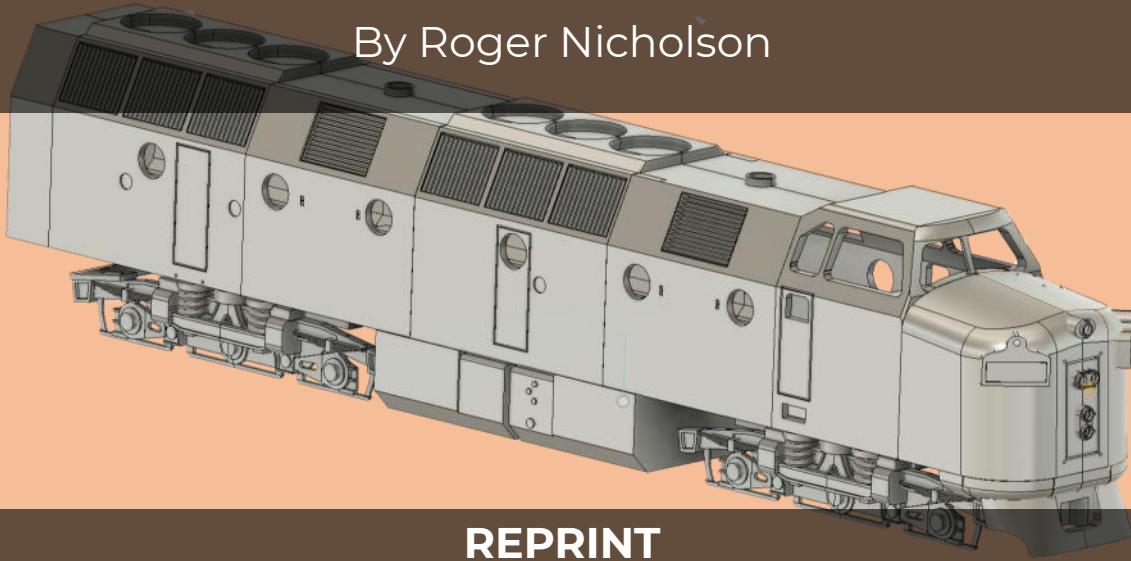


# THE 3-D PRINTING DEPARTMENT

## Building a Krauss Maffei ML 4000 “Cab Unit”—Part 1

By Roger Nicholson



### REPRINT

**When a fellow BAGRS member asked me if I could build a couple of 3-D printed locomotives for him, I didn't realize exactly what I was getting myself into.** Up until this point, the most complicated 3-D print I had ever designed and built was a replacement power truck box for the old Bachmann 2-Truck Shay. I never shy away from a challenge however, so I told him that I would give it a try. He asked me specifically to build two different locomotives: A “SW 1500” and a “Krauss Maffei.” I had never heard of these and had to look them up to see what they looked like.

I've already written the story of how I modified the publicly available OpenRailway SW 1500 design by Daniel Noree to add USA Trains motor blocks and Southern Pacific lighting. I made the final modified design available on both [Thingiverse](#) and [Printables](#). I used this experience of reworking an existing, non-powered design into a functioning locomotive as a way to learn just what it takes to 3-D print a working locomotive. The lessons that I learned from the SW 1500 were then to be applied to the first complete locomotive design of my own creation: The Krauss Maffei ML 4000 “Cab Unit.”

The German-designed Krauss Maffei ML 4000 (hereafter referred to as the “KM”) was used by the Southern Pacific and the Rio Grande for a fairly short amount of time. Their unique appearance, however, makes them popular with the model railroading crowd. Because of this, the KM is available in HO Scale from Piko. That's great if you model in HO, but garden railroaders have been pretty much out of luck if they wanted a KM on their railroad. A few have built the KM units by hand. Photos of some of the SP KM units can be viewed in the “Espee archive” here: <http://espee.railfan.net/spml4000.html>

## Where do we begin?

Since I had used USA Trains motor blocks for the SW1500, I decided to use USAT three-axle motor blocks in my KM design. Specifically, I chose the USA Trains R22-422 SD-40 -2 diesel motor block. One of the things that I like about the USA Trains motor blocks is the ease with which you can connect to the motors using the independent motor and track power pin connectors on the edge of the motor block.

I decided that I would design and 3-D print a custom locomotive base, side frames and mounting brackets for the power trucks. I learned how to do this from my experience with the SW1500.

