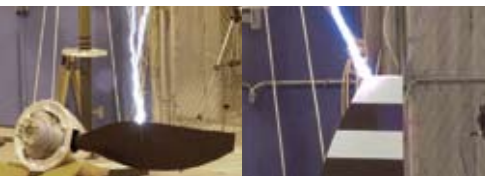
key component in the overall performance of the propeller. Since metal blades can be made quite thin, they have traditionally set the performance standard over composite props with their thicker sections. The combination of materials and the proprietary Hartzell ASC-II construction method result in achieving a thin airfoil and, therefore, performance comparable to metal.

Complementing the strong monocoque construction, Hartzell ASC-II blades have an integral co-molded stainless steel shank. The retention strength between the shank and the composite airfoil has been proven to withstand a centrifugal load almost seven times that seen in normal use. This design precludes the need for any secondary fasteners, such as bolts or screws or as in the case of Hartzell's earlier composite blades a secondary retention winding added post-cure, all of which only add to manufacturing and maintenance cost. The Hartzell ASC-II design is also an improvement over Hartzell's earlier composite blades in that the composite material is now contained within the shank, allowing for an external metal bearing surface. The use of high strength stainless steel for the shank also permitted the design to incorporate an integral pitch change knob that was previously bolted on.

An extremely hard, co-molded electroformed nickel erosion shield protects the outboard leading edge of composite material. Co-molding the erosion shield eliminates post-cure installation, helping to reduce manufacturing cost. While the nickel shield is much more durable than the leading edge of an aluminum

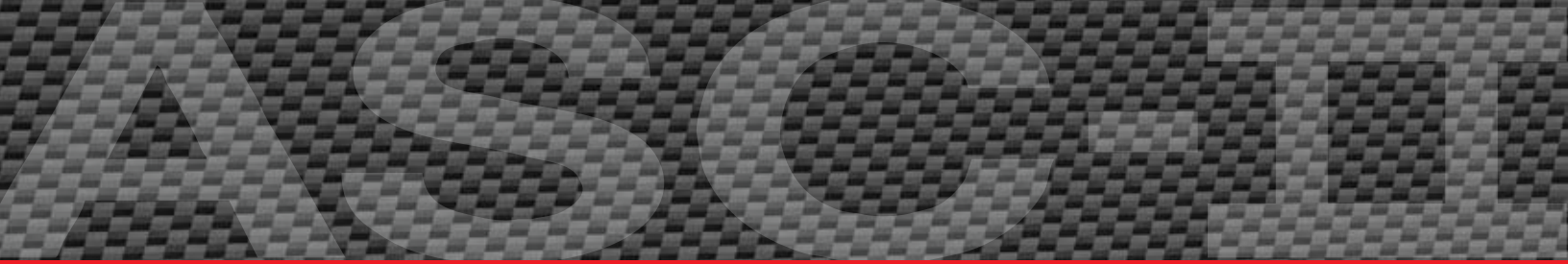
blade, it is ultimately a sacrificial part and is field replaceable. A conductive aluminum screen is embedded directly beneath the surface of the blade to provide lightning protection. The only post curing process is to apply Polane® T polyurethane enamel paint in order to provide a durable, long-lasting finish.

The certified Hartzell ASC-II advanced structural composite propeller provides an optimum combination of weight, cost, durability and performance. The evolution of Hartzell composite propeller technology is about to create a revolution in general aviation propulsion.



LIGHTNING STRIKE TESTING

The Hartzell ASC-II incorporates an embedded aluminum mesh screen which allows it to survive direct lightning strikes shown here in testing with a 200,000 amp charge.



DESIGN PERFORMANCE OPTIMIZATION

- » Intensively tested, resulting in first FAA certified advanced structural composite designed specifically for general aviation applications.
- » 30% less weight per blade than aluminum blades.
- » 50% reduction in inertia for smoother operation.
- » Ability to repair erosion damage results in life cycle cost competitive with metal blades.
- » Durable carbon / Kevlar® monocoque construction.
- » Strength of carbon and proprietary molding process permits use of thin, high performance airfoils.
- » Stainless steel bearing surfaces for improved thrust bearing performance.

MANUFACTURING PROCESS OPTIMIZATION

- » Utilization of a resin infusion process permits the use of dry fiber plies of carbon and Kevlar® in place of more expensive pre-preg materials.
- » Dry fiber plies are easier to handle, reducing lay-up labor.
- » Automated resin infusion molding process to reduce labor input required.
- » Integrated stainless steel shank design is co-molded to eliminate the need to apply secondary retention windings or fasteners later in the manufacturing process.
- » Electroformed nickel erosion shield length reduced due to the use of an embedded aluminum screen for lightning protection.
- » Erosion shield is co-molded to eliminate installation labor.
- » Integral pitch change knob reduces parts count and eliminates installation labor.



BUILT ON HONOR

The phrase "Built On Honor" is as applicable today as it was at Hartzell's founding. It means each Hartzell propeller is designed, engineered, and built by highly qualified professionals using the most advanced technology available.

When you buy a Hartzell propeller "Built On Honor," you can count on the ultimate in performance... and a propeller optimized for your needs.



The Hartzell ASC-II is backed by the same outstanding service and support provided for any of our propellers, including a worldwide network of audited repair / overhaul centers and 24/7/365 technical support availability. This service and support system has a wealth of experience with Hartzell composite propellers and was developed to meet the demands of airline operators to help keep you in the air, not on the ground. See our website, www.hartzellprop.com, for your nearest recommended repair station.

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