AEDC Memories

by Glenn Norfleet

FROM THE BOONDOCKS TO AEDC

I was born and raised in Oakwood Tennessee, population never counted, and sometimes I want to think I've done pretty well for an "ole country boy." Then I remembered that my buddy Leon Jordan, from the adjoining farm, is a federal district judge in East Tennessee. His brother Roy received an appointment to the Naval Academy followed by a distinguished career in the Navy. And recently I discovered that Congressman Roe of the Tennessee First District grew up about 10 miles further into the boondocks than our farm. Is this a great country, or what!

After Oakwood grade school, two rooms for six grades, it was on to Woodlawn for the seventh and eighth grade. They had indoor plumbing and I loved it. Then I went to the big city Clarksville High School which had an indoor swimming pool, wow! From there it was on to Vanderbilt where I learned that basketball is more important than football – although we did beat Auburn in the Gator Bowl my senior year. But in basketball we finished the season rated 10th in the nation.

My fraternity brother, Al Rochelle, was the point guard and averaged 18 points per game. On a double date he introduced me to his date, Carolyn Combs. Two years later Carolyn and I were married. No one ever accused me of being a fast worker, particularly in that category.

At Vandy, my buddy Bill Wills and I decided that helicopters were the wave of the future for private transportation and we planned to ride that wave to fame and fortune, together, after our military service. My first job was with McDonnell Aircraft Corporation in the Helicopter Division where I learned that helicopters were not the wave of the future but that I really liked the aerospace world. So I decided to go to graduate school after I completed my six-month stint as a green second lieutenant in the Army.

After military service, it was on to Princeton's Fluid Dynamics Lab in pursuit of a master's degree in Aeronautical Engineering. At Princeton, the most important thing that I did was marrying Carolyn – then came getting my degree. I learned that I really liked research and that the folks in the Fluid Dynamics Lab considered AEDC to be the premier R&D organization in their world. Their high esteem was the major factor in my choice to pursue my career at AEDC. Did I fail to mention that Carolyn said she would go with me anywhere in the world – so long as it was within a three-hour drive from her mother in Pembroke, Ky.?

TEAM AEDC

If a phenomenon is understood with an acceptable degree of certainty, the answers are found by mathematics and computers, not by testing at AEDC. So at, AEDC, the engineers, scientists, and others are frequently pushing the state-of-the-art. This was very true for the Hypervelocity world that I worked in while at AEDC. Many folks played crucial roles and those involved were far too numerous for me to identify them in these memories – so no more names.

I arrived at AEDC in the early days of the Cold War and the Space Race, and the Russians were clearly ahead in both. The biggest firework displays of those times were our rockets exploding on the launch pad – shown regularly on TV. Team AEDC played a crucial role in both. We won both. As Pogo, a comic strip character, would say, "It makes me humble and a little bit proud to have been a part of that team."

Dr. Bernhard Goethert is pictured in the center as congratulations were extended to AEDC's newest citizens. Dr. Goethert received his naturalized citizenship papers along with other AEDC employees pictured.

For my entire career, my work has been on some sort of team working on some sort of project of many different types, sizes and places. When I hired-on for my AEDC job, it was still German-scientist-time at AEDC. I met two of them; the past director of the von Kármán Gas Dynamics Facility (VKF), Ed Stollenwerk, who was known for his saying, "We will burn that bridge when we get to it". Ed stayed pretty much focused on the problem. And the director of the Engine Test Facility (ETF), Dr. Bernard Gothert, who was remembered for the time when they had to repair a test cell before an urgent test could be continued. He asked the repair team how quickly it could be done and was told that it would take 400 man-hours. His response was, "Well, put 400 people on it and finish it in an hour." Dr. Gothert tended to focus on the solution.

Over time I developed a valuable insight into life. I came to learn that there are three general categories of people. There are those who are part of the problem. The last thing you want to do is to add someone to your team who is part of the problem.

