New Boeing Blended Wing Body Military Transport Scale Model Design and Build

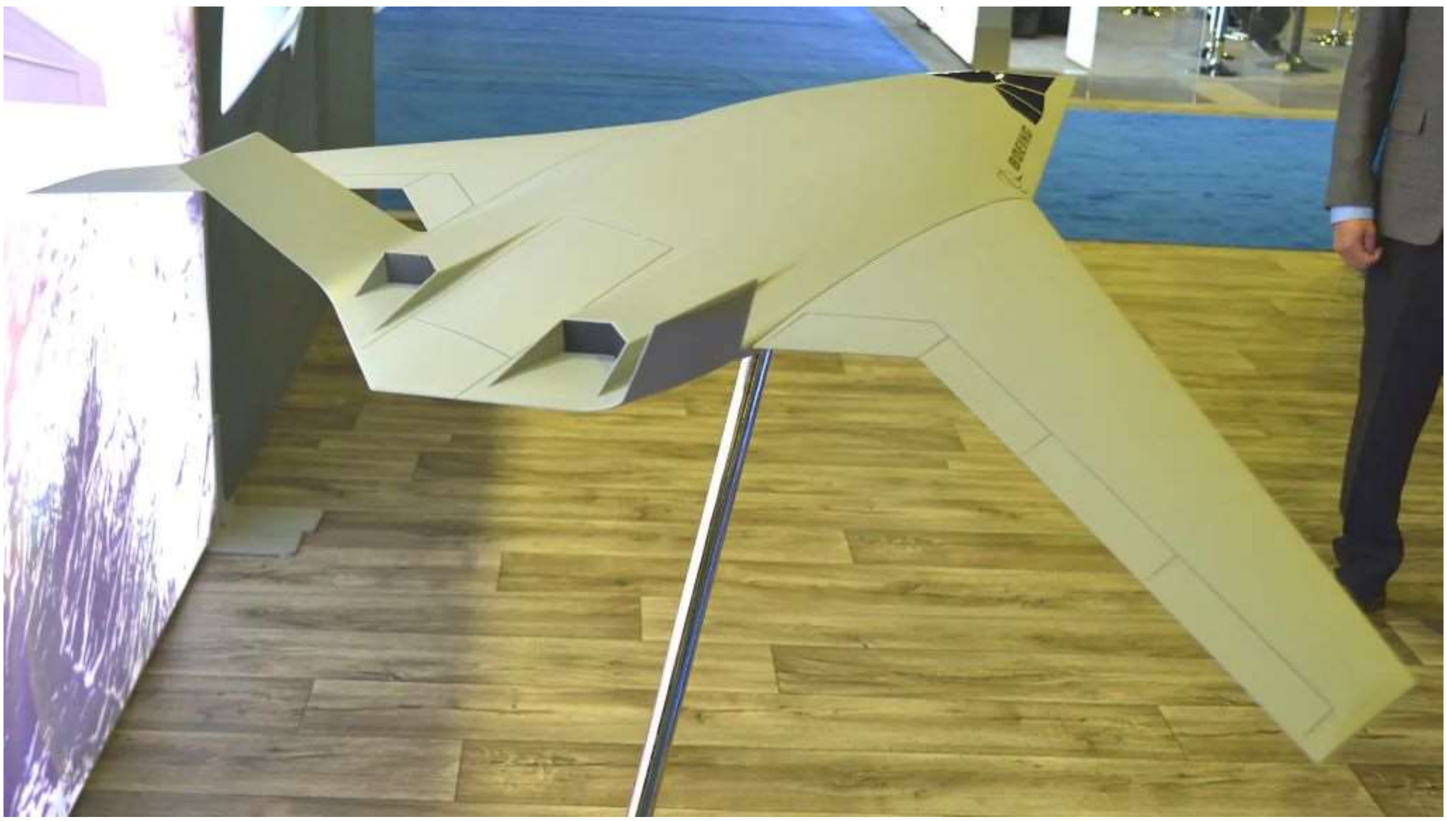
This build description is going to be somewhat different from others I've produced in the past for my other scratch builds. First, this build is based only on a picture (shown below) I ran across in my copy of Aviation Week and Space Technology (Feb 13-26, 2023) of a new concept from Boeing for a Blended Wing Body (BWB) military transport for the US Air Force. This scalable configuration could be developed as a tactical airlifter Lockheed C-130 replacement, or a Boeing C-17 size strategic transport. The wingspan of the initial concept is estimated at about 130 feet, using medium- or even high-bypass-ratio turbofans buried along the sides of the center fuselage.

Second, there are no plans that I can download from the web for this build. Therefore, we must start this build description by working up the requirements of the model, and development of the plans to build from.

The first thing I needed to do was to see what additional data I could find on this new BWB transport, which I rapidly found was only a few more pictures. Nothing in the way of any three views, line drawings, or specs. Below is a top view which I used to work up my initial "scale" representation of the BWB outline.

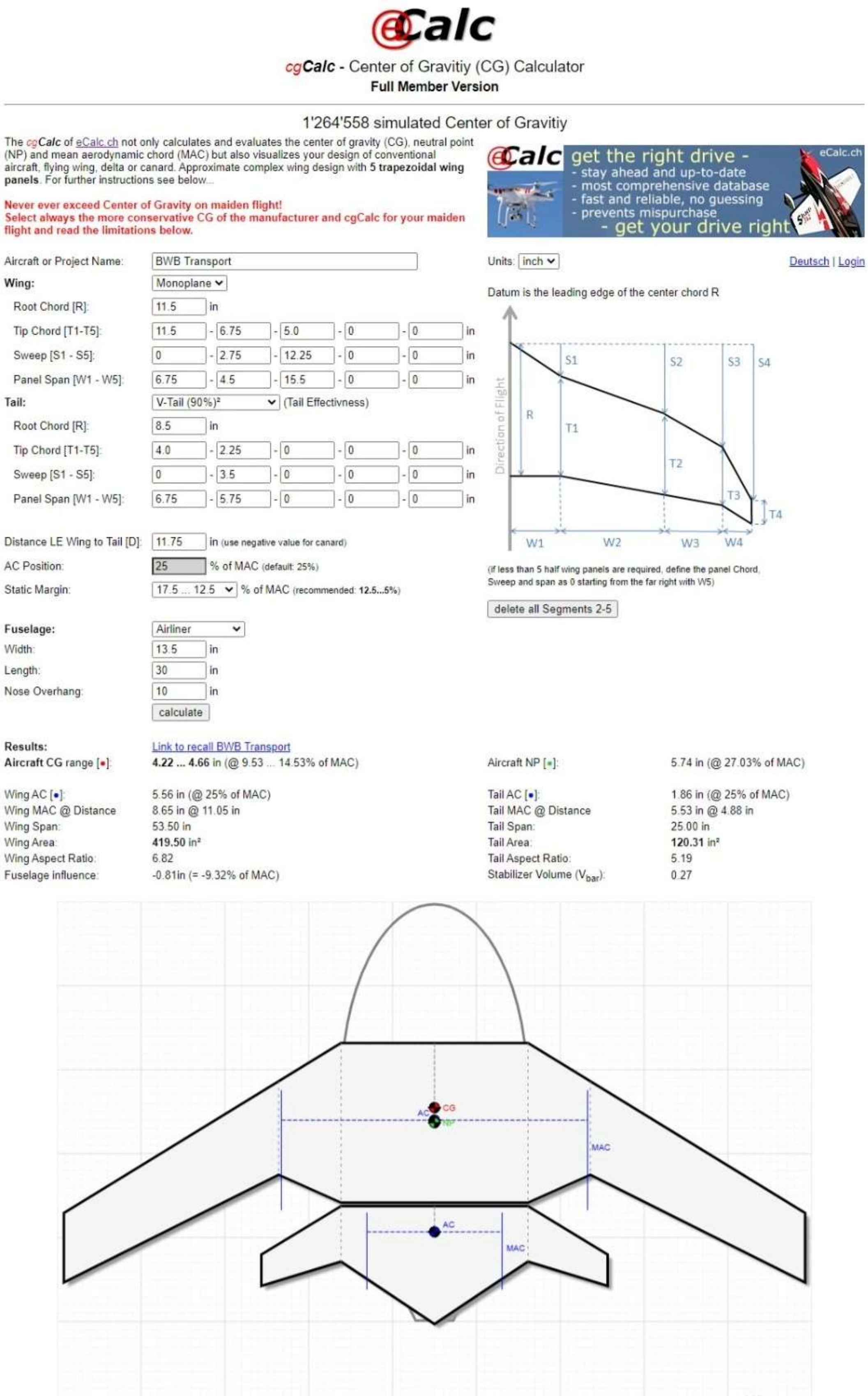
Next, I broke out my old engineering design drawing kit (from my bachelors engineering class back in the mid-70's) and pulled out several scaled rules to find something that would provide me with a scale I could use to end up with a model in the 48–60-inch wingspan range. This wingspan range was set to be able to store the model in my workshop, and to carry it to the flying field in the bed of my Colorado pickup. What resulted was an initial plan that comes in with a 54-inch wingspan and a center fuselage of 13.5 inches wide by 30 inches long. So, this top view of the overall outline was put down on drawing paper as the starting point for my plans.

Below are a couple other pictures I found on the new BWB concept, which I'll also use to help define my model plans.



