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APOGEE PEAK OF FLIGHT NEWSLETTER

The Ultimate Rocketry Glue Guide

Part 1

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New Hawk Hobby Kits at Apogee Components

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The Ultimate Rocketry Glue Guide - Part 1

By Dave Virga

It happens all too often… A rocket leaps off of the pad; a split-second later, it is cartwheeling across the sky while its fins flutter back down to the launch pad. Another rocket makes it to apogee, but then the ejection charge blows the body free of its recovery system; it screams down to its ruin while the nose cone gets a nice slow ride on the gentle breeze to land far away. So what happened? In both cases, components of the rocket were not securely attached – the fins in the first scenario and the shock cord anchor in the second. Ask the rocketeer what kind of glue was used and you'll surely get an answer like "Hot glue," or "Rubber cement," or "School glue." Whatever the answer, it will be that an inappropriate glue was used, or that an appropriate rocketry glue was used in the wrong way.

In rocketry, we need adhesives that are strong yet as lightweight as possible. Rockets are subjected to some incredibly strong forces – hard acceleration on liftoff; aerodynamic drag and wind shear during flight; violent jerks at recovery system deployment; and pounding landings on hard ground. Our adhesives need to be able to withstand these forces as much as the materials themselves do. Motor mounts and centering rings cannot be allowed to break free from the body tube. Fins need to stay attached when several hundred mile-per-hour wind forces try to strip them off. The shock cord needs to stay firmly anchored when the ejection charge snaps it out to its full length. Household glues and kindergarten pastes don't have the tenacity needed for rockets; we need some sort of "industrial-grade stick-um."

This is the first part of a two-part article in which I will discuss many popular types of adhesives. I will explain in detailed yet understandable terms how each adhesive works. I will identify the good, the bad, and the dangerous of each, as well as its applicability to rocket construction.

Many different types of glue

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About this Newsletter
You can subscribe to receive this e-zine FREE at the Apogee Components web site (www.ApogeeRockets.com), or by sending an e-mail to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject line of the message.

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Definitions

Here are the definitions for a few general terms that will be used in this article.

Aliphatic: This is a chemical term that refers to how organic (containing carbon) compounds are interconnected. Aliphatic compounds are organic compounds in which the carbon atoms are linked together in non-cyclic chains.

Emulsion: An emulsion is a mixture of two normally unmixable liquids that are held in suspension by some added compound that prevents them from separating (an emulsifier). For example, mayonnaise is an emulsion of oil and water, with egg yolk (lecithin) being the emulsifier.

Fluidity / Viscosity: These terms are inverses of each other that refer to the thickness of a liquid and its ability to flow. Low fluidity, high viscosity and thick are relative synonyms, as are high fluidity, low viscosity and thin.

Monomer, Polymer: A monomer is a small molecular compound that can be joined to other monomers to form polymers.

Resin: A resin is a viscous liquid that is capable of hardening. Resins can be either naturally occurring, such as tree sap which turns to amber, or synthetic. Since nearly all adhesives are viscous (i.e., able to flow) liquids in their uncured state, and solids in their cured state, they are resins.

How Glues Work

A common misconception is that more glue is better; very rarely is this the case. The bonding action only occurs at the intersection of the items being bonded. Any extra glue only adds unnecessary weight and reduces the performance and efficiency of your rocket. To fully understand this, you need to look at how glues work at the molecular level.

Modern adhesives, in their uncured state, are resins that are made up of small molecular compounds called monomers. During the curing process, these monomers link together in chains to form polymers. Longer-length polymer chains create stronger bonds than shorter polymer chains. It takes more time to construct long polymer chains, which is why slow-cure adhesives create stronger bonds than rapid-cure adhesives. For even greater strength, some polymer chains will also be connected at various points along their lengths by cross-links; for example, the heat treatment process for rubber (vulcanization) causes sulfur to create cross-links between the rubber polymers.

