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The Spoken Word II: Recollections of Dryden History, Beyond the Sky

**edited by
Curtis Peebles**

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edited by Curtis Peebles

Editor's Foreword

Since the founding of the Dryden Flight Research Center History Office in 1996, its staff has conducted about a hundred interviews with retired employees. These recollections represent a unique resource in understanding the development of aerospace technology in the second half of the twentieth century. Their personal experiences, insights, and opinions allow readers to gain an appreciation for what it was actually like to have been involved with some of the milestone events in aerospace history. A selection of interviews has been edited and assembled into this monograph to enable a wider audience to share in this adventure.

This collection of interviews is the second in a continuing series on the history of the Dryden Flight Research Center. The new volume covers the period between the establishment of NASA in 1958 and the beginning of space shuttle flights in the early 1980s. This time frame encompasses the flights of the X-15, the U.S./Soviet race to the moon, the evolution of the lifting-body concept, and the initial shuttle flights.

These events took place as jet propulsion and supersonic flight became everyday occurrences. They transpired amidst the ongoing Cold War and the social, cultural, and technological upheavals of the 1960s, and advances in aerospace technology, such as digital fly-by-wire, of the 1970s. They are told by the people who participated in these landmark activities, in their own words.

Curtis Peebles
September 2010

Prologue

The Approach Of The Future

Aviation's future was already dimly visible when the first contingent of National Advisory Committee for Aeronautics (NACA) engineers arrived at Muroc Army Air Field in September of 1946. They set up the Muroc Flight Test Unit in a wartime hangar at the field's South Base to support Army Air Forces flight tests of the X-1. By the spring of 1947, the initial powered flights of the X-1 were under way. The research plan, developed jointly by the Army Air Forces and the NACA, called for an incremental speed build-up until the aircraft exceeded Mach 1. NACA personnel were responsible for the instrumentation on the two X-1s, reducing the data after the flight, and assisting the Army Air Forces with flight planning. Once the initial contractor and military test flights were completed, one of the X-1s would be transferred to the NACA so research flights could be undertaken.

The work by the Army Air Forces and NACA personnel was part of a continuing pattern in aircraft development. Since the first flights of the Wright brothers, the quest had been to fly farther, higher, and faster. Initially, that meant an airplane was able to make a complete circle around a large field. A decade later, World War I saw airplanes flying combat missions over the Western Front. By the 1920s, both the U.S. and European nations had regular airmail service, while the first passenger airlines also were being established. The daring of Charles Lindbergh's transatlantic flight, in May of 1927, captured the imagination of the world. By the end of the 1930s, international air travel was a reality. The world was suddenly smaller; a trip by airplane from the U.S. to Asia or Africa now took only about a week as compared to nearly a month by ship.

The vertical dimension of flight also was changing. Advances in engines and aerodynamics allowed aircraft to reach altitudes too high for survival by unprotected humans. A pilot would have to, in effect, bring the ground along with him. This involved either a pressurized cockpit or a pressure suit to maintain an artificial environment.

But it was the ever-faster aircraft speeds of the late 1930s and mid-1940s that led to establishment of what would become the NASA Dryden Flight Research Center. High-powered piston engines combined with highly refined/low-drag airframes meant that, in dives, aircraft could reach velocities near the speed of sound.

Air flowing over wings and tail surfaces in these dives moved at “transonic” speeds, between Mach 0.8 and Mach 1.2, causing an increase in drag and the formation of shock waves. This rendered the controls useless and caused the aircraft to shake violently. Wind tunnel tests provided little help understanding these problems, as the transonic flow also rendered their data inaccurate.

John Stack and other researchers at the NACA Langley Memorial Aeronautical Laboratory at Hampton, Virginia, decided the only way to resolve the unknowns of supersonic flight would be to build a specialized research aircraft, equip it with instrumentation, and fly the aircraft at high speeds. From this concept emerged the Bell X-1 rocket-powered research aircraft.

To reach speeds above Mach 1, a unique flight profile was used. The X-1 would not take off from the ground, but would instead be dropped from a B-29 in flight. The X-1 would use all of its fuel supply for the speed run or in a climb to high altitude. A rocket engine carries both its fuel and oxidizer so that, unlike a jet engine, it operates independently of the oxygen in the atmosphere. This meant that a rocket could operate at altitudes far too high for a jet engine, and even in space itself.

Once the rocket engine exhausted its propellant, however, the X-1 would have to glide back to a landing. This eliminated the possibility of operating the aircraft from the NACA’s Langley facility, where the risk of an unpowered landing by an experimental aircraft on a conventional runway was too great. The Muroc site had the advantage of the vast expanse of Rogers Dry Lake. This provided the perfect landing area, with runways marked on miles of flat, hard-packed surface.

On October 14, 1947, the speed build-up culminated with Capt. Charles E. “Chuck” Yeager making the first supersonic flight. This accomplishment took place against a rapidly changing international and technological background. In July of 1947, the Cold War between the U.S. and the Soviet Union had formally begun. The world was now divided between East and West, in a struggle that would last more than four decades. With the threat of Soviet Communism looming, U.S. technological superiority, particularly in aviation, was an imperative. While the X-1 had shown that supersonic flight was possible, a vast number of unknowns remained to be discovered and understood. In the process, aviation technology underwent a revolution. Every aspect of aircraft design would change over the next two decades. The road traveled during these years was a difficult one, and many losses would be suffered along the way.

The horizontal tail configuration was among the first changes to aircraft design. Since the early years of powered flight, horizontal tails had two parts, the fixed horizontal stabilizer and the movable elevator. As an aircraft neared Mach 1, a shock wave formed and moved backwards on the stabilizer. When the shock wave reached the hinge line of the elevator, the airflow over the elevator was disrupted and the control surface was rendered ineffective. A pilot in a dive was suddenly unable to raise the aircraft’s nose to pull out, as he no longer had pitch control.

On a flight at just under Mach 1, Yeager pulled back on the control wheel and nothing happened. The elevator was no longer effective. He shut off the rocket and slowed, regaining control once the shock wave had moved forward. Bell engineers had designed the X-1’s stabilizer to be movable on a pivot, rather than fixed, as a means of trim control. In discussions after landing, Yeager and the engineers realized this movable stabilizer also could be used for pitch control at speeds just below and above Mach 1. A two-part tail design was clumsy, however, and soon a single-piece, all-movable horizontal tail, called a “stablator” or “stab,” became standard on high-performance fighter aircraft. To avoid wing wake, this all-movable tail was placed on the vertical tail.

A more visible change was in wing design. Both the X-1 and early jets, such as the F-80, F-84, and F-89, featured thin but long and straight wings reminiscent of piston engine aircraft. But as speeds climbed, so did the drag. The solution was to use new low-aspect-ratio wings, such as swept-back wings, triangular delta wings, and short, straight wings. (This refers to ratio between the wing’s span and its chord. A sailplane’s wings in contrast, have a high-aspect-ratio wing.) Use of low-aspect-ratio wings delayed the onset of the increase in drag at high subsonic speeds.

This solution, however, created new problems. Aircraft with low-aspect-ratio wings suffered from “pitch up.” This occurred when an aircraft was maneuvering at a high angle of attack, such as during a landing approach or in a dogfight. Vortices from the wingtips and the fuselage created a downward force on the stablator, causing the aircraft’s nose to pitch up and the aircraft to lose speed. This loss of control could cause a stall/spin accident. Major efforts were undertaken to find a solution. The D-558-II #3 (NACA 145),

which had swept-back wings, was used to test different designs of sawtooth wing leading edges, wing fences, and slats in attempts to eliminate the problem. The results were disappointing. Some of the designs reduced the effects of pitch up, others aggravated it. To address the problem, the location of the stabilator had to be changed. Rather than mounting the stabilator midway on the tail, as with the D-558-II, the F-100 and F-8 fighters had their stabilator placed on the lower fuselage, below the wings.

The new jet aircraft designs also featured extended fuselages to accommodate jet engines and fuel tanks. The short, low-aspect-ratio wings, and the concentration of the mass in the fuselage, reduced aerodynamic stability and made the aircraft vulnerable to inertial coupling. The dangers posed by what had been only a theoretical phenomenon became apparent when several F-100s crashed.

Flying at high speeds, F-100 pilots rolled at a rate that exceeded the critical value for the speed, altitude, and weight of the aircraft. As long as the roll rate was below the critical value, the aircraft remained stable. Once it was exceeded, inertial coupling occurred and the aircraft suddenly yawed sideways as it rolled, breaking up in flight as a result of excessive air loads. The cause was soon identified, and the solution was to enlarge the F-100's vertical tail and wingtips. This improved high-speed aerodynamic stability at high roll rates, and allowed the F-100 to be returned to service.

Beyond these design changes, the rate of technological change also had accelerated. Production aircraft were reaching speeds as great or greater than those of earlier rocket-powered research aircraft. As one generation of fighters was entering operational service, another was undergoing flight testing and a third was in development. The pace of aircraft design and development directly reflected the pace of discovery at the NACA High Speed Flight Station and Air Force flight test facilities. Unlike any previous era in aviation, each new generation of military aircraft was quickly rendered obsolete by new developments and discoveries, leading to short service lives.

