Issue 638 / November 5th, 2024

PEAK OF FLIGHT NEWSLETTER

Apogee Components, Inc. / ApogeeRockets.com / Colorado Springs, CO

How to Make a Rocket Kit - Part 2

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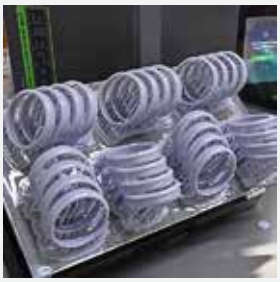
COVER PHOTO

DynaStar LexxJet Rocket Kit

The LexxJet rocket model resembles a business jet that could be the future of luxury corporate travel in the not-so-distant future. It will quickly deliver its passengers to any part of the world in the shortest amount of time.

FEATURED ARTICLE



How to Make a Rocket Kit - Part 2

by Tim Van Milligan

This article details the process of designing and manufacturing a rocket kit at Apogee Components. It explains the 22-step sequence involved, from idea generation to marketing.

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About this Newsletter

You can subscribe to recieve this e-zine FREE at the Apogee Components website: www.ApogeeComponents.com, or by clicking the link here **Newsletter Sign-Up**

Editor-in-Chief: Tim Van Milligan
Managing Editor: Michelle Mason
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Layout Design: Ogden Sikel

An Apogee X-15 rocket rips skyward on a white-lightning motor

Would you like to see your launch photo featured in the *Peak-of-Flight* newsletter? Submit your photo at apogeerockets.com.

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We previously had an article by Chris Textler, one of our previous product designers, where he wrote about how to design a rocket kit for Apogee. I thought I'd expand on that, because I'm seeing some contrarian philosophies that are popping up in our industry, at least on some of the steps that affect customers the most. I think I know understand what is happening, and why other companies are making the changes they are doing. And I just want to point out how Apogee is still different and unique in the hobby.

Our core philosophy is to give customers a fantastic experience when they buy, build, and fly an Apogee model rocket kit. That hasn't changed. Actually, I think we're delivering a better experience now than we ever have, and that is because our process of creating kits and other products has become more systematized and standardized.

The long-standing process we use when designing and manufacturing a kit follows this general sequence:

1. Come up with an idea for a rocket
2 Build a prototype
3. Fly the prototype and see what breaks
4.Revise the design
5. Fly it again
6. Start designing any new plastic parts that need to be ordered
7. Get quotations on the parts, and get the tooling ordered
8. Wait for the prototype plastic pieces to arrive
9. Design the wooden parts that can be laser-cut in house
10. Receive the plastic parts, evaluate them and build a new prototype to test their flight worthiness
11. Freeze the design, and get the first production pieces made.
12. Start the design of kit decal sheet - they need to be ordered or produced in house so the final prototype can be built
13. Estimate the cost of goods to produce the kit
14. Write the text for the kit instructions.
15. Make a video series showing how the rocket is assembled - this tests the steps in the text of the instructions
16. Build the photo model, and make the final flights for marketing purposes
17. Start drawing the illustrations for the instruction sheets
18. the instruction sheet
19. Make the packaging artwork, and get it ordered from the printer
20. Send out the final instructions to be printed
21. Actually start production of all the parts needed for the kit, and package it up
22. Make the website and any marketing materials.

I thought I'd go through some of these steps to clarify some things. I'd also like to point out how things have changed over the

Figure 1: West shows off a vacuum form sheet for the X-15 rocket kit. This is step 21, where the parts are produced.

years, and how I think Apogee is different from other model rocket manufacturers.

Step 1: This was covered in Christopher's article at **https://www.apogeerockets.com/Peak-of-Flight/Newsletter556**, and it is worth reading. Coming up with a worthy idea has the most impact on whether or not a new kit will succeed. We often go out to our customers to bounce ideas off you to gauge if the idea is worth pursuing. For example, earlier this year we did a poll to find out which order we should be planning new releases. The Nike Hercules was one of the winners, which is why it is the next rocket we plan on getting out to customers. As I write this, we're "just" about to announce the release.

I see a lot of rocketry manufacturers do this opinion testing, so Apogee is not unique in this regard. I think this is one reason that the hobby is so strong and still growing after 60+ years.

Rapid Prototyping

Moving to step 2, which is prototyping the rocket, a lot has changed even in the last decade. We now have the ability to do rapid prototyping of plastic parts using 3D printer technology. When I first took over Apogee Components in 1994, one of the biggest obstacles to making a kit was the access to nose cones. It was easy to get paper tubes to make all the parts, but getting a new nose cone shape was the biggest barrier to entry for new companies.

