TARC 2013 Coverage

SPORT ROCKETRY

OFFICIAL JOURNAL OF THE NATIONAL ASSOCIATION OF ROCKETRY

SEPTEMBER/OCTOBER 2013

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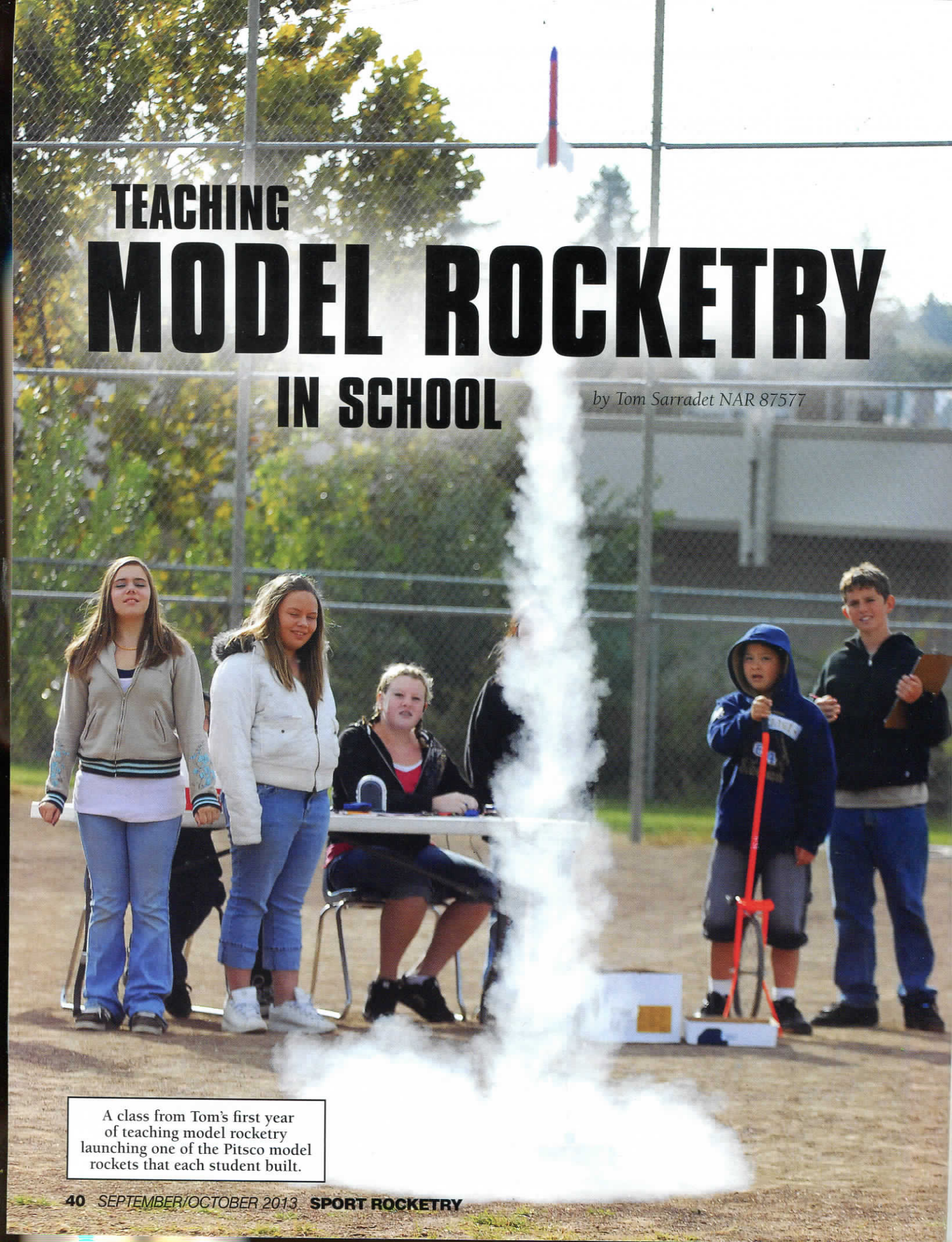
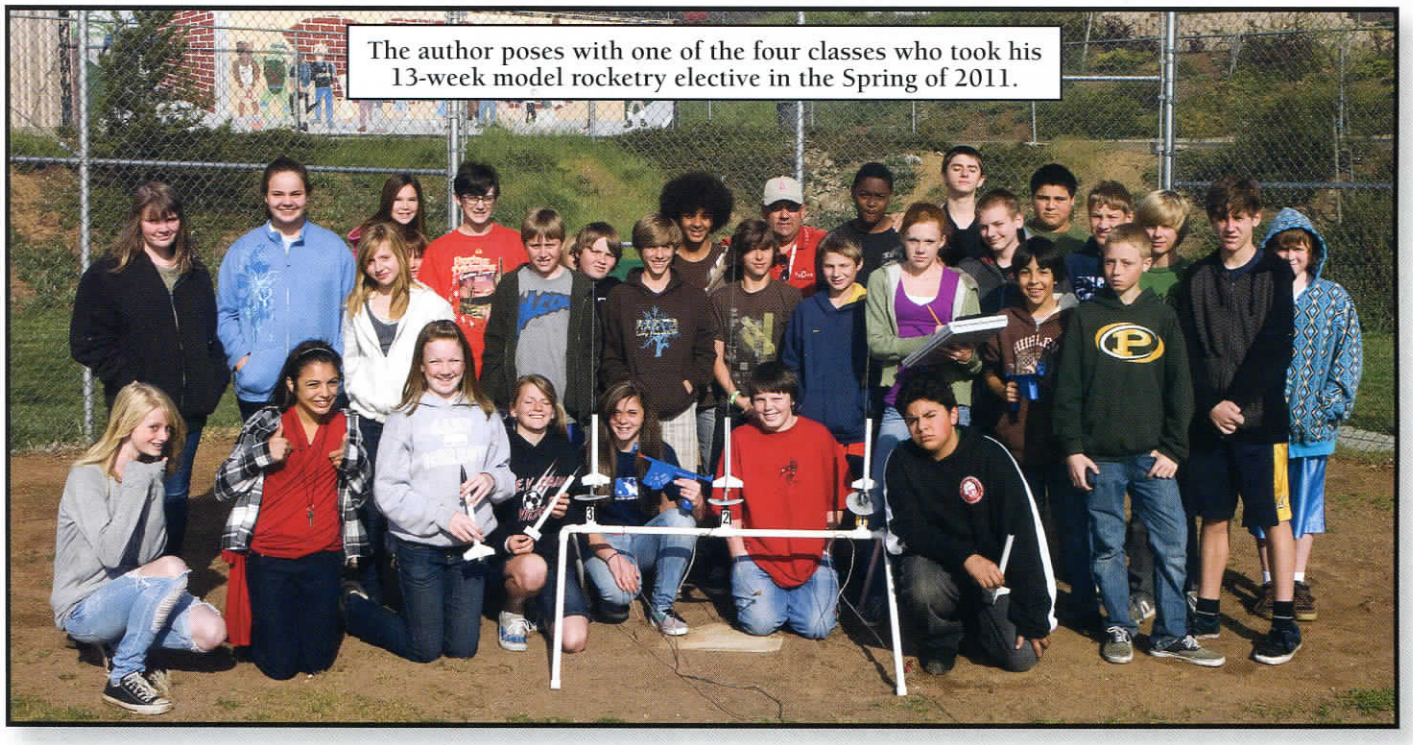
2013 NATIONAL SPORT LAUNCH