As an example of this increase in performance, the prototype XP-86 exceeded Mach 1 in a shallow dive on April 26, 1948, just seven months after Yeager's groundbreaking flight and not much more than a month after an NACA pilot flew an X-1 beyond the supposed sound barrier. By the end of 1949, two entire Air Force fighter groups had been equipped with production F-86s.

While much of the research work undertaken with rocket-powered aircraft in the late 1940s and early 1950s focused on understanding the demands of high-speed flight, efforts also were being made to reach ever-higher altitudes. By making a "zoom" climb, rocket planes could reach altitudes far above those of conventional aircraft. Air Force test pilot Major Frank "Pete" Everest began a series of high-altitude test flights in 1949 with the X-1. After several aborted attempts, Everest reached an altitude of 71,902 feet on August 8. His next flight, on August 25, underscored the dangers of high altitude. As the X-1 climbed through about 69,000 feet, cockpit pressurization was lost. Everest's partial pressure suit inflated, and he was able to make an emergency landing. He was the first pilot to be saved by a suit in a depressurization incident.

The D-558-II also was used for high-altitude flights. In the summer of 1951, the D-558-II #2 underwent a series of test flights after being modified for air launch from a P2B-1S, the Navy version of the B-29. Douglas Aircraft Company test pilot William B. Bridgeman undertook these high-speed/high-altitude flights. On June 23, 1951, Bridgeman reached a speed of Mach 1.85 at 62,000 feet. When he began the speed run, the aircraft began to oscillate violently in all three axes. Wing rolling reached ± 80 degrees per second. Bridgeman was forced to shut down the rocket engine to bring the aircraft under control. For his next attempt, on August 7, Bridgeman did not move the controls as abruptly as he made the speed run. As a result, the instability was less severe and he reached a speed of Mach 1.88 at 68,600 feet. Bridgeman's final flight was made on August 15, reaching 77,800 feet. This surpassed Everest's flight two years before, and represented a new unofficial altitude record.

To mark the 50th anniversary of the Wright brothers' first powered flights, the D-558-II #2 was again used for a series of altitude flights, these piloted by Marine test pilot Lieutenant Colonel Marion Carl. The flights were to take place at the edge of the D-558-II's performance envelope, but Carl's first two altitude attempts ended in failure. Then, on August 21, 1953, Carl reached an altitude of 83,235 feet, setting a new record.

The Air Force was next to attempt setting altitude records during the spring and summer of 1954. The aircraft used was the X-1A, a second-generation version of the original X-1 configuration used to break Mach 1. While the D-558-II could barely exceed Mach 2, the new X-1A could easily surpass it. This speed capability meant that it also was capable of surpassing Carl's altitude record set the year before. The X-1A's

directional stability dropped sharply as it approached Mach 2, however. This, in turn, meant the aircraft was susceptible to inertial coupling at very low roll rates.

The new X-1A project pilot, Major Arthur "Kit" Murray, found the altitude goal both elusive and frustrating. Of his first five flight attempts, only his checkout flight was successful. The other four were aborted as a result of various problems. On May 24, 1954, Murray reached 87,094 feet, over a half mile higher than Carl had flown. The flight was made without significant control difficulties.

Murray's next attempt illustrated the dangers of attempting to set records in an aircraft with marginal stability. The altitude flight was made on June 4, and ran afoul of instability and inertial coupling. During the climb, Murray noticed the aircraft rolling to the left to an angle of about 10 degrees. He corrected this using the aileron and rudder. As the X-1A rolled back toward a wings-level position, Murray moved the ailerons to stop the motion. He also reduced the pressure on the rudder pedals, returning the rudder to its normal trim position. The rudder was slow to respond, apparently due to friction, which caused Murray to overcontrol. This triggered a roll rate of about 115 degrees per second.

Murray shut down the engine, but the X-1A continued to climb as the aircraft rolled out of control. In attempts to stabilize the aircraft using the ailerons and rudder, he overcontrolled. The X-1A reached a peak altitude of 89,750 feet and began to descend. Murray was finally able to regain full control at about 65,000 feet, at a speed of Mach 1.65.

Despite the inertial coupling, the attempts to reach still-higher altitudes continued, as did the problems. Murray's next six attempts were aborted. Finally, on August 26, 1954, he was successful. The flight conditions were nearly identical to those of the June 4 flight (Mach 1.97 and an altitude of about 87,000 feet), during which Murray had experienced the inertial coupling. As he climbed, the X-1A was in fairly steady flight. When he shut down the engine, however, the aircraft abruptly yawed and rolled. Murray rapidly countered the motion, preventing a loss of control. He reached a peak altitude of 90,440 feet on the flight, besting his previous altitude records.

The pilots who ventured to these high altitudes saw aviation's future most clearly. Below their aircraft, the mountains and valleys spread out like a map, brilliantly illuminated by the unfiltered rays of the sun. The horizon gave a hint of being curved, indicating that Earth was a sphere. Looking away from Earth, they saw the color of the sky changed gradually from the white haze on the horizon to a pale blue and to deeper shades of blue, merging to become the blue-black dome of the sky overhead. It was the color of space.

The pilots and engineers who worked on the early experimental aircraft had grown up with comic strip space heroes like Buck Rogers and Flash Gordon, while their children followed the television adventures of *Tom Corbett: Space Cadet*. Flight beyond the sky seemed to be at once inaccessible yet within their grasp. The Bell X-2 would have a top speed of Mach 3 and a potential maximum altitude above 125,000 feet. It was easy to imagine that a series of experimental aircraft could be built, with each new design capable of reaching faster speeds and greater altitudes, until an aircraft finally went into orbit around the Earth.

Attempts to turn this concept into reality met with a host of technical problems and physiological and psychological unknowns, as well as daunting political opposition. Doubling the performance capabilities of the X-2 would produce an aircraft capable of reaching the edge of space. Doing so, however, would require a much larger aircraft built of new, heat-resistant materials, with a larger, more powerful rocket engine. The inertial coupling problems that plagued the early attempts at both high speeds and high altitudes would have to be prevented. The high-altitude flights of the D-558-II and X-1A took place within Earth's atmosphere, where standard aerodynamic control surfaces such as the rudder and ailerons still were viable. As aircraft went higher, however, aerodynamic pressure would diminish until the aircraft would be traveling in a near vacuum. A separate set of non-aerodynamic controls, such as small thruster rockets, would be needed to maintain stability.

The aircraft would also have to re-enter Earth's atmosphere, where its high speed within the thickening atmosphere would cause it to heat dramatically. In addition, dynamic pressure on the vehicle would increase rapidly from zero to as much as one ton per square foot during return. Any errors in the trajectory, or control problems such as those experienced with the X-1A, would lead to the vehicle's destruction. These were the engineering problems complicating development of a Mach 6 aircraft capable of reaching the fringes of space. Entering orbit would require speeds of Mach 25, which meant far greater heat protection would be needed.

Beyond the engineering issues, there were the looming unknowns of the human response to spaceflight.

Could a pilot actually *fly* such a vehicle? Could he continue to function under the high g-loads of the launch? Once the engine shut down, the vehicle would follow a ballistic trajectory. This meant the pilot would become weightless for two to three minutes. How he might respond to such a prolonged period of weightlessness was altogether unknown.

There also was the complicating factor that there seemed to be no military or civilian role for aircraft able of operating at speeds of Mach 5 or above. From the military's perspective, even long-range rockets were seen in the late 1940s and early 1950s as a distant possibility at best, due to their cost, technical unknowns, limited accuracy, and the great weight of the heavy A-bomb warhead. Instead, the U.S. focused its short-term development efforts on "pilotless missiles" such as the Regulus, Mace, Matador, and Snark, jet-powered aircraft that flew to their targets under automated control.

Compounding this, very few civilian scientists and engineers in the late 1940s and early 1950s were directly involved in space research with high-altitude sounding rockets or instrument-carrying balloons. There were a few studies made of satellite use for scientific research, military reconnaissance, weather observations, or communications, but none of these potential applications garnered sufficient political support or funding to go forward. The cost of traveling in space would be high, and the need was not seen as pressing. Spaceflight was, at best, a distant possibility, decades from becoming reality. Most scientists dismissed it as science fiction.

Against this background of beckoning possibilities and towering obstacles, a few individuals at the NACA and within the military services decided that the time was right for a new research aircraft. Goals for the new aircraft were ambitious—its maximum speed and altitude would be more than twice that of the X-2. The vehicle would be designed to fly Mach 6 and reach altitudes where it would experience zero dynamic pressure.

To understand just how ambitious this effort was, it must be remembered that, when the program was being discussed, the highest speed yet attained in piloted flight was Mach 2. The first flights of the Wright brothers were barely more than a half century in the past.

The new research aircraft was to be called the X-15, and it would be the first manned spacecraft ever designed.

