VisualCAM for SOLIDWORKS At The Minnesota Giant RC B1 Lancer Bomber Project!

Lance Corporal Zachary Geragi, USMC (medically retired) from Farmington, MN, an Iraq war veteran and his team of RC hobbyists are on a historic mission. To be the first to build and fly an AMA flight certified radio controlled ⅛ scale replica of the B1 Lancer Bomber jet aircraft (the actual B1 is shown here)! Because of the technical difficulty, this feat has yet to be successfully accomplished and no easy feat it is.

The ⅛" scale jet aircraft adheres to AMA weight restrictions and is built with the same space-age technology including honeycomb & carbon fiber composite construction and 820 epoxy resin used on the actual Lockheed Martin F-22 Raptor and F-35 Lightning! All of the CNC machining g-code for this project was generated using VisualCAM from MecSoft Corporation. This case study is our tribute to Zach and his team of RC hobbyists for taking on this historic project.

Why this Mission?

Zach's radio controlled B1 Lancer Bomber project is a tribute to the aircraft that supported him on the ground during his deployment to Iraq in 2003. More specifically, Zach's RC hobby and the comradery of his RC friends has helped him cope with the symptoms of PTSD (Post-traumatic stress disorder). To honor the service of Lance Corporal Zach Geragi, his friend Kyle Kazmierczak arranged for a B1-B Lancer to fly a mission over Iraq carrying the Stars and Stripes. [You can read more here](). That flag was later presented to Zach, along with this certificate commemorating the mission. We want to thank Zach for his dedication and service to our country.

Why VisualCAM for SOLIDWORKS?

Zach had no previous experience with CAD or CAM software but he is a member of the Experimental Aircraft Association (EAA) which provides access to educational licenses of SOLIDWORKS for all of its members. Zach then purchased a Tormach 1100 3 Axis CNC machining center with PathPilot controller, a Grizzly Gunsmithing Lathe and a Jcut 1553 5x10 CNC routing table with water cooled spindle. Next he needed CAM software to generate G-Code. For this a friend who also owned a CNC machine recommended VisualCAM from MecSoft Corporation a Gold-Certified Partner plug-in for SOLIDWORKS. Zach essentially taught himself how to use CNC technology by research, watching videos and utilizing MecSoft technical support! The best part is that Zach is sharing his mission with daily progress updates, photos and videos on the The Minnesota Giant RC B1 Lancer Bomber Project facebook page.
We invite you to visit for daily progress updates.

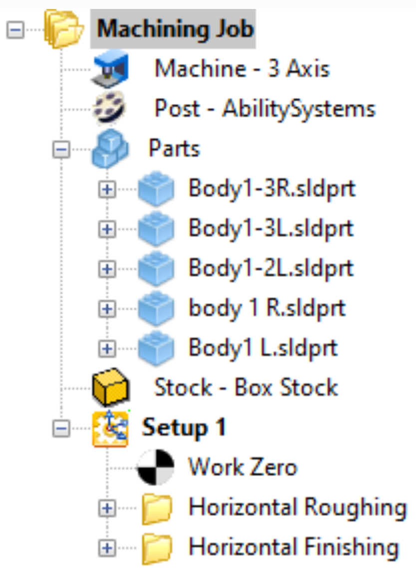
"When I needed a good CAM software to go with SOLIDWORKS a colleague recommended MecSoft Corporation. Since then I have learned CNC from scratch by researching, watching videos and assistance from MecSoft technical support! I know engineers who are shocked that I was able to teach myself CNC machining! You guys have been an integral part of this project. Thank You!"

Zachary Geragi,

CAM Programing, CNC Machining, Composites, Molding
The Minnesota Giant RC B1 Lancer Bomber Project

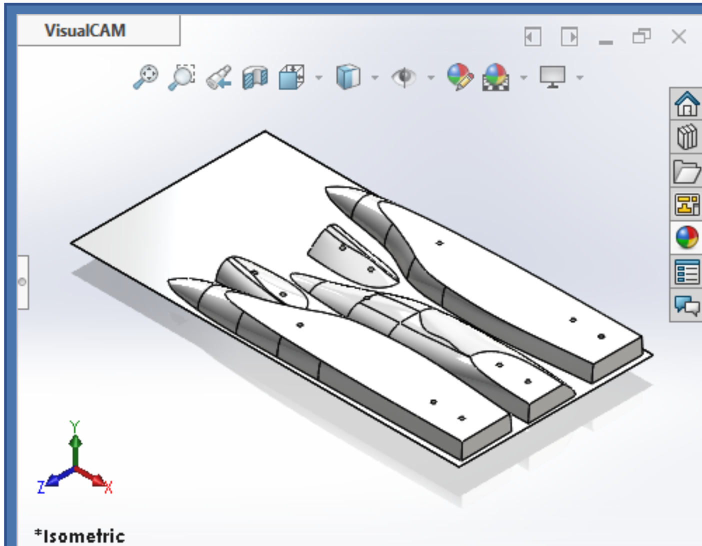
The Composite Carbon Fiber Fuselage

The fuselage core for the RC B1 Lancer was actually 3D scanned from a plastic Revell model kit including the actual panel lines! The scan was then scaled to ⅛ actual size and converted to a closed surface model. The fuselage 3D model was then cut into sections so that they could be machined from 48”x96”x4” foam sheets on Zach’s routing table.