TEACHING MODEL ROCKETRY IN SCHOOL

by Tom Sarradet NAR 87577



A class from Tom's first year of teaching model rocketry launching one of the Pitsco model rockets that each student built.



The author poses with one of the four classes who took his 13-week model rocketry elective in the Spring of 2011.

Last year I was fortunate to be selected to receive the Robert L. Cannon Education Grant that was instrumental in the success of my model rocketry program. I want to thank you, the members of the National Association of Rocketry, for your generous support of model rocketry education. Pay it forward.

On the subject of model rocketry education in groups, perhaps you may envision 10 or so scouts gathered around a kitchen table under the watchful eye of a knowledgeable parent, each building the same rocket from a bulk pack purchase followed by a launch in the back yard. But is it possible to teach 100 students or more, each building their own rocket and launching each one? With proper planning, equipment, and support it is very possible and is what I have been doing for the past four years with great success.

I have been a teacher at E.V. Cain STEM Charter School in Auburn, California, for 14 year now. Four years ago I was reassigned as full time electives teacher for 7th and 8th graders and given the task of coming up with a curriculum that would engage the students for a 13-week trimester. I would have three groups rotate through each period for the school year for a total of over 300 students. It was up to me to come up with a curriculum that would be fun and educational at the same time.

My first thought was of model rocketry. I had built rockets in the 70s when I was in middle school and flew them in the cane fields near my home town in south Louisiana. As with most, I dropped the hobby as I found other interests in high school and rediscovered the hobby when my children were young. As they grew older the rockets flew less and eventually stopped altogether. Their dusty remains are still stored in our garage.

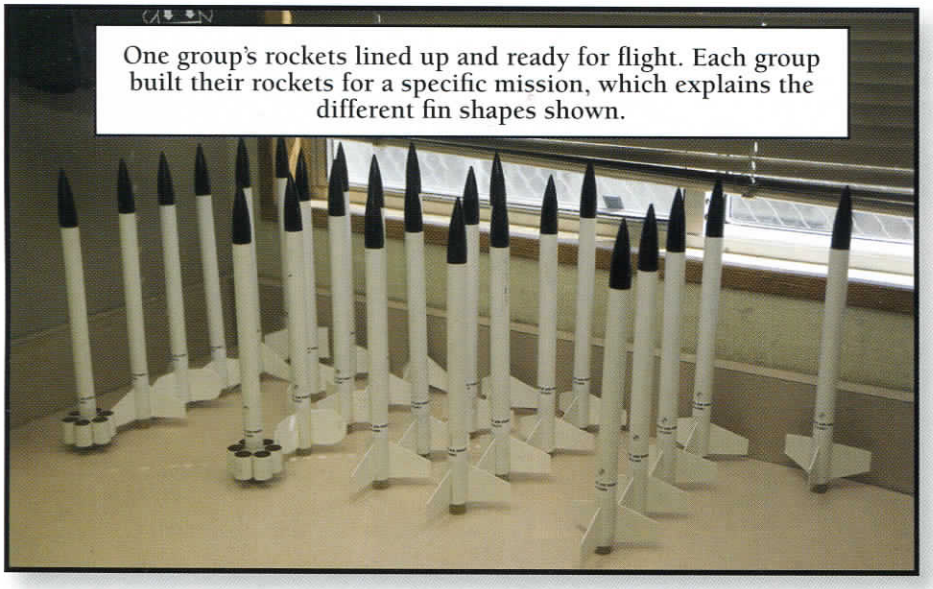
In my first year of teaching model rocketry I learned about the Team America Rocketry Challenge and from my first group of 7th graders I was able to form my first TARC team.

My initial idea was a grand one. I would teach model rocketry to the 7th graders and model airplanes to the 8th. I was given access to some funds from an arts grant and purchased three cases of bulk model rocket kits and motors from Pitsco. Also from Pitsco I purchased some tissue and paper rubberband-powered airplane kits. I contacted the local hobby store and with their help purchased some simple to assemble remote control park flyer kits with the idea to teach them how to fly RC aircraft. I joined the NAR and AMA and spend the summer planning my lessons.

