Crafting Apache Fin Leading-Edge Extensions

By John Brohm, NAR #78048 **May 30, 2026**

Introduction

Sometimes the scale modeler is confronted with the challenge of reproducing very thin fins. Depending on the prototype and scale factor, the required model fins may push the limits of available materials.

That's exactly the situation with the sustainer fins on the Nike Apache I'm currently building. The prototype Apache fins were 0.26" thick[1]; at our scale factor (1/5.489), they shrink to a width of just 0.047" - little more than 1mm. This raises two key questions: how to produce a fin at true scale thickness that's still robust enough for flight, and how to replicate the Apache's distinctive leading-edge bevel on such thin material?

In this article, I'll share with you the approach I've taken to address both challenges.

The Prototype Apache Fin

The Apache fin was an aluminum extrusion that included the mounting flanges, and was cut to the planform illustrated in Figure 1.

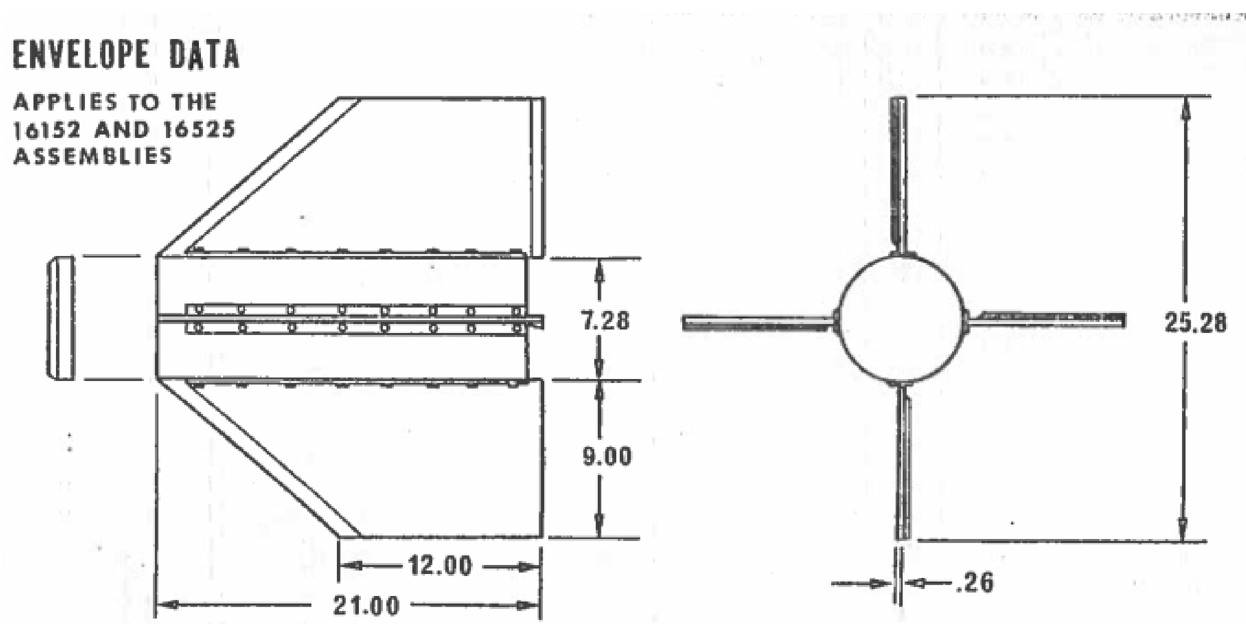

Figure 1: Nike Apache Fin

Standard Fins – Cajun-Apache Rocket Motors

[1] "Standard Fins – Cajun-Apache Rocket Motors", Atlantic Research Corporation

Each Apache fin featured an Inconel leading-edge cuff for thermal protection, and was fitted with a field-machined trailing edge spin tab to induce a specific roll rate. Each fin assembly was screwed to an extruded aluminum shroud that was, itself, screwed to the nozzle section of the Apache motor.

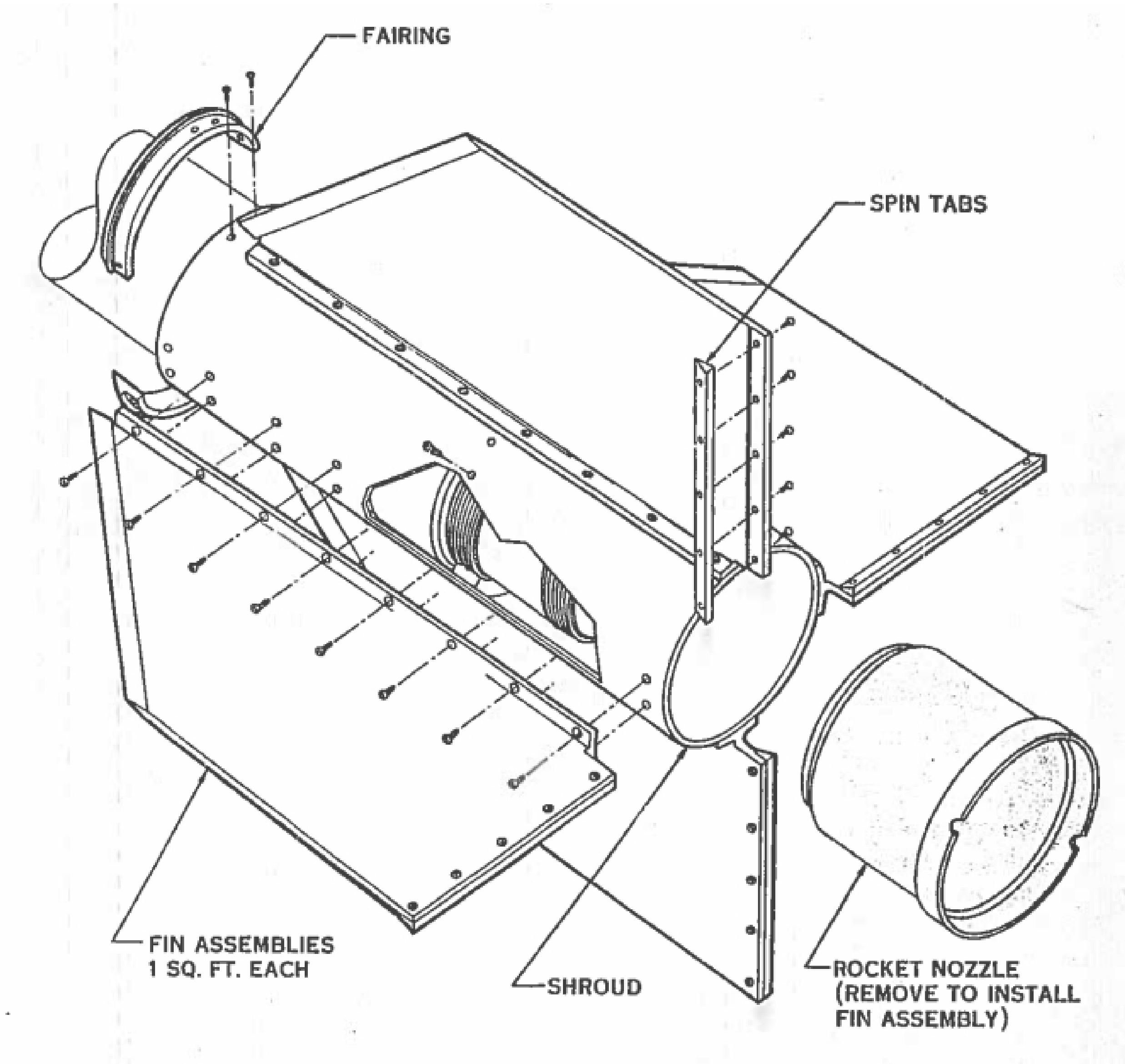

Figure 2: Apache Fin Can Assembly

Standard Fins – Cajun-Apache Rocket Motors

Apache and Cajun fin can assemblies were interchangeable; as described by Buzz Nau[2], *"Cajun and Apache are so similar that they are often regarded in NASA reports as "Capache", signifying the material is relevant*

[2] "Nike Cajun and Apache Sounding Rockets", **Total Impulse**, Vol 18/No. 1 https://cv41.org/newsletters/V18I1.pdf

for both rockets". We'll take advantage of this interchangeability by borrowing photos of both prototypes so that we might more clearly visualize the key features.