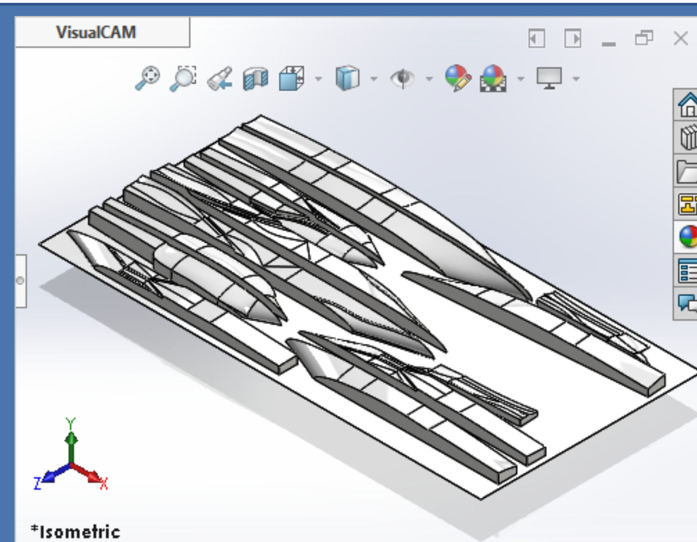


The typical VisualCAM Machining Job is shown here. Each sheet is one SOLIDWORKS assembly of fuselage sections. The fuselage assembly section components are listed in the Parts section of the Machining Job. The setup for each sheet consists of a 3 Axis Horizontal Roughing operation using a ½” end mill and a Horizontal Finishing operation using a ¼” ball mill. Two of the sheets are shown below along with some cool images and videos.

Zach and the 18 foot long RC B1 Lancer carbon fiber composite fuselage



SOLIDWORKS Assembly Fuselage Sheet 1



SOLIDWORKS Assembly Fuselage Sheet 4

Once the ⅛ scale fuselage sections were machined and assembled, they were used as the core plugs to layup each section of the composite carbon fiber outer shell. The carbon fiber sections were then assembled to form the complete light weight and extremely strong fuselage. Zach is doing an incredible job documenting the complete project on his facebook page so please check them out for many other videos, images and lots of technical discussion. The is a team effort and we want to give a shout out to Zach's friends and fellow RC hobbyists Michael Sarysz, Richard Steine, Darren Bitzer, Rick Freeman and Rusty Freeman for joining in on this mission. See below for the team roster and responsibilities.

Richard Steine (Left) and Darren Bitzer (Right) assist with construction and assembly of the giant 18 foot long B1 Lancer carbon fiber fuselage.

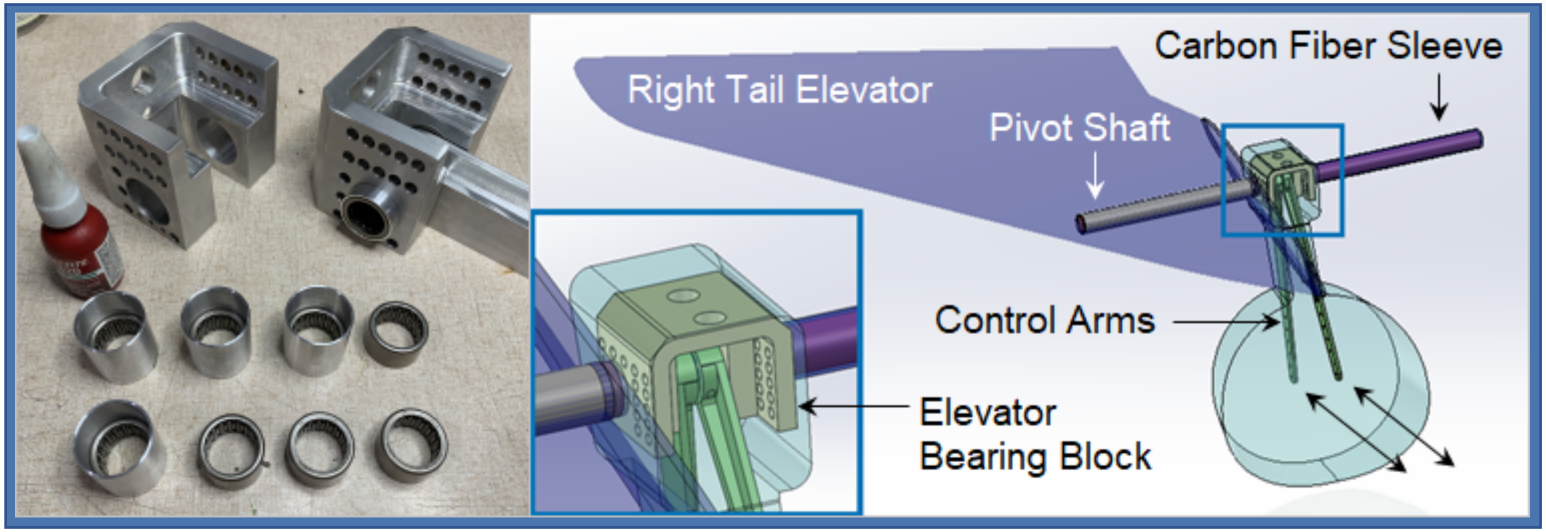
[Fuselage Core Nose Section Video](#)

[Carbon Fiber Fuselage Assembly Video](#)

Watch Zach show and discuss the RC B1 Lancer fuselage core mold, carbon fiber composite components and assembly in the video links above!

Machining the Elevator Bearing Block

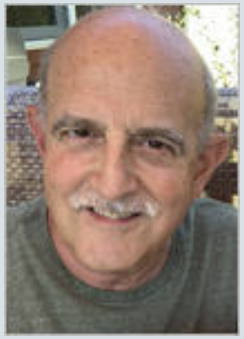
Zach and his team have designed and machined a plethora of components and molds during this mission to date. However, we needed to select one part to take a closer look at for this article. For this we chose the Elevator Bearing Block. This component plays a central role in the actuation and control of the rear elevators on this radio controlled B1 Lancer jet aircraft. The actual elevator bearing block, bearings and the SOLIDWORKS sub-assembly are shown below.