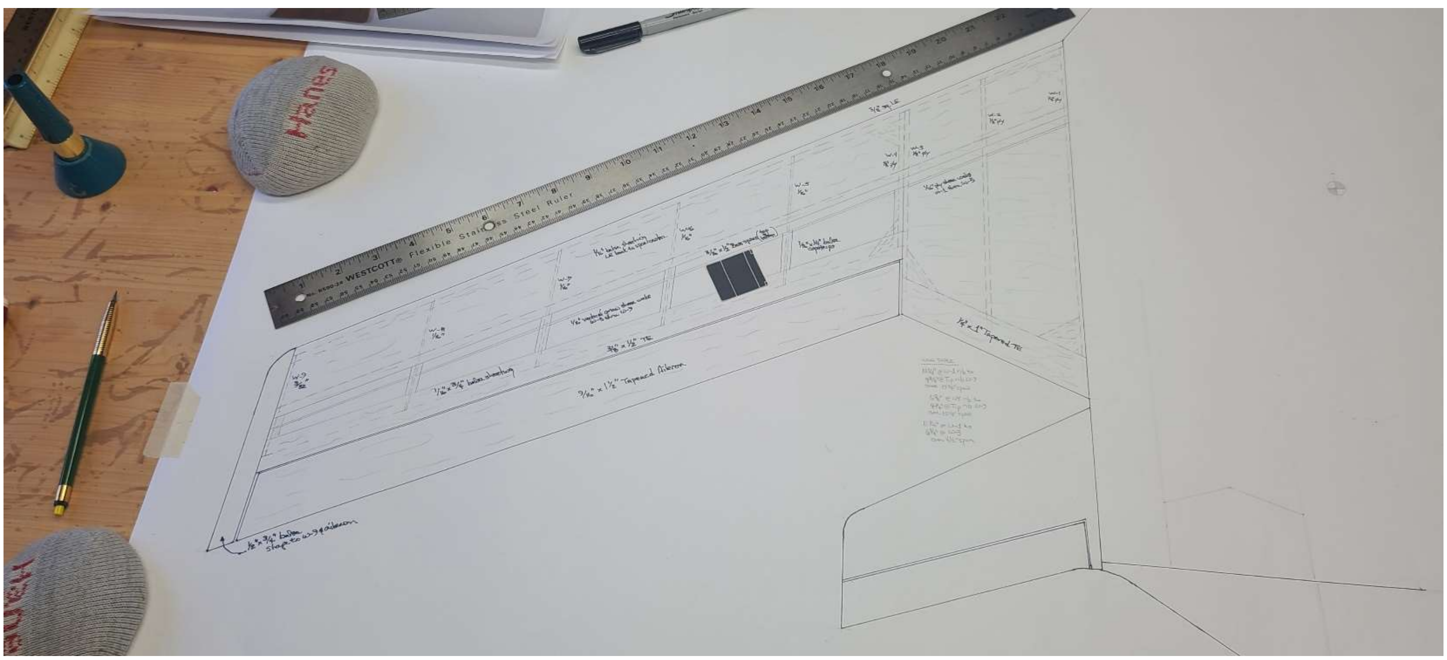
Now I must set some expectations on what kind of performance I want for the model. I'm not one who flies RC models that travel 100 mph; therefore, this build is being designed as a "mild" sport flyer. The initial weight was targeted in the 5-6 lb. range fully ready to fly (batteries included). I wanted to use twin electric ducted fans (EDFs) for power and being I'm not an electric powered plane flyer (no LiPos other than my NX8 transmitter), so that added to the research I was setting myself up to have to work through. I'm an old, retired fart, so what better do I have to do than spend a few dozen hours reteaching myself airfoil design, EDF power system sizing, and related components (electronic speed controllers, LiPo batteries, etc.) selection.

I figured I'd first check and see where the Center of Gravity (CG) falls for this kind of model. So, I started my research on the web to find something that could help. What I ended up using was found at https://www.ecalc.ch/cgcalc.php. This site has all kinds of calculators you can use to aid you in RC model designs. Using the eCal CG calculator, I plugged in all the numbers needed for my initial plan layout. Below is the output obtained from eCalc.



With this output I now know the CG range is 4.22 – 4.66 inches back from the wing leading edge, which is located 10 inches back from the nose of the fuselage. This gives me some idea where I will need to place the major components (LiPo battery, EDFs, ESCs, servos, etc.) in the fuselage, and the position of the main landing gear which must be aft of the CG for a tricycle gear plane. It also provides me data that was used to calculate the resulting wing loading, or for my estimated weight of 5.5 lbs. yields an overall wing loading of approximately 23.5 ounces per square foot, which is in the range you would expect for a sport or military model. I added the tail area to the wing area obtained above because this is a BWB, and therefore the entire wing-tail-fuselage area acts as lifting surface. The nose in front of the wing leading edge adds another 135 square inches to the total area, but I did not include that here.

Let's look at getting some definition to the model internal structure. Being that I've laid up many scratch builds over the years, I'm comfortable in laying out the details of the wing build for this BWB. While the BWB concept shows inboard elevators/flaps, center ailerons, and I'm assuming split outer rudder/ailerons, all along the aft of the wing, to keep this build simple I'm only going to use single piece ailerons on the wings of my BWB model. Some time ago I scratch built a plane called the Cloud Dancer which is a .60 size sport flyer using a full symmetrical airfoil. I pulled those plans out to review that wing build and decided to incorporate much of that wing structure into my BWB wing. That wing is based on what is called a "Boxed D" design. The main spars are made up of basswood spars running along the top and bottom of the ribs with vertical shear webs between each rib, and then 1/16" balsa sheeting is placed on the top and bottom from the balsa leading edge back to the center of the spars. Therefore the "D" definition. This design is very strong, yet light. Using this design, I laid out the left-wing structure within the outline shape established from the scale drawing of the BWB top view picture. Below is a picture of the left wing.



This will require nine ribs spaced no more than 3" in each wing, with a large taper in both chord length and thickness from W-1 through W-3, and then small taper changes for ribs W-4 through W-9. One change I had to make from the original scale outline was to increase the chord length of the wingtip because using the scale measurements resulted in a wingtip rib that was only 3.5" long and the thickness would have been too small for the build. I increased the wingtip rib length to 5" and the drawing above reflects that change. Rib W-1 needs to be quite thick to properly matchup with the larger wing shape of the center fuselage, being a BWB. So, the taper from W-1 out to W-4 is sharp. You can somewhat see this change in thickness in the frontal picture of the concept model. I may have to change this once I lay out a front view of the model wing, so we will see. As shown, the aileron is a single piece of 9/16" x 1.5" tapered trailing edge, which I plan to drive using a Hitec HS-125MG wing servo (the small black box). Wing thickness between ribs W-5 and W-6 is not large enough to use a standard size servo inside the wing. An aileron servo will be used in each wing and controlled via separate receiver channels so I can have both aileron differential, and flaperon control. Each wing will attach to the center fuselage using a carbon fiber tube running along the backside of the wing center spar and through rib W-1 out past W-4. The diameter of the carbon fiber tube will be determined once I finalize the ribs and have the side view of the fuselage drawn up, so it is not on the drawing yet. The hole for the servo lead will also be drawn once the carbon fiber rod location is set.

Now that I have the wing structure and related materials sizes defined, the next thing needed is to define what airfoil I'm going to use. Using the web, I researched what airfoil shapes have been used for flying wings, and other models of similar configuration to the BWB. After much reading, what resulted was a "reflex" airfoil named MH-61. A reflex airfoil is a modified semi-symmetrical airfoil that has a trailing edge which is slightly flipped upward to help with controlling the nose-down tendency of a flying wing. This is like setting each aileron's center position slightly above the wing trailing edge, which I plan to also do on the BWB wing for initial flights. With the airfoil established I needed to generate a full set of ribs that would match the sizes required for my wing drawing. This was accomplished using www.airfoiltools.com to generate a full-size printout of each rib based on the measurements taken from the wing plan. Below is a picture of that site and the output for my rib W-1 which is 11.5" long and 1.75" tall. This was then done for all nine ribs. For ribs W-6 through W-9, I set the pitch input of each rib to a negative value increasing each by -0.5 degrees to get a final washout of -2.0 degrees at the wingtip. This is done to improve the handling characteristics of the flying wing.

Having all nine ribs in full size, the next step was to take accurate measurements (I used a 1/40th of an inch scale) from the wing plan for each distance from leading edge to the front of the top spar, and then to the front of the trailing edge. These measurements were then transferred to the full-size printouts for each rib to locate the position of the 3/8" square balsa leading edge and 3/16" x 1/2" basswood top/bottom spar cutouts, and the cutoff line at the rear of the rib. With this being a double taper wing, I had to draw support tabs below each rib that will hold it at the correct height above the magnetic building board until all the sheeting is in place on one side of the wing. I was planning to use my wing jig to hold all the ribs during the build, but the small size of rib W-9 did not provide enough room for the two 1/4" holes that would have to be drilled to fit each rib on the jig rods, so I had to go the tab route. The picture following the airfoiltools.com picture below shows all nine wing rib profile drawings with required cutouts and tabs.

Ribs W-1 through W-3 will be cut from 1/8" lite ply, W-4 from 3/32 ply, W-5 through W-8 from 1/16" balsa sheet, and W-9 from 3/32" balsa sheet. The vertical grain shims between ribs W-1 out to W-5 will be 1/16" plywood, and between W-5 out to W-9 will be 1/16" balsa sheet.