Section I

Into Space



The development of the X-15 took place amid a changing aeronautical environment. The NACA detachment at Edwards had outgrown its single hangar and other makeshift facilities at South Base. In the summer of 1954, as the X-15 program was gaining momentum, NACA personnel moved into a new facility near the Edwards Main Base. With the move came status as an independent facility and a new name, the “High-Speed Flight Station.” The new organization continued to undertake high-speed and high-altitude flight, but also was now deeply involved in the full range of activity in aeronautics at mid-century. This included research in pitch-up and inertial coupling, evaluating new aircraft and providing technical support and advice to the military.

But even as the High-Speed Flight Station was filling such traditional NACA roles, the X-15 program was taking shape. Following the studies at Langley and other NACA facilities, proposals for the rocket plane's design were solicited from contractors. These were evaluated, and North American Aviation was selected as the winner. The X-15 program proved far more costly than previous X-plane development. As a result, it would be jointly funded by the Air Force, the NACA, and the Navy. The NACA would have overall responsibility for technical direction and planning.

The X-15 was not the only advanced space activity under way. Elsewhere, work was beginning on the Vanguard satellite, which was the U.S. contribution to the International Geophysical Year in 1957-58. The Air Force also was developing the WS-117L reconnaissance satellite program. High-altitude balloon flights were being made by both the Air Force and the Navy to determine the effects of cosmic rays and near-space conditions on both animals and humans. Dr. Hugh L. Dryden, the NACA director, quietly began to shift more effort and funding toward space research. At Langley, for example, a Satellite Vehicle Group was established to investigate structural design, trajectories, and guidance, while the Pilotless Aircraft Research Division began rocket studies. Without a national commitment to undertake space research, however, such activities remained poorly funded and were regularly on the verge of cancellation.

Volume 2, Issue 3⁴

NACA HSFS - Edwards, California

August 8, 1958

PRESIDENT SIGNS BILL CREATING NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

On July 29, President Eisenhower signed into law HR-12575, thus creating the nation's first civil space agency--the National Aeronautics and Space Administration. In signing the legislation, which was passed earlier in July without a dissenting vote in either house of Congress, the Chief Executive stated...

"Enactment of this legislation is an historic step, further equipping the United States for leadership in the space age. I wish to commend the Congress for the promptness with which it has created the organization and provided the authority needed for an effective national effort in the fields of aeronautics and space exploration.

"...The present National Advisory Committee for Aeronautics (NACA) with its large and competent staff and well-equipped laboratories, will provide the nucleus for the NASA. The NACA has an established record of research performance and of cooperation with the armed services. The combination of space exploration responsibilities with the NACA's traditional aeronautical research functions is a natural evolution.

"The enactment of the law establishing the NACA in 1915 proved a decisive step in the advancement of our civil and military aviation. The Aeronautics and Space Act of 1958 should have an even greater impact on our future."

At the same time, both the U.S. and Soviet Union had begun an intensive effort to develop intercontinental ballistic missiles. U.S. officials had not been willing to approve work on ICBMs until the development of lightweight/high-yield thermonuclear weapons in the mid-1950s. Size, weight, and accuracy requirements were reduced for such missiles, making development of ICBMs technically and economically feasible. The U.S. missile program involved development of the Atlas and Titan ICBMs, which could strike targets in the Soviet Union from launch points in the U.S., along with shorter-range Thor and Jupiter missiles based in England, Italy, and Turkey. The Soviets built the R-7 ICBM as their long range missile. Because development of the R-7 began earlier than that of the U.S. missiles, at a time when the estimated size and weight of nuclear weapons were still very large, the R-7's payload was far greater than that of the later U.S. ICBMs.

These missiles were designed to deliver nuclear warheads to targets inside enemy territory, but could also provide the means to reach space. On October 4, 1957, an R-7 rocket lifted off its launch pad in Soviet Central Asia. At 5:58 p.m. EDT, an announcement by the Soviet news agency TASS reported that the first satellite had been success-



Volume 2, Issue 25

NACA HSFS, Edwards, California

April 4, 1958

PRESIDENT PROPOSES NACA AS NATIONAL SPACE AGENCY

WASHINGTON, D.C., April 2--President Eisenhower at noon today sent a message to Congress outlining his plans for future conduct of the Nation's space technology program. The President's message included a draft proposal for the legislation necessary to accomplish the Administration's plan.

The proposed legislation calls for establishment of a new, independent civilian agency to be known as the National Aeronautics and Space Agency. If enacted into law by Congress, the staff and facilities of the NACA will become the nucleus of the NASA. The responsibilities of the NASA will include, but be larger than, those currently administered by the NACA, and in addition to research, will involve both development and operation of space vehicles. The NASA will also work closely with the military services and other agencies, public and private.

Time will be required, of course, for Congress to give attention to the President's civilian space program proposals. In this period, the NACA will continue to do its important work on the problems of flight, as well and as rapidly as possible. We shall also be planning for the new responsibilities we may be given in the future. In the days ahead we will have much to do that is important and challenging.

(The above message was received this week from Dr. Hugh L. Dryden, NACA Director, for dissemination to HSFS employees.)

HSFS PERSONNEL TO MAKE OFFICIAL FLIGHT TO FRANCE

Three members of the HSFS staff will embark on Monday from Andrews AFB, near Washington, D.C., for France, where they will furnish technical assistance in flight research on the Trident airplane.

Chief of the Station Walter C. Williams, pilot Joseph A. Walker, and research engineer Thomas W. Finch will make the trip to Paris and other points in France. They will be accompanied on the two-to-three week mission by Capt. Iven C. Kincheloe, USAF, and AFFTC engineer John Louis Wesesky.

EXTEND COMPLETION DATE FOR UNITED FUND COLLECTIONS

The Board of Directors of the HSFS United Fund has voted to extend the collection period of this year's Fund Drive from March 31 to April 30. This change has been made to allow contributors more time to finish payment of their pledges.

An overall balance of \$1,159 remains to be collected. To date, a total of \$2,262 has been collected for 27 agencies in localities designated by the individual contributors.

The Board urges those who have not completed payment of United Fund pledges to make every effort to pay-up during this final month. A statement of individual pledge balance will be prepared by Elinore Berger (Dispensary) for any employee requesting it.

CREDIT UNION INTEREST RATE TO BE REDUCED

The Board of Directors of the HSFS Federal Credit Union has voted to reduce the interest rate on loans made to Credit Union members. The revised rate of interest will be determined as soon as a new rate schedule can be obtained from the California Credit Union League.

HSFS employees are urged to obtain loans through their credit union to finance current expenses such as income or real estate taxes, vacations, the purchase of a new automobile or appliances.

fully placed into orbit around the Earth. Called Sputnik 1, it was sent into an elliptical orbit with a high point of about 900 kilometers, inclined 65 degrees to the equator, and took an hour and 35 minutes to complete each orbit. The Soviets also announced that the satellite's radio signal could be picked up by ham radio operators. The signals from Sputnik 1 were first picked up in the U.S. at the RCA receiving station at Riverhead, New York. Soon after, word began to spread about the Soviet launch.

The launch of Sputnik 1 triggered a period of soul-searching verging on pandemonium. American society was condemned as complacent and materialistic. Schools were viewed as being more concerned with "life adjustment" than with teaching their students math and science. A parallel result, however, was that space activities suddenly enjoyed a level of political support that would have been unthinkable prior to the Soviet launch. On October 1, 1958, the NACA ceased to exist, and the National Aeronautics and Space Administration took its place. The public unveiling of the first X-15 came two weeks later, on October 15. The Air Force already was considering a follow-on vehicle, the X-20 Dyna-Soar (for "Dynamic Soaring"), which would make higher-speed, boost-glide suborbital flights using a missile as launch vehicle. Ultimately, it was thought, the X-20 could be put into orbit.

SAFETY RECORD

Since our last lost time accident:
 294 days
 443,456 man hours (estimate)

Number disabling injuries in 1956	2
Number disabling injuries in 1957	0
Number days lost in 1956	5
Number days lost in 1957	0

(Figures are for period up to and including January 24, 1957.)

FOR SALE - 1956 Del Rey 2-door Chevrolet V-8 with Powerglide. \$1,350. Call ext. 40471, Kenneth Berger.

Two films will be offered to HSFS'ers for lunch-time viewing on Tuesday, February 5.

Beginning with the words from the Book of Genesis, "...and God said, Let there be light..." the 10-minute color film, "The Story of Light", traces the history of artificial light sources from the time of the caveman to the present. Stop-motion photography, featuring tiny, doll-like figures, is utilized in the movie.

Using the city of Syracuse, New York as an example, "And a Voice Shall Be Heard" shows how a well-trained, well-equipped Civil Defense organization can spring into action when an atom bomb strikes a city.

 Donate today to Hungarian Relief.
 Take your contribution to Dorothy Fleming, personnel office, room 112.