The needle bearings are a press fit into sleeves with retaining compound. These parts form a bearing cartridge which is a push fit into the bearing block. This allows for easy repair & replacement as needed. Between the block, you see two long actuator arms that can move together in the same direction, or the opposite, depending on the radio commands from the ground or from the automatic onboard gyroscope. As much as 2000 in oz of torque is transferred to each of the two pivot shafts by hex sockets on the end of each actuator arm. The pivot shafts are slip fit within carbon fiber sleeves and transfer control to the two rear elevators.

Watch the actual B1 Lancer elevators in actions here!

In the B1 Lancer, roll control is accomplished with the rear elevators moving opposite each other and together for pitch. In this control mixing, they are referred to as elevons (i.e., a combination of elevator and aileron). On the B1 Lancer, since the "elevons" are smaller, the angle of deflection is extreme to make up for the fact they're closer to the center roll axis. It is this extreme angle of deflection that makes it look like they are tilting in this video, when in fact the tilting is an optical illusion.

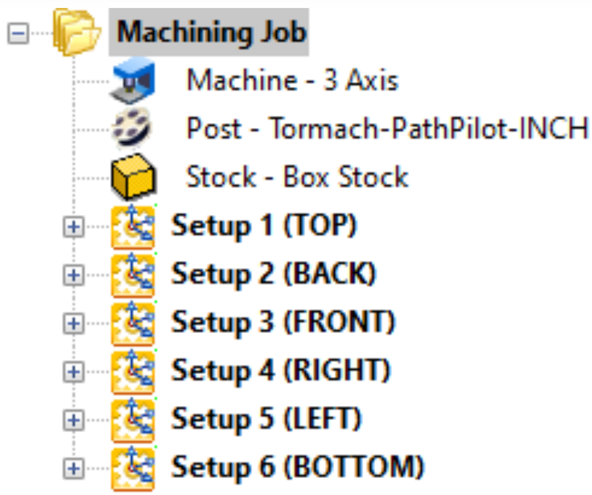


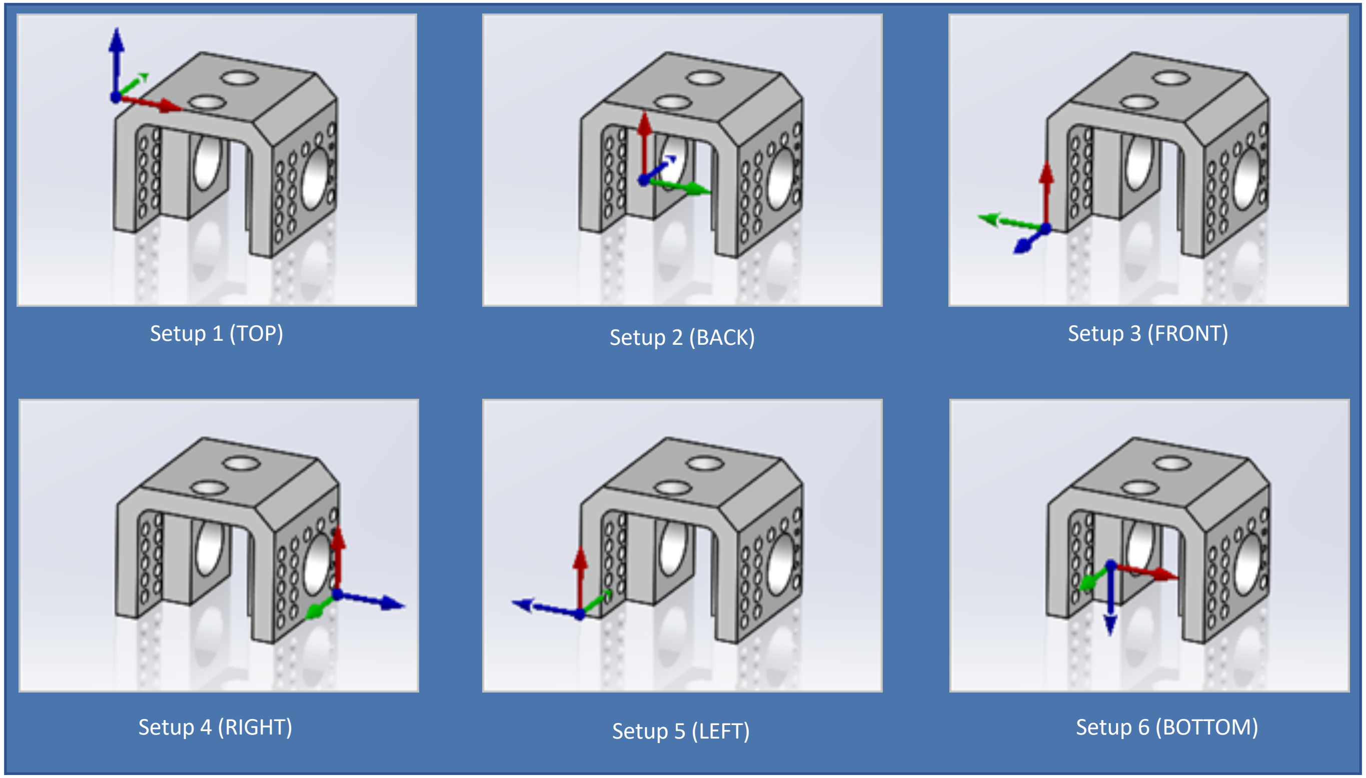
"It's amazing the tight tolerance Zach was able to hold on the elevator bearing block without having to use our boring bar attachment! You guys at Mecsoft have been very open and helpful to us as we expanded our CAM skills, and became adept at designing for manufacturing. We appreciate what you folks do very much!"

