The COS-Rocketeer

The Bi-Monthly Newsletter of the Colorado Springs Rocket Society

Volume 10, Number 1 January/February 1999

NEW CLUB OFFICERS ELECTED

The 1999 Officers and Committee Heads were elected at the December meeting. The following results of those elections are described below, and for an interesting twist, I've listed the history of each position. Note that COSROCS' first official meeting was held on the 20th of March in 1989 – marking the formation of the club.

President: By unanimous acclaim Neil Kinney was nominated and elected the club's fifth President. Our first president was Randy Cohen, one of the founders of the club. Mark Jilson, Ben Hays, and Steven Hackett followed Randy in turn. I am saddened to see Steve leave the area, as he was one of a fine line of Presidents who added their interests and unique twists to the club's history. Thanks for the fine leadership and the tremendous growth! I want to personally congratulate Neil on this new responsibility – I am looking forward to his leadership, friendship, and love of this hobby!

Vice-President: Two nominations (Tom Dembowski and David Thompson) were voiced for this position. Dave garnered 10 votes over Tom's 4 and became the club's fifth Vice-President. Junior Todd Schneider (at least he was junior at the time!!) was the club's first vice-president, followed by Nate Goebel, Jeff Proffitt, and Tom Dembowski.

Secretary: By unanimous acclaim Tom Dembowski became the club's second secretary. David Nauer previously held this post from the very start of the club. This is perhaps the most time demanding position in the club, one Tom is well suited for. I look forward to helping Tom become the leading "scribes" of the club!

Treasurer: By unanimous acclaim Dagmar Thompson became the club's second treasurer. David Nauer previously held this post from the very start of the club. Dagmar has already proposed several improvements to this position, and will take the anachronistic system I've used from the start and bring us into the 90's (about time!) – welcome to another time consuming and central position in the club!

Senior Advisor: By unanimous acclaim Warren Layfield continued as the club's Senior Advisor. Warren has been the club's Senior Advisor for all but one year when Ben Hays acted in that role. Warren was the club's first Senior Advisor.

Launch Operations Committee: By unanimous acclaim Warren Layfield continued as the club's head of the Launch Operations Committee. Warren held this position for all but the first year of the club when David Nauer held this post.

Contests and Records Committee: By unanimous acclaim David Nauer continued as the club's head of the Contests and Records Committee. Dave has been in this position for all but the first year of the club when Todd Schneider held the post.

Club Activities Committee: Three nominations for head of this committee were voted upon. Sherri Day, Nadine Kinney, and Frank Bittinger represented the most interest ever in this committee position. By a large margin Sherri Day was elected to head this committee. In past years Warren Layfield, Mark Jilson, Mike Frazier, and Frank Bittinger have held this post.

Member At Large: This interesting position was always in the club's by-laws, but was not filled until the second year of operation when someone (OK, OK, OK, it was me!) read the by-laws and determined that we needed to fill this position. For many years Debbie Moller ruled in this slot, followed by Ron Krenzin, Jens Moller, and Stan Huyge. Steve Hackett wanted to remain active in COSROCS even from afar; Steve was elected unanimously to the post of Member At Large.

COS-Rocketeer Newsletter Editor: Dagmar Thompson became only the fourth editor of our club's newsletter – the COS-Rocketeer. In the early days of the club the news "note" was called The COSROCS Report, but a more formal quarterly newsletter was created for the Spring 1990 edition. This new newsletter, the COS-Rocketeer, became bi-monthly in 1991, and never missed an edition until this year. Past editors included David Nauer, Jens Moller, and Stan Huyge. Welcome Dagmar to a most challenging position!

Club Librarian: This relatively new position was initially held by Ron Krenzin, followed by Nate Goebel and Stan Huyge. By unanimous acclaim Nate Coit became the club's fourth club librarian. Uh, Nate, do you still have that Hartsel Saturn-1B tape in the archives??

WEB Master: A new position was created and filled this year. The position is called WEB Master. Tim Day was elected unanimously.

By Dave Nauer

WHAT'S NEW...

With the New Year come some changes to the COSROCS. The most significant change is the new club logo. The design was provided by our Web Master, Tim Day. In January's club business meeting, the new logo was voted on and accepted.

At the meeting, it was also decided that it might been time for COSROCS to get it's own address. COSROCS now has an address – a P.O. Box. The address is:

COSROCS
P.O. Box 15896
Colorado Springs, CO 80935-5896

The new president, Neil Kinney thought it might be time for COSROCS to acquire a phone number. This number is (719) 575-0060. Since the phone is at the Kinney resident, it will be easier for members to stay in touch.

The final change is will affect the membership's pocket. The membership dues change effective April 1st. The new rate will be $20 per year. Everyone will receive a renewal notice in March with dues due in April. $20 will cover both the family and single over 17. The "junior" membership stayed a $5. The membership type is designed for young people whose parents do not participate in the club.

By Dagmar Thompson

DAVE'S RANGE BOX

NEW MEMBERS JOIN – Two membership applications turned up after being filed for some time – we've ensured these new members have extended memberships through the end of next year – and hope they continue to come out to our launches!

The Fredrich Family – Mike, Tami, Robert, and Logan – have been involved in rocketry for three years. Robert attends Eagleview Middle School in School District 20. Their goal is to learn more about rocketry and meet people who share our interests. Those interests include large rockets, high-powered rocketry, and multi-staged rockets. Welcome!

Pete Glesser joined the club as a new comer to the hobby. His interest is in sport rockets, and includes high-powered rockets. He joined COSROCS for one simple reason: FUN!

