



AIR SHOW

Email digital pictures of you and your aircraft to editors@flyrc.com, and send a note describing your plane. If you have any flight shots, please include them!

White Knight

WARD SHELLEY ■ TRACY, CA

by Ward Shelley

[Editor's note: From time to time uniquely interesting projects cross our desks. Thus is the case with Ward Shelley's version of White Knight, Burt Rutan's mother ship to SpaceShipOne, the first successful civilian space craft with which Rutan was able to capture the Ansari X-Prize last fall. Such projects exemplify the innovative spirit of model builders, as well as the endless possibilities of model aviation. Indeed, Mr. Rutan won many model competitions before moving on to design and fly some of the most interesting aircraft seen in recent years. Congratulations, Ward, for a project well done.]

My White Knight has an interesting genesis. I like unusual airplanes, and in the back of my mind a small voice has been saying "Build a White Knight—must build a White Knight" ever since I laid eyes on photos of the big one. I was trying hard not to listen though; that airframe is a bit intimidating. Couple the complex build with unknown aerodynamics and the pair of ducted fans, and I just couldn't quite get started. But I really wanted to. One day early last winter, I was pushed over the edge.

A friend emailed me a link to the Nasty Toes Aviation website and suggested that I might find an interesting project there. Nasty Toes has complete kits, but what really caught my attention was their line of modular airframe components. You can buy a combination of wings, tail surfaces, fuselages, etc. and build up whatever you want. This concept was really appealing, and that little voice suddenly became a bit louder. I



SPECS	
WINGSPAN:	93 in.
WING AREA:	832 sq. in.
FLYING WEIGHT:	64 oz.
WING LOADING:	11.1 oz./sq. ft.
LENGTH:	45 in.
RADIO:	flown with a JR8103 transmitter, JR NER-549 9 channel receiver, 2 Hitec HS-55 (elevator) and 4 Hitec HS-81 Servos (aileron and steering)
POWER SYSTEM:	2 Mega 16153 brushless motors with VAS400 ducted fans, 2 Jeti Advance 30 amp brushless controllers, Thunder Power 3S2P 4000mAh Li-Poly battery
FULL THROTTLE POWER:	30.6 amps, 300 watts; 4.69 W/oz., 75 W/lb.
TOP RPM:	26,000
DURATION:	20+ minutes
MINIMAL FLYING AREA:	RC club field w/smooth runway



PHOTOS BY WARD SHELLEY AND DAVE ROBERTS

just couldn't resist anymore. After some noodle time, I made up a parts list and sent off the email order. Just after Christmas, three large model type boxes showed up on the big brown truck. When opened, a mountain of Styrofoam parts covered my bench. Somewhere inside that mountain was my White Knight. Now I just needed to find it. The kicker was I wanted to have it ready by mid-February for the Mid Winter Electric Festival in San Diego.

DESIGN, ENGINEERING AND CONSTRUCTION
I had done some preliminary R&D before my original Nasty Toes order. Since the wing cores were just under 24 inches, I set the span to just shy of eight feet, making the scale about 1:10. I had also contacted Hobby Lobby for the servos, ducted fans, brushless motors, speed controls, and Li-Poly battery. These arrived on January 22nd, and then the project started in earnest. I had just over three weeks to pull it all together.

Unfortunately, Scaled Composites wasn't able to supply three views, so I laid out a fresh sheet of butcher paper on the workbench, gathered up dozens of pictures from the internet, and sketched out the basic airframe. On January



25th I cut the Styrofoam cores for the fuselages and the main cabin. I set them in the back of my Jeep and realized that I could build the entire aircraft as a single piece with removable wingtips and stabilizers. The added strength required to make the fuselages removable would have added significantly to the weight of the project. Since I had set a goal to stay under four pounds, the once piece approach seemed the way to go.

SOLVING PUZZLES

White Knight presented a number of design challenges. The first on the list was how to steer the model on the ground. The fuselages taper down to a very small cross-section in the front, and I didn't want to have big bellcranks sticking out of the side of the noses. Instead, I chose to steer the rear wheels and built a set of custom landing gear attached to a small



AIR SHOW

I added a few clicks of down trim and then brought the WK down for a feathery return to earth. THE LOW WING LOADING MAKES IT FLOAT LIKE A GLIDER, so I only had to overcome my nerves for a nice landing.



piece of plywood that was eventually buried in the foam. I attached the nose gear to a piece of carbon fiber arrow shaft. This became a structural element that carries landing loads back



into the fuselage where the foam could tolerate the load. I also stiffened the wings and the fuselages with .007 carbon tape and epoxy applied flat on the surface or in slots as appropriate.

I sliced the wing tip panels off just past the fuselages and cut balsa ribs to face both cut faces. A small carbon and dowel joiner made the tip removable. I glued three-pin Deans connectors to the ribs to automatically connect the aileron servos when the tips were plugged in. I also added a small carbon-locating pin near the trailing edge. I routed pockets into the bottom of the wing for the aileron servos. The ailerons were cut from the wing, then faced with balsa to provide some stiffness.