The actual bonding between the adhesive and the parts happens in two ways. First, the monomers may be able to incorporate the molecules of the joined components into the polymer chains; this is a chemical bond. Second, while in a more fluid (low viscosity) state during the early stages of curing, the adhesive can flow into porous materials and lock onto them mechanically when they harden. Adhesives cure by either reaction with a trigger compound or by drying.

So, you can see from this discussion that the critical interfaces are the direct contact points of the adhesive with the parts being joined. Any additional adhesive is simply along for the ride. (Structural gap-filling adhesives are an exception.)

Wood Glue

Wood glue is by far the most widely used adhesive for model rocketry. It is used to join porous wood and paper items. It creates a mechanical bond and cures by drying. It has low gap-filling capability.

Wood glues typically use polyvinyl acetate (PVA or PVAc) or similar polymers as the adhesive in a water emulsion (approximately 50% water and PVAc), so it shrinks considerably. It remains somewhat flexible when dry as well. PVAc is a synthetic polymer composed of organic molecules (hydrocarbons); since the hydrocarbons are linked by their carbon atoms, it is considered an aliphatic compound.

Continued on page 4

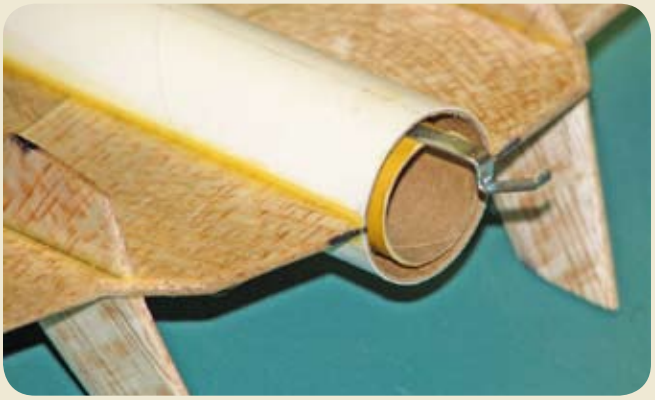
Continued from page 3

The two most common wood glue brands are Elmer's and Titebond. Both companies have a wide variety of products, but not all are adequate for rocketry. Look for Elmer's Exterior Waterproof Wood Glue, Elmer's Carpenter's Exterior Wood Glue, Titebond II or Titebond III. All of these glues produce bonds stronger than the wood and/or paper being bonded. They are all non-toxic. These latest formulations are more water-resistant than earlier versions, and so will not deteriorate as much over time due to moisture. Note that even though the first Elmer's product has "Waterproof" in its name, it is only water-resistant; it is not intended for long-term immersion.

Elmer's Carpenter's formulations contain 5-10% wood flour, which will improve its gap-filling capabilities slightly. Titebond II uses a cross-linking PVAc compound, which will improve its bond strength compared to a similar non-cross-linked polymer. Titebond III though, uses an "advanced proprietary polymer" which has slightly higher bond strength than Titebond II.

Avoid the wood glues that are intended for indoor use. While they may appear to work satisfactorily in the short term, they will not withstand the test of time as well as the more moisture-resistant exterior formulations. Also, avoid the polyurethane formulations; these will be discussed in Part 2 of this article.

Wood glue is very simple to use. It starts to set quickly, and cleans up with water. Because it does set so quickly, care must be taken when gluing parts such as motor blocks and centering rings; they must be placed immediately after the glue is applied and accurately positioned in one smooth motion. Attaching fins is quick and easy as well. While the instructions on the bottles say to clamp the parts, it is not practical or necessary to clamp fins while attaching them; firmly pressing them in place by hand for approximately thirty seconds is sufficient. The Apogee video book Building Skill Level 1 Rockets (http://www.apogeerockets.com/skill_level_1_video.asp) contains an excellent video of this process. Finally, after the initial joint has had a chance to dry for about fifteen minutes, thin fillets need to be added on both sides of the joint for added strength; do not try to make thick fillets here with the wood glue though, as it will provide no structural benefit.