Applications

- Airfoil database search
- My airfoils
- Airfoil plotter
- Airfoil comparison
- Reynolds number calc
- NACA 4 digit generator
- NACA 5 digit generator

Information

- Airfoil data
- Lift/drag polars
- Generated airfoil shapes

Searches

- Symmetrical airfoils
- NACA 4 digit airfoils
- NACA 5 digit airfoils
- NACA 6 series airfoils

Airfoils A to Z

- A a18 to avistar (88)
- B b29root to bw3 (22)
- C c141a to curtisc72 (40)
- D dae11 to du861372 (28)
- E e1098 to esa40 (209)
- F falcon to fxs21158 (121)
- G geminism to gu255118 (419)
- H hh02 to ht23 (63)
- I isa571 to isa962 (4)
- J j5012 to joukowsk0021 (7)
- K k1 to kenmar (11)
- L l1003 to lwk80150k25 (24)
- M m1 to mue139 (95)
- N n0009sm to nplx (174)
- O oa206 to oaf139 (9)
- P p51droot to pw98mod (16)
- R r1046 to rhodesg36 (63)
- S s1010 to supermarine371ii (176)
- T tempest1 to tsagi8 (8)
- U ua2 to usnps4 (36)
- V v13006 to vr9 (17)
- W waspsm to whitcomb (4)
- Y ys900 to ys930 (3)
- List of all airfoils

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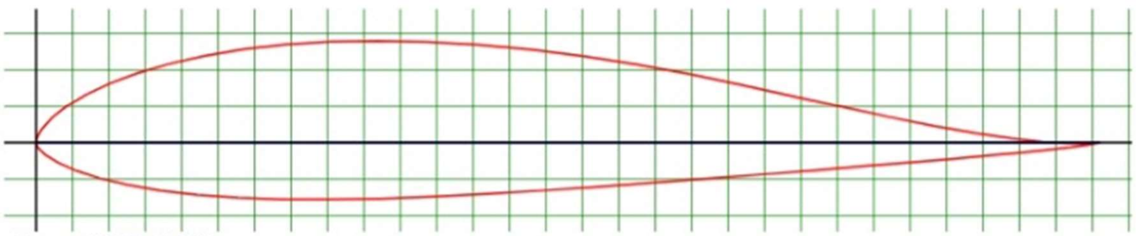
Airfoil plotter (mh61-il)

MH 61 10.26% - Martin Hepperle MH 61 for flying wings

Plot and print the shape of an airfoil (aerofoil) for your specific chord width and transformation. The dat file data can either be loaded from the airfoil databaseor your own airfoils which can be entered hereand they will appear in the list of airfoils in the form below.



Name = MH 61 10.26%
Chord = 292.10mm Radius = 0mm Thickness = 145% Origin = 0% Pitch = 0°

Open full size plan in new window

Open paginated plan in new window for multi page printing

CSV file of coordinates

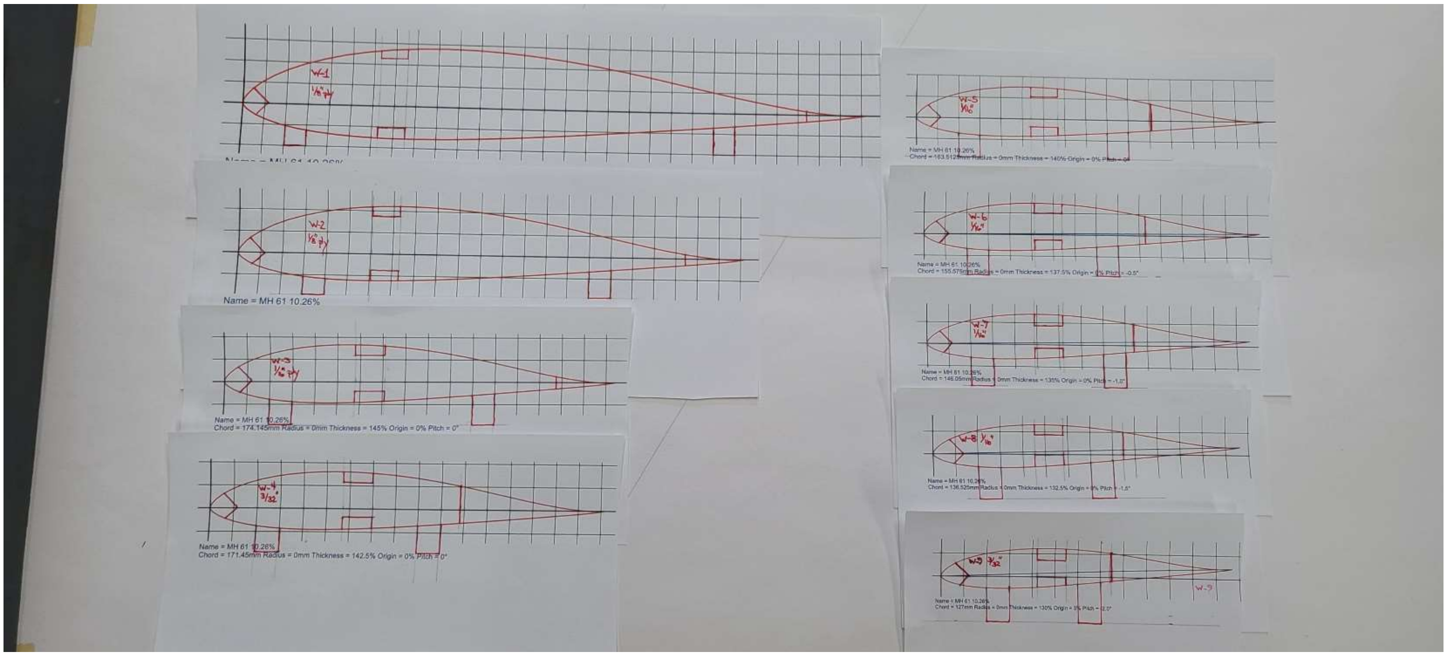
SVG image as text file

Restore defaults

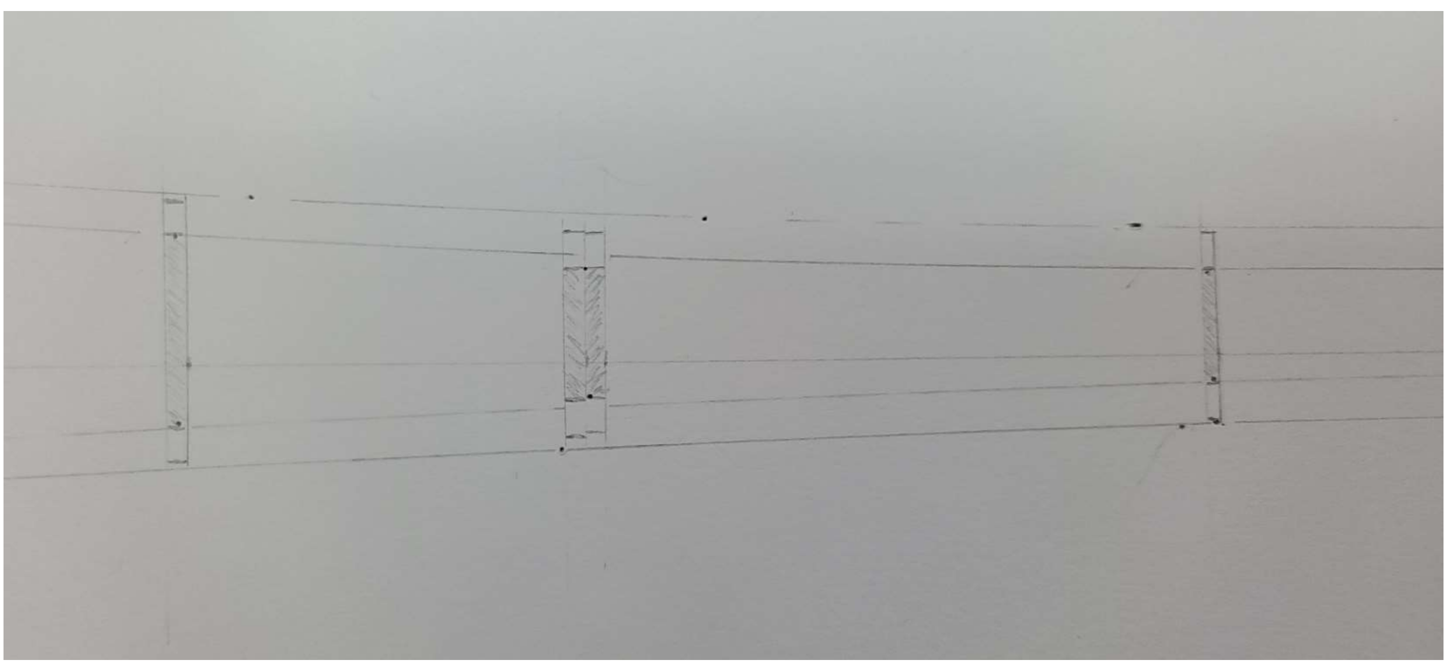
Download PDF file

Airfoil	mh61-il - MH 61 10.26%	Choose from database list or add you own airfoils here.
Chord (mm)	292.10	Chord width in millimetres. (1 inch = 25.40mm)
Radius (mm)	0	Radius of camber in millimetres, Zero for no curve
Thickness (%)	145	Thickness adjustment 100% is normal thickness. 50% is half. 200% is double
Origin (%)	0	Adjust the position of the origin e.g. 50% is mid chord
Pitch (degrees)	0	Pitch or angle of attack. 180 flips the plot
Halo (mm)	0	Line parallel to airfoil for wing covering or jig. Negative values are external, positive internal.
Halo (mm)	0	Second line parallel to airfoil as above
Colour	Colour	Colour palette or black & white
Line thickness (%)	200	Scale the line thickness (10% to 500%)
Reverse	☐	Plot a mirror image
Data box	☑	Print the airfoil data on the image
Camber line	☐	Show camber line on image
X grid (mm)	10	X grid size in millimetres
Y grid (mm)	10	Y grid size in millimetres
Paper width (mm)	280	Used for printing plan. A4 landscape approx 280mm
Paper height (mm)	180	Used for printing plan. A4 landscape approx 180mm

Plot



As I indicated back on page 5, the transition of the slope at ribs W-3 and W-4 was something I felt could potentially not support laying the 3/16" x 1/2" basswood spars along. Before going any further with the model design, I decided to check this out by drawing up a frontal view of the wing. Using the measurements at the spar line in each rib, I generated a frontal view and then pinned the basswood spars in place such that they would either fit into the spar slots, or as close as possible without too much force required to match the original ribs thickness. The results of this are shown in the picture below where you can see how much ribs W-3 and W-4 need to be modified in thickness such that I will be able to bend the spars enough at those ribs. Rib W-5 could also be modified slightly to help with the transition. Using the new thicknesses required for ribs 3-5, I went back into the airfoil generator and adjusted the percent thickness numbers until I was able to get the rib profiles needed. These new rib templates will now be used to build the wings.