Rick Freeman,
Engineering, CAD Design, Machining
The Minnesota Giant RC B1 Lancer Bomber Project

The 6-Sided Setups

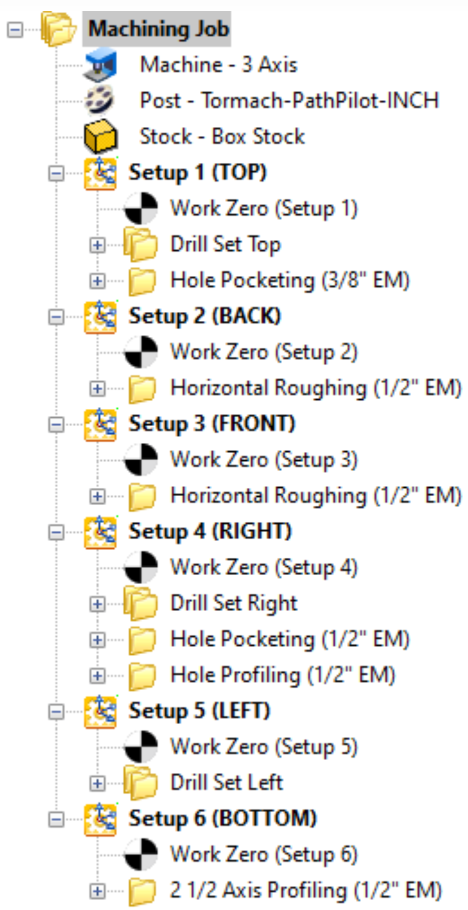
The Elevator Bearing Block requires machining from all 6 sides. Each side includes its own setup and work zero definition. The VisualCAM Machining Job tree here shows each setup in it's collapsed state. The critical side is Setup 4 (RIGHT) because it includes the Drilling and Hole Milling operations for machining the bearing shaft through hole. This hole is cut through to both sides of the block and requires a push fit with each of the bearing cartridges. The blue Z Axis arrow shown in each setup below indicates the machining direction for that setup.




Setup 1 (TOP)
Setup 2 (BACK)
Setup 3 (FRONT)
Setup 4 (RIGHT)
Setup 5 (LEFT)
Setup 6 (BOTTOM)

The Machining Strategies

Shown here is the complete VisualCAM Machining Job for the Elevator Bearing Block. You will notice Drill Set folders for the Top, Right and Left side setups. These can be expanded to show the Drill operations used for that setup. Each machining operation and drill set are also shown graphically in the images below.



Setup 1 (TOP)

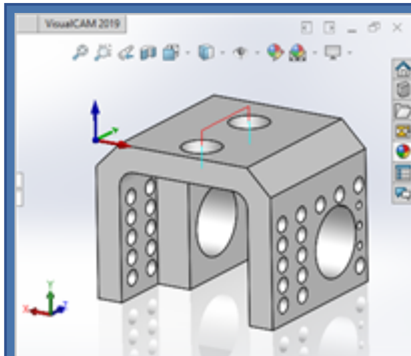
The machinable features on the top include two ⅝” daimeter through holes. Drill Set Top (image (1) below) includes a Center Drill operation with a #9 Drill x 0.13 deep followed by a ½” Deep Drill x 0.80 deep at step increments of 0.125. These ½” holes provide access for machining two 5/8" Dia x 0.80 deep holes using a Hole Pocketing operation (image (2) below) using a ⅜” end mill with a 0.125 stepover and a 0.05 stepdown.

Setup 2 (BACK)

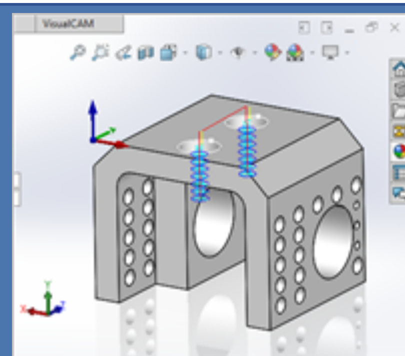
This is a 3 Axis Horizontal Roughing operation (image (3) below) to machine the back prismatic contour using 0.5” end mill. It uses an offset facing cut pattern, a mixed cut direction with a 25% setover and a stepdown of 0.05. A bottom Z depth containment is set to -1.7 since it is only roughing half of the cube.

Setup 3 (FRONT)

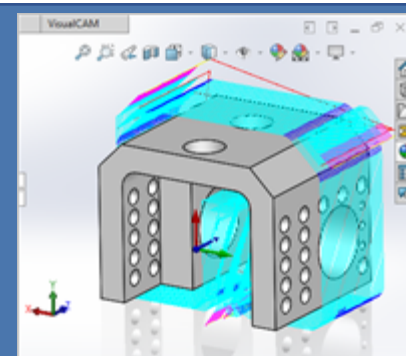
This contains a copy of the 3 Axis Horizontal Roughing operation (image (4) below) used in Setup 2 (BACK) but with the bottom Z depth containment set to -1.0. This operation is used to machine the front prismatic contour.