That has completely flipped. It is now the easiest part of designing a rocket. A 3D printer is cheaper than most power tools that you'll find at Home Depot. And with it, anyone can make a new nose cone shape. And they can be produced in quantities that make it worthwhile.

While I'm personally not a huge user of filament printers (FDM),

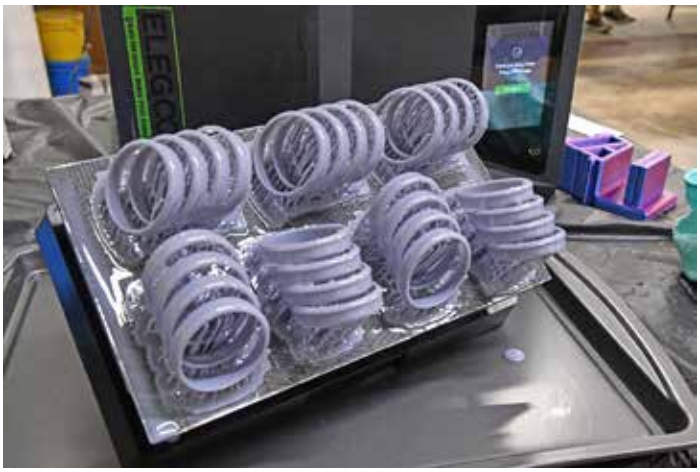

Figure 2: Freshly printed resin parts for the Nike-Hercules kit.

because the surface quality is jagged and rough, I can see where they have opened up a lot of potential for many new rocketry companies. It is hard to even keep track of all the new companies that pop up because now plastic parts are no longer the barrier.

I personally favor the resin printers (SLA - type) that grow parts from a pool of liquid urethane. I bought my first one in 2014 (ten years ago) when the first economical one was available from a kickstarter company.

The surface finish on the parts was a lot smoother, and the resin harder which made it easier to sand to a glass smooth appearance. The thing that impressed me over the years, was that with just a software upgrade to the machine, the surface finish got a even better. And that was with a 10 year old machine.

That machine allowed us to make prototype rockets much quicker, and it dramatically shortened the development time of new kits.

This summer, we purchased a new 3D printer, which cost 1/20th as much as my original machine, and the surface finish of the new parts is so smooth, you can barely feel the layer lines. It only takes a light sanding to get them glass smooth.

Additionally, there has been an explosion in different types of resin that you can use. The first resins, while hard, were also very brittle. Now there are resins that have exactly the type of properties that you'd want in a rocket - hard but that can be flexed without cracking.

It was after getting this new machine, I came to the conclusion that 3D printing technology has "finally" gotten to high enough quality and speed of production, that it can be used for production parts in Apogee kits (see Figure 2). My quality standards are pretty high, because I want customers to have a great experience with our kits. I don't want them to have to sand and fill 3D printed parts that some other manufacturers require their customers to do.

We're going to phase in 3D printed parts in places where it makes sense, and where the user's experience is better than what we had in the past. For example, we've already switched over to 3D printed nose cones in the **SR-72 kit,** and for the glider pod hooks for the **Mini-Condor Boost Glider**. These kits have gotten "better" with the use of 3D printed parts because they are stronger and smoother than what was used in the past.

While CAD designed rockets have been around for a long long time, they are getting better with software upgrades. Adding details to parts to models is easier now, and since we can also 3D print them for production use, it only makes sense to add them into the components of the kits. I think some really exciting things are going to happen with future kits, because we can finally marry the CAD designs with the production parts that we'll be able to print.

There are still some areas where we can't 3D print parts. The most obvious case is large nose cones. The 3D printers are still not large enough to do anything that is over about 7 inches long, or that has a large diameter. I hope that this limitation will go away in the future, but I don't know how long it will take for technology to catch up to our desires.

So we'll be ordering tooling for a while yet. This past year we ordered a large 3" diameter boattail for the **Nike-Hercules kit**, as well as the injection molded transition for the missile. That takes up

Figure 3: Cutting slots in a complex part, like this plastic blow-molded boattail for the Nike Hercules kit is a new skill we developed this year with our laser cutter machine.

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to steps 7 and 8 in the development of the kits. Unfortunately, not much has changed in the process of ordering tooling from outside manufacturers in the last decade. It is still a slow and painful process. Although I have to say that the first parts coming out of the mold are better and require less modification to the mold than they did in the past. The reason for that is that parts are drawn in CAD software, which makes everything more precise from the get-go.