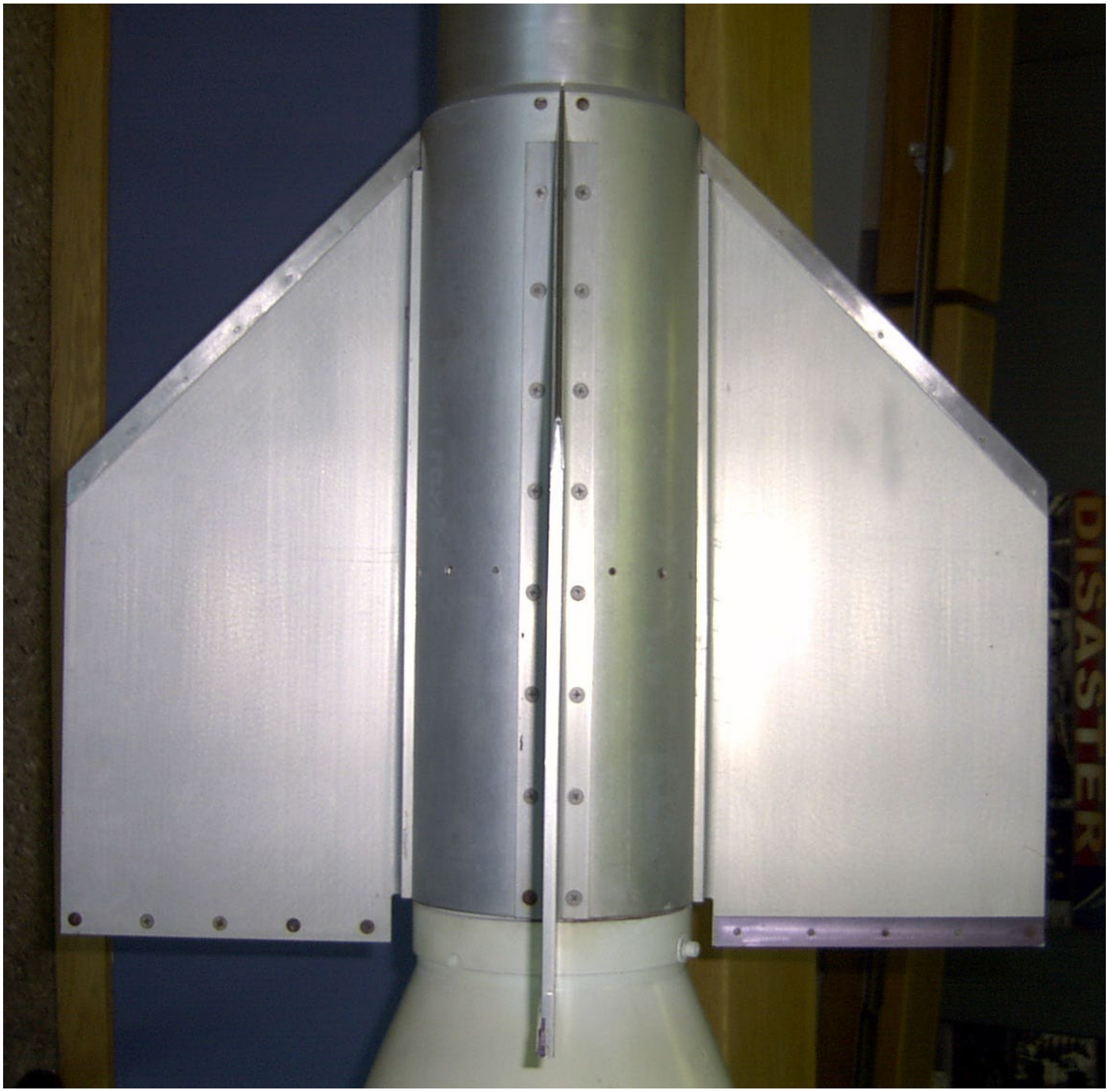

Photo 1: Apache Fin Can

Photo courtesy of Buzz Nau

Photo 1 highlights the leading-edge Inconel cuff and the trailing edge spin tab. Of note is the way the leading-edge cuff lands flush at the shroud; because the fin extrusion is cut short of the shroud's forward edge, a small gap is created between the forward edge of the fin extrusion and the aft edge of the Inconel cuff. This is a detail that we'll want to capture on the model fins.

At the aft end of the fin assembly, one can see how the fin trailing edges have been notched to provide clearance for the motor nozzle – that's the white ring just behind the fin can. Often this ring is confused as a part of the Interstage Adapter; Photo 1 makes it clear this ring is the rocket nozzle as depicted in our earlier Figure 2.

Photo 2 provides an oblique view of the fin assembly, and highlights the motor nozzle.

Photo 2: Cajun Fin Can

Photo courtesy of Chris Timm

Photo 3: Cajun Fin Can

Photo courtesy of Chris Timm

Zooming in on Photo 3, one can clearly see the gap between the Inconel cuff and the forward edge of the fin root.

Finally, Photo 4 – it provides a close-up detail of the Inconel cuff itself.

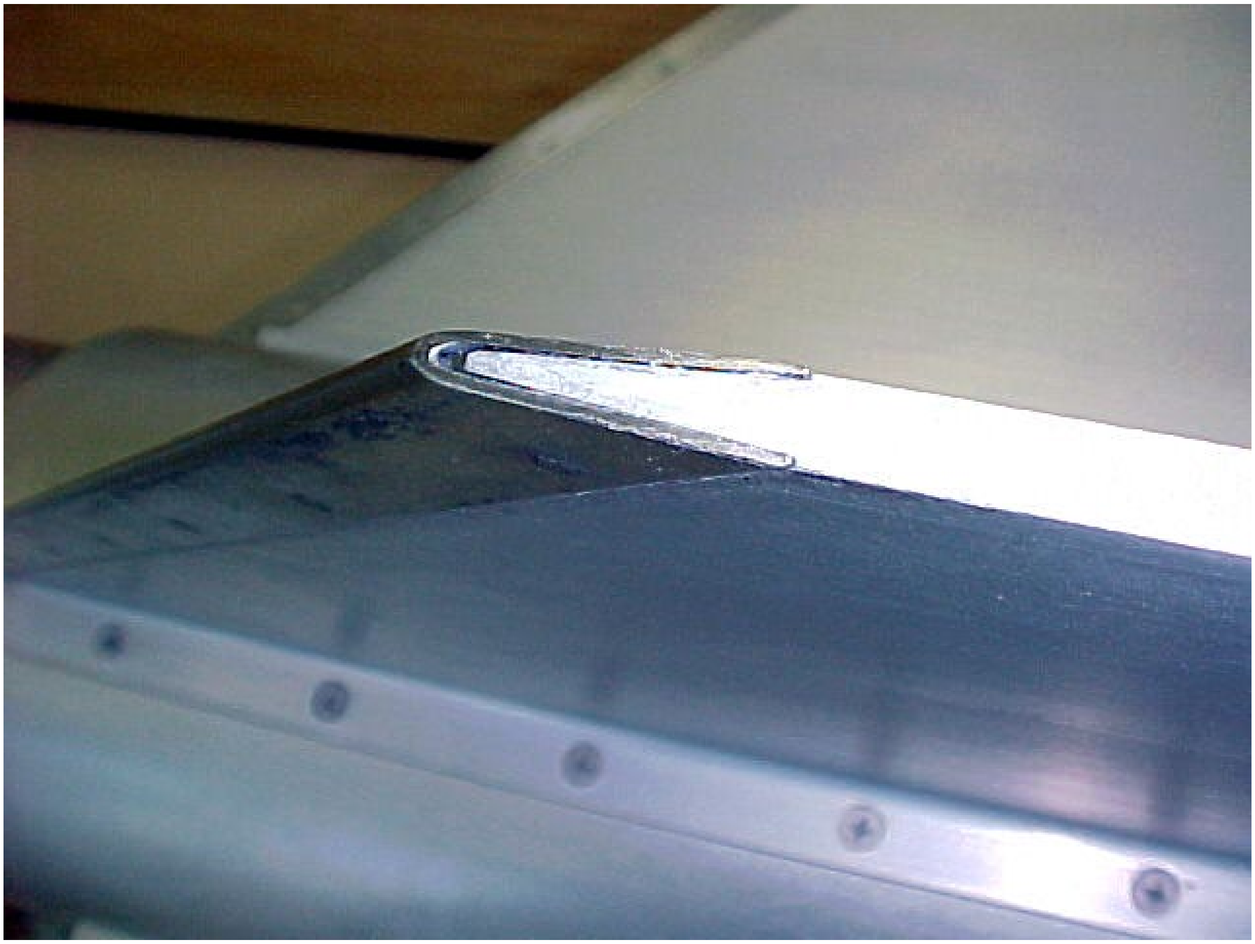

Photo 4: Leading Edge Inconel Cuff

Photo courtesy of Buzz Nau

As Photo 4 shows, the fin's leading-edge was milled to seat the one-piece cuff. The photo also shows how the fin's leading-edge/cuff is aerodynamically beveled, and how the Inconel cuff sits slightly proud of the fin at the mating edge. The beveled leading-edge is a feature that we'd like to capture on our model, however, with fins of a thickness just barely more than 1mm, creating a consistent leading-edge bevel will be a challenge indeed.

Considerations for Crafting Scale Apache Fins

The fins for our model's Sustainer will be quite thin – 0.047″ thick; there are no traditional modeling materials (balsa, plywood) available in this thickness. One option would be to craft a composite material fin by sheeting 1/32″ (typically 0.035″, or 0.8mm) thick balsa with a lightweight fiberglass cloth and epoxy resin. The resulting composite fin would likely be stiff enough for flight, but controlling the thickness of the layup would be challenging.

The scenario calls for a stiff material with precise dimensional characteristics, such as G10 fiberglass. Here, we can find sheets of 1mm and 1.2mm thickness, with the 1.2mm thick material being almost exact scale. However, while G10 offers the qualities we seek (stiffness, robustness), those very same qualities present serious obstacles when we consider how best to replicate the leading-edge bevel, especially on such a thin fin.

As a practical matter, in the absence of a reasonably precise milling set up there is no easy way to achieve a consistent ~0.5mm half bevel on 1mm G10 – certainly not by hand. So, our strategy will be to prepare the beveled leading-edge as a separate part, and then glue it to the G10 fin. But first a decision must be taken as to which material – 1mm or 1.2 mm – will be used for the fins.

Normally our preference is to use exact scale materials whenever possible. The problem here is the math - 1.2mm is 0.047″. Since the bevel occurs on both sides of the leading edge, that means the half bevel is 0.0235″. There is no convenient material set that can be adapted to create such a bevel.

However, 1mm is 0.0394″, very nearly 0.040″. A half bevel with this material would be 0.020″, a standard size in sheet Styrene. So, a leading-edge cuff mold could easily be crafted for 1mm G10 material. The downside is the 1mm-based fin would be slightly undersize, thin by 0.0035″ on each fin side. But that's the unfinished fin – primer and paint will help the finished fin land close to scale thickness.

So, with these considerations in mind we'll select 1mm G10 as the fin material, and we'll craft a separate beveled leading-edge extension which will be added to the fin.

Sizing the Leading-Edge Extension (LEX) & Inconel Cuff

The November 1969 issue of Model Rocketry magazine, pages 5-9, contains a scale article and drawing of Nike Apache FLT 14.04UE. The drawing (page 6) provides a stock width for the Inconel cuff of 0.75″. Unfortunately, we can't be sure of the accuracy of this dimension, as other dimensions in the drawing are known to be at variance with actual source material[3]. We are therefore disinclined to rely on this drawing.

However, we do have actual prototype photos of the Apache/Cajun fins (e.g.: Photos 1-4, herein), and from these we can approximate the cuff width by scaling from these photos. Admittedly, this process introduces some error, due to parallax issues with the photos. Nevertheless, by taking measurements from several different photos, we arrive at a likely stock dimension for the cuff in the range of 0.625″ (5/8″) to 0.71″.

For the model, I decided to go with the 0.71″ dimension, only because this returns a prototype chord length of 1″ (i.e.: $0.71 * \sqrt{2} = 1$), a conveniently round number[4]. But it could just as easily be 0.884″ if the 5/8″

[3] "Standard Fins – Nike Rocket Motor", Atlantic Research Corporation
"Standard Fins – Cajun-Apache Rocket Motors", Atlantic Research Corporation
"Nike M5 Rocket Motor", Biedron/Tschirhart, 1996/2012

[4] The Apache/Cajun fin leading edge was swept 45 degrees

prototype stock width is correct (or perhaps it's actually some other measurement, maybe even 0.75"). Until a confirmed prototype measurement or engineering drawing is found, we'll go with our scaled interpretation.

Taking these considerations into the fin's design, we arrive at the planform shown in Figure 3, based on our scale factor of 1/5.489.

