Association of Experimental Rocketry of the Pacific

TRIPOLI Rocketry Association, Inc. Prefecture No. 23

Volume 21 Issue 2

October 2015

AEROPAC Fall 2015 Newsletter

Photo by Phoenix 4, courtesy of Curt Von Delius

President's Pad Jim Green

Greetings, fellow AEROPAC members.

As most of you know, Tony Alcocer has stepped down as our President and Prefect after 8 years of service. A big thanks to Tony for all of his hard work over the years.

I have volunteered to take on the role of President and Prefect along with our new Vice President, Erica Bradley.

Karl Bauman has volunteered to take on the role of Chairman.

What's Inside

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President's Pad

On a sad note, we lost our Vice President, Richard Hagen, this year. Richard played a big part in our club and will be sorely missed.

We continue to see high flights at our launches. Curt Von Delius and Monica got one up to 96,000 feet at XPRS.

A big thanks to Ken Biba for the fundraising he has done. With his help we have received large donations from Sonoma State and Magnitude IO to pay for the Sat Van expenses and education programs.

Of course, a big thanks to my wife Becky for running her butt off keeping ARLISS on track, along with help from Jennifer Curtis and Eric Melville.

Photo by J. DuBose


Photo by J. DuBose

Thank You, Tony!

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Richard Hagen

1947—2015

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Volume 21 Issue 2
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End of the Year Member's Party

December 6th

Frankie, Johnnie & Luigi, Too!

11891 Dublin Blvd, Dublin, CA 94568

Party Schedule

11:30 am - Board of Directors meeting

12:30 pm - Member Gathering

1:00 pm - Lunch served

3:30 pm - End of festivities

Special Guest Speaker: Bill Colburn

Rocketry Pioneer and Aerospace veteran

“ A History of Experimental Amateur Rocketry and Details of the Oak Project to Space”

Book Review: *Sacramento's Moon Rockets*

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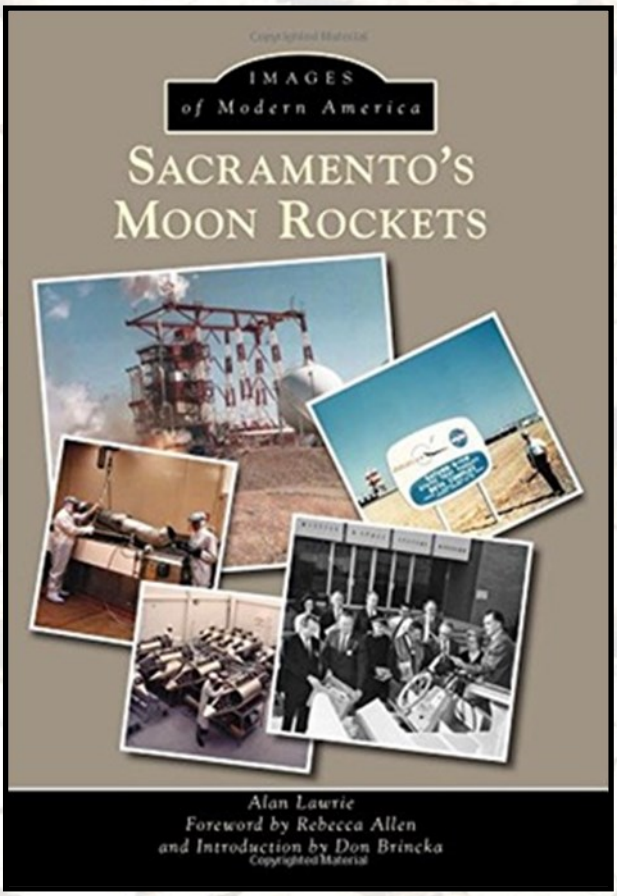

Sacramento's Moon Rockets
by Alan Lawrie
Arcadia Publishing, 2015
paperback, 96 pp., illus.
ISBN 978-1-4671-3389-0
US$22.99

When thinking about the key facilities that made the Saturn V possible, a couple obvious places come to mind: the Marshall Space Flight Center, where the vehicle was designed, and the Kennedy Space Center, where it was launched. Others were involved in the production of the vehicle, including the Michoud Assembly Building in New Orleans where the first stage was built, and factories in Southern California that produced the second and third stages.

What likely doesn't come to mind is Sacramento, California, which can make the title of Alan Lawrie's new book, *Sacramento's Moon Rockets*, a little surprising. Yet Sacramento—or, more accurately, the suburb of Rancho Cordova—did play a key role in the Saturn V, serving as the test site for the S-IVB third stage after it was built by Douglas in Southern California and before it was shipped to the Kennedy Space Center for integration.

The test site, known by Douglas as the Sacramento Test Facility, or SACTO, had its origins in the mid-1950s, when Douglas won a contract to develop the Thor missile and needed a test site. Douglas purchased 2,000 acres of property that Aerojet had acquired several years earlier in Rancho Cordova for its own engine testing—land that had been used for gold mining at the turn of the 20th century and rendered unusable for farming or other development as a result—and established a test site. Those facilities were expanded when Douglas won the contract to build the S-IVB stage.

Book Review: *Sacramento's Moon Rockets*

The book is largely a pictorial history of SACTO, covering the site's development and use through the Apollo program in images and captions. That includes chapters on the site's development, transportation of stages (initially by ship, and later by Super Guppy aircraft), testing, and several notable explosions that took place there during those tests. One notable benefit of those explosions, former Douglas chief test conductor Don Brincka notes in the book's introduction, was that it allowed NASA to calibrate the explosive force of the combination of liquid hydrogen and liquid oxygen propellants: while NASA once thought that this combination would have the explosive force equivalent to 65 percent of TNT, it turned out to have only five percent the force.

The book's last chapter revisits the site near the present day (2006 and 2013), long after the test site had been abandoned. Douglas (later McDonnell Douglas, and now part of Boeing) didn't use the site again after completing acceptance testing of the last S-IVB stages in 1969, and sold the site back to Aerojet (now Aerojet Rocketdyne) in the 1980s. Those photographs of the remaining structures were part of efforts to document the sites for Historic American Engineering Record before they were demolished.

Sacramento's Moon Rockets is not a thorough history of the development and later decay of SACTO: the book relies on photos, and not other historical documents, to tell the story of how Douglas used the test site during the early Space Age. It is, though, a reminder of the vast scope of the Apollo program, one that made use of facilities long since forgotten to achieve the goal of landing humans on the Moon.

Jeff Foust (jeff@thespacereview.com) is the editor and publisher of The Space Review, and a senior staff writer with SpaceNews. He also operates the Spacetoday.net web site. Views and opinions expressed in this article are those of the author alone.

Available through Amazon.com

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Volume 21 Issue 2
October 2015

XPRS High Power Contest Winners

Darryl Paris

XPRS 2015 went down as one of the best weather conditions I've ever experienced, perfect no wind and mild temperatures made for a perfect contest atmosphere! This is the first year we've had participants in every motor class and a few classes having up to 7-8 competitors and we've also done away with posting the entrant cards to the table in favor of a ballot box to keep it more competitive. This year there have been some competitors that have really shown their stuff, like Joe's H-motor rocket to 10.5k' and Jonathan's Full Bore Linear Panic 2-stage rocket to 55.3k'. Matt Sikkink had two perfect 2 stage flights with the same airframe—the second one ripped to 44k' plus. And, of course, there was Curt's NASA quality PHX4 screaming to 95,786' !!!

Random items: There has been some talk of opening up a two stage rocket class and I'd like to hear some feedback on how we could judge this. Do we judge this on motor impulse and have a disqualifier if a rocket part comes in hot? Let me know on the club email or AEROPAC Facebook page.

I think the contests are a good avenue to bring new flyers closer into the "all volunteer" club and this year we've had new faces get involved, so encourage your neighbors the at the next camp to compete & participate in the contests, who knows they might end up being our club Prez one day!

Left: James Flenner won the "J" Impulse trophy

Right: Matt Sikkink took the "M" Impulse trophy.

Left: Jonathan DuBose took the "N" Impulse award.

Right: Curt von Delius, shown with his support team, took the "O" impulse class.

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TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

XPRS Loft Duration Contest Winners

Darryl Paris

A Motor class
1st Place Zoe Paris 13.30 sec *"Iris"*
2nd Place Michael Paris 11.57 sec *"Dark Star two of Doom"*
3rd Place Will Swenson 6.59 sec *"Golden Snitch"*

B Motor Class
1st Place Keanu Paris 52.53 sec *"For the NCR"*
2nd Place Keanu Paris 48.52 sec *"Alpha Rocket"*
3rd Place Zoe Paris 29.92 *"Dragonite"*

C Motor Class
1st Place Zoe Paris 124 sec *"Sky Writer" 54" chute!*
2nd Place Keanu Paris 115 sec *"Subject III"*
3rd Place Hailey Yearnshaw 53.06 sec *"Nightmare Moon"*

D Motor Class
1st Place Michael Paris 65 sec *"Dark Star of Doom"*
2nd Place Will Swenson 47 sec *"Decal Monster"*
3rd Place Will Swenson 45.53 sec *"Decal Monster"*

E Motor Class
1st Place Michael Paris 97 sec *"Dark Night Jr"*
2nd Place Will Swenson 63 sec *"Masonite"*

F Motor Class
1st Place Michael Paris 51 sec *"Blue Thunder"*

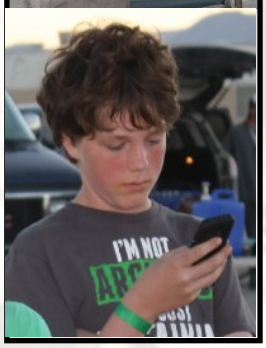
G Motor Class
!st Place Keanu Paris 219 sec *"My Mustache is Awesome"*
2nd Place Trevor Gabbard 151 sec *"Red Flame"*
3rd Place Trevor Gabbord 142 sec *"Red Flame"*

Zoe >>>>>>>

Michael >>>>>>

Keanu >>>>>>>

Will >>>>>>>



Photos by J. DuBose

XPRS Awarded High Altitude Rocket - “Purple Passion” - 3rd Place “M” Impulse

Derek Stavenger

This was my level 3 rocket. I built it to last with Hawk Mountain tubing, G10 fins and tip to tip carbon/ Kevlar fin reinforcement. I find carbon/Kevlar less brittle (and breakable) than plain carbon. The difficulty in working with it is that the cloth has to be well covered with fiberglass and one must be careful not to sand through to the Kevlar or fuzzy Kevlar fibers will be exposed, which will not sand off.

One design feature was to put the main parachute in the nose cone. I potted a piece of Kevlar in the nose cone tip to which I attach the chute and shock cord. The way it works is that you put your charge in first, followed by the Nomex-protected chute. I was a bit worried about the Kevlar eventually burning through with repeated charges but it has shown little signs of wear after 12 flights. I like the parachute in the nosecone which uses potentially wasted space. This allows the airframe to be shorter.

The first flight of the rocket which was also my first level 3 attempt was not successful! The lower airframe was attached to the nosecone and avionics bay via an "eye nut" turned on a threaded rod which was in the end of the motor case. Tumbling from 20,000 feet on drogue, the eye nut unscrewed itself! This resulted in the famous core sample photo which appeared on the club membership card for a couple of years. Ouch! The motor case was slightly damaged but the airframe was, by and large, fine. I dug out the playa plug and trimmed 1/2" off the end and the rocket was ready to fly again (but with a new shock cord attachment). I used the old eye nut and the new and current attachment system, which is a Kevlar harness I made and secured with 2 lock-nuts.