MINI-CONTESTS PLANNED FOR THE WINTER – Our club hosts mini-contests at each of our sports launches. Since December was a "no fly" day, I've decided to reschedule our December contest to March – and give it a try again. We selected the following mini-contests through the March sports launch:

January	Winterfest VIII
February	"Any Impulse Streamer Duration"
March	Ping-Pong Ball Spot Landing

If you have any questions on the rules, please ask Dave Nauer! Ping-Pong Ball spot landing is simple – use any impulse engine allowed at our site and launch a rocket which will eject a ping-pong ball. You must land your ping-pong ball as close as possible to a stake – closest wins! You can fly as many flights as you desire!

"Any impulse streamer duration" is wide open – YOU choose the engine. YOU choose your rocket. YOU choose your streamer. Design it however YOU want. The engine and rocket must meet NAR and our club's safety standards, and you must meet our site requirements for weight and impulse. You can fly as many flights as you want, but only a single time will count and the longest time RETURNED to the site wins! If you lose the rocket that flight doesn't count, or if the rocket separates or has an unsafe flight it will be disqualified. If you beat an existing COSROCS record in the chosen impulse class (for example, you fly a "D" Streamer rocket and beat the club record for "D" Streamer) your flight will become that record!

Plan For The First Tripoli Launch of the Year – Right now it looks like the first CO Tripoli Launch of the Year will be scheduled for April 24th starting at 8:00AM. Circle your calendars! For a tentative date, TRA-CO is planning an experimental launch on Sunday 27 June at 8am – their "normal" Saturday launch

FLY HIGH – FLY SAFE!

By David J. Nauer

LAUNCH CALENDAR

13 January – COSROCS Business Meeting, 7:00PM, Gold Hill Police Station

16 January – Possible Ellicott Sports Launch – check with COSROCS president before attending

16 January – CRASH Sports Launch, 10:00AM Bear Creek Lake Park, Denver

30 January – Tripoli Colorado meeting, 10:00AM Castlewood Library, Denver

6 February – COSROCS Sports Launch – Stetson Launch Site, 9:00AM, Mini-Sports Launch: Any-Impulse Streamer Duration

7 February – CRASH Sports Launch, 1:00PM Bear Creek Lake Park, Denver

10 February - COSROCS Business Meeting, 7:00PM, Gold Hill Police Station

20 February – Possible Ellicott Sports Launch – check with COSROCS president before attending

20 February – CRASH Sports Launch, 10:00AM Bear Creek Lake Park, Denver

27 February – Tripoli Colorado meeting, 10:00AM Castlewood Library, Denver

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Winterfest VIII Results

The Colorado Springs Rocket Society's (COSRCOS) ninth winter contest reflected typical Colorado weather and Colorado winter contests. The temperature started at 13 degrees F and increased through the day to a balmy 20 degrees. The skies were mainly clear with early bright sunlight and no wind in the early morning. Unfortunately winds increased steadily throughout the morning, making the final afternoon flights particularly challenging. Eight contestants joined the fun, and numerous sports launches ranging from A through G impulse were flown.

- F Helicopter Duration

A much-awaited event, F Helicopter challenges engineering skills and consistency, especially on a morning where rubber bands lost their elasticity due to the extreme cold. Bruce Markielewski had the best flight of the day on an Apogee F10, but was unable to find his model due to extreme weather cocking and a long burn. David Nauer won this event with the second best flight of the day (but the best-found flight of the day) using his old F Helicopter model from NARAM 34. His time of 74s set a new COSROCS record. Todd Williams flew the only other qualified flight, exiting spectators with a spectacular curving flight. The converted Estes Skywinders didn't fare well as all were successfully boosted, but none safely deployed their rotors and most crashed

Name	Time #1	Time #2	Total	Points (Division – NAR Section #)
1. David Nauer	1:16	--	74	520(C – 515)
2. Todd Williams	0:43	--	43	312(C – 482)
3. Bruce Markielewski	NR	--	FP	52(C – 482)
Nathan Coit	Separation	--	DQ	0(C – 515)
Neil Kinney	Crash	--	DQ	0(C – 515)
Greg Elder	Crash	--	DQ	0(C – 515)

- 1/4A Parachute Duration

Six entries resulted in six qualified times, but this deceptively difficult event challenged each competitor. The winds were starting up before the first flight was flown, but thermals could be found even on flights that barely cleared 150 feet before ejection. Colorado's newest B Division competitor strutted his stuff by beating all of the C Division entries by almost double with his single flight. Paul Gray managed a new COSROCS B division record with an 84s flight despite the extreme cold and winds. David Nauer took second, barely beating Melvin Gray, Paul's father, by 4 seconds. Bruce Markielewski followed up with fourth place.

Name	Time #1	Time #2	Total	Points (Division – NAR Section #)
1. Paul Gray	1:24	--	84	140(B – 482)
2. David Nauer	DQ	0:45	45	84(C – 515)
3. Melvin Gray	0:41	--	41	56(C – 482)
4. Bruce Markielewski	0:35	--	35	28(C – 482)
5. Greg Elder	DQ	0:14	14	14(C – 515)
6. Todd Williams	0:10	--	10	14(C – 482)

- D Dual Egglofting Duration

Dual egglofting is always challenging – the extra weight of two eggs can short-circuit even the most carefully planned flights. Although we had no separated egg capsules, there were a few shredded parachutes, and several egg capsules that left the body tube at burnout rather than at ejection. The results were predicable – Seven attempts with three successful flights. Most disappointing were the broken eggs suffered by Nathan Coit, Neil Kinney, and Bruce Markielewski who had fine flights but broken shell syndrome. First place was captured by COSROCS' best NAR competitor last year – Greg Elder – with a fine flight of 91s. Todd Williams, the Colorado Rocketry Association of Space Hobbyists' (CRASH) president, had a fine 25s flight in the winds to grab second. David Nauer followed with a nylon parachute flight to minimize the effects of wind and weight to take third.