The servos for the elevators were routed into the vertical tails with the wiring run to the wing in-grooves routed in the foam. Once the wiring was in place, I used some Red Devil lightweight spackle to fill the grooves. I attached the elevators to the fins by inlaying $\frac{3}{8}$ -inch balsa into the fins and then drilling and tapping for 6-32 nylon bolts. I made small plywood control horns and used z-bends on the elevator with Dubro micro hardware on the servo control arm.

I used slow-setting epoxy and flocking to glue the fuselages to the wing and fill the gaps. Everything was blocked and jugged to be in the correct alignment and then left to cook off under lamps over night since the temperature was in the low 50s in the garage.

I then turned my attention to the main cabin. After carving and sanding for a few hours, it looked like the drawings and mated neatly to the center section of the wing. I added a hatch for the receiver and flight battery. After routing out an area to put the battery, I routed a second, deeper section for the receiver. I added plywood rails on the sides to attach the battery tray. I lined the bottom of the receiver section in $\frac{1}{16}$ balsa coated with CA and added a piece of Velcro to hold the receiver. I also added Velcro to the battery tray along with a safety strap of Velcro.

FINAL ASSEMBLY

It took a while to figure out how to align the main cabin and the wing. I ended up using a laser clamped to the ceiling in the shop with a diffraction grating to project a straight, plumb, laser line across the middle of my bench. With the wing centered on the

AIR SHOW



laser line, I used epoxy with milled fiberglass to glue the cabin to the wing. Another night with the lights saw the entire aircraft in one piece!

I then glued the motor nacelles to the main cabin and through into the wing, and routed out a space on the top of the cabin to install the ESCs. Since there was too much wire, I removed the shrink-wrap and made custom wiring for the speed controls. I added new shrink-wrap and glued them into the cabin. With the wiring covered in spackle, the construction was basically complete. I tried a couple of quick taxi tests and noticed a fair amount of flexing in the fuselages while it bumped down the road. A quick balance check showed that it was going to end up being a little nose heavy. I decided to add small diameter carbon arrow shafts to the tops of the fuselages from the trailing edge of the wing to the leading edge of the fin. The fuselages stiffened up considerably.

All of the foam surfaces received a complete sanding. The upper surface of the wing and the fuselages then received a coat of lightweight spackle that was thinned to the consistency of light whipped cream. Once dry, everything was sanded with a fine sanding sponge, and it was ready for covering.

I used UltraCote to cover the WK. The adhesive activated at about 15 degrees less than the foam melted. It was a challenge to get the covering to stick well without melting the foam. Since the WK has a number of compound curves, it was interesting trying to make the covering look clean. The main cabin was particularly fun. I cut several petal-shaped pieces and then pieced them together until it was covered.

I spent a couple of hours on the computer collecting sponsor logos and images for the fuselages. I printed them onto clear label stock and clear coated them with spray lacquer. Once they were attached I added the red swoops



using UltraCote. The final details were the cabin port-holes cut out of black EconoCote. With the White Knight logos added, the build was complete. When I placed the WK on the scale it toggled back and forth between 3 pounds 15.8 ounces and 4 pounds even, finally settling on my original target of 4 pounds.

AIRBORNE

The project was completed on Thursday night at 5 P.M. and packed into the van. We departed for the Mid Winter Electric meet in San Diego at 4 A.M. Friday morning. When we arrived in San Diego there was a 15-20 mph crosswind and rain. The rain and crosswind would stay constant for most of the weekend with only occasional breaks in the rain. Saturday afternoon at about 4 P.M. the wind and the rain faded away. The WK was readied with some last-minute programming since my primary transmitter died Saturday morning. With a range check complete and a quick taxi test, I decided it was time to try a maiden.

The WK was carried to the end of the runway and lined up. A few last-minute pictures were taken by the crowd, and the throttle was advanced. The WK accelerated quickly and tracked straight down the runway. It didn't want to fly off, so I fed in some up elevator. When it unstuck it pitched up sharply. After a few PIOs (pilot induced oscillations) I got the aircraft and the pilot settled down. The WK was flying! I throttled back and made some small adjustments to the elevator trim. Several passes were made to feel out the control response, which turned out to be very good. The elevator rates will be adjusted down some for future flights. It would fly on just a few clicks of throttle and cruise at a nice slow speed. With the throttle advanced, it flew fairly quickly. After five minutes I tried a couple of approaches. When the throttle was closed all the way down, the WK would pitch up and then settle into a slightly nose down attitude. I added a few clicks of down trim and then brought the WK down for a feathery return to earth. The low wing loading makes it float like a glider, so I only had to overcome my nerves for a nice landing.

CONCLUSION

I want to extend my thanks to Nasty Toes Aviation and Hobby Lobby for their support and inspiration. Without their help, my White Knight would have remained just an idea. I also would like to thank my family for being so understanding of my single-minded pursuit of this project. Finally, a shout out to my flying buddies who helped with the final preparation, shot video of the maiden flight, and stood next to me for moral support during the flight. Thanks guys! 🙏

Links

Hobby Lobby International, Inc., www.hobby-lobby.com, (615) 373-1444.

Nasty Toes Aviation, nasty-toesaviation.com, 425-870-4032

For more information, please see our source guide on pg. 161.