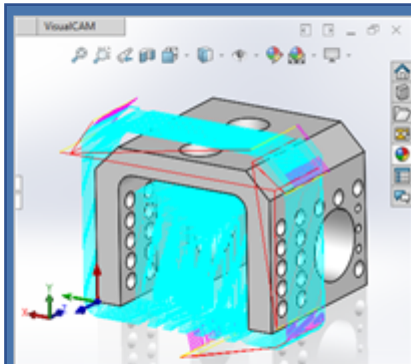
(1) Drill Set Top



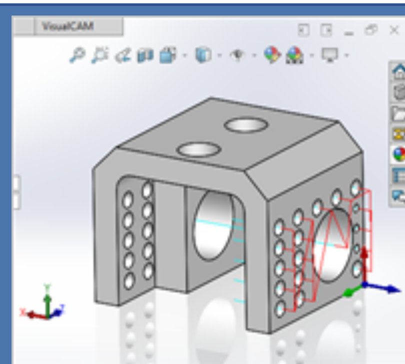
(2) Hole Pocketing (3/8" EM)



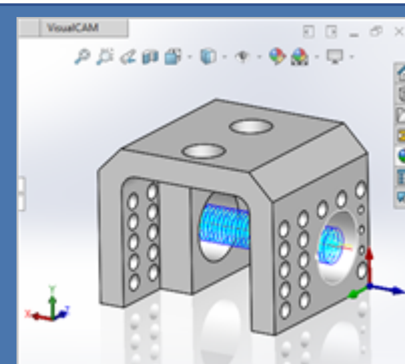
(3) Horizontal Roughing (1/2" EM)



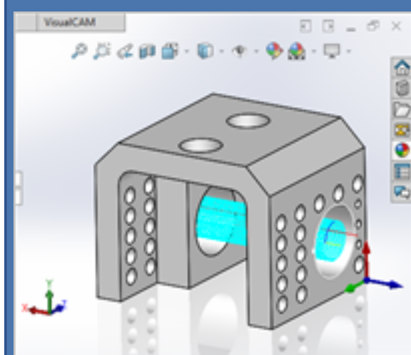
(4) Horizontal Roughing (1/2" EM)



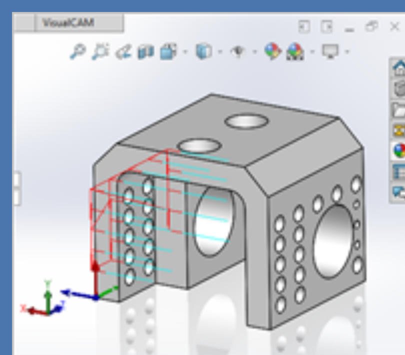
(5) Drill Set Right



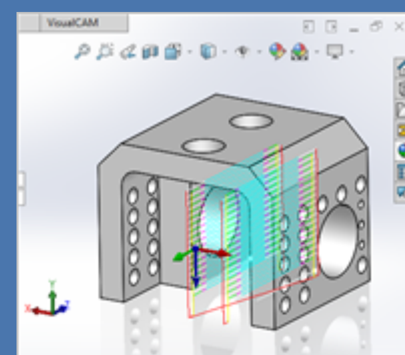
(6) Hole Pocketing (1/2" EM)



(7) Hole Profiling (1/2" EM)



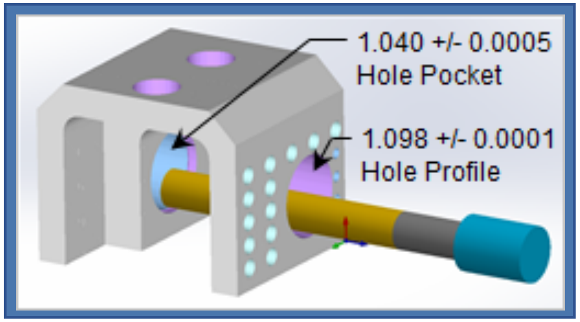
(8) Drill Set Left



(9) 2 1/2 Axis Profiling (1/2" EM)

Setup 4 (RIGHT)

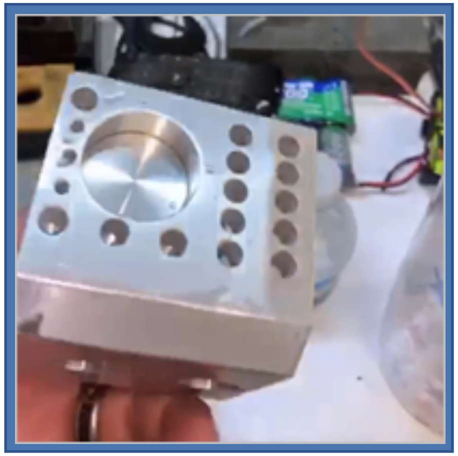
This is the critical setup that includes the hole machining operations to cut the two 1.098” diameter bearing cartridge holes that require the push fit. It begins with Drill Set Right (image (5) below) that includes Center Drill and Deep Drill operations both for the surrounding hole pattern as well as an access hole to mill the primary bearing cartridge hole. The last operation in Drill Set Right is a ⅝” Deep Drill. This provides the access needed for the ½” end mill to perform the Hole Pocketing & Profiling operations.



Watch the Cut Simulation Video!

Milling the bearing cartridge hole begins with a 2½ Axis Hole Pocketing roughing operation at a diameter of1.040” +/- 0.0005 (image (6) below) using a ½” end mill. The final 2½ Axis Hole Profiling operation (image (7) below) is the 1.098” +/-0.0001 finishing operation that removes the remaining 0.058” of material. To maintain concentricity, these two milling operations cut the bearing cartridge hole on both sides of the part at the same time. The final Hole Profiling operation is shown in the simulation illustration above.

Watch Zach machine and discuss this part and assembly in the video links below!



