

Project EXtra



We are about to embark on an exciting adventure! This is *Model Aviation's* first Giant Scale construction article and we're presenting it in a "build-along" monthly series. Join us as we talk frankly about products and services, opinions and options, tips and techniques, and discuss the rationale behind many of our component choices.

This series will have widespread value for *anyone* building *any* model aircraft. Consider this a set of "how- to" articles that use a particular Giant Scale aircraft as the demonstration platform.

Back to Basics

Scale Aerobatics (SA) has been growing steadily in popularity during the last several years. Nearly every Radio Control (RC) manufacturer now offers one or more scale aerobatic models. In addition, the almost-ready-to-fly (ARF) market has grown by leaps and bounds, and many of the ARFs available are International Miniature Aerobatic Club-style (IMAC) SA airplanes.

In this series we focus on a segment of the hobby that is gaining popularity, SA, while revisiting a skill set that is losing ground due to today's top quality ARFs, but central to our hobby—building your own model.

This six-part series will focus on the construction of an original design 35% Extra 300LX. An airplane of this size is certainly not for everyone, and in the long run can be quite expensive to complete.

Even if you're not interested in building this aircraft, don't let that stop you from getting some useful information from these articles! These models are state-of-the-art for performance RC, so the information we present should interest most modelers.

We'll cover topics from foam sheeting techniques to computer radio basics. And, if you decide that this is the aircraft you've been waiting for, you can purchase the plans and build right along with us. We'll highlight techniques and tips in the articles and also offer a step-by-step instruction manual with detailed photos via the *Model Aviation* internet site as a PDF download, www.modelaircraft.org/mag/index.htm.

The Aircraft

The Extra Corporation's naming convention can be somewhat confusing and some RC manufacturers even get it wrong! To set the record straight, this aircraft is the Extra 300LX. The "300" designates both the design lineage and the engine's horsepower. The L means it's a low-wing two-person aircraft, and the X designates the experimental oversized rudder and elevators.

There was never an aircraft produced by Extra that had the moniker of 330. Two airshow performers put "Extra 330" decals on an airplane and the name just stuck. You can order a 330 HP Lycoming for your Extra 300.

The 330 horsepower IO-580 is a fairly common engine in most newer aerobats these days. I recently saw an Edge 540 with one at an IAC meeting but I didn't hear anybody calling it an Edge 580!

Phil Knight has modified the stabilizers and elevators on his personal aircraft. The tail modifications are not FAA-approved and therefore cannot be type-rated in the US. However, the modifications can be ordered from the factory, but the airplane will be designated as Experimental.

In this case, the airplane will be called an Extra 300LX or 300SX (not 330 and not 300XS as most model manufacturers mistakenly have it). But be assured, officially, there is no such thing as a 330!

The airplane we'll be building is the third version of a design I created four years ago and built with the help of Norm Cassella, renowned IMAC Nationals Unlimited champion and an early Tournament of Champions (TOC) competitor. Norm also designed and built one of the first competition level biplanes, the Pulsar.

Originally I chose to design an Extra because it's one of the most neutral-flying scale precision models available. By neutral I mean that the airplane reacts with pure motion to the control inputs; rudder imparts only yaw with no tendency to pitch or roll, aileron roll is on axis, and throttle does not affect altitude or heading.

I don't know of any scale models that are perfect, but in general the Extra is as close as it gets.

At the time of my initial research, no manufacturers offered an Extra in the size and with the 3D capabilities that I wanted. Today however, there are several good choices

for an Extra in sizes that are close to this one. Two of the best designs available are the 33% Radiocraft Extra and the 31% and 33% Aeroworks Extras. All excel in 3D and in precision. (*See the manufacturers list for contact information.*)

Designed for Precision and 3D

I chose the two-seat L version over the single seat S model because it has tested to perform slightly better in knife-edge flight due to its more forward profile canopy. Unfortunately, that large canopy gives us a weight penalty but the tradeoff is worth it.

Besides being a very neutral and forgiving aircraft for precision competition flying, the Extra (when duly modified) is also very good at freestyle 3D flying such as torque rolling and harrier flight.

This airplane has been specifically designed to take advantage of characteristics that make it suitable for both 3D freestyle and to keep it as neutral as possible for competition. The stab has been lowered about 8% to reduce pitch coupling. The elevator and rudder utilize the “X” experimental design criteria (which, by the way, were influenced in the full-scale world by successes in the RC arena) for more positive tumbling and 3D freestyle maneuvers.

Some of the other design nuances are for strength, longevity, and aesthetics while trying to keep the airplane as light as possible. For example, the landing gear has been angled forward to help change the twisting force from landing to a more survivable compression force, and aluminum “L” brackets transfer the load to the motor box eliminating the need for a heavy plywood plate.