Name	Time #1	Time #2	Total	Points (Division – NAR Section #)
1. Greg Elder	1:31	--	91	540(C –515)
2. Todd Williams	0:25	--	25	324(C –482)
3. David Nauer	0:19	--	19	216(C – 515)
Nathan Coit	DQ	DQ	DQ	0(C –515)
Neil Kinney	DQ	--	DQ	0(C – 515)
Bruce Markielewski	DQ	--	DQ	0(C – 482)

The cold and wind took their toll on the competitors as few second flights were attempted. In particular, Bruce Markielewski decided to pack it in despite the potential to refly D Dual Eggloft and 1/4A Parachute. The feedback was positive, albeit spoken through frozen lips, and ended with a nice meal at the nearest Colorado Springs Boston Market. My thanks to the hardy competitors who once again proved that cold weather is **not** a reason to stay home!

The final results demonstrated the importance of qualifying in the high weighting factor flights. Only David Nauer and Todd Williams successfully flew qualified flights in the three events, and Dave took this year's championship followed closely by Todd. Greg Elder finished third despite a DQ in Helicopter, while B Division competitor Paul Gray took fourth in the C Division competition. Bruce Markielewski, Melvin Gray, Neil Kinney, and Nathan Coit brought up the remainder of the competitors.

Name	F Heli-copter	1/4A Para-chute	D Dual Egg Dur	Total NAR Pts
1. David Nauer	520	84	216	820
2. Todd Williams	312	14	324	650
3. Greg Elder	DQ	14	540	554
4. Paul Gray	X	140	X	140
5. Bruce Markielewski	52	28	DQ	80
6. Melvin Gray	X	56	X	56
7. Nathan Coit	DQ	X	DQ	0
7. Neil Kinney	DQ	X	DQ	0

For the club competition COSROCS accumulated 1,374 points over CRASH's 926 points and took the club championship.

By David J. Nauer

ESTES SATURN V

One of the "Holy Grails" of model rocketry is available once again. Estes has released a new version of its 1/100th scale Saturn V model. Hobbyists have been clamoring for this kit since Estes last produced a Saturn V kit in 1994. This new version of the classic Saturn V combines elements of the previous Estes version, along with components from the old Centuri Saturn V model rocket.

For those that enjoy building challenging rockets, this skill level 4 kit is a treat. It consists of various sized body tubes (BT-50, BT-58, BT-80, and BT-101), die cut cardboard components, vacuum formed plastic parts, molded plastic pieces, and wooden strips. Because of the different components used in the Saturn V, a variety of glues are required during construction (wood glue, plastic cement, spray adhesive, and CA). In addition, putty must be used to fill and smooth any seams.

I found the fifteen pages of illustrated instructions easy to follow. The motor mount/stuffer tube consists of a long length of BT-50 tubing that is mounted with three centering rings inside the BT-101 main body tube. A traditional engine hook is used for motor retention. The motor mount assembly is recessed about 3 3/8" inside the rear of the BT-101.

The Saturn V third stage section and Lunar Module/Service Module (LM/SM) section are assembled next. The construction of each section is very similar. Couplers are constructed to fit at the end of the appropriate body tubes (BT-80 and BT-58). Then, shrouds are formed from card stock to fit over the body tubes and attach to the top of each coupler.

One aspect from the old Centuri Saturn V model present in this kit, is that the body wraps are vacuum formed plastic, rather than paper. The wraps must be carefully cut from the plastic sheets and then glued at the correct locations onto the various body tubes. I used 3M spray adhesive for attaching the wraps. This worked fairly well and I was able to reposition wraps as needed before the adhesive fully dried. The ends of a couple of wraps did come unglued after a day. I remedied this problem by using medium CA to glue down those ends. The fins and fairings are also vacuum formed plastic. The instructions recommend using liquid plastic cement for these parts. I used medium CA instead, which seemed to work quite well. I believe, however, that the plastic fins will probably not hold up to any type of direct, hard landing.

The Apollo capsule and escape tower are formed from molded plastic parts. Plastic model cement works quite well for these pieces. Some of these parts are small and you may need to use a pair of tweezers during assembly. Since the escape tower is a fragile piece, you have the option of not gluing it to the capsule. This way you can remove it before flight.

A removable unit for the Saturn V main engine nozzles is also assembled from molded plastic parts. The five engine nozzles attach to a bulkhead which has a spacer tube glued to the top. This unit then slides into the rear of the rocket for display. It must, of course, be removed for flying the Saturn V.

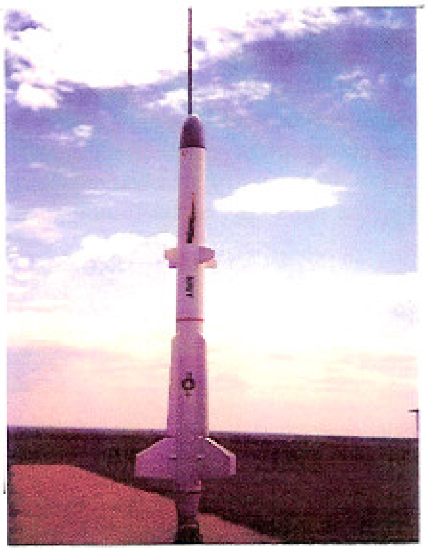
Wooden strips are used to finish the detailing of the rocket. Specifically, strips are used to connect and continue the tunnels between the body wraps. Cut the wooden strips as precise as possible, in order to minimize any gaps between the wooden strips and the tunnels on the wraps.

Two 1/4" diameter launch lugs are used with this kit. The previous version of the Estes Saturn V used 3/16" launch lugs. For recovery, two 24" preassembled plastic parachutes are used with the main body section. An 18" parachute is used to recover the third stage and LM/SM section has a single unit. A harness arrangement is built for this unit so that it returns to earth horizontally, thus protecting the capsule.