***** NASA NEWS NOTES *****

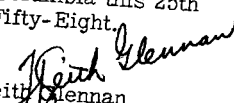
*****NASA ACCEPTS McDONNELL PROPOSAL FOR MANNED SPACE CAPSULE*****The NASA has selected McDonnell Aircraft Corporation as the source for the design, development, and construction of a space capsule capable of carrying man into orbital flight around the earth. Twelve companies submitted proposals in the competition. Dr. T. Keith Glennan, NASA Administrator, said McDonnell's proposal was selected after a careful assessment of the technical value of the proposals, and of the facilities, experience, and other qualifications of the various companies. Total cost of the satellite capsule and its subsystems is expected to exceed \$15 million. The space capsule, serving as the payload of a powerful booster, will be designed to carry a human passenger through the atmosphere, into orbital flight, and safely back to earth again. The satellite system will provide a means of studying the psychological and physiological effects of space flight on man. The development program of the capsule system, and its subsequent launching and orbital flight are called Project Mercury. The project is expected to continue for several years.

The X-15 and the proposed X-20 represented the conventional wisdom about how piloted spaceflight could be achieved. At the same time, however, a new concept for spaceflight was emerging. NASA Administrator T. Keith Glennan approved development of the Mercury capsule. Rather than a winged, aircraft-like vehicle, Mercury's design would instead be based on missile warhead technology. It would be launched into orbit by a modified Atlas ICBM. At the end of the mission, a retrorocket would fire and the capsule would enter the atmosphere protected by a heat shield and splash down in the ocean under a parachute. The goal would be to test human responses to such spaceflight conditions as weightlessness.

A PROCLAMATION

1. By virtue of the authority vested in me by the National Aeronautics and Space Act of 1958 (Public Law 85-568, approved July 29, 1958, 72 Stat. 426, 433) I hereby proclaim that as of the close of business September 30, 1958, the National Aeronautics and Space Administration has been organized and is prepared to discharge the duties and exercise the powers conferred upon it by said law.
2. In accordance with the provisions of the Act, all functions, powers, duties, and obligations, and all real and personal property, personnel (other than members of the Committee), funds, and records of the National Advisory Committee for Aeronautics are hereby transferred to the National Aeronautics and Space Administration.
3. The existing National Advisory Committee for Aeronautics Committees on Aircraft, Missile and Spacecraft Aerodynamics; Aircraft, Missile and Spacecraft Propulsion; Aircraft, Missile and Spacecraft Construction; Aircraft Operating Problems; the Industry Consulting Committee; and the Special Committee on Space Technology and their subcommittees are hereby reconstituted advisory committees to the Administration through December 31, 1958, for the purpose of bringing their current work to an orderly completion.
4. Existing policies, regulations, authorities, and procedural instructions governing the activities of the National Advisory Committee for Aeronautics, not inconsistent with law, and which are applicable to the activities of the National Aeronautics and Space Administration, shall be continued in effect until superseded or revoked.
5. The Langley Aeronautical Laboratory, the Ames Aeronautical Laboratory, and the Lewis Flight Propulsion Laboratory are hereby renamed the Langley Research Center, the Ames Research Center, and the Lewis Research Center, respectively.

DONE at the City of Washington, District of Columbia this 25th day of September in the year Nineteen Hundred and Fifty-Eight.


T. Keith Glennan
Administrator

CALLING ALL 'COKE' BOTTLES

A plea for cooperation in lessening the loss of Coca Cola bottles has been received from the EAFB Exchange. Unless the number of bottles lost is reduced considerably, the Exchange will be forced to discontinue Coca Cola vending service to the facilities where losses are greatest. From October 10 to December 3, 1956, it is reported, the Exchange lost 14,060 "Coke" bottles throughout the Base at a cost of \$281.20. HSFS' share of this loss was 694 bottles, or \$14.



Neil A. Armstrong

Interviewed by Dr. Stephen E. Ambrose and
Dr. Douglas Brinkley, September 19, 2001

Neil A. Armstrong grew up amid the golden age of flight in the 1930s, when wood and canvas biplanes gave way to all-metal monoplanes, top speeds greatly increased, and the idea of a “sound barrier” first started to take root. His high school years, spanning the end of World War II and the initial post-war period, saw the introduction of the first generation of jet aircraft and the first supersonic flight. As a Navy pilot during the Korean War, Armstrong personally experienced the difficulties that service branch had in adapting to the jet age. F9F Panther jets were being flown from straight-deck aircraft carriers originally built for propeller airplanes. The Navy’s jets also were lacking in performance when compared to the Soviet-built MiG-15s opposing United Nations forces in Korea.

Armstrong represented a new generation of test and research pilots that came to prominence in the jet age. Earlier test pilots were skilled “stick and rudder” men rather than engineers. Few had degrees, and no formal test pilot training programs existed until World War II. Indeed, in the 1930s, some military pilots had been assigned to test-pilot duties right out of flight school. During World War II, service pilots tested new aircraft between combat tours. Such on-the-job training was not suitable for the new demands of jet aircraft and supersonic flight. In addition to individual skill and cour-

age, formal engineering and test pilot training were required of test and research pilots in the post-war generation.

Armstrong flew a wide range of projects at the High-Speed Flight Station. These included the B-29 launch planes, the B-47, F-100, the F-51 and the R4D (the Navy version of the DC-3). His first rocket flights were in the X-1B, for tests of an early reaction-control system. Armstrong was selected as one of the pilots for the X-15, which was described at the time as “America’s first spaceship.” Armstrong flew the X-15 during its development phase, and in 1962 went to the Manned Spacecraft Center in Houston [now the Johnson Space Center] as an astronaut. He made two space missions. Gemini 8 was an Earth-orbital mission that accomplished the first docking of two spacecraft, while on Apollo 11 he became the first man to walk on the moon.

BRINKLEY: I wanted to start with a little bit about growing up in Ohio. Ohio is an aviation state. I read somewhere that when you were very young, your father took you to the National Air Races in Cleveland. You were so young; do you have any recollection?

ARMSTRONG: I was two the first time I went to the Air Races. Of course I have no recollection of that now.

BRINKLEY: Did your father have an interest in flight? Is that why he would take you there, or was it just in the air at that time—it was so exciting?

ARMSTRONG: I don’t think he had a particular interest in flight, but just an opportunity to take children to new experiences, I guess.

BRINKLEY: You got to ride in your first plane when you were age six, in one of the Ford Tri-Motors. Do you have recollections of that?

ARMSTRONG: I do not.

AMBROSE: When did you first hear of [Charles A.] Lindbergh?

ARMSTRONG: I can’t remember when the first time was, but I’m sure it was when I was a schoolboy, in elementary school.

BRINKLEY: Did you later have an opportunity to meet Lindbergh? Was he somebody that had been in your mind when you were becoming a pilot, thinking about Lindbergh? Did he mean a great deal to you as an American icon?

ARMSTRONG: I did have the opportunity to meet him on several occasions. Had enormous admiration for him as a pilot. I’d read some of his books. I was aware of the controversial position he took on certain issues. But I was very pleased to have had the chance to meet him, and I think his wife [Anne Morrow Lindbergh] was a wonderful person and quite an [eloquent] writer.

BRINKLEY: Did you ever correspond with him at the time of the Apollo? Was there any kind of wishing you well before the Apollo 11 mission, wishing you luck sort of—

ARMSTRONG: I can’t recall that. I think I have some letters from him in my file, though.

AMBROSE: When did you begin building things? Your interest and your concern with engineering, your wanting to build things—is that a part of your memory from when you were five or six years old? Did you have a special bent towards that?

ARMSTRONG: I began to focus on aviation probably at age eight or nine, and inspired by what I'd read and seen about aviation and building model aircraft, why, I determined at an early age—and I don't know exactly what age; while I was still in elementary school—that that was the field I wanted to go into, although my intention was to be—or hope was to be an aircraft designer. I later went into piloting because I thought a good designer ought to know the operational aspects of an airplane.

AMBROSE: Were you good in mathematics?

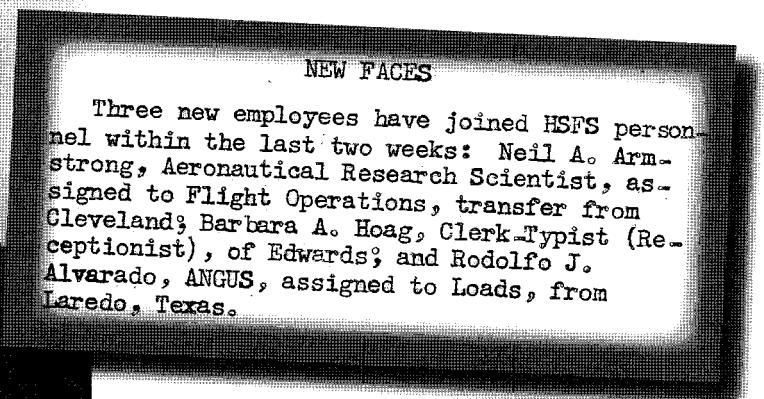
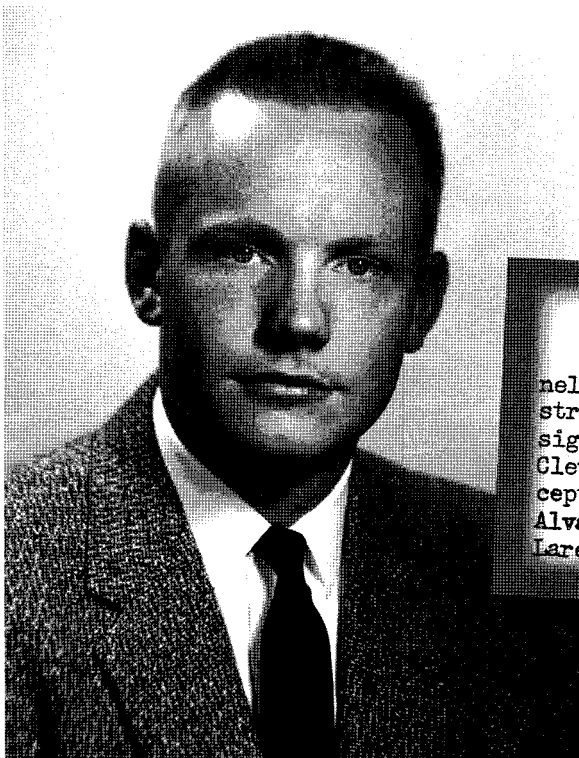
ARMSTRONG: Everything's relative. I was good in my small classes. However, I've since met many people who have far better mastery of mathematics than I will ever have.