Elevator Bearing Block Video

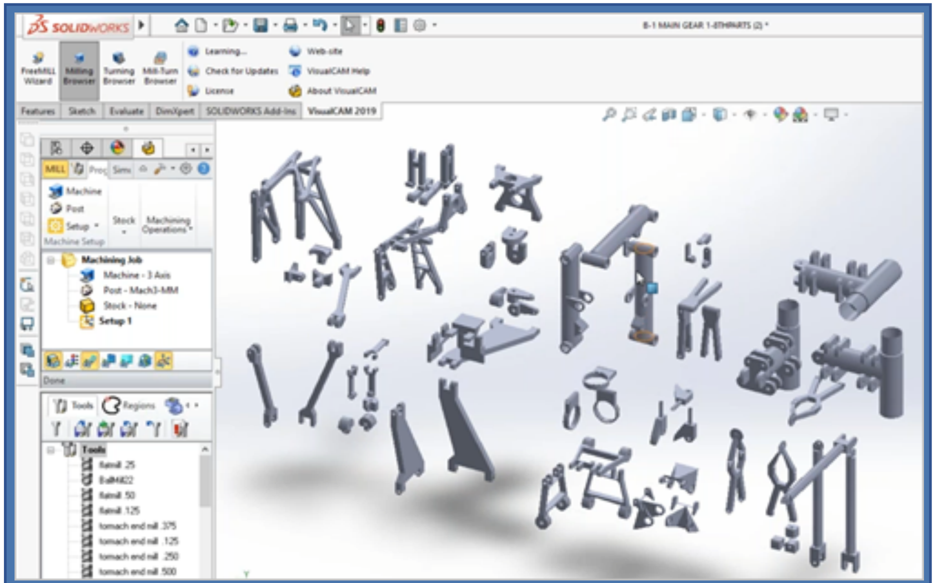
Elevator Assembly Video

Setup 5 (LEFT) & Setup 6 (BOTTOM)

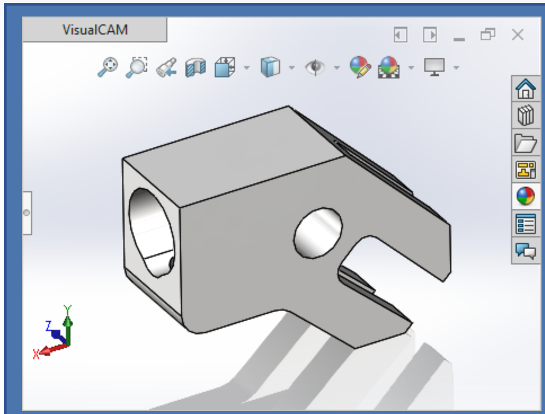
Setup 5 (LEFT) performs the Center Drill and Deep Drill operations for the symmetrical hole pattern on the left side of the elevator bearing block (image (8) above). This does not include the bearing shaft hole that was finished in Setup 4 (RIGHT) above. Setup 6 (BOTTOM) contains one 2½ Axis Profiling operation (image (9) below) using the same ½" end mill. This is a finishing and cleanup operation that also removes the ¼" radius fillets left over from the two Horizontal Roughing operations from Setups 2 and 3.

Other Machined Components

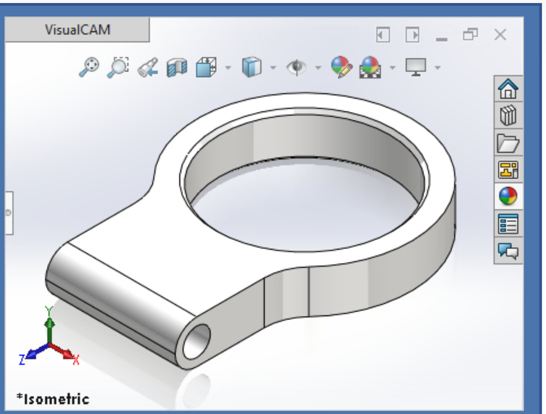
Here are just a few of the additional machined components that comprise the awesome RC B1 Lancer Bomber Project that Zach and his team have completed. This project is not for the faint of heart. I remind you that this IS NOT a pre-designed kit. Zach and his dedicated team will be the first to complete and fly a working ⅛" scale RC B1 Lancer Bomber jet aircraft! They have designed these components in SOLIDWORKS and programmed all of the CAM toolpaths using VisualCAM for SOLIDWORKS!



