THE LEADING EDGE

Newsletter of the Northern Illinois Rocketry Association, Section #117

Volume 15, Number 5
September/October 1992

T MINUS 1 - NIRA'S CALENDAR OF UPCOMING EVENTS

MONTHLY MEETINGS

All meetings start at 7:30 PM, and include refreshments, entertainment and a brief business meeting. Don't forget a model for "Model of the Month" voting. We need volunteer speakers to entertain the troops after the business meeting, so call Mike Jungclas at 708-910-1267 if you can help with ideas or can speak yourself.

September 4, 1992 - Review final plans for Labor Day and hear the latest on our search for a new field. Also discuss the results of the NIRA membership survey and the NIRA-Tripoli Prefecture merger voting. Bunny will discuss reloadable motors for entertainment.

October 2, 1992 - Begin planning for the RCHTA show. NIRA will again run the building session and a display booth. By volunteering to help out, you get into the largest hobby trade show in the country FREE!

November 6, 1992 - Find out details about this year's Xmas party.

1992 LAUNCH DATES

All launches or other activities start at 2:00 PM. BYOL (bring your own launcher). Casualty insurance required or else RSO must inspect and launch your model. **Note: As of the time of press, we still do not yet know the location of our permanent site. Before attending any launch, call either Mike Jungclas (708) 910-1267, or Lawrence Bercini (312) 561-8098 to find out where "home" is. Probable location for the remaining launches this year is Melas Park in Arlington Heights**. The park is located on the north side Central Avenue in Arlington Heights, just east of route 83 (Busse Ave)..

September 20, 1992 - Event: Military Missile Day: Bring a model of a military missile to fly. Vote for your favorite. Also remember to welcome new members who joined up at the Labor Day Launch.

October 18, 1992 - Event: Terminal Altitude: Winner is the contestant whose rocket lands at the highest spot.

November 15, 1992 - Last launch of the 1992 season. Event: Sounding Rocket: We;ll have a decibel meter on hand. If your rocket makes the loudest noise, you win. Also help push the club's year to date total launches for the Box Score as high as possible by flying as many models as you possibly can.

OTHER ITEMS OF INTEREST

Monday, September 7, 1992 at 2 PM. HELP FLY LABOR DAY!

NIRA will be holding its 29th annual Labor Day Launch on Monday, September 7th at 2 PM. Please show up BY 1 PM to help setup and to begin preparing your models to fly. Flight cards will be available before the launch - much prep time can be saved if these are filled out in advance. Let's set a goal of 150 models to fly between 2 and 5. Check-in will close at 4:30 PM. We'll also need models to display and help with various range activities. We'll also have a NIRA sign in sheet - please sign in and obtain "HELLO MY NAME IS" badge.

This is an opportunity for NIRA to introduce itself to Chicago community. In past we have sold pop and kits to help out club's treasury. If you have kits etc. that you like to donate to club to sell please bring them to launch

For more information contact Labor Day Launch Coordinator Bob Wiersbe at (708) 690-5442 (HOME) or (708) 979-1336 or Mike Jungclas at (708) 910-1267 (HOME) or (708) 979-4571 (WORK). See you there!

September 13, 1992 - STS-47 Launch, Pad 39B, Kennedy Space Center. Bunny will have a full report in the next issue. on NAR member Jay Apt's second flight into space aboard Space Shuttle Endeavour.

September 13-20, 1992 - World Model Rocket Championships, Melbourne, FL. Remember to cheer Jedi George Riebeschl and Ben Roberto, members of the US Team, on to the gold.

September 19, 1992 - Tenth Annual model contest and swap meet. Itasca Holiday Inn. For more information: Mark Oppenheim, 5520 Carpenter St., Downers Grove, IL 60516 (708) 852-4925.

October 31 and November1, 1992 - The Big One's Back! Time again for the Chicago Hobby Show. NIRA will once again man a booth introducing the public to the hobby of model rocketry as well as tell them about us! Like last year, NIRA will also be running a consumer seminar co-sponsored by Estes. This year the model is expected to be the E2X Bandit. More details will be available at the September club meeting.

CONTRIBUTORS

Tom Beach, Lawrence Bercini, Bunny Bundick, Alan Jones, Mike Jungclas, Kevin McKiou, Bob Wiersbe

STAFF

Lawrence Bercini - Editor/Photographer
Bunny Bundick - Typesetting

THE LEADING EDGE, published bi-monthly by and for members of the Northern Illinois Rocketry Association, NIRA, NAR Section #117, is dedicated to the idea that Sport Rocketry is FUN! Articles, plans, other newsletters, and news items of interest should be sent to Lawrence Bercini, Editor, 6033 Sheridan Rd. #33J, Chicago, IL 60660. Information can also be transmitted via CompuServe or Internet using CIS #70651,3147. Send membership applications (dues: $3/year, including a six issue subscription to the Leading Edge) and non-member subscriptions ($5 per six issues) to Mark Bundick, 1350 Lilac Lane, Carol Stream, IL 60188. Any item appearing in the Leading Edge may be reprinted by American Spacemodeling with proper credit given; all other uses require written permission of the Northern Illinois Rocketry Association.

GENTLE REMINDERS

September - Bob Wiersbe
October - Lawrence Bercini

LAUNCH RSO/LOG KEEPER

The following volunteers are to be RSO and Log Keeper at the upcoming launches. This duty includes doing safety checks, keeping the flight logs for our "1992 Box Score" project, and compiling the launch coverage for the "Leading Edge". New forms designed by VP Bob Wiersbe make this easier than every to do!

September - Bob Wiersbe
October - Mark Bundick
November - Lawrence Bercini

BOX SCORE PROJECT

We are closing in on that elusive goal we've missed the past two years! Our year to date launch total now is 874 through the July club launch! Way to fly rockets folks! Provided we can find places to fly for the rest of the season, we WILL make 1,000 flights this year.

