ISSUE 135, NOV. 22, 2004

APOGEE PEAK OF FLIGHT NEWSLETTER

Feature Article

How To Make Your Own Rocket Motors

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ISSUE 135 - NOV 22, 2004

APOGEE

PEAK OF FLIGHT

How To Make Your Own Rocket Motors

By Tim Van Milligan

One of the most common email questions I get goes something like this: *"Dear Apogee. Can you tell me how to make my own rocket motors?"*

This particular question always gets me thinking about something that I consider important. So what I'd like to do in this article is to give you my opinions and feelings on this important subject. I understand if you don't agree with my assessment, but hopefully I'll get you to think about it a bit more deeply.

The Study of Rocketry

Let's begin by talking about the *Study of Rocketry*. In other words, if you were to teach someone about rocketry, what would you teach them?

When modelers (particularly those that are Level 3 high-powered certified) talk about "studying rocketry," what they almost always mean is studying *propulsion*. In other words, how do rocket motors work? This is pretty simple and short discussion, as even a rubber balloon can be used to demonstrate propulsion principles. So eventually, it leads to the discussion of chemical formulations, and how to make motors.

People that want to study propulsion seem to be discouraged right now. After the attack of 9-11, there seems to be more government involvement in our hobby of rocketry. With all the regulations and the renewed enforcement of those, the propulsion-minded people are asking questions like: *"Where will the next generation of rocketeers come from? What will they aspire to? With fewer options do we narrow our dreams?"*

I can see their point. However, I don't necessarily agree with it, nor the assumptions on which it is based.

Why Make Your Own Motors?

I lead off this article with a reason that people always give as why they want to make their own motors. They say they want to *Study Rocketry*. In other words, the educational aspects related to the science of propulsion. I mentioned this above, and we'll talk about it more later on in this article. But what are some of the other reason people give for wanting to make their own motors?

There is a perception that says home-brew motors are cheaper. We'll talk about this separately because while the materials are cheap, the process is complicated and therefore expensive. But it is a compelling reason to make your own motors if it is true, and it is why a lot of legitimate modelers are interested in the subject.

Another reason that many people want to make their own motors is because of the shipping restrictions of big motors. If you can make them yourself, you don't have to have to go through the expense and hassle of shipping motors or storage issues. Personally, I think this regulation problem needs to be addressed and solved by the government. If they don't, they'll have thousands of people across this country putting their own lives at risk, just to avoid the hassles of bureaucracy.

The fourth reason to make your own motors is psychological. It is a manly thing to do, and makes you feel like a rocketry expert. You can one-up other modelers if you can say: "I built this motor myself." Personally, I think this is the reason why most rocketeers want to build their own

Continued on Page 3

How To Make Motors

Continued From Page 2

motors, although they have a hard time admitting it. Having to admit your working to satisfy your ego is NOT a manly thing to do.

A fifth reason people may have for making their own motors is because they have a specific need for a "tailored" thrust curve. This is a legitimate reason, but it isn't a common one. There are so many different pre-manufactured motors available, that there is almost always some motor that would fit the mission objectives. And it is possible to have a company like ISP make a custom motor that is far cheaper and higher quality than making them yourself.

A final reason someone might be interested in making rocket motors is for malicious purposes. After all, since the US Military uses rockets as weapons, they must be somehow useful? While I'm strongly against using rockets for anarchist purposes, I just wanted to state the reasons people might have for making their own motors. And this is one of them. Again, we'll talk about it a little bit later.

The Downside of Making Your Own Motors

There are the obvious negative aspects of making motors. Most of all, despite what people say, making home-made rocket motors is dangerous. Enough said? Good people at major motor production facilities have gotten killed. Quest, COX, and Aerotech have all had major accidents where people have died. What makes you think you're safer than these companies?

What about the expense? One of the main reasons people have for making motors is to save money. Unfortunately, this is a myth. It is very expensive to make that first successful motor.

In a review of a book on the www.RocketReveiws.com web site about 'how-to-make-homebrew-motors,' the reviewer lists just a few of the major items needed: powder mill, scale, vacuum pump, vacuum chamber, lathe, and a thrust stand and software to see if the motors are working ok. You're already pushing $2,000 or $3,000 at this point. Plus you'll need specialized tools that you'll have to custom make: nozzle molds, case retainers, core spindles, and tamps. And you still haven't bought raw chemicals yet. Your first motors are going to be hundreds of dollars a piece. That is a waste, since you can easily buy something of higher quality for just a few dollars on the Apogee Components web site (www.ApogeeRockets.com) or a local hobby store.

