
Skip with his home-built simulator 691YE

# EAA Chapter 691 Newsletter
# March 2024

On the Web @ eaachapter691.org

EAA 691 is:

President: Will Fox

Vice President: John George

Secretary: Pierre Levy

Treasurer: David Young

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## Upcoming Events

**Meetings Schedule (unless otherwise noted)**

**9:30am - social time**

**10:00am - business meeting**

**10:30am - speaker/workshop/ training**

# Upcoming Events

Check out our Chapter Website at https://www.eaachapter691.org for more information about upcoming activities.

**Saturday March 16th** @ Los Alamos Terminal Building Skip Egdorf and Marc Bonem present “Flight Simulators for the Home and Chapter”.

A reminder that the EAA Chapter 691 March meeting  will be held this Saturday, March 16 in the Los Alamos Terminal Building. As usual we will have coffee and donuts at 9:30, a short business meeting at 10:00, and the featured presentation at 10:30.

**Experimental Aircraft Association**
**Green Chile Chapter 691**
**Location: Los Alamos Airport, Terminal**
**Meeting: March 16, 2024, social time (donuts and coffee) at 9:30 am, meeting at 10:00 am, presentation at 10:30 am.**

This Saturday, March 16th

## Speakers:
## Skip Egdorf and Marc Bonem
## "Flight Simulators for the Home and Chapter"

For questions or additional information: go to eaachapter691.org or email Marc at mbonem7@gmail.com. All are welcome.

# President's Report

by Will Fox

## Simulators Galore

There is a lot going on this month. This Saturday, March 16, 2024 at our meeting we will have a presentation on Flight Simulators by Marc Bonem and Skip Egdorf. They will have three flight simulators on hand for demonstration. You will be able to try out the flight simulators following the meeting. By the way, these simulators have been assembled and networked together using donated computers, control yokes, rudder pedals, and monitors from our members. They are also running FlightGear which is an open source application that is free. So, come to the meeting which starts at 9:30 with coffee and donuts and learn all about flight simulators and get to try flying one that you could build yourself for pennies on the dollar.

We also started the Build and Fly Project this month. For those of you who haven't heard, it a project for Young Eagles to learn how to build and fly Remote Control (RC) aircraft. We aren't talking drones here, but instead real scale balsawood airplanes that require piloting skills to fly them. We are doing the project in two phases. The first phase involves teaching the mentors for the kids how to build an RC model called the Sig Senorita which has a 5 foot wing span and weighs about 4.5 pounds. The second phase will have the mentors teaching the kids how to build and fly a Sig eKadet LT-40 that has a 6.5 foot wingspan and weighs about 6 pounds. Both aircraft are powered by electric motors. We are working with our local Academy of Model Aeronautics (AMA) club to teach the kids how to fly RC models. Walt Atchison is leading the effort and it is going to be a heck of a lot of fun. We are meeting on Saturday afternoons from 2:00pm to 4:00pm in the EAA hangar at the Los Alamos airport. All members are welcome to come and see what we are doing or join in to learn more about building RC aircraft.

Our schedule for the year 2024 is posted on the Chapter website at https://www.eaachapter691.org/upcoming-events if you would like to check out our upcoming events. Also check out our YouTube channel at https://www.youtube.com/@eaachapter691 for the latest videos.

I hope to see you all at Saturday's meeting. It will be a lot of fun.


691YE is a prototype Flight Simulator built by Skip Egdorf for our Young Eagles STEM program.

The EAA Chapter 691 Young Eagles Build and Fly project will teach kids how to build and fly remote control model airplanes.

# From the desk of the Vice President

By John George

## Oshkosh Anyone?

EAA AirVenture is the place to be in late July for all things aviation!

Whether your interests run to homebuilt aircraft, ultralights, classic and vintage planes, warbirds, heavy iron, hard to find parts, the latest avionics, or skills classes for building and flying, chances are you'll find what you're looking for at Oshkosh.

EAA Chapter 691 is exploring membership interest in organizing a flight of aircraft to attend the big show. The official dates this year are Monday July 22 through Saturday July 28. Most aircraft arrive on the Sunday before opening, which probably means leaving NM on Saturday or earlier.