CLUB RECORDS

At any NIRA launch, you can attempt to set a club record in any standard NAR duration event. Just see Ric Gaff, Harland Pell or Lawrence Bercini to have your model timed. Existing records are:

Youth		
1/2A SD	Andy Linder	69 sec.
Adult		
1/2A SD	Don Linder	77 sec.
1/2A HD	Kevin McKiou	118 sec.*
1/2A Flex	Lawrence Bercini	62 sec.
1/2A BG	Lawrence Bercini	192 sec.
B EL Dur	Tim Marcy	35 sec.
B RG	Dave Price	67 sec.
B SD	Ken Hutchinson	61 sec.*

["*" indicates a new record]

MODEL OF THE MONTH WINNERS

HELP! Our roving reporter inadvertently lost the notes on the MOM winners for June. If you were the MOM winner in June, please contact the editor immediately, so we can all see your smiling face and beautiful bird here in the next issue!

Congratulations to our July winners: Matt Price and his Rebel slide wing rocket glider. with Kevin McKiou and a non-RC model, the Strike Fighter.

Our August MOM winners are Ed Thiel and his modified SDI Satellite Killer. Bob Wiersbe proudly displays his super scale scratch built Nike Tomahawk.

ERRATUM

In the last issue, Mike Jungclas (2504 Woodlyn Dr., #201, Woodridge, IL 60517) was inadvertently omitted from the list of MRFF Sponsors. Mike donated the American Spacemodeling advertisement.

NIRA CLASSIFIEDS

Bunny's Massive Plastic Kit Liquidation! Don't miss these unheard of bargains in dozens of plastic kits, some no longer in production, and all suitable for the Plastic Model Conversion event! $85 for the entire lot or make him an offer on individual kits. He pays shipping or delivers locally!!! In 1/32 Scale: Revell F-15E Strike Eagle,F-16,F-104 C/G. In 1/48 scale: ESCI Saab JA-37 Viggen and F-5E; Monogram F-106 Delta Dart, F-16, Mirage 2000; Revell MIG-21PF; in 1/72 scale: Airfix Me-262/Mosquito and Mirage IIIC, Frog Saab JA-37 Viggen; Hasegawa MIG-21 Saab JA-37 Viggen, MPC Saab J-35 Drakken, Revell F-16 and Saab J-35 Drakken, and Testors F-5A (two kits) and F19 Stealth Fighter. Write Mark Bundick, 1350 Lilac Lane, Carol Stream, IL 60188 or call 708-293-9343 after 7 PM.

Need Big Nose Cones? Bunny has just the thing for you. Sears Craftsman wood lathe with 12" turning diameter, 36" long bed. Sturdy metal stand with 1/2 HP electric motor. Adjustable pulley allows for three different turning speeds. Yours for only $50. Contact Bunny at the address above!

ON THE COVER -

Jim Christenson's Starburst lurches skyward backed by twin D12's.

June Club Launch

by Kevin McKiou

The June 20 launch was a Section meet featuring 1/2 A RG, 1/2 A HD, B SD and parachute spot landing. There were a total of 94 flights; 27 RCRG, 42 sport, and 25 competition. The recent loss of Ackerman Park as a flying site resulted in our use of the RC helicopter field at Fullerton Park in Addison; a site graciously offered by the Dupage County Forest Preserve.Fullerton is actually a pretty decent site if the wind is out of the north and you are good at spot landing. Otherwise, you are like likely to land in the woods or on Grace Avenue. As you might imagine, RC helicopters don't require a large area to fly. Fortunately the day of the launch the winds were, indeed, out of the north. One other complication to the Fullerton Park site is the time of day we are allowed to use it. We were given(paid $25 for) a time slot from 9:00 a.m. to 2:00 p.m.. This posed a bit of a problem for regular church-goers such as the Bundicks and, in the case of the Prices, caused them to completely miss the meet. I hope this is a problem that we can rectify in the future. Unfortunately, we were stuck with either accepting the time given us or not having a section meet. WE ARE ACTIVELY SEEKING ALTERNATIVE FLYING SITES. IF YOU HAVE AN IDEA, PLEASE CONTACT ME (708-717-5830) OR BUNNY (708-293-9343).If you can, please prescreen your site by contacting the owner/administrator to determine if it is a viable possibility for flying model rockets.

When I arrived at the site Mark "Bunny" Bundick and Ben Roberto were busily prepping Bunny's RCRG for a flight. Bunny made two nice flights and one good landing. It's back to the work bench for tail feather repairs. Bunny will be back in the air at the next opportunity. The damage was minor. Ben went on to make 10 D12-P and 6 D12/C6-P flights with Draggin, Too in preparation for the September World Championships in Florida. Ben reported that Bunny is "coming along". He also noted that thermals were abundant and he had several flights over 5 minutes. George "Jedi" Riebesehl was also tuning his RCRG for the World Championships and completed 9 D12-P flights.

The Section meet had 6 participants in C division and 1 in A Division. Ron Husak walked away with the A Division honors in Spot Landing with a distance of 115' 9" and B SD with a total time for two flights of 47.07 seconds.

C Division 1/2A RG was a three way contest between myself, Bob Kaplow and Bob Wiersbe. Bob Wiersbe had an interesting bi-wing RG design.Unfortunately it disintegrated at max-Q and Bob was out of the contest.I flew a NARAM-32 original design slide-wing model. My first flight was a less than stellar 35.05 seconds. However, I was more patient on the second flight and waited for good air. The wait paid off with a respectable 1:00.66 flight. Bob Kaplow flew an extraordinary RG that he originally built for NARAM-20-something. It had a variable camber wing with a torsion spring hinge at the high point that allowed the camber to vary from essentially none to several degrees. It boosted with the camber washed out and, when the ejection charge fired, a thread burned allowing the spring to move the back portion of the wing down like giant flaps. The ejection charge also moved the motor back shifting the CG for glide. The result was an RG that boosted straight and had an excellent glide ratio. It's too bad for Bob that such exotic technology has a price, reliability. Bob's first flight DQed because the ejection charge failed to shift the CG and the glider spiraled in. His second flight was much better and earned him a total time of 52.56 seconds in the air.Thus, I took top honors in C division. However, I loved Bob Kaplow's model.