In step 9, we're designing the laser-cut wood parts that a kit might use. This step hasn't changed too much in the last 10 years either. We got our laser cutter in 2014, and we've always been on the cutting edge of how it is used. We do some incredible things with our laser that I don't see any other manufacturer doing. Things like cutting complex patterns in tubes, along with etching the surface to draw lines on tubes to show where parts are attached.

I'm always looking for new ways to use it, and this year we started cutting slots into nose cones for through-the wall fins (see Figure 3). The Hi-Roc (**https://www.apogeerockets.com/Model-Rocket-Kits/Skill-Level-5-Model-Rocket-Kits/Hi-roc**) was the first kit with nose cones that were laser-cut. And the Nike-Hercules will have two blow molded pieces that are laser cut with slots in them.

Step 12 is where the decals are made. In the last 10 years, we've purchased three different machines to print our own vinyl decals in house. The ability to make our own decals is another thing that sets us apart from other rocket kit manufacturers. The reason I invested in the three different machines is that I wanted better quality and more efficiency for our decals. We probably put too much into decals for the rockets, but I want to give customers the option of having a really nice looking rocket when they are done.

The only decals we can't do in house are those that are either water-slide, or that have white on them.

Water slide decals are currently silk-screened which is slow

Figure 4: One of the many decals that we print here at Apogee's facility for our rocket kits.

Figure 5: Printing white ink on a clear vinyl is something we can't do yet. This was printed by another vendor.

and requires equipment that we don't have. So we have them made by an outside manufacturer that specializes in water-slide decals. Really, the only kits we use water-slide decals on are scale models, like our **Saturn V**, **Saturn 1B**, **X-15**, and the new **Nike Hercules**.

Our current vinyl printer does not have the capability to print using white ink. Printing with white has an advantage in that you can print on clear material and have it look nice when laid down over a dark color rocket. What we do currently is just design our rockets with a color scheme that doesn't require white letters.

However, we are planning on breaking this design rule with a future kit. We've already gotten samples for the Invicta rocket (**https://www.apogeerockets.com/Model-Rocket-Kits/Skill-Level-4-Model-Rocket-Kits/Invicta**), where the decals are printed on a clear background, with white being one of the colors (see figure 5). We look forward to that model coming out early next year.

Step 15, where we make videos of the construction of the rocket, is another area where we are different from other manufacturers. We don't make video instructions for every rocket we manufacture, but it is very important on the more complex rockets.

One of the things that I have seen that is really helpful for people is the "technique" of how various tasks are performed. For example, a common task in rocketry construction is to cut out pattern sheets. I always show how to lay the ruler down over the part so that if the knife blade strays off the edge of the ruler, it doesn't cut into the important part of the pattern. This is a technique that most people never learn, because they've never seen it done before.

A lot of the quality that is seen in a model, is the result of the techniques that are employed, not in the materials.

Recording and editing videos does take a lot of time, and we don't sell the videos we produce. So I can understand why other manufacturers don't make videos. But I believe that if I raise the

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skills of modelers, they'll be willing to try more advanced models that are more rewarding to fly. I also want to make sure that our models are actually built - not just collecting dust in someone's "build pile." When you are confident that your rocket will come out as good as the one you see in my videos, because I'm explaining the important steps and why they are critical to the outcome of the build, then you'll be more likely to start the project.

I'm really hoping that you'll at least watch the new build videos on the Nike-Hercules missile when the kit comes out. There are a bunch of new things we do in this model, like assembling fins with integral skins, and shaping airfoils into some of the smaller fins.

I actually moved the step of recording the videos up in the sequence of the development of the Nike-Hercules. Typically, it was done very last, after the rocket was listed on our website as being for sale. The reason for moving it forward in the sequence, was that I used the video series to help our artists that were drawing the illustrations in the instruction book.

This is step 17 in the sequence of making a rocket kit.

We use drawings instead of photos because they reproduce better when printed in a booklet. You can also show only the important aspects of the assembly step, and ignore the background information. This makes it easier for the user assembling the rocket.

Figure 6: Our videos are meant to show technique, which is an important part of the construction process.

For the Nike Hercules missile, there are a lot more construction steps than a typical model rocket. So I knew we'd need help making the instructions, and I'd have to get outside professionals.

While those professionals are artistically talented, they don't know what a fin fillet is. When you look it up in a dictionary, it is some portion of a fish before you put it in a frying pan. So when we gave the illustrators the text of our instructions, I also needed to show them what we wanted the artwork for the drawings to show.

I have to say, in retrospect, that it was a partial success. Even with the videos, it still took a lot of hand-holding with the artists to make the drawings for the kit. They've never built rockets before, so they don't know what they don't know. But without their help, we wouldn't have completed the instruction book in the limited amount of time we had. All told, there were 7 different artists that drew over

Figure 7: The illustrated instruction book for the Nike Hercules kit has over 250 drawings.

250 images for the 72 page instruction book for the Nike Hercules.

The other reason we decided to work with outside artists, was that we are shortening the time of every step in the development of a new rocket kit. The instructions were becoming the limiting factor on how many new kits we're able to produce in any given year. With everything else speeding up, like being able to 3D parts

in such a quick amount of time, we had to try to shorten the time to make illustrations too.

Compared to other rocketry kit manufacturers, I can see that they have the same problem. Where we are different is that we feel "printed" instructions are still very important to customers.

Not only do other manufacturers not provide images (nor even-photos) to make assembly easier, I even see other manufacturers that have stopped creating instructions all together (not printed, and not even a pdf that can be downloaded from their website). They just assume that every rocketeer has built enough rockets to know how to assemble their kits.

I know this is not what rocketeers want, because they end up calling us up here at Apogee and getting guidance for a kit they purchased somewhere else.

I understand the need to cut costs in a rocket kit, but cutting out the instructions is a great way to lose customers.

Marketing The New Kit

Step 22 is the final thing that needs to be done when making a kit. This is to create the web page and any marketing materials.

Up until this year, I would have said that nothing has changed in regard to creating web pages and marketing materials. But with Artificial Intelligence (A.I.), this is one area that has probably undergone rapid acceleration.

I've looked around at other rocketry manufacturer's webpages, and I can tell they are using A.I. extensively to generate sales copy. At this point, it is still easy to tell text that was written by a machine. The A.I. doesn't know the "why" that a customer might have when they are considering a rocketry purchase, so the text is pretty generic and goes something like this: "Take your rockets to new levels."

The machines also think that every rocket is perfect, and doesn't have any comparison to other rockets. No rocket is without any peers that customers are going to compare against, but the A.I. doesn't know that yet. If you look at the Apogee website, you'll see that we list the negative aspects of a kit, so that you know how it compares to other rocket choices you might have.

I'll admit that I've used A.I. to write marketing copy too. But I rarely use what it generates. I'm not impressed by it, and I have to go over it quite extensively and heavily modify it. The machines don't have what I have, which is extensive knowledge about rocketry and why one feature of a rocket may be really important to a buyer. That is what this article is really all about… sharing the knowledge that I have about making rocket kits, and comparing it to what has happened in the last 10 years.

When it comes to "experience and wisdom," it is going to be some time until the machines are able to replace humans. But I

Figure 8 (above): This is the orginal unedited photo we took showing the Catalyst rocket on a launch pad. We didn't like the background because it didn't frame the product in an appealing manner. We used A.I. image generation to create a new background shown in Figure 9 (below). Now this would be a near perfect launch range, which is what we were going after.

do think that A.I. will get better than humans in other areas. I'm really impressed with the graphics capabilities that many image generation applications have. And I believe that is the immediate future where we'll see a lot of A.I. in rocketry. Here is a photo we took in a local park showing the size of the Nike Hercules. Then

we took the image and modified it in A.I. to remove and replace the background. The actual rocket and the person are real, only the background was modified to make a better image that is more pleasing to look at.

With that, I'll say that image generation is looking really promising for us here at Apogee, and we'll be embracing the technology because it will allow us to be faster and better at providing what our customers want.

Conclusion

In this article I tried to expand on our previous newsletter that described the process of making rocket kits. It is part history of what has changed over the last 10 years, and part philosophy of how we do business here at Apogee Components with a comparison against other manufacturers. I'm hoping that you get a glimpse of what a huge investment we make into every rocket that has the name Apogee on it.

If you're interested in more of the history of individual rocket kits, and how they were developed, particularly the engineering aspects of them, I'll point you to a couple of other newsletters that you might like reading.

In Peak-of-Flight Newsletter 609 (**https://www.apogeerockets.com/Peak-of-Flight/Newsletter609**), Martin Jay Mckee talked about the development of the Draco Boost Glider kit. It was an interesting article about all the revisions he had to make to the rocket to make the concept of this unusual swing wing glider work to perfection.

Peak of Flight Newsletter 387 (**https://www.apogeerockets.com/education/downloads/Newsletter387.pdf**) tells you what went through my mind when I was developing the Fly-Away-Rail Guides (https://www.apogeerockets.com/Launch-Accessories/Fly-Away-Rail-Guides). It was a long process of figuring out the important aspects of making them work properly.

In our next issue of the Peak-of-Flight Newsletter (**https://www.apogeerockets.com/Peak-of-Flight/Newsletter639**), Martin will give you the complete background of the new Nike Hercules missile kit. This kit took longer than the Draco, and since it was a 2-stage rocket, it had a lot more challenges to over-

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. He is an avid rocketry competitor and is Level 3 high power certified. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward an M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and also the author of the books: Model Rocket Design and Construction, 69 Simple Science Fair Projects with Model Rockets: Aeronautics and publisher of the "Peak-of-Flight" newsletter, a FREE ezine newsletter about model rockets. You can email him by using the contact form at https://www.apogeerockets.com/Contact.

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Article Submission Guidelines
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SUBMITTING ARTICLES TO APOGEE

We are always looking for quality articles to publish in the *Peak-of-Flight* newsletter. Please submit the "idea" first before you write your article. It will need to be approved first.

When you have an idea for an article you'd like to submit, please use our contact form at **https://www.apogeerockets.com/Contact**. After review, we will be able to tell you if your article idea will be appropriate for our publication.

Always include your name, address, and contact information with all submissions. Including best contact information allows us to conduct correspondence faster. If you have questions about the current disposition of a submission, contact the editor via email or phone.

CONTENT WE ARE LOOKING FOR

We prefer articles that have at least one photo or diagram for every 500 words of text. Total article length should be between 2000-4000 words and no shorter than 1750 words. Articles of a "how-to" nature are preferred (though other types of articles will be considered) and can be on any rocketry topic: design, construction, manufacture, decoration, contest organization, etc. Both model rocket and high-power rocket articles are accepted.

CONTENT WE ARE NOT LOOKING FOR

We don't publish articles like "launch reports." They are nice to read, but if you don't learn anything new from them, then they can get boring pretty quick... Example: "Bob flew a blue rocket on a H120 motor for his certification flight." As mentioned above, we're looking for articles that have an educational component to them, which is why we like "how-to" articles.

You can see what articles and topics we've published before at: **https://www.apogeerockets.com/Peak-of-Flight?pof_list=archives&m=education**. You might use this list to give you an idea or two for your topic.

Here are some of the common articles that we reject all the time, because we've published on these topics before:

- How to get a L1, L2, or L3 Cert
- Building cheap rockets and equipment (pads & controllers)
- How to 3D print parts, or a Rocket Kit
- How to Build a cheap Rocket Kit
- Getting Back Into Rocketry After a Long Hiatus

ARTICLE & IMAGES SUBMISSION

Articles may be submitted by emailing them to the editor. Article text can be provided in any standard word processor format (MS Word, Libre Office, etc.) or as plain-text. Graphics, meanwhile, should be provided in either a vector format (Adobe Illustrator, SVG, etc.) or a raster format (such as jpg or png) with a width of at least 600 pixels for single column images or a width of 1200 pixels for two-column images. If possible, it is generally preferable for images to be simple enough to be readable in a two-column layout, but special layouts can use the whole page width if required.

Send the images separately via email as well as show where they go by placing them in the word processor document.

ACCEPTANCE

Submitted articles will be evaluated against a rubric (available here on our website). All articles will be evaluated and the results will be sent to the author. In the evaluation process, our goal is to ensure the quality of the content in *Peak-of-Flight*, but we want to publish your article! Resubmission of articles that do not meet the required standard are heavily encouraged.

ORIGINALITY

All articles submitted to Peak-of-Flight must not run in another publication before inclusion in the *POF* newsletter, but it may be based on another work such as a prior article, R&D report, etc. After we have published and paid for an article, you are free to submit them to other publications.

RATES

Apogee Components offers **$300** for a quality-written article over 2,000 words in length. Payment is pro-rated for shorter articles.

WHERE WILL IT APPEAR?

These articles will mainly be published in our free newsletter, *Peak-of-Flight*. Occasionally some of the higher-quality articles could potentially appear in one of Tim Van Milligan's books that he publishes from time to time.

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