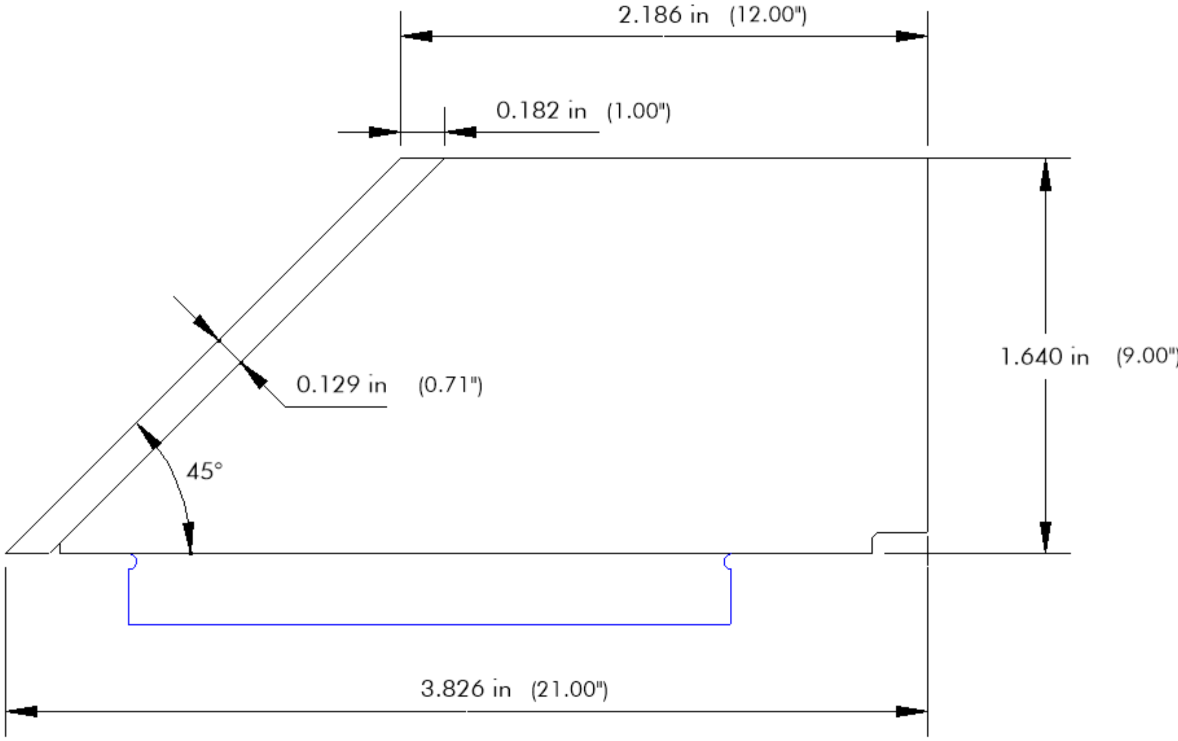

Figure 3: Scale Model Apache Fin

Prototype Dimensions shown in Parentheses

The diagram shows that the beveled leading-edge stock width is 0.129", and its chord length is 0.182". We'll base our LEX on these dimensions.

We will also add a cuff to the LEX to complete the fin assembly, just like the prototype. This separate part will be a one-piece wrap, fashioned from 0.005" thick Styrene sheet and will be sized to match the LEX as shown in Figure 3. Making the cuff a separate Styrene part also affords the opportunity to detail the part with the rivet pattern we see in our earlier Photos 1-3. The photos also make plain that the Inconel cuff had a brighter sheen than the dull aluminum fin extrusion, so we'll address that issue during the finishing stage.

But first, let's cut those G10 fins.

The Scale Model Apache Fin

Using the planform in Figure 3 (minus the LEX), a set of four 1mm thick G10 fin blanks was cut.

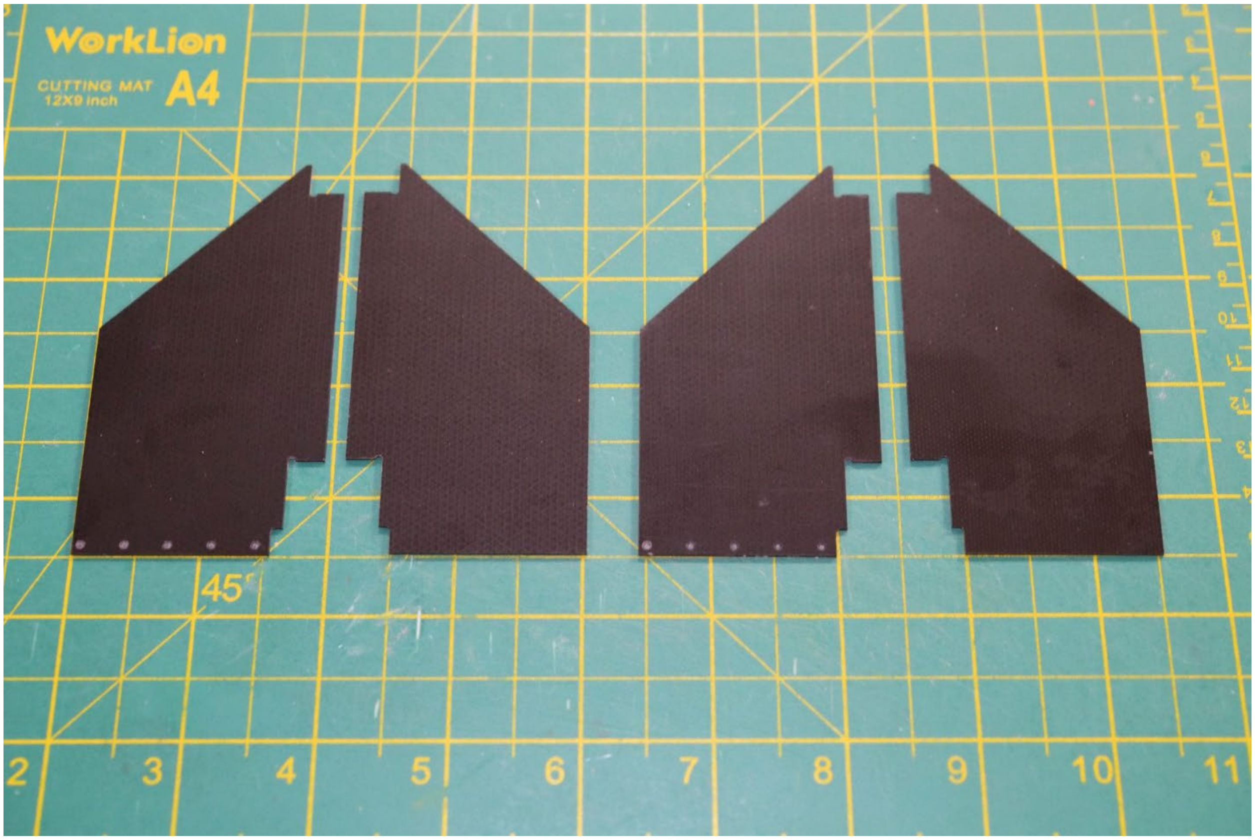

Photo 5: G10 Fin Blanks

One may have noticed the five counterbored holes on the right-facing side of the fins. Those are there to accept the Phillips head screw details we'll add later to represent the spin tab fasteners (see Photo 1).

The next challenge is producing a consistent, repeatable leading-edge bevel. As mentioned earlier, given the hardness of the G10 material and the dimensions involved (a half bevel of 0.5mm over a 0.129" stock width on each fin face), filing/grinding this feature directly into the G10, either by hand or by machine, would be extremely difficult. Instead, our strategy here will be to replicate this feature with a separate part, which will be glued to the leading edge of the fin.

The leading-Edge Extension (LEX)

Since we've decided to craft the LEX as a separate part, let's consider our fabrication options.

One consideration would be to have the part 3D-printed. However, while 3D printing might seem like an option, the part's dimensional requirements — a 1mm base tapering to a knife's edge over a 0.182″ chord — might exceed the practical resolution of most hobbyist FDM printers.

Another option might be to attempt to handcraft the part from a soft, workable material like balsa or basswood. But again, given the part's dimensions, the part would be extremely fragile to handle while shaping, and it would be very difficult to achieve a consistent bevel along its length, if at all.

That leaves a third option, which is to resin-cast the part from a silicone mold – that's the approach we'll take here. Using standard materials, we'll craft an accurate geometric mold that will produce a precise LEX part.

To create the silicone mold, we first need to prepare a molding buck, which itself will be resin-cast from a built-up Styrene mold. The buck mold begins with two pairs of 0.020″ Styrene strips; the base piece was cut to a 0.25″ width, and a wider strip was cut to include the added LEX stock width (0.25″ + 0.129″ = 0.379″ wide).

Photo 6: Mold Preparation

With a pair of strips stacked and glued together, a 0.020" step is created at the edge of the narrower strip. That step is the form for the half bevel. The step is then filled with an epoxy clay (in this case, Milliput), and is feathered out to the front edge of the wider strip to make the half bevel shape. Once the clay cures, the half bevel is sanded smooth, with any divots filled with modeling putty and then sanded again. The process is repeated for the other pair of strips.

Photo 7: Mold Sides

Satisfied with the shape and smoothness of each half bevel face, the two mold sides are glued together at the 0.25" base strip to form the completed bevel mold. The resulting bevel mold forms an inverted isosceles triangle, with a width of 1mm (0.040") and a height equal to the stock width of the LEX (0.129" at our scale factor).