**Let us know:**

**Do you want to go to AirVenture 2024?**

**Are you are interested in flying your own aircraft?**

**Are you looking for a ride?**

**Do you want to land/ stay on the show field (Whitman) or elsewhere?**

**Are you willing to stay for the entire show?**

**Do you want to camp on the field or find someplace to stay offsite? (nearby rentals may be hard to find)**

**Any other comments or questions?**

**Please answer these questions, and express your interest by contacting:**

John George john.altaera@gmail.com

Marc Bonem mbonem7@gmail.com

# Lunch in Las Cruces

By Marc Bonem

Roger Smith and I planned to go to the Cactus Fly-In in Casa Grande, AZ, but the weather forecast was for high winds on Sunday for the return, so we decided to go on a Friday excursion to Las Cruses.

It was a very scenic flight. We flew over a line of row volcanoes and Sandia (now Suika) Speedway south of Albuquerque. We also saw a huge open pit mine around Socorro. We flew along several reservoirs, proving that surface water does exist in New Mexico. New Mexico's magnificent geography is kind of standard everywhere, right?

Las Cruces has an un-towered airport with three runways and two FBOs. They also have self-serve gas, which is approximately $.50/gallon cheaper. Was that an old DC-3 parked near the southwest corner?

The airport restaurant (Jim Bobs BBQ) was a lot of fun. Decorations include the fuselage of an old airplane, which you can climb into. It still has full instrumentation and controls. One wall is covered with photos of pilots and their airplanes. Another wall is covered with children's coloring pictures (of airplanes). There are tables with old instruments and engine parts to examine. A spiral staircase leads to an enclosed balcony with a nice view of the airport. Other decorations include the usual assortment of old props, parachutes, and helicopter parts.

The restaurant offered great food. Though they bill themselves as a barbecue joint, I had a very excellent veggie burger. Roger had their highly recommended breakfast burrito. They offered a choice of approximately six different kinds of meats for the burrito and eight different kinds of sauces for whatever.

If you are looking for a destination for a $100 hamburger, this may be just the place.

# The Evolution of 691YE

By Skip Egdorf


## A Young Eagles flight simulator for EAA Chapter 691

**Genesis**

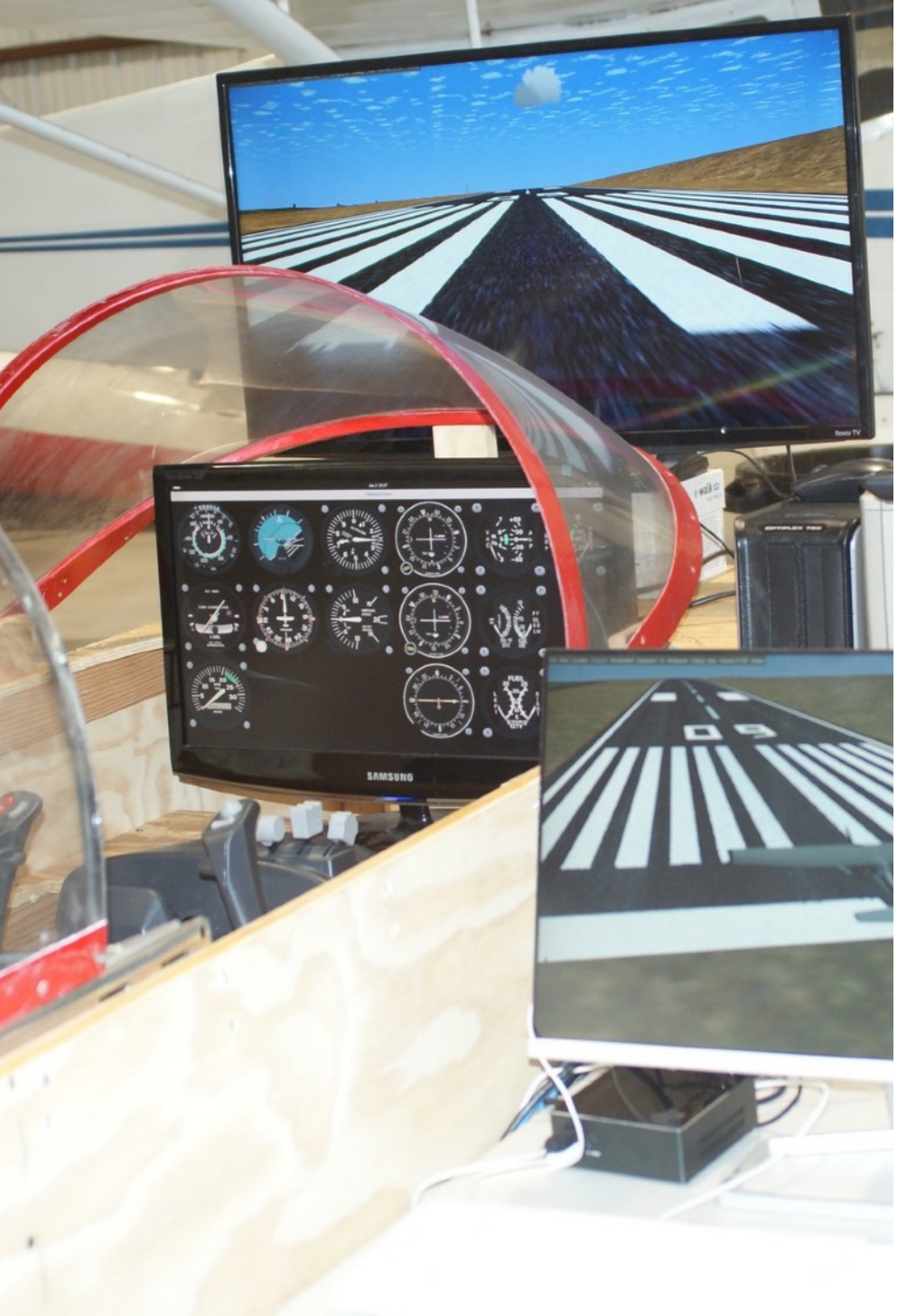
Over the last year or two, chapter members have developed interest, or assisted friends who have developed interest, in flight simulation. This usually begins with someone wanting a flight simulation system for their home computer for entertainment or education. This is a popular and worthy goal. The EAA and various vendors like Sportys encourage this interest. I believe that the chapter will benefit from supporting our members in working with such systems.