There is more than just cost involved too. You'll also need the necessary government permits, and using a remote location to make the motors. Obviously, you can't make them in an apartment building. If the ATF catches you doing something that stupid, you're looking at Federal Prison time.

I mentioned before that one reason people might want to make their own motors is for military or malicious/anarchist

Continued on Page 4

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How To Make Motors

Continued From Page 3

purposes. If that is your desire, I have some bad news for you. Unguided rockets, like the ones used for hobby or educational purposes, are terrible weapons. Pretty much useless in fact. You don't believe me? Look up the facts yourself. The Palestinians have been firing home-made rockets (named Qassam rockets) at Israel for decades. Hundreds, if not thousands of them have been fired. The accuracy of the missiles has been dismal. And even if by some stroke of luck they actually hit something, the damage caused is pretty minimal. They just don't have the horse-power to carry any type of significant warhead.

http://edition.cnn.com/2002/WORLD/meast/03/05/qassam.facts/

The downside of these rockets for the Palestinians has been much worse. Whenever an attack is made, the Israelis respond with far more lethal weapons. So the attacker becomes the attacked as highly accurate artillery shells are rained down on them.

Even the large V2 Rocket used by Germans in WWII, which could carry a 1,000 pound warhead had very little impact on the war. More people died producing it than from the launching of it as a weapon. If you are going to use rockets as a weapon, the only useful one has a nuclear warhead at its tip. In that case, you're wasting your time with making small rockets. The technology doesn't scale up easily; meaning that making big rockets is quite a bit different than making little ones.

Other Negative Aspects

Here are some other considerations about making home-brew motors. And these are even more important.

Whenever someone makes motors and something goes wrong (which is far too often), there is a lot of publicity and news that is generated. For example (a true story): there was a guy here in Colorado Springs area that made rocket motors and his house blew up earlier this summer. Within days, rocketeers throughout the country had heard about it. I was getting dozens of emails from all over asking me if I knew of the person that got killed in the explosion.

Here is the point of this tragic story. Not only did the person die in the explosion, but "rocketry" as a hobby got its image tarnished too. Newscasters don't distinguish between amateur rocketry and model rocketry. To them, it is all just "model rocketry."

I take this more personally that other people. Why? Because my paycheck is tied to safe and legal rocketry. If enough incidents happen, politicians are going to take notice and start banning certain aspects of rocketry -- sound familiar? So I may lose my business because other people are doing stupid and dumb things.

I'm not the only one that loses. Everyone that enjoys rocketry is affected in the same way. The National Association of Rocketry was founded because basement bombers were giving the hobby a bad reputation. People that make motors are affecting the lives of the people that don't, because it all gets lumped together. And future generations of modelers may not ever get to experience the benefits of rocketry because of the selfish behavior of a few people. That sucks.

Educational Aspects of Studying Rocket Propulsion

While making "fire" is fun, the educational aspects of making your own motors aren't really that great. After all, in a way, it is like mixing a cake. It is that basic, and not very educational except for the concept of *following directions*. You might as well make a real cake that you can eat. It is much safer and tastier.

What about studying chemical reactions? If that was the real reason, you'd be looking at the stochiometric equations of chemicals; not looking for instructions or a recipe.

And speaking of formulations, theoretically there is only so much thrust you're going to get out of chemical reactions. To me, it seems somewhat silly to recreate the

Continued on Page 5

How To Make Motors

Continued From Page 4

same dangerous experiments someone has done decades ago in the name of education. You're not going to learn anything that you couldn't have learned by reading about it in a book. Everything else is pyrotechnics, like changing flame color.

If you are generally interested in the chemical reactions of propellants, go to a university. I would recommend the ones that I went to: Embry-Riddle Aeronautical University, and Florida Institute of Technology. Or there are many other great educational institutions you can go to. And they'll teach you the most current formulations available.

To be blunt about it, if you want to make fire, join a fireworks pyrotechnics guild. Leave rocketry out of it for the benefit of people that want to pass this hobby along to a new generation of modelers.

To Space and Beyond...

There is another myth that propellant-producing modelers buy into. They believe that if they tinker just a bit more they'll fall upon a formulation or a methodology that will allow them to make inexpensive motors. In other words, they'll be able to build spaceships that will take mankind into orbit and beyond. More than that, it will be as cheap as buying an airline ticket.

I've even seen big companies with deep pockets fall buy into this myth. For example, Beal Aerospace built huge booster rockets and spent millions of dollars chasing the myth. They never left the ground. And I also think of how many different programs and how much money the Air Force and NASA have wasted trying to build "Big-Dumb-Boosters." It is a tax-payer travesty.

