The NASA Educator Engineer,
a STEEM* Story
*Science, Technology, *Education-Engineering* and Mathematics

by Jerry Woodfill

What do these astronauts have in common with the author?*

(Read to find out.)

I guess I'm writing this in defense of my career as a graduate engineer. For the past score and ten years my wife has often commented, "You really don't do much engineering with all that educational outreach you enjoy." No, giving demonstrations to educators and students isn't exactly engineering in the sense of my duties as Apollo 13's Warning System Engineer. But just because my outreach efforts aren't the heady stuff of a Moon landing doesn't make them less worthy of my engineering education and experience.

That's what this treatise is about. To explain to my wife and others, that I use the same process. Yes, that which birthed the lunar lander's warning system is needed to reach educators and students. That method led to an eternal reward for my alarm system. Born in the mid-1960's, it now rests in the bowels of Armstrong's ***EAGLE*** at Tranquilly Base. The process which made that possible works for education as well.

To make my point, I've chosen a single example. It's something I conceived to give my school presentations an unforgettable WOW FACTOR at the close. First, I've got to explain about the talk I give. Predictably, it's named "Failure Is Not An Option." As the Apollo 13 "Failure" engineer, my role was to have options to save the astronauts' lives should their spaceship fail. Working with the individual system managers resulted in picking the best way to warn an astronaut of impending danger. It was sort of similar to having the "engine hot" light tell you to take action and add coolant to the radiator.

My education-engineering problem was with the presentation's closing PowerPoint slide. While the teachers and students watch a video clip of Gene Kranz calling for the flight controllers status at launch, I hide behind the podium pumping up a balloon. In place of the names of the controllers, I'd inserted my voice listing school courses.

"Apollo 13 Flight Controllers, are you ready to launch?" asks Ed Harris in APOLLO 13. Then, he sequentially lists their call names: "ENCO, GUIDO, RETRO…" and finally, "CAPCOM!" After each, comes the retort, "Ready Flight!" So I substitute, depending on the audience and their courses, "GEOGRAPHY, ARITHMETIC, HISTORY, MATH…"

When Ed Harris says, "We are ready for launch" the video shows the majestic movie liftoff scene. The scene is accompanied by the inspiring APOLLO 13 musical score. After a few seconds, the score transitions into STAR

AND STRIPES FOREVER. Indeed, the moment is one of patriotic glory, fading into the message…"Students, You Have Cleared the Tower and Lifted Off…Godspeed to all of you!"

Now, while the audience is transfixed by the video, I am pumping up a whistling elongated balloon I bought at the Dollar Store. As the STARS AND STRIPES march fills the room, I release the balloon in sort of a rocket launch above the audience. It is a "wake-up" call for the most disinterested member of the audience.

However, when I first tried the scenario in a presentation, it was altogether frustrating to execute. The balloon would pop before I released it. Or the pump was too weak for sufficient air to fill the balloon. This resulted in a feeble dribble over the podium at my feet. This spoiled the entire outcome as the students burst into laughter. Additionally, my initial choice of balloons was awful. Spherical types buzzed about like a food-seeking fly too small to notice. The elongated types, like clowns use to fashion balloon-like animals, often darted into errant orbits behind the podium.

Ah, but then, I applied my Rice Bachelors of Science degree and Apollo engineering principles to the problem. I remembered those NASA Preliminary Design Reviews, known as PDRs. The idea was to consider the suitability of approach to the problem. From this, the adequacy of the design would be assured. In order to make it work, a materials list was compiled. This led to selecting vendors and manufacturers of those parts and materials. Following the same process, I'd found The Dollar Store as my equipment vendor for the balloon pump (…with balloons included, no less).

For my NASA lander's warning system, the vendor was ARMA Corporation on Long Island adjacent to New York City. The lander's main builder was the Grumman Corporation only a score of miles distant. However, I would be my balloon launch system's main contractor, and my launcher provider would be The Dollar Store. Cost was a factor with regard to making the Apollo alarm system. This was, likewise, true for my launcher.

But performance far outweighed price as an important factor for Apollo and my presentation. Neil Armstrong would not appreciate having the EAGLE explode while its fuel tank was being pressurized to launch from the moon. When performance is an issue, the tenets of engineering along with its brothers and sisters, mathematics, physics, and science come to play. While I, like NASA, wanted a launch system made by the "lowest bidder," it needed to work reliably. Mine wasn't doing that.

NASA, a half century ago, and to this day had what is called "A Feasibility Study." The idea is to evaluate alternate approaches, first based on analysis, then on actual testing. The winner is the one you go with as the solution to the problem.

Well, being an engineer, I knew experimental trials were a must. So I got a half dozen of those cheap (low bidder) party shop balloons. My text explained that the center of thrust, i.e., the blast of air expelled by the exit "orifice" (akin to a NASA rocket's thrust chamber nozzle) should not change direction. Likewise, it should be directed away from, but inline with the center of mass of the balloon. I thought about this. "If I held the balloon perpendicular to the floor with the nozzle in line and straight with the center of the inflated balloon, the trajectory should follow the direction I pointed the balloon rocket." It worked!

Then I remembered past attempts for my audiences. Generally, I rushed the process, nervous about the response. This led to miscues in orienting the nozzle when I released the balloon. In practice, i.e., what NASA calls "real-time" operation my launch scheme would fail.

I needed both a longer-straighter nozzle or a more stream-lined balloon shape to succeed. I needed a balloon-like rocket booster! Such an invention existed. I found an entire fleet of them at the 99 cent store on Spencer Highway in Pasadena, Texas. I'd gone there looking for cheap electronic cables for my home computer while I waited to pick-up my wife. I was supposed to pick her up after she finished instructing her night class at San Jacinto Community College.