C Division 1/2 A HD had 3 participants: me, Ken Hutchinson, and Bob Kaplow. Ken flew a RotoRoc style helicopter that was a bit lower aspect ratio than the original design. Ken's was about 8" long which made stability more of an issue. His first flight was DQed but returned in a very nice second flight of 47.06 seconds. I flew a RotoRoc clone that was about 14" in length. My first flight was a dismal 27.5 seconds. However, I made up for it on the second flight. Just as I pressed the launch button a big whoosh of air signaled the arrival of a thermal. The timers lost sight of it at 1:58.43. I searched for an hour before giving up - it was gone. Bob Kaplow again had an extraordinary model from NARAM-20-something. Instead of the usual RotoRoc rubber bands to deploy the rotors, he used torsion springs for less drag. The rotors appeared to be 1/32 balsa that had been formed into an airfoil by molding them while wet around a piece of tubing. It was an

extremely light and aerodynamic model. It also flew well. Bob's first flight was 1:04.85 in little, if any, lift. He decided to concede the contest after the first flight since he would likely have had to lose the model to win.

C Division B SD had 5 participants: Bob Kaplow, Jon Charbonneau, Ken Hutchinson, Bob Wiersbe and me. I made two throw-away models for two throw-away flights. My first flight DQed after shredding the fins. The second DQed due to a streamer separation. Bob Kaplow turned in a qualified flight of 20.01 seconds. Bob Wiersbe DQ on his first flight with a separation and managed 27.10 seconds on the next flight. Jon Charbonneauturned in consistent flights of 30.80 and 32.62 seconds with an Estes Calypso. Ken Hutchinson was the man to beat with 36.19 and 1:01.44 flights on a Zinger.

Parachute spot landing was the largest event with Ken Hutchinson, Mark Holle, Jon Charbonneau, Bob Wiersbe, Bob Kaplow and me participating.Bob Kaplow and I landed far enough from the spot we declared it to be"out". Ken Hutchinson used a Patriot under A-power but landed 106' from the spot. Mark Holle and Bob Wiersbe didn't do much better landing 101' and 94', respectively, from the spot. Jon Charbonneauturned in the only respectable flight, landing 48' 7" from the spot. Tricky event,parachute spot landing.

Bob Kaplow had one of the most notable sport launches. He launched his Graduator with an FSI D18-4 (that's what the log says) expecting a CATO. The motor worked fine except it operated more like a D18-6.The rocket stuck very neatly into the ground and stood there until the ejection charge dutifully fired, ejecting the parachute, nose cone, and mother-earth. Well...the earth didn't move much. Bob also made a ritual launch of his Happy Meal. What NIRA launch would be complete without one?

"Lucky" Lloyd Liechentritt has the best luck of any rocketeer I know. He CHAD-staged an Estes Black Brant D12-0/D12-5 off this tiny field never expecting to see the rocket again. In fact, it looked like he never would see it again. It appeared to drift more than a mile from the field toward a commercial area. I'll be doggoned if he didn't show up with it just as I was leaving the launch site. He said he found it in the parking lot of a commercial center. Lloyd also flew his Mini-Mean Machine, Mercury Redstone and a beautiful V-2.

The Slouber clan was present, accounted-for and flying rockets. Lionel had two flights with a Thunderhawk (A8-3) and Advanced Target Drone(B6-4). Rosela flew the Mark 2 (A3-4T) and new Estes Bail Out (B6-4).Kleve flew a new scratch-built Astro 6 (Quest B6-4) and the old reliable Honest John (B6-4). Unfortunately I wasn't able to talk with the Sloubers before they left. However, they are always a lively bunch and add fun to every NIRA launch.

Ric Gaff has been on a building frenzy and showed up with a number of new kits. He even flew some of them. The Estes assortment included a Dagger (A8-3), a very nice Titan (D12-5), and a mini-Patriot - Ric calls it a pocket rocket since it neatly fits in your pocket (1/2 A3-4T). He also flew two Quest kits; a Nike-something-or-other(A8-3) and an Astra(B4-4).

Ken Hutchinson had three sport flights with a Zinger (A6-4), Saturnian (C6-3), and a Super Big Bertha (D13-4 RMS). If you have never seen and heard the D13 Reloadable Motor System, you have missed something neat. It is LOUD and the White Lightning reloads produce a bright white flame. The Super Big Bertha and the D13 RMS make a great demo combination.

Mark and Scott Holle had sport launches with a Micro (A10-3T), 2 with a Meanie (A10-3T, A3-4T) and one with an Alpha (A8-3). Mark and Scott are relatively new NIRA members and we are glad to seem them at launches and meetings. Be sure to say "Hi!" next time you see them.

Ron Husak also posted 3 sport flights. Unfortunately, for the first one,only Ron's name and motor type (A8-3) are listed on the log. Do you suppose Ron is rocket-assisted <grin>? Besides himself, he also flew a Der V-3 (B4-4) and an Honest John (B6-4).

New members Jim, Mary and John Foster were on hand. Mary builds the rockets (beautifully, I might add) and John launches them.John had a little mix-up with which button is the continuity tester and which one is the launcher on a Lancer (B4-4). So, the count-down was a bit brief. Things went a bit smoother with a Flying Saucer (C6-0) and Jammin' (1/2 A3-2T). As a bonus, the Jammin landed in a field of ripe wild strawberries - mmmm...they were good! Jim is interested in high-power and was side-lined due to the size of the field and lack of waiver.

Jonathan Charbonneau also had some sport flights with a Scout, Calypso (B4-6) and Beta (B6-4). Jonathan's bigger darts were also left at home due to field size. Pity.

Finally, Bob Wiersbe also did some sport flying. He flew a Microsonde-II with a B6-0/A8-5 combination. Then, apparently feeling confident, flew it again with a C6-0/C6-7 combination. Bob was not as lucky as Lloyd.Someone did recover his first stage, but the second stage is now history. He also had a successful flight of his Space Shuttle (C5-3). It actually worked quite nicely. The shuttle portion could use a little less nose weight, though.

The Price clan showed up at the launch site just as I was leaving. Apparently,Dave forgot to check the launch time change when he received the notice. Though, it wouldn't have made much difference since they had a conflict with church that morning. Sorry about that, Prices. We are working to find a better location and launch window. DON'T FORGET TO CALL ME OR BUNNY IF YOU COME UP WITH A PROMISING SITE!