Photo courtesy of D. Stavenger

Having to buy a new case and another M motor was painful and steered me in the direction of making my own motors. Thank you, Tony for your generous teachings! I did fly one more commercial motor, an M650, which flew to 31,000 feet. All 9 subsequent L and M class EX flights have been successful. The contest winning flight was "Soylent Green" propellant which has worked well in long cases. Thank you, Jeff Huber! There was one post flight glitch. I had put some masking tape on the bottom of the motor case to keep it from rattling around which resulted in the motor case getting "glued" to the airframe. All the strap wrenches and all the King's men couldn't budge it. Aidan Sojourner and I devised a method for pulling the case out of the airframe. I used a short piece of body tube, a piece of slotted plywood and a wheel puller pulling on the internal snap ring. Came right out! Thank you, Aidan!

I like building my rockets strong with some attention to weight. In fact I only have 2 airframes, this one and a minimum diameter 54 each with a dozen or more successful flights. Next year we might see new airframes (nose cone and fin can design with no body tube!) Motors might be for a 75mm 10,000 ns Kosdon case and a 98mm full N case (thank you, Frank!}.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

XPRS Awarded High Altitude Rocket - "TAS EXpress" - 1st Place "M" Impulse Class

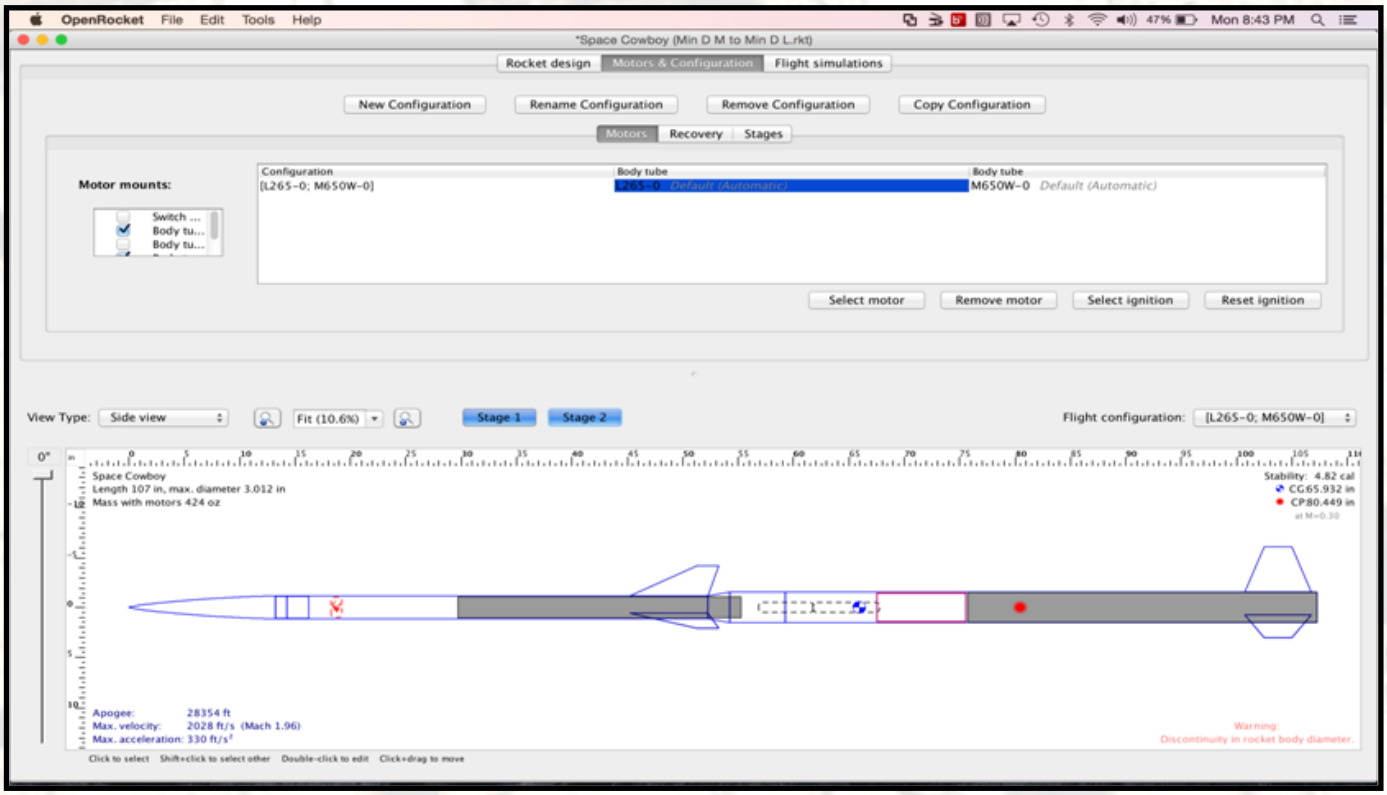
Matt Sikkink

Overview

Last summer, after a brief stay in lovely Alabama, I attended my first Maryland-Delaware Rocketry Association (MDRA) launch at my new home in the Washington, DC area. After a visit to the local proprietor of all things rocket related, I discovered that CTI released a long burn L motor in the 54 mm 6GXL case. After about 3-4 seconds of thought, I decided this motor was begging to take a ride in the sustainer of a two-stage rocket and made a purchase. I'd flown a couple of two-stage rockets before with varying degrees of success, but I was able to launch and recover a two-stage rocket to over 30K. Using this knowledge, I realized I could get some serious altitude with a relatively small (<M) amount of installed impulse. All that was left was to start designing and building!

Design

The basic design philosophy was to create a minimum diameter 54 mm rocket staged from a minimum diameter 75 mm booster. My primary goal was to build a stable platform (to combat some problems I had on previous designs) that minimized recovery space. I chose the Aerotech M650W for the booster due to its excellent initial boost, long burn, and regressive burn profile. For the sustainer, I picked the CTI



"TAS EXpress"

Matt Sikkink

L265 in the aforementioned 6GXL case. I played around with some various fin designs but decided on Nike Smoke-style trapezoidal fins for the booster and swept fins for the sustainer. Fully loaded with motors, I was looking at over 4 calibers of stability for the full stack and just under 3 calibers for the sustainer. All in all, I felt that this configuration would yield an extremely stable but not over-stable flight and gain decent altitude. Initial simulations indicated I should reach over 40K.

Sustainer Build

The sustainer build was quite challenging due to the limited recovery area and space for electronics. I decided to put the electronics in the nose cone and use a parachute cutter on a 36" Fruity Chutes IRIS Ultra, which solved both problems. I turned my own aluminum bulkhead on a lathe (thanks TechShop DC -Arlington!) and also built my own motor retention device. I was able to fit a Altus Metrum TeleMega, Raven w/Power Perch, and battery in a Performance Rocketry 54mm Von Karmen nose cone.

Photo by M. Sikkink

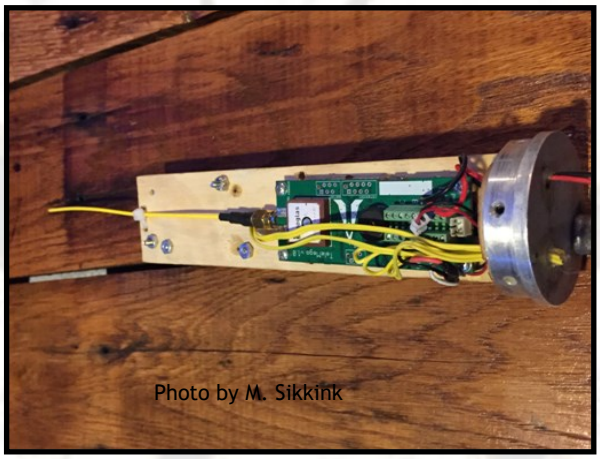


Photo by M. Sikkink

The chute cutter (from Archetype Rocketry) worked great after some trial and error. I eventually decided to attach the parachute directly to the nose cone to avoid problems with the e-matches fouling during the long descent on drogue.

For the fin can, I cut custom .060 G10 fins on a Shop Bot 3D router using a PCB bit at very high speed. I was very pleased with the results from the Shop Bot and it beat cutting fins the old fashioned way!

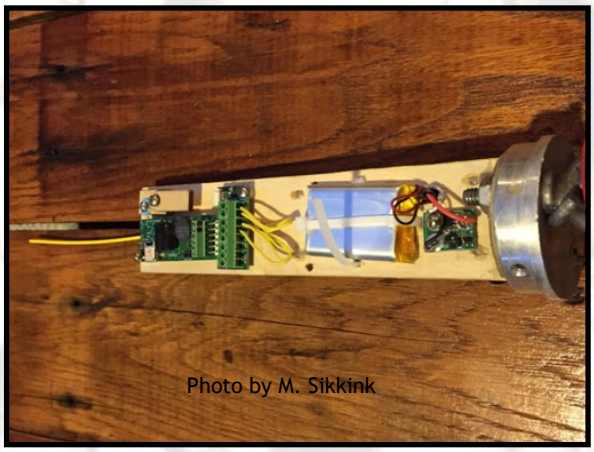


Photo by M. Sikkink

"TAS EXpress"

Matt Sikkink

After I cut the fins, I vacuum laminated 3 layers of carbon fiber cloth on each side for an extremely strong yet lightweight fin core. I attached the fins to the rocket body with JB weld on the roots and Pro Line 4500 for the filets. After this, I vacuum bagged 3 more layers of carbon fiber cloth tip-to-tip for added strength. All in all, probably overkill, but the fins were extremely strong and I had no worries about their integrity over the extremely stressful two-stage flight.

All that was left was to figure out how to light the CTI motor on the upper stage. More on that later!

Booster Build

For the booster, I faced many of the same challenges as building the sustainer. Minimized recovery space was a difficult task, so I used a Y harness similar to the AEROPAC 100K project with a 12" Fruity Chutes drogue and 48" Fruity Chutes IRIS Ultra main. I once again turned my own motor retention, but added a lip to attach a coupler that would house the electronics.

I 3D printed a sled to house a Raven w/Power Perch, Missileworks RRC3, and a BRB 70 cm for telemetry. All in all, I was able to minimize space while utilizing a complex array of electronics.

I made the fin can in a similar fashion to the sustainer and was very pleased with the results. I cannot say enough about the resources at TechShop and the precision with which I was able to cut parts on the Shop Bot.

Interstage Coupler

With the sustainer and booster built, I needed to build an interstage coupler. Having built a few, I decided to turn my own on the lathe out of solid aluminum. Because the aft closure of the CTI 6GXL motor does not allow for motor use as a coupler, I had to use the outside of the sustainer body tube. Not a big deal, but it changed the design slightly. Boring a 3" solid piece of aluminum is not all that fun, but after some trial and error (and the purchase of a ¾" indexable boring bar) I came up with a good process that gave me the result that I wanted.

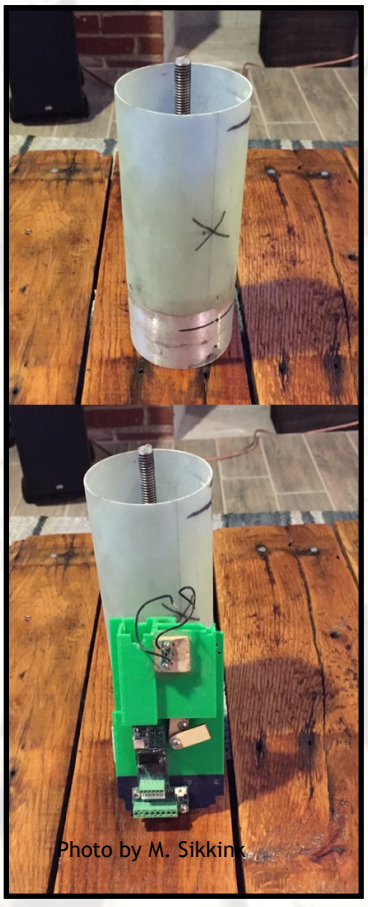


Photo by M. Sikkink

"TAS EXpress"

Matt Sikkink


Photo by M. Sikkink

Because I wanted to use active separation, I turned another bulkhead to sit between the recovery system and the ISC. This served two purposes: one, I had somewhere to put the separation charge completely isolated from the booster recovery section, and two, if the sustainer lit before separation it would only torch the aluminum bulkhead.

