PEAK OF FLIGHT NEWSLETTER

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PLASTIC MODEL CONVERSION (PMC)

https://www.apogeerockets.com/Rocket-Kits/Skill-Level-2-Model-Rocket-Kits/Diamondback

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APOGEE COMPONENTS

PEAK OF FLIGHT

Plastic Model Conversion

By Bobby Potter

Plastic Model Conversion (PMC) is the act of taking a static model, meaning a model that the manufacturer did not intend to be flown, and making it flyable. This conversion needs to also adhere to the dimensions, look, and feel of the original model. This is a craftsmanship event in NAR competitions, but can also be a fun way to flex your skills as a rocketeer and collect some eyeballs at your next launch.

For competitions under the NAR, the plastic model you select for conversion is limited to rockets, aircraft, or other space vehicles, but the hobbyist community has done countless different models, from model tanks to piggy banks, and so on. There are unlimited possibilities, as with the right approach and enough force, anything can be made to fly.

FIGURE 1: SPACEMONKEY V-2 AFTER A PLASTIC MODEL CONVERSION.

NAR Competition Judging Criteria

For NAR competitions, it is usually helpful to get familiar with some of the rules. The PMC contest is no different. There are 3 different criteria in which a plastic model conversion will be judged. They are:

1 - Craftsmanship (500 points)

This is the largest category, and is a major determining factor in your success. To provide clarity to the scoring metrics here, the NAR has broken this section down into a few different categories. They are:

-Neatness and Care in Construction
-Craftsmanship of Details
-Degree and Quality of Finish
-General Appearance

Essentially, this category judges you on how good you are at the basics, as well as how much care and effort you put into the model. Judges will ask themselves questions like “Does this model look like the real thing?”, “Are there glaring flaws like streaking paint, poorly done fillets, or unfinished surfaces?”, “How detailed is this model? Does it go down to every nook and cranny, or does this model just represent the general aesthetic?” and “Overall, how does it look?”

With 500 points possible, the craftsmanship represents the largest section. Even if you score well in all the other sections, if you don’t take your time and build the model with great care, you could be virtually eliminated from the competition from this section alone. It accounts for nearly half of the total possible points.

2 - Degree of Difficulty (300 points)

It is not enough to build a model well, but your final result will be affected by how challenging of a project you undertake. A very basic and simple rocket, with an easy method of conversion, will score you far fewer points than a complicated and detailed project would. An example might be a basic V2 rocket in comparison to the complexity involved in converting a plastic X-15 model to (stable!) flight. It’s just on another level of complexity, where many more variables need to be taken into account, and therefore is worth more points.

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FIGURE 2: N-1 MOON ROCKET - THE KIND OF DETAILING THAT WOULD BE CONSIDERED A HIGHER DIFFICULTY (NOT A PMC)

To determine the difficulty, judges look for:

-Asymmetry inherent in the model
-Intricacy of paint patterns
-The number and complexity of internal and external components
-Difficulty of converting to a stable model
-Difficulty of converting the model to accept functioning motors and recovery systems

A lot of this section comes down to the model that you select. Some models, especially models of rockets, may have fins and promising locations for the center-of-gravity and center-of-pressure needed for stability. Some are well suited to paint or design tasks, while others have many small components that require individual detailing.

3 - Flight Characteristics (300 Points)

This section is all about the model in flight. It is broken down into two main sections: the mission and the general flight.

The mission is the larger of these two sections, and it refers to the parameters and objectives the original model would have had during flight. Is this a multistage rocket? Yours should be too. This can be as creative as simulating cloud seeding or more basic like operating your electronic payload. So long as it adheres to the NAR safety code and makes the flight more realistic, you could find yourself some extra points here.

The general flight characteristics are the same that we have become familiar with as members of NAR and Tripoli. Did your engine misfire? Was the rocket stable in flight? Did the recovery system deploy correctly and reduce the velocity enough to prevent any significant damage on impact? All of these criteria, and more, can affect your score in this section.

A Warning on Heat Death of Plastic Models

Unfortunately, a large portion of plastic model conversions aren't going to survive their first flight unscathed. These models aren't designed for flight, and the plastic used varies a great deal. Sometimes the model can handle a surprising amount of heat generated from the motor and the ejection charge and remain in good shape, however many of the models can't handle the heat and will melt and deform around the motor.

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The most common and noticeable damage caused by plastic death is around the nozzle of the motor, or any of the plastic that underhangs the motor.