The model airplane idea was a disaster. The fragile airplanes were not so forgiving to building mistakes and many students ended up with a destroyed plane on their first attempted flight. I spent all of my time with a bottle of super glue frantically trying to repair broken planes faster than the students could crash them. The RC planes didn't go much better. In spite of my best efforts, the best that I managed was to have three students flying at the same time for about 5 seconds before all three suddenly nose-dived into the ground.

But in my 7th grade model rocketry classes, every model rocket flew. For those of you not familiar with the Pitsco kit, the student must make the airframe with gummed paper wrapped around typing paper over a 1" plastic tube serving as a form. The fins are a compressed cardboard material that can be cut with scissors and are glued in place with a special plastic fin template that ensured that they were straight. The instructions call for a V2 type fin that produces slow liftoffs and gentle recoveries. Out of the 600 or so Pitsco rockets that my students built and flew over two years, I would say that less than 5 of them had erratic flights.

I managed to fly all of those rockets on our athletic field with a single launch pad at an average of three a day for each group



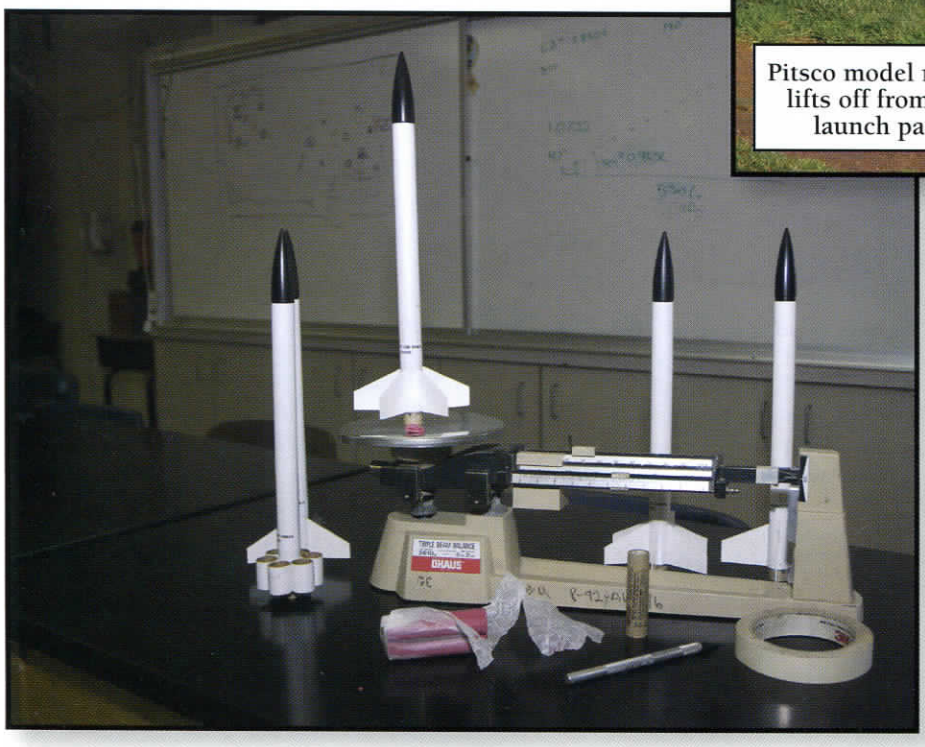
One group's rockets lined up and ready for flight. Each group built their rockets for a specific mission, which explains the different fin shapes shown.

of students. My experience as a flight controller on a Pershing Missile Combat Alert Site helped me create launch procedures that kept the operation running with military precision. Each class would grab the launch equipment stored in several tool boxes and had the first rocket airborne in 10 minutes in accordance with the motto of the Pershing Missile crewmen; Quick, Reliable, and Accurate. After three or so launches they would pack it all up and be back in the classroom before the bell rang for their next class.