Completed rocket:


Photo by M. Sikkink

Sustainer Ignition

There are only two ways, in my mind, to light the upper stage. Preferably, I would have liked to use head end ignition. Due to the nature of the CTI motor, this was much more trouble than it was worth. I decided to use copper foil tape run along the body, insulated with Kapton tape. I soldered the upper stage leads and igniter to the copper tape. This system worked surprisingly well and was actually not too difficult to pull off.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

"TAS EXpress"

Matt Sikkink

The Flight

I flew a test stack on Friday of XPRS to make sure all my systems worked. They did, and I successfully flew a K550 to I242 to over 12K with perfect recovery and superb telemetry. I cleaned up the flight, prepared the rocket, and looked forward to flying on Saturday .

Saturday at XPRS was one of those rare flying days on the playa where the wind was minimal on the surface and the altitude winds were very light. After witnessing Curt and Jonathan fly their two stages successfully, I decided to put TAS Express in the air.

After some exciting igniter issues, I was finally ready to go. I set the tilt angle to less than 20 degrees on the TeleMega and set the staging delay to 2 seconds. Rather conservative on the delay and a little aggressive on the staging angle, but I didn't think either would be a problem.

After a perfect boost, I waited in extreme anticipation as the sustainer lit and flew out of sight. I lost telemetry after exceeding the GPS limits, but regained it shortly after the drogue deployed. Confident I had a good rocket on drogue, I began to look for the booster. Initial reports were that it was coming in hot, but both chutes actually shredded and it came it very hard but a deployment event did happen. After much data analysis, I could not figure out why both chutes shredded, but based on the physical evidence, it happened at a very high speed. Both booster altimeters reported over 17K for the booster, leading me to believe it was arcing over and going very fast when the drogue charges fired, pulling out both parachutes and shredding them both. I had some minor airframe damage and a dent in the motor case (from slamming into the ISC which landed just before it), but I recovered the electronics intact.

The sustainer deployment went perfectly and my team (the one and only Dr. of BBQ, Dick Jackson) and I recovered it less than two miles away. The result? 44,947 ft on 8,610 N-s (roughly 66% M).

Photo by J. DuBose

Smoke trails from Matt's M650 to L265 flight

"TAS EXpress"

Matt Sikkink

2015-09-19-serial-1619-flight-0011.eeprom

Flight Graph | Configure Graph | Flight Statistics | Map

Serial	1619		
Flight	11		
Date/Time	2015-09-19	23:04:50 UTC	
Maximum height	13700 m	44947 ft	
Maximum GPS height	14213 m	46631 ft	
Maximum speed	614 m/s	1373 mph	Mach 1.8
Maximum boost acceleration	156 m/s²	513 ft/s²	16 G
Average boost acceleration	67 m/s²	219 ft/s²	7 G
Drogue descent rate	-31 m/s	-101 ft/s	
Main descent rate	-20 m/s	-65 ft/s	
Ascent time	13.0 s boost	35.0 s fast	10.0 s coast
Descent time	462.2 s drogue	15.2 s main	
Flight time	526.4 s		
Pad location	N 40° 51.110664'	W 119° 7.344504'	
Last reported location	N 40° 50.147742'	W 119° 5.021844'	

Search the web and Windows 8:18 PM 10/12/2015

For an airframe optimized for stability and flying with a short staging delay, I'm quite pleased with the performance. Minus the booster, I am very happy with the whole flight and have no problem with how the flight finished. The booster issue still perplexes me as the data doesn't really indicate what happened, but physical evidence being what it is, I can safely say the booster suffered from a high-speed deployment. Overall, TAS Express proved many of my design concepts and construction techniques. I'm already working on optimizing the platform for next year by reducing the fin spans, reducing recovery space even more, and trying to reduce the overall weight. Thanks much to my rocket support team of Jonathan DuBose and Dick Jackson and all the wonderful folks at AEROPAC! See you on the playa!

Photo courtesy of Matt Sikkink

Association of Experimental Rocketry of the Pacific
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Volume 21 Issue 2
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XPRS Awarded High Altitude Rocket - "Full Bore Linear Panic"* - 1st Place "N" Impulse

Jonathan DuBose

I got the 2 stage bug in 2007 when I saw Dave Raimondi's beautiful Quantum Leap fly at Snow Ranch. At BALLS that fall, I flew my own PML Quantum Leap II (QEII) to ~14k' using an AT K550 staging to an AT K185. I was jazzed and could hardly sleep thinking about the possibilities 2 stage rockets offer.

Before I go any further I have to pay homage to AEROPAC's 100k team. Although I had a plans for an N to M two stage before that team existed, they led the way and showed that while using available commercial motors, electronics and components, it was indeed possible to create and fly rockets very high. In the end I borrowed many ideas from their pioneering effort. I won't mention every concept I borrowed but if you are familiar with their design when you see pics of my rocket you will immediately understand they are first cousins, if not siblings, maybe even fraternal twins. Ken Biba and Dave Raimondi encouraged and educated me along the way.

Arming the sustainer electronics—two Featherweight magnetics switches, XPRS 2015

Flying high-power two–stage rockets requires a lot of focus, attention to detail and just plain hard work. It is way more than just 2 times a single stage rocket, but the satisfaction felt after a successful flight is right up there with knowing you have flown a season of ARLISS or helped a kid fly his first rocket. Perhaps this article will help point the way for others thinking of a similar project.

I Found out what " Complex" means

Flying high-power two-stage rockets does get quite complicated – we call them "complex" for a very good reason, and getting to the point where I felt confident to even try such a project was an interesting process.

This article is not an exhaustive read on everything about "Full Bore." There are many sources for carbon fiber layups, mounting electronics, etc. Instead, I will outline how a number of problems, encountered in building and preparing to fly this rocket, were resolved.

Flight Computer: Finding a flight computer that made sense to me and had the functionality to stage was somewhat of a challenge. I found that the Featherweight Raven was a nice compact unit, was easy to use, and had the functionality I needed and was reliable for staging my K to K two stage rockets as

Full Bore Linear Panic

Jonathan DuBose

well as standard dual deploy as long as I used the Barometric settings (not "Accelerometer") settings. There are a lot differing opinions on the Raven and not everyone's experiences have been as positive as mine. However, the Raven was not going work for a staging device on this project but was used for backup deployment.

Tilt Angle Failsafe: For very high-flying two-stages there is another critical factor to consider. Lighting a long burn motor after an off-vertical boost can result in flying out of the waiver and should be avoided. In the early stages of planning, the only device that addressed this issue was the Tiltometer, an off vertical failsafe, but it was no longer in production. In late 2013, Altus Metrum introduced the Telemega, which featured configurable, off-vertical functionality, allowing the user to easily define "tilt limits" - what angle is acceptable before lighting the sustainer motor. This high functionality unit has everything – apogee/ main deployment, 4 more programmable pyro channels (I use "A" to fire the sustainer motor) as well as a GPS with telemetry. The use of Kalman filtering gives this unit stellar performance. For me, the Telemega sets the standard. Actually, if there is any other product which delivers this amount of functionality I am not aware of it.

Right: Altus Metrum Telemega mounted on a 3D print sled. An AEROPACK Min Diameter retainer reinforced with a JPS aluminum sleeve also acts at the thrust ring. Secured to airframe with qty 7 6/32 allen head screws. Photo by J. DuBose

I have flown the Telemega 7 times, 3 times in 2 stage situations with expected performance. The exception was an early firmware glitch causing early staging and that was immediately corrected.

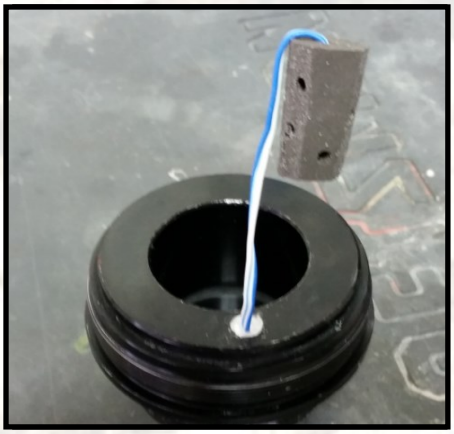
AEROTECH Blue Thunder ignition: Another hurdle was figuring out a pyrogenic device to actually ignite the sustainer motor. Normal igniters won't work since they require more current than flight computers can supply. Karl Bauman at Aerotech gave me a tip that got me on the right track. He suggested using Blue Thunder propellant and an e-match (initiator). I experimented with Blue Thunder and found that if you (very carefully and very slowly!) drill a hole long ways through the center of an ~ 1"X3/8" piece of BT and bore 4 horizontal offset holes sideways through the slug and insert an ematch halfway into the vertical hole, you get 6 jets of flame and the slug doesn't try to fly out your nozzle. Flame jets out of the top and bottom and out of the horizontal holes, and that will light ANY motor. Getting this device positioned in the motor, especially offset cores with Medusa nozzles, can be a challenge. Some folks use thermite,

Full Bore Linear Panic

Jonathan DuBose

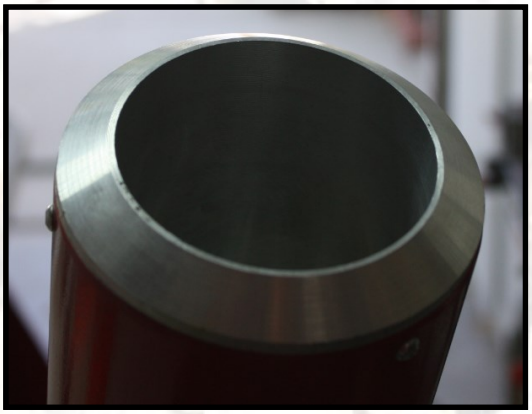
some use a pyrodex pellet. My Blue Thunder method works for me.

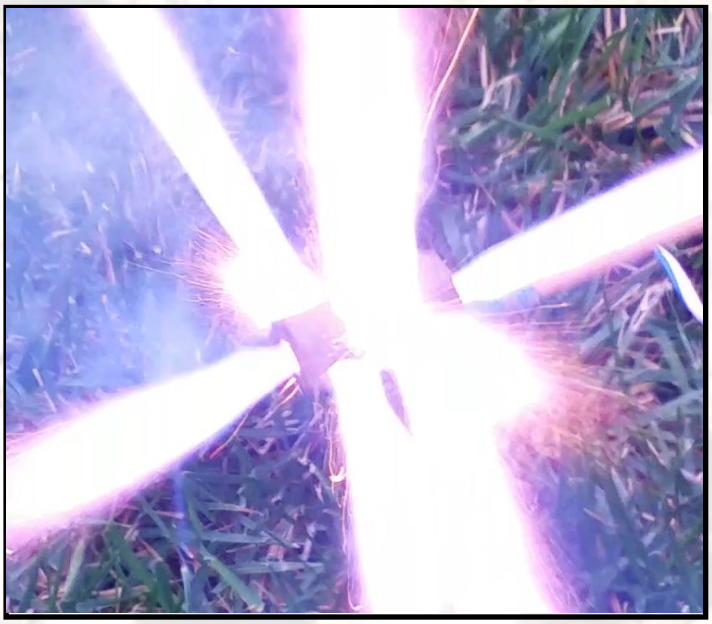
CAREFUL! Blue Thunder works well because it lights very easily. Use extreme care when handling this propellant!