### KM side frames

The KM “cab unit” has a very unique looking set of trucks, and I set out to design something that would at least get close to what they were supposed to look like. Given the complexity of the task, I decided that these side frames would be a solid piece and that springs would be added for cosmetic purposes only.

3-D printing, for me, is an iterative process. I design and print an object, then make hand measurements and changes to that object. I then incorporate those changes into my design, and print another version. This process continues until I reach the point at which I am satisfied with the object. I also had to make changes based upon the real requirements of running on a layout, such as allowing a tighter turn radius.

Here, we can see the evolution of the KM side frame. I went through four iterations of the side frame design, testing each version on the layout and making any necessary changes.



KM side frame—Version 1



KM side frame—Version 2



KM side frame—Version 3



KM side frame—Version 4



## The KM motor mounting bracket

The USA Trains R22-422 (SD40-2) motor consists of two axles which extend into the bearing surface of the side frame, and one floating axle, which is hinged to two axle unit. From my observations disassembling a USAT SD40-2, the pivot on the USAT mounting bracket is centered between the two fixed axles, and the rotating axle is captured in a curved metal bracket attached to the locomotive body. I wanted a mounting bracket that would pivot in the center of the assembly, rather than have it offset above the fixed wheels. I designed a new mounting bracket, which captures the two fixed axles in stainless steel bearings mounted into the side frame. I left the rotating axle free, without any constraint. (My original plan and design was to constrain it to the mounting bracket rather than the locomotive body, but I later decided that this was unnecessary.)

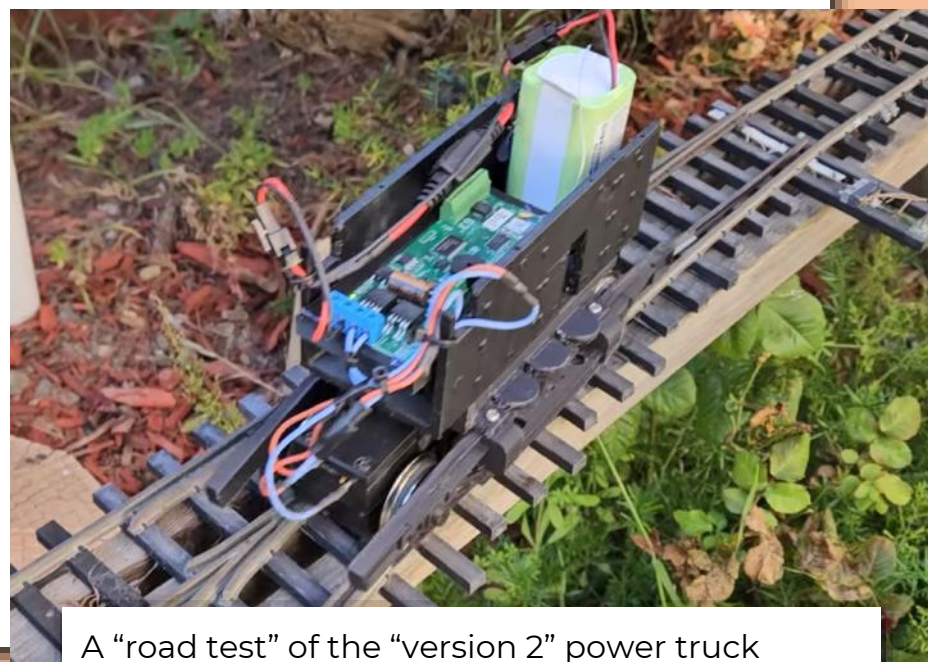
I also found that I needed to add a cross brace between the ends of the side frames in order to keep the end side frame from bowing inward. The final design captures the two fixed axles and allows the rotating axle to swing from side to side within the frame. The pivot is directly in the center of the assembly. This design was intended to allow the truck to negotiate the more challenging curves on my layout.

## Testing the power truck

I tested the power truck on my track in order to determine how the truck design would perform when encountering turnouts. Here you can see a test of the “version 2” power truck as it passes through a turnout. There were no derailments, which gave me the confidence to proceed with this design.