Then there are those who are part of the solution but focus on the problem – okay, but less valuable than those who are part of the solution and focus on the solution. These are the people you really want on your team. These are the people who really get things done. AEDC was well endowed with this type.

I learned this concept slowly, from serving on many teams of many types – in the beginning, as a team member and later as the team leader. I didn't fully grasp this concept in time to incorporate it into our parenting, but our children seem to have absorbed it. They all practice it.

Let me illustrate the concept by my favorite work assignment – manager of the Aeroballistics Branch. We shot things from

guns. Everything from 20 mm cannon rounds, at a few thousand ft/sec, to models of re-entry vehicles, up to 20,000 ft/sec, space debris up to 30,000 ft/sec, and, oh yes, chickens at a few hundred ft/sec.

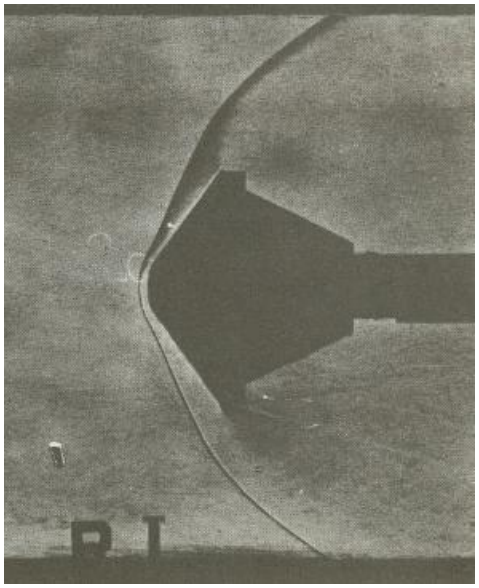
The big challenges were to design and build models, some with low strength materials that would withstand the horrendous launch stresses; and provide instrumentation that could make data measurements really fast – as short as a few nanoseconds.

As you might expect, we had our own machine shop and machinist for making models and a permanently assigned section of instrumentation engineers and technicians for making measurements. As you might not expect, we had an outstanding record for quick response to changes and in meeting schedules. Clearly, we had a great team. A great team gets value even from its differences of opinion and the whole is much greater than the summation of the parts.

MY FAVORITE PROJECT OF ALL

Think back to the bad old days of the intercontinental ballistic missile (ICBM) face-off with the Soviet Union. Our fundamental strategy was to maintain a capability that would ensure we could destroy them even if they launched first. Of course that was their strategy. Thus came the term mutually assured destruction, shortened in the media to MAD. The re-entering nose tips had to survive enormous heat rates and this forced the use of carbon based materials – cousins to pencil lead. These materials can handle high heat but they have very low strength. The trick was to balance between strength and heat protection capability just right to survive reentry.

The development of these materials was an intense and crucial national defense effort, and several facilities at AEDC were heavily involved. This included Range G, where we could develop the reentry conditions, but the problem was to develop a model that would survive launch accelerations using these low strength materials and to develop instrumentation to measure the nose tip recession rate at 15 – 20,000 ft/sec while shrouded in a cloud of white-hot "whatever" coming off the nose tip. We developed the capability and completed a multi-year test program that was instrumental in the upgrade of our ICBM capability.



This Schlieren photo shows shockwave off of an early nose cone for the Atlas ICBM with airflow of about Mach 5 in the von Karman Gas Dynamics Facility supersonic wind tunnel.

Developing this capability was a team effort in every sense of the word. It stretched the knowledge, imagination, skills and determination of an entire Range G "super-team" with key roles played by our Air Force oversight partners – both locally and at the customer level.

In the late 1960s it was discovered that the nose tips could possibly be destroyed when flying through the ice crystals found in most clouds. While nose tips reenter at very high speeds, ICBMs go out through the clouds slowly and are not damaged. So

clearly, if the Russians were going to push the nuclear button, they would take advantage of this natural “ice crystal” missile defense system. We had to know what cloud cover our warheads could survive. Since we had been very active in nose tip testing, we were asked for recommendations on testing in ice crystal environments.