Forward Closure modified for Head End Ignition with Blue Thunder slug and initiator

Interstage Coupler: Creating a strong inter-stage coupler (ISC) is essential for any 2 stage and especially for a rocket that would use the motors I planned for. I decided to use the lower end of the sustainer motor as a "coupler" that would slide into an aluminum machined receiver on the booster. I had seen this done on several 2 stage projects. Having seen work done by JPS Machining I contacted James Marino. James delivered a beautiful piece of work but alas (!!!) my spec was not clear and I soon realized it wasn't going to work. James created another masterpiece and UPS lost that one! At that point, Matt Sikkink offered to try his new machining skills after being certified by his local "Tech Shop." Matt delivered his "best work to date" and my problem was solved. The AT 75/7600 (or 6400) motor case with a "min diameter closure" slid in and out smooth as silk and with no slop at all.





Blue Thunder… it works for me!

Wiring for 2nd Stage ignition / Head End Ignition (HEI): Another problem to address with minimum diameter sustainers is how to run the wiring from your flight computer to your pyrogenic device for lighting the sustainer motor.

Option 1: Run an adhesive—backed flat paired wire over kapton tape down the outside length of the sustainer motor, cover it with another layer of kapton, solder one end to wires leading to the flight computer staging channel and connect the other end to the pyro device which is fed the normal way into the motor. I have seen this method work well but I have also seen it fail seemingly as often.

Full Bore Linear Panic

Jonathan DuBose

Option 2: Head end ignition (HEI). This method requires drilling a channel through the forward closure to allow an initiator to be fed through. A larger channel ~.25" is drilled from the bottom of the closure. It is then necessary to "pot" the initiator into the .25" channel with a material that will prevent hot gases from burning through the closure.

I decided to use option 2 and again turned to JPS Machining which delivered another very nice piece of work. After some research and consulting with others who used this method (99K team, Dave Kenyon), I decided to use a potting material called Ceramacast 575N. The specs indicated that this material should work fine.

Right: Post flight analysis indicates no degradation of material used to "pot" the HEI device. In fact, it seemed to get harder and more dense with the heat of the burning AT M650W

Building an Aerotech long burn, offset core motor modified with HEI: Another issue is how to build the motor around the forward closure with the head end device. Since the forward closure threads on and the initiator with pyrogen also has to fit through the seal disk with an offset opening, simply building the motor will result in a sheared off initiator/ pyro device. To compound the problem, the motor is an offset, moon burn core. Quite a conundrum.

When consulting with Dave Kenyon, the only person I know who has used head end ignition with an Aerotech long burn motor (TheoMAX N2000 to N1000 XPRS 2010), I got the answer. Instead of screwing the forward closure into the casing, you screw the casing onto the forward closure while holding the forward closure in place and keeping the liner with the glued in grains and forward seal disk from turning. I created a jig that stabilized the liner / grains / seal disk and built the motor. It helps to have someone hold the forward closure in place while the motor case is turned. Being able to relatively easily build the 75/6400 or 7600 motor with HEI was a huge breakthrough. Thanks Dave! **Note: HEI makes your rocket an "EX" project since you are modifying a commercial product.**

!!!HEI Caution!!! Installing the HEI should be the final prep before heading to launch pad. Extreme care must be taken while building an "HEI" motor! When HEI is installed your motor is now "live", you have a low current igniter installed. Avoid static electricity or anything that could initiate ignition. Short the ends of the initiator. Point the rocket away from camp, don't stand behind it . Get a "remote" RSO signoff in your camp. Very bad things *WILL* happen if premature ignition occurs.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

Full Bore Linear Panic

Jonathan DuBose

Sustainer Design/Build: The sustainer is basically an upscaled "Space Cowboy". I really like this rocket especially the fin design / shape. I cut the fins from .125 G10, tacked them to a Performance Rocketry (PR) filament wound 3" fiberglass airframe and made fillets with System 4500 high temperature epoxy. I then did a tip to tip layup with a two layer lamination using 5.7 oz,, 0.012" thick, 3K, 2x2 twill weave carbon fiber fabric with West Systems 105 resin and 206 slow hardener epoxy. The leading edges of the fins are painted with Proline 4500 epoxy. The entire airframe was coated with West Systems 207 "brushable" epoxy and clear coated with MAX Spray 2K Glamour High Gloss Clear Coat.

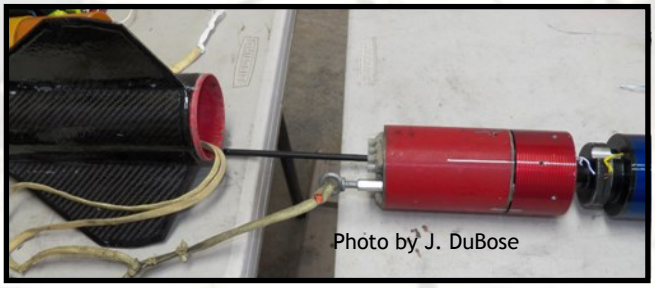


Photo by J. DuBose

Final prep: Note parachute "Y" harness, Telemega antenna chimney. E-bay screwed onto the retainer / thrust ring which screws onto the top of motor forward closure. Note that HEI system has not been connected. All this slides forward into airframe and is secured as mentioned above.

The nose cone is an off the shelf PR 5:1 fiberglass Von Karman design. A Big Red Bee 70cm GPS unit is mounted in the nose.

Booster design and build: 4" PR filament wound tubing with a 3 fin Rousetech fin can.

Full Bore Linear Panic sustainer buttoned up and ready to rock.

Test flights at XPRS 2014 / OROC Spring Thunder 2015: The booster airframe flew on an AT M1419W at XPRS. It flew exceptionally straight and everything worked as expected. I also flew the sustainer on an AT M685W at XPRS. In a surprise to me the sustainer exhibited considerable instability. According to ROCKSIM and OpenRocket I had over 1 caliber of stability and the final balancing bore that out. Although I was confident that, with the speed of a two stage boost and the stability afforded by the 30 ft Uber Rail, sustainer stability would not be a problem, I wanted another test flight.

OROC – 2nd sustainer flight, May, 2015. After adding 9oz of weight to the sustainer nose cone, I went up to Brothers, OR to make another flight. Full Bore (S) again showed some instability but it was a very straight flight to over 30k'.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

Full Bore Linear Panic

Jonathan DuBose

XPRS 2015 Configuration: Motors: AT M1419W to AT M650W

Sustainer electronics: Altus Metrum Telemega with telemetry (2 sec delay sustainer ignition, < 20 deg angle), Featherweight Raven 2 backup deployment charges, Big Red Bee GPS w70cm Ham w/telemetry, Booster electronics: 2X Feather-weight Raven 3


Photo by Gary Goncher

Full Bore Linear Panic sustainer test flight at OROC in May

MUDROCK 2016 Configuration: Motors AT N1000W to AT M685W

* "Full Bore Linear Panic"? I borrowed it from a book called "A Fine and Pleasant Misery." It is composed of humorous excerpts from "Field and Stream" articles from the 1950's. The author, Patrick McManus, recounts his childhood in Idaho and his camping trips which were "training" for his future career as a "Mountain Man." His father gave this name to the kid's reaction to unforeseen events while "training." My favorite "full bore linear panic" was caused by a grizzly bear that visited the campsite during the night. It seems that once a full bore linear panic is "underway there is no stopping it" and it "gains momentum with every stride, and the participants get so caught up in it they forget the reason for holding it in the first place." The "grizzly" turned out to be a stump.

Special thanks to Matt Sikkink and Dick Jackson Not sure I would have got this bird in the air without their support.

The Hanson Brothers came to ARLISS / XPRS from southern California, stayed all week and flew a slew of rockets

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

XPRS Awarded High Altitude Rocket - Phoenix 4 - 1st Place "O" Impulse Curt von Delius

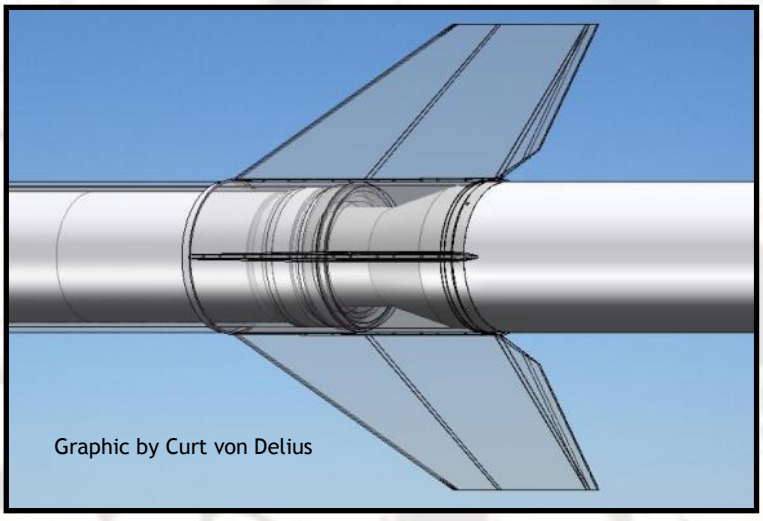
Check out the video of the Flight of Phoenix 4 at: https://vimeo.com/142539325

When asked to write an article about the PHOENIX 4 Project for the newsletter, it made me consider, what some of the most important aspects that influenced this project are.

The following three stand out.

- **Extensive use of Computer Aided Design CAD**
- **Unidirectional prepreg composites**
- **NASA technical papers**

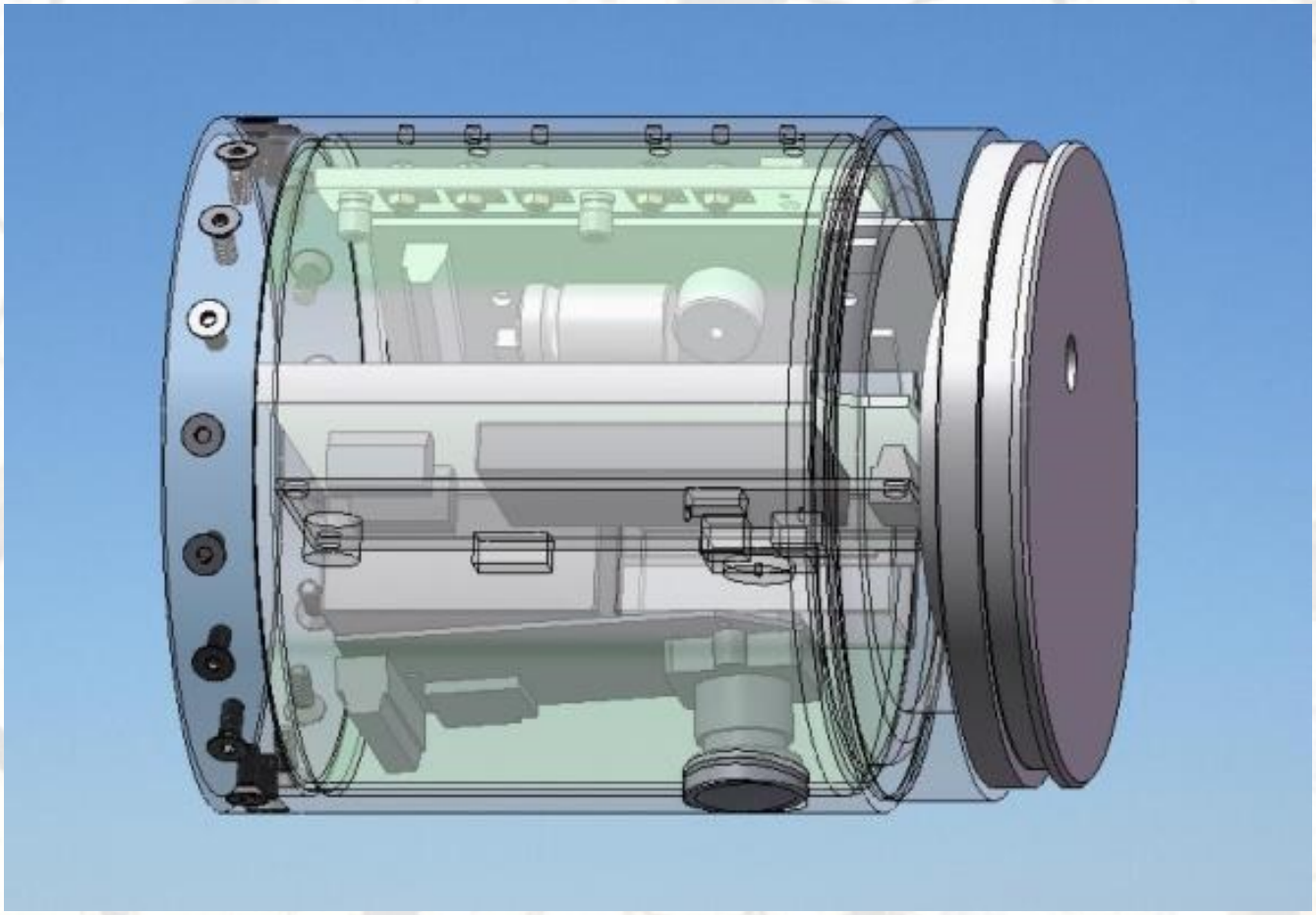
CAD is a powerful tool and nearly every part of a rocket design can be replicated to exact size, mass and appearance. New parts can be created and designed to interface other parts with ease. Individual parts 'Models' can be combined in 'Assemblies' and provide information such as total mass and center of gravity. For example, by 'Suppressing' parts in an Assembly, such as propellant grains, you can quickly arrive at your burnout mass and CG..