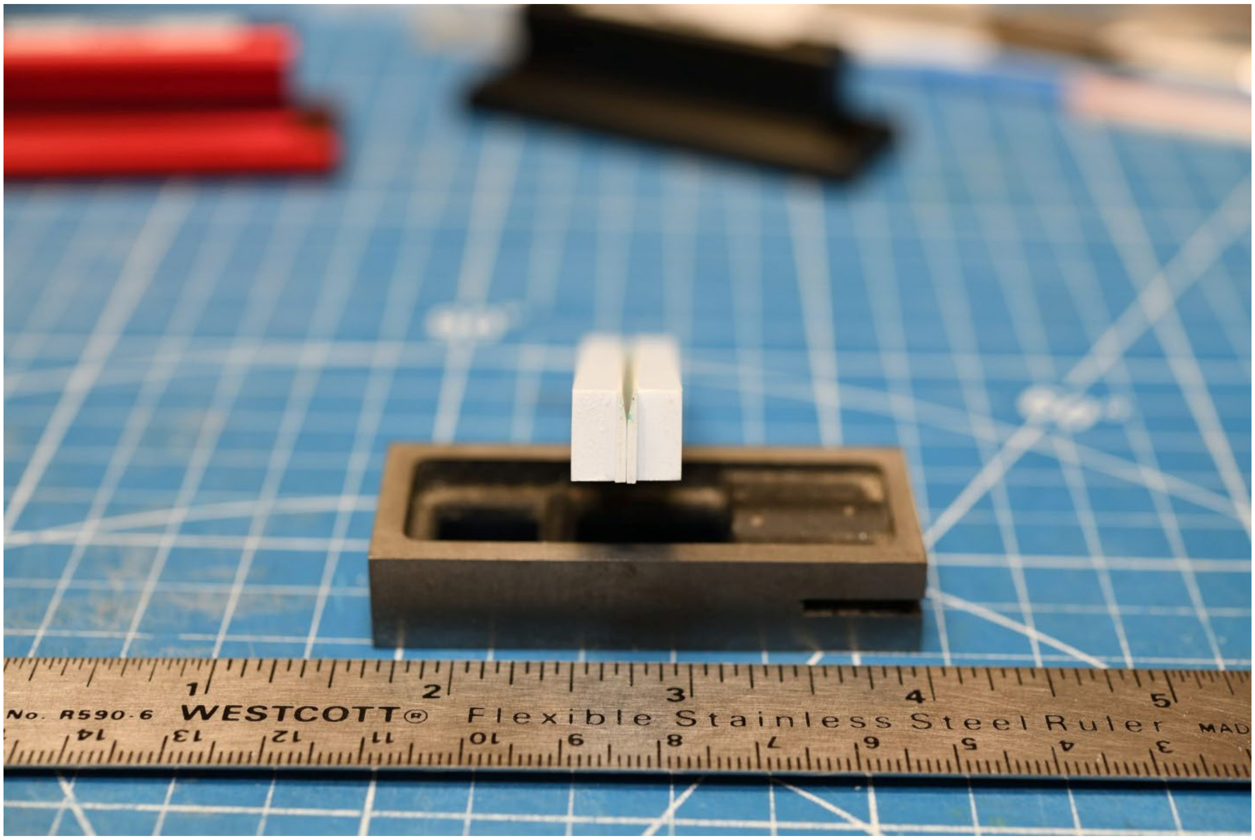

Photo 8: Bevel Mold – End View

A length of 0.25″ x 0.375″ Styrene strip is added to each side of the mold to keep the thing straight and rigid. Small cap pieces are added to cover the open ends. After spraying the mold with mold release, the mold is chucked in a vise, and resin is poured.

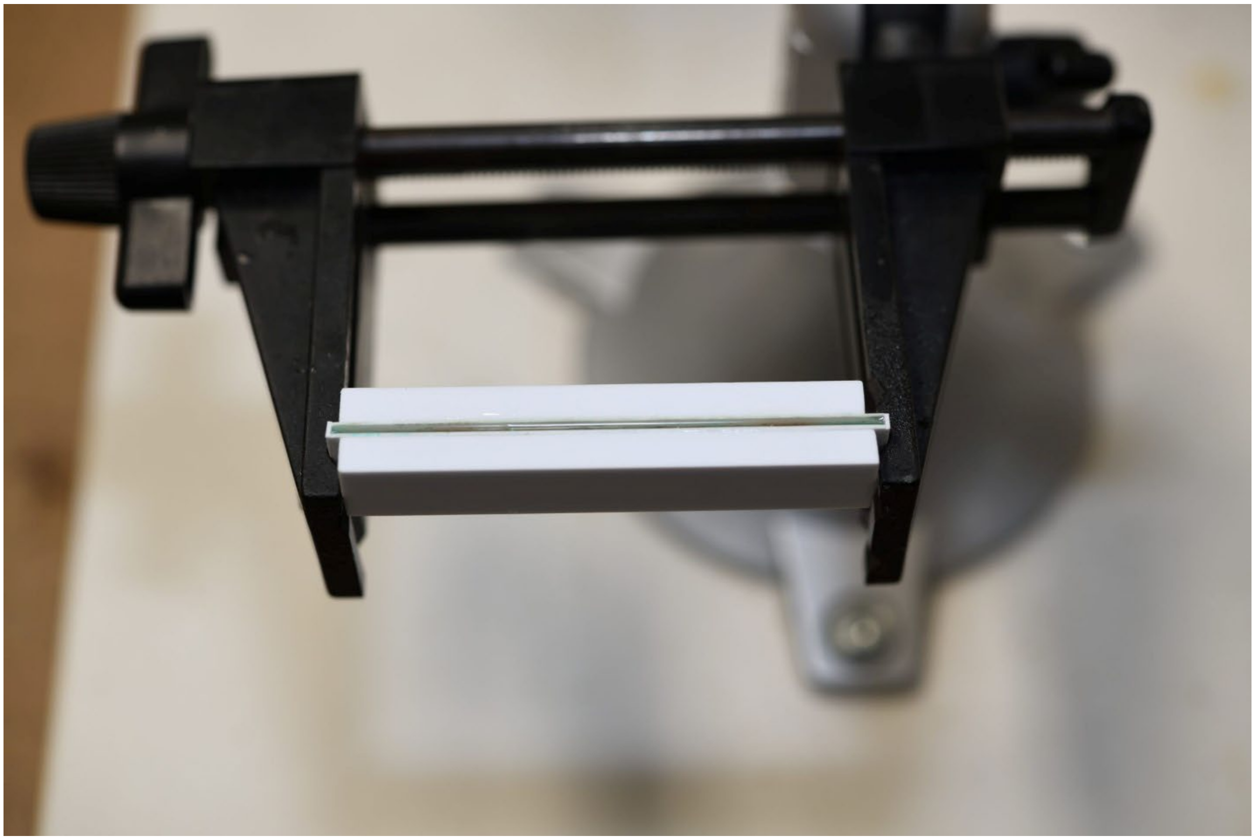

Photo 9: Resin Poured.

Once the resin has cured the mold is broken apart, and our mold buck is revealed. Let’s take a look at its fit on one of the fin blanks cut earlier.

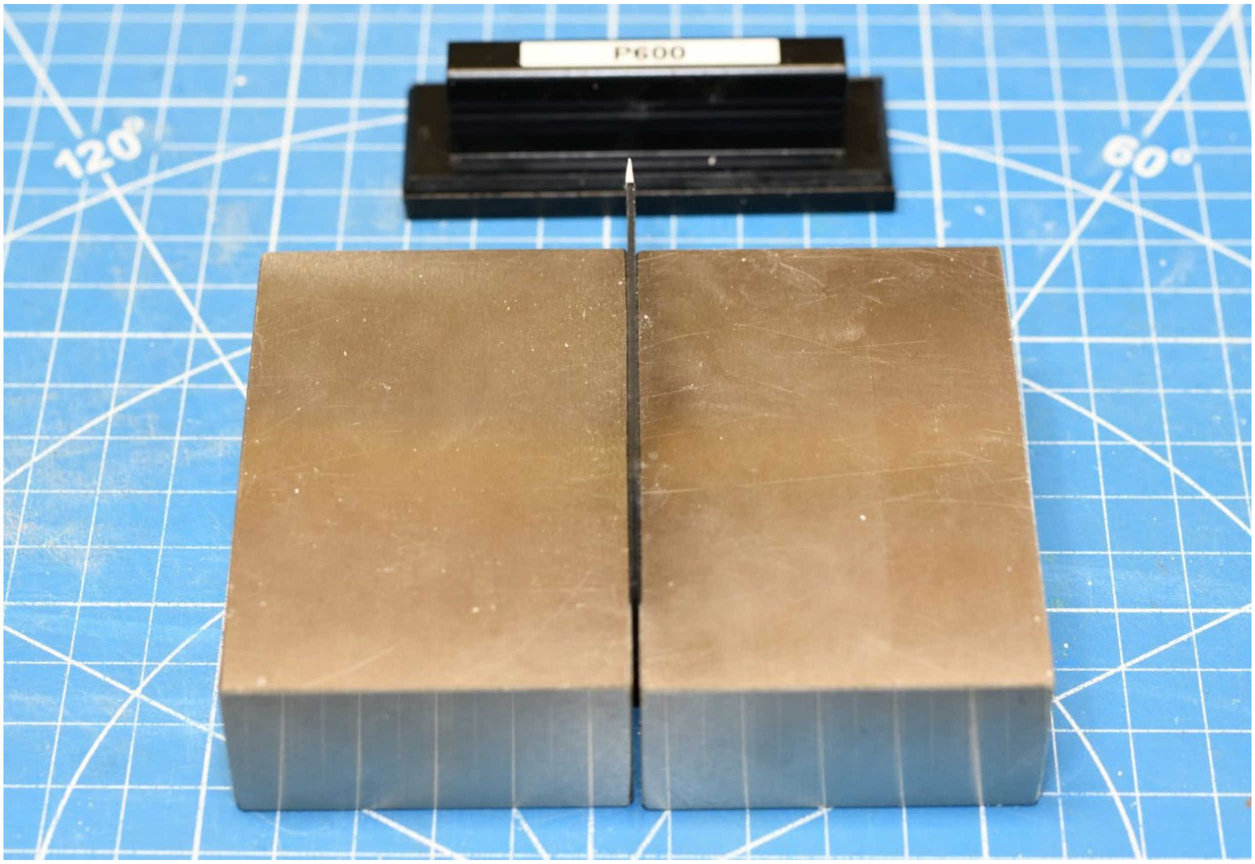

Photo 10: LEX Test Fit

It's rather tiny, but Photo 10 provides an end view of the LEX sitting on the leading-edge of the fin blank. It's the tiny white triangle perched up on the edge there. This initial cast is used as the buck for a silicone mold from which we'll cast the LEX parts for the fin set.

The mold box is crafted from pieces of 0.030" Styrene, starting with the base. The buck is glued to the base with some thin Styrene cement. The box sides are added, and we're ready to pour the silicone rubber.