A two-page painting guide is included with the instructions, showing the appropriate paint scheme for all sides of the Saturn V. With all the masking required, painting realistic patterns on the rocket is probably one of the more difficult tasks to accomplish. Some of the tunnels and details on the wraps have to be masked to remain white, while the rest of the wrap is painted black. Water transfer decals are provided to finish out the model.

While the Saturn V is a challenging rocket to build, I did not find it as difficult as I thought it might be when I first looked at all the parts. Be sure to read the instructions carefully, to understand exactly what is involved with each step before you do it. I did have many seams that had to be filled with putty. The body wraps do not quite fit all the way around the tubes. I had about a 1/16" gap between the end of each wrap. You will have some left over parts when finished (the instructions state so). Since this kit combines parts from the original Estes and Centuri kits, you end up with some pieces that are not needed.

The only recommended motor for the Saturn V is the D12-3. The projected altitude is 175 feet. I have not flown my Saturn V yet. (I'm still waiting for the perfect flying conditions.) I have seen previous Estes Saturn V rockets fly on D12-3's. Those flights have usually been heart-stoppers, as you hold your breath waiting for parachute deployment after the low altitude launch. (Hint, build this rocket as light as possible.)



I highly recommend this kit. It is a great looking rocket when finished, which you can use as a display model if you do not want to fly it. I have heard that this new version of the Saturn V has a limited production run, so it may not be around in quantities. Perhaps if this kit is a "hot" seller for Estes, they will re-release some of their other classic kits, like the Mars Lander, Orbital Transport, and others. We can only hope.

By Greg Elder

Where the Rocket Scientist Shops

Several people have been mentioning some really great stores that are trying to cater to the rocket hobbyist. One of those stores most of us have visited is Hobbytown USA located near the Westminister Mall. Dave and I were talking and he wrote a quick note on how to get there. I realize the most of the avid rocketeers have already been there, but for everyone else....

By now I know most of you may have heard about the hobby shop in Denver. It's a Hobbytown USA. It is located at 6975 West 88th Avenue. Take I-23 to the Boulder Turnpike, get off at 88th Avenue and go west past the Westminister Mall. About go about two miles, you will see the Hobbytown USA in the strip mall. This shop has an immense selection of LOC/Precision tubing, couplers, nosecones, centering rings, adapters, chutes, PML kits, PML tubing, couplers, nosecones, and Estes kits and parts. All tubing and ring range in size down from 5.5" and motor sizes include 54 mm, 38mm and 29 mm. They also, have motors – F101's, G55's and K's. They give a 20% discount to members of a club, especially Colorado Tripoli members. I went there a couple of months ago and spent almost $300. According to Steve Hackett, they restock every Tuesday. So if you happen to up there after Greg, Neil, or myself wait a week and they'll have restocked. It's a great shop and a great way to spend a day with your significant other!

While Terri and Frank Bittinger were out doing Christmas shopping, they came across a shop located in Monument. The shop is called Monumental Toys. The address and phone number is:

274 Washington Street
Monument, CO 80132
(719) 481-1361

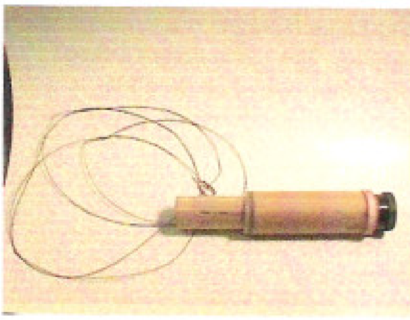
The owners are Betty Johnson and Gayle Wade. They stock Estes, but are willing to do special orders. They are just discovering rocketery. With the right encouragement…

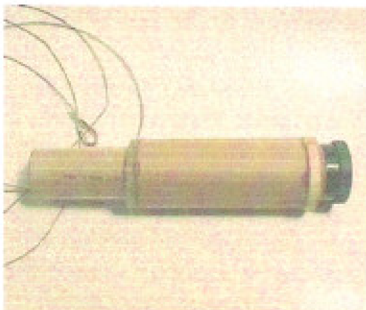
54MM TO 38MM MOTOR TUBE ADAPTER

This all started at LDRS 17, when I purchased two kits. I asked for a 38mm Vaughn Brothers King Blobbo and a 38mm Binder Design Raptor (A.K.A. Cobra). Upon arriving home, I discovered they were 54mm motors. I went to the Hobbytown in Westminister and purchased a 54mm to 38mm adapter. This adapter came with two tubes and 2 plywood rings. A very sturdy design. In order to make it a quik change unit, I wrapped 1/32nd inch thick by ½" plywood around the base of the 54mm tube. This plywood was epoxied and then soaked with thin CA. This forms the stop ring when inserted in the motor tube of the rocket. I used a 38mm Aeropak Retainer on the 38mm motor tube of the adapter. I love these retainers; they glue onto the motor tube and have a screw on retainer ring. These accept reloadable motor system casing.

After seeing some reloadable casings separate from the rocket! I have installed a safety cable from the 38mm tube of the adapter that will attach to the shock cord/parachute inside the rocket. Casing are to expensive to lose and too hard to find in the field, unless your at the Salt Flat or some other flat unobstructed area.

I can change adapter/motors in the rocket in a manor of a couple of minutes, not counting the time to build a motor. But, if you more than one casing you can have several motors built/ready to fly. I can use the same rocket repeatedly by just packing the chute, inserting "binder dust", and inserting motor. It actually takes more time to fill out the launch card than to prep the rocket.





The safety cable I use is a recycled 1/16" thick 27 strand of stainless steel wire from the scanner system of copy machines. I worked on copiers for a number of years, saved these cables for use on R/C airplanes and boats. Yes, I do R/C airplanes and boats; but that's another story! Anyway, these cables have been used in more than half my rocket. They are flame proof, flexible, and *&%$# strong. Have not had a failure, yet! I used nothing but this cable on my THOY Phoenix with a J350 and it has never failed. I only hope its strength and mounting on the adapter is never tested. Well, time to get back to my projects! So many rockets to build so little time! Work just get in the way!