Phoenix 4

Curt von Delius

Parts can be quickly modified and also stressed to study the efficiency of the structural design. Very innovative assemblies and part design can result from CAD combined with high strength materials and Numerically Controlled machine tools. Most of my parts involve some level of machining and every part of the rocket, including altimeters, is designed in CAD. It also ends up being an endlessly useful tool for calculations, mold making or designing the parts of a tower.



Graphic by Curt von Delius

Unidirectional Prepreg Composites can be formed to provide some of the strongest, lightest, heat resistant structures available. Carbon Prepreg is usually available in a thin continuous sheet of unidirectional fibers saturated in a partially cured resin on backing paper. Various resins are available including cynate ester/epoxy blends, commonly with Tg of around 356 degrees F. Resin systems may include modified rubber to increase toughness.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

Phoenix 4

Curt von Delius

Unidirectional composites can be 'engineered' to provide the highest strength by using the most efficient orientation of fibers in a shape or structure. Individual plys can be stacked in alternating orientation in order to obtain the maximum strength and rigidity in plate, tubes and reinforcements. Because the material is inherently stable, it can be precisely sized and placed using patterns.


Photo by Curt von Delius

Extremely rigid plate can be formed by following a Quasi Isotropic stacking sequence. However, the sequence must be balanced and symmetrical or the plate will twist from internal stress.


Photo by Curt von Delius

Processing prepreg requires a curing oven capable of 270 to 355 degrees F with higher temperatures for post cures to increase the glass transition temperature. Currently, prepreg is expensive and difficult to obtain and requires R & D to be processed successfully.

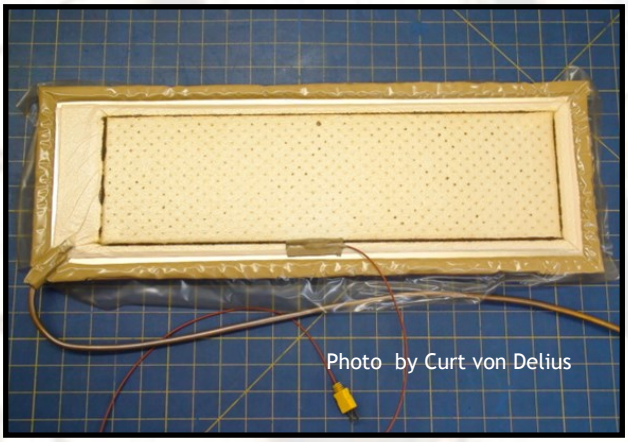


Photo by Curt von Delius

Phoenix 4

Curt von Delius

Fig. 33 Sled Vehicle during Peak Velocity AIAA-3055

NASA Papers. One of NASA's mandates is to distribute its hard-won knowledge for the next generation of scientists and engineers. Throughout the 1960's and 70's, they published the NASA Space Vehicle Design Criteria, SP 8000 Series and endless Technical Notes, TNs. These monographs lay out the best knowledge and science at the time for each subject.

Much of the technology developed in the early space program directly relates to what we are doing today in high performance rockets and is still very relevant. NASA, AIAA and others, continue to make available papers on virtually every subject, as well, information can be gleaned from program handbooks, patents and other sources.

I've built a substantial library of technical papers relating to various areas of rocket science and it has helped me to develop my own systems based on state of the art principles and technology.

A list of the SP 8000 papers can be found at http://www.arocketry.net/sp-8000.html or the NASA Technical Reports Server.

"Basic research is what I'm doing when I don't know what I'm doing"

Werner von Braun **AIAA 2003-2129**

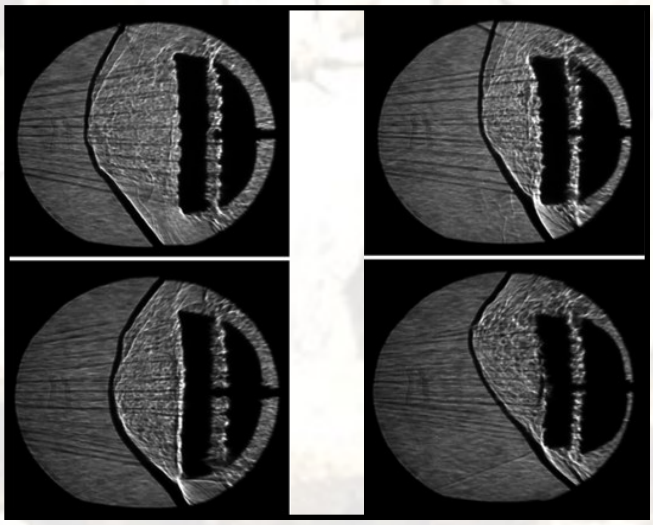
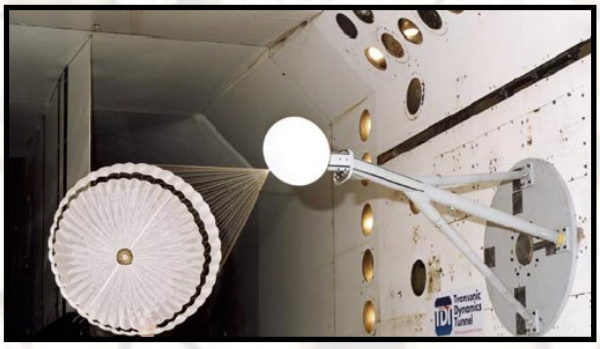


Fig 13 Shadowgraph of bow shock when parachute is fully inflated (top) mach 2.0 and (bottom) mach 2.5

JPL, Anita Sengupta

Fig 14 Shadowgragh of area oscillation at (top) mach2.0 and (bottom) mach 2.5. These images correspond to the most collapsed of the canopy during area oscillation event



Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

Little Joe II-
Testing the Escape System on Apollo

Ever thought about what would have happened should it have been necessary to destroy an off course Saturn V moon rocket? Ever wondered how the escape system for the Apollo Moon rocket worked?

Get the inside story from rocket pioneer and legend Bill Colburn, engineer on the Apollo Lunar Project and designer of 5 mission critical pyro systems for the flights.

Bill is available to talk to interested groups about his work for NASA on the Apollo program and other topics.

Contact Bill at: 831-524-2398

S4 Competition Winners Selected following flights at MUDROCK

Lynn Cominsky

Five teams of eager secondary students came to MUDROCK to participate in the S4 competition. The S4 program (aka Small Satellites for Secondary Students) is a NASA-funded program led by Prof. Lynn Cominsky at Sonoma State University that developed a payload platform for middle and high school students to build and use to do sensor-based experiments. In 2014, NAR reached out to SSU to sponsor a competition using the S4 payloads due to the temporary cancellation of NASA Student Launch Initiative. SSU then solicited science-oriented proposals from the top 25 teams at the 2014 TARC. Ken Biba made the NAR connection and arranged for the prize money to be donated by NAR through John Lyngdal. In January 2015 SSU received proposals from 9 teams and down selected to choose 5 teams that received free S4 payload hardware and support from SSU staff in assembling their payloads. The S4 program also paid for the motors to be used to fly the payloads at MudRock. The names of the teams and their projects were:

1) Team 1 from Newark Memorial High School - Atmospheric Effects on Descent Rate

2) Team 2 from Newark Memorial High School - Precision of S4 Payload Sensors

3) Team 3 from Newark Memorial High School - Establishing a Model for the Variability of Wind Speed

Photo by J. DuBose

Elena Christian Jr. High, St. Croix, US Virgin Islands

4) Elena L. Christian Junior High School in St. Croix, US Virgin Islands – Measuring and comparing relative air humidity in Arid and Equatorial Regions

5) Northview High School in Sylvania, Ohio Calculating the Migration Patterns of North American Birds

The requirement was to fly their S4 payloads on an ARLISS-K rocket and then to analyze the data and present their results to the judges. The judging team included John Lyngdal from NAR, Tony Alcocer, Becky Green, Dave Raimondi and Kevin John. Additional judges listened in to the analysis presentations via tele-

S4 Competition Winners Selected following flights at MUDROCK

Lynn Cominsky

con following the playa trip, including Ken Biba, Lynn Cominsky and William Walby. Flyers and/or mentors for the teams included Dave Raimondi, Jim Green, Charlie Wittman, Paul Pittenger, Tim Robbins, Dick Jackson and Jonathan DuBose. If time permitted, the teams also were allowed additional flights using their own rocket. Thanks to all who helped support these enthusiastic students!

The winning teams were:

First place and a $750 prize provided by NAR:

Newark Memorial High School Team 1 (Descent Rate). The judges were impressed by the team's computer modeling and data analysis, as well as their outreach efforts and rocketry on the playa.

Second place and a $250 prize provided by NAR:

Northview High School (Bird Migration). The judges appreciated the team's spirit, outreach efforts, 3D print designs and rocketry on the playa.

Best flight and a $100 prize provided by Ken Biba:

Newark Memorial High School Team 3 (Wind Speed). This award recognized skills in rocketry on the playa and the novel design that included a third party anemometer.

Darryl Paris originally created the trophies for the club and trophy labels were created for these three teams by Becky Green. A great time was had by all! For videos of the presentations and flights, and interviews with the teams on the playa, see http://s4.sonoma.edu and look at the blog entries, 2015 Team listings, presentation page and Media gallery for videos and photos .