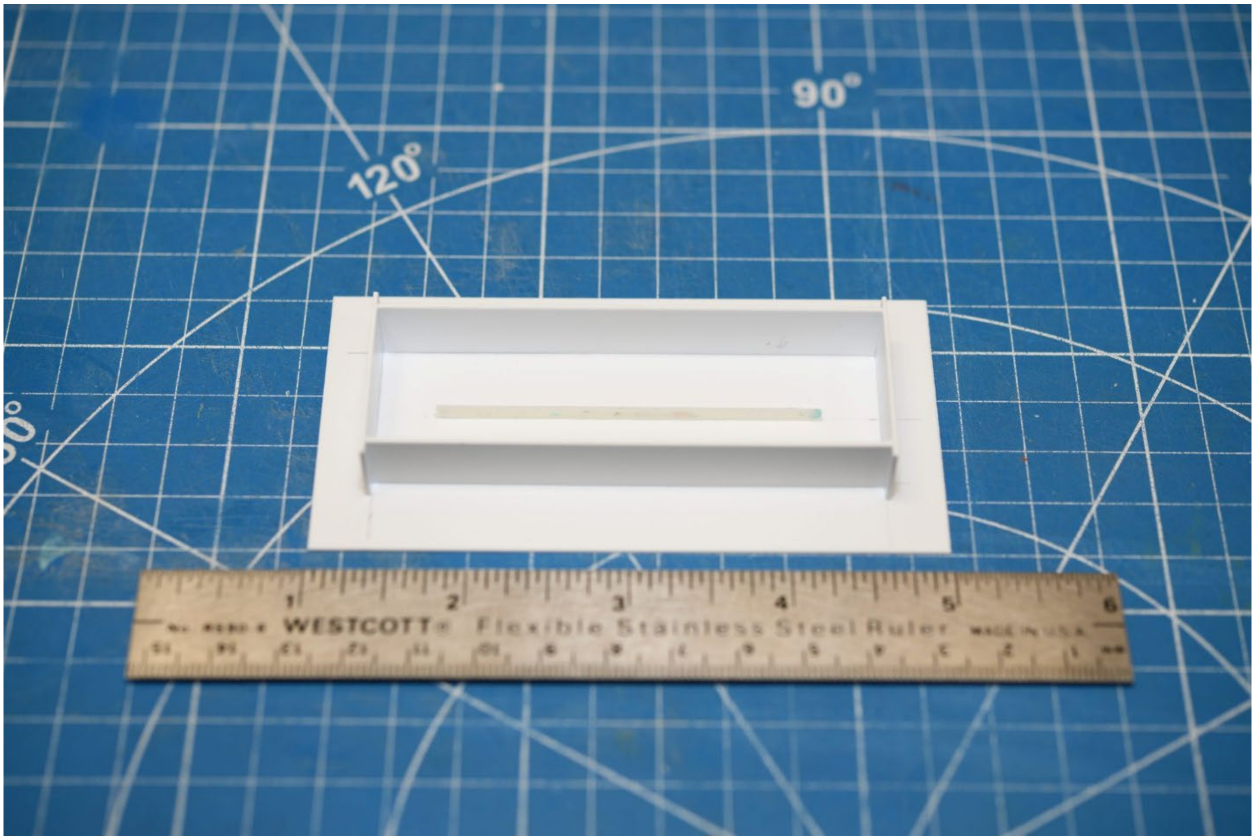

Photo 11: Preparing the Silicone Mold Box

Once the rubber has cured, the mold is popped, and we're now ready to resin-cast some leading-edge extensions. With a squirt of resin from a Monoject 412 syringe and some appropriate curing time, we arrive at a LEX, ready for application.

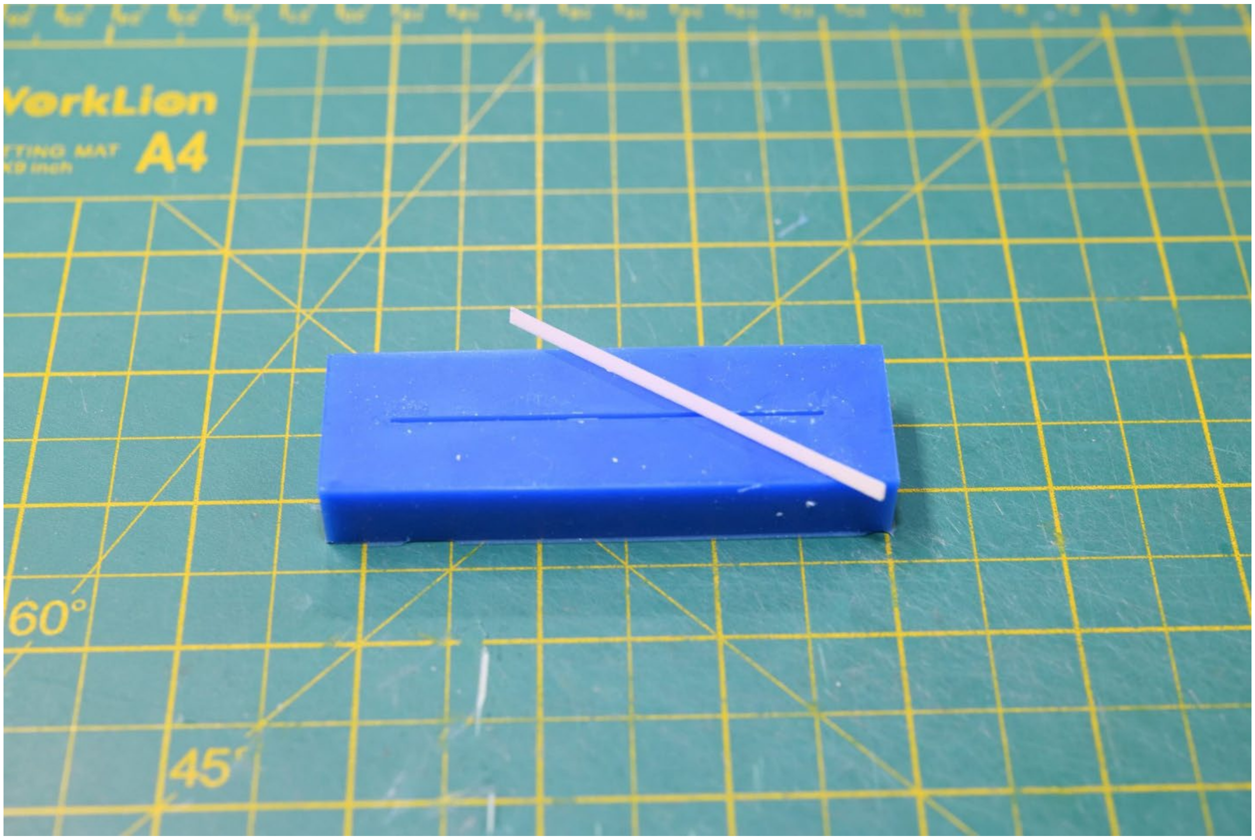

Photo 12: Molded LEX

This process is repeated until we have the complete set of LEX parts we need.

With the extensions molded, the next step is integrating them cleanly onto the G10 fins; this step will require careful alignment but will deliver the beveled edge appearance we're seeking.

Mounting the LEX

Aligning a LEX on a G10 fin is a little like walking a balance beam; a misplaced step can lead to tragedy. In this case, our beam is only 1mm wide, so we'll prepare an alignment fixture to help us stay on beam. As for the extensions themselves, we'll apply them in their over-long state, and trim them flush once the glue cures.

The alignment fixture is a simple affair – a "V" trough that the LEX is placed in, and then with the aid of some alignment blocks, the fin is held in place until the glue sets. The V-trough ensures the extension sits perfectly centered, preventing roll or tilt during glue-up — alignment issues that would be difficult to correct once the glue cures.

The fixture begins with a base of 0.100" thick Styrene. A 'V" trough is created from a pair of 0.020" x 0.100" Styrene strips, glued against 0.100" thick Styrene support bars located on each side of the trough. The width and shape of the trough is controlled during fabrication by inserting one of the LE extensions as a spacer.

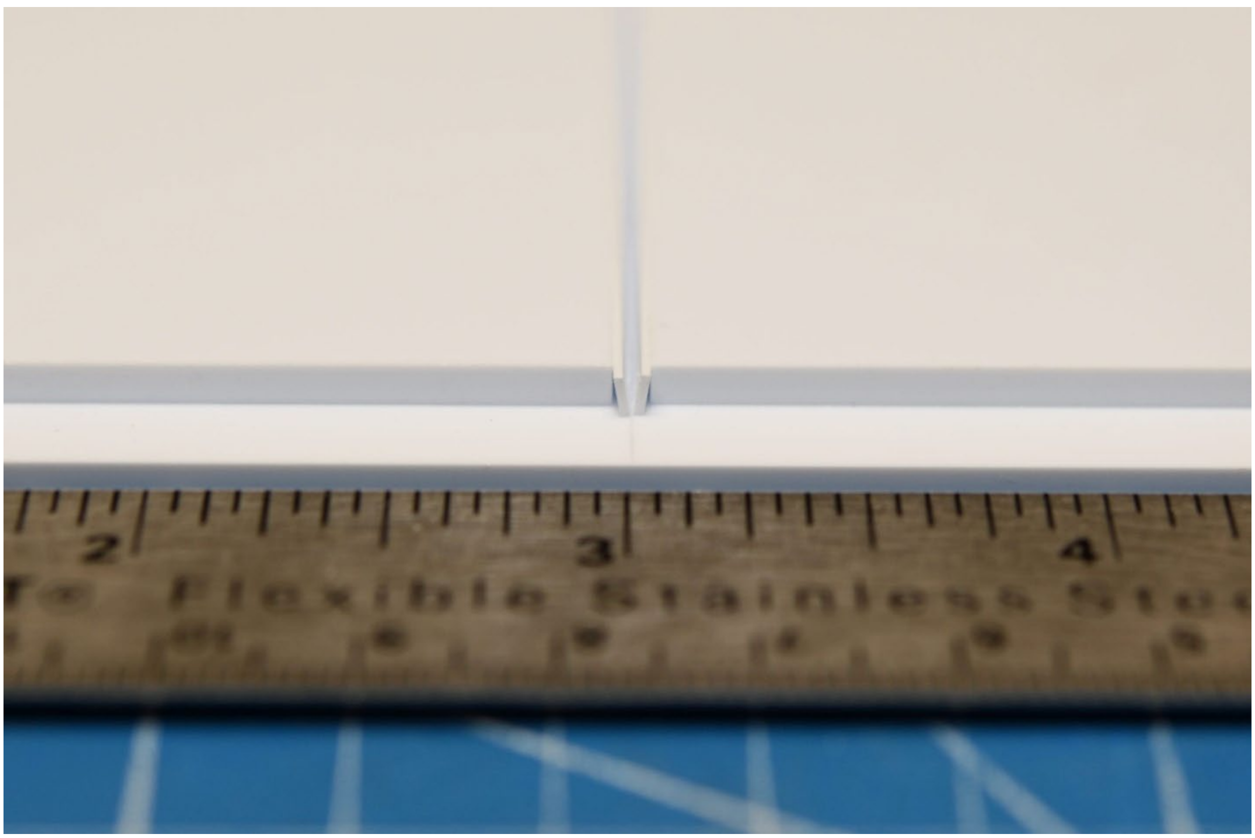

Photo 13: LEX Alignment Fixture

The 0.100" thick Styrene support bars ensure the trough stays straight and rigid.

A LEX is placed inverted in the trough, and then a very thin film of epoxy is judiciously applied along the LEX with a toothpick. Epoxy is the adhesive of choice here, as it provides the necessary working time to check, double-check and correct any alignment issues that may arise during the gluing process.