But also during recent Young Eagles events several of the Young Eagle participants have noted that they have home flight simulation systems. Discussions within the chapter noted how flight simulation seems to energize and encourage the Young Eagle participants. Having chapter Flight Simulator resources at our events would seem to be a wonderful marketing tool for maintaining interest and excitement among our participants. Naturally this led some in the chapter toward thoughts of how flight simulation technology might add to our Young Eagles workshops.

A normal desktop simulator can meet the needs of some parts of our workshops. However, looking to the Young Eagles events and the attraction of flight simulation, it seems that these events need something more than a desktop system to grab their attention. What might some marketing glitz look like?

Then came another idea in a quite separate realm. Our electric Dragonfly project has always had an aspect of investigating the aerodynamic and performance aspects of an electric conversion. For example, questions arise of how cleaning up some aspect of the plane might effect performance of the final plane. Questions arise regarding electric propulsion characteristics at different altitudes. Many aerodynamic and performance issues will need to be addressed. Flight simulation at a sufficiently technical level might help us address some of these issues.

And finally a suggestion was made: We have three Dragonfly fuselages in various states of completion. One of them will almost certainly never fly. Why not cut up one of them and make a full Dragonfly simulator?




The many uses of flight simulation listed above along with a great many other possible uses led me to the conclusion that if I wanted to address these many and various flight simulation possibilities, I needed to learn a lot about flight simulators. I really know next to nothing about flight simulator technology and if I wish to participate in any of the many possible projects, I need some significant education and experience.

Thus, I decided to build a prototype flight simulator so that I could explore the technology, begin to learn about flight simulators, and make my mistakes on something cheap and replaceable rather than on one of our few Dragonfly fuselages. And if I did it well, I might also learn something about how to attract and excite our Young Eagles participants.

**Requirements**

The primary goal is a personal one: for me to learn about flight simulators. What does that mean? We already have folks gaining experience in desktop simulators for proficiency training.

The challenge of doing a model simulator of a plane like the Dragonfly means that I need some experience in building something that is more of a full sit-in-it simulator. What factors arise when someone actually sits in and tries to fly a simulated flight? I should experiment with pilots ranging from Young Eagle participants through adult chapter members. Thus, it should support pilot sizes from a 4’ tall Young Eagle up through a 6’6” adult.