One of the finished trophies for the winning teams

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

S4 Competition Winners Selected following flights at MUDROCK

Lynn Cominsky

California's Newark Memorial High School Team 3, Winner for "Best Flight" (Wind Speed) with flyer Paul Pittenger

Northview High School in Sylvania, Ohio , 2nd Place Overall (Bird Migration)

Sonoma State's S4 program Evolves to include Community Colleges

NASA recently announced that a team led by Dr. Erin Quealy from Napa Valley College has been selected to develop a one-semester college course entitled "Rising Data." Modeled on the successful experience with SSU's S4 program, the community college students will learn how to build sensor-based payloads, which will then be flown on medium-sized model rockets as well as unmanned aerial vehicles. Both the rockets and drones will also be built as part of the curriculum. SSU and CSU Fresno are leading the curriculum development effort which will be piloted at five Hispanic-serving California Community Colleges in the academic year 2017-2018, and rolled out to an additional five schools in 2018-2019. The three-year program is funded by NASA's Minority University Research and Education Project (MUREP) which has awarded a total of $750,000 for three years of effort to the Rising Data program. The community college students will also be eligible to apply for summer internships at NASA centers including Armstrong and Ames, and at university groups that have NASA funding (including SSU and CSUF). Community college students will be attending local rocketry events with LUNAR, TCC and ROC in order to do their model rocket flights. Unfortunately there was not enough funding to support travel to Black Rock for Aeropac launches but we hope that AEROPAC members will provide consulting services to help us develop the curriculum, and oversee the student launches beginning in the winter and/or spring of 2017.

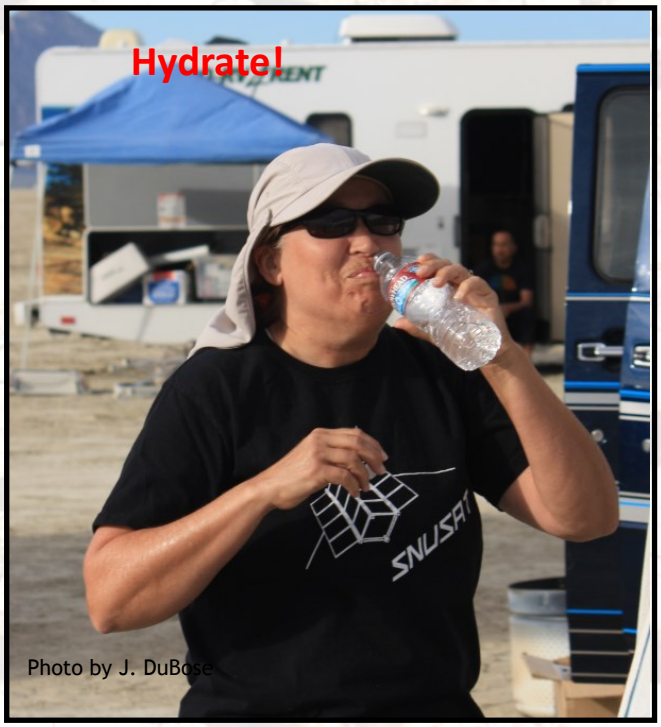
Association of Experimental Rocketry of the Pacific

TRIPOLI Rocketry Association, Inc. Prefecture No. 23

Volume 21 Issue 2

October 2015

Habits of Highly Successful Rocketeers



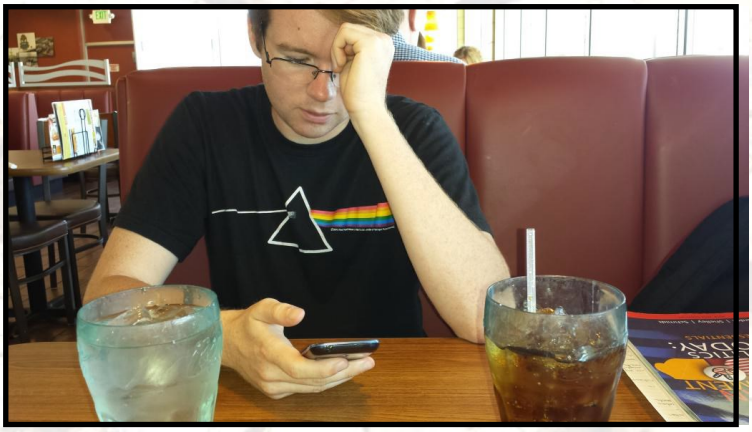
Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

2015 Launch Director's Report

Gene Engelgau

MUDROCK 2015

Thursday Setup – I got out to the launch site around 5:30 I'm guessing. My son Phil was with me this time which was very nice! He has not been out for a few years. We had to stop in Reno for him to do an online test. We did a summer class for one of his GE requirements. He is a Pre-Med / Molecular Biology major at CSU Monterey Bay.



Darryl was already out as well as quite a few other folks. We had a good crew for setup, I would estimate 12 people so setup went fairly smoothly. The weather was nice and not too hot, but a bit windy. We had quite a few problems with the equipment for this launch and getting all the L2 pads (21 – 30) working, I now know it is mostly issues with the cable running that bank and you need to do some wiggling of the connectors to get them all clean. We also misplaced the light used to test the pads which made testing harder. We found it at the end of the launch!

Again we used GPS coordinates to get to the launch site and it seems most people found it OK. We had a pretty good crowd Thursday evening, which was nice.

Friday – We woke up Friday to good weather as usual. We had our flyers meeting around 8:30AM and the launch was looking pretty good. As I recall the weather remained pretty nice till around 1PM, then it got a bit windy. Below is a nice cozy group for the flyers meeting.

For this launch we had a lot of schools out flying there Student Satellites in Arliss K rockets. The launch was actually pretty full due to all the groups participating. I think maybe 10 to 12 groups were out.

2015 Launch Director's Report

Gene Engelgau

Saturday – For Saturday we again had a nice sunny morning. The day was similar to Friday with nice conditions earlier on and then wind picking up later. Again there were many flights for the student satellites as well as other good flights.

By Saturday we actually had pretty good attendance for MUDROCK with some nice high flights.

Sunday – Sunday there was some expectation that it might get very windy by around noon so we tried to load out fairly early. There were some last minute student launches that we squeezed in. We rolled out with the trailer around 11AM with Markus Kraus helping get the trailer back to Empire.

Phil posing with my Full Yellow Jacket flying on a CTI L2340, which really moved out!

Aeronaut 2015

Thursday Setup – For this launch Karl Baumann of Aerotech helping tow the trailer from Empire. I met him around 4PM. We got out on the Playa around 5PM. One the way we picked up a number of other groups who started heading out but waited for a site to be selected. For this launch I moved it about a quarter mile NW and the Playa was much better than MUDROCK which was soft.

Friday – Friday we had a nice group of flyers who made it out. For much of Friday we were dogged by high overcast making flying a bit hard for some of the larger projects. We had a lot of student flyers who had come out to fly some high flights. We were trying not to fly into the clouds. For me on Friday I didn't have to worry about that. I flew "That's a Fact Jack" on a J180T moon burner. It went about 3000' I'm guessing.

Saturday – The clouds had cleared overnight and it was nice as usual. More folks had arrived so we had an OK attendance. We had our flyers meeting. Tony Alcocer took the photo so I could be in it! Again,

2015 Launch Director's Report

Gene Engelgau

there were quite a few college students who came out for the summer break. We also had a Boy Scout troop out with many Scouts running around from time to time.

I flew my newly painted Magg Max on an AT L1770 (4 grain 75mm blue thunder). It went about 9K feet and just went Mach 1. Not bad for a really fat rocket!

Sunday – Sunday there was some concern that it would again be very windy, and this time there may be rain in the afternoon. We loaded out fairly quick. We managed to pack the trailer just about perfectly this time.

We rolled out about 11AM and again Karl Baumann helped me get the trailer back to Empire. Thank you Karl!

ARLISS / XPRS 2015

I made it out to XPRS this year on Wednesday, a day later than 2014. I arrived Wednesday just ahead of what was looking like possible rain. In fact, it rained pretty good here and there on the way out. It was drizzling pretty good and quite windy when I got there Wednesday so I could not setup camp. I had some dinner with the Greens and otherwise went to bed in the back of my Sequoia.

Thursday – It was really quite cool Thursday in the morning, but otherwise looking pretty good and clear for the most part. I mostly got my camp setup next to Aerotech.

Photo by J. DuBose

Aerotech static tested a new "O" 5000+ single use motor. There were many shouts of "I'll take one!" More testing needed but keep an eye out for a demo flight in 2016

2015 Launch Director's Report

Gene Engelgau

Later Thursday it again started to get pretty windy and that limited flights some. I spent most of the day completing my setup of my new project Dark Energy 75 and didn't get to fly any rockets. Thursday afternoon was the setup for XPRS and we had enough help. I think it took just an hour to complete setup of the low power pads, and the back row of the high power. Friday – Friday was looking like a really good day and it delivered. The entire day was just perfect with low winds and lots of flights. Again, I spent much of Friday completing my setup of Dark Energy 75. I may have flown one rocket.

Saturday – There were many more people out and again some amazing weather. Low winds and perfect conditions all day. It could not have been better!

At the Saturday flyer's meeting we also had some folks talk about our missing friend Richard Hagen. There were some emotional moments for sure, he will be missed so much. And during the day there were a few flights in his honor.

For me I finally flew DE-75. I got 32011 feet on a M650. Next year I'm going for 40K on a M685. We'll see if I make it.

Sunday – For me Sunday I had a commitment back home that I needed to be there at 6PM. I helped with some load out still, mostly directing other folks to help prepare for the final pass. I left around 11 AM.

The End till 2016 Season!

Photo by J. DuBose

It was great to see a smiling James Marino on the Playa. Rocket motors always seem to make James happy!

Association of Experimental Rocketry of the Pacific

TRIPOLI Rocketry Association, Inc. Prefecture No. 23

Volume 21 Issue 2

October 2015

Community Outreach

Jonathan DuBose, Dick Jackson and Ken Biba represented AER-OPAC and N. California rocketry clubs at Sacramento's Capital City Airshow. We were hosted by Aerojet Rocketdyne and displayed in their "Launch Pad" Pavilion

Jonathan and Dick also attended "Space Day" at Ed Harris Middle School (Elk Grove) as guests of Science teacher Autumn Nguyen (below).

Photo by J. DuBose

Photo by D. Jackson

Photo by J. DuBose

Photo by D. Jackson

ARLISS 2015

Becky Green

Wow….I can't believe we just had our 17th ARLISS. ARLISS 2015 was probably our most challenging ever but we managed to pull it off thanks to a fantastic team.

It began Sunday at Bruno's when the students began their meet and greet meeting that ended around 1:30. By about 2 pm a huge line of cars appeared out of the mirage and approached camp.

Photo by Becky Green

We probably had 80-100 students that day. They helped unpack and set up the entire ARLISS camp in a couple hours.

Then about half of them stayed at camp and the other half went off to set up the target. About 5 or so they all went back to Bruno's, Fernley or where ever they were staying. Also, we had a team of volunteers who went back with my van to get the equipment trailer and started setting up the launch site while we were setting up ARLISS camp. Thank you to all who helped….you know who you are.

Photo by Leonora de Lemos Medina

Monday morning they were all back for our welcome meeting at 8 am. Not all were there that day….because we wound up with about 150 students over the 4 days from Georgia Tech, Czech Technical University in Prague, UC Berkeley, University of Louisiana @ Lafayette, University of Hawaii Winward Community College, Seoul National University, Cairo University-Egypt, Universidad National de Ingenieria-Peru, Oregon Flight Club (consists of several Oregon schools including University of Oregon), Tokyo Institute of Technology, Tokyo Denki University, University of Tokyo, University of Electro-Communications, Tokyo Metropolitan University, Aichi University of Technology, Tokyo University of Science, Kyushu Institute of Technology, Keio University and the UNISEC team. Costa Rica was there as well….but this year they didn't send students… they sent a team of professors to get their Level 1 and or Level 2 certifications and observe the entire ARLISS event. They were busy building their rockets so they could be done before they left on Thursday morning early.