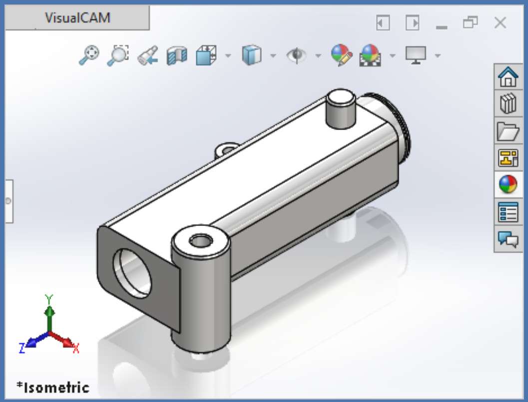
Landing Gear Assembly Components



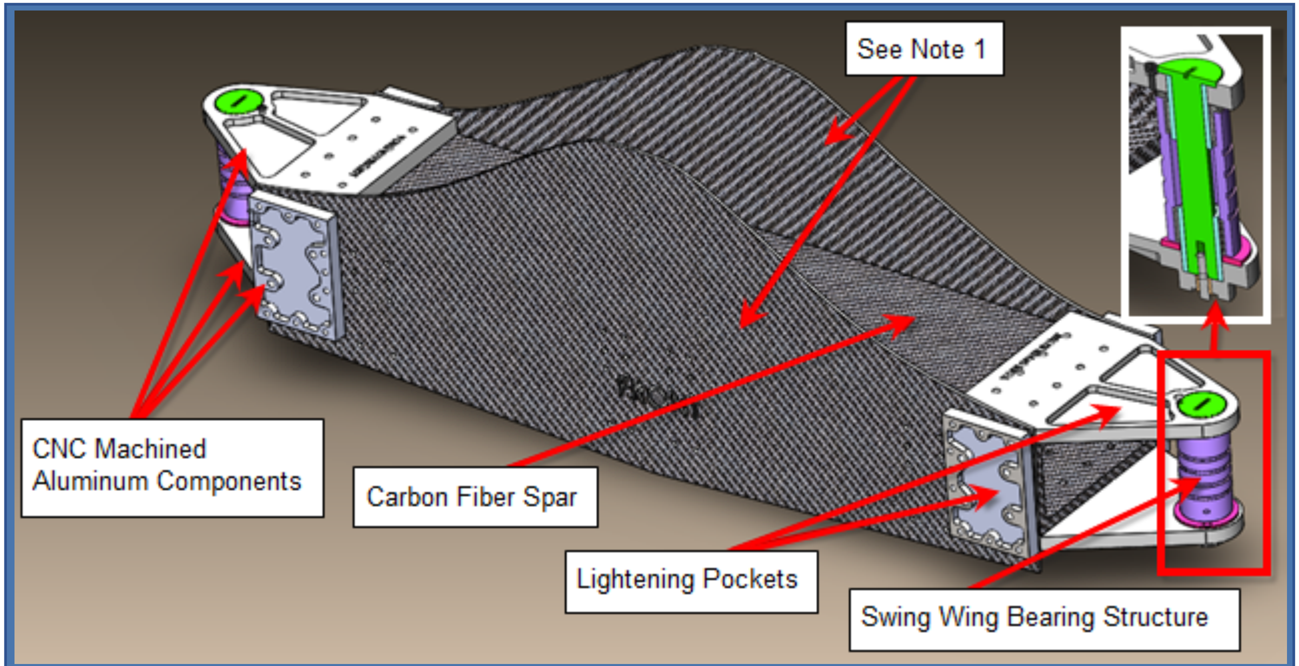
Nose Gear Trunnion



Nose Gear Lower Oleo Swivel



Nose Gear Axle Housing

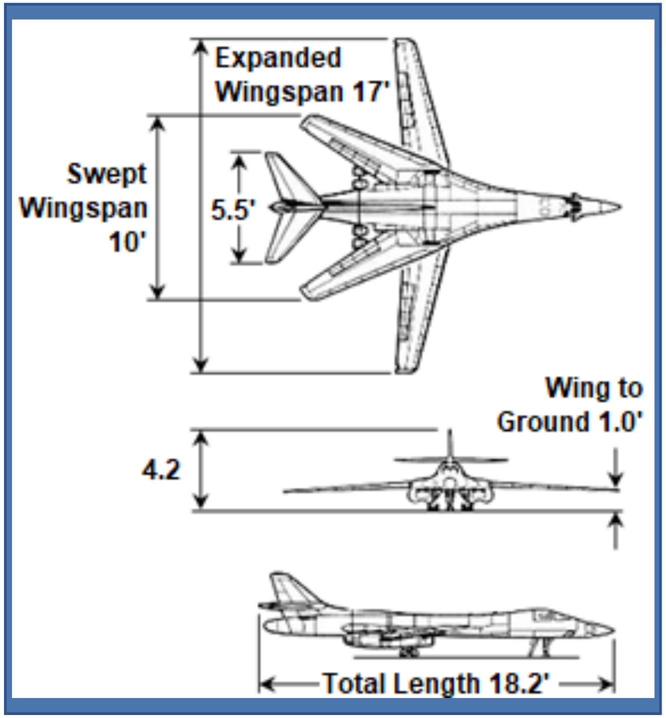


B1 RC Model Wing Spar & Pivot Construction, Note 1: The structural heart of the B1 RC model is the pass-thru wing spar and wing pivot. The two formers and the square tube spar are hand laid-up composite carbon fiber. All components are CNC machined using VisualCAM G-Code. Note the extensive use of pocketing to lighten the structures. There are more 100 VisualCAM-generated hole patterns.

About the Giant RC B1 Lancer Bomber

Zack's history making Remote Controlled Swept Wing B1 Lancer Bomber is an AMA approved ⅛" scale gas turbine powered jet aircraft with the following dimensions and specifications:

- Expanded Wingspan: 17.0 feet.
- Swept Wingspan: 10.0 feet.
- Total Length: 18.2 feet.
- Total Height: 4.2 feet
- Wing to Ground: 1.0 feet
- Fuselage: Honeycomb & Composite Carbon Fiber
- Engines: Gas Powered Jet Turbines
- Hand-held Radio Controlled



The history of attempting to build an AMA flight-ready RC B1 jet aircraft this large is long, complicated and thus far unsuccessful. However, with the valued input from those previous attempts and with the availability of lightweight and strong composite materials and expertise not available at the time, Zach and his team hopes to be the first!

