Official Magazine of the
American Composites Manufacturers Association

May 2008

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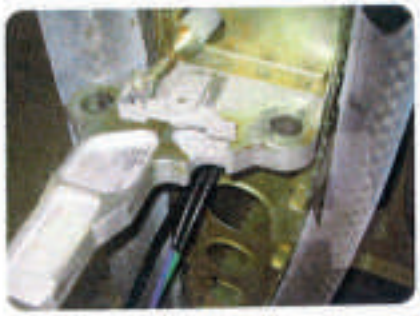

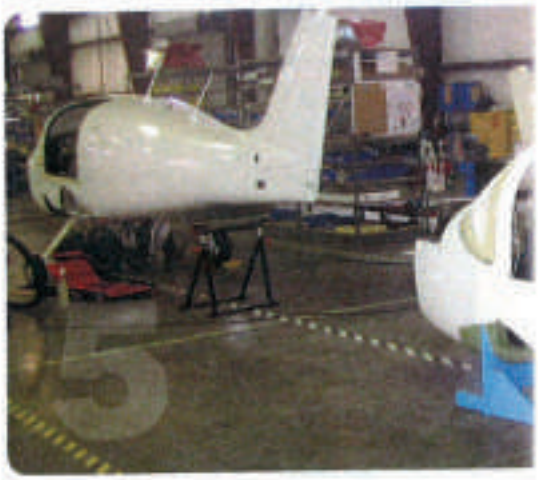
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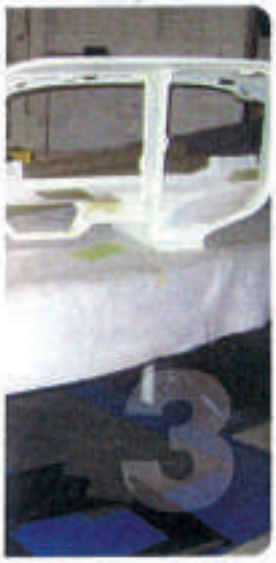
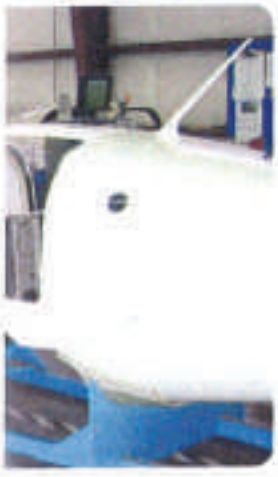




Liberation from the Ordinary

. Liberty Aerospace Soars With its XL2 Airplane

By Scott M. Lewit

Located on a stretch of eastern Florida called the "Space Coast," it's no surprise that Melbourne is home to Liberty Aerospace Inc. Founded in 2000, The company manufactures and markets the Liberty XL2, a certified two-seat touring aircraft designed for private pilots.

At first glance, those pilots have little in common with the astronauts working an hour north at Kennedy Space Center. The XL2 measures only slightly more than 20' long and reaches a maximum operating maneuvering speed of 115 mph, while the space shuttle looms approximately 150' tall and travels at more than 17,000 mph. But the people who climb into the cockpits of both have two things in common: They are adventurers who love soaring into the skies and they are better enabled thanks to advanced composites.

The innovative team at Liberty Aerospace sought to create a next generation, advanced aircraft at the lowest possible purchase price and operating costs for adventure-seeking pilots. The result was the XL2, which has a central body—or fuselage—constructed of composites and removable wings and other control surfaces made from aluminum.

I was intrigued by the choice of materials for the XL2: The benefits of a composite fuselage were clear, but the selection of metal wings and control surfaces surprised me. Since my company, Structural Composites, is only a few miles down the road from Liberty Aerospace, I hopped in my car recently to tour the aerospace company's 52,000-plus square foot facility at the Melbourne International Airport.

1. The Liberty XL2 proves that carbon fiber prepreg construction can be used in an affordable aircraft.
2. Parts are placed in this fixture and trimmed to shape.
3. The instrument Console of the XL2 is made from Fiberglass prepreg.
4. Removable wing connection detail.
5. The production assembly line at Liberty Aerospace

A Certified Success

Prior to touring the facility, I received a brief history of the XL2 from Jason Russell, chief design engineer at Liberty Aerospace. The plane has its roots in the Europa, an experimental kit plane designed by Ivan Shaw. Joining Liberty's team of engineers and designers, Shaw helped the company develop a design concept for the XL2. The company's goals were to create an aircraft with some of the following requirements:

- Low price
- Economy and ease of maintenance
- Advanced structural materials offering strength and durability
- Excellent handling

In April 2001, the Liberty XL2 departed on its maiden voyage, and for the next several years, the company painstakingly developed and tested the plane's spin, fatigue, weight and balance, and more.