Our basic problem, models don't fly down the center of the range, so the cloud ice field had to be two to three feet in diameter and 1,000 ft long. Not only did we have to create such an environment but we had to measure the nose tip recession and the ice crystal properties virtually any place in this environment. The data quality from our first test program demonstrated the true nature of this – a very long three-dimensional horror. Having no idea what to do, we had a classic brainstorming session during which someone suggested using a track to guide the model at 15,000 ft/sec! There was only muffled laughter and, as we discussed it, we couldn't conclude that it was impossible.

With a track, the ice crystal field would have to be only a couple of square inches in area and distributed at intervals along the track. Suddenly the problem would become manageable. So, we put together a conceptual design team which concluded that this thing might actually work. And oh, by the way, if it does we might be able to recover the model intact for inspection and confirmation of measurements.

This was followed by a briefing to appropriate contractor and Air Force management and a decision by the AF technology folks to support the development of the capability.

The Range G team planned and implemented an intense, short-term, research study that indicated it could be done and provided some preliminary design data.

During a chance visit from a friend from McDonnell Douglas, to catch up on areas of mutual technical interest, when I mentioned the track idea he got a quick, strange look on his face. A couple of days later he called me to tell me that his cohorts at the McDonnell Douglas Aircraft Corporation (MDAC) were already developing a small track system and had applied for a patent.

The Air Force technology folks, in conjunction with our customer, quickly made a deal with MDAC that would allow unrestricted use of the concept and AEDC would provide for further development at both MDAC and AEDC. If implementation were warranted, they would contract with MDAC for design of a track to be built at AEDC.

The Range G team was tasked to develop the technology needed for growing ice crystals to match those encountered in nature; a system for releasing the crystals in the path of the model just before arrival, a technique for measuring the mass of the crystals impacted by the nose tip and nose tip recession.

Because of the urgent need for national defense, research, design, development and installation were overlapping. Shakedown was done during the first test program and we got good data on all the shots other than the first. From inception of this system – a precise 1,000 foot track, 500 foot recovery system, ice crystal field, and all the required one-of-a-kind instru-mentation – to the first test program was about a year, as I recall. The installation and activation of the operational hypervelocity G-track system was successfully completed on cost and on schedule.

The operational G-track provided the required erosion test capability, provided

significant improvement in the accuracy of in-flight recession measurements and, most importantly, enabled post-test recovery of the nose tip, undamaged by the recovery process for examination in the laboratory. The lab work included post-test assays of the physical properties of the nose tips such as post-test dimensions, depth of char layer, surface erosion details, and functionality of transpiration cooled nose tips. The ability to routinely capture a test model traveling at some 15,000 ft/sec without damaging the relatively fragile nose tip was a seminal contribution to reentry nose tip test technology.

Was it a success, absolutely, it provided the data needed for the decisions and most importantly, the Russians never pushed the button. It received the annual national AAIA ground test award.

Development of the Range G track was my favorite project of all time and the best and most extensive team of which I have ever been a member.

I would like to point out that this is another excellent example of our system working the way it should work because it is populated by the kind of people who make it work.

LEAVING AEDC

Some things were not fun. I was a substitute writer on the proposal for the first AEDC operating contract competition. I had never written on a proposal before; I did a lousy job. If I wrote one satisfactory paragraph a day, I was lucky. I hated the experience and I vowed “never again!”

Therefore, when the second competition rolled around, I was appointed proposal manager. Actually there were five proposals, A, B, C, AB and ABC – the whole, the parts and the sum of two parts. And then there was the Technical Volume, the Cost Volume, the Past Performance Volume and the Resume Volume – and it seems like maybe another one– for each of the five.

We delivered the proposal copies in two pickup trucks. It took around six months to turn out the proposal and the team peaked at around 100 people. We lost all but part A, and I was devastated. But it's an ill wind that blows no good and in a few years. I had come to realize that the competition and the loss had been a good thing for me, our company and for AEDC. We were all made stronger for it and all prospered.