Altitude Calculations for Multi-Staged Models Revisited

by Alan Jones

This article responds to Tom Beach's Jan/Feb 1991 article. Tom wrote a Hypercard stack for his MacIntosh using the extended Malewicki equations from the book "Topics in Advanced Model Rocketry". When a user reported a bug in Tom's software, he reviewed his program, then claimed to have found a "bug" in the equations themselves. Tom's fix was indeed correct, but failed to address the entire problem. This article expands on Tom's presentation and adds some additional comments.

Coding Comments

One seldom codes equations in the manner they are normally presented. Equations are reformatted to make typesetting easier or that allows for more obvious application in further derivation of equations. Tom's "corrected" equation on page 13 of his article is more difficult to typeset than the one found on page 59 in "Advanced Topics". Tom's version eliminated the hyperbolic arctangent, but now t_n and V_{n-1} appear in two different places. In Equation 59, t_n and V_{n-1} appear only once, so one could solve for t_n or V_{n-1} given V_n. Equation 59 is clearly the correct form for publication and further analytical work. I'm confident the "Advanced Topics" authors didn't intend that the equations be coded exactly as published. Both equations are correct and appropriate as used, and it is probably unfair to say Equation 59 has a "bug".

On Mathematical Modeling and Derivation of Equations.

We seek equations and methods to calculate the altitude of multi-staged models with a computer. We want the fastest calculations speed consistent with our accuracy requirements. We will restrict ourselves to deterministic one degree of freedom vertical flight. We'd like the equations to have a closed form exact solution. Unfortunately, there is none, except for special cases.

The basic equation is Newton's law of motion, which states that the time rate of change of linear momentum is equal to the sum of the applied external forces. This isn't exact since it neglects the effects of quantum mechanics and relativity on model rockets. For typical computer applications, the equations are perfectly adequate for model rockets and nearly all of aerospace engineering.

We can also treat gravity as a constant and neglect the rotating earth. Variable mass and drag leave us with a nonlinear second order differential equation. To solve such equations, they must be numerically integrated. This is slow, can have numerical accuracy problems and doesn't give us an analytical equation that can be used for other purposes. If we neglect drag, there is a well know solution accounting accurately for variable mass assuming a constant thrust and specific impulse. Since drag plays a major role in model rocket flight, and few motors are constant thrust, this is of little interest to model rocketeers.

For model rockets, a reasonable approximation for drag is:

$$D = .5 \times \rho \times C_d \times A \times v^2$$

Rho is air density, which varies with altitude, temperature and air pressure. We usually use a sea level constant, 1.225014 Kg/m^3. High performance rockets expected to reach over one kilometer should try to account for air density variation with altitude. C_d drag coefficient, will vary with Reynolds number, R_n, and Mach number, M, both of which vary with velocity. The Mach number variation can be ignored for speeds less than .9M, and most model rockets meet that assumption. Drag coefficient typically decrease with R_n and we use a constant value. Thus, a simplified drag equation for model rockets is:

$$D = K \times v^2$$

with K as a constant. If we also treat thrust as a constant average value, we get a reasonable closed form analytical solution to the nonlinear second order differential equation.

Tom Kuechler also derived and published several good approximate solutions, including an infinite power series, variable air density and linear thrust variation. These are academically interesting, but I prefer the Malewicki solution and numerical integration for practical work. Readers interested in Kuechler's work should consult the November/December 1974, April 1975 and March 1976 issues of the "Model Rocketeer" or get a copy of the NAR Tech Review, Volume 4, Number 5, from NARTS.

The Malewicki Type Equations

"Advanced Topics" gives two methods for exact solutions of the simplified differential equations. The Fehskens-Malewicki solution is a straight forward separation of variables. Integrals are looked up in the standard integral tables. Very satisfying. However one must note that two different solutions are given, one with hyperbolic functions and another with trig functions and you must use the appropriate equation.

The other method is the Coporaso-Riccati solution. This method uses a transformation of variables after which with a BFO you recognize the equation and immediately write down the solution. Not satisfying, since you basically just "guess" the solution. "Advanced Topics" gives the Caporaso-Riccati solution as Equation 34:

$$V = \frac{M}{K}\left[\frac{a_1 He^{bt} - a_2 He^{-bt}}{a_1 He^{bt} + a_2 He^{-bt}}\right], \quad H = \frac{1}{M}\sqrt{K(f - mg)}$$

A1 and A2 are constants that are determined from the initial conditions of V(0) = v0, and h(0) = 0. You can think of this as the unifying form that incorporates both the hyperbolic and trig forms of the Malewicki solution. You must also understand that calculations must be done with complex math. You can simplify this exponential form into two separate forms, identical to the Malewicki type solution, that require only real math. Using only the real math is faster, but requires us to add some additional logic.

Equation 34 may seem redundant since it gets us to the same equations as Malewicki, but I find it useful. Tom found an argument out of Bounds in the hyperbolic arctangent of Equation 59. He then found an alternate form of the equations eliminating the hyperbolic arctangent. This appeared to solve the out of bounds condition.

Although the algebraic substitution and manipulation is correct, it doesn't guarantee the new equation form is correct. When you look up the solution in the table of integrals, there are limits of applicability given. You've probably seen mathematical "proofs" where you improperly divide by zero, cancel zero from the numerator and denominator or take an improper square root, and prove something ludicrous. Tom's method isn't rigorously satisfying. Maybe Tom or someone else could provide a more rigorous derivation of his method.

I'm not giving boring derivations here for results that are well known to most rocketeers who could follow them. Rather, I give actual computer subroutines (see Exhibit 1) you can confidently use in your own programs. COMAL 2.0 was my language, but the code is readable. You can translate it to Fortran, Pascal and other languages. I don't recommend BASIC if you have another choice.

"perf" is called to calculate the final altitude and velocity, hf and vf, after time interval , t. You can use any consistent set of units, either English or metric. "grav" is the acceleration due to gravity, 9.8 mt/sec^2. "roha" is .5 x air density x reference area. The ont "trick is that if perf is called with t = 0, it will calculate the time and performance at apogee. It works equally well for ascent, descent, flying through apogee and perigee, the special cases of no drag, and thrust equal to weight.

Thrust is always positive upwards, but you can use a negative thrust for a "retro rocket". The model may flip over on descent, but the routine will not change the sign of the thrust. You must do this externally if that is what you want. A superroc or large scale bird may well descend under thrust without flipping over before burnout. When you fly through apogee or perigee, the routine must break up the interval into two parts to change the direction of the drag force.