Searching out other simulator projects on the internet shows both a wide range of fantastic simulators and a rich academic field that uses flight simulation to augment aerodynamic research issues. Characteristics that many simulator projects display include multiple monitors showing the terrain to the sides to give more than just a view-ahead picture, and detailed custom controls with their associated electronics to interface to the host simulator system. One characteristic that makes sense to me is to separate the control panel in the cockpit from the

terrain view out of the cabin windows. How easy or hard is it to design a custom control panel? How easy or hard is it to support multiple terrain views?

Additional requirements involve an instructor or flight advisor outside the simulator controlling some aspects of the flight. For example think of initial testing of a new home built. When it is time to do one of the EAA test cards, might it be nice to have the pilot fly the test in the simulator guided by the flight advisor rather than just doing the flight as we do now? Another example recalls the chapter presentation a few months ago about *The Impossible Turn*. Might it have been an advantage to have participants sit at a simulator, take off from our airport, have an instructor fail the engine at some unexpected point and allow a test of a turn back to the runway? So having an instructor/controller position outside the simulator seems to be desirable.

Learning about the various software systems available, their characteristics, problems, and strengths is needed. Doing a full up simulator like the Dragonfly will take more computer power than a single desktop, regardless of how powerful a gaming machine it may be. Can clusters and networks of computers cooperate and coordinate to provide an open-ended powerful capability? How difficult is development of custom controls that mimic the actual Dragonfly? What knowledge of the simulator software will be required?

**Development**

Those requirements seemed to lead me toward a simple cockpit simulator that ican be modified at will to develop controls and sensors needed in something like the Dragonfly. Such a cockpit box will help let me experience what it takes to build a more realistic full simulator. Finally, if it just polished and complete enough, perhaps we can gauge interest among participants at our Young Eagles events.

As a side note, in the massive piles of junk in my hanger were an old single-place canopy from a wrecked biplane and a spare fiberglass seat from my Acrosport. It looks like I may have enough stuff to build a reasonable prototype simulator. The existing seat and canopy dictate a roughly 30” width. A length of about 72” allows for adjustable rudder pedal distance to accommodate the desired range of pilot sizes. A couple of sheets of plywood and some 1x2s and 1x3s later along with some glue and screws gave a simple cockpit box. Sitting in the box gave a very pragmatic placement for the control attachment and cockpit control panel placement.

Software choice was driven by a couple of requirements. I wanted to become familiar with a broad range of software systems. The commercial systems like Microsoft Flight Simulator and X-Plane were somewhat familiar to myself and other chapter members and I wanted to expand my knowledge. Most important was that I wanted in the future to be able to pursue more academic areas such as adding aerodynamics of a plane like the Dragonfly based on technical information like wind-tunnel data. Thus, I explored who is doing aerodynamic simulation research and what governmental and academic organizations used flight simulation tools. I settled on FlightGear as a very suitable tool. Studies comparing it with commercial systems such as MS Flight Simulator and X-Plane have found it to be similar in capability. In addition, the system's architecture expands far beyond the commercial flight simulations systems due to its broad use in academia. It fits my primary requirement of giving me a tool that allows exploration of a wide range of flight simulation areas.
The controls used a network of computers from the start. This allows older, less powerful systems to support the simulator as well as exploring and investigating the capability of a coordinated network rather than a single simulation computer. There is a master computer that manages the flight dynamics and aerodynamics. There is a system that manages the cockpit control panel. Finally, there are one or more terrain-rendering systems that control screens outside the cockpit showing various views of the terrain. All these systems coordinate and cooperate over a local network.