To keep all students engaged in the launches, I devised a position for each student. While the engineers were setting up the launch pad and prepping the first rocket, trackers were taking positions on the other side of the schools small athletic field with Estes Alti-Traks, while others grabbed stop watches to time the flights. A couple of students would collect data on wind speed, humidity, and air pressure using anemometers, sling psychrometers, and barometers. Because we were sharing the field with the students in physical education, some students were tasked with security and kept a watchful eye for anyone entering the launch area. The students whose rockets were being launched manned the flight control center and coordinated the launch using a launch script and two-way radios. By the end of the trimester, I was merely an observer as the students handled the launches with military precision. The first thing out of the students' mouths was "Are we launching today?" As soon as I said yes they were grabbing the equipment and out the door. I knew that I had found the right subject to teach this age group. After two years I abandoned the model airplane idea and went exclusively with model rockets.

Pitsco model rocket lifts off from the launch pad.

A group's rockets are prepped for launch. For the fin design mission, as well as other missions, each rocket is carefully weighed in grams and clay added to the nose cones to make their masses equal in order to get more accurate data on fin performance.

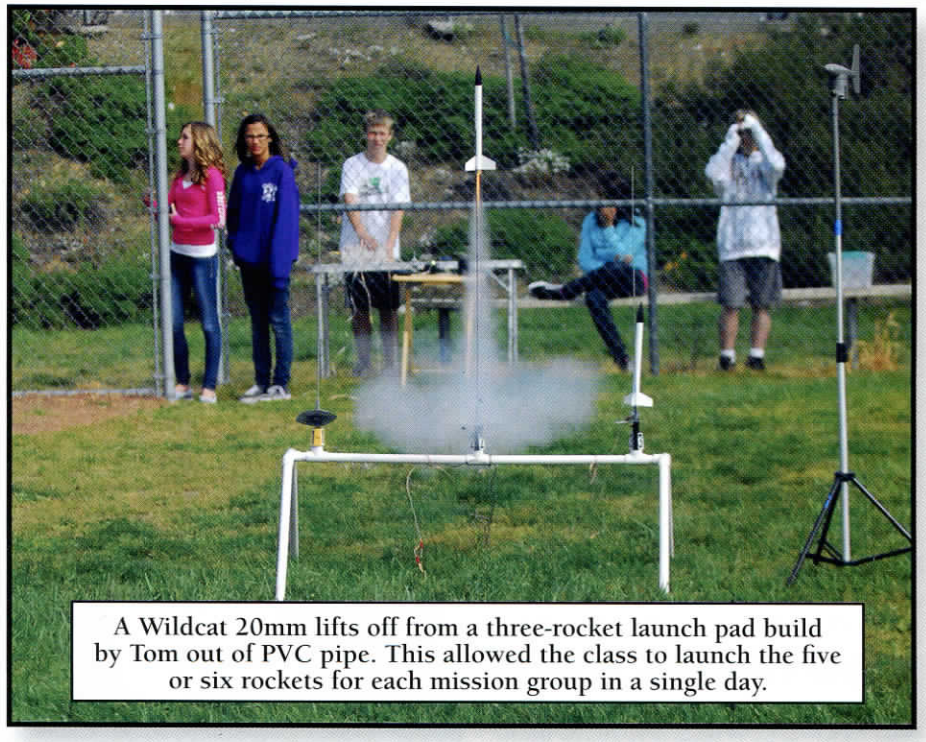


Every week we would analyze the data and determine the altitudes, velocities, and flight paths of the rockets. I would remind the students that these calculations are being made with data that they collected in the field rather than random numbers taken out of a textbook. I would like to say that the students embraced this portion of their studies with equal enthusiasm, but they didn't. The thrill was watching the rockets fly. But crunching the numbers for 30 plus model rocket slights is going to sink in eventually and it was very reward-

ing to see the light bulbs over their heads turn on when they finally understood the lesson.