Proper computational use of the extended Malewicki type equations is complex. The only nearly foolproof way to communicate this to casual users was to provide computer code. In "perfn", I calculate the hyperbolic functions from the exponential definition. This can cause large errors when the argument is small, and you may want to use a series approximation in that case. If your computer language provides the hyperbolic functions, use them.

Also, if you release software for use by others, try to make it idiot proof. Test for proper inputs, such as mass greater than zero, and tell the user what he did wrong. Don't let the program fail in either your or my routine with a cryptic division by zero error.

Once Again, Mathematical Modeling!

We now have a set of consistent equations for exactly solving (apart from limited precision numerical errors) a differential equation that approximates the performance of a model rocket. Now you need to know how to apply the equations to minimize the error inherent in our initial assumptions.

When Doug Malewicki developed his famous book of model rocket altitude performance charts, computer time was very expensive. Only large corporations owned computers, and most people just rented time on them. Doug provided the cheapest method for creating altitude charts with little regard for accuracy. Errors of a few percent were acceptable. He modeled the entire thrust portion of the flight as a single constant thrust, and followed it with a simple coast to apogee. Doug is the first to admit his published charts were wrong.

I talked with him at NARAM-14 after he had left Estes and Centuri, both of whom had published versions of his work. Doug used manufacturers' published catalog values for total impulse, which grossly overestimates the actual total impulse. The charts were still quite reasonable for making sure your recovery site was large enough and for selecting a delay time. If you actually track a flight, however, and work backward to a drag coefficient for your model, you can get huge errors. Today, computing is cheap, and there's no excuse for calculating results with more than 1 % errors.

Your first step is to start with good motor data. NAR Standards and Testing Engine Certification reports are available from NARTS, and are the only data I trust.

The worst approximation made by Malewicki is a constant thrust motor. Improve the model's result by creating an actual time thrust curve with a series of different constant thrust time intervals. This situation is handled just like a multi-staged model, except that you do not change the drag coefficient or airframe mass of the single staged model you're analyzing like you would with a multistage model.

I typically use four intervals for each motor, but it really depends on the actual thrust-time curve and how much accuracy is needed. There are some simple rules to bear in

mind when your create an engine thrust model this way.

To have any hope of calculating the burnout velocity right, you want the integral of thrust over time, or total impulse, the same. To have any hope of calculating the burnout altitude right, you want the first moment of the thrust time curve the same. You would also like to minimize the mean square error between the actual curve and your constant thrust approximation. If your thrust model changes the burn time, be sure to change the coast time as well. I generally keep the same total impulse, and "eyeball" everything else.

The next approximation is constant mass. Dividing the thrust portion into several segments does most of the work, since you will account for the propellant mass burned off. I assume a constant specific impulse so that propellant mass is burned off proportionally to the impulse expended. This will give us an initial and final mass for each segment, m0 and mf. There is some m* between m0 and mf that will give us the best variable mass solution in our equations.

We might consider the algebraic mean, (m0+mf)/2, , the geometric mean, sqr(m0*mf), the harmonic mean, 2/(1/m0+1/mf), or a more complex value based on the variable mass rocket equation. The mass enters the equation in two ways; as a gravity force, and as a divisor to get acceleration. If gravity dominates acceleration, as in a low thrust sustaining flight, then the time average algebraic mean is best. If acceleration is dominant, as in boosting flight, then the harmonic mean is best. The harmonic mean is generally best for model rocketry, but I use the algebraic mean since it's simpler when calculating partial derivatives.

The constant C_d assumption is reasonable because we rarely know C_d within a few percent anyway. If you do have C_d for different velocities, us a value that is close to the maximum expected velocity. You might also consider a hybrid method for supersonic models. Use the Malewicki equations when velocity is below m.9 and use numerical integration with a C_d dependent on M, when M > .9. Equation 59 can be easily solved for the time to reach a specified velocity.

Conclusion

I attempted to tell the whole story about the Malewicki type equations that Tom Beach started to tell. I also provided computer code subroutines you can apply to the equations with confidence.

I haven't given you any recent or earthshaking results. The NARAM 27 R&D judges were nonplussed with my Malewicki equation work, but my program has astounding support for such simple equations. It can calculate and propagate partial derivatives, which can be used to solve some interesting problems. It includes some general optimization routines, generates performance tables, calculates engine selection domain boundaries, estimates C_d from tracked altitudes and more. Since I lost my copy of the NARAM-27 R&D report, I'd appreciate a copy from anyone who might have a copy they could spare.

AND NOW FOR SOMETHING COMPLETELY DIFFERENT...

HEARD ON THE STREET

Rumors and Such, with Apologies to the Wall Street Journal

Fly With Me - Warmest NIRA congratulations to "Jedi" George Riebeschl and Sandi McIntyre who announced their engagement August 20. No wedding date has been set, but we're sure this is to be the NIRA social event of the season.

Planet Cafe - Terraformer wannabe, James Kasting of Penn State believes Venus can be made habitable: "First you cool Venus down and add water, by bringing comets in from the Oort Cloud. You would also need to block out the amount of sunlight hitting the planet by erecting enormous reflectors tethered to the planet.." Phew! Any thoughts on the budget deficit James?

"Hopping" to See You Up and About - Best wishes for a speedy recovery to Karen Wiersbe, Bob's wife who had foot surgery August 11. Bob's been an outstanding NIRA trooper, helping his Karen to recuperate while also working on organizing the Labor Day Launch.