ARLISS 2015

Becky Green

Registration started about 8:30 Monday and by the time it was completed you would have thought it was late afternoon when the "Big W" often raises its ugly head. It was already blowing when we started registration and we only managed to get one flight off that day while we were still registering everyone.

Since the weather was so bad on Monday I had all the teams arrive at 7 am Tuesday to start flying so we could catch up from the flights that wanted to fly on Monday. Well….that day turned out to only be slightly better. I think we had a total of 6 flights before the "Big W" showed up again about 11:30. We knew it wasn't going to calm down so pretty much everyone left to work on their payloads.

Wednesday we started again at 7 am. That day was just about the same but I think we got 9 flights. Ok….this is really not a good start….I knew I had at least 46 flights scheduled and knew Thursday was going to have to be a perfect day to pull this off.

We also managed to get the Costa Rican certification flights flown on Wednesday before the "Big W" got there. BTW….Jim and I helped Costa Rica this summer make history (see my article Dreams Can Come True)…..and now we helped them make history again. Two of the three team members were going for their Level 1 certification and one of them was going for Level 2 as well. The first person ready to fly was Leonora de Lemos Medina and she was the first person from Costa Rica (yes a woman) to ever certify Level 1 and Andres Mora (yes a male) was the first person from Costa Rica to certify Level 1 and Level 2. We actually got another break in the weather about 6 that evening and were able to fly a few FAR 101 flights so Leonora and Angela Garcia Leon got to fly 3 more flights before leaving Black Rock. I wished they could have stayed longer…..because the weather was perfect the rest of the launch. Oh well….at least they got to do what they came to do. They will be back next year.

Oregon Flight Club

Thursday morning everyone showed up again at 7 am and we started kicking some serious butt. We were down 3 rockets that morning but we were able to use the nose cone from one rocket (that had electronic problems) and put it on the Gumby rocket while Gumby was playing hide n seek on the playa so I was only down 2 rockets.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

ARLISS 2015

Becky Green

OMG….I couldn't believe how fast we were getting rockets up to and off the pads. Poor Dave had to have Charlie and James help….yes James Marino was there. It was so great to see him. While they were retrieving his rocket….Dave put another team up in his second airframe. Now was crunch time. We had to recycle 10 rockets to get more payloads in the air. We had the best team effort ever wrangling motors. William along with Ted Tagami, and Tony So from Magnitude.IO and possibly others, were out in front of my RV and were cleaning the motors and then William built them all. He lost count but it was about 20 +/- 3….that is probably a record. We were switching cases and just giving them to the next flyer that was recycled and ready to fly. I've never had a team waiting….normally it's us waiting on them but I had a line up. We later that day lost another airframe due to bad e-matches (remember….always check them with a meter before flying).

Photo by Becky Green

While all this chaos was going on….Ken (Captain Kirk) was manning the bridge of the sat van, helping me with registration and running up and down the flight line assigning teams to all the flyers, delivering motors etc.

I also had the help of Eric Melville the whole week and on Thursday up until he had to leave for Costco to get all the food for the banquet. Yes, this year I had a volunteer (thanks Eric) to go to Costco. It was a huge help. I know others could have stepped up and managed to assign and keep things running….but I was sure glad I was there instead of shopping. Eric got back late that afternoon and was helping once again. We went until the end of the day flying rockets. We managed to get 30 flights on Thursday. That might be an ARLISS record for the amount of flights in one day. The guys were all exhausted and just looked at me at 5 pm and said are you kidding…you want another flight…but jumped up and did it. Thanks guys you are all the best.

Friday morning I took off early with many of my helpers to set up for the banquet. There were 3 more ARLISS flights that day while we were at the Community Center. We had 137 students, all my helpers and UNISEC at the banquet. We had lots of food so many were able to go back for seconds. We didn't have a lot left this time. We have this thing dialed in now.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
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ARLISS 2015

Becky Green

I just want to say a BIG THANK YOU to everyone who made this a spectacular ARLISS. If I missed your name please don't be mad….I'm probably having a senior moment….LOL.

Photo by UNISEC

Jim Green, Ken Biba, William Walby, Peter and Jamie Clay, Evan and Jenn Curtis, Eric Melville, Paul Forrester, Mike and Marla Parker, Dave Raimondi, Charlie Wittman, James Marino, Dick Jackson, Matt Sikkink, Jonathan DuBose, Tim Robinson, John Lyngdal, Joe Bevier, Dean Walton, DJ Wyrick, all the students and Karl Baumann. Without all of you this wouldn't be possible.

Photo courtesy of J. DuBose

Dreams Can Come True

Becky Green

When you have a dream you always wonder if it will ever come true. Not only if it will come true but how long will it take before it does. In this case it took about a year.

It was a dream Prof. Leonora de Lemos Medina, professor of Mechanical Engineering at the University of Costa Rica in San Jose, Costa Rica had. Her dream was to put together a rocket camp in Costa Rica. By the way, Costa Rica has never had a rocket launch in their country before so this would be a great idea if it could be done.

Well, it proved to be very hard to accomplish, but Leonora started out on a quest to find out if it would ever be possible. Leonora first approached the director of her department at the University to tell them her idea.

They thought her idea was good but really didn't know what or how to do it. She eventually was told to reach out to Dr. Andres Mora who started the ARLISS program in Costa Rica in 2013 at RobotiFest.

By the way Jim and I went to Costa Rica in 2013 to help Andres judge the ARLISS teams by tossing off the projects from a fire truck and ladder and watched the projects parachute to the ground to then power up to go to a pre-determined target point on the soccer field just like in Black Rock.

The winning team was sent to Black Rock to attend ARLISS 2013. Costa Rica was the first Latin American team to join us at Black Rock.

Sorry….back to the dream. Leonora was able to speak with Andres and told him her entire dream. Andres told her it was a fantastic idea, one that he also shared, and knew exactly who they would need to speak with to help with the rocket part of the camp. Jim and I had a conference call in October, 2014 with them to discuss the idea. Of course Jim and I jumped on this opportunity. Not only to be able to go and teach High School and University students how to build rockets but to be a part of the Costa Rican history. After this Leonora was able to go back to the principals and they were all very excited to have this dream become a reality.

Now all the hard work was about to begin. Leonora assembled her team which included professors Alejandra Sanchez, Luis Rapso and Edgar Solano and approximately 20 engineering students. They all started working together to set up the entire camp. We had many conference calls and emails trying to figure out how much of space they would have for recovery and to determine what size rocket and motor would be best for them. I started doing my homework assignment which was to find them the perfect rocket and motor.

After a lot of research, I came up with an AeroTech Mustang (with a 6" payload section added), which is called an AIRSPIKE. Mike and Marcus at BAR said they used these for scouts launching eggs with an F motor. I bought 7 kits from BAR at Snow Ranch in December even before I got the approval from Costa Rica. I just had a feeling they would like this choice. Now I had more homework to do. I found out we didn't have enough recovery area for an F motor so I had to figure out what else would work. I saw the E15 would send the Mustang to about 850' so the AIRSPIKE should fly to about 500', my best guess. I also mentioned they should get an S4 kit and put a payload in it. Those fly on a G80 to about 900'. I ordered 3 of them from Tony.

In early January I got approval for the (7) AIRSPIKES and (3) S4 kits. Now I had to make sure the E15 was going to have enough thrust off the pad to keep the AIRSPIKE straight. I bought one more AIRSPIKE kit so Jim and I could

Dreams Can Come True

Becky Green

make sure we could build the kit in a few hours, because that is all the time we had to show them how to build it. Since they were not going to be flying eggs in the payload, Jim had to make bulk plates and end caps to make the electronics bay. I started collecting all the parts for the electronics bay, all-thread, nuts, washers, eye bolts and made enough for the 8 kits. I just threw everything in the boxes since I ran out of time to be able to put them in the kits. I also bought 1/8" Kevlar rope for the shock cords instead of using the elastic that comes in the kit. We used 1/2" nylon coming out of the rocket tube to help with any possible zipper. Remember we are working with some pretty powerful motors….LOL. We also wanted to make sure we did a test flight. We had it ready to fly for Rendezvous but that launch got rained out so we were going to have to send everything without being tested.

The shipping turned out to be the hardest part of this entire experience. The University had a shipping sponsor, Aeromar, who paid for the entire shipment. After hundreds of emails we were able to get all the International documents and 1.4 E documents filled out and now the packages were ready to be picked up. Well that got delayed because it was a residential pick up so they arrived the next day. I had left the house for a few minutes and Jim called saying they were there so I hurried home. The driver didn't even know he was picking up a dangerous goods package. Luckily I had all the documents printed and ready for the driver to take….but the driver didn't want to take any of the paperwork. I finally had to put it all in a plastic envelope, put it on the box and run down the driveway for him to take the package. I really thought he was going to leave it behind. Delay after delay….finally it arrived in Miami and the boat didn't want to take the shipment so they had to turn to the airlines. Now more documents are needed. We got it done in probably 25 emails that time. The only problem is….the plane it was scheduled to go on panicked and wouldn't fly them to Costa Rica. A few more days go by and they were finally able to find an airline that would take the whole shipment. Yay….next day it was finally in Costa Rica. We knew it would take about 4 days to clear customs and get delivered to the university and I think they used every day of that and maybe more….but just as I was to board the plane to Costa Rica for a little vacation prior to the camp I received word that the university finally had everything. It was a great feeling and now I didn't need to worry and could totally relax on my vacation. Oh….did I forget to mention we started the shipping process the first week of May and it arrived at the university on July 10th? Yes, that is how long it took. Good thing we started early…..Phew!!!!!!!! Big kudos to Sabrina and her boss Jorge at Aeromar for keeping it together and actually managing to get someone to take the packages.

Finally another launch where we could test launch the rocket…..yes, it was MUDROCK. However, I was sooooo busy during Mud Rock with S4 that I wasn't able to fly it until Sunday morning just before the launch was over. Yes, I flew the rocket….me….the one who said she would never fly a small rocket.

Dreams Can Come True

Becky Green

I think Jonathan even got a picture of me to prove it….LOL. It was already getting windy by the time I flew but I think it was a perfect test because Costa Rica generally has a breeze. It flew straight to a whopping 494' and landed maybe a 100' away. It was going to for sure be perfect for them.

Becky and the AIRSPIKE

The next challenge we had was the S4 parachute. It comes with a 50" parachute so they can have a lot of hang time for the S4 project. In this case, we wanted to come down as quick as possible without damaging. Tony ran OpenRocket to show it coming down on a 36" parachute and it showed it would work so I changed them out to 36" parachutes.

Jim and I left San Jose, CA July 10 late in the evening stopping in LAX and from LAX to San Jose, CR about 6 am on July 11. As you all may know…..it is always such an experience flying in and out of LAX. Our plane was on time leaving LAX but getting to LAX was another story. Originally we were to have a 3 hour layover at LAX so we should have had plenty of time….yeah right. After many different delays in San Jose….due to a huge back up of airplanes at LAX….they would not let us leave. Eventually we left and arrived at LAX just to get off our plane and hurry to the next terminal to the plane that had already started

Dreams Can Come True

Becky Green

loading. Oh well….at least we made it.

After 8 days of relaxation on the Caribbean coast….the time came for us to come back to reality and start our busy schedule. We arrived back in San Jose at noon on Saturday the 18th and were picked up by Leonora. We got all our bags in her car and off we went to meet up with Andres and his parents. They were awesome hosts and took us around to see a few sights in San Jose while Leonora continued with all her last minute preparations. She picked us up around 6 pm and took us to her house for a home cooked meal and allowed us to stay with her.