A pair of completed KM “version 3” power trucks



A “road test” of the “version 2” power truck

## Creating the KM base frame

3-D printers have limits with regard to the size of objects they can print. I determined that in order to achieve the length of the base that I needed, I would have to print it in four different sections. I had already achieved good results with the 1:29 version of the SW1500 by breaking the base of the existing design from two sections into four sections and securing those sections together using 4 mm bolts. I took the same approach to the KM. Here you can see the prototype base consisting of four sections secured by 4 mm bolts. There is no glue involved—the entire assembly is held together using the bolts, and it appears to hold up just fine.



The four-part 3-D printed KM base assembly

## Testing the KM base and power trucks

I mounted a set of “version 2” KM power trucks on the base, and sent it around my layout to see how it would handle imperfect track and turnouts. One lesson I learned from the SW1500 was not to over constrain the movement of the power trucks. I constrained the rear truck from rocking side to side, but allowed it to rock forward and backward. The front truck had no constraints at all, and could rock side to side, forward and backward. The road test of the entire frame assembly was very successful. There were no derailments.



The “road test” of the entire KM base assembly



In order to get the clearance that I needed for the trucks to be able to rotate sufficiently to handle my layout's curves, I had to make the base quite high. After examining photos and drawings of the ML 4000, I concluded that the bottom edge of the body would need to be a bit lower than the base. That meant that the sides of the body would need to overlap the base.

I printed the "tail" section of the body and determined that in order for it to fit and be at the proper height, that I needed to trim about 4 mm off the entire edge of the base. This is the nature of my 3-D printed prototype—I hack away at it until I figure out what I need to change in the design.

### Next steps . . .

With a fully functional base and power trucks, I am now ready to begin the task of building the body of this beast. That, coincidentally, is the subject of the next installment of this series! ■

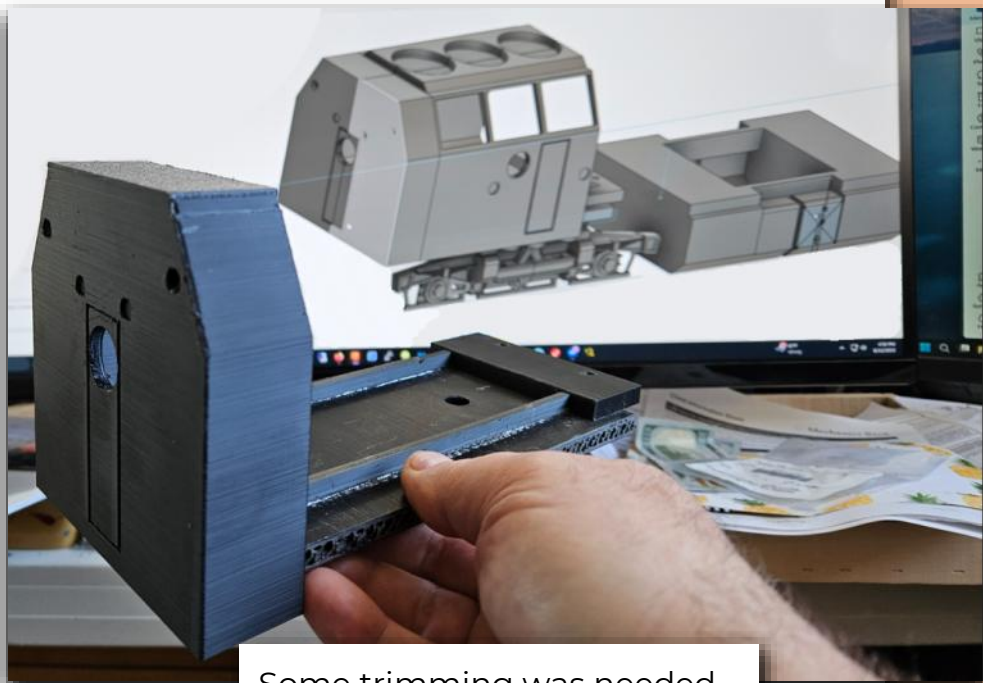
### Here are some YouTube videos of the few KMs that exist in G Scale:

Krauss Maffei ML 4000 "hood unit" in G Scale on "Olli's Railroad": [Krauss Maffei ML4000 SP9010 gscale](#) (This is a model of the Niles Canyon Railway locomotive)

Some beautifully detailed hand-built G Scale "cab units" (Models created by Rob Fern and built by Carsten Kannengiesser) [Krauss Maffei ML 4000 cc - 1:29 - G-Scale](#)



"Dino" enjoyed a smooth ride!



Some trimming was needed