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Exhibit 1

```
PROC perf(REF t, mass,thrust,cd, REF h0, REF v0,REF hf, REF vf) CLOSED
//      model rocket performance routines by Alan V. Jones
//      Comal 2.0 computer language
        // calculate vf,hv and apogee coast time if t = 0
        IMPORT perfc, perfn, grav, roha
        f:=thrust-mass*grav
        IF cd=0, THEN // drag free case
                IF t=0 THEN // coast to apogee?
                        t:=-v0*mass/f; vf:=0; hf:=.5*v0*t+h0
                ELSE
                        vf:=v0+f/mass*t; hf=.5*(v0+vf)*t+h0
                ENDIF
        ELSE
                k:=roha*cd
                IF v0<0 THEN k:=-k
                IF f = 0 THEN //thrust = mg case
                        t1:=1+v0*k*t/mass
                        vf:=v0/t1; hf=mass/k*LOG(t1)=h0
                ELSE
                        a:=f/k
                        IF a>0 THEN  //normal boost or descent case
                                perfn(t,mass,a,k,h0,v0,hf,vf)
                        ELSE
                                b:=sqr(-a);tc:=mass/(k*b)*ATN(v0/b)
                                IF t=0 THEN //apogee
                                        perfc(mass,k,b,h0,v0,hf,vf)
                                        t:=tc
                                ELSE
                                        IF t<=tc THEN // thrust<mb ascent or thrust>mg descent
                                                perfn(t,mass,a,k,ho,vo,hf,vf)
                                        ELSE
                                                perfc(mas,k,b,h0,v0,hf,vf)
                                                perfn(t-tc,mass,-a, -k,b,hf,vf,hf,vf)
                                        ENDIF
                                ENDIF
                        ENDIF
                ENDIF
        ENDIF
ENDPROC perf
//
PROC perfn(t,mass,b,k, REF h0, REF v0,REF hf, REF vf) CLOSED
        a:=SQR(abs(b)); t1:=a*k/mas*t
        IF b>0 THEN //thrust>mg ascent or thrust<mg descent
                st1:=EXP(t1);t1:=EXP(-t1)
                ct1:=.5*(st1+t1); st1:= .5*(st1-t1); tt1:=st1/ct1
                vn:=v0+a*tt1
        ELSE // thrust<mg ascent or thrust<mg descent
                st1:=SIN(t1); ct1:=COS(t1); tt1:+st1/ct1
                vn:=v0-a*tt1
        ENDIF
        hf:=mass/k*LOG(v0/a*st1+ct1)+h0
        vf:=a*vn/(a+vo*tt1)
ENDPROC perfn
//
PROC perfc(mass,k,b, REF h0, REF v0,REF hf, REF vf) CLOSED
        t1:=v0/b //coast to apogee
        hf:=mass*LOG(1+t1*t1)/(k+k)+h0;vf=0
ENDPROC perfc
```

Prairie School Demo II

By Kevin McKiou

May 27, 1992 Prairie Elementary School in Naperville, Illinois invited me to speak to my daughter's class about my hobby, model rocketry. I was pleased that about 100 3rd graders attended my talk and demonstration. Most of them remembered me from last year and, due to local newspaper coverage, I was now the "Rocket-Man"; quite an honor for my daughter, Kerri.

We assembled in the Learning Resource Center (I remember it as the Library) where I began by giving them the basics: components of a model rocket, recovery system, how a motor works and safety. We talked about different aspects of model rockets. I brought a phantom (see-through), scale model, Rocket Glider (RG), and a Radio Controlled Rocket Glider (RCRG) as props. The kids were really impressed with how a rocket could be remotely controlled. I was quite surprised and pleased when I asked how many kids had actually launched a model rocket. At least 70% of the raised their hands! This was a big difference from one year earlier when only about 10% had launched a model rocket. I'd like to believe that I had something to do with the increase. But, it may have been all those Estes catalogs I handed out last year. I heard reports of kids sleeping with them, studying them at recess and carrying them where ever they went.

Once the preliminaries were over, it was time for the main event, a demonstration launch. I was assisted in the demonstration launch by Mike Jungclas and "Jedi" George Riebesehl.

Conditions were nearly perfect and the setting was gorgeous. The sky was clear blue, the breezes light and the temperature was about 75 degrees. The demonstration was atop a grassy knoll in an ample field behind the school. There is something almost magical about seeing a model rocket rise into a clear blue sky with 100 enthusiastic on-lookers.

As a warm-up we started with an Athena powered by an A8-3. The countdown and flight were flawless. It was nice to know that there was no loss in enthusiasm over the past year. Everybody joined in the countdown and cheered like it was a space shuttle landing at touchdown. Next came flights of a boost glider, a rocket glider that caught a weak thermal for a very nice flight, a Helio*Copter, Pathfinder, Flying Saucer, and a Nerf Javelin. The Javelin is a converted hand-toss toy and it does quite a spectacular bounce on impact. Just straighten it and it's ready for another flight. The final flight was my Optima-G. It is an Optima modified to fly with G42 motors. For the demonstration I chose a D13-4W Reloadable Motor System. The flight was spectacular! The D13 makes a large white flame and is very loud. It deployed its parachute just after reaching an apogee of about 500 feet. It was a beautiful sight.

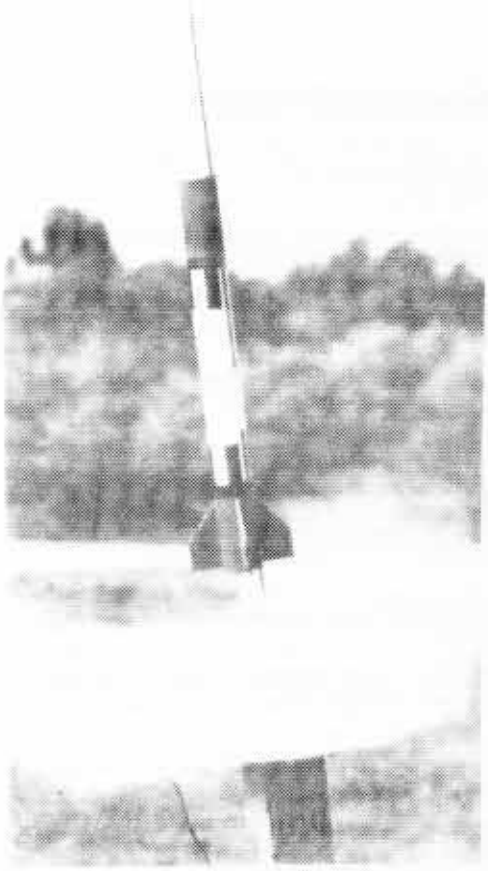
Regrettably, we were not prepared to fly the RCRG. We will be next year!