In my first year of teaching model rocketry I learned about the Team America Rocketry Challenge and from my first group of 7th graders I was able to form my first TARC team. As this was moving into the realm of mid-power rocketry, I sought advice from more experienced hobbyists. I called Jack Garibaldi, owner of What's Up Hobbies, and in the course of 30 minutes got a crash course on reloadable motors. As my team was ready to make their first test flights, my search for reloadable motors led me to a local hobby store at which the manager told me that there were some people who live in the area and who are very knowledgeable about rocketry. I soon was in contact with Dave Kenyon and Jonathan DuBose, both of whom were invaluable in the advice that gave to me and my team. They helped us to get us off the ground and achieve qualifying flights. The hobby store put us into contact with another hobbyist, Matt Comfort, and soon the Sacramento Area Rocketry Group was reactivated as NAR Section 557. We now have an excellent launch field and club support for future TARC teams and are actively outreaching to local youth organizations in the area to offer our facilities and expertise. Our goal is to increase TARC participation in northern California.

About the time that I started my rocketry classes, I enrolled in an educational leadership masters course at California State University, Sacramento. For my Masters project, I chose to develop a model rocket STEM based curriculum that focuses on the skills needed for the Team America Rocketry Challenge. The path led me to NAR President Trip Barber and NAR



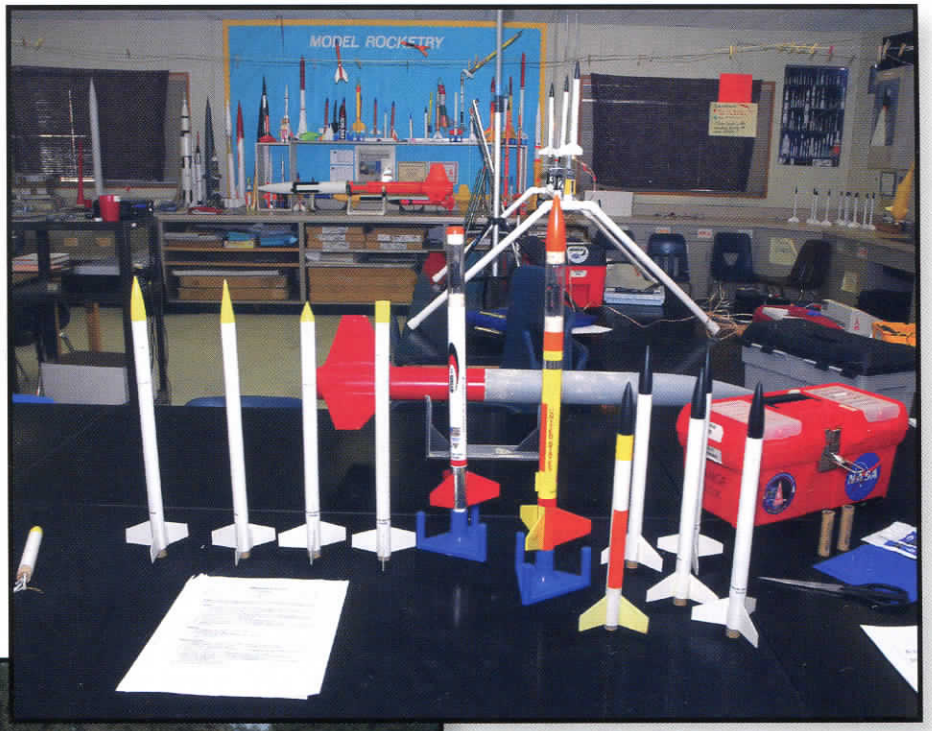
A Wildcat 20mm lifts off from a three-rocket launch pad build by Tom out of PVC pipe. This allowed the class to launch the five or six rockets for each mission group in a single day.

Education Director Vince Huegele, both of whom were highly supportive of my efforts to accomplish this task. The curriculum that I developed, along with additional materials, can be found on NAR's education CD and on the TARC website. I have also posted them on the SARG website.