With the updated wing profile, I was now able to set the diameter for the wing carbon fiber joiner tubes.

The 3/4" diameter tubes will run perpendicular to ribs W-1 through W-4, and into the fuselage center section the same distance, or approx. 11 inches for an overall length. Once the center section detail is better defined, I can then determine what structure will be needed at W-1 to attach each wing to the fuselage and hold it in place.

Let's start the work up of the fuselage center section. To do this I must first establish the size of the EDFs that will be needed to power this BWB beast. As seen in the picture below and using the general rule for a pattern or warbird model, I need to size my overall power system to produce 140-160 watts per pound. Using my estimate of the final model weight at 5.5 lbs., I'll need approximately 880 watts total to have a 1:1 power-to-weight ratio. So, this sets the power for each EDF at 440 watts. The values shown below are "total system."

Electric Motor / ESC / Battery Sizing Calculations

Motor Gliders: (50 to 60 watts per pound)
Trainers: (70 to 80 watts per pound)
Sport Models: (100 to 120 watts per pound)
Pattern and Warbird Models: (140 to 160 watts per pound)
3-D Aerobatic Planes: (200 to 220 watts per pound)
Pylon Racers: (250 watts per pound and up)

All calculations below are for a single motor, ESC, and battery setup

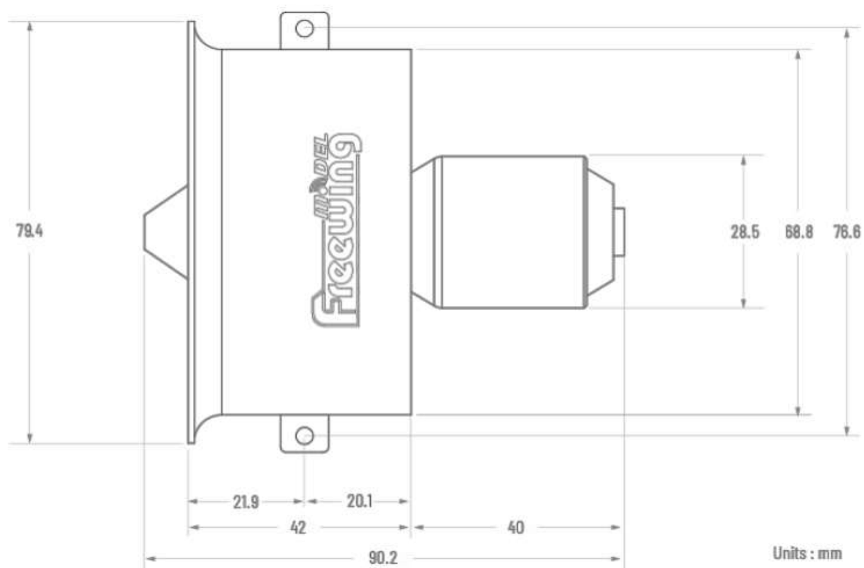
Enter watts per pound needed for your plane	160
Enter estimated weight of "ready to fly" plane (lbs.)	5.5
Total watts required for plane	**880**
Enter planned # of cells in LiPo battery	4
Total voltage under load for LiPo battery pack	**14.8**
Resulting Amps required from battery	59.5
Recommended min ESC size (max amps)	**65**
Recommended motor max current rating	**68**
Now select your motor using motor performance data charts	
Calculated current to voltage ratio	**4.0**
Note: This ratio should be between 3 and 5 (adjust # of cells if not)	
Enter throttle average over flight for your plane (%)	70%
Enter amps of motor/prop/LiPo cells combination you selected for plane	60
Resulting average current draw over flight (amps)	**42.0**
Enter number of minutes desired for a flight	6
Resulting "C" rate of discharge	8.0
Resulting battery pack size (mah) required	**5,250**

Note: This leaves a 20% reserve on battery

Some other constraints I'm placing on my design is that I want to use a single 4S LiPo battery pack to power both EDFs and control each EDF with a separate ESC. This then sets the ESC requirements of at least 40A each, and the single 4S LiPo battery of at least 5,000 mah. Now to size the two EDF power systems. I searched the web for various EDF systems that would fit my initial design constraints and came up with the table below.

EDF Power Systems Comparison									
	Brand								
Specifications	Powerfun	Powerfun	Powerfun	XQ-Motor	Xfly-Model	Xfly-Model	Freewing	Freewing	Freewing
Fan Diameter	70mm	64mm	70mm	64mm	64mm	70mm	64mm	64mm	70mm
# of Blades	12	11	12	12	12	12	12	12	12
Motor	2842			2822	2840	2680	2840	2945	2849
KV	3400	3500	2800	3800	3200	2200	2850	3100	2550
Max. Voltage	16.8	16.8	16.8	14.8	16.5	22.2	14.8	14.8	14.8
Max. Amps	75	52	75	62	50	65	45.5	46	55
Max. Power	1260 W	874 W	1260 W	918 W	825 W	1443 W	673 W	681 W	814 W
Max. Thrust	1810g	1460g	1820g	1570g	1250g	2200g	1270g	1340g	1500g
Set Weight	178g	150g	182g	138g	137g	269g	142g	169g	180g
Recom. ECS	70A	50A	80A	80A	60A	80A	60A	60A	70A
Recom. Battery	4S 3500mah 35C	4S 2600mah 35C	4S 3500mah 35C	4S 3500mah 35C	4S 2600mah 35C	6S 4000mah 45C	4S 2600mah 35C	4S 2600mah 35C	4S 3500mah 35C

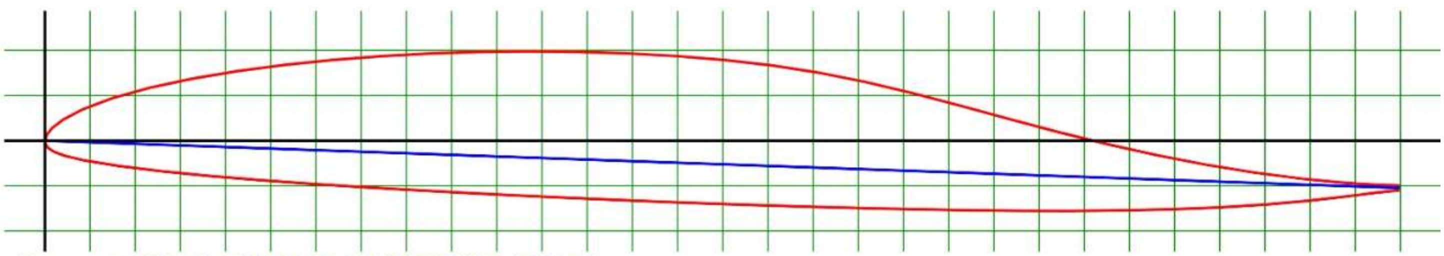
Having this to start with I also wanted to see what the vendors were using for EDF systems in similar models. I found a Sky Flight Hobby B-2 Spirit Stealth Bomber EDF Jet ARF that has a wingspan of 63 inches, length of 28 inches, flying weight of 54.7 oz. (1550g), and uses two 64mm 5 blade EDFs with Lanxiang 3500KV brushless motors and 30A ESCs that produce a total of 1600g of thrust. They recommended using a 4S 14.8V 5200mah 25C LiPo. I also found a 1/24th scale B-2 Spirit Bomber from Freewing Model that has a wingspan of 86.6 inches, is 34.9 inches long, weights 112.9 oz. (3200g), and uses two 70mm 12 blade EDFs with 2952-2100Kv brushless inrunner motors, and two 60A ESCs. They recommend using a 6S 22.2V 4000-6000mah LiPo. Given this, I'm looking at going with two 64mm EDFs along the line of the Freewing 2840-2850KV (outrunner motor) that will produce an overall total thrust in the 2500g (5.5 lbs.) region and sell for $37 each at MotionRC. Everything seems to fit my design requirements and constraints.



With that all set there are some other design considerations that need to be defined for the center fuselage. I want access to the two EDFs and two ESCs from the underside of the model. The ESC units will need to have some airflow across them for cooling. A removable hatch will be needed in the top of the center fuselage to gain access to the battery compartment, control servos, and mounting lugs for the two wings. I want to use fixed tricycle landing gear with nose gear steering. No retractable gear for this design, maybe next one. Each EDF intake duct opening will be designed to 100-110% of the EDF effective fan area (EFA), and each EDF exhaust duct will be designed to 90-95% of the EFA. I calculated the EFA for a single Freewing 64mm 2840-2850KV EDF at 3,080 mm^2, or 4.77 in^2.

The two angled and tapered tail control surfaces will each have a rudder/elevator like a normal V-tail configuration. Additionally, there will be a horizontal elevator between the EDF exhaust ducts to further aid in pitch control. The ailerons will each be controlled by separate wing servos using the transmitter flaperon function and differential control throws.