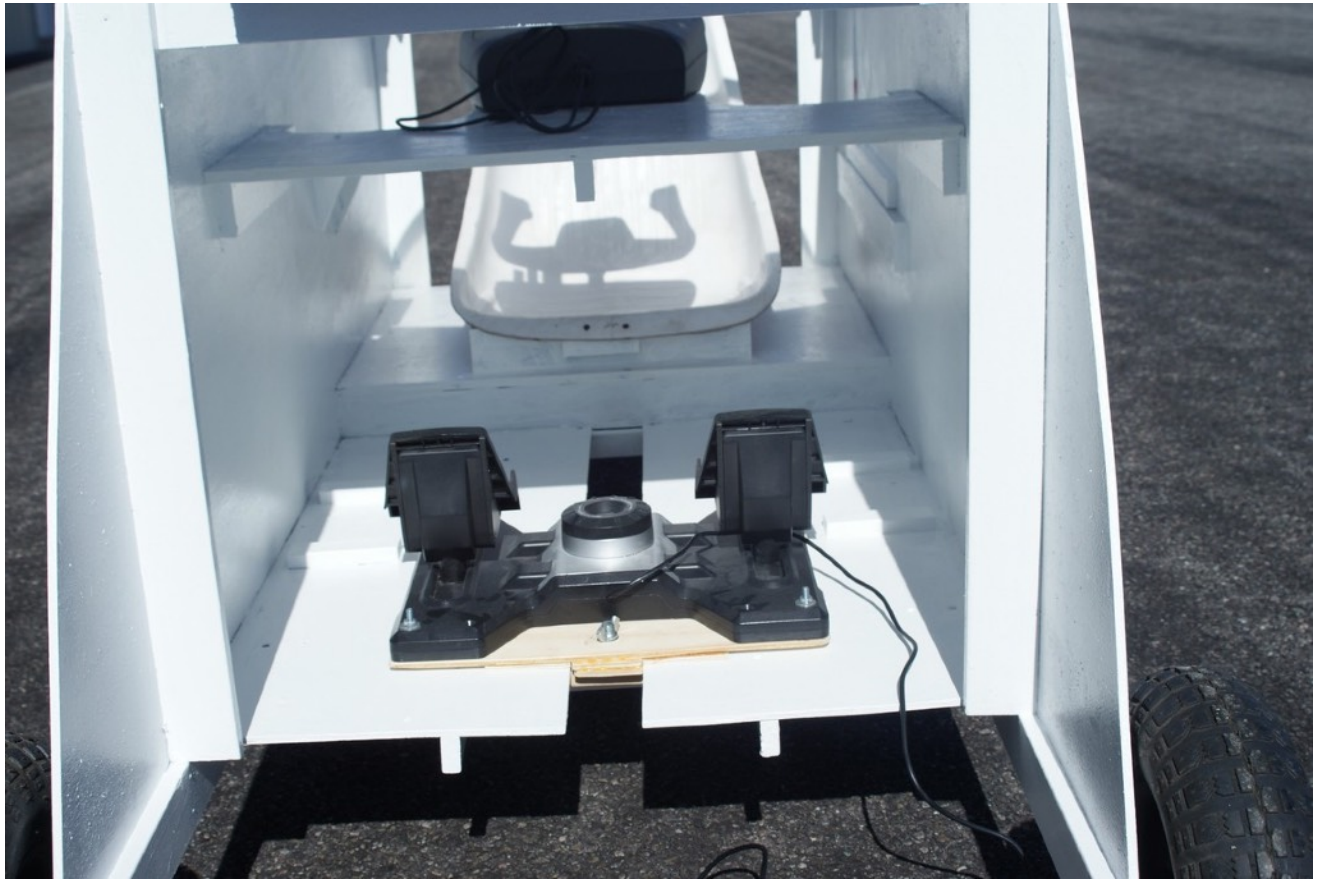
Three screens are used initially. The first is the master flight dynamics screen on a table next to the cockpit that allows an instructor or flight advisor to manage the simulation. The second is a dedicated control panel in the cockpit. The third is a large (well, small by today's standards) big-screen TV showing the terrain ahead of the flight. All of this is old relatively slow hardware. The flight management master computer is a 12-year-old Intel i3. The terrain system is a 15-year-old Intel Core-2 Duo system with a simple Nvidea graphics card. The system running the control panel is a $40 Raspberry Pi 4.

**Initial Reaction and Lessons Learned**

The system has been exercised and several initial lessons have been learned.
Response among the limited number of beta testers has been generally good with an appreciation of the potential of this sort of simulator. I do stress that this is a prototype whose purpose is education on how to build a real one, but the general response is that even in its initial form this has a place in the chapter's activities.


