Historian's Corner

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NOTE: We would like to invite retirees from all Lockheed Martin divisions to consider writing a short article for the Historian's Corner telling about your activities in any of the current member companies. The aerospace industry was in its infancy when many of us entered our careers, and many things were so different from the normal technical, environmental, manufacturing, and financial challenges we faced in previous activities that entirely new perspective and tools were required. As a result, most everyone has had an interesting, or even exciting, event or time that others would enjoy hearing about. After my recent STAR article, I enjoyed hearing from many of my old friends and coworkers who remembered those days - it was great to hear from every one of them. Please share your experiences with us. We will help you put it into final form if you wish. Photos are also desirable.

Ray Ziehm

Keeping Rockets Alive: Two Phases of My Aerospace History

By Joseph Keeley

Phase 1: As a newly hired ex-Army solid rocket test engineer, I began my Martin Co. (MMC) career at Denver/ Waterton in January, 1957 in the partially completed two-story Engineering Building south of the new Titan missile factory. The million=gallon water tank stood high atop the western ridge ready for the massive rocket test facilities down in the valley.

John Youngquist, the Propulsion Manager, introduced me to Titan Pressurization, Propellant Feed, and Design leads for the mighty Titan I two-stage rocket propulsion systems. My engineering task assignment on the Engine Integration team was to assure the second stage Aerojet General XLR-91 rocket engine worked seamlessly with the other propulsion and flight systems.

Wings Over the Rockies Aerojet XLR91 Titan Missile Rocket Engine

The engine, built by Aerojet General Corporation (AGC), burned RP1 and liquid oxygen and produced 90,000 lbs. thrust at altitude. The integrated engine systems had to meet all USAF BSD mission requirements and fit/work both at ground level and thru entire two stage powered flight. Tom Jenkins was the XLR-87 stage 1 engine integration engineer. I soon met our 2nd Floor Final Assembly factory team starting with Doug Kellogg, rocket engine specialist, our Aerojet interface specialist, Joe Dougherty, who was co-located with us in Colorado. I journeyed to the D-1 Battleship test stand, where propulsion engineers Bob Sheffer and Earl Cook were starting to get the engine, test stand, and blockhouse equipment delivered, installed, and wrung out.

The first hot firing tests in Waterton were for the Stage I XLR-87 rocket engines mounted on heavy steel "battleship tanks" on the D-1 stand.

Program priorities dictated major early emphasis on completion of the 300,000 lb. thrust Stage I engines to meet the tight static testing and flight preparations schedules. This allowed additional time for 2nd stage design engineers and technicians along with factory and test personnel to work closely as a team to make our challenging early firing tests successful.

Summer 1957

I was selected to be on the first MMC team going to the AGC Sacramento, CA., facility for two months of "hands-on" training and test participation on the XLR-91. They welcomed us with intensive engine overviews. Classes were conducted by key Aerojet designers, the XLR-87 Engine program manager Dan Price, and XLR-91 program lead, Louis Wilson. Key AGC technical experts covered overall Engine design, thrust chamber, turbopump, gas generator, valves, controls and piping, manufacturing, instrumentation, electrical and controls, ground support equipment, safety, test stand operations, and much more. With less than seven months at Waterton, I relished the upcoming challenges as did all our team. I witnessed dozens of cryogenic cold flow and hot firing test stand ops including both successful and unsuccessful firing attempts. The complicated second stage firing sequence consisted of over 80 hot firings to successfully complete and prove out the total in-flight operations. The Martin engine trainees returned back to their jobs at Waterton and Cape Canaveral eager to begin the pressurization and propellant system tests before we attempted full stage two system hot firings.

My hands-on AGC hardware experience paid back quickly as I checked the initial second stage flight article completing assembly on the 2nd floor factory. The complete Aerojet engine assembly was installed and mated with our Martin pressurization and propellant feed system components. I noticed an auxiliary pump lox valve was installed backward and I discussed the problem with the factory floor propulsion lead. We found a drawing error and had the responsible designer join us; he generated a Drawing Change Notice quickly and avoided future time delays, system malfunctions, and potential damage. Our propulsion team tracked the factory completed stage 2 (with engine installed) through the Vertical Test Facility until electrical and sequence tests were completed. The stage was then delivered to Denver D-2 test stand with Ray Ziehm and many more test specialists for captive missile individual and sequenced side-by-side engine firings. These Titan Night firings lit up the sky and were easily visible and audible from South Santa Fe.