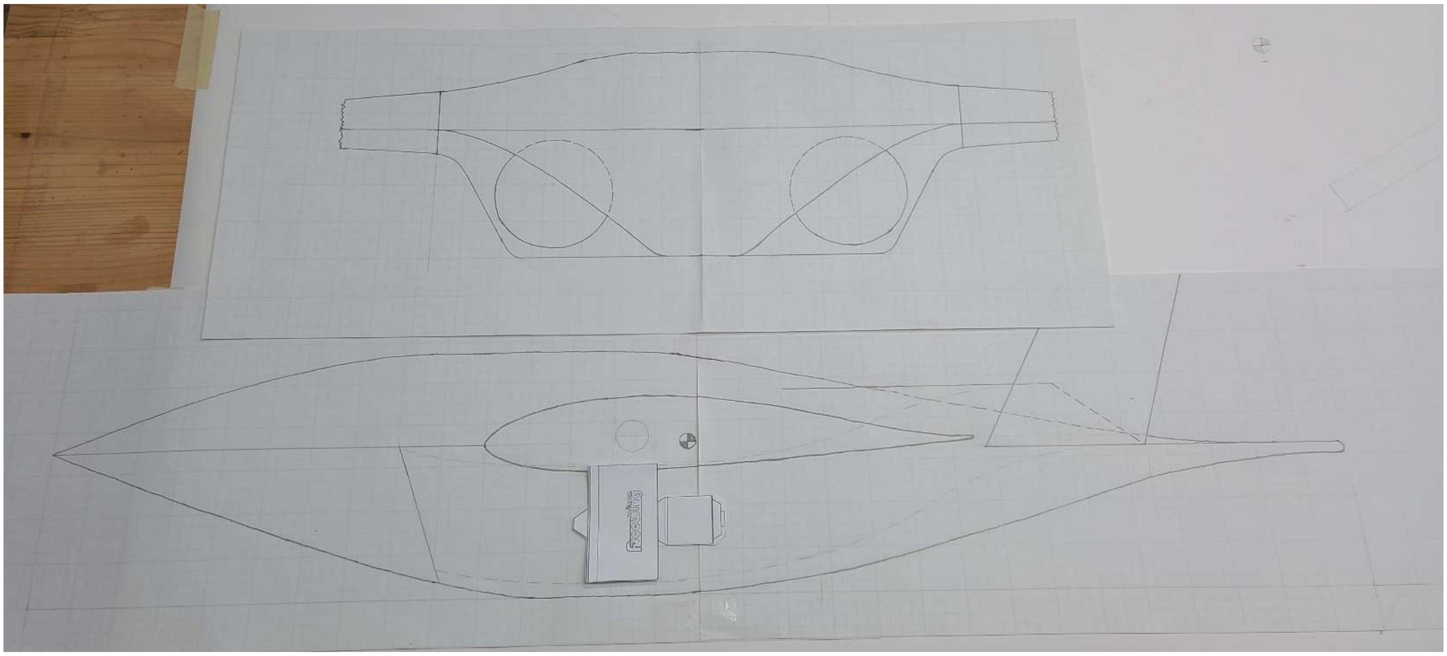
Let's look at what fuselage airfoil shape will provide room for the EDFs, allow for a smooth transition to the selected wing airfoil shape, and still provide an overall appearance as close as possible to the Boeing BWB transport. Looking thru airfoils provided in the www.airfoiltools.com database, I selected one called Roncz/Marske-7 low drag flying wing airfoil, which is a semi symmetrical reflect airfoil that has a maximum thickness of 12.1% at 42.8% of the chord, and maximum camber of 2.8% at 39.1% of the chord. This provides the fuselage thickness required for the EDFs to be located at the calculated CG of the model. Below is the output from the airfoil generator using the model fuselage length of 762 mm at the centerline, 90% of the airfoil thickness, and a +2.0 degree of pitch.



I set this airfoil shape at a +2-degree angle of attack (AOA) to have a line running as straight as possible from the EDF intake ducts below the front of the fuselage airfoil (not drawn here) and the EDF exhaust ducts above the back of the fuselage airfoil (not drawn here). This AOA also helps to place the EDF intake ducts low enough inside the forward fuselage such that the wing 3/4" OD carbon fiber mounting tubes pass above the intake ductwork.

Now to establish the thickness (depth) of the fuselage. Using the frontal view picture of the BWB transport on page 3, I transferred the scale measurements to a frontal view of my model drawing. The position of each EDF (represented by a circle drawn to the actual EDF diameter) is set as low as possible in the fuselage and in line horizontally with the exhaust ducts drawn on the model top view. Using French curves, I draw lines representing the outside profile of the frontal view such that it forms a smooth transition from the top of the fuselage to the top of the wing roots (which must be placed so the carbon fiber tubes pass above the EDF circles), and the general appearance is as close as possible to the BWB pictures. I must also ensure the area of each EDF intake opening provides the required EFA. This hand-drawn frontal profile yields a fuselage thickness of 5.75" at the centerline, so I need to adjust the sizing in the airfoil generator to produce this result.

Using the adjusted airfoil shape as a starting point, I transfer the model top view measurements for the center fuselage to a new sheet of drawing paper to work up a side profile of the model. I printed out a full-size drawing of the Freewing 2840-2850KV EDF and wing W-1 rib profile to ensure the side profile captures the correct positioning of these two items. I set the EDF near the calculated CG and put W-1 back the required distance from the model nose, and then started the outline from there. After several iterations of side profile shapes trying to best match what I have in pictures for the new BWB transport, below is a picture showing what I was able to draw up.

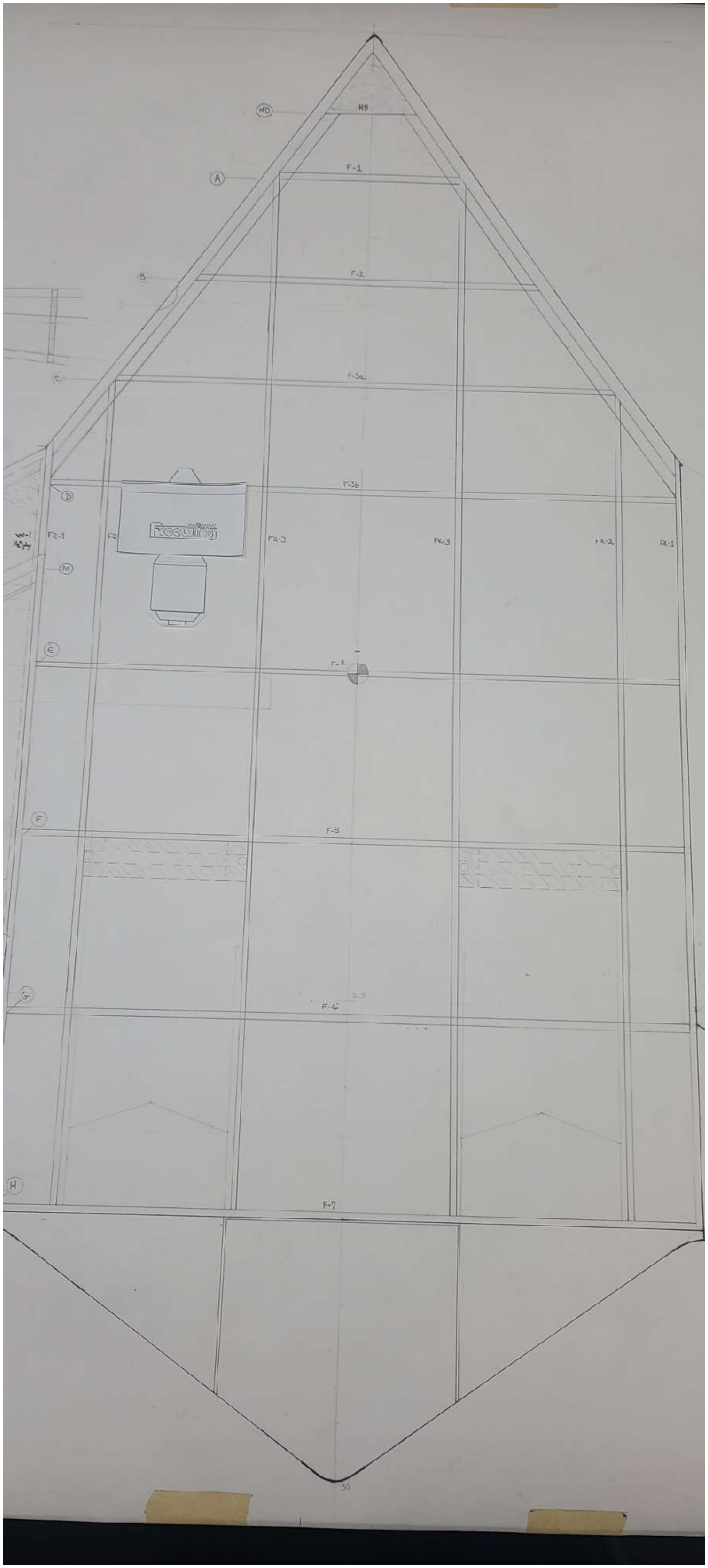


The first thing that became apparent was that the EDF ductwork is NOT going to be an easy task. This is driven by Boeing positioning the intake ducts below the wing and then having the exhaust ducts above the wing. I understand the need for the position of the exhaust ducts to reduce the real-world heat signature of the jet engines, but I'm not sure what drove the intakes below the wing other than to try and make as much room as possible in the center fuselage cargo bay area and still having the engines hidden inside the BWB shape for reduced radar signature. Anyway, this is what I'm working with at this point of the design.