By Dave Thompson

AN EXPLANATION OF ROCKET MOTOR NAMING

At a recent demonstration for a Boy Scout troop, I was asked to explain what all the letters and numbers on a rocket motor meant. When I was that age I didn't understand either. I just used the recommended motors. That's actually good advice, but understanding why a certain motor is recommended over another adds to the enjoyment. It's also a necessity when scratch building a rocket, or progressing into mid and high power. Motor manufacturers publish a lot of information about their motors such as thrust duration, total impulse, max liftoff weight, thrust curves, etc., but what does it all mean? What is an A8-3 or an H128W-M? The name tells you a lot about the motor, but there's more.

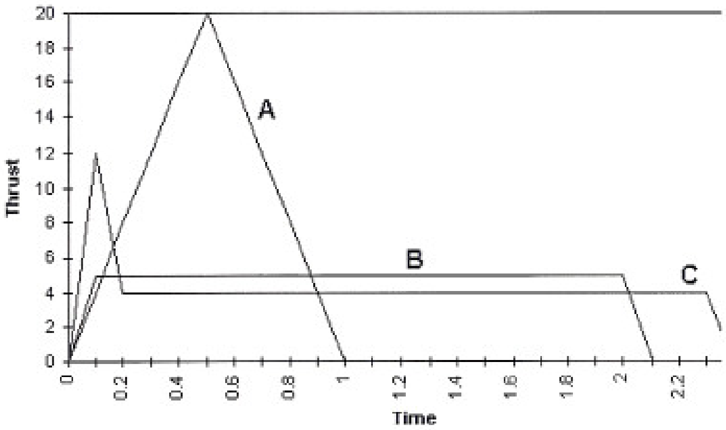
I'll start by explaining the terms. I know this is the boring part so I'll keep it short. The thrust or push of a rocket motor at any given instant can be measured in pounds or newtons. 1 newton is equal to 0.225 pounds. I'll use newtons in this discussion for reasons that will become clear later on. (Hint: It's easier.) Impulse is another term you'll need to know, which is defined as thrust*time. The "*" symbol means multiplication for all you non-programmer types. The total impulse of a motor is measured in newton-seconds (ns) which is defined as 1 newton of thrust for 1 second.. That's all there is. At any particular point in time, the thrust can be measured in newtons. The total impulse generated by a motor during the entire time it's burning is measured in newton-seconds (ns).

The first part of a motor designation is a letter of the alphabet used to classify a motor based on its total impulse. From our term definitions above, we know that it would be measured in newton-seconds, but how do we get that out of a letter? Each letter of the alphabet indicates twice the power of the previous letter. For example, a C has twice the power of a B, which has twice the power of an A. Motors smaller than an A have a fraction placed before the A such as 1/2A or 1/4A. Each letter actually covers a range of values as you can see in the table below. The Estes model rocket motors all come in at the top of their ranges so a C is fully twice as powerful as a B, etc. When you get into the mid and high powered motors, where the range of each class becomes very wide, you will find that the letter doesn't tell the whole story. The terms "baby", "half" and "full" are sometimes used to describe where a high power rocket (HPR) motor fits into its range. The motor manufacturers publish the total impulse for each of their motors, which you will have to check to determine the true power of a motor, but the letter gives you a general idea. Here's the table, up to the H range, the smallest of the motors considered to be high power.

1.25<	A	<=	2.5
2.5	< B	<=	5
5	< C	<=	10
10	< D	<=	20
20	< E	<=	40

40	< F	<=	80
80	< G	<=	160
160	< H	<=	320

The second part of the motor designation is a number indicating the average thrust in newtons. Higher values generally mean the motor pushes harder while it is burning, but that it will burn for a shorter period of time. Let's invent some imaginary motors (C5, C10, C20) to see how they compare. Our motors are full C's, so they all have 10 ns total impulse. Warning! Math ahead! But it's easy. Remember from above that ns=newtons*seconds, or to turn the equation around, seconds=ns/newtons. Our C5 will push with 5 newtons for two seconds (10 ns / 5 newtons = 2 seconds). Our C10 will push with 10 newtons for 1 second (10 ns / 10 newtons = 1 second). Our C20 will push with 20 newtons for half a second (10 ns / 20 newtons = 0.5 seconds). From that you can see that the cost of a harder push is a shorter burn time. The higher average thrust of the C10 or C20 may give them a better chance of lifting a heavy rocket than the C5, but the shorter burn times means it still won't go very high. What if we increased the burn time? OK, lets go with 20 newtons for 2 seconds. Now we can lift that heavy rocket way up there, but wait! 20 newtons * 2 seconds = 40 ns. That's an E20! I guess it's true, you can't get something for nothing. Now I'll throw you a little curve (pun intended). Notice that I said average thrust at the start of this paragraph. Real motors don't burn at a fixed thrust. At the very least, they ramp up at the start and/or sputter out at the end. Manufacturers publish thrust curves to accurately describe the specifics of their motors. Thrust curves are generated by hooking a rocket motor up to a device that's technically not much more than a sophisticated bathroom scale. It continuously measures and records how hard the motor is pushing during its burn time. Averaging all those measurements gives the average thrust that we've been talking about. Plotting the measurements gives a thrust curve. I've included a chart with several imaginary motors below. Time progresses from left to right. You can see how hard the motor is pushing at any point in time by checking how high it's curve is at that point. All 3 motors would be in the C class with 10 ns of total impulse. Motor A, steadily builds up thrust to a peak, then drops off just as steadily. It would be rated a C10. Motor B burns at a pretty constant rate throughout. It would be rated a C5. Motor C has an initial thrust spike, but then settles back into a low thrust mode. It would be rated a C4. That spike is common on many motors and helps to get the rocket moving off the pad. Based on it's name, the C10 (A) would seem to be a good choice for a heavy rocket but the slow ramp up might not get it moving fast enough to become stable. The C5 (B) is actually less stressful than the C4 (C), and might be a better choice for a light glider. Again, the name doesn't tell the whole story. If I've got you worried now, don't be. Most low and mid powered motors are similar to Motor C, although the mid-powered tend to have a more gradual drop off from the spike. There are a few type B motors in the mid power range. The small Estes motors are similar to A only because they run out of propellant after the spike.