Over the course of four years and the launching of over 600 model rockets in that time, I have sought to tweak and improve my curriculum. I have come to the conclusion that maximum time should be given to launching the rockets and to the collecting and analyzing the data. While there are skills to be learned by building the models, I feel that this phase should be done as quickly as possible in order to give maximum time in the field. The majority of the content standards that model rocketry addresses are from activities after the rocket is built.

While the Pitsco model rocket is an affordable option, it takes a certain knack to make the gummed paper airframe. I wanted a rocket that could be built in large numbers for the least cost and could be completed in five days or less. In addition, I wanted a rocket that students could easily build correctly, thus avoiding skewing the data because of variations in the student rockets. In other words, I wanted a simple, cheap, high performance model rocket. I combed the Internet looking for the cheapest way to do this and came to the conclusion that the best way is to create a kit myself using parts from different vendors. So with the help of RockSim, I came up with what I call the Wildcat 20mm, in honor

of our school's mascot. This rocket uses a Quest Aerospace 20mm nose cone on their 20mm airframe cut to 10 inches. (This tube comes in a 30" length from Quest, so you get three.) The 18mm motor mount has an engine block glued inside and the assembly slides neatly into the airframe, eliminating the need for centering rings. The fins are made from the compressed fin material from Pitsco. These fins are cut to a clipped delta shape, using the formula found in *Handbook of Model Rocketry* by G. Harry and Bill Stine. While I am partial to trapezoidal designs, the clipped delta allows the rockets to be stored upright on a table. The recovery system is a 1 by 10 inch Mylar streamer, which I purchased from a marching band supply vendor online, on a shock cord cut from a bulk roll from Pitsco using the Estes system of attachment. A



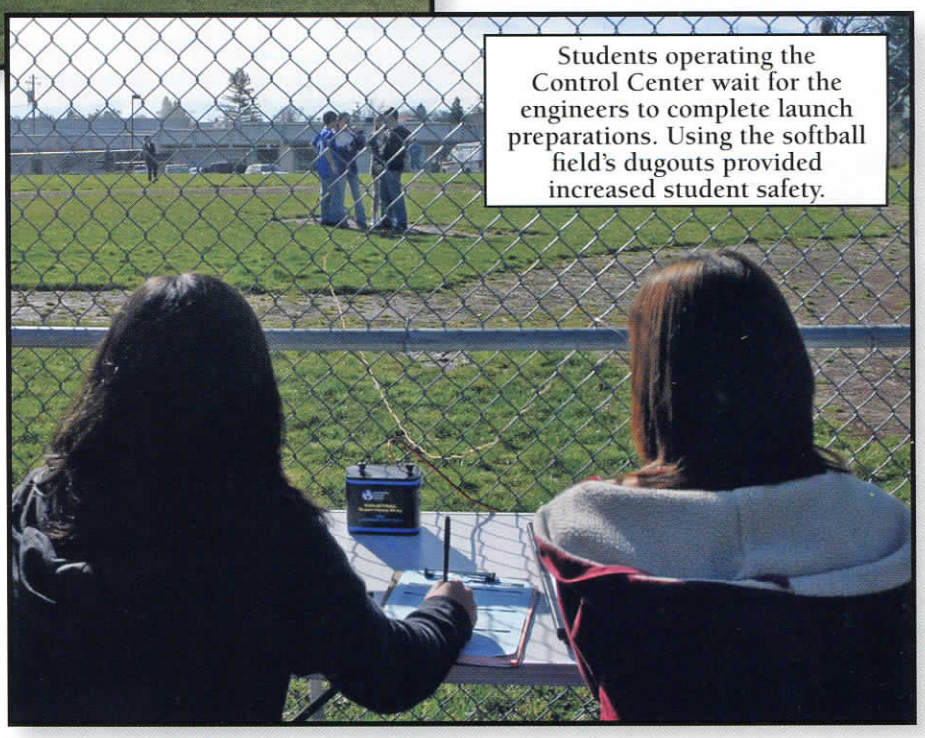
Rockets on display for the school's end of year open house. The models in the foreground are prepped for a nosecone analysis mission. Each carried an electronic altimeter and a custom nose cone.