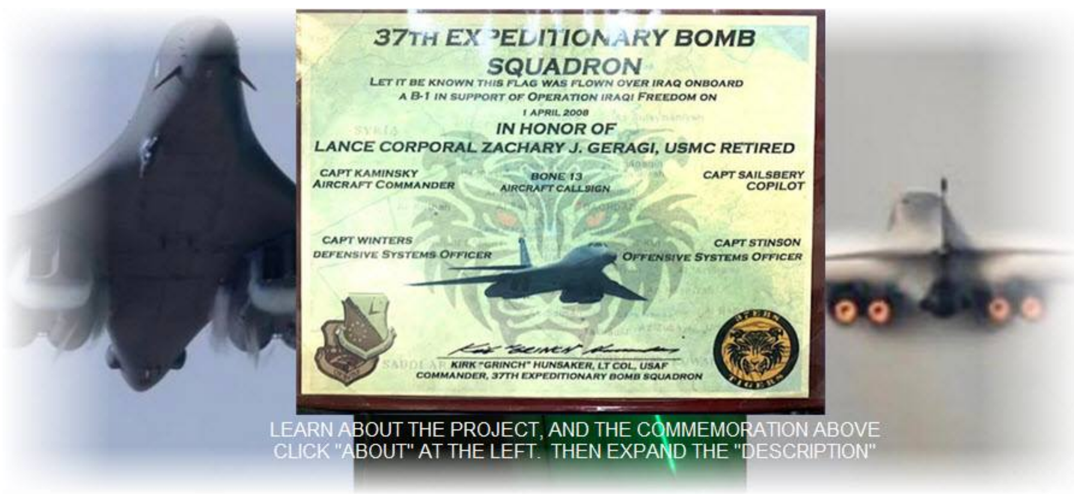
About the Full Scale B1 Lancer Bomber

Here are a few interesting facts about the B1 Lancer. You can learn more here. The Rockwell B1 Lancer is a supersonic variable-sweep wing, heavy bomber used by the United States Air Force. It is commonly called the "Bone" (from "B-One"). It is one of three strategic bombers in the U.S. Air Force fleet as of 2018, the other two being the B2 Spirit and the B52 Stratofortress.

- Range: 7,455.8 mi
- Unit cost: B-1B: US$283.1 million in 1998 ($415 million in 2018 dollars)
- Number built: B-1A: 4; B-1B: 100
- Engine type: General Electric F101
- Manufacturers: Boeing, Rockwell International, Meritor, Inc.
- The first B1 took off in 1984 and the first B1B bomber was delivered in 1985.

About The Minnesota Giant RC B1 Lancer Bomber Project

Zach Geragi and Rick Freeman collaborate on high-end radio control jet aircraft designs, landing gear, and accessories through The Gear Bunker & The Minnesota Giant RC B1 Lancer Bomber Project. With nothing more than word-of-mouth, they are so busy they get to pick and choose only the best projects. The AMA (Aeronautical Modeling Association) is the governing body that works with the FAA for RC flight and under which this aircraft will make history and its maiden flight in October 2020 at the EAA AirVenture at Wittman Regional Airport in Oshkosh, Wisconsin.



The Minnesota Giant RC B1 Lancer Bomber Project - Team Roster

Zachary Geragi
CAM Programming
CNC Machining
Composites, Molding

Michael Sarysz
Engine Turbine,
Installation
Flight Testing

Rusty Freeman
CAD Design
Fabrication
Rubber Molding

Rick Freeman
Engineering
CAD Design
Machining

Darren Bitzer
Composites
Fabrication, Painting
Finishing

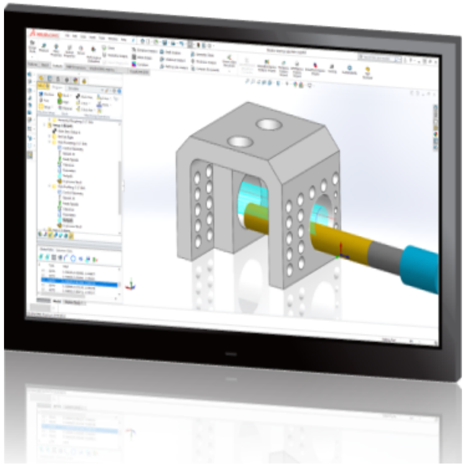
Richard Steine
Molding
Fabrication
Painting

A Very Special Thanks

We want to extend a very special thanks to Zachary Geragi and his wonderful family for allowing us to share their remarkable story. Thank you Zach for your dedication and exemplary service to this great country, the United States of America!

We are following this project closely and will bring you more updates in the near future. Stay tuned!

More about VisualCAM



VisualCAM for SOLIDWORKS is available in five configurations (Express, Standard, Expert, Professional and Premium). The multi-setup part shown here was programmed using the Professional configuration. Each setup can also be programmed separately using the Standard configuration. Here are some additional details about each of the available configurations. For the complete features list, we invite you to visit the VisualCAM for SOLIDWORKS Product Page.

- **VisualCAM MILL Express**: This is a general-purpose program tailored for hobbyists, makers and students. Ideal for getting started with CAM programming. Includes 2 & 3 axis machining methods.

- **VisualCAM MILL Standard**: This configuration includes everything that is in the Express configuration and additional 2-1/2 Axis, 3 Axis & Drilling machining methods. Also now includes 2½ Axis Turning!

- **VisualCAM MILL Expert**: Suitable for 4 Axis rotary machining. Includes the Standard configuration, plus 4 Axis machining strategies, advanced cut material simulation and tool holder collision detection.

- **VisualCAM MILL Professional**: Ideal for complex 3D machining. Includes the Standard and Expert configuration, plus advanced 3 Axis machining strategies, 5 Axis indexed machining, machine tool simulation, graphical toolpath editing and a host of other features.

- **VisualCAM MILL Premium**: Tailored for complex 3D machining with both 3 Axis and full 5 Axis methods. Includes the Standard, Expert and Professional configurations, plus 5 Axis simultaneous machining strategies.

For the complete features list, we invite you to visit the
VisualCAM for SOLIDWORKS Product Page
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