What's Next

So there you have an introduction to the world of adhesives, with the specific focus on rocketry usage. Wood glue was the first adhesive to be discussed in depth. In Part 2, I will continue discussions of additional types of adhesives – plastic cement, epoxy, cyanoacrylates, and more. I will also give you a set of web links that you can peruse to study adhesives in even greater depths.

Until next time… Keep flying, and keep learning!

About The Author

Dave Virga holds a Bachelor's degree in Computer Science, and is an Information Technology Specialist for the Department of Defense. A typical Born Again Rocketeer, he enjoyed building and flying rockets through high school, then set the hobby aside for college, career and family. He re-discovered rocketry in the late '90s, and has become a voracious student, teacher and practitioner of rocket science. In past lives, he has been a naval submarine officer, computer systems engineer, ski instructor and Scout leader. A trombonist since elementary school, he will also on occasion sit in with his wife's early music ensemble when a bit of sackbut is needed. He lives in Black Forest, Colorado with his wife, son, dogs and parakeets.

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Apogee Components, Inc. is pleased to announce the second annual grant program geared toward model rocketry education organizations!

The rules are simple:

1. Entrants must submit an essay to Apogee. There is no length requirement for the essay.

2. Any club, organization, or school program, is eligible for entry. This would include rocketry clubs or prefectures, 4H, scouts, etc.

3. The content and purpose of the essay is as follows:

- If we gave you $300.00, How would you use it to impact the rocketry community?
- How many people do you think it will reach?
- How many people will be involved in the organizing and running of the event?
- How big of an effect will it have on the rocketry community?

4. One of the biggest things to keep in mind when composing your essay is **"How is what I am planning unique?"**

There will be only one winner of the grant, which is $300.00 towards any order with Apogee Components.

The deadline for entry is November 30, 2007.

Make sure it is post-marked by November 30th!

The grant winner will be announced on January 1, 2008.

What a great way to start off the new year!

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or: orders@apogeerockets.com

http://www.apogeerockets.com/rocket_grant_money.asp

DEFINING MOMENTS

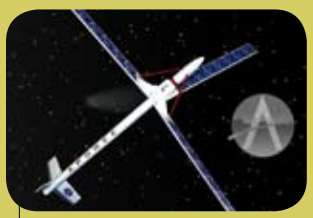
Autogyro (or Helicopter) recovery is one of the lesser-used forms of recovery for sport rockets, but it is a real crowd-pleaser, nonetheless. '*Heli*' recovery uses a horizontal propeller/rotor to create the drag necessary to slow the rocket's descent. Though it's usually reserved for competition rocketry events, there's no reason why it can't be used for sport rockets.

The key to successful autogyro recovery design is finding a way to efficiently store and deploy the rotor system. There are three main ways of doing so.

The first method is to incorporate the rotors into the fins of the rocket. At Apogee, a portion of each fin is allowed to bend to a sharp angle, all in the same direction. The Apogee Texas Twister (http://www.apogeerockets.com/texas_twister.asp) uses this recovery design.