I'm looking forward to a repeat performance. Next year I will have 2 kids at Prairie school. Maybe we can give two demos. We received many complements and thanks from the teachers and principal, Mr. Pool. He asked all kinds of questions about getting started and carrying a camera as a payload. Hmmm...Too bad the Astrocam is discontinued (hint,hint). Many thanks to Mike Hellmund and Mary Roberts for supplying 100 catalogs to give to the kids and teachers. I know they were appreciated by the kids and teachers.

Kevin fields questions from the enthusiastic crowd (Kim McKiou photo)

June Launch:
A Celebration of Things with Wings

Lawrence readies a 20 year old model



Ken's "Scud Buster" caught at ignition

Dave Price has discovered the the joys prepping slide-wings

Stephen Slouber checks out his Advanced Target Drone.

July NIRA Launch

By Mike Jungclas

2On July 19th, NIRA held its monthly launch at Melas Park in Arlington Heights. At least 59 people attended the launch. This was exceptional considering the late notice of the launch and the poor directions that most of us had. Some 112 rockets were flown.

Naperville Cub Scout den showed up to participate in the launch. Lucky Lloyd hosted the activities.

The Rest of the Story...

By Lawrence Bercini

While "Lucky" Lloyd handled the barrage of Gnomes and Leprecauns boosted by the Cub Scouts, NIRA was celebrating "Wing Ding". Our celebration of things with wings was greeted with much enthusiasm. Ken Hutchinson even took the trouble to build a Quest Aurora just for the day. The little glider performed famously!

A less auspicious attempt came from Ed Thiel whose chad-staged X15 was, shall we say, "interesting"? Dave Price was back with his Rebel slide wing an upgraded Delta "Tiger" parasite lofted by a Big Bertha. The Bertha weathercocked severely and appeared it would "buy farm" before it ejected, but the Tiger was released just in time.

Yours truly brought *only* winged models. On hand for the day for the first time in years, were all three sizes of the Strato Cruiser series. The Maxi executed its typical barrel-roll flight. Also well received was the maiden flight of the ESS Raven and a repeat performance of the National Aerospace Plane. Perhaps the most surprising winged entry was an old off-the-shelf flexie which boosted inordinately high with a 1/2A. Several minutes later the flexie was still climbing. Kevin McKiou was amazed! Curiously, Kevin had no winged models of his own...and the whole idea was his!

Although wing-less, other flights of note include Steve Koszuta's Roto Rocket, Ric Gaff's cute little Patriot, "Lucky" Lloyd's D Region Tomahawk, and Jim Christenson's E15 Initiator.

Everbody seemed quite pleased with Melas Park as a launch site. Given the right wind conditions it could host a variety of motor sizes.

Adept Rocketry

A Product Review

by Tom Beach

I just got an order of electronic goodies from Adept rocketry (Tommy Billings) and I'm a happy camper!

I got to see some of Tommy's devices at NARCON and hear his talk on electronics for rockets. I was very impressed with both the devices and with his knowledge of electronics. There are several soon-to-be-releaseditems that I'm particularly interested in (and, unlike announcements from other rocket companies, I get the distinct impression that this stuff will actually materialize more or less on schedule). If you haven't sent for the info sheets from Adept yet (see ad in the latest American Spacemodeling) here's what's on it:

Eight (8) different staging/deployment timers in various shapes, sizes and capabilities. All of these timers employ a nifty acceleration sensing switch to detect launch (the acceleration must continue for more than 0.5 sec before the circuit believes that you've really launched it -- you can't start it by shaking the model as may happen with a mercury switch system). I got the ST1210C, the smallest and lightest timer, 1.2 oz. with 12V lighter battery. It will fire a flashbulb or electric match. Time delay from 1 to 14 seconds is set with a screwdriver. LEDs indicate when the unit is armed and when you have ignitor continuity. Because of the "magic switch" it is a bit large (fits in a 1.15" inside diameter tube) but Tommy says smaller and cheaper timers are coming (perhaps in kit form, too) that are activated by burn wire or other switch. The ST1210C costs $27.95.

I also got a top of the line model, the PST940A, which is microprocessor based. Delay is set by dip switch, 0.5 to 25.5 seconds (0.1 sec increments). A piezo beeper indicates (by different beep patterns) when the unit is armed and if there is ignitor continuity (so you don't need holes in your model to see the LEDs). Fits 2.35" I.D. tube, weighs 2.5 oz. with battery. The battery is a GE rechargeable ni-cad, so this puppy can fire copperheads, homebrew thermalite, or up to four Solar ignitors (see below). $32.95.

Adept has five sonic beacons. They use patterned beep tones that repeat every 2 seconds, so the batteries will last up to 24 hours (or so it says). All units include a mute system that can keep the beeper silent until deployment (to save battery life and the nerves of the launch crew). Again, I bought the smallest and the largest units.

The SB1210A uses the tiny 12V lighter battery and puts out 85 decibels. It weighs 0.6 oz with battery, and fits in a 0.8" I.D. tube but can to fit into a BT-20 if you trim the corners on the battery holder. Cost is $7.95.

The SB950B is very impressive (and LOUD). It is powered by a regular run-of-the-mill 9 volt transistor battery, but the circuit includes a voltage multiplier so the unit puts out over 110 dB (Joyce won't let me play with it in the house anymore). 2.7 oz., fits 1.75" I.D. tube. The big beeper (SB950B) is priced $18.95. It comes with a warning that

the beacon is loud enough to cause permanent hearing damage... yeow, I believe it!

Coming in July is a $49 altimeter that is great. Relatively small (BT-50?...I don't have the specs) you launch it into the air, and when it returns it will be beeping out the maximum altitude (beep-beep-beep...beep-beep...beep = 321 feet). Too cool. A $79 altimeter is due in August that will log the altitude data into EPROM for later recovery and downloading.

Not to mention the on-board computers (four models, most with built in altimeters). Dave Gianakos' Saturn 1B (see cover of recent 'Spam & Tripolitan) flew with a prototype of these units. And further in the future there are the transmitters ($10-$20 range), and other goodies. The on-board computers are due out between June and December, depending on which model you want.

If you love rocket electronics, you should check out these nifty devices. No, I don't own stock in the company or anything like that -- I just hope enough people buy these things so he'll stay in business long enough for me to buy one of each! Tommy also seems quite receptive to suggestions, so if you have some electronic device you always wanted for your rocketry activities, drop him a line and request it.