A G10 fin is then mated to the extension in the inverted position with Gravity doing all the work. The fin is set against a vertical support block that sits carefully aligned with the trough. Any excess glue is easily wiped away, and a second block is carefully placed to maintain the assembly's vertical alignment.

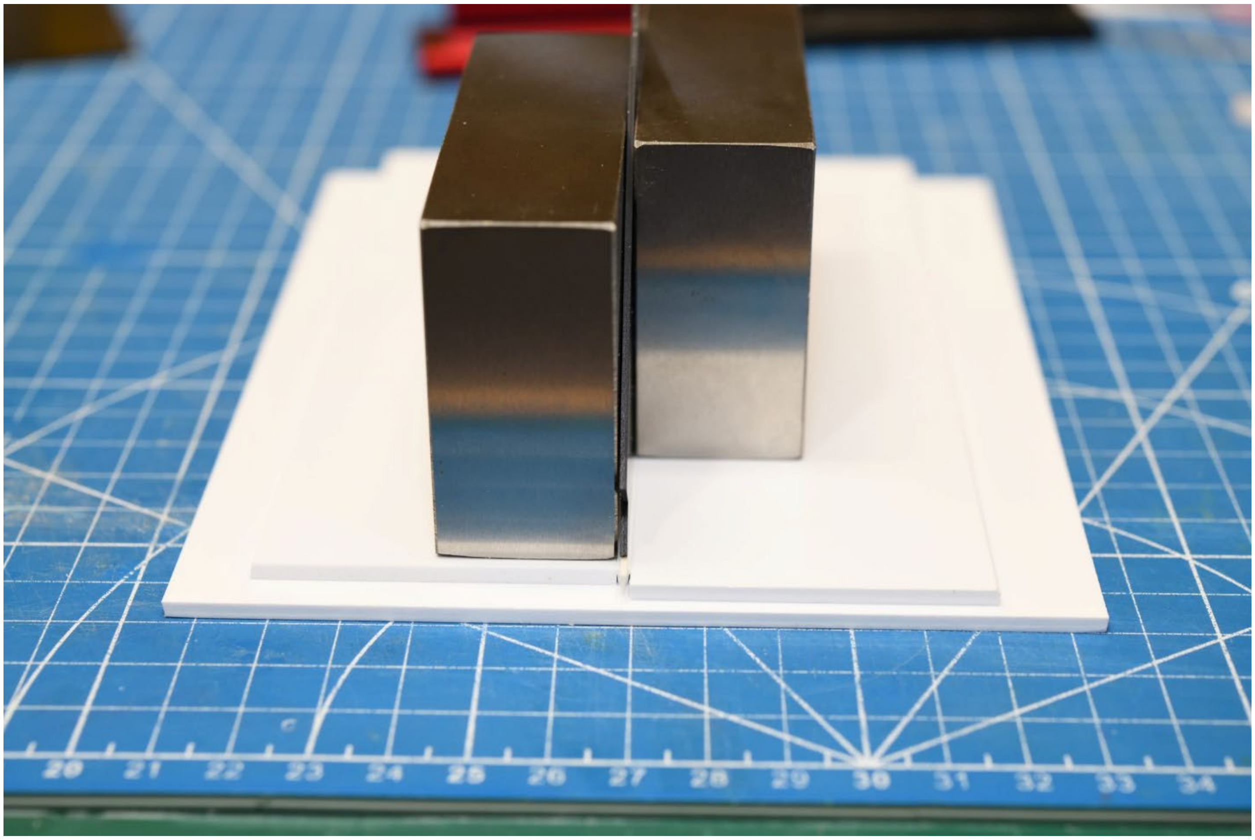

Photo 14: LEX Glued

Once the epoxy cures the fin assembly is removed from the fixture and the ends of the extension are carefully trimmed with a fine-toothed razor saw.

Photo 15: LEX Trimmed

Looking closely, we can see that our fin assembly has a little gap between the aft edge of the LEX and the forward root face of the fin, just as we saw with the prototype in our earlier Photo 3.

We'll repeat this process for four more fins so that we end up with a total of five assemblies. We'll use one of the fin assemblies as a painting and finishing mule to confirm the techniques we'll use to finish the four fins for the model. But before we move on to finishing, let's first fabricate and test our Inconel cuff wrap.

The Inconel Wrap

Several photos were scaled to arrive at the cuff's rivet spacing. Using this and the dimensions for the LEX, a cuff wrap pattern was drawn in CAD which was then used to craft a cuff and rivet template from a piece of 0.020" Styrene.

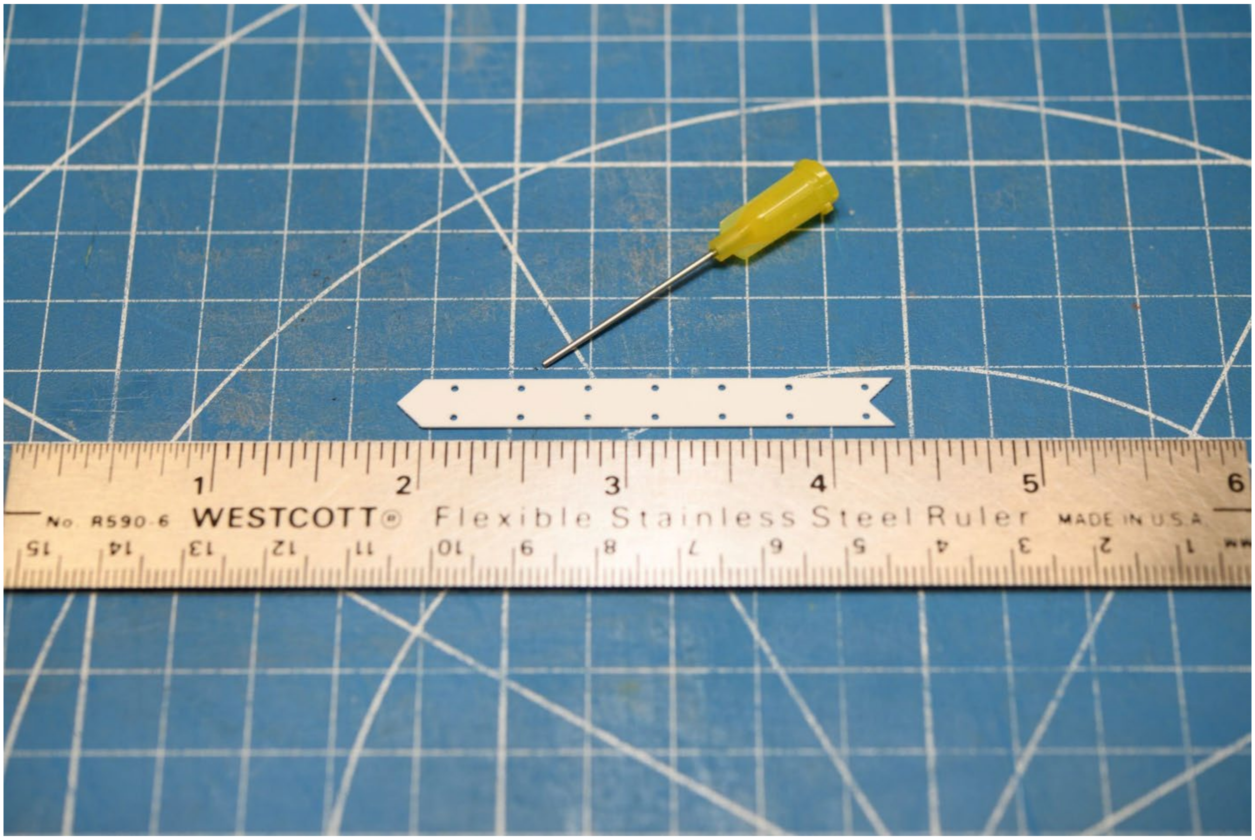

Photo 16: Inconel Cuff Template

The template holes were sized to accept a 20ga glue syringe needle; this needle produces a rivet impression with a 0.036" diameter. With the template securely taped in place over a sheet of 0.005" Styrene, its outline was carefully drawn with a fine point Sharpie and the rivets were lightly pressed, hole by hole, with the rivet tool.

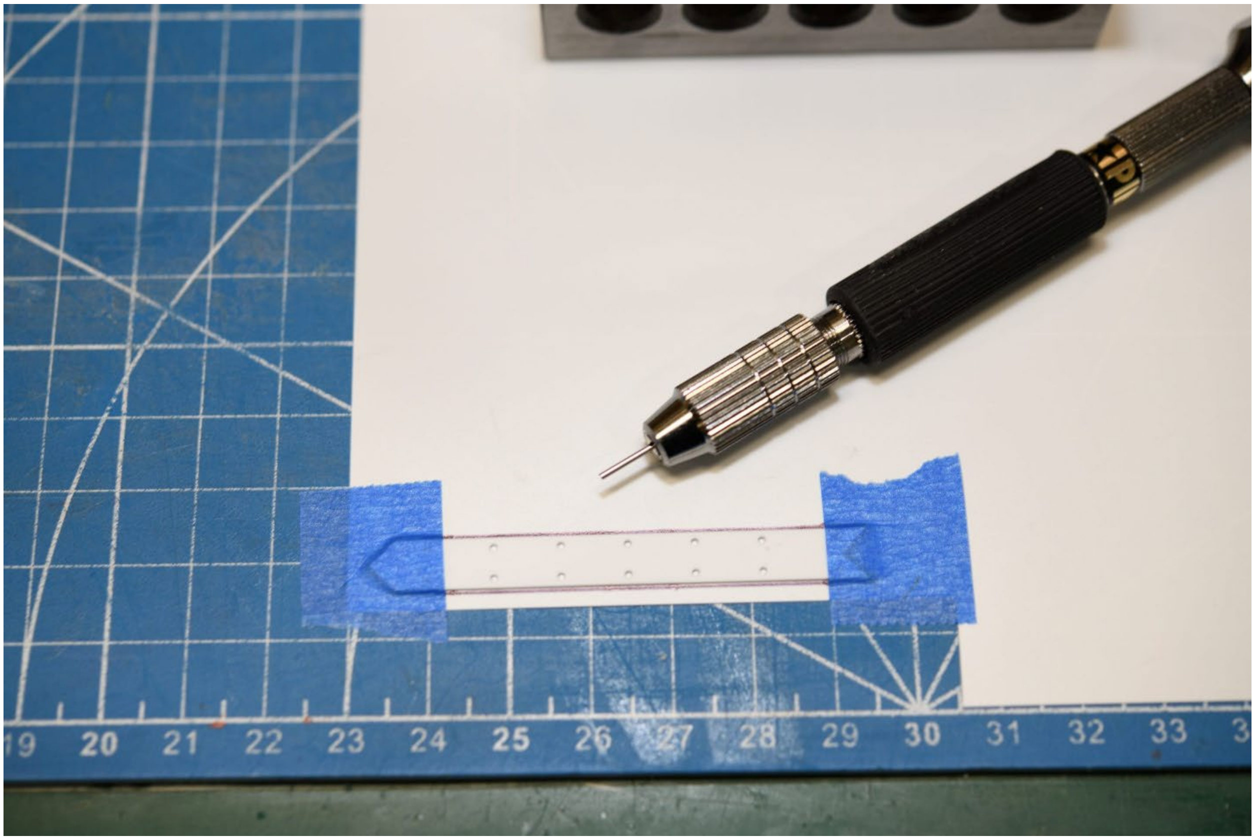

Photo 17: Riveting Underway

Once all the rivets are pressed, the template is removed and the cuff is cut from the sheet with a fresh, sharp, #11 blade. Since the cuff pattern was drawn along the outside edge of the template, it's important to carefully cut the pattern along the inside edge of the Sharpie lines. Doing so preserves the accurate size of the part.