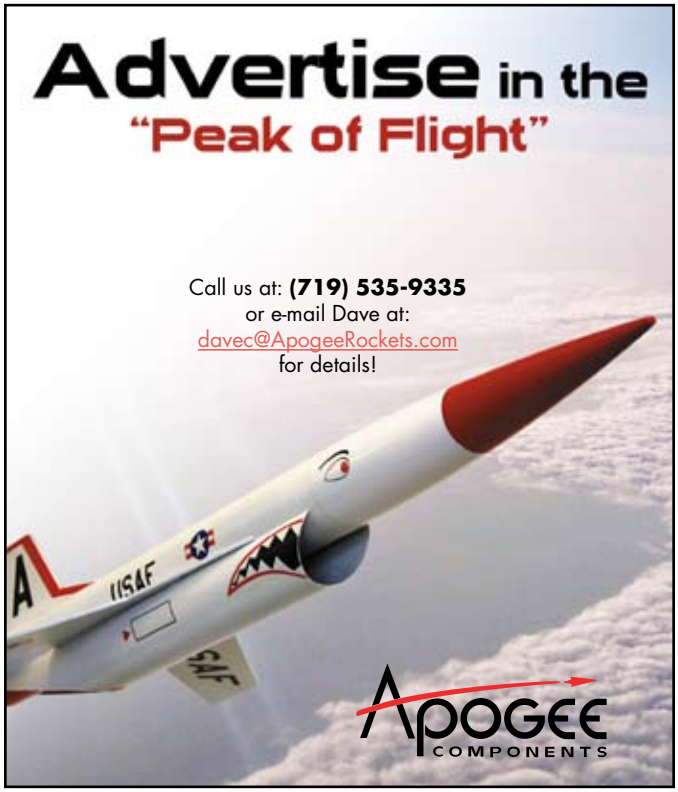
Texas Twister

The second and third methods are very similar. Long, thin rotor blades, very much like those on helicopters, are deployed. The rocket falls tail-first, and the airflow through the blades causes them to spin rapidly. Additionally, the blades are angled and airfoiled to provide lift as they spin. The difference in these two design methods is in how the blades are stowed for flight – either internally or externally. The Apogee Heli-Roc (http://www.apogeerockets.com/Heli_Roc_Kit.asp) is an excellent example of an externally-stowed rotor design.



Heli-Roc

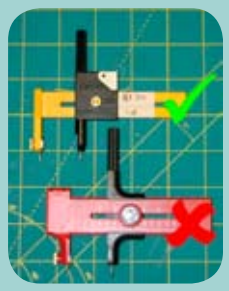
So if you're tired of the same-old Woosh-Pop, give Woosh-Whirl a try – you'll be the star of the launch!



TIP OF THE FIN

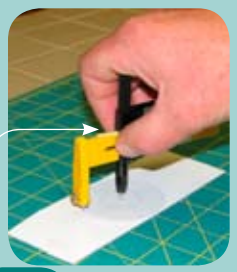
The ultimate circle cutting tool (so far)

So you've designed your rocket using RockSim, and you're ready to cut your centering rings. How do you easily and accurately do this? I have tried just about every trick and tool out there, and have settled on one – the OLFA Compass Circle Cutter (CMP-1). There are other compass cutters available, but none are as sturdy and stiff as the OLFA. Stiffness is very important to ensure a perfectly round circle and repeatable results, and the OLFA has it.



The tool itself is not the entire solution though. You need to know how to properly use it. Here are three keys to successful compass cutter usage.

- Use short, light strokes, especially for the first two revolutions. Future passes will follow this initial groove, so it's critical that you get a good start. Hold the cutter as vertical as possible, and keep your strokes to ½" – ¾" maximum.
- Turn the work piece, not the cutter. Your hand and wrist can only comfortably swing through a short arc; don't contort beyond this comfort zone to continue the cut farther around the circle as this will cause a loss of control and accuracy. Instead, rotate the work piece so that you stay in your comfort (and accuracy) zone. Overlap your swipes to maintain a clean, single inscription.
- Work from both sides. Cutting half way through from each side will create a cleaner finished product.



Note that there is a slight bit of play in the tool that can make the difference between a loose and a snug fit. You can fix this very easily by inserting a paper shim between the two pieces as shown.

You can find this tool at many local and online craft and hobby suppliers. Grab several and leave them set for specific sizes, as I do. Give it a try!

For additional info on centering rings, see: http://www.ApogeeRocket.com/education/downloads/newsletter 63.pdf

QUESTION & ANSWER

Ty recently asked, "I, along with my 2 sons, have been experimenting with model rockets for nearly a year now. We are ready for the next step, however, I'm a little confused. I am trying to find something near 36" using D/E size engines. The only 'starter set' I can find is a $150 Aerotech kit which is great, however, I really want to be just under $100. Do you have any suggestions?"