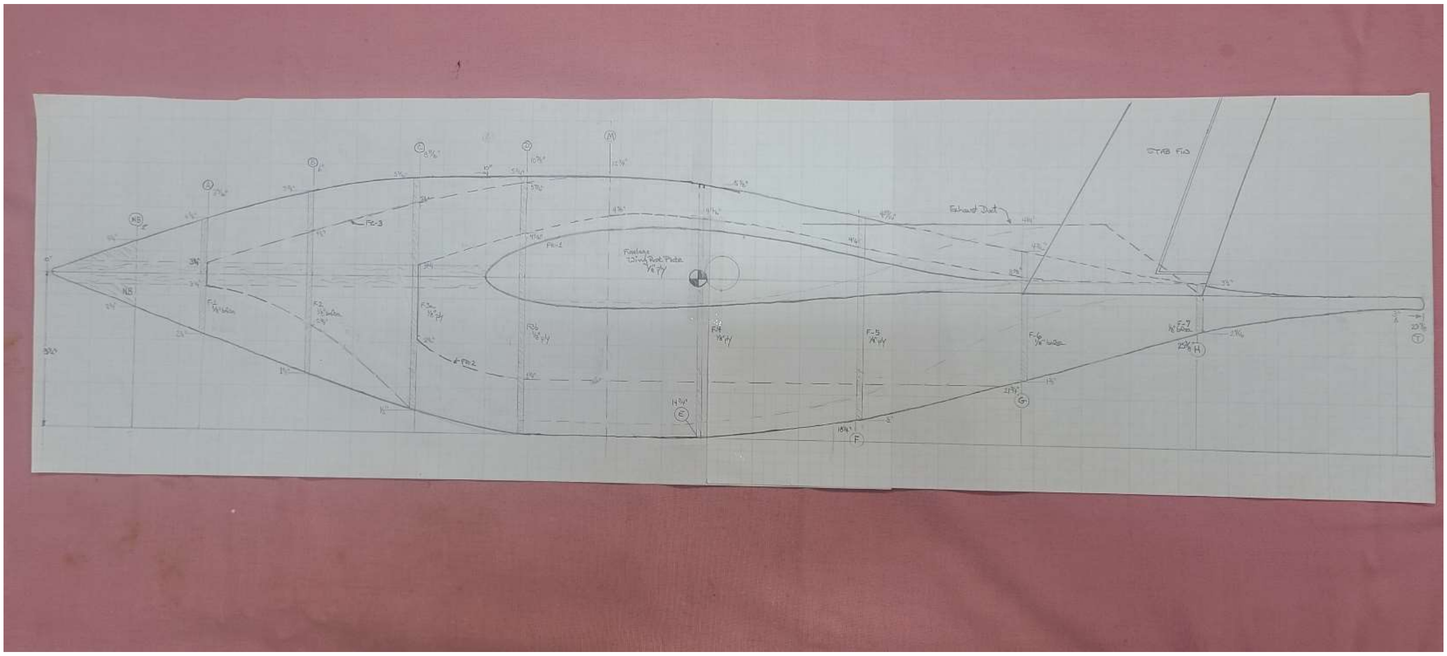
Well, I can't build a model just using profiles, so I need to define some internal structure for the center fuselage. The first thing needed is to define just what all components and hardware are going to need to be put inside the center fuselage so their positions and related support structures can be integrated into the design. Here is my list of the various items that need to be considered: two EDF units with an ESC for each (which need to be air cooled); intake and exhaust ducts for each EDF; a single 5,000 mah LiPo battery; eight channel Spektrum 2.4GHz receiver with "Safe" technology features; fixed tricycle landing gear (may look at making twin wheel gear); a servo for nose landing gear steering; three other servos in fuselage (one for each rudder/elevator in the canted stabs and one for the horizontal elevator in the flat tail); assorted wiring for EDFs, ESCs and servos; carbon fiber tubes for wings along with wing mounting hardware; any hardware needed for the various access hatches that will be needed (four in the bottom of the fuselage – each EDF, nose land gear servo access, and the ESC cooling hatch) and an access hatch in the top to gain access to the battery compartment, servos and receiver; and control surface control rods and horns.

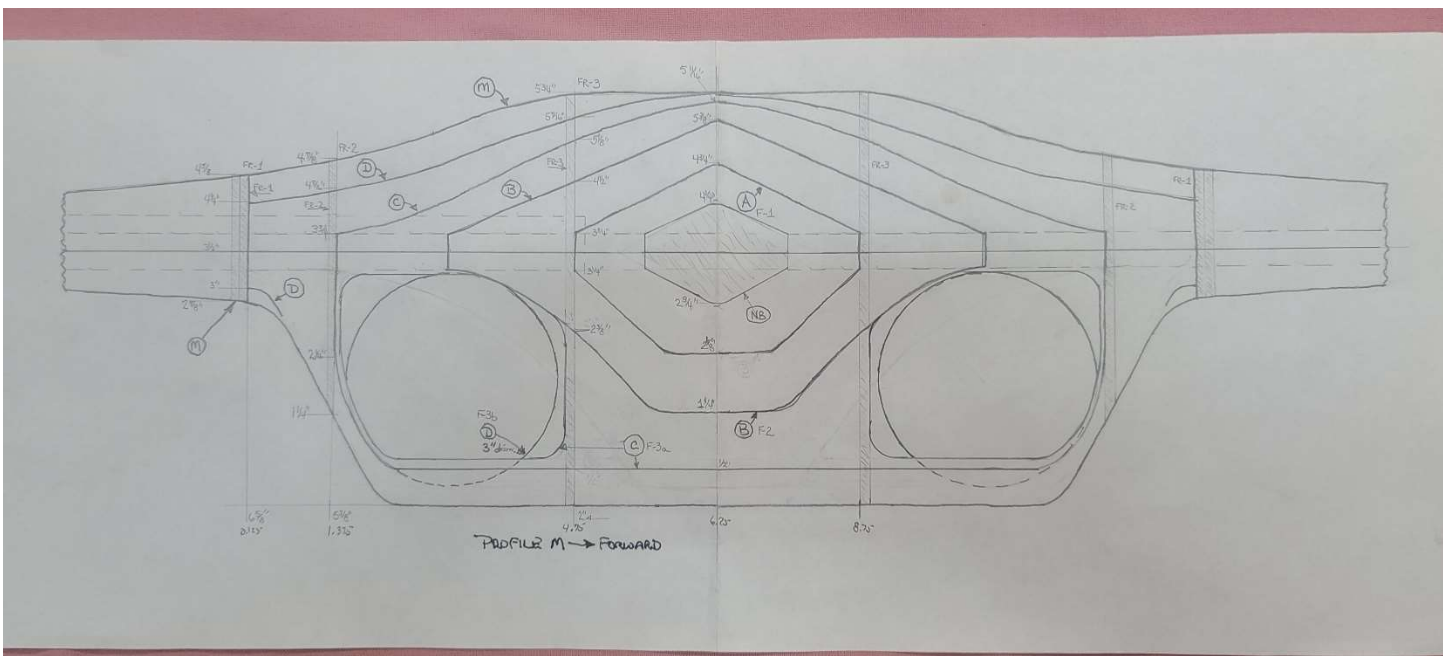
To get some idea on how I might approach the design of the internal structure I jumped on the web to look for some model drawings of similar designs. I came across two plans on Aerofred.com that help a great deal. One is an unpowered delta wing glider called Delta Diamond, and the other is a plan for the Horten Go 229. Both plans use an internal structure for the fuselage made up of interlocking formers and center frame side rails (or ribs), and thin balsa planking and sheeting to cover the fuselage section. I'm going to attempt to use the same approach. As I define the various formers and fuselage ribs, rather than cutting wood I'm going to cut out each internal structure using 1/8" foam board to see how all things fit together and adjust as needed. Only after I feel everything fits together as needed will I use the plan templates to cut plywood and balsa. So now off to setting up where all the formers and fuselage ribs need to be placed and sized to result in the initial profile shapes.

First, I laid out the location for each of the fuselage ribs and formers in the top view. I did this because I knew there had to be a fuselage rib on each side of the EDFs to build the associated air intake and exhaust ducts, and formers in key locations for wing carbon fiber tube mounts, MLG wires, and NLG mount. Pictured below is the resulting top view.