In 2004, the Federal Aviation Administration awarded Liberty Aerospace with Part 23 Type Certification for the XL2, recognizing the aircraft's airworthiness standards. It was the first two-seat aircraft to be awarded certification in more than 30 years. In addition, the XL2 was the first piston-engine aircraft to be certified with a Full Authority Digital Engine Control (FADEC) system. Simply put, a computer controls the engine.

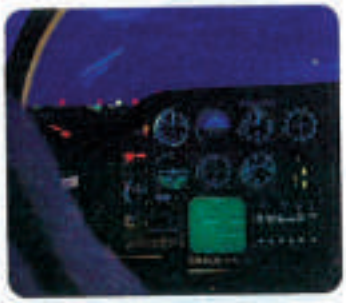
While the company is proud of its certifications, customers may be more impressed with some other figures: The price for the XL2 ranges from $188,000 to $212,000. The aircraft sips fuel, using only 5.5 gallons per hour at a cruising speed of 125 knots. That's more than 26 miles per gallon—a welcome number for

Into the Wild Blue Yonder

A tour of Liberty Aerospace would not be complete without a trial flight. After a preflight check with the help of my instructor Paul Everitt, business development manager for Liberty, I enter the XL2 by climbing on the wing, putting my feet in the cockpit, then sliding into the seat. The cockpit is very spacious, and the carbon fiber seats are molded into the fuselage. The seat is fixed so the rudder pedals have move to adapt to your body size. The large windows allow extended visibility, and the instrument panel and controls are all logically placed for easy access.

The XL2 contains a four-point seatbelt compared to the normal three-point seatbelts in other aircrafts. Everitt explains other differences of the aircraft compared to the widely used 172SP manufactured by Cessna:

- The XL2 utilizes a stick instead of a yoke to .
- Feet control the rudders.
- The brakes are finger-controlled on the center console.
- The XL2's front wheels do not turn the rudder controls.
- Levers near the throttle control act as brakes for the left and right main wheels.
- The rudder controls turning during taxiing.



The XL2 is approved for Full Authority Digital Engine Control (FADEC), which means a computer controls the engine. This offers several advantages: It's simple for the operator. A computer controls the electronic fuel injection and fuel mixture, so the only engine control is the throttle. The computer scans the engine parameters and optimizes it several times a second. The FADEC system consists of two redundant computer systems: If one experiences a problem, the backup system takes over.

Starting the engine is about as easy as starting a car. After obtaining authorization from Melbourne International Airport traffic control tower, I taxi to our designated runway. After only a little throttle, the lightweight plane begins to move. A slight pull with my finger and the plane turns nicely. Once moving, I don't have to use the finger brakes much as the rudder is effective at staying on the centerline.

Everitt explains takeoff procedures as we taxi. "The only difference you will notice is that you do not need to rotate much to take off," he says. "The XL2 uses push-rod controls throughout instead of cables. You simply let the plane build up speed and apply slight back pressure on the stick."

Once cleared for take off we taxi onto Runway 5. The XL2 accelerates smoothly. Once we reach 60 knots and apply back pressure, we are airborne. We reach 2,000 feet and head south. I enjoy the spectacular view from the cockpit: Low wings and large windows give the sensation of being in an open cockpit airplane. During various maneuvers, I notice that the plane is very responsive and smooth. I could hold a steep turn without putting too much back pressure on the stick or adding a lot of additional power.

On route back to the airport, Everitt discusses landing the airplane. "As we get close to the runway, I will tell you when to pull out power, flare the aircraft normally and then just wait for the slow sink toward the runway, holding her off slightly until touchdown," he says. As advertised, the landing is easy and smooth.

As we taxi back to the ramp, I think what a nice job Liberty has done on the XL2. Liberty Aerospace is truly an American success story!

pilots who've watched the cost for aviation fuel skyrocket to more than $5 per gallon.

Liberty Aerospace has clearly achieved its goals of creating an advanced airplane with low purchase and operating costs. Having learned a bit about the company and its pioneering airplane, I was anxious to begin my tour and see how the XL2 is built.