Two Sides Of the Same Coin

Returning to my original question: *If you were to teach someone about rocketry, what would you teach them?*

I know I'm personally in the minority. But when I think about studying rocketry, I think about studying *Aerodynamics*. How objects and vehicles move through the air. What I'm saying is that there are two sides of the rocketry coin: *Propulsion* and *Aerodynamics*. Both sides are important. But I believe the aerodynamics side is more important of the two.

When it comes to studying aerodynamics, there is never an end to the usefulness of rocketry as an educational tool. As I've been saying for years, nothing motivates students like rocketry. It can be used to teach highly useful and practical topics with phenomenal results.

Even from a modeler's perspective, there are an endless number of designs one might create. There is always something new to try: gliders, helicopters, landers,

etc. If you think you've done it all, I'm saying to myself: "You aren't a very innovative or creative person." There is always something new I'd like to try with a small rocket.

Someone once asked me why I don't fly that much high-power rocketry. Because I'm still not even close to trying all the different possible combinations that are possible with smaller (i.e., cheaper) rockets. There are plenty of safe and politically correct dreams to aspire to without having to step up to bigger and more expensive rockets. And they're all fun, and worthy of exploring.

Why do I believe aerodynamics is more important than propulsion? That is a great question. To answer it, I have to ask myself another: *"Which (airframe or propulsion) has the better chance of getting man into space faster and cheaper?"*

Surely you know the answer to this one... There was a contest to get into space faster/cheaper called the X-Prize.

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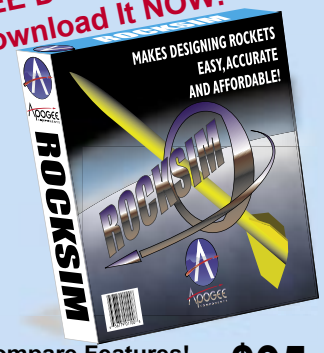

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How To Make Motors

Continued From Page 5

Scaled Composites' SpaceShipOne (foreground, top picture) and its drop-ship the White Knight (background, top picture). The bottom image shows SpaceShipOne and the White Knight together. CREDIT: Scaled Composites

The winner of course, was Burt Rutan: who used radical shapes and airframes. Not only are his vehicles cool to look at, they are radical in how they work.

Burt didn't spend too much time working on building rocket motors. In fact, he outsourced the propulsion aspect to the lowest bidder. Why? Because concentrating on it would just be like re-inventing the wheel. He's smart enough to realize that the most important part was the airframe and the aerodynamics.

The other x-prize contestants all focused on low-cost propulsion. They are still to have their first attempt into space, let alone trying to man-rate their vehicles. They lost before they even started, because they focused on the wrong thing.

Conclusion

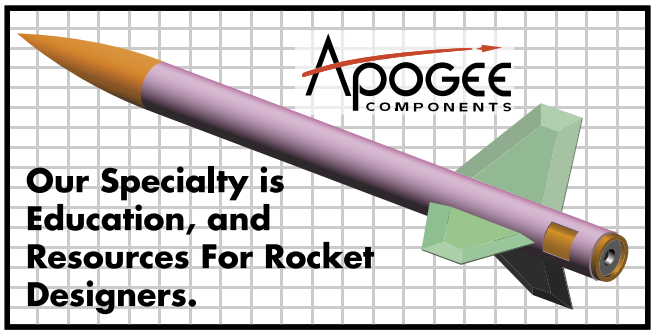
This article started with a common question: "Can you tell me how to make my own rocket motors?" The answer to that question of course, is "NO." If you don't see that aerodynamics is the more important aspect of rocketry to study, I can only assume you have evil intentions, or that you aren't even smart enough to make motors legally and safely.

I probably stepped on a few people's toes by writing this article. As you can tell, I don't think amateur rocketry is all that it is cracked up to be. While it is fun to walk in the footsteps of pioneers like Von Braun and Goddard, the amateur rocket motor builders are still following, not leading.

G. Harry Stine must have come to the same conclusion, which is why he founded the National Association of Rocketry. Its original mission was to promote the safer and more valuable aspects of the hobby -- aerodynamics instead of propulsion. It saddens me that we're still fighting the same battle more than 40 years later.

But as I said in the beginning, I am writing this article to get people to think about the subject, even though I doubt I've changed anyone's mind.

About The Author:

Tim Van Milligan has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward a 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 the curator of the rocketry education web site: http://www.apogeerockets.com/education. He is also the author of the books: *"Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics"* and publisher of the FREE e-zine newsletter about model rockets. You can subscribe to the e-zine at the Apogee Components web site, or sending an email to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject line of the message.

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