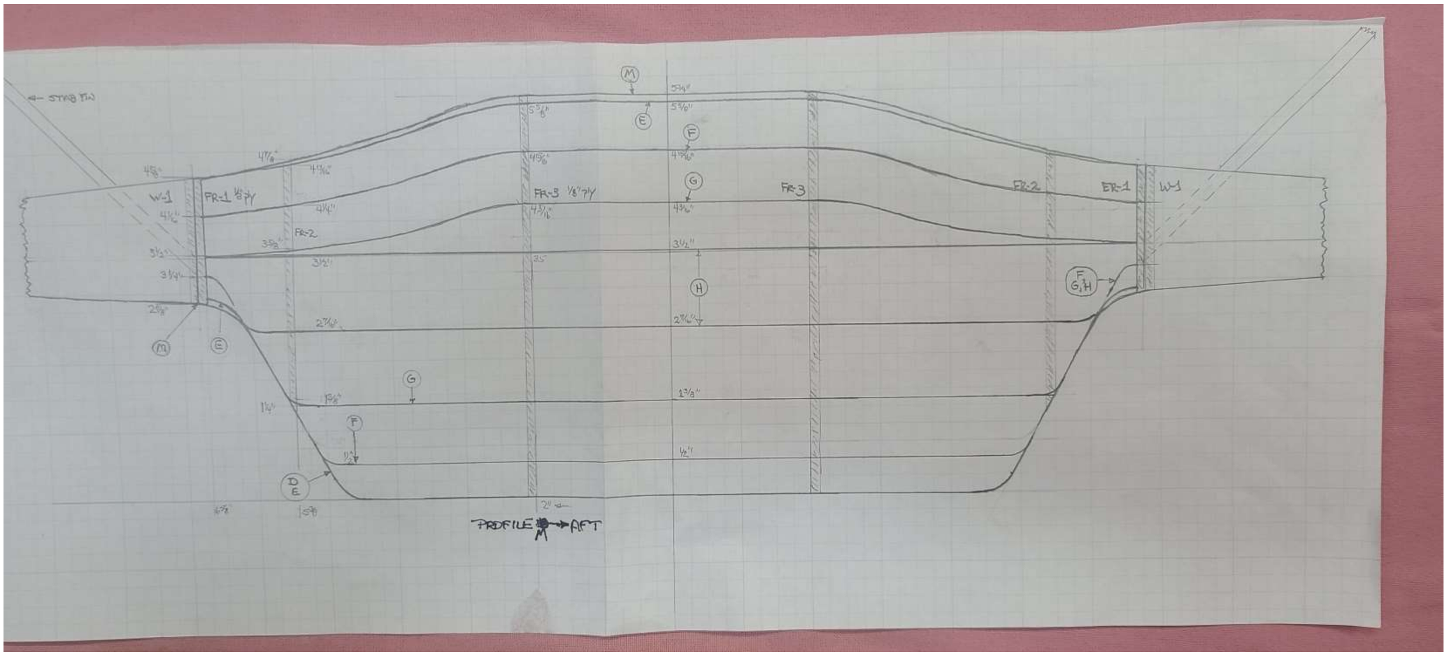


As shown in the picture, there are six fuselage ribs (FR-1 through FR-3; identical on each half) and eight fuselage formers F-1 through F-7 (F-3 was changed to F-3a and F-3b due to design changes). All the fuselage ribs will be cut from 1/8" lite ply. Formers F-1, F-6 and F-7 will be 1/8" balsa sheet, and all the other fuselage formers will be 1/8" lite ply. Leading edge of the fuselage is 3/8" square balsa with a solid balsa nose block (NB). The entire center fuselage will be covered using 1/16" balsa strips and sheets. With the initial positions set for all of these, I transferred their locations to the side view so I could then determine the height for each former at the centerline (thickest location). Below is the side view with the formers added. Using those measurements, I then established a frontal view that represents various cross sections of the center fuselage from the wing spar location (set as cross section "D", also thickest part of fuselage) forward to the tip of the nose, and a rear view that represents various cross sections from "D" rearward to the end of the fuselage (cross section "H" which is also former F-7). This gives me a general outline for each of the formers and sets the height for each of the fuselage ribs at the intersection with each former so I can then transfer those measurements back to the side view to provide a general outline for all the fuselage ribs. Shown below are the resulting frontal and rear-view drawings.



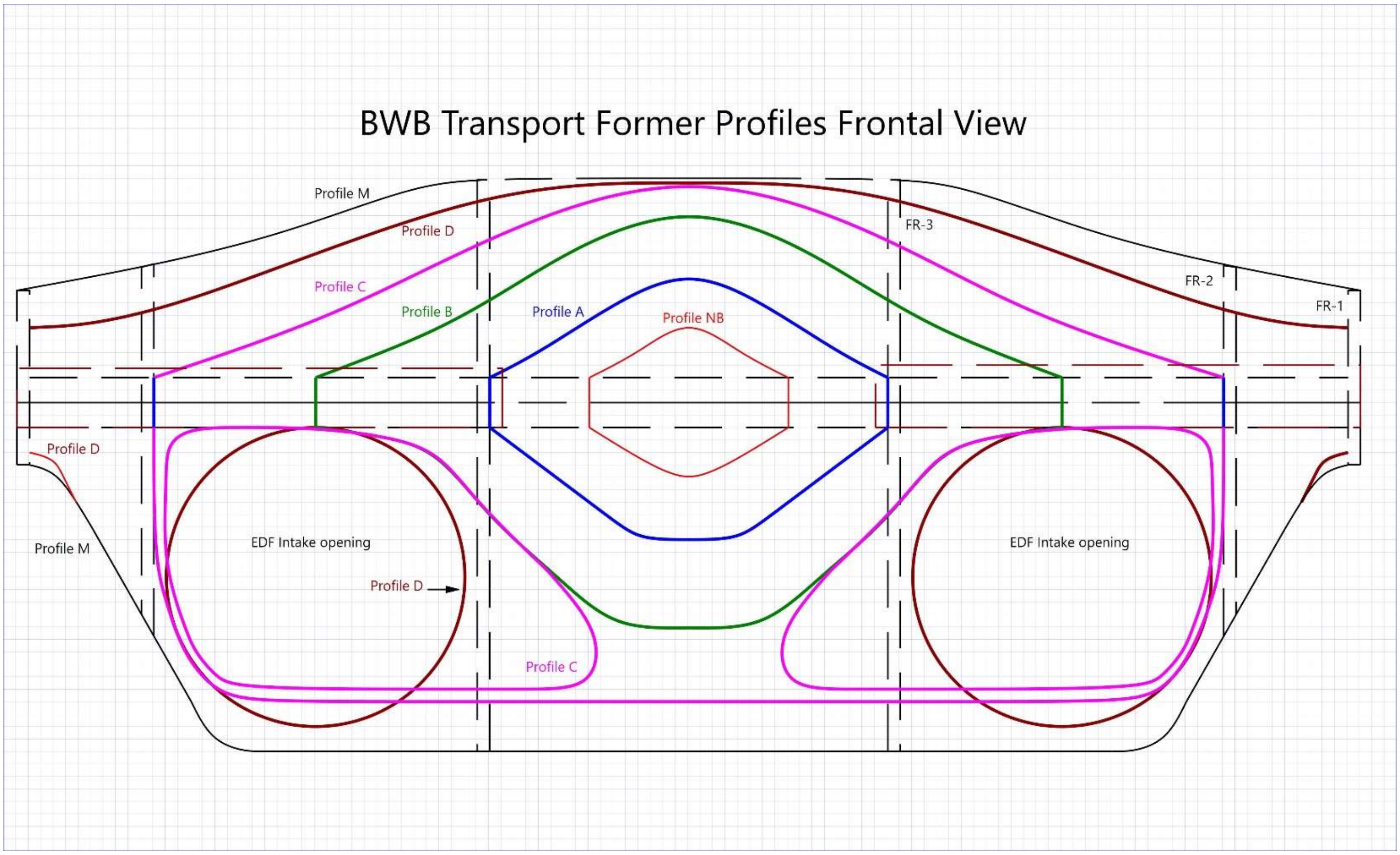


The two 3" diameter circles in the frontal view above represent the EDFs outer fan intake duct diameter at cross section "Profile D" which is the back side of former F-3b.



OK, going through this exercise made me realize that attempting to accomplish this model design using pencil and paper, moving measurements from one view to another, making changes using my trusty erasers, and redrawing the changes was NOT the way I wanted to continue. Since my engineering drawing classes were back in the mid-70s, the pencil and paper route were the only thing available. But today all that has changed with the creation of engineering designs using Computer Aided Design (CAD) program. I've never used a CAD program, but it was clear I needed to learn one. After looking through several reviews and articles on the web, I decided to attempt my design using a simple 2D CAD program called "Back to the Drawing Board" available in the Microsoft Store. Yes, there are many other CAD programs out there, but all I need are drawings that will provide me with the various templates to cut out the balsa and ply pieces needed for the model. While 3D CAD would be nice, trying to learn how to use one would take many more hours and not really give me anything more than I can get from 2D.

So, I moved everything I'd drawn so far on paper to digital format using the 2D CAD program. Learning the program was quite simple, and the more I used it, the easier things became. Pictured below is the resulting frontal view of the fuselage former profiles from the nose block (NB) back to the middle reference profile M.

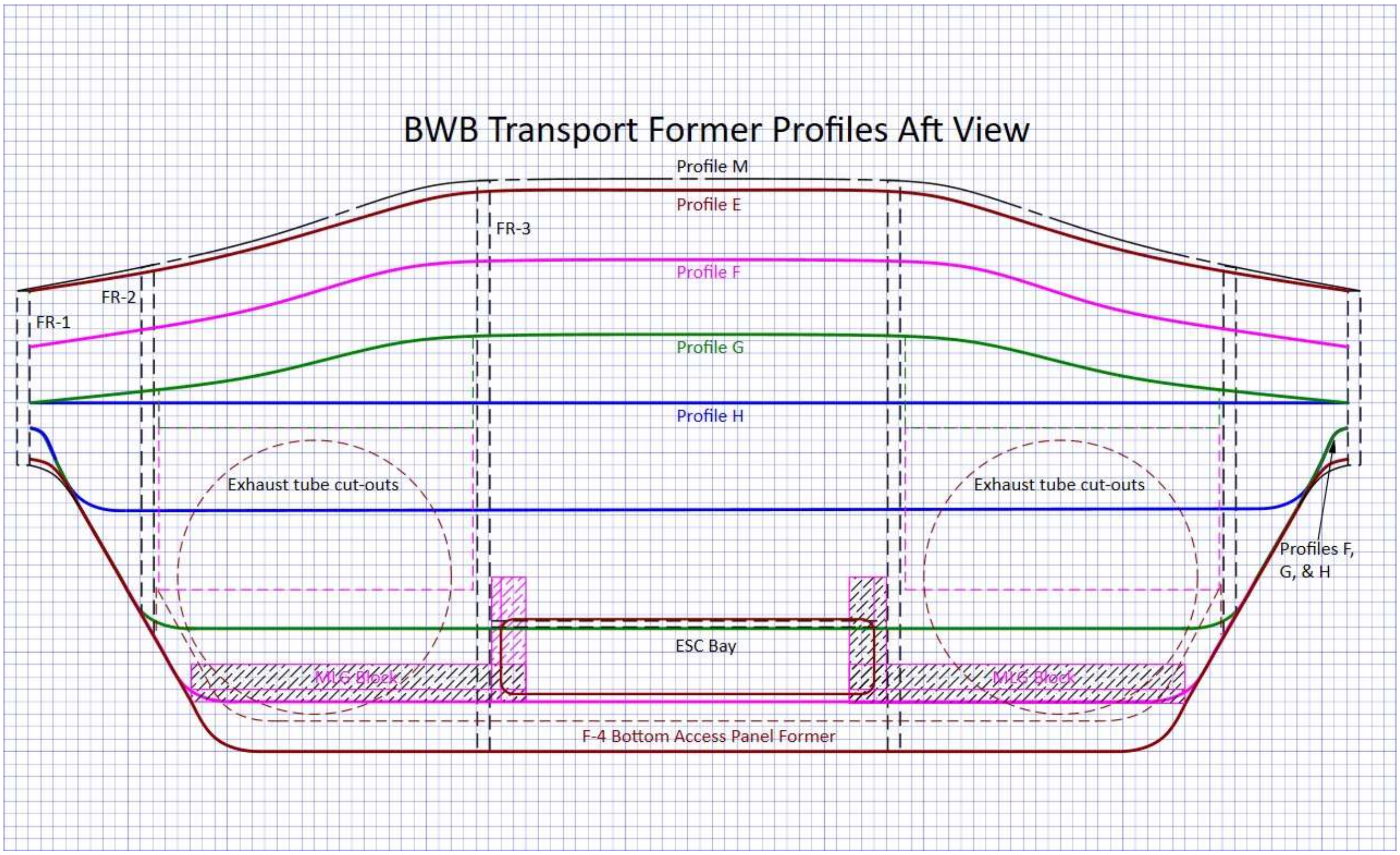


Using the 2D CAD program, I'm able to assign each cross-section profile in the fuselage to an assigned layer within the drawing (i.e., Profiles A-M pictured above), which then allows me to pull out a given layer only showing the related former I desire. Using the fuselage side view drawing I did the same thing for each of the fuselage ribs (Fr-1 through FR-3). OK, I'm sold on using a CAD program, and can put the paper drawings away.