We now need to precisely bend this very thin, somewhat springy, plastic cuff along its center line so that it will tightly drape over the LEX when applied. Attempting this bend by hand is likely to annoy the Fabrication Gods and will seriously aggravate the Builder. So, we'll not do that; instead, we'll use a tool that will deliver the precise tight bend we need.

Over in the Plastic Model world, often times kits can be detailed with photo etch parts that must be precisely bent to a required shape. This is accomplished with a Photo Etch Bender, of the type shown in the following photo. That same tool (available in various sizes) will work perfectly for our purposes here.

Photo 18: PE Bender

Before making the bend we'll first lightly score the backside of the cuff, center to center, with the backside (the blunt side) of a hobby knife blade. This must be a light scoring, as the Styrene is virtually paper thin.

The cuff is then carefully positioned under the bender fingers and clamped in place. The long bending blade seen to the right of the Bender will be used to make the bend.

Photo 19: Cuff Clamped

The long bending blade is slid underneath the cuff up to the score line we made earlier, and then with gentle even pressure, the free side of the cuff is bent up and over the bender fingers. With some patience and practice we get a precisely sized, sharp edged beveled cuff, ready for the fin assembly.

Photo 20: Completed Beveled Cuff

Let's give the cuff a dry fit. The following photo, somewhat underexposed to highlight the rivet detail, gives us a glimpse of how the part will look once it's glued in place. It seems the cuff might need a hair or two trimmed for a proper fit.

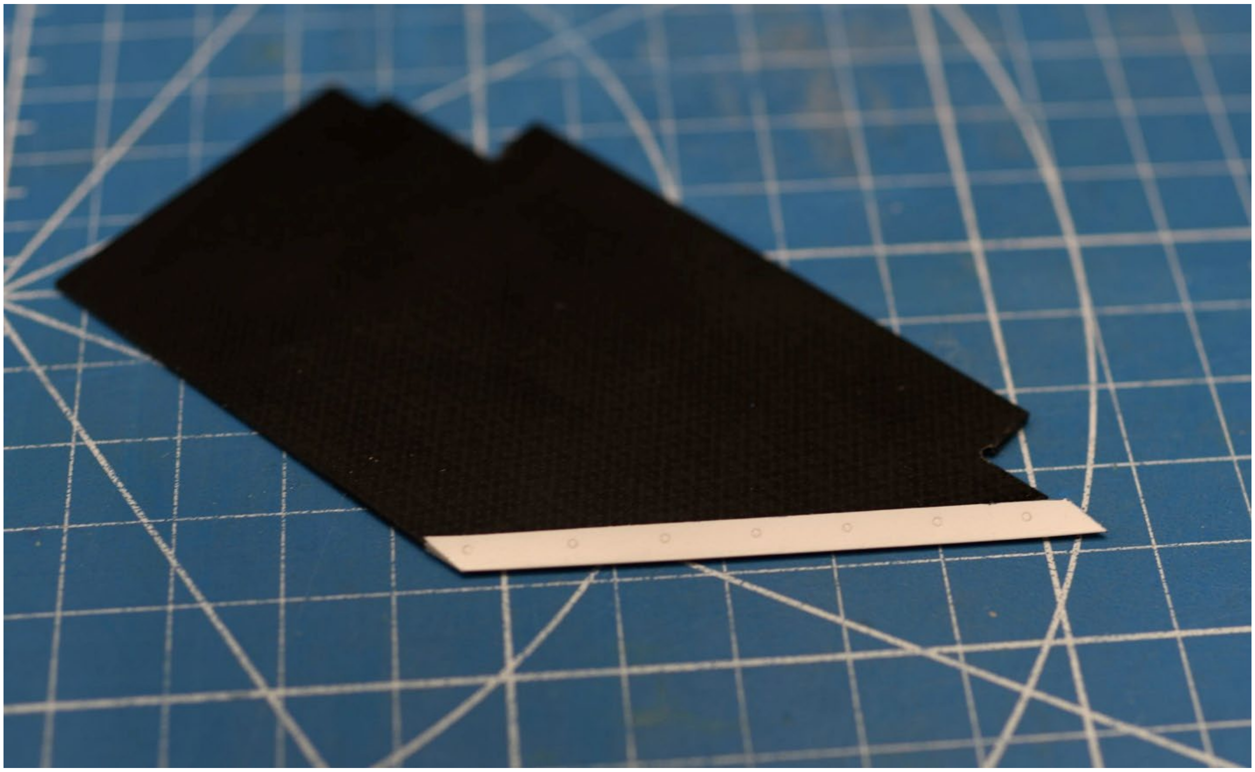

Photo 21: Inconel Cuff Dry Fit

Once satisfied with its fit and position, the cuff is glued in place with very light dashes of extra thin Styrene cement, placed carefully underneath the cuff's edge. "Carefully placed light dashes" are the watchwords here, as any excess cement risks damaging the very thin Styrene cuff.

I had considered finishing the cuff separately and then gluing it on once the fin was painted, but experimentation with this method failed to produce a reliable bond with any non-marring adhesive one might use. So, with the cuff now an integral part of the fin, we'll need to consider how best to realize the cuff's bright metal sheen once we get to the later finishing stages.

It will be apparent that the cuff wrap presents a very slight raised edge at the cuff's transition. This is both unavoidable and prototypical — the real Inconel cuff also sat slightly proud of the aluminum fin extrusion, as we saw in our earlier Photo 4. So, we're on reasonably solid scale ground here, and we can move forward with some confidence in our build. Let's now turn our attention to the finishing process.

Fin Finishing

Given that the upper stage Apache fin can and fin set all present a common aluminum finish, it won't be necessary to finish the fins separately before they are installed on the model. The fin mounting flanges, part of the fin extrusion on the prototype, will be added to the model as separate pieces after the fins are installed, and once blended and primed, the entire fin can package can be finished and painted as one integrated assembly.

But before we do all that, let's take the opportunity to choose the metal paint we'll use, and as well, decide how we'll represent the brighter metal finish of the Inconel cuffs. For this experimentation, we'll use one of the fin assemblies as a painting mule to nail down the fin finishing process.

To start, the mule is inspected for surface defects - surface preparation is paramount here, as the thin metal paint will be viciously unforgiving of any overlooked defect. Particular attention must be paid to the seam/joint between the LEX and the fin blank, with any gaps or divots filled and sanded. Once satisfied with the assembly's surface finish, the mule is then wet-sanded with a good #400 grit followed by a wet-sanding with #600. The mule is then wiped down with IPA (Isopropyl Alcohol), the fin mounting tab masked, and the assembly is then sprayed with a quality primer – in this case, I'm using Tamiya #87042 Surface Primer.

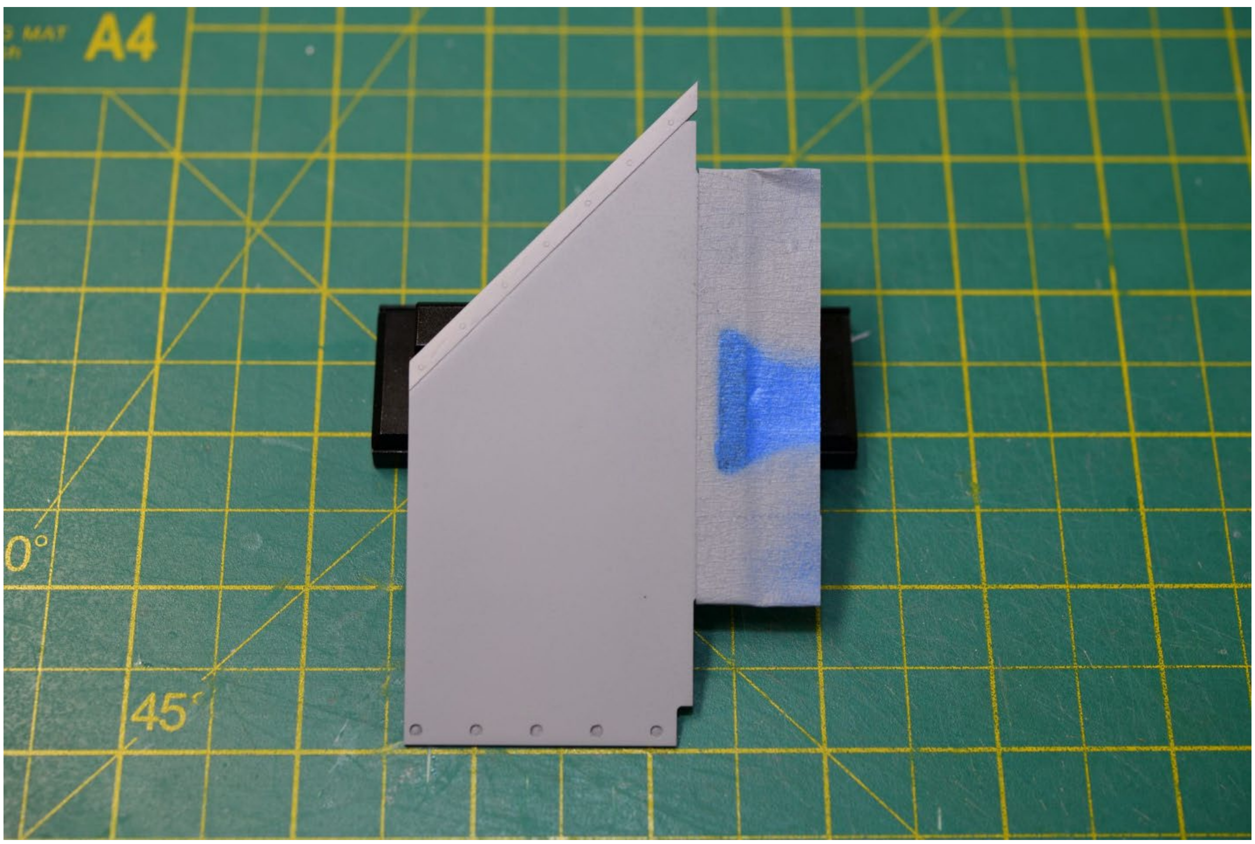

Photo 22: Primed Mule

Provided our pre-primer surface prep efforts were suitably fastidious, one even primer coat should be sufficient; paint management is important here to protect the cuff rivet detail. Once the primer has cured, the mule is then carefully wiped down with a micro-fiber cloth, of the kind one would use to wipe a pair of glasses. This action removes any surface dust that may have accrued without scratching the primed surface. This done, our attention now turns to paint.