The cockpit has a small door on the left that swings down to let one step onto the seat, turn, and slide down into the cockpit. The system is great for a youngster to access. But for a 70-year-old software guy, it is a hard (but not impossible) job to get in and out of the simulator. For adults, a better access structure needs to be designed.

The adjustable rudder pedals are a very good idea. They allow a wide range of body types to use the simulator. Adjustable yoke position or an adjustable seat seem to be less necessary. The system includes simulated sound. This seems a mixed blessing. It does add to the immersive character of the simulation, but sometimes when the external advisor and the internal pilot are trying to work together it gets in the way. Fortunately, there is a volume knob. An initial result is that sound is a valuable addition to the simulator. One of the hardest parts of bringing the simulator up for operation is to tune the control responses to match one's expectations of control response. The elevator may be too sensitive and the rudder too slow. Fortunately, there are controls to adjust the electronic responses. However, the initial tuning of the system requires a large amount of work.



**Further Exploration**

As the old saying goes: We have barely scratched the surface. This simulator provides a platform on which to explore different aspects of more detailed and realistic simulators like the Dragonfly. A few areas of immediate interest include the following. I suspect that at this point each reader has their own “we should try this...” idea.

The current control panel display was built by me in a few days as an early exercise. I was impressed at how easy it is to build a custom experience for a specific application.

Flight simulators with multiple screens giving not just a forward view but visibility to the sides is commonly accepted as necessary for more advanced simulators. The prototype should easily allow use of multiple displays as the hardware becomes available.

Customization of new aircraft and terrain are documented, but I have not yet explored those capabilities. I intend to.

The system currently uses a relatively standard yoke, control quadrant and rudder pedal set. Exploring how to build custom controls and hook them into the software needs to be investigated. There are a lot of examples of people who have developed such things, but there seems to be no standard tutorial available.  This seems to be a necessary capability to master if we wish to build a more complex simulator like the Dragonfly.  Finally, it is important to use this simulator in a wide range of areas. Use by both Young Eagle participants and adult chapter members should provide surprising and useful experience teaching us a lot about the technology.

I’m excited to see where this goes.

# Tech Corner

by Will Fox

## Titanium

Titanium is a fascinating material. It is as strong as high strength steel but 45% lighter. In fact it has the highest strength to weight ratio of any structural metal. It is highly resistant to corrosion and fatigue cracking, maintains a high strength even at 800 F, and has a stiffness that is almost twice that of aluminum. It was the only material that could meet the operational requirements of the SR71 and resist the high temperatures of sustained operation at Mach 3.

There are several grades of titanium with Grade 5, commonly known as Ti-6Al-4V, that has a tensile strength of 140,000 psi. Compare that to 2024-T3 aluminum which is commonly used in GA aircraft which has a tensile strength of 62,000 psi, half that of titanium. Titanium has an elastic modulus (stiffness) that is half way between that of aluminum and steel. This makes it deflect less under load than aluminum but springier than steel.

Titanium is also one of the most bio-compatible metals and has a density very similar to bone that it readily adheres to. It is commonly used in surgical implants like hip implants, dental implants, and heart stents. It is also used to make titanium dioxides that are used in paint pigments and cosmetics. Titanium also forms a very strong and durable oxide that makes it very resistant to corrosion and gives it its trademark shimmer and shine.

Titanium is commonly used in the aircraft industry. The B787 airframe uses about 20 tons of titanium and the A380 uses a whopping 75 tons of it in each plane. It is also used extensively in the F22, F35, C17, and the UH60.

Titanium can be challenging to form because of its strength and high melting temperature. It is also very tough and that

The skin of the SR71 is made of titanium in order to withstand operating temperatures over 600 F when traveling at Mach 3 .

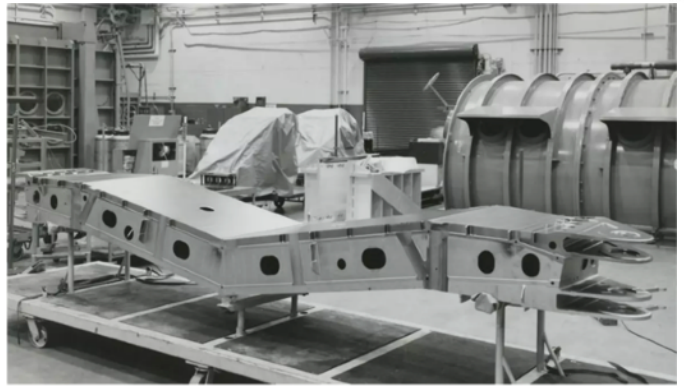
This aerial view of the Guggenheim Museum-Bilbao in Spain highlights the titanium panels that cover the structure.

can make it difficult to machine with anything less than cobalt or carbide tools. It can be welded using either tungsten inert gas or electron beam techniques. The F-14 Tomcat's massive 20 foot long titanium wing carry through structure was welded together using electron beam welding.