Trackers armed with Estes AltiTraks follow a rocket's flight path. Collected data were analyzed in the classroom as part of a post-flight activity.

rate. I have tried several types of engines but have settled on the Estes A8-3 engine. This engine gives consistent flight that is slow enough for the students to track and keep the altitude low enough for a successful recovery on a typical middle school

more expensive option would be to use a Kevlar string attached to the engine block, but since most of these rockets will only fly once, I chose the cheaper route. The engine is held in place using masking tape for a friction fit or small pieces of clear tape on the outside of the airframe.

At the time, I was able to keep the price per rocket to $1.65. Unfortunately, prices have risen since then, but the cost is still well below any kit on the market today and the cost can easily escalate when you are buying for 300 students. Because the airframe and fins are white, it can be left unpainted or the students could use markers to personalize their rockets. I prefer to leave them unpainted because some of the lessons require rockets of equal weight and also the rockets should be as identical as possible for the collected data to be accu-



Students operating the Control Center wait for the engineers to complete launch preparations. Using the softball field's dugouts provided increased student safety.

athletic field. I buy them in the bulk pack online and look for sales to keep the cost down. My last purchase was through AC Supply, an online vendor. My preferred glue hands down is Pitsco's HD Bond. It tacks quickly, which is a must for young impatient rocketeers. Make sure that you get the white variety and not the colored glue used for bridge building. For emergency repairs I have some CA glue on hand.

As to launch equipment, I wish that more vendors would come up with some affordable multi-launch equipment geared towards limited school budgets. Pratt Hobbies is the only vendor that I know of the offers multiple launch controller system at a reasonable price. The premier word when dealing with large groups of students is SAFETY. The teacher must maintain control of the activity at all times. In addition to a two-way radio, I have a whistle around my neck and blow it three times prior to each rocket launch. This not only alerts my students but also the students engaged in other activities like P.E. If conditions are not perfect for launching, I stop the launch, regroup, and reboot. Teach and practice the model rocket safety rules. They are your road map to success.

Using *Electronic Model Rocket Launched Construction Plans* by Tony Wayne and available through Apogee Components, I built launchers capable of hooking up three rockets using the recommended Radio Shack parts. I built the system to handle 12 volts because I launch the rockets on one of our school's softball fields and I need the power to handle a 50-foot distance from the dugout to the pitchers mount. Having the rockets well beyond the minimum distance requirements for low power rockets gives that extra amount of safety that is wise in a school environment. It also allows the students to track the rockets better, since part of the data collection is on flight characteristics. It is very critical that any system that you use have a safety key that can be removed whenever students are on the launch pad. I purchased a "Remove Before Flight" lanyard with a detachable key chain that I keep around my neck during the launches.

I built a three-rocket launch pad out of PVC pipe that is very portable and inexpensive. I was able to pick up a six-rocket launcher off eBay and once I build a second launch pad, I will be able to prep and launch six rockets a day per class. Since I have grouped the students into five- to six-man teams with team missions, this will allow me to launch all rockets testing fin or streamer design in a single day, giving more accurate results to collect and analyze.

The lessons that I developed are explained in detail in my curriculum, *A STEM Based Model Rocketry Curriculum,* which is available for download at http://www.rocketcontest.org/resources.cfm and on the Estes Educators CD. The lessons are designed to have students conduct missions to determine the effects of fin shape, nose cone shape, mass, recovery drag, etc. The lessons teach them the skills that they need to develop, test, and fly a TARC rocket but these skills are useful to all students in a model rocketry class. These skills are also matched to California and national content standards in science, technology, engineering, and math.

Please use these resources to develop or improve your own large-scale model rocketry curriculum and feel free to contact me at tsarradet@auburn.k12.ca.us if you have any questions.