About the 9 volt battery: During his talk, Tommy discussed the special properties of the General Electric 9 Volt (well, 7.2 volt) rechargeable ni-cad battery. Because of its very low internal resistance, this battery can throw multiple amps of current through an ignitor (other 9V ni-cads have a much higher internal resistance, so they CAN'T do this). I've placed some wire (the thick part of a solar ignitor lead) across the terminals of a GE ni-cad... Fffzzt! Vaporized. Impressive! Tommy claims that when you use these batteries to fire copperheads, the high current will melt away any of those pesky shorts around the edges of the ignitor that often make copperheads difficult to ignite (and then will pop the ignitor, of course).

Note that Radio Shack and other 9V ni-cads I have tried can not do this. In fact, Tommy also said the Eveready 9V ni-cad (which is really the same GE battery) will work as well, BUT BE WARNED: I have found that the Eveready 9V batteries available in my area are NOT the same as the GE (Eveready apparently has changed their source of batteries). The GE battery is has squarer corners, is dark gray in color, and is made in Hong Kong. The bad batteries have rounder corners, are black, and are made in Singapore. On the good Eveready batteries, the label goes only part-way around. On the bad Eveready batteries the label goes all the way around the battery.

Adept's full line catalog is supposed to come out later this year. For now, you can get the latest info sheet by sending $1.00 or a #10 SASE to: Adept Rocketry, P.O. Box 846, Broomfield, CO 80038-0846.

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Move Over, Jane - The 176 pg. "Aerospace Facts and Figures 91-92" provides historical data on missiles and space programs. Write: Aerospace Industries Association, Attn: Aerospace Research Center, 1250 Eye Street, N.W., Washington, DC 20005. Cost is $21 plus $4 shipping.

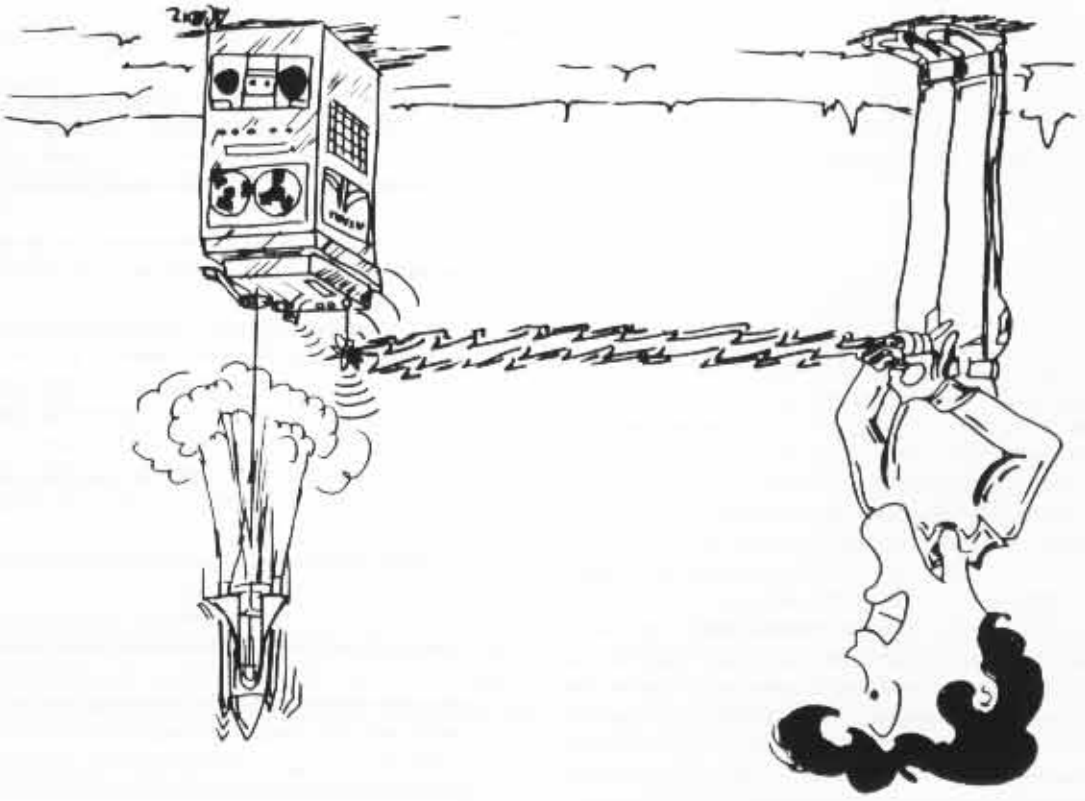
Final Flight - We are saddened to learn of the death of Ric Gaff's 93 year old grandmother in Fort Wayne, IN. Ric, please accept our sincerest condolences.

What a Ride! - "I would describe it as the bottom floor of a tall building exploding...you hear a ripple of pops...you get a lot of buffeting...feels like the great train wreck...the whole thing unloads likd a coiled spring and you get bumped around a bit." No, it's not a description of a new Great America attraction, it's astronaut Ed Gibson's recounting of riding inside a Saturn 1B.

New York, New York! - A fond NIRA farewell to Pete Olivola and his family. Pete's taken a new job in the NYC area to do some custom software development. Our loss is Garden State's gain. During his time with the club, Pete helped add to our HPR expertise and spearheaded the NIRA-Tripoli 36 merger. Best wishes in the Big Apple, Pete!

Baby Parks - No, it's not a new place to fly 1/4A events. Instead, NIRA congratulates Bob and Karen Parks, scheduled to be proud parents come April 1993. Bob is the designer of the Aerotech Phoenix.

Life in the CIS - More news on the space front from the Commonwealth of Independent States. A new MIR 2 space station has begun construction. The station will ultimately replace the current MIR core sometime in the mid-90's. Energia will be used to loft this slight larger main module along with additional Kvant type modules pre-attached. Also under development is a prototype "solar sail". Made of an aluminized plastic, the sail will be tested after a Progress supply craft departs MIR. Cosmonauts aboard the station will monitor the deployment from several hundred meters away. The sail contains no frame and will be deployed using solar pressure only after a spring assist from the Progress. Finally, CIS is trying to interest payload managers in a Progress vehicle that will put 2,200 lbs into low earth orbit.



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