As the points are awarded after the model's flight, heat death is a significant contributor to lost points in NAR competitions. Unfortunately there isn't a whole lot you can do to prevent this, but applying a few coats of paint can help. Additionally, epoxy can do wonders to protect the model when applied in a thin layer, however this will mostly be used on the interior of the model, as a layer of epoxy on exterior components will affect the aesthetic of the model.

Common Methods Utilized in PMC

Really, anything is a go here. Plastic model conversion is all about your creative problem solving skills, and however you can figure it out is fine by the rules of the game. That being said, there are some pretty standard techniques used in plastic model conversion. Before we get to a step-by-step guide, I thought we should cover some of these basics.

Transparent Plastic Fins

Unless you are some electronics expert who has already figured out thrust-vectoring systems, your model is almost certainly going to need fins. If you are doing a model of a rocket that is already utilizing fins, these may be enough to keep your rocket stable, but you need to still run the appropriate simulations (the center-of-pressure on a scale model should remain in the same location, but the center-of-gravity could vary wildly). If your center-of-gravity is too far toward the aft end of the rocket, you could correct this by adding an appropriate amount of nose weight or by making the fins on your model slightly larger than they came (moving the center-of-pressure further back).

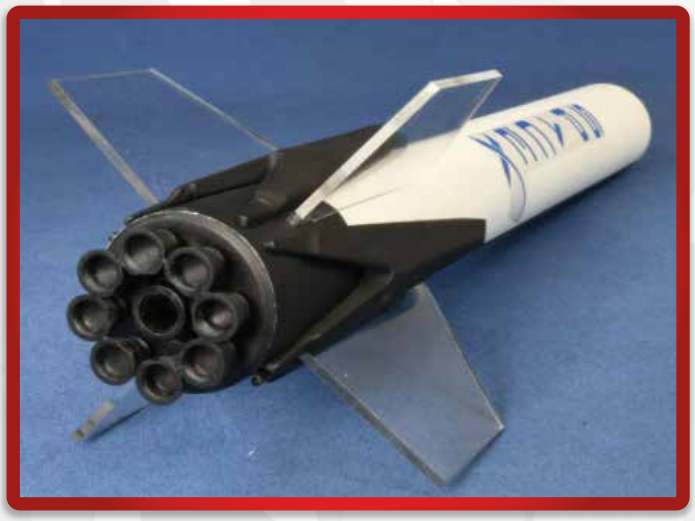

FIGURE 3: ACRYLIC FINS TO MAINTAIN SCALE AND STABILITY ON A FINLESS ROCKET.

If your model does not use fins for stability, or is not a model of a rocket at all, it is a standard procedure to use transparent plastic fins for stability. These fins will not negatively affect your score, as they are a well-known and universally accepted practice. These fins are most commonly made from acrylic.

We've used these on scale rockets from time to time, like on our scale Falcon 9 and Crew Dragon rocket (https://www.apogeerockets.com/Falcon-9-Crew-Dragon-Plan). For this rocket, we used .08" thick acrylic, and we laser-cut them to size.

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Rear Ejection

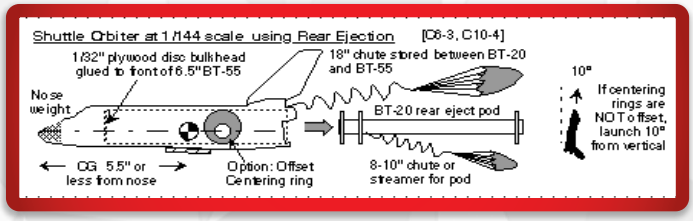

FIGURE 4: LAYOUT OF REAR EJECTION SHUTTLE CONVERSION (SOURCE: GEORGE GASSAWAY & NAR - https://www.nar.org/contest-flying/competition-guide/craftsmanship-events/plastic-model-conversion/***)***

One of the hardest problems to overcome on a plastic model conversion is the recovery system. On a typical rocket, the nose cone ejects and with it comes the parachute. On models that were never intended to fly, there is usually no separation built into the model. This leaves you with just two options: create a separation, or eject the motor mount.

Creating a separation on the front of the rocket can leave an unsightly seam which could detract from your total points (as this does not always look like the original model, but many people manage to do it well). However, by deploying your recovery system with rear ejection, you don't have to make any modifications to the forward part of the airframe, keeping the model as close to "as intended" as possible. That being said, rear-ejection is not suitable for all models or modelers.