I was included in a group of Denver engineers that Dewey Rinehart took to NASA MSFC (formerly ABMA-Army Ballistic Missile Agency) to support consideration of Titan as a candidate for the planned Saturn family of space boosters. There we witnessed a full diameter (partially full fuel tank) slosh test using a small railroad car with adjustable dynamic parameters for eccentric loading. The Jupiter IRBM insulation and structure penalties for the "sealed can" booster engine compartment caused us to recommend and implement a ventilated stage 1 engine compartment for the Titan. Vanguard's proven "Fire in the Hole" staging to ignite the upper stage rocket engine prior to stage 1 separation was later incorporated into Titan II to eliminate the separation rockets used on Titan I.

Our nation needed a more rapid launch response with increased payload capability that required higher performance and advanced technologies.

USAF Museum Dayton Titans I & II with Peacekeeper, Thor & Minuteman 3

Increasing world tensions led to the Titan II Storable Propellant missile system concept using hypergolic storable propellants providing a 60-second launch response. The new design also increased payload lift and accuracy capability, simpler systems, autonomous guidance and propulsion systems. In Systems Engineering,

we jointly created the Titan 2 Design Criteria with the sub-system designers to configure the entire vehicle and ground system.

NASA HQ teams were working many options for post Apollo Missions, focusing on usage of unassigned manned Apollo flight hardware, Saturn I and V boosters and KSC processing and launch facilities. The chosen mission was the first manned space station, the Skylab Orbital Workshop, consisting of a stripped-down S-IV B stage, outfitted for three crewmen living and working for many months supported by crew rotation and consumables resupply launches.

Skylab on orbit

The SL-1 Skylab module, 32Ft in diameter, with the attached Multiple Docking Adapter (MDA) and Apollo Telescope Mount (ATM) would be launched as a single combined payload atop a 7.5 million lb. thrust Saturn V booster with an operating S-2 second stage delivering the unmanned Skylab module mounting dual extendible solar panels to orbit.

These programs illustrate the varied experience most of us had in the early days of the space era. Most Martin retirees were involved in these and many other programs that required a broad spectrum of unique skills and dedication.

I feel very fortunate to have shared part of this era with all of you. We were all involved and made a difference in so many exciting and critical programs. We retirees can do a great service to our country and our students to impart some of our lessons learned, and have fun doing it.

Phase 2: At retirement, the challenges and euphoria experienced at successful test or flight while working in the aerospace industry came to a sudden end. I and others who participated in these great advances of the aerospace industry, which moved at such a fast pace, found that we missed the technical cooperation shared during our Martin careers, the excitement of responding to new requirements and challenges every new program encountered. Each new program seemed to bring on bigger, faster, higher, hotter, colder, more costly, more dangerous, and more exciting issues than the last one. The thrill of planning and accomplishing things that had never been done before was gone. We now interface mostly with folks involved with more conventional industries and realize how fortunate we are to have been a part of this phenomenon. We gained knowledge and experience that very few people in the world can even imagine. This background is a valuable resource to students, industry, and the country. We should strive to forward it, if we can, to avoid new personnel having to "re-invent the wheel".

Now retired, as I spoke with old friends and extended family, particularly elementary through high school youngsters, one of the questions was "What did you do at the Martin Waterton plant when you were there?" Consider their ages and remember that today's sixth grader was born in 2004 and twelfth grade seniors, in Y2K -2000.

I looked to "try giving back to the new generations", the helpful guidance assistance from parents, my job bosses, associates, high school, college and opportunity school technical teachers, machinists, construction craftsmen and several WWII foreign mechanic refugees who helped me learn my skills.

In 1995, after my first five retirement years, an opportunity emerged to use some of the lessons learned in the industry and to engage youth. My high school's new science teacher sought alumni to develop and provide a week long, mini-program concentrated on aerospace science using experienced, Denver area rocket and aircraft engineers and technicians. They

were to lead and conduct sessions in class rooms, labs and facility tours for high school students. These students were not even born when many of the major aerospace advances were made and they were not aware of the significance of major events in the world theater such as WWII, Korea, Vietnam, the cold war ICBM standoff with USSR, Cuba crises, and Iraq's Desert Storm. They know very little of programs like Titan, Skylab, Apollo, Viking, and Shuttle. Most of the retirees I know have had some interface with these programs, and could impart significant information beyond what students will learn in school or see on TV.

I contacted fellow Martin retirees Bill Marcy, an Experimental Aircraft Association (EAA) leader & member and long-time veteran of the joint USAF/NASA X-aircraft programs at Edwards Air Force Base, and other retirees Kent Paser and Kent O'Kelly to conduct a week-long series of interactive lectures, using 1995 vintage visuals and overheads, VCR tapes and movies with presentation techniques from our Martin careers. We added our hands-on model and test flight skills and full-scale aircraft building background. A visit to the Martin Waterton second floor Titan factory was arranged (with eager parent guides) to see, talk and touch real rockets in their final build and test cycle and talk directly to the shift floor supervisors and local MMC factory veterans. The impact on students and parents was really great. The MMC factory and test personnel dramatically emphasized that senior students need to learn their math and science, and to be real craftsmen since the rockets must be a success from liftoff through mission completion since there is no further system tweaking after they leave the launch pad. In addition, for manned flights, safety is paramount.