Inside the Composites Layup Shop

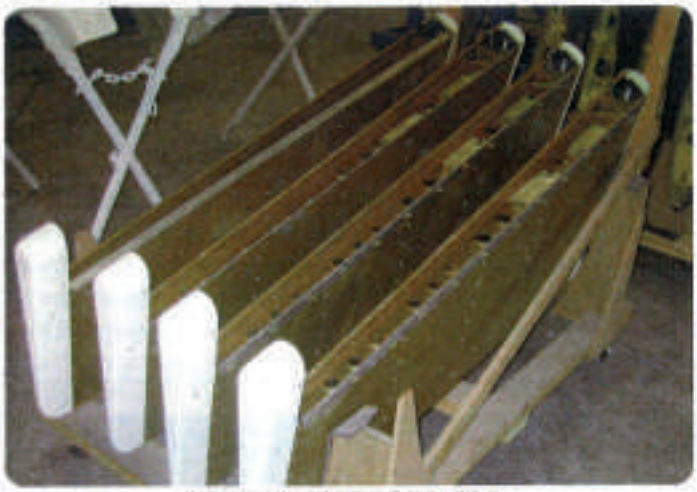
Liberty Aerospace is currently in full production: It's manufactured more than 100 aircrafts and has a backlog of orders around the world. The company's main facility is divided into three primary segments: the composites layup shop, the cure and finish shop and the assembly area.

As Russell and I leave the executive offices and walk toward the composites layup shop, he answers some of my questions about using a combination of composite and metal materials. One of the reasons that Liberty Aerospace selected aluminum wings was to facilitate maintenance. "Wings stick out, and things that stick out tend to get bumped," says Russell. "Repair on a composite wing is a big deal. The expense factor and difficulty in locating the FAA-certified expertise to execute the repair did not fit our 'low cost to maintain' mission."

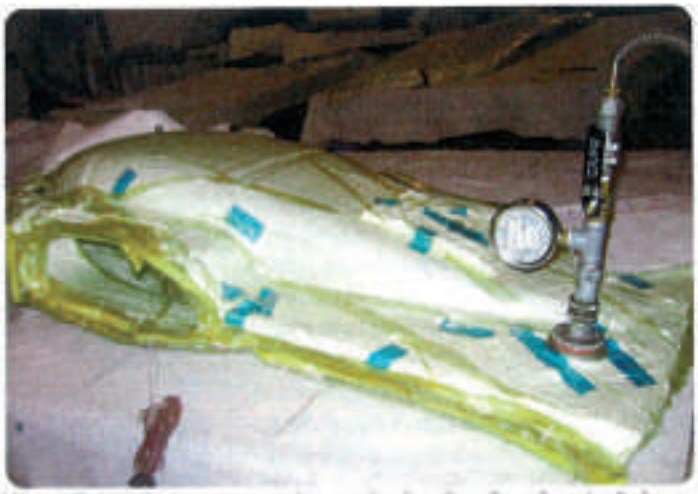
Molded Fuselage for the LX2 after being oven cured. When trimmed the part weighs between 101 and 103 lbs.

Another factor in utilizing aluminum is having removable wings. "Much of our market is supplying trainer aircrafts both here and overseas," says Russell. He continues, "Wings that can be taken on and off quickly are a plus for storage, transport and airplane maintenance." It takes two people approximately five minutes to install the wing on an XL2. So if the wing sustains minor damage, the hangar can swap out the wing and have the plane up and flying again in minutes.

Russell and I enter the composites layup shop, where construction occurs on the XL2's carbon fiber prepreg composite fuselage. I immediately notice that it's ➤



Rudder assemblies for the XL2.



Wheel Fairing being vacuum bagged using the glove bag technique.

climate controlled and ultra clean. Workers in pristine lab coats and gloves are busy placing the prepreg reinforcement into molds or bagging parts that have had material laid in them.

I'm introduced to Adam Maxfield, composites shop manager, who explains that we are in the Clean Room, where Liberty stores, cuts and places the prepreg onto the mold. Rolls of prepreg are stored in a walk-in freezer prior to kit cutting along with completed kits. The rolled goods are taken from the freezer and placed on a Gerber CNC fabric cutter. Workers then cut the kit, inspect it for quality and bag the kit for later use in an assembly or sub-assembly.

"The assembled kit will have all of the materials needed for that part of the operation, including the prepreg carbon and fiberglass, lighting strike material and film adhesives," says Maxfield. He notes that fiberglass prepregs are used to break the electrical connection between the carbon laminate and aluminum components to prevent galvanic corrosion.