We sure do, Ty! We don't have a complete mid-power starter set, but we do have all of the components. First, pick your favorite large model rocket from our online selection (http://www.apogeerockets.com/Mid-power_kits.asp), and pick a recommended motor from the rocket's web page. If you need recovery wadding or igniters, these are available as well. The Estes Porta-Pad® "E" (http://www.apogeerockets.com/Estes_launch_pad.asp) will accommodate any rocket through E impulse. Finally, the Pratt Hobbies GO BOX (http://www.apogeerockets.com/go-box_controller.asp) is a fine launch controller that can provide the punch to reliably ignite your cluster flights.

If your only option is to fly solo, then these ground support components will serve you well. However, if there's a rocket club nearby, we strongly encourage you to check them out. They will have all of the ground support equipment needed, as well as the experience to help make sure that your flights are straight and true as you venture into larger rockets. Plus, you and your family will get to share the excitement of everyone's rocket flights, not just your own. To find a club near you, go to the National Association of Rocketry's website (http://www.nar.org), and search their list of local rocketry clubs.

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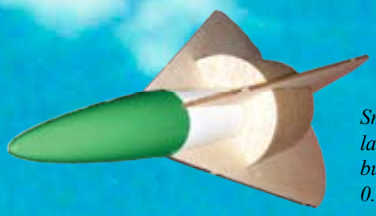
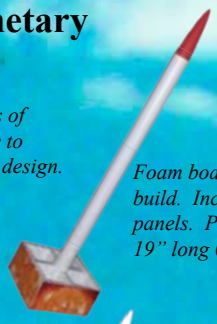


Interplanetary Shuttle

Small rocket with lots of laser cut balsa. Easy to build with distinctive design. 0.976" dia 11"long



Box Racer

Foam board fins for a different build. Includes pre-printed side panels. Plastic nose cone. 19" long 0.976 dia.

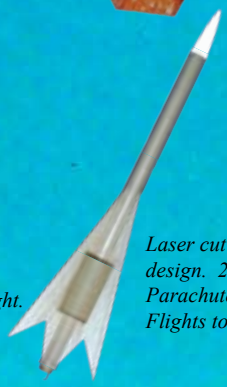
Space Speedster

Printed body with foam board fins. Preprinted fins. Laser cut foam mounting rings.

Flechette

3 fins 6 piece laser cut balsa. Flights to 1000'/ 300m. Parachute recovery.

Flechette: *The word flechette is French for "dart." In military use, it is a projectile having the form of a small metal dart: a sharp-pointed tip and a tail with several vanes to stabilize it during flight.*



Explorer

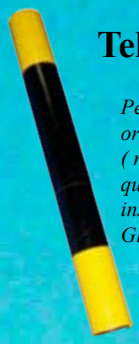
Laser cut 4 fin with distinctive design. 21" long 0.976" dia Parachute recovery. Flights to 750'/ 250m

Bug Me Not!

Great beginner's rocket. Laser cut fins. Streamer recovery. 0.976" dia 11" long.

Lightning Fury

Simple to build. Laser cut fins. Streamer recovery. 0.796" dia, 21" long



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Web Site Worth Visiting

Apogee Components is as much about rocketry and education as it is about bringing fine rocketry products to you. Another outstanding organization that shares this education vision is the Challenger Center for Space Science Education (http://www.challenger.org/). As stated on their website, "Challenger Center is an international, not-for-profit education organization that was founded by the families of the astronauts from Challenger Space Shuttle mission 51-L. Through Challenger Center's programs and its international network of Challenger Learning Centers, the diversity, spirit, and commitment to education that exemplified the Challenger 51-L mission continues to make an impact on students, teachers, and families today. These positive learning experiences raise students' expectations of success; foster a long-term interest in mathematics, science, and technology; and motivate them to pursue careers in these fields."