The final part of the motor designation is the delay time. It can be either an actual number, or a letter such as S, M, L meaning Short, Medium, Long, which equate to about 5, 10, 15 seconds. The delay time is the number of seconds that elapse between when the thrust stops and when the ejection charge activates. It is also referred to as coast time. The ejection charge is used to deploy the recovery system. Model rocket motors with a 0 delay are lower stage motors. They have no delay or ejection charge. When the propellant is just about gone, the pressure breaks through the thin crust of remaining propellant at the top of the motor, which sends hot particles into the nozzle of the motor in the stage above. This will (hopefully) light that motor and staging is accomplished. There are no high power staging motors. Electronics must be used to light upper stages in HPR. Many high power rockets also use electronics instead of the motor delay and ejection to deploy the recovery system. Some common electronics are timers which simply count, barometric pressure sensors which detect altitude changes, accelerometers which detect motion changes and remote control (RC) which is sometimes used as a manual backup.

You will sometimes see a suffix on the average thrust or delay number. Estes uses a T suffix on the delay for their 13mm motors. Estes made a short 18mm motor many years ago and it had a suffix of S. I'm not sure, but T does follow S and the T engines did replace the S engines. Makes sense doesn't it! Aerotech uses a suffix of W, T, J, and FWL to indicate propellant types of White Lightning, Blue Thunder, Black Jack or Fast White Lightning. Manufacturers use different propellant types and shapes of the propellant grain(s) to achieve the different burn rates and thrust curves. But that's another article.

Manufacturers often list a maximum liftoff weight for a motor. It is a combination of all the factors we covered above. Bigger motors can of course lift bigger rockets. Motors with longer delays will have a lower liftoff weight because bigger rockets don't go as high or coast as long. Manufacturers also provide a lot of other information about their motors. Much of what I covered above is available in the manufacturer's catalogs. If you want to use a motor that is not recommended for your rocket, check the motor's specs. You may be able to figure out why you shouldn't use it, or that it will work just fine. But if you don't know what you're doing, trust the recommended engine list. Your rocket will live to fly again.

To sum it all up, the letter indicates the total power of the motor. The number immediately following the letter tells you if the motor pushes hard for a short time, or soft for a long time (but you need to see the thrust curve for the details). The number after the dash is the delay time between motor burnout and recovery system ejection. I hope this has explained away the mystery of naming rocket motors.

By Mark James

NOTES FROM THE EDITOR

I wanted to take the time to thank everyone who provided input into this quarter's newsletter. It is always an adventure pulling it together.

Everyone has been asking for a drop-dead date for each newsletter. The next newsletter will be published and available for the Stetson Hills launch in April. This would put the drop-dead date a March 15th. If you miss the dead line, your article will get put in the next quarter. Please include pictures, they add color and attract interest. If you can't provide a picture as a file, I do have a color scanner. Once I have scanned the picture for the newsletter, I will return the picture the owner. I do ask that you put your name on the back.

The more people who submit articles, the more interesting and diverse our newsletter will become, so please keep writing.

Dagmar Thompson
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Understanding Rocket Simulations
Part 1 — The Rocket Thrust Curve

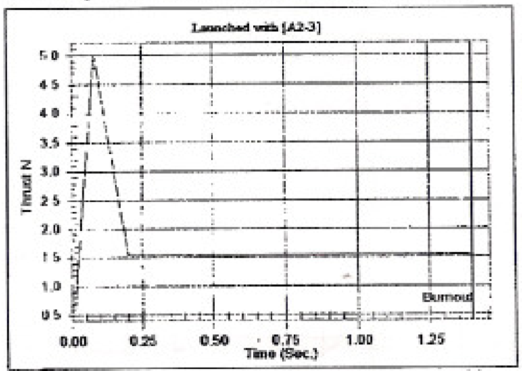
By Tim Van Milligan
email: tvm@apogeerockets.com

When most people use computerized rocket simulations, they do so to find out only two things: how high and how fast their rocket will fly. While these things are important to know, there is so much more information available to the modeler. In this series of articles, I'll try to show you what information can be extracted from computer simulations, and what practical use it has — meaning; how we can use the information to make better rockets and more successful flights!

It is hoped that the reader is interested in learning more about their rockets; as I believe it makes the hobby safer. But using "computer simulations" is also a fun way to enjoy rocketry. I have found from conversations with other modelers that playing with simulations is as fun as playing a computer game. Better yet, it is educational at the same time, so you are never wasting time!

When you perform rocket simulations when using a computer, you are given the option to display a lot of different graphs. The "big three" are *Velocity, Acceleration* and *Altitude*. Some of the others that you can print out are: "Thrust", "Drag," "Momentum," and "Range." In this series of articles, I'll try to show you how to interpret some of these graphs, and how to use the information to make your next launch more successful.

Let's start with the "Thrust Curve," which is shown in Simulation #1. This graph is a printout of the thrust-vs-time curve for your rocket motors. At first glance, when you



Simulation #1: Thrust curve plot that is generated by a rocketry simulation program.

display a thrust curve on a computer, it may look different from the thrust curve graphs supplied by the motor manufacturer. But this is probably a result of the scales of the display. Typically, the vertical — "thrust force" — axis, is proportionally taller than you are accustomed to seeing. Or the time scale may have been compressed. That withstanding, this graph has the same information as those you've seen printed on paper.