Bill Marcy's chalk talk classes on "Aerodynamics Theory- How Propellers and Wings Work" presentations challenged many students and led into my "scratch-built" model airplane build sessions. Students selected and built model aircraft of their choice from hobby shop materials either as gliders, or "fish pole power control line" models with designs scaled up/down with manual grid or enlarger using WWII aircraft spotter photos, recent model and EAA magazines, and catalogs provided ideas for their projects. Each student made their own balsa WWII fighter with Duco cement and spray paints and flew them outside the school building, learning about center of gravity, center of lift, and control mechanisms.

5th grade students check CG balance for proper flight preparation

The best flyers were the Mustang P-51, and ME109 Spitfire. I flew my scratch built 20-inch British Mosquito bomber on a 10-foot fishing pole using one-hand elevator control lines for up/down control to fly the airplane. The Mosquito still flies after surviving control flights by 84 high school students and teachers (about 30 seniors each year during consecutive program years).

This mini-course, with a mix of volunteer teachers/craftsmen, provided open discussion, student hands-on build and test flying. Joint visits to our Martin factory employee meetings were a success for students and parents by showing the school's faculty interest and desire, active senior student participation, and eager, competent, and strong parental participation.

An opportunity came when NASA sponsored a SPACE ART display in 2000 using three converted Pullman railroad cars outfitted as art exhibits with rocket- and spacecraft-related art including drawings and paintings by some of the astronauts. The railcar was on an Arvada siding off the main track to Coors Golden. A fifth grade teacher friend asked me to join their 20-student class on a guided tour; I volunteered and suggested library sources for the young students to read in order to participate and gain the most benefit from dialogs with the NASA

staff. As the tour progressed, some of these 11-year-olds showed their interest, and desire to learn more. I was pleasantly surprised by their knowledge, preparation, and genuine enthusiasm for space subjects. One former student is currently pursuing an aerospace engineering BS degree and is aspiring to be an astronaut, even with the uncertainty of new astronaut program opportunities.

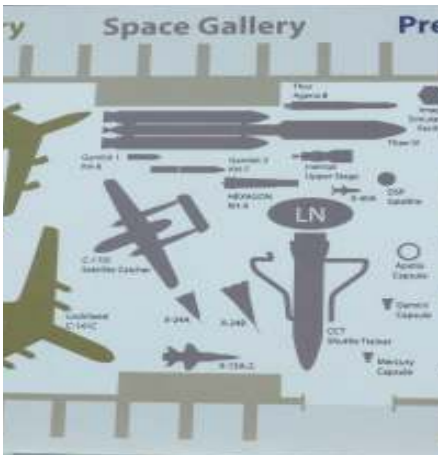
During 2 years of active rehab, from an accident with broken knees. I checked our regional and local library for availability of books, magazines & videos that I could recommend for student references. In 1994, I surveyed Denver & Jefferson county library bibliographies and found 56 books that I reviewed and recommended to my high school senior attendees. Eighteen years later in 2012, I made the same check of Jefferson, Denver and Prospector listings. After personal visits to 4 Jeffco libraries, only 4 books were found. The false assumption is that the written page has been replaced by the internet mouse certainly emphasizes the importance of programs like ours.

A major benefit from this Phase 2 activity is to expand your outreach and your mind. Joint participation with younger people transfers their youthful enthusiasm and appreciation into older folks that get involved. It's a win-win situation for all. The physical and mental rewards contribute to improved elderly health.

Here are a few tips if you find this an interesting challenge:

- Leave your *Legacy* Soon!

- Visit our Aerospace Museums soon to see your contribution to these aircraft & space flight pioneers and gain knowledge and interest for your future participation!



USAF's Museum's new wing will feature complete Titan IV and payloads with X-24A & X-24B in the Space Gallery

- Get involved with groups:-kids, adults and retirees by locating prospective organizations. Contact their meeting/program leaders and offer to prepare and participate at sessions designed to interest and motivate their audience.

- Prepare to share ideas, inspire future actions, creating and delivering innovative sessions that inspire audience participation through concept, design, fabrication, then testing to enjoy success, survive failure and fixing first hand to feel real pride in accomplishment.

- Seniors/retiree groups especially need help to sustain a positive mental attitude and can help others by sharing their life experiences.

If you'd consider a similar effort, I am eager to discuss any ideas you might like to try, or help you initiate a new program of your own.

Wings in the air on a beautiful morning at Arvada Hackberry Elementary