There are currently 51 Challenger Learning Centers – 49 in the United States, 1 in Canada (Toronto, Ontario) and 1 in the United Kingdom (Leicester). Many more are in the planning and funding stages, including one in Seoul, Korea. These learning centers are designed and equipped to run realistic simulations that give the participants a taste of what it's like to work in a space mission environment. There are currently five mission scenarios, including "Rendezvous with a Comet", "Return to the Moon" and "Voyage to Mars", as well as the new "Journey to Jupiter and its Moons" coming soon.

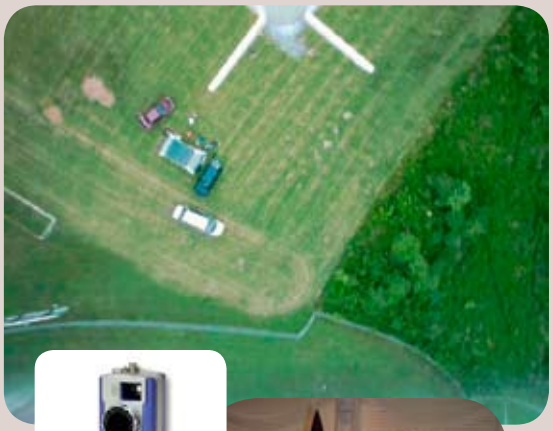
The Challenger Learning Centers are the centerpiece of the organization, but there's a lot more to the Challenger Center. Be sure to check out all of their other programs!

Payload Contest Winner!

Congratulations to James Rorror of Eden North Carolina. He has won a copy of RockSim version 8.

We looked at a lot of great enrtries in the last month and found that we enjoyed the payload that James flew the best. James made a scratch built rocket that he installed a camera into. The pictures are outstanding and he had a great story to go along with it. Here is his story:

First of all, I have flown all kinds of payloads to include some with altimeters for two stage recovery, but I believe my mind was made up when I was only 10 years old back in 1968 when it comes to the greatest rocket payload of all time.



In 1968 I was deeply interested in real rockets and had never missed a launch aired on TV. It was at this time when I heard about model rockets for the first time, so I went out and got a copy of Boy's life and ordered the Estes Catalog that was being advertised. My eye caught the Camroc camera rocket right from the start. I was thinking, how neat it would be to be able to take pictures from high up in the sky.

Two years later that was topped with the Cineroc, a rocket that could take moving pictures! Wow! I had to order that baby and I was successful in taking some movies from it. Of coarse, the Cineroc is long gone, but I never forgot it and what it could do.

I got back into rocketry in 1989 mainly because of wanting to share the thrill of the hobby with my then 4-year-old son. In 2004 I decided to build the Greatest Payload by trying to make a scratch built rocket that I would call Cineroc 2004. It would be very close to the old Cineroc but with an updated camera. After doing some research I found a camera that I thought would be perfect! An Aiptek 1.3 meg. Mini Pen Cam which was only 1"x1"x3.5" in size and very light weight.

The camera can take over 30 seconds of Video and it now cost only $9.99. I got some ideas from an Internet article also at the following web-site. www.seed-solutions.com/gregordy/Rockets/VideoRockets.htm

I made some improvements on the payload bay design that would house the camera. I also cloned an Omega booster that the Cineroc used but 4 inches longer for a more stable flight. I was very happy to be able to design and put it all together and have it work so well.

I went on to improve on the Greatest Payload by using a mini wireless video camera the size of a nickel. Not only could I watch the flight as if I was onboard but I also had sound! This updated rocket was called Cineroc 2005 since it was designed and flown in 2005.

The reason that I consider the camera the greatest payload of all time is simply because a picture is worth a 1000 words. Not only is a picture worth a 1000 words but a picture is like a time capsule, it is one of the few things that can record a moment in time so that you go back to that time and remember.

It is one of the few things that can help you share that moment with other people too.

If you want to give arial photograghy a try, check out the Snapshot(http://ApogeeRockets.com/estes_snapshot.asp) and the Oracle rockets. (http://ApogeeRockets.com/estes_oracle_video_rocket.asp)