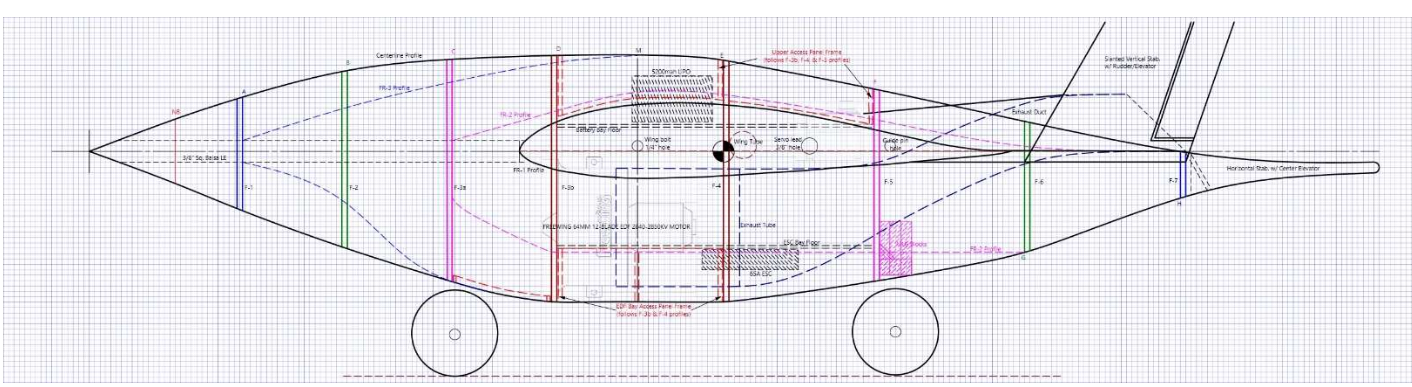
I continued moving my paper drawings to digital format until I had the frontal, aft, top, bottom, and side views of the center fuselage, a top view of each wing, a profile view of the wing, and airfoil shapes for all the wing ribs. All these were drawn to full scale. Next step is to put final definition on where all the internal components are going to be placed so any required structures can be determined and put into the CAD drawings. Scale representations of the 64mm EDFs were inserted between fuselage ribs FR-2 and FR-3 and positioned so the intakes would be just aft of fuselage former F-3b. This also placed the weight of the electric outrunner motors close to the model CG. I want to install the EDFs and ESCs from the underside of the fuselage, so this drives an access panel on the bottom of the fuselage, an ESC bay floor, and cooling air pathways through required formers. Several other items (such as the LiPo battery, control surface servos, receiver, NLG steering, wing attachment screws, etc.) all require access panels in the fuselage, so these were the next items to lay out in the design.

Now I need to get digital representations of the various internal components drawn to scale so they can be placed into the different drawing views for fitting and final position determination. Simple research of the web provided everything I needed. Using the top view of the fuselage I established placement of the four servos (elevator, NLG steering, and two rudder/elevators) and their control cables, an 8-channel receiver, and the 5200mah LiPo battery. On the fuselage bottom view, I placed the two ESC's and the two EDFs, and the MLG wires support structure. The locations of these various components were then transferred to the fuselage side view. The aileron servos were positioned into both wing top views.

Now with all that set, I can attempt to see how the various fuselage ribs and formers will need to fit together. I'll do this using 1/8" foam core board cut to the various 2D CAD profile templates. The drawing below is the fuselage aft view and the profiles for each former from the middle of the fuselage (Profile M) back to Profile H, which is the front side of former F-7. F-7 is the front side of the horizontal stabilizer and center elevator.

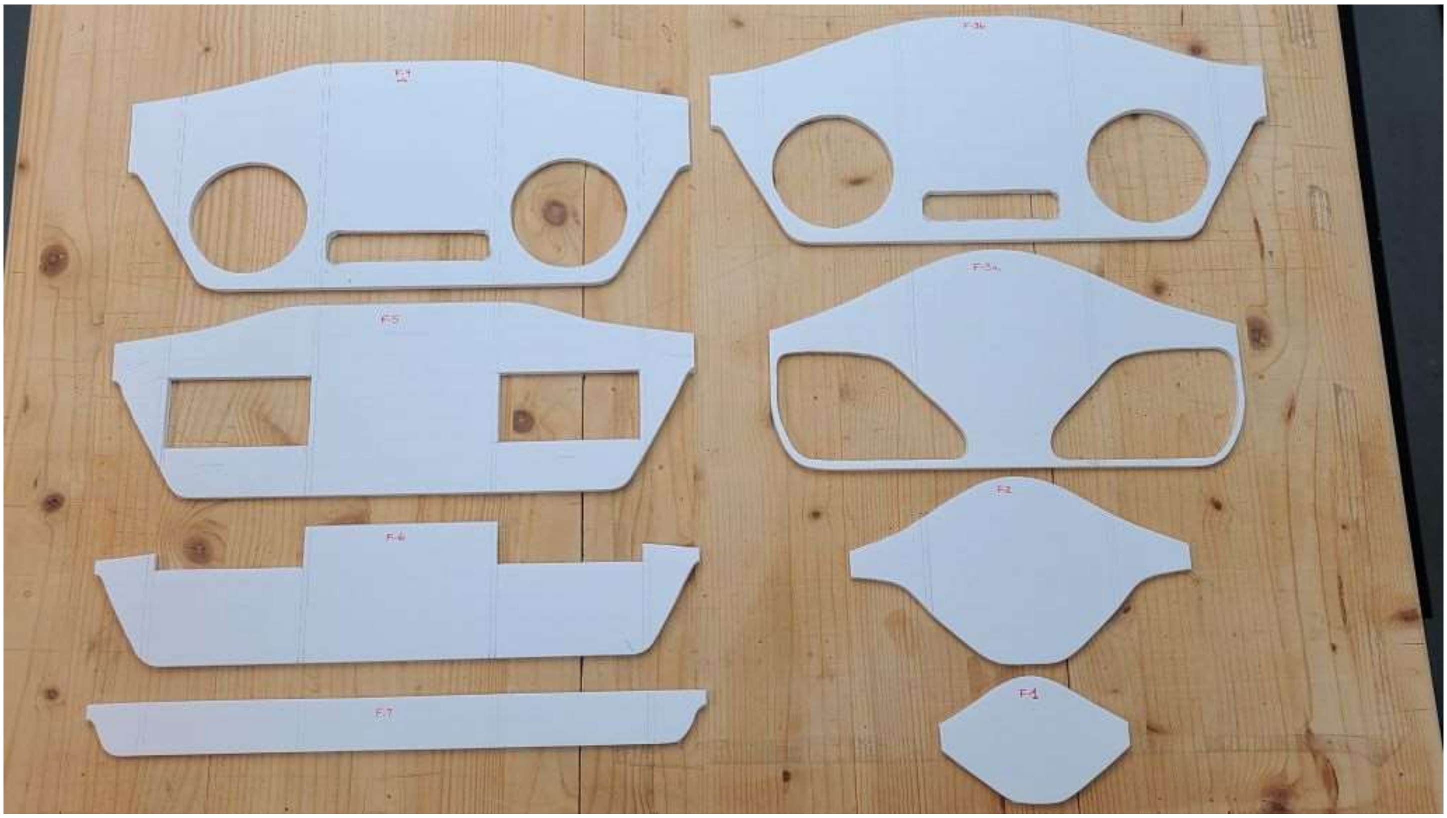


The fuselage ribs (FR-1 through FR-3) will also be cut from 1/8" foam core board using the profiles established in the 2D CAD fuselage side view shown below.



While I've tried to identify the required passageways through the formers for the EDFs intake and exhaust ducting, and the ESC bay cooling, the many cuts required in each of the formers and fuselage ribs will still need to be determined so all can be interlocked together to form an internal center fuselage structure. And then I'll need to identify any areas in the formers and ribs that can be cutout to help reduce the weight of the model. So, with the 2D CAD templates in hand, I'm headed off to cut some foam core sheets.

After the better part of a day, the picture below shows the results of my effort on the fuselage foam core board test fit formers.



The four on the right are from the 2D CAD frontal view and the cutout areas in F-3a and F-3b are the EDFs intake ducts, and the rectangle in F-3b is the ESC bay cooling air intake. The four on the left are from the 2D CAD aft view where the cutout areas are for the EDFs exhaust ducts and the ESC bay cooling air exhaust. The interlocking notches in each former will be defined once I have the fuselage ribs.

With the announcement on 13 October 2023 https://www.airforce-technology.com/projects/jetzeros-blended-wing-body-aircraft-usa/?cf-view from the USAF that JetZero, an aerospace company based in the US, will build the world's first blended wing body (BWB) demonstrator aircraft for the USAF, my design efforts to model the Boeing BWB have been placed on hold. Should I decide to try and model the JetZero BWB concept, updates will be posted on this webpage. More to come, maybe.