When needed, kits are taken from the freezer and warmed to room temperature before being removed from the bag. The material is then carefully laid and pressed onto the designated tool using special rollers. "We are building a certified aircraft, so we are required to track every material and every processing step," says Maxfield. "Sign-off sheets for quality are a constant throughout the operation: If it's not signed off, we cannot proceed."

The fuselage is the largest single component of the aircraft. Bagging this part is no easy task, nor is laying the many plies of reinforcement. The part uses a 54' long vacuum bag that fits around the three-piece mold. Prepreg reinforcements are laid in 3- to 4-ply stacks, and then debulked through vacuum bagging. After debulking, the bag is removed and more reinforcement

Adam Maxfield shows a prepreg kit being stored in the freezer.

stacks are laid. The process is repeated until the full laminate stack is completed.

"Some parts of our laminates consist of 33 to 99 steps, which can equal up to thousands of plies of material, some with core, so you can imagine the effort needed to get the part ready for the oven," says Maxfield.

Watching the crew drape the prepreg into the tool, I notice the overlaps are smaller than the minimum two inches used in the marine industry. Since much of my experience is in the marine market, I ask Maxfield to explain the difference. He tells me, "Our overlaps are a minimum of ¼ inch and are a maximum of one inch, which is adequate for load transfer. We are always trying to save weight."

Once the layup is completed, the part is again bagged and made ready for the oven. Walking around the shop it is clear that excellent vacuum bagging skills—and patience—are job requirements at Liberty. "Our console is a challenging part to produce. It consists of three molds, each of which is preloaded with fiberglass prepreg," says Maxfield. "We then put the molds together and lay prepreg over the seams. Once this is done and passes inspection, we then proceed to bag the part."

Liberty uses a "glove bag" technique to bag the inside of deep parts with limited access, such as the wheel fairing. "We use two bags, one large and one small, which have been sealed on three sides with tacky tape," explains Maxfield. "We take the small bag and flip it inside out so the tacky tape forms a seam in the center. The small bag is inserted into the cavity and seals to the larger outer bag."

Workers at Liberty Aerospace lay prepreg carbon reinforcements into the mold.

Curing, Finishing and Assembly

Once all checks and cross-checks are made on the bagged part, it moves to the cure and finishing shop. This is where you really see the airplane taking shape. Cured parts are in various stages of trimming, assembly and finishing.

Once in the shop, I pick up an unpainted fuselage, and I am shocked at how light the part is! Maxfield tells me the XL2 composite fuselage weighs between 101 and 103 pounds. Not only is the weight amazing, but the narrow range of variance between the

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parts clearly demonstrates the benefit of the prepreg and the tightly-controlled manufacturing environment.

I walk over to Liberty's two ovens used for curing parts. Cure-time depends on the part and the laminate schedule. Maxfield discusses the operation: "Our thicker laminates undergo a soak-dwell, where we heat the part to 190°F for two hours, then raise the temperature to 270°F for 1.5 hours," he says. "Thinner 6- and 2-ply laminates can go directly to 270°F and will need to stay at temperature for 120 to 150 minutes."

When a completely bonded fuselage is placed in the oven for post cure, an employee at Liberty Aerospace attaches thermocouplers to it to monitor temperature specs and regulations throughout the oven cycle. Documentation is required to produce a certified aircraft.

Once out of the oven, components are cooled and de-molded. Next, they are trimmed and integrated with other assemblies. Trimming is controlled with full-scale templates and drill jigs. Then it's on to the finish shop, where the surface of the cured assembled parts are smoothed using a lightweight fairing compound. The surface is sanded, painted and sent to assembly.

The assembly area at Liberty operates like a manufacturing line. The plane rests on carts until it is sufficiently built to ride on its own wheels. Airplanes—like boats—need various wires, cables and sub-components installed. However, unlike with boats, everything needs to be documented and signed off by an FAA-certified inspector before moving to the next step.

While Liberty Aerospace produces the composite fuselage on site, it has a contract with S.C. Constructii Aeronautics S.A. in Romania to fabricate the chassis, wings and various metal parts. All the pieces come together in the company's production unit in Melbourne. The headquarters also houses a flight test and delivery center. (See "Into the Wild Blue Yonder" for a glimpse at a test flight.)

After touring the plant, I better appreciate the hard effort and sleepless nights the Liberty team spent designing, developing and certifying this aircraft. The risks were high, but Liberty is starting to see the rewards and flying high with its XL2. CM

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