We had a wonderful breakfast at Leonora's to start our Sunday off and then the packing began. There was sooooo much stuff to bring we had to travel in two cars to Liberia campus which was about 4 hours away. Her wonderful boyfriend Jose was the other driver. We picked up Andres and off we went. We stopped along the way for snacks and finally arrived in Liberia at 2pm to check into the hotel and then went out for a late lunch and back to the hotel. We had to be back in time to watch the Costa Rica vs. Mexico Gold Cup soccer game. No negotiations on that….so we all went to the bar and watched and cheered them on. It was a heart breaking game ending in a bad penalty call in overtime by the ref.

Many preparations were still needed to be done and few finally went to bed around 11 just to get up by 6 to start the long day. We all met for breakfast and then went our separate ways. Jim and I were treated to a special field trip to AdAstra Rocket Company owned by NASA Astronaut Franklin Chang Diaz who is from Costa Rica and has been on 7 ISS missions. It was unfortunate that he was at the Houston facility while we visited his Costa Rica facility. We were picked up by Dr. Jose Castro Nieto, Chief Specialist from AdAstra….wow, that was service.! He didn't even send one of his interns. We traveled to AdAstra with Sandra Cauffman as well, who is also from Costa Rica and is currently working on the GOES-R Satellite. She is the Deputy Systems Program Director from NASA Goddard Space Flight Center. She was the Deputy Systems Program Director on the MAVEN Satellite as well. She was giving the AdAstra team a presentation. We were able to sit in and listen to the presentation and then we were taken around their facility to see the plasma rocket they are currently working on. BTW….I think the E15's have more thrust than what the plasma rocket puts out in space…but of course they don't need much up there. They are also working on hydrogen motors there at the plant and will be putting them in cars soon.

We had to rush through so we could get back to the university to have lunch and start the camp. There were many speeches all of which were in Spanish. The good news is we were able to talk with most of the presenters prior to their presentations and heard what they were going to be to be talking about. Some of the Powerpoint slides were in English so we were able to follow along most of the time.

Dreams Can Come True

Becky Green

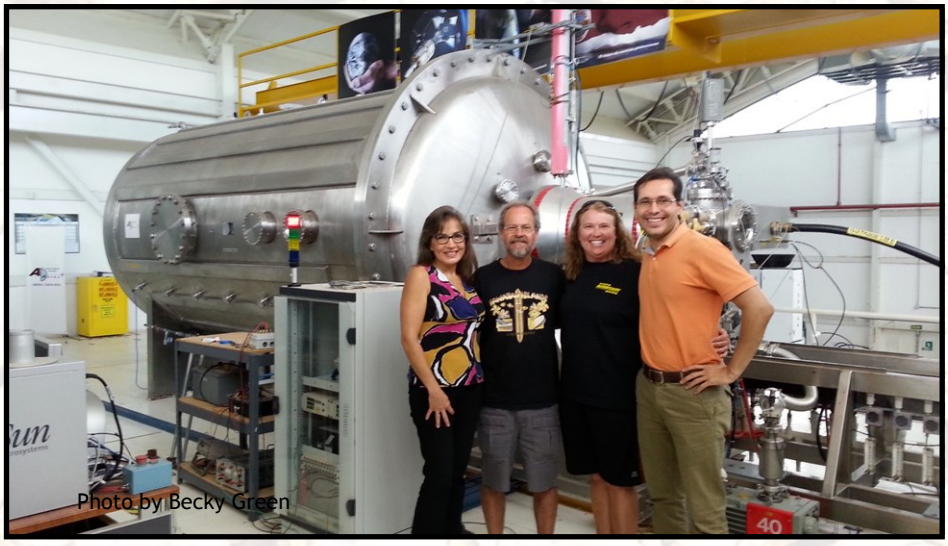
Photo by Becky Green

We took a break and were all taken out to the soccer field and gathered around to watch 3 water rocket launches. After the launches we were treated to a VIP showing of a Planetarium movie.

We then went to dinner and after dinner was our turn to present. This was perfect timing since we had a few short videos and it was dark by 6 pm. As usual I started to talk and panicked. I handed Jim the microphone and by the end of the first slide I got my composure and was able to continue. We were a tag team talking about ARLISS, ARLISS eXtreme and S4. It was well received and many students came up to us after and wanted to know how to participate in ARLISS.


Photo by Brandon Segura

After all the presentations that evening we were treated to a special viewing of the stars by an astronomer who recently retired and is spending most of his time doing events like this with kids. Skies were clear so it was a perfect night. Here is a photo of Saturn taken with a phone through the telescope. That night ended around midnight.

The next morning once again up by 6 to start another very long day. The students were all in class all morning to learn all about rockets and how to design their own using OpenRocket. While they were doing that Jim and I were busy with the entire staff team assembling the kits and putting them on all the tables. The staff was amazing and we finished everything just prior to the students arriving. Oh did I mention these rockets were all built outside ?

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

Dreams Can Come True

Becky Green

The Howler monkeys decided to join us each day in the trees right next to the covered area. At one point there were 22 napping in the tree….they had a long day I guess. Everyone we talked with said that was the closest they have ever been to a Howler. We had entire families including the babies. That was one of the coolest things we witnessed.


Photo by Becky Green

A couple more presentations and then it was time to start building. That's when we shined. The students were amazing and all spoke English. They didn't want to wait for us to show them each step and tried to get ahead of us. Well….that started to be a bit tough but we were showing the staff and everyone took a table and spread the word very quick so we could avoid problems. There were a few….but nothing we couldn't handle. As things progressed it was dark and we were working under big lights. There was plenty of light so it was fine….but the 10 min. epoxy we were using seemed to set up too quick for some teams and we had a few problems with the electronic bay section. One team's coupler got stuck and they had to cut it out but we were able to make a field repair and it still worked great. We told all teams to wait until I got to their table to make sure that didn't happen again. Well not everyone listened. We had that happen to one other team but we knew


Photo by Becky Green

Dreams Can Come True

Becky Green

how to fix it very quickly. Then there was another team that had a similar problem but they couldn't even get the coupler in the tube because they had some 10 min. epoxy inside the tube. We had to break for dinner so we left it on the table in two separate pieces and went to dinner. When I returned the team was over there struggling. I asked them what happened and they said the coupler was stuck and they couldn't get it out. How did that happen….it was in two parts when we left? They swore to me none of them put it in. I took it and pulled as hard as I could and luckily it came out. They all cheered and I was the hero. Well….at least until I told them how long they were going to have to sand the inside….LOL. The only answer we had to how those two pieces got in there was the monkeys came down while we were at dinner and they put them together….they were just trying to help the team…..LOL.

Photo by Adolfo Fallas

All the teams were starting to paint them by 9 pm. and we had to vacate the premises by 9:30 pm but we were trying to finish last minute details. We finished all the major things and knew we could finish the next morning early. We had no time to put anything away so the university put one of their security guards there to watch everything all night long.

While I was working with all the student teams building the AIRSPIKES, Jim was working with the staff who were building the S4 rocket kits. Since their payload was not on the normal S4 fiberglass board we had to change the build slightly even from the test one we built at home. Since we knew they only had part of a day to build this kit we had to build ours with 5 min. epoxy instead of the JB Weld Tony included

Dreams Can Come True

Becky Green

in the kit. We also had to do many different steps so we had to write up special instructions for a quick build. As it turned out when we got kicked out that kit had a lot more that we needed to complete. All the fins and fillets had to be put on. Jim, Andres and I went back to our room to finish them. Andres left about 12:30 am and Jim and I continued our assembly line and completed the 2 kits they needed. I suggest no one use 10 min. epoxy in a hot area to put fillets on. They were not the best fillets we've done before. We felt like it we were cramming for an exam but managed to finish by 2 am and were up by 6 to continue another busy day.

This was now L-Day (launch day). We got to the university to help everyone do the last minute things like vent hole and attaching the parachute and how to fold them. Everyone was already gathering on the bleachers (they built special for this event the day before) on the soccer field so we had to hurry. As each team finished they would take their rocket to the soccer field. Finally all the rockets were complete and we were all there. They started all the announcements and the first three teams assembled in the area marked off for teams only. I had each team put their motor adapter in and then gave them the motor and igniter. Some teams the motor clip didn't lock it in place so we had to friction fit. As the teams were called they all got to go out and put the rocket on the pad and the photographer took one picture and they had to retreat to their area. After the first three rockets were put out there they allowed one teammate go push the launch button. They did a countdown from 10 in Spanish and they pushed the button. Nothing happened!!!!!!! Jim quickly switched the leads to the AeroTech launch system we brought for them and the countdown started again. This time they pushed the button and it spit the igniter. Well….at least we knew the system worked. Jim ran (well at Jim speed) out and put another igniter in and taped it again. Once again the countdown started. Third time is the charm right? Yes it was….we finally had lift off! The crowd went crazy. History has been made or something like that was being said in Spanish. The parachute ejected at apogee but was still balled up when it came out. I thought oh no I've let these students down. What did I do….I know I folded the same way I've folded for the last 20 years….it's gotta work. Well….in typical Becky excitement the parachute opened perfectly about 100' off the ground and landed almost dead center of the range. Once again the crowd went crazy. We grabbed the rocket up and got the altimeter reading. It went to 132 meters (433'). The rest of the rockets launched and the weather got calmer so they were getting better altitudes. The highest of the AIRSPIKES went to 169 meters (554'). All but one of the AIRSPIKES landed on the field. However one was eaten by the jungle surroundings. I think those monkeys ran off with it…..LOL.

In between the AIRSPIKE launches they launched one of the S4's. The S4 was launched on a G80 7 and was absolutely perfect. The parachute ejected right at apogee and of course the BIG W came up and

Dreams Can Come True

Becky Green

took it well into the jungle. However it had a tracker so they weren't too worried. But in the end they just couldn't get into close enough range and were unable to track it down. Maybe they will find it someday soon. They of course would love to get everything back but they did receive packets during the launch so they were very happy about that.


Photo by Anel Kenjekeeva

Oh….I forgot to mention there was a company called Difacom that built a special carbon fiber rocket and gave it to the university. This was the first rocket they ever made….and it was beautiful. There were no centering rings or rail buttons and we didn't have plywood to make the rings but we improvised by using thin cardboard and sandwiched about 5 pieces together to get about 1/2" thick and we put a motor adapter in as the motor tube and then attached an eyebolt. It was in with some extra parts I sent so they made it ready to fly. That rocket flew on an E15 but went so high because it was a very light weight rocket. It flew perfectly straight and ejected right at apogee. They made their own parachute out of really thick garbage bags which worked really well…..but it was way too large for that rocket and it went off into the jungle along with the S4 and one AIRSPIKE. I am picturing all those Howler monkeys retrieving them and jumping from tree to tree and getting them all together and having a party….LOL.

There were two rockets they didn't get to launch but the event ended so we had to stop. It was actually good because the second S4 had a GoPro in it and that would have sucked if they lost it too.

We all went back to the build area and cleaned everything up and they had a couple closing speeches and the camp was officially over. Many of the students stayed around taking pictures with us and were talking about doing this again. Some knew now they wanted to pursue a career in aeroapace. The sparks in those students' eyes were so rewarding. We were so excited to have been invited to help them make history and I'm sure there are many of those students who are going to be building rovers, robots or fliers and start attending ARLISS there in Costa Rica in hopes of winning the competition so they can come to Black Rock and launch their projects in our rockets.

Also, I've already heard the university team has started planning next year's rocket camp. Now I call that a very successful trip.

So to sum this all up…..DREAMS CAN COME TRUE. Never give up on your dream no matter what it is.

Association of Experimental Rocketry of the Pacific
TRIPOLI Rocketry Association, Inc. Prefecture No. 23
Volume 21 Issue 2
October 2015

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