AMBROSE: Did you have physics in high school?

ARMSTRONG: Yes, I did.

AMBROSE: Do you remember your teacher?

ARMSTRONG: Yes, it was John Crites. I remember him very well, because he was sort of an unconventional teacher. He allowed a few students in each of his classes to do special projects, and so we didn't go to class very much. We were always off working on our projects.



LOST, STRAYED OR pair of horned-rimmed glasses. Last seen hanging on sun shade in car in Station parking lot, Ed Lynch, Ext. 67, Calibration Hallway.

TO TRADE - will trade lot at Big Bear and life membership in Peter Van Woodland Club for a good, late model used car. Phil Walker, Ext. 28.

AMBROSE: What was your project?

ARMSTRONG: In physics we had two. One was building a Tesla coil. I think it was probably about a 50,000-volt Tesla coil, good enough to light up fluorescent bulbs in the next room. Then, a wind tunnel. That project was by myself. The Tesla coil, I did with another student.

AMBROSE: Tell us about the wind tunnel.

ARMSTRONG: Well, my knowledge of aerodynamics was not good enough to match the quality of the "Wright brothers" tunnel, and at that point I suppose I was equally educated to them. But it was a fun project. Blew out a lot of fuses in my home. Because I tried to build a rheostat, which would allow the electric motor to change speed and then get various airflows through the tunnel—not altogether successfully.

BRINKLEY: During this period you were traveling around Ohio to a lot of different cities. Is there one beyond Wapakoneta [Ohio], other cities that you really identified with? Did you go to different schools in all those different towns?

ARMSTRONG: Yes. I went to...half a dozen schools.

BRINKLEY: Were you able to develop friendships when you were going to that many different schools...

ARMSTRONG: I'm certain I had friendships in every one of the schools I was in, but I don't remember those friends prior to, probably, the junior high school age. I still have friends that I see and remember from that time period and subsequent.

AMBROSE: Beyond your physics class and the projects, were you an avid reader? Were you reading engineering and aerodynamics or history or what?

ARMSTRONG: I was an avid reader, yes, and I read all kinds of things. I spent a lot of time in the library and took a lot of books out of the library, both fiction and nonfiction. However, when I was building things, like models and so on, they were predominantly focused on aviation-related stuff.

AMBROSE: Do you remember any specific book you read about aviation [that gave you] that "Wow!" kind of response?

ARMSTRONG: I recall that I read a lot of the aviation magazines of the time, *Flight* and *Air Trails* and *Model Airplane News*, and anything I could get my hands on.

BRINKLEY: What about like Robert [H.] Goddard, science fiction, things about space? Did you ever read any of the science fiction writers of that time?

ARMSTRONG: As a young boy I don't recall reading much science fiction. I did come to enjoy it when I was perhaps late high school and college age.

AMBROSE: You were what, a sophomore in high school when World War II ended?

ARMSTRONG: That's approximately—let's see. Yes, I was between my sophomore and junior year.

AMBROSE: The assumption among young men at that time was, 'As soon as I graduate or as soon as I get to be eighteen, I'm going into the service.' But then the war ended when you were fifteen. So you completed high school without any 'I'm going to enlist' kind of feeling.

ARMSTRONG: That's correct. We had a few people in my school who had either lied about their age or were a little older than the class, who had gone into the service and came back and finished high school after the war was over. We had several of those fellows in our school, but the youngest of those would probably be two years older than I was.

AMBROSE: You got a Navy scholarship to Purdue [University, West Lafayette, Indiana] immediately after graduating high school, I gather.

ARMSTRONG: I believe that the tests for what was called the Hollaway Plan, the Naval Aviation College [Naval Reserve Officer Training Corps, NROTC] Program, were administered nationwide while I was still in high school, probably shortly before graduation, although I cannot remember the precise date. It was early enough so that we could pick a school. If we were accepted into this program, we could pick any accredited school in the nation to attend.

AMBROSE: [Was the test] mainly mathematics, or mathematics and physics?

ARMSTRONG: I'm sure they had a focus on things that would be appropriate to aviation, because it was an aviation-directed program, but I can't remember the details of the test, except that I recall it was quite long.

AMBROSE: What do you mean by long? All day?

ARMSTRONG: Yes, it was an all-day test.

AMBROSE: So you came out well, obviously, and the Navy offered you the "Holly" Plan—it was like Naval ROTC [in] that you would get tuition and a stipend of twenty-five bucks a month or something like that, I suppose.

ARMSTRONG: Fortunately, it was a little more than that. They would pay tuition fees and books, plus a stipend for board and room.

AMBROSE: So when you were accepted in this program, you were signing up, in effect, accepting a call from the Navy.

ARMSTRONG: A seven-year program, yes. Two years of [university study], then go to the Navy, go through flight training, get a commission, and then serve in the regular Navy for a total then of three years of active duty, after which the plan would be

FLIGHT LINES

Candy and cigars were much in evidence at HSFS during the past two weeks announcing the arrival of:

Eric Alan, born to Mr. and Mrs. Neil A. Armstrong (Pilots), on Sunday, June 30, 5 pounds 6 ounces;

Milton Barron, son of Mr. and Mrs. Jack McKay (Pilots), born Saturday, July 6, 5 pounds, 7 ounces;

Steven Craig, born to Mr. and Mrs. Frank Fedor (Shirley, formerly in Purchasing), on Sunday, July 7, 7 pounds 14 ounces.

MOVIES

Scheduled for lunch-time viewing on Tuesday, March 5, is "Piercing the Unknown", a futuristic movie which explains how "electronic brains" helped bring civilization to the threshold of the atomic age.

The 22-minute color film, open to all HSFS'ers, will begin at 11:15 a.m. in the third floor projection room.

CAFETERIA NEWS

Be kind to your wife..eat breakfast at the HSFS cafeteria

2 eggs, any style.....45
Ham, or bacon, and eggs....75

Lunch

Assorted salads....10, 15, 25

Sandwiches

Egg salad, bologna, liverwurst...30
Tuna...35 Ham or beef.....40
with cheese.....45

Coffee....5 1/3 qt. milk....15
Buttermilk.....10

to return to university and finish the last two years. The intent of this program, named after Admiral [James L.] Holloway [Jr.], who, if memory serves, was [astronaut Walter M.] Wally Schirra's father-in-law—and the intent was to build up the naval air reserve strength, which they felt was going downhill because people after the war really didn't want to do that stuff anymore. That was my understanding at the time.

AMBROSE: So you were called up for flight training after what, one year at Purdue, or two years?

ARMSTRONG: A year and a half. It was supposed to be two years, but I suppose they saw [the] Korea[n War] coming or something, and they needed to ratchet the volume up a little bit, so they called us in early.

AMBROSE: So now you're in uniform, but not yet commissioned, being trained as a pilot, is that correct?

ARMSTRONG: Yes, I was in naval flight school.

AMBROSE: Tell me about training. How did the Navy go about training you?

ARMSTRONG: Well, they found that the way I had learned to fly before wasn't nearly what they expected.

BRINKLEY: Just to backtrack for one second, you got your pilot's license at age sixteen in Ohio. Could you have gotten it any earlier? Is that almost like getting an auto license back when you're 14, 15?

ARMSTRONG: I believe you could get it in a glider at age 14, but in a powered aircraft you had to wait till you reached your 16th birthday, and then the license you got was called a student pilot's license, which allowed you to fly solo but not take passengers with you.

BRINKLEY: Do you remember your first solo flight in Ohio when you actually could be up in the air on your own? Do you have any recollections of that?

ARMSTRONG: Yes, I have vague recollections. A very exciting time, when you go on your first solo.

BRINKLEY: Where was the location?

ARMSTRONG: It was in Wapakoneta, at a grass field there.

AMBROSE: Who was your first instructor?

ARMSTRONG: Oh, let's see. I had three. The first one's name escapes me at the minute [Frank Lucie]. The second one was named Aubrey Knudgard. The third was Chuck Finkenbine.

BRINKLEY: They lived in that area, in Wapakoneta area?

ARMSTRONG: I don't know where they lived, but I'm sure they didn't live far away.

BRINKLEY: Was this unusual for a young man your age? Were a lot of contemporaries of yours wanting to get [a] pilot's license?

ARMSTRONG: I was in a class of maybe about 70 students, about half boys. We had three in my class that learned to fly at the same time I did. So I don't know how unusual that is, three out of 35–10 percent. Not very unusual.

BRINKLEY: Before we get back to the Navy, can I ask one Ohio question? I'm curious because of living in Ohio. Do you remember the towns that you lived in? Research says you lived in a lot of different towns, but [the interviews] never say the names of them.

ARMSTRONG: I moved a lot before I entered school, and when I entered school, the rate of change of towns slowed down somewhat, but still about every couple of years it seemed like we were moving.

BRINKLEY: What were the names of some of the other towns besides—

ARMSTRONG: First school was in Warren, Ohio; and then Jefferson, Ohio; Moulton, Ohio; then St. Mary's, Ohio; [Upper Sandusky, Ohio]; then Wapakoneta, Ohio.

BRINKLEY: I never knew those other towns. Thank you.

AMBROSE: When you began with the Navy...you had been up in a single-engine plane for some soloing, but now you're with the United States Navy. How did they train you?

ARMSTRONG: Training was divided into three parts. The first was a [four]-month nonflying ground school and physical training regimen. The second part was called basic training, which was all flight students went through the exact same protocol, did the exact same kinds of things—learning to fly, getting some experience soloing, learning to do cross-country flight, navigation, that sort of thing, learning to fly instruments,

to fly acrobatics, to fly formation, to drop bombs, to fire guns, and learning to land on an aircraft carrier. After that, advanced training, where...you [were selected to become the pilot of single-engine aircraft (fighters and attack aircraft) or multiengine patrol aircraft]. In my case, I asked for fighters and got fighters. Then we went to Corpus Christi, Texas, and went through training there in single-occupant aircraft, in my case [the] F8F Bearcat. We went through...the same kinds of things, learning to fly on instruments and learning to do advanced navigation, over-water navigation.

AMBROSE: Navigation by the stars, or navigation by radio or navigation by compass, or what?

ARMSTRONG: We had learned in the earlier part...the ground school part, how to navigate and use celestial navigation. ... Celestial navigation was used by multi-engine pilots predominantly, while single-engine fighters and attack aircraft required the full attention of the sole occupant on the flying, and so he couldn't be taking sextant shots and things like that. So the navigation was somewhat more rudimentary, but it required dead reckoning and use of radio aids and whatever might be available at sea....

AMBROSE: How do you dead-reckon at sea?

ARMSTRONG: By computing your true speed over the ground, by using your air speed, altitude, and outside temperature, and noting the direction of the wind however you could by wave action or cloud shadow movements....

At least you'd hopefully be in the right direction, probably weren't always. And then the pilots had to be able to return to their carrier, so there were certain kinds of electronic aids that were peculiar to a carrier you wouldn't find anywhere else, wouldn't find in land-based navigation. So it was a matter of learning those and, of course, learning to use the aircraft as a weapon defensively and offensively, and learn tactics, and then finally qualify again on a carrier in advanced aircraft....Other students went into multi-engine flight in either patrol bombers or transports or some variety of other craft. Everyone went their separate ways.

AMBROSE: In the Army Air Forces in 1942, '43, '44, only the very best got to be fighter pilots. If you weren't quite up to that standard, then they put you in a two-engine or a four-engine [aircraft]. Was that also true in the Navy?

ARMSTRONG: The fighter pilots always said that was true.

AMBROSE: I'm not asking you to brag on yourself.

ARMSTRONG: But I don't know what the commanding officer of the training command would say about that. I was not privy to what process they used in deciding. My own guess is that a large part of it had to do with what needs they had at the time you graduated, because in my particular class, most of my classmates happened to get what they asked for, while I can recall people from a different generation saying nobody got what they asked for. So I can't really know.

AMBROSE: I've read that you told your mother you didn't want to be responsible for others; that's why you wanted a single-engine fighter. Is that story accurate?

ARMSTRONG: I don't know that I ever told her that. You know, I might have said something like that, but I don't remember saying that.

AMBROSE: When did you get your wings and commission? What was the date?

ARMSTRONG: I got my wings in August of 1950, but that was about 17 or 18 months after I'd begun my active duty service, so I still had another six months to go. So I was one of those rare birds, a midshipman with wings. So I went to the fleet squadron, was in a standby unit for a while, then assigned to a jet fighter squadron, still was a midshipman making seventy-five bucks a month plus flight pay—50 percent of seventy-five bucks.

BRINKLEY: Landing on carriers at night, that was extraordinarily difficult to learn. Was there one aspect of this period that was a hard thing for you to conquer?

ARMSTRONG: I happened to be a day fighter pilot. We had night fighter pilots on the ship I was on, and I thought they were crazy.

BRINKLEY: Did you ever have to do a night landing?

ARMSTRONG: I did it only in practice. I never did it on a carrier. All my landings on a carrier were in day. I was always happy about that.

AMBROSE: So, August of '50, the Korean War is now a couple of months old.

ARMSTRONG: Yes, just started.

AMBROSE: And you're completing your basic. Did they send you right off?

ARMSTRONG: I asked for the Pacific Fleet and was given the Pacific Fleet. But as I say, I was first sent out to a squadron called FASRON, Fleet Air Service Squadron, which is a utility squadron, handled all kinds of miscellaneous jobs that needed to be done around a large naval air station. That sort of was a holding position. They would typically take new entrants that come to that base and stick them there for a time period until there was a squadron opening for assignment, so I was in that squadron for probably three or four months, until there was an opening for me in Fighter Squadron 51 [VF-51].

AMBROSE: That would have been at the end of 1950.

ARMSTRONG: That was the end of '50. November or December, as I remember.

AMBROSE: And then off to the fleet?

ARMSTRONG: Yes. We immediately prepared to be assigned to the Korean action...Again, you sort of do the same sorts of things as you did in training. Now you're in a new aircraft, but you have a much more specific objective because you sort of know what kind of an environment you're going into. We didn't know to what extent we would be offensive, in the sense that we would be dropping bombs or shooting guns, or to what extent we might be defending the fleet against Chinese or Russian incoming aircraft, to what extent it might be air-to-air or air-to-ground. So we had to prepare for sort of all of those, plus become carrier-qualified in jet aircraft and doing a lot of practice with weapons delivery, instrument flying, and so on, the things that we would be facing when we got in operation. I was very young, very green.

AMBROSE: Which coast of Korea were you on when you flew your first mission?

ARMSTRONG: All the time we flew off the eastern coast of North Korea, off Wonsan Bay, about a hundred miles out, something like that. [We] had two kinds of flights. One would be called combat air patrol, which was defense of the fleet, basically. And the other was predominantly interdiction flights, flying against bridges and railroads and trying to find an occasional tank—

AMBROSE: Bombs and bullets?

ARMSTRONG: Bombs, bullets, and rockets sometimes, depending on what target it was. We had a combination of two jet fighter squadrons, [an] F4U Corsair squadron, and an AD [Skyraider] squadron. [They] could carry the 2,000-pounders and really do some damage.

BRINKLEY: Seven [airplanes] in a squadron?

ARMSTRONG: I can't speak specifically to the numbers in each squadron. In our squadron we had 24 pilots and 16 aircraft.

AMBROSE: Sixteen. But only 24 pilots.

ARMSTRONG: Yes. Started with 24.

AMBROSE: Started with, yeah. The Army liked to have two pilots for every airplane. Tell us about your first mission.

ARMSTRONG: I can't recall it.

AMBROSE: [I]n flying combat air patrol, did [the Soviets] ever come in and try to attack the fleet at night?

ARMSTRONG: No. I would not have enjoyed trying to go—well, I probably would have enjoyed it, but I don't know that I would have won against a MiG in an old *Panther*. It was a pretty primitive airplane. Of course, the MiG was pretty primitive too, but had a little better performance.

BRINKLEY: How did the F9F Panther perform?

ARMSTRONG: It was a very solid airplane. We thought it was wonderful. In retrospect, it was an airplane of the time and it didn't fly [particularly] well.... But we didn't know that at the time...

BRINKLEY: What were the weak points?

ARMSTRONG: It didn't have particularly good handling qualities. Pretty good lateral directional controls, but very stiff in pitch. Its performance both in absolute altitude, max speed, and climb rate were inferior to the MiG by [a] substantial amount.

BRINKLEY: There's a story about September 3, 1951, when you had to eject from a Panther after receiving antiaircraft fire. Was that one of the moments of the Korean War where you really feel your life is being put on the line?

FLIGHT LINES

MARRIED on Saturday, March 14, were Harold Wallick (Instrumentation) and Sandra Bowman of Biloxi, Mississippi. The ceremony took place in the Keesler Air Force Base Chapel in Biloxi. The couple plan to reside in North Edwards.....BY taking second place recently in the Junior AAU Championships at North Hollywood High School, Russell Mills, son of Russell Mills (Instrument Service) became the first Antelope Valley athlete to win a silver medal in Junior AAU competition. This is the highest AAU award ever won by a local student. Russell, a junior at AVJUHS, is now eligible to enter the Metropolitan Gymnastic meet. If he qualifies in this event and in the Senior AAU meet, he will be eligible to compete in the National championships.....MARRIED in Phoenix, Arizona on March 10 were Dick Simmons (Personnel) and Edna Ann Wood. The couple are living in Lancaster.....MAKING speeches recently were pilots Neil Armstrong and Jack McKay. Neil participated last week on a panel of test pilots at an ASME meeting in Los Angeles, and Jack spoke this week at the Air Force Academic Instructors Workshop, Moore Air Base, Mission, Texas.....BORN on Wednesday, March 11 to Mr. and Mrs. Douglass Pratt (Dee Ella, Library) was a 6 pound, 4 ounce daughter, Yvette..... A SURPRISE farwell luncheon was held Tuesday in the EAFB Civilian Club for Joyce Hall who terminates her NASA employment today. A baby stroller was presented to the honoree, accompanied by the following poem authored by Della Mae Bowling: "Since a love of hotrods in your family runs, this is for your daughter (or your son). It has 4-wheel brakes and a real rag top, and a place for groceries when you shop. It takes no gas or license fee, just lots of push and energy. No white-wall tires, not much chrome, there should be one in every home. Our love comes with this gift to you, to Tommy and the baby too. And as you go along your way, don't forget N A S A"...Attending the luncheon were Mabel Marriott, Jessie Hagood, Elinore Berger, Bea Corrington, Vicky Ikeler, Helen Errard, and Della Mae Bowling.....NEW FACES - Mildred L. Smith, a returnee clerk typist in Instrumentation from Lancaster; James M. McKay, transfer from Langley, an aeronautical research engineer in Aero-Structures, now living in Lancaster; and Barbara J. Skinner, a clerk typist in Editorial, of Lancaster.....ANNOUNCED here this week was the birth of a daughter, Sharilyn, to Mr. and Mrs. Herman Rediess. Weight: 7 pounds, 6 ounces. Date: March 6. Herm, who was employed at HSFS under the Coop Student Program, is now attending U. C. at Berkeley..... FOR SALE OR TRADE - Maple kitchen table - formica top. Clinton Johnson, Ext. 21071.....RECENT visitors to HSFS include Mr. Kazuto Yoshida, Washington correspondent for the Tokyo Broadcasting Company; "Guadalcanal Diary" author, Richard Tregaskis, who is currently working on an X-15 story; and 384 freshman cadets of the Class of 1962, USAF Academy, accompanied by Academy faculty members and administrative personnel.

ARMSTRONG: I do remember that one. It wasn't antiaircraft fire, although antiaircraft fire was ubiquitous at the time. I don't know to what extent that antiaircraft fire played a part in it, but I actually ran through a cable, an antiaircraft cable, and knocked off about six or eight feet of my right wing. If you're going fast, a cable will make a very good knife.

BRINKLEY: And what happened at that point?

ARMSTRONG: I didn't think that I could risk slowing the airplane down to landing speed, because once—

AMBROSE: You must have been almost right on the deck.

ARMSTRONG: Well, these are strung between mountains, so I was up maybe 500 feet or something, not an unusual altitude for the kind of things we were doing. I don't remember exactly what the altitude was, but they didn't put those big balls on the cables so that you could see they were there, in those days.

BRINKLEY: What happened after that moment?

ARMSTRONG: I was flying on the wing of John Carpenter. He was an Air Force major, on an exchange program with us. We talked it over and decided not to try to land it, because if I got a little bit too slow and started to snap, I would have no [ability] to control it after that, so consequently decided it would be better to jump out. So, took it down south into friendly territory and jumped out in the vicinity of Pohang Airport, K-3, which was operated by U.S. Marines.

MACH TWAIN CLUB TO SPONSOR TOURS TO EUROPE
AND SCANDINAVIA

Two 30-day all-expense tours—one to Europe, one to the Scandinavian countries—are being offered to NACA employees at a cost of \$888 per person for each tour. The May 15 to June 14 tours, sponsored by the Mach Twain Club (a social group at NACA Headquarters), will include round-trip air transportation, first class hotels, most meals, sightseeing, admission fees, taxes, gratuities, and evening entertainment.

The low price of the tours is based on full passenger participation—71 passengers are needed to make the flight, and at least 30 for the tour. Those wishing to take the flight only may do so at a cost of \$335 for the round trip.

Preference for seat location and hotel space will be given in accordance with receipt of application. A deposit of \$100 is required with each application, with the balance due before April 5. Full refund will be made if the tour is cancelled for any reason.

Itinerary for the European tour includes: England, Holland, Belgium, Germany, Switzerland, Italy, and France.

The Scandinavian tour will cover Scotland, England, Holland, Belgium, Germany, Norway, Denmark, Sweden, and France.

Those interested in the tours should contact Leona Corbett for application forms and further information.

AMBROSE: Had you had any parachute training?

ARMSTRONG: No, we had not, but one of the gentlemen in the squadron, one of my classmates, actually, was assigned a collateral duty of being the equipment and escape officer, so he went over to parachute school, as I remember, in El Centro, California, and came back and told us how to do it, if the need ever arose.

BRINKLEY: Did you get rescued quickly once you landed, with no problem?

ARMSTRONG: Yes. A jeep drove up just as I was landing, from K-3. The driver was a roommate of mine in flight school.

BRINKLEY: A roommate from where?

ARMSTRONG: In flight school. He was now a Marine lieutenant operating out of that field.

BRINKLEY: What was his name?

ARMSTRONG: His name was Goodell, Warren.

BRINKLEY: Did you ever, during the war, receive other heavy damage flying—from ground fire?

ARMSTRONG: Yes, we had a lot of bullet holes in our airplanes when we brought them back. We'd patch them up.

AMBROSE: Put a little duct tape over that hole.

ARMSTRONG: Yes. Made them look pretty good, painted it over.

BRINKLEY: After your first month on the [U.S.S.] Essex [CV-9], then you had liberty in Japan when you'd get to spend time there?

ARMSTRONG: Usually we'd spend four or five weeks at sea and then they would take the entire ship back to Yokosuka for a week of refurbishing and reprovisioning and things like that. About one day a week we did some reprovisioning at sea (fuel) ..., but on a monthly basis, five weeks or something like that, we'd go back in for five days or six days, something like that.

AMBROSE: You could get aviation gasoline [av gas] while you were at sea? Or when you say fuel, you mean fuel for the carrier?

ARMSTRONG: You know, I don't really know what all kinds of fuel, but they had a pipe, a hose that they could put over from the provisioning ship to the carrier. I assume they had both [bunker fuel] and jet fuel, and maybe av gas, too.

BRINKLEY: The teamwork and camaraderie experience on the *Essex*—is there any way to compare that at all to being in the astronaut corps or with engineers and contractors in the space program? The concept of teamwork—now, this is something that became a big part of your life from this point on. What was the teamwork aboard the *Essex*?

ARMSTRONG: Yes, it was [a] teamwork operation, certainly. We had very few occasions when we would do anything on a solo basis. Almost everything we did as teams, and in our case we usually liked flights of four at least, to help each other out. Eight eyes are better than two in looking for trouble and looking for targets.

AMBROSE: A diamond formation with the four?

ARMSTRONG: We used a formation, usually an echelon two airplanes each, separated by probably a quarter to a half mile. That would allow us to see a broad panorama both to the rear of the other—we would be looking after their tail and they would be looking after ours. That was a different approach than had been earlier introduced, or at least attributed to [Commander] Jimmy Thatch, the so-called Thatch Weave.... We did not use that technique.

BRINKLEY: Can you characterize your air group commander, Marsh Beebe, and your squadron leader, E. M. Beauchamp? Did they have a big impact on you, teaching you, or did you get to learn from them new ways of flight that you hadn't previously on your on-the-job training on the *Essex*?

ARMSTRONG: I flew with Commander Beebe some, and thought he was quite a good air group commander, the first I'd known and certainly the first in any operational circumstances or any combat circumstances. So I wasn't in a position to be critical anyway. I was, one, inexperienced, two, a junior officer. I was delighted when I had the chance to fly with him. Ernie Beauchamp, a wonderful skipper, [I] had enormous respect for him. I thought he was—and is; he is alive today—a superior leader. I think if there was anything I learned from our skipper [it] was that it's not how you look, it's how you perform.

AMBROSE: So, you came home from Korea and you'd completed your obligatory time in the Navy, and you went right back to Purdue to finish school. Is that right?

ARMSTRONG: Actually, my time expired when I was flying off the *Essex*, and so my options were to either extend or swim home. So I extended.

BRINKLEY: Were you excited to return to civilian life after the war and get on with getting back to going to Purdue and back to finishing your college degree? You must have been older now—right?—going back to college. You were one of the youngest pilots.

ARMSTRONG: I was 22. I was really getting old. When I went back to the university, kids looked so young.

AMBROSE: Did you have a decision to make or did you always say, 'I'm going back to Purdue and I'm going to finish this degree?'

ARMSTRONG: Well, there were tempting options, but I decided—

AMBROSE: To stay in the Navy, for one.

ARMSTRONG: To stay in the Navy or otherwise use the skills that the Navy had taught me. Those opportunities showed up periodically, but I thought it was important to go back and finish my education, so I put that in first position.

BRINKLEY: Then you joined the National Advisory Committee for Aeronautics [NACA] at that point. Did you then move to Cleveland?

ARMSTRONG: I did. That was my first job out of college.

BRINKLEY: And that was at the Lewis Flight Propulsion Laboratory [now NASA Glenn Research Center].

ARMSTRONG: Right.

BRINKLEY: You just rented an apartment on your own, or how did you—

ARMSTRONG: I rented a room at first, in a private home, and later met one of the

other young bachelor engineers there, and then we rented a small place for the two of us.

BRINKLEY: Was this close to the laboratory or in downtown Cleveland?

ARMSTRONG: Well, I don't think we were more than ten minutes from work.

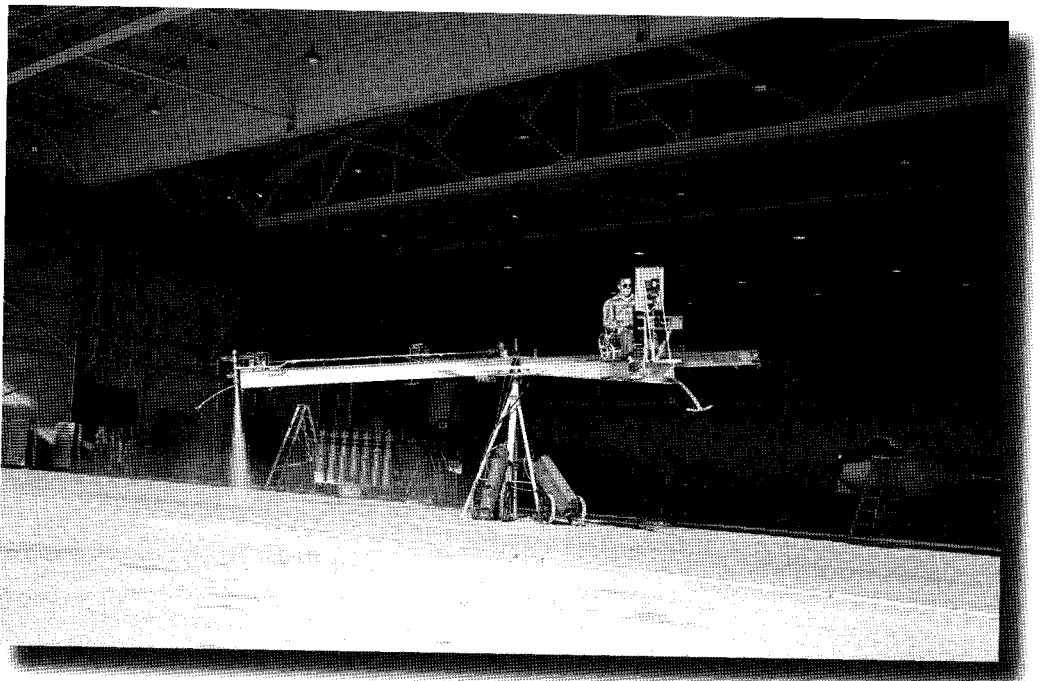
BRINKLEY: Did you acquire an automobile?

ARMSTRONG: Yes.

BRINKLEY: What were your general duties and responsibilities there at the laboratory in Cleveland?

ARMSTRONG: A dual job as a research pilot and a research engineer. Actually, I think at that point they called them research scientists. The flying involved doing work with new anti-icing systems for aircraft, which we had a C-47 (or R4D or DC-3) with various kinds of anti-icing equipment that we would fly out in the worst weather we could find, out [over] Lake Erie and try to pick up a lot of ice and find out which were the most efficient ways of shedding it. We also did some work in high Reynolds number, high Mach number heat transfer, and this project involved flying an F-82, which was a Twin Mustang, and flying out to the Atlantic Ocean and going to high altitude and launching a multi-stage rocket downward into the atmosphere to get very high Mach numbers at very low altitudes, and therefore very high heat-transfer rates. The nose cone was instrumented to measure those kinds of things.

I did a lot of work in that area, also on my scientist or engineer job, in analyzing that data and also designing components for advanced versions of the rockets that we were using....But I wasn't there long, and I'd originally applied to Edwards for my first job. They didn't have a spot. Unbeknownst to me, they had transferred my application to the other NACA laboratories, and as a result of that, the Lewis Laboratory talked to me about coming up there and filling an opening that they had. It was the lowest-paying job that I was offered coming out of college, but I think, in retrospect, it was the right one.



Among Neil Armstrong's early activities were tests of the Iron Cross. A ground simulation of the reaction control system being developed for the X-15 project is shown. (E56-2578)

BRINKLEY: Were there any memorable incidents or things that occurred in your time in Cleveland, in flying? Were there any things in your mind where you said, 'I want an opportunity to test this?' Were you anxious, with all the technology changes in aviation—were you wanting always to be headed for the newest research that was being done?

ARMSTRONG: The only product of the NACA was research reports and papers. So when you prepared something for publication, either as a principal or associate author of some sort, you had to face the 'Inquisition,' which was the review of said paper by experts who were predominantly lady English teachers or librarians who were absolutely unbearably critical of the tiniest punctuation or grammatical error, and that is what NASA needs today. Because it really made a good product. The rigor of the language, which I never mastered, but I appreciated after being exposed to those charming ladies who were so tough.

AMBROSE: I know exactly what you mean. That's my wife that you're talking about. [Armstrong laughs.] And I get asked, 'What's the secret to being a successful writer?' I say, 'Marry an English major.'

BRINKLEY: When you left Cleveland, did you drive from Cleveland to California with your car?

ARMSTRONG: I did.

BRINKLEY: Where did you go immediately when you went to California? What was your destination city? You were going to Edwards?

ARMSTRONG: Edwards, yes.

BRINKLEY: What were your first projects there when you got to Edwards?

ARMSTRONG: I'd have to look in my log to be sure. First they wanted me to learn a little bit of the NACA techniques for data collection and so on, and they had a P-51 [Mustang] that they had very rudimentary instruments and data-collection techniques for. They made me go out there and do a lot of flights and practice a lot of maneuvers for test purposes, and turn in the results so they could see whether I was starting to get the hang of it. Took me awhile, but it was a good experience—

AMBROSE: Tell me about that plane.

ARMSTRONG: It is a nice airplane, and had a wonderful sound, particularly when you retarded the throttle and you got those stacks putt-putt-putting. It was quite elegant. I enjoyed flying the airplane. Just didn't have the performance of an F8F, but it was built [to fly at] high altitude. Well, it first was built to be an attack airplane, not a fighter, but a fighter version of it became predominantly a high-altitude escort long-range aircraft.

AMBROSE: So, continue with—

ARMSTRONG: Other airplanes? They flew some other jets. They had a YRF-84F [Thunderflash]. When I got there, I was the fifth pilot. [A.] Scott Crossfield had announced that he was going to go be the pilot on the X-15 program, whoever won it. He...had agreements with all the different bidders, that if they won the contract, he

would get the job. So [Crossfield] told them he was going to leave, and that's what gave me the opportunity to transfer there. They had five pilots, and, if memory serves, 17 aircraft, pretty much all different. A lot of X-airplanes and fighters, the B-47 [Stratojet] and R4D and a couple of B-29s [Superfortress], all kinds of exotic aircraft. So they let me fly a few of these at first, and as they became more confident in my abilities and as I became more experienced, why, they gave me more and more jobs. I did a lot of different test programs in those days. That was the first time I ever flew supersonically, when I got an F-100 [Super Sabre], and I flew that aircraft a lot, a very nice early F-100.

AMBROSE: And you flew a B-29?

ARMSTRONG: Yes. We had two that we used for dropping rocket aircraft, the X-1s and the [Douglas D-558-II] Skyrockets. So I, either as the right-seat or the left-seat guy in the B-29, launched over a hundred rocket airplanes in the '50s.

BRINKLEY: A couple of your X-15 flights became pretty well known, one in which you lost your stability [system] and had to recover, and then there's also the mission which you ended with the longest X-15 flight on record, when you had to fly back to Edwards from the south. Do you mind just commenting on particularly those two flights?

ARMSTRONG: I can remember several different system problems in the flights. You almost always had something. I can't recall the details of the SAS [Stability Augmentation System] problems. I would have it in my notes someplace, but I don't have it in memory. The [other] flight was an altitude flight. I had done a lot of the development work on a new type of flight control system that was installed in the number three aircraft and different from the ones they numbered number one and number two. That system was developed by Minneapolis Honeywell in Minneapolis [Minnesota], and I would go up there and fly an F-101 [Voodoo] they had outfitted with a prototype version of this system.

Because the X-15 covered such a wide speed range and altitude range, it was impossible to set the gains in the flight control system to a single value that was optimum for all flight conditions. The one and two airplanes, you had to continually be changing the gains because at one minute you're at Mach

B-29 LOSES PROPELLER

BUT LANDS SAFELY

A safe landing on the Dry Lake was made