I'm partial to AK Interactive's Xtreme Metal finishes, although Alclad metal lacquers work just as well; Xtreme Metal is just my preference, and that's what we'll use here. AK's Xtreme Metal is an enamel-based paint, airbrush ready right out of the bottle. For the Apache's dull, somewhat oxidized, fins we'll go with AK's #488 Matte Aluminum. And like a James Bond martini, this paint is best prepared when shaken, not stirred.

Photo 23: AK Interactive #488 Matte Aluminum

Metal paints look best when sprayed over a black base, and generally, the glossier and more polished the underlying black paint is, the brighter the over-sprayed metal paint will appear. But glossy and bright isn't what we're going for here, so we'll stay with the grey Tamiya primer and airbrush the matte aluminum paint directly over it. For this paint application I'll use an airbrush fitted with a 0.35mm nozzle and 15psi air pressure.

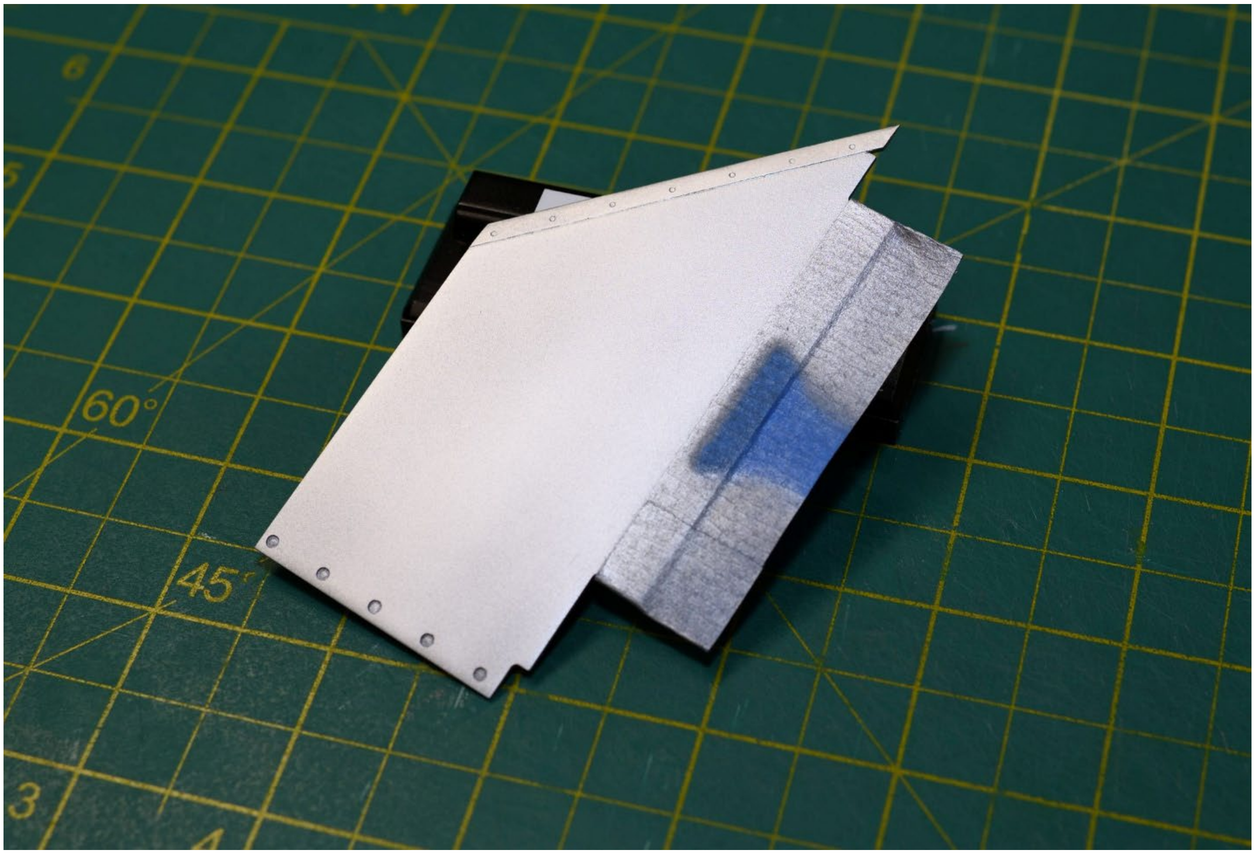

Photo 24: Metalized Fin

Once the paint has cured, the LEX is rubbed down with a micro-fiber cloth. We'll finish the Inconel cuff with strips of Bare Metal Foil, in this case BMF-001 Chrome. Using BMF precludes the need to mask and paint the cuff.

The BMF is cut into oversize strips with a single-edge razor blade. Several passes with a light touch are needed here to avoid tearing the foil. Once placed over the LEX and aligned with its aft edge, the foil is burnished along the LEX with a cotton swab; this is followed by carefully burnishing the rivet impressions with the tip of a toothpick to help them stand out. Again, the lightest of pressure should be used here to avoid tearing the foil. Satisfied with the fit, the foil strip is trimmed and the process repeated for the other side of the LEX.

Even though the focus of this article is the fabrication of the beveled leading edge, I thought it would be interesting to add the remaining Apache fin details – the Phillips head screws on the right-facing trailing edge, and the spin tab/wedge on the left-facing trailing edge. Doing so would give us a view of a fully completed Apache fin. The next photo gives us that view.

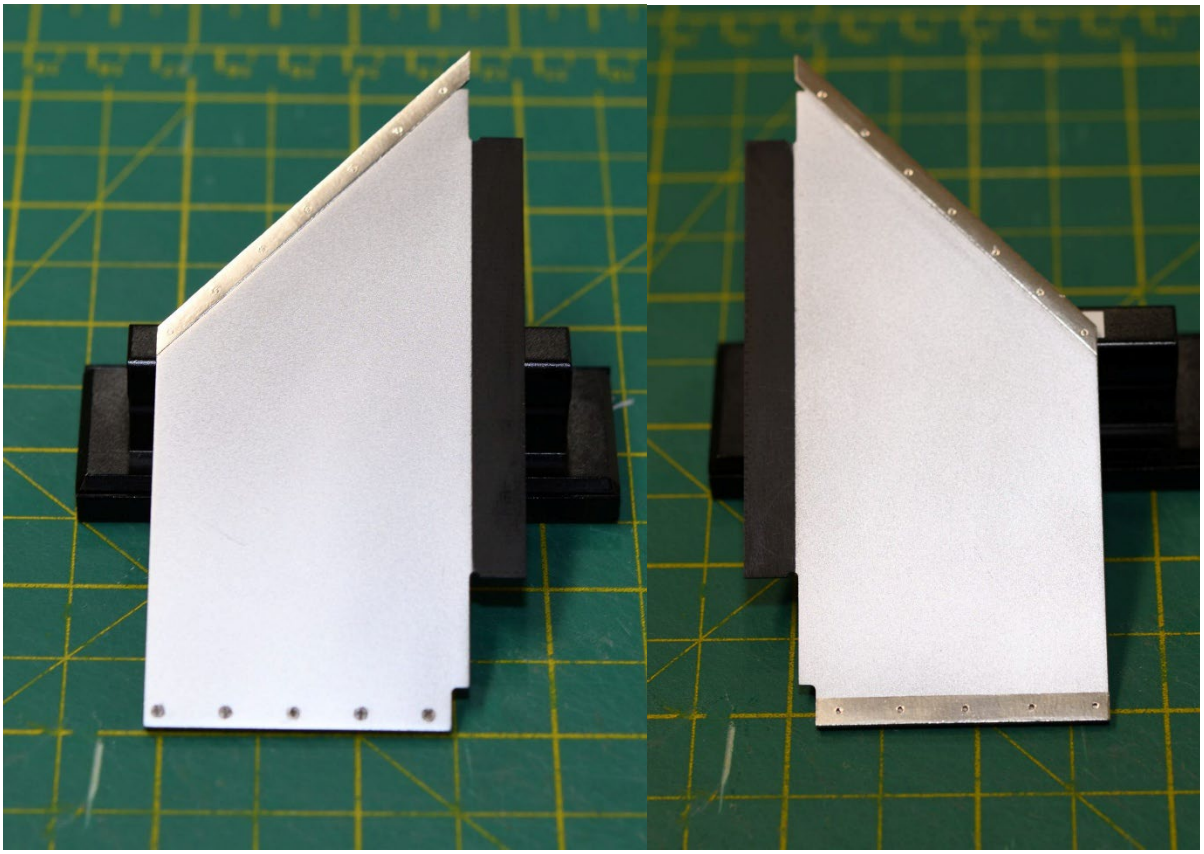

Photo 25: Detailed Apache Fin

Regarding the final details, the spin tab is another resin casting, created much the same way as the LEX, and drilled at the appropriate locations with a #67 bit to represent the through holes for the tab mounting screws. Once primed the spin tab was foiled with BMF Chrome to match the LEX, and then set in place with MIG's Ultra Glue Matt. The Phillips head screws are just 1.6mm diameter disks, punched from 0.010" thick Styrene with an RP Toolz Punch & Die set. The disks were then pressed with a small jeweler's screwdriver to make the head impression. These were painted with GSI's Mr. Metal Color #213 Stainless and were likewise placed with MIG's Ultra Glue Matt.

And there you have it, a very thin but finished, detailed scale Apache fin. Having finalized our fin construction and finishing methods, we can look forward to applying these techniques to the actual scale model.

While the Apache's thin fins and features present an unusual set of challenges, the methods described here — resin casting, controlled alignment fixtures, and careful metal finishing — are applicable to many scale projects where geometry and material limits collide. I hope these techniques prove useful in your own work, and as always, I wish you every success with your scale modeling projects.