I used 37 pounds of titanium in my Pegazair homebuilt aircraft. Most of it went into the main gear legs and the tail spring. The rest of it went into structural brackets, heat shields, and the defroster manifold. Why the defroster manifold? Because it looks cool and doesn't corrode:-). The Pegazair originally used Piper Cub like welded steel tube main gear and an aluminum tail spring. I wanted something tougher for back country flying and decided that a titanium spring gear would be more aerodynamic and stronger for the same weight. I bought a 20 ton Harbor Freight hydraulic press and welded up some steel tooling to use to form the gear. I ordered some ¾" thick titanium that was waterjet cut to the shape I needed. I rigged up the tooling and the titanium leg to start bending it, and then I found out how strong Grade 5 titanium really is.

The main gear leg was 3/4" thick and 6" wide where I needed to bend it. I broke the press before I ever came close to bending it. I rebuilt the press and made it stronger and tried again. The 20 ton hydraulic jack did not have enough force to permanently deform the titanium. It would bend the gear leg a little but it would just spring back. I bought a 40 ton hydraulic jack and tried that and it broke the press again. I welded a big I-beam across the top of the press and re-enforced a few other parts that were giving way and tried again. The titanium gear leg had finally met its match and began to bend at about 43 tons of load. I was able to put the 45 degree bend in the main gear leg that I needed. The tail spring was much easier and I was able to bend that by hand using a 10' cheater bar made from 3" rectangular tubing with ¼" walls.

Through some miracle the gear legs came out pretty symmetrical and I only needed a few shims to get the toe and camber properly adjusted. The gear works really well. The titanium gear absorbs bumps better than the bungee gear ever did. The tail spring is really tough, and I haven't broken it yet. I ground the main gear into a semi-airfoil shape using a heavy duty grinder. It only took about two days and I had to wear welding googles because the sparks were so bright. The plane is noticeably faster with the streamlined spring gear. One thing is for sure and that is if the Pegazair is ever in a crash, the landing gear won't have a scratch on it:-)



The titanium carry through structure for the F-14 Tomcat was electron beam welded together.

Homemade titanium gear leg on my Pegazair.

Will Fox is a flight instructor and homebuilder. He also serves as a Technical Counselor and Flight Advisor for the EAA. In his spare time he enjoys working on and flying his two homebuilt aircraft, a Pegazair P-180 and a Questair Venture. He is also fascinated with solar power and electric vehicles, so his next airplane will be electric. Please feel free to contact him at tailspinfox@gmail.com if you have questions or comments.

# For Sale

Have something to advertise for sale that is aircraft related? Please email the newsletter editor for placement in the newsletter

**For Sale:**
**Aircraft Building Tools**

The kit also includes a 3x Rivet gun. I put the whole set into a shopping cart at Cleveland Aircraft Tools, and the total came to almost $2,400. I am willing to sell the whole set for $1,000.

If interested, please call Joe Pringle at 678-595-6717 or email me at joseph.pringle@gmail.com. If you are planning to build an RV, this will give you a great head start and save you a lot of money.

Hey Kids! Keep an eye out for upcoming work sessions to Electrify the Dragonfly!

# EAA Chapter 691 Membership Application/Renewal Form

***Please mail this form along with $25 to our Chapter Treasurer, Checks can be made out to EAA Chapter 691:***

David Young
819 Gonzales Rd
Santa Fe, NM 87501

Name: _____
Spouse/partner's Name: _____
EAA #: _____ Expiration Date (MM/YY) _____ / _____
Address: _____ City: _____ State: _____ ZIP: _____
E-mail: _____
Home phone: _____
Work phone: _____
Cell phone: _____
Please list your currently flying A/C and any finished or in-progress projects: