

REDEFINING THE SOUND BARRIER

BY STEVE SCHAPIRO



THE STARJAMMER: Music in the Air

What twinkles like a couple hundred stars, has the potential to be louder than the space shuttle, and can be seen tumbling through the sky day or night? It's the Starjammer, and its pilot and builder, Elgin Wells, EAA 373602, believes it could be the next generation of aerial entertainment.



For the past 14 years, Elgin has been building the ultimate air show plane, featuring 250 multicolored LED lights and a 4,000-watt onboard speaker system that plays music he has composed to choreograph his routine. “The Starjammer represents a new art form, or at least a new instrument for entertainment,” Elgin said. It’s like nothing anyone has ever seen—or heard—before. **Welcome to the Stradivarius of the sky.**

Creating a finely crafted musical instrument or building an airplane is not an easy undertaking, and no one knows that better than Elgin. “My deepest roots are in music,” the Atlanta-based singer, songwriter, and composer said.

He began playing trumpet when he was 9 years old, took up the guitar when he was 12, and was performing in bands by the age of 14. While becoming the Georgia state high school vocal champion and learning to play a total of 22 instruments, he picked up his father’s inventiveness. “I grew up with the mentality ‘if there is something you need that you can’t find, make it,’” Elgin said. “All it takes is a little thought, ingenuity, and some tools.”

At the age of 22, Elgin began carving his own experimental electric violins using some of the innovation that Les Paul pioneered with early electric guitars. He sought the assistance of an expert violin carver to teach him the traditional ways of making violins. Then Elgin added a fifth string to give his instrument the range of both a violin

and viola and included a cutaway like an electric guitar and tuning machines instead of ebony pegs. For testing the vibrations to ensure the nodes were in the right place for the sound he wanted, he built his own testing rig. After 800 hours of build time, the result was an instrument immune to the acoustic feedback that normal violins can develop when amplified. Following his passion, Elgin’s 40-year musical career has resulted in 12 albums and six Billboard songwriting awards. But music isn’t his only love.

ALL I WANT TO DO IS FLY UPSIDE DOWN

Growing up the son of a World War II P-38 squadron commander who went on to a career as a captain for Delta Air Lines, Elgin caught the aviation bug early. Elgin Sr. wanted his son to follow in his footsteps, but all Elgin Jr. wanted to do was fly upside down. “When I learned to fly, my dad made the mistake of buying a Citabria. I caged the gyros and drove around upside down,” Elgin said. “When he figured out that’s what I was doing, he sold the airplane.”

For the next 20 years, Elgin focused on his music—until his father bought him a sortie with an aerial laser combat simulation for his 40th birthday. Dogfighting in a T-34 reignited his passion for flight, and both father and son renewed their certificates. His dad bought a Decathlon, and it wasn’t long before Elgin was flying aerobatic competitions and air shows.

He won the first-time competitor award and finished sixth in his first competition in 1991, and he flew in the Intermediate division in the Decathlon through 1996. Elgin helped revitalize IAC Chapter 3 in Atlanta and became friends with Fred Meyer, the designer of the Acro 1, Atlantis, and the Meyer 360. In 1998, Elgin won the Unlimited class at the Southeast Aerobatic Championships in the Meyer 360, and for the next three years, he and his wife, Lisa, ran the regional competition.

THE PROJECT BEGINS

In 1996, Elgin purchased plans for an IAC One Design with the intent of modifying it for Unlimited competition. Like putting

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together a band, Elgin assembled a diverse group of friends to help him. Fred was commissioned to make a custom wing for the Starjammer, resembling a scaled-down Extra 300 wing.

To test the composite wing, Elgin went back to what he learned building violins. "At the time there were no known tests for structural integrity. Wood and metal distort before failing; composites just shatter," Elgin said. So he decided to use the same Chladni vibration techniques he used for testing his violins—just on a bigger scale. He set up the wings with large speakers underneath and sprinkled black pepper on top. He played various notes and frequencies to excite the pepper, causing it to form patterns on the wing showing where there was no vibration.

Once the wing was complete, Fred borrowed it to fly on a Meyer 360 while Elgin worked on the Starjammer's fuselage. He lengthened it 25 inches from the One Design plans for more stability, which made crafting the turtledeck more challenging. Because of the compound curves that run into simple curves, Elgin decided to make the turtledeck out of carbon fiber, but he needed help. His friend, Jim Fuller, came in and showed Elgin how to make the molds, and Elgin taught Jim how to do composites.

THE BIRTH OF A STAR(JAMMER)

During the building process Elgin had a career crisis: He realized there are only so many hours in a day. "I said to myself, 'I should really commit to either the music or to the flying,' when it dawned on me: With a few pieces of technology integrated into one venue, I could actually do both," Elgin said. "That's when I decided to integrate music into the performing aspect of the aircraft."

He was inspired by the approach Cirque du Soleil took in redefining the circus. "I searched for a way in which I could present novel aerial performances, enhanced by an

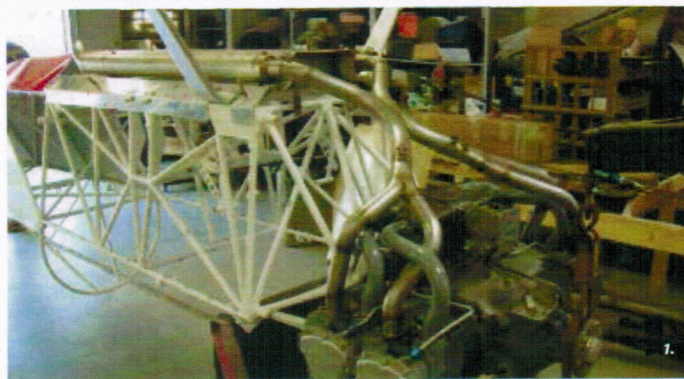
exotic, kinetic 'costume' (glamorous paint scheme, lots of super-bright LEDs, and copious smoke), and original music that could vary in mood to produce a moving experience," he said.

One challenge for air show performers is they don't hear the music during their routine since it is illegal to broadcast over communications channels. "Air show pilots are relegated to the status of 'deaf dancers,' hoping that the music they've chosen somehow adds to their aerial ballet," Elgin said. With most air shows having poor sound systems, "there is no chance of performing precisely to the music, like they do in ice skating, dance, or rhythmic gymnastics." Time to get creative.

THE SOUND SYSTEM

The first step was to look at speaker designs and mufflers. The challenge was to find a system that could play the music loud enough to be heard by a crowd from 3,000 feet away, while minimizing the sound of the engine so it wouldn't drown out the music.

Elgin chose to mount four police siren speakers in the wing roots—one facing up, one facing down—on each wing. Each speaker is capable of producing 120 decibels (dB) at a distance of 10 feet. "They are the loudest sirens I've heard outdoors," Elgin said. "They have a full range and are made of nylon, so they are weather-resistant." In the fuselage, he drilled 312 holes to install 10-inch, 500-watt woofers coupled with



1. Custom-designed, dual 4-foot mufflers are fitted to the belly during construction to help dampen the sound of the engine.



2. Black pepper forms patterns on the wing during vibration testing, using techniques from violin making.



3. Proving that all forms of art are related, Elgin combined his skills at creating musical instruments with his love of aerobatics. The result: a stunning live air and music show.

400-watt tweeters on both sides just behind the cockpit. The combination of speakers ensures that no matter what attitude the plane is in, there are always speakers pointing toward the crowd. "By placing loudspeakers on the aircraft, I sought to achieve a consistency of sound and synchronicity with the aerial performance that's nearly impossible to achieve through conventional means," he said.

The next issue to address was dampening the engine noise. Elgin built dual mufflers into a custom belly pan and lined them with fiberglass to make the engine as quiet as possible. Now he's looking at ways to eliminate the noise from the propeller using phase cancellation techniques.

One thing he worried about is the sound level in the cockpit. Elgin is essentially sitting inside a speaker cabinet that is able to produce anywhere from 150 to 200 dBs from the six speakers. Surprisingly, he said it's not very loud: "The first time I flew with the music I couldn't hear it." That was due in

part to not playing the music at full volume. But even if he had, he wouldn't hear much.

Elgin made his own helmet with molded earpieces similar to what NASCAR drivers wear that serves as passive noise reduction. Besides providing noise protection, he wanted the helmet to be lightweight and strong. Military surplus helmets tend to weigh around 3.5 pounds, meaning during a 10g maneuver, "you've got 35 pounds grinding on your neck while you're trying to look around and get your references." So Elgin took a ski helmet, replaced the Styrofoam lining with two layers of puncture-resistant Kevlar, and lined it with tempered foam. It weighs about 1.75 pounds.

Another modification that reduces cockpit noise is the speaker modulation. Typically, speakers are in phase with one another, pushing and pulling at the same time. "I reversed the polarity of the speakers so that when one is pushing, the other is pulling, so it tends to cancel out the waves inside the aircraft," Elgin said. "I can barely hear it. The lights are my primary cue in terms of timing."

THE LIGHTS

The Starjammer at night looks like the Christmas tree in Rockefeller Center, with red, white, blue, and green lights dotting the fuselage and wings. "The effect that I originally wanted was an airplane that would twinkle in the dark," Elgin said. "Kind of like how a bomb burst from a firework gives these little flashes of light." His first thought was to use strobe lights when he realized he could use the same musical instrument digital interface (MIDI) technology that he uses to control stage lights for his musical performances.

Just as he did when building his first violin, Elgin sought out help. Barry Smith, who owns a prototype company called 3D Partz, found extremely bright LEDs and built a MIDI control system to integrate the lights and the sound that is mounted just behind the seat. This allows Elgin to control each LED individually in time with the music. "I wound up with a system of light control that incorporates several hundred

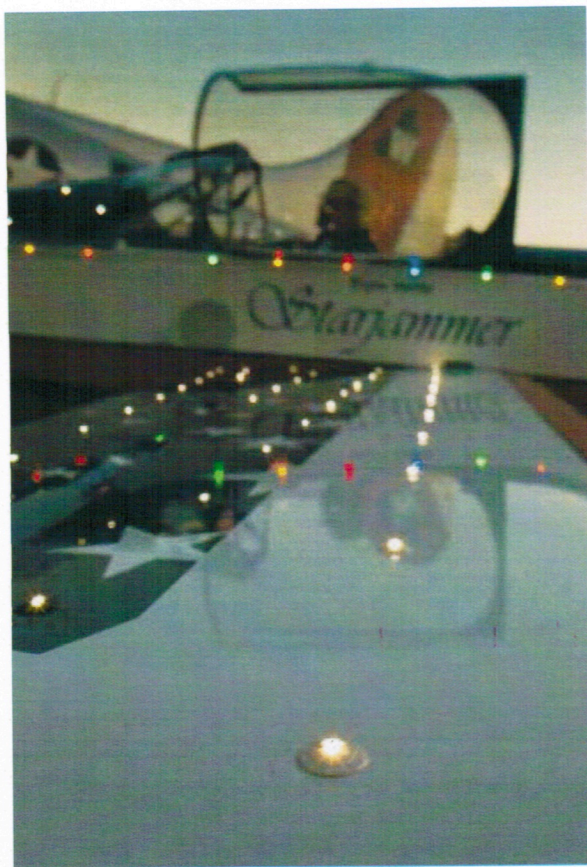
1. Elgin's custom-designed helmet weighs about half what a standard military helmet does, and it protects his hearing.

2. Elgin synchronizes his lights and the pace of his music with a touchscreen mounted within fingertip reach of his throttle hand.

3. One of four police siren speakers that can produce up to 120 dB of sound.

4. A matrix of high-power woofers and tweeters mounted in the Starjammer's fuselage and wing roots ensures the crowd will not miss a note of Elgin's performance.





The LEDs on the wing and cowling have 4 millimeter-high fences that prevent Elgin from being blinded by the light.

channels—more sophisticated than state-of-the-art concert halls,” Elgin said.

To install the LEDs in the wing and fuselage, Elgin had to drill hundreds of half-inch holes in the wing, cowling, and turtledeck. Each mount is about the size of a quarter and uses hot glue underneath and a vinyl donut tape seal on top to keep it in place. The mounts have 4-millimeter fences or blinders that prevent Elgin from seeing the

out, along with Will Moore, a Lockheed engineer who works on the F-22. Will also advised Elgin on stress and vibrations.

Each of the LEDs is connected to the MIDI box by two wires that had to be threaded through the airframe and wing. The critical part was where the wires might conflict with the aileron controls. “I fiberglassed the wires inside the skins of the wing, turtledeck, and cowling so they couldn’t come loose during the frequent +9g/-8gs I pull.”

To create an even more interesting visual effect, Elgin is testing the viability of adding LEDs to the propeller blades. If he can do it safely, he’ll be able to modulate the lights individually. “We’ll play around with the rpm of the prop and blinking them on and off so you get strobing patterns on the propeller,” he said.

To control the lights and sound, Elgin has a Dell laptop with a dual core processor and a solid state drive with no moving parts, which means it won’t be impacted by the g-forces.

BY PLACING LOUDSPEAKERS ON THE AIRCRAFT, I SOUGHT TO ACHIEVE A CONSISTENCY OF SOUND AND SYNCHRONICITY WITH THE AERIAL PERFORMANCE

lights directly. “I can see there’s a little glow, so I know they’re working, and I can pick up cues from them, but they don’t mess with my night vision at all.”

Creating the mounts was only half the job. “Wiring the lights was its own monumental challenge,” Elgin said. Once again, he had some friends help. Gene Timpson, a mechanical engineer, took the lead on the wiring project and also made custom fittings and brackets for the avionics. Barry helped

Elgin secure the computer behind his carbon-fiber seat, which was designed around his body. He took a mold of a race car seat and a fiberglass mold of his Softie parachute to create the perfect fit.

He controls the computer with a touchpad in front of his throttle, and sequences the pace of the music based on actual wind conditions. “I didn’t want to be at the mercy of the winds in terms of rushing to make my mark or delaying to make my mark,” Elgin

said. So he divided the music into segments of 20 to 30 seconds with a fermata, or hold note, which is as long as 15 seconds. He can start and stop the music without releasing the throttle by selecting one of the 12 icons that correspond to the 12 segments of music. “That way, the music follows me, and I don’t have to compromise the flying.”

He also has synced his performance with the lights about a second behind the music so the light and sound reach the crowd at the same time. One of the unexpected effects of performing with airborne speakers is the constantly moving acoustics. “The upper voices, especially strings, flutes, and horns, echo off the buildings, hills, and trees to create a fascinating dynamic spatiality,” Elgin said. He also noted that the rapid roll rate of the Starjammer creates a Doppler vibrato reminiscent of the rotating speakers in the legendary Leslie tone cabinet used by organists.

The visual artistry is completed with five smoke canisters painting a red, white, and blue ribbon through the sky. At night, LEDs mounted on the tail and landing gear facing backward light up the trail. For added safety, Elgin designed tip canisters out of aircraft aluminum with hinges for easy loading. He drilled relief holes in the rare case there is a detonation to direct the explosion away from the aircraft. On a recent test flight, his design proved effective. One of the canisters on the stabilizer detonated, but there was no damage to the aircraft.

With the lights, sound, and smoke, Elgin plans to bring his artistry, inventiveness, and creativity to the sky next spring. The Starjammer gives this musician a one-of-a-kind instrument to entertain air show crowds with a unique and memorable performance.

“I finally have my magnum opus. It brings together everything I love to do—flying and music,” Elgin said. “I feel like I just finished a Stradivarius and now my job over the next decade is really to learn how to play it well.” **EAA**



Steve Schapiro, EAA 1018168, is senior editor of EAA publications. He owns and flies a Piper Cherokee Arrow that has been part of his family since his father picked it up at the factory in Vero Beach in 1968. To see videos of Elgin Wells and the Starjammer in flight, visit www.SportAviation.org.