Thrust curves, like all the graphs, are read from left to right. The bottom, left-hand corner is the zero-zero point (zero thrust at time zero). As you trace along the curve, if the line goes upward to the right, the thrust of the motor is increasing; and if it falling downward, it is decreasing. If the curve flattens out, the thrust is constant during that portion. This is pretty simple.

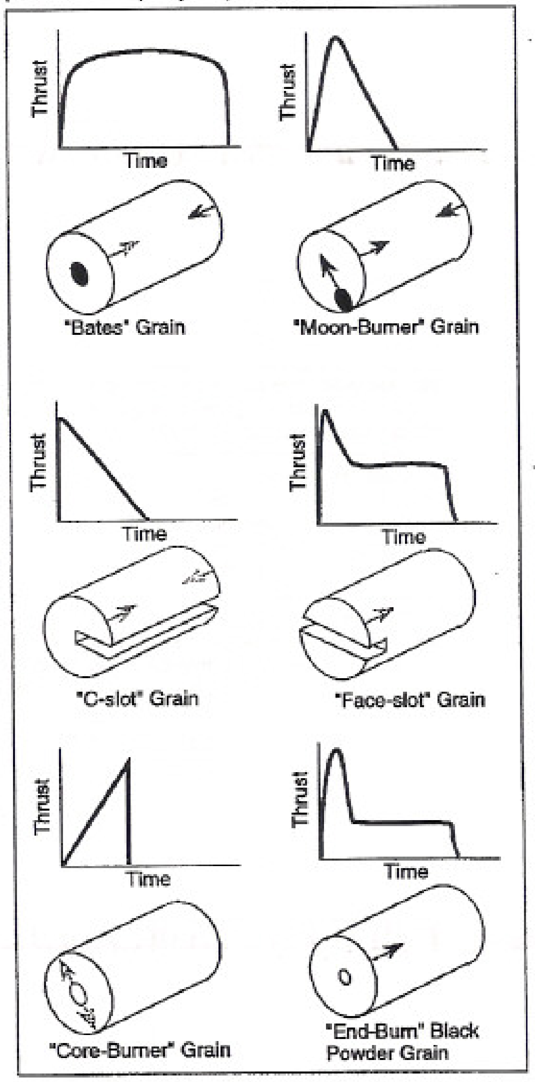
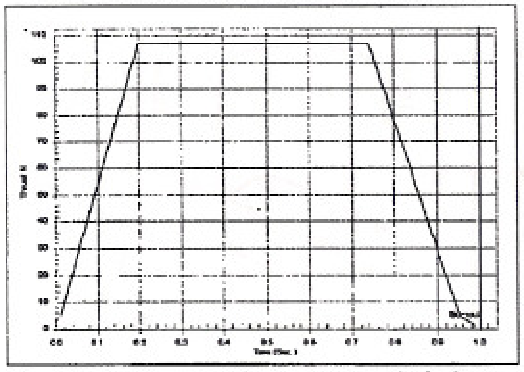


Figure 1: The shape of the thrust-time curve can give an indication of both the type of propellant, and the grain geomentry inside the motor case.

The Shape of The Thrust Curve

The curve's general shape can tell us something about the motor; like the type of propellant, and the grain geometry. By grain geometry, we mean the physical dimensions, and what kind of holes are running through it. This is important because it controls the amount of thrust that is being produced at any time during the burn.

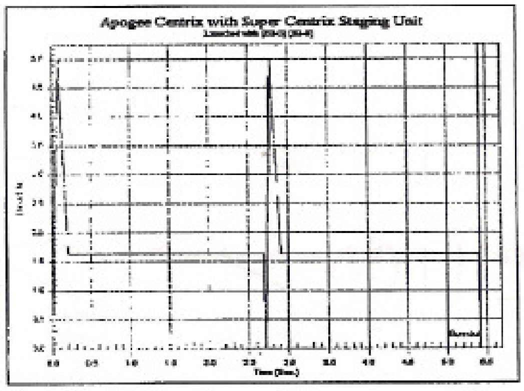
Understand that the amount of thrust is controlled by



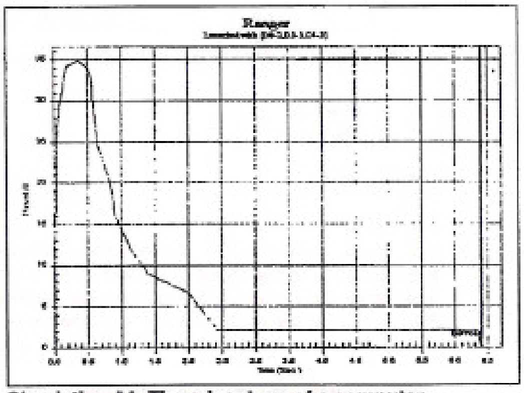
Simulaton #2: You can tell by the shape of this G80 thrust curve that the grain configuration was likely a "Bates Grain" because of its flat top.

how fast the propellant is being consumed. The faster the slug of propellant is burned up, the higher the thrust level. The manufacturer can somewhat control how fast the propellant is being consumed by varying the pressure inside the motor, and by the amount of surface area of propellant is burning at any given point.

The pressure inside the motor is important, because the chemistry of the propellant is sensitive in one way or another to it. This means, that the higher the pressure inside, the faster the propellant is burned. So the manu-



Simulation #3: Thrust curve of a two stage model. In this case, it is a Apogee Micro B2/B2 Combination.