To learn more about rear-ejection and how to do it, we have a great article on the topic. (https://www.apogeerockets.com/education/downloads/Newsletter439.pdf)

Creating a "Nose Cone" for Standard Recovery Deployment

In the case that you are not wanting to do rear-ejection for whatever reason, you are going to need a "nose cone" that separates when the ejection charge fires. I put nose cone in quotes because if you are making a flyable tank, there isn't going to be a nose cone as we would normally understand it, but instead it would just be the front part of the tank that needs to eject.

This process can be a lot easier than you might think at first glance. The first step is to just cut off the "nose cone" wherever you want the separation to occur. Then, being careful to ensure proper alignment, glue a coupler into the nose cone which will act as a shoulder, securing itself with a friction fit into the body tube you are using for the model. This could be either the motor mount tube or a more standard body tube if the model itself is large enough to fit one.

FIGURE 5: CONVERSION KIT FOR THE SPACEMONKEY V-2 (https://www.apogeerockets.com/Rocket-Kits/Skill-Level-3-Model-Rocket-Kits/V-2-Conversion-Kit***)***

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For a better understanding of this process, check out the instructions for the Spacemonkey V2 Conversion kit (https://www.apogeerockets.com/downloads/PDFs/12111-V-2-conversion-instructions.pdf) we sell here at Apogee. This conversion kit provides all the necessary components needed to convert the Spacemonkey V2 into an actual flying model rocket.

A Step-by-Step Process to Approaching your Conversion

Regardless of what you are converting to a flyable model, there is a tried and true method for conversion. Don't consider this a limiting factor, something you need to adhere to, but rather a general guide to help you get your footing. This process can be used for nearly any conversion, and should yield the kind of results you are looking for.

Much of this process I need to credit to Kenneth Brown and John McCoy of the NAR who detailed their process to act as a guide for those of us in the hobby rocketry community. You can find that original document here: https://www.narhams.org/library/tech/009-PMC.pdf, and I highly recommend reading it for anyone trying this process for the first time. It goes into much more detail the tools you should be using, and the general process every conversion takes, as well as recommends models for everything from beginners to experts.

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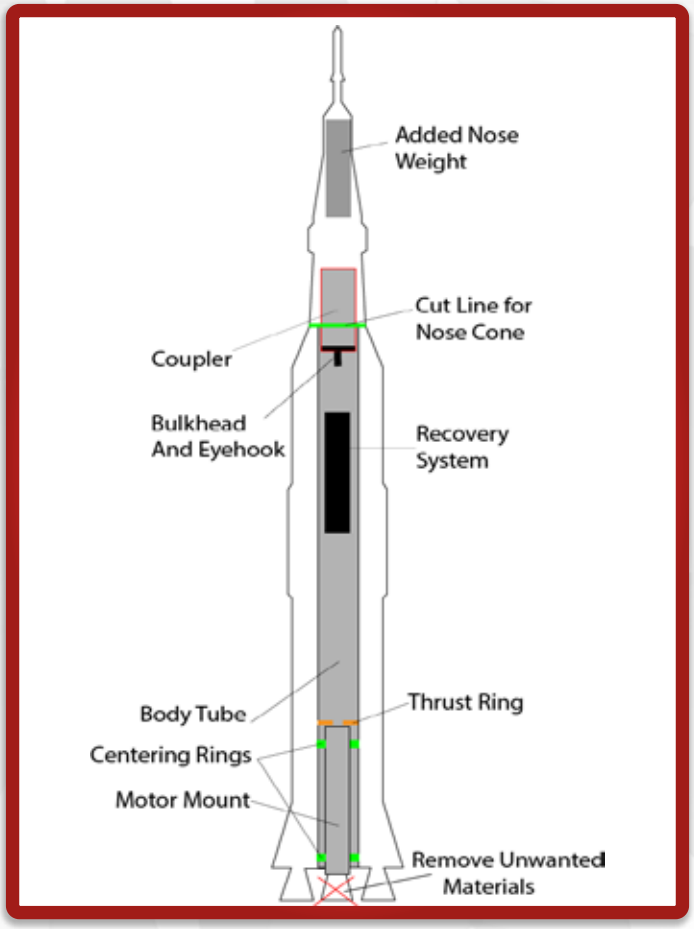

FIGURE 6: A TYPICAL LAYOUT FOR A SATURN V PLASTIC MODEL CONVERSION

Step 1 - Picking your model

In theory, pretty much anything can be made to fly. That being said, some models make more sense than others, and the model that you pick is going to have a large impact on the challenges you face during the conversion. IMPORTANT: Any model using a significant amount of metal components should not be used for conversion. It's much harder

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to cut metal, and under the NAR Safety Code, you can't fly them anyway.