The original prototype was built with a motorbox that captured the wing tube. With this design, the vibration from the motor was transferred more directly to the wings wreaking havoc on ailerons, hinges, servos, and linkages.

I noticed that designs that did not capture the tube seemed to be much smoother so in the second design I stopped the motorbox short of the wing tube. It worked! The wing tips and ailerons vibrate much less and the hardware seems to incur less wear and tear.

One of the unique qualities of this design is the extensive use of laminating balsa over long expanses of thin light plywood. The process creates a strength in shear that outweighs the sum of the two materials and makes the structure light while keeping it rigid.

Its shape is also different from other designs. The full-scale Extra is slightly rounded at the front, but for ease of construction and simplicity most models are designed in a wedge shape utilizing completely straight lines. Viewed from the top, the fuse sides form a long triangle from the rear of the cowl to the tail and the transition to the cowl is often a sore spot.

I wanted to do something about that without creating any additional complexity or weight so very slight angles were designed into the airplane to fill it out slightly, getting rid of the ‘starved horse’ look and the strict delta shape. It’s not a huge change but I think it helps the overall appearance. It also helps to smooth the transition from the cowl to the fuse.

In IMAC, percentage of full scale is calculated using the span of the wing. In this case, the full-size L has a wingspan of 25 feet, 3 inches, giving us a 35% span of 106” for our model. I kept the wing planform, the root and tip chords, and the overall length at

35% scale but made the width of the fuse a bit smaller at 33%. I like the sleeker look of the slightly slimmed, but still scale-shaped, fuse. Keeping the fuse smaller may help to keep the weight down, increase rigidity and slightly reduce drag (although in my opinion drag is not a problem in Scale aerobatic models). Mostly I did it because I like the way it looks!

Our second prototype, the finished one seen here flying and on the cover, came in at 27.5 pounds ready to fly. With a huge wing area of 2,060 square inches, that gives us a very light loading of 30.75oz/sq. ft. Even at our mile-high altitude here in Colorado, the Desert Aircraft DA100 engine pulls this airplane out of sight with the ability to accelerate out of a torque roll. At sea level this combo would be ballistic!

In normal flight the airplane floats on the wing like a glider and for 3D it's slow and very agile. Not being one to rest on success, this third rendition strives for an even lighter weight. I opened up the fuse sides, eliminated the formers in the rear, and made a more careful selection of wood, including some contest-grade balsa sheeting for everything except the main wings. We're hoping to take a pound off the airplane and get it down to 26.5 pounds which would bring the wing loading down into the 20s.

The Design

The design for this airplane is rather conventional and compares to other SA aircraft currently being produced. It was specifically designed around Desert Aircraft's (DA) twin-cylinder 100cc gas engine. DA engines are light, powerful, and very reliable, but best of all the customer service from DA is second to none.

Wings and stabs are each two-piece and removable for storage and transport; they slide on to an aluminum tubing spar. The fuse sides are of 1/8 light ply but are nearly 70 inches long, so finding the wood will take a little legwork. I found a 4'x8' sheet for about \$16 from a local plywood specialty distributor, and after a bit of research was able to find several sources in my area.

Cowl, wheel pants, canopy, and landing gear cuffs are all supplied from Aeroglass. Flying Foam.com offers very high-quality CNC-cut foam parts. However, if you want to cut your own foam parts the plans have templates for cutting. While the first two airplanes were built with parts that we cut at home, this airplane uses foam parts supplied from Flying Foam.com.

The 1.5" x 36" .049 wing tube, 5/8" x 16" .035 stab tube, and the landing gear are from TNT landing gear. The tubes come with the phenolic sockets that you will need for construction. (A complete list of supplies and suppliers is in the manufacturers list.)

We'll discuss the components that we chose as we install them. The rest of the airplane is balsa and light ply with only three pieces of aircraft ply, namely the motor box sides and the landing gear plate.

Dr. Erik Richard, a National Oceanic and Atmospheric Administration (NOAA) physicist, will be constructing this airplane for our demonstration purposes. Erik has spent his lifetime building and designing model aircraft and has been exposed to design since early childhood. His father was an aeronautical engineer with many famous full-scale designs and was also an avid model designer/builder.

This design has been an evolving process and many good changes have come from the results of testing. We are building this third model in as close to real time as possible for conventional publishing. In an airplane of this size and power, the equipment

and hardware you use needs to be different from what you might use with smaller glow-powered aircraft.

We have been very careful about our selections to keep things simple yet strong enough to handle the job. Pay careful attention to the linkages and fasteners that we use and please don't risk off-brand or standard servos or low-quality electronics. It's not just your airplane that is at risk, it's you and everyone around you. If you're ready, let's start building!