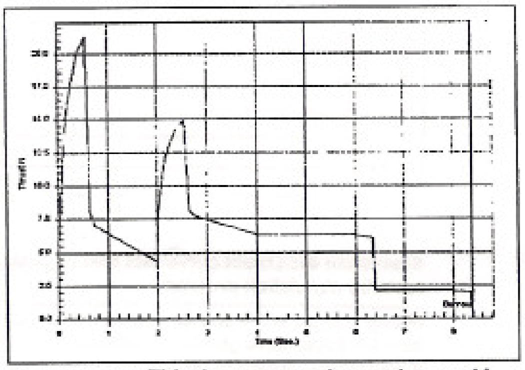


Simulation #4: The advantage of a computer simulation is that it allows you to add thrust curves of different motors together. This is a curve of a three-motor cluster: a D3, D10, and C4.

facturer can make the propellant burn faster or slower by varying the pressure in the motor. This is done by varying the size of the nozzle throat. A very tiny nozzle throat, and you'll have a high pressure.

To make a long-burn motor then, the manufacturer wants the pressure to be relatively low. On the other hand, for a high thrust motor, you'd like the internal pressure to be high. However, the final limitation on peak pressure is the strength of the motor case. If the manufacturer wants a very high thrust motor, he can only allow it to be so great, or the motor case will burst.

The other controlling factor of internal pressure is the surface area of the propellant that is burning at any given time period. The greater the area, the higher the internal pressure, and the greater the thrust. To make a low thrust motor, the manufacturer wants a grain geometry that has a small surface area that is burning at any given time. The one most commonly chosen is the "end-burners" — or



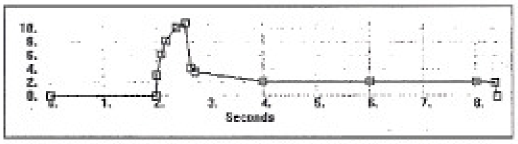
Simulation #5: This thrust curve shows what would happen if you clustered three D3 motors together, and one of them happened to ignite two seconds late.

sometimes called "cigarette burners." This means that the grain is burning on the bottom surface, and starts at one end, and works its way to the other.

Another common motor in model rocketry is the "Bates Grain" core-burner. It has a hole through the center, and burns from the inside diameter, outward; plus each of the two ends is burning toward the middle. So the surface area is fairly constant, translating to the thrust that is mostly level for the duration of the burn.

Those two shapes are just some of the endless combinations that are available. Illustration #1 shows several drawings of the other more common grain configurations that are used in model rocketry, and what the general shape of the thrust curves will look like.

For the user using a computer simulation, you can look at the thrust curves, and make a good guess as to what



Simulation #6: The thrust curve of the delayed-start motor in Simulation #5 was created by shifting each of the data points over by two seconds in the motor wrasp data file. A program like Apogee Components' "EngEdit" is required to modify thrust curves like this.

grain configuration is used in the motor by the general shape of the curve. See Simulation #2.

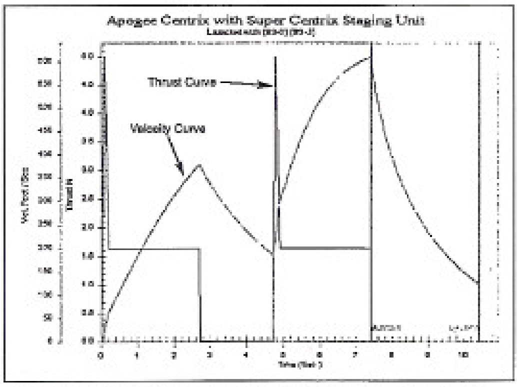
Are there Exciting Thrust Curves?

For rockets with a single motor, the thrust curve by itself may not be too interesting. As mentioned before, this information can be found with the motor's instruction sheet. But when motors are clustered or staged together, the curves can get real exciting. In the case of clusters, the computer simulation is probably the only place that shape of the curve of several motors added together is available.

In Simulation #3, we see a classic two-stage rocket, and it appears that each motor is identical. The shape of each motor has the classic "black powder" propellant look to it (most black powder motor curves start out with a high initial spike, and then have a fairly flat sustaining portion).

Simulation #4 shows a cluster of three different motors. This gives a thrust curve with a very weird shape. It has a very strong initial thrust spike, and then a fairly long sustaining portion.

Simulation #5 appears that the model is either staged, or it was clustered, and that one motor was air-started after the first motor(s) have started to burn. This is characterized by the thrust dropping down before the second motor is started. From this one thrust curve, you can't tell for sure whether or not it was a cluster, but if you were to see the velocity and mass curves of the model plotted at



Simulation #7: Altering the thrust curves of motors can also be used to perform delayed staging. One interesting thing in this curve is that it shows the velocity decreases during the period between motor burns. This helps the rocket drag to stay low.

the same time, you would be able to make the determination.

To create this type of simulation, you need to change the thrust curve of the motor that ignites late. This is done by editing the motor wrasp file, and moving the data points further to the right. The curve of the single motor is shown in Simulation #6.

Rockets that use delayed staging, where there is a short period of zero-thrust between motor firings, can also be simulated on a computer. Setting up a seperate "delay motor" like was shown in Simulation #6 needs to be done first. Then you can run the actual simulation; like shown in Simulation #7.

Now that we know how to read the thrust curve graphs, we can use the information to design rocket *missions*. To achieve the highest altitudes, we want a low-thrust — long burn duration motor. If we can't find a motor available that meets this criteria, we can stage motors together, and used delayed staging to further increase the thrust phase.

To break Mach 1, we want a motor with a very high initial thrust. This could be done by clustering motors together to get the thrust spike needed.

In the next article, I'll talk about how to read the velocity and acceleration curves, and how these are shaped by the thrust curve.

Author's note: the simulation graphs presented in this article were created using the RockSim v4.0 software. Readers can try out the "demo" version of this software — it is free from the Apogee Components web site (www.ApogeeRockets.com).