Fully inflated, those magnificent balloon rockets were nearly a yard in length. Also, they had inch long nozzles that kept their shape after release. And even more wonderful were those nozzles' loud vibrating squeal of exiting

air. They sounded like clarinets playing hi-C at the conclusion of "Star and Stripes Forever." I named these rocket "screamers."

If I was careful to straighten the inflated rocket balloon, keep the nozzle in line with the linear shape, and point the balloon booster at a 45 degree angle with the horizon, an impressive launch ensued. Though not altogether without pitch and yaw from the pointed direction, the rocket always sailed ten to twenty feet above the audience, an impressive finale to my program.

Based on more "feasibility-testing," I launched both the "clown-balloons" and "screamers". Though six for a dollar compared to two dozen for the same price, the screamers definitely would be my choice. Additionally, the "screamers'" had this whistling scream as they jetted from the podium upward and outward. I retrieved my Physics 100 college text and examined the aerospace physics involved. Soon, I understood why these pneumatic rockets from afar (They were manufactured in China.) worked. But, even though the screamers had a beneficial innate guidance system, they continued to ether burst or flop earthward short of the audience. This was caused by my pumping technique.

I examined my college thermodynamics text, the chapter on the gas law. The principle equation in play was: PV=NRT. I recalled that if solved for P, i.e., pressure, since both the room temperature,"T" and "N" were constant, the greater the pressure meant the balloon's volume or length would be longer. The agent of pressure was, of course, my Dollar Store pump. Obviously, when the balloon was not filled, i.e., because of inadequate pumping or pressure, the exhaust velocity of air molecules due to the pressure differential within the balloon and the room resulted in a short flight. Also, the screaming mechanism gave off a low pitched moan akin to a clarinet player's weak blowing across the instrument's vibrating "reed." An examination of the physics of the production of sinusoidal sound waves in my college text explained that fact.

So my mission, akin to assuring that a rocket reached orbit, was to successfully pressurize the streamer balloon to the volume of at least its yard-long length. This must be done within the allotted time of the closing video of the launch of Apollo 13. Again, a test seemed the answer. Prior to speaking to the Texas Convention of the Community College honor society students, I began pumping the screamer balloon in my hotel room. The Dollar Store pump was a cylinder only five inches long with an inch diameter. It sort of reminded me of the Mercury-Redstone rocket booster which catapulted America's First Man in Space Alan Shepard several hundred miles down range above the Atlantic Ocean.

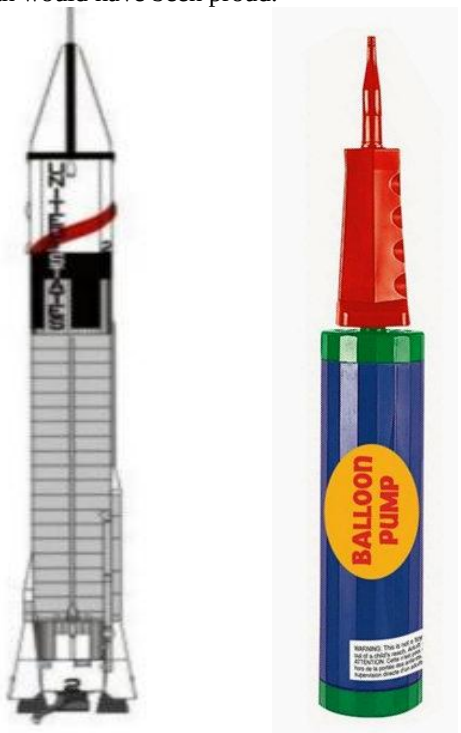
After I'd pumped 62 strokes, the balloon had sufficient pressure/volume to perform correctly. It burst in my face after a few more pumps. I was exhausted. Unhappily, that many pumps, likely, would take too much time. I'd still be pumping when my program concluded. What I needed was a new pump, a new rocket, one like launched John Glenn into orbit a half century ago. I needed an Atlas balloon pump.

Several visits to various balloon pump vendors: Dollar General, The Dollar Store, Target's dollar bins, Goodwill, and others were fruitless. I had not found an Atlas pump. Just as NASA needed to apply added finances to acquire larger boosters, so would I need to visit more powerful balloon pump vendors.

Redstone Booster Redstone Balloon Pump

It was at the PARTY SHOP emporium that my pumping Atlas was discovered. It cost five times more than my Redstone pump! $5.39 including tax.

Excited about my discovery and purchase, I performed the same flight test on the "screamer." After only a dozen pumps, I watched the screaming missile soar to the ceiling of the Gilruth NASA Ballroom where my program would be presented. Indeed, Dr. Gilruth would have been proud.



Atlas Booster Atlas Balloon Pump

And the scream! A wonderful ear piercing din of sound on the threshold of pain came forth. I would have to be careful not to employ the Atlas pumper with the elderly or weak of heart present. The capacity of the Atlas pump filled the screamer projectile with but a dozen strokes. Wonderful! Now I could enjoy watching my audience thrill to the Apollo 13 launch, the chords of John Philip Souza's STARS AND STRIPES, before unleashing the launch of the ATLAS SCREAMER.

Best of all, I had applied the same engineering principles and techniques used to launch rockets into the cosmos. Perhaps, my wife would have a greater respect for my educational outreach endeavors? Indeed, they, too, employed the same engineering methods needed to design my warning system and land astronauts on the moon.

*Answer: The Redstone and Atlas rockets.