FIGURE 7: A STANDARD ASSORTMENT OF COMPONENTS FOR A CONVERSION CONSISTS OF A BODY TUBE, COUPLER, MOTOR

First, consider the size and detail of the models you are considering. A smaller model is generally going to be easier and the detailing less complex, but that is not always the case. You should also be considering what motors you want to be using, and what size tube the model can fit.

Step 2 - Dry Fit

Put the model together as best as you can, using scotch tape in place of a more permanent adhesive. This gives you the opportunity to see how everything comes together, and more importantly, check that the body you'll be using can extend from where the motor will go, all the way to the nose cone. You should use this step as an opportunity to mark and remove any plastic that will interfere.

Step 3 - Glue it Together

Here, we put together the model. Use the correct adhesives, and make sure the construction will be able to handle the stresses of flight. Leave out the body tube and coupler in this step.

Step 4 - Cut the Nose Cone

Using rear ejection? Skip this step.

Now that the model is starting to resemble the finished product, we need to make the recovery system. Find and cut the model wherever you would like the nose cone to separate from the rest of the airframe.

In some models, there is a natural separation where this cut can be disguised most easily. Look for grooves or natural lines in the model.

Step 5 - Secure the Body Tube and Coupler

Place the body tube into the model, and the coupler into the nose cone. Align them correctly, and cut the body tube to the correct length, so the model comes together like it should. Make sure the coupler provides plenty of shoulder length to hold it securely. Secure them in place using scotch tape and then glue the coupler into the nose cone and the body tube into the model.

Step 6 - Attach the Shock Cord & Nose Weight

If your model requires nose weight, be sure to add that now. Then, attach the shock cord to the nose cone using your preferred method (on the Spacemonkey we use a bulkhead and eyebolt in the coupler, but you could just use

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some adhesive).

Step 7 - Add the Motor Mount & Launch Lugs

Glue in the motor mount tube, thrust ring and centering rings or (if minimum diameter) just the thrust ring. Then add your launch lugs, and your model can fly!

Step 8 - Paint and Finish

All that is left to do is paint and finish your model! At this stage, you can start gluing on accessories (like missiles hanging from wings). We recommend painting the accessories before gluing them onto the finished model.

Step 9 - Cut Out and Attach Acrylic Fins

After verifying through simulations the size of fins you need, create a template and cut them out from the acrylic sheets. Then, secure these to the body of your model. If this model is going to be used with any particularly high-thrust motors, you may want to consider cutting slots into your model and mounting these through-the-wall and onto the body tube. This will greatly enhance the forces it can handle during flight, and reduces any potential damage upon landing.

Step 10 - Attach and Load Recovery

Whether you are using a parachute or streamer, you are ready to attach and load your recovery system and get this thing to the launch pad!

Remember to run simulations or otherwise verify stability before flight!

Other Resources you Might Find Helpful

The NAR has several resources that detail the competition spirit and rules a bit more than I did here. You can navigate to those resources from this page: https://www.nar.org/contest-flying/competition-guide/craftsmanship-events/plastic-model-conversion/. This page contains an article written by George Gassaway and was originally published in Sport Rocketry in 1999. It details his thought process and procedure for completing plastic model conversions.

The Rocketry Forum has a great collection of plastic model conversions. You can see that gallery and some tips and tricks on this thread: https://www.rocketryforum.com/threads/plastic-model-conversion-pmc-gallery.19860/

Conclusion

Plastic model conversions, though a relatively niche competition, can be a great way to test your building and creative problem solving skills as a rocketeer. It can give you a new toolkit and a better understanding of the building processes, different methods of recovery system ejection, and the fine crafting skills needed to do scale models well. If you want to give it a try, consider the Spaceymonkey V2 (https://www.apogeerockets.com/Rocket-Kits/Skill-Level-4-Model-Rocket-Kits/Spacemonkey-V2-A4-Scale-Model) and the conversion kit (https://www.apogeerockets.com/Rocket-Kits/Skill-Level-3-Model-Rocket-Kits/V-2-Conversion-Kit) to get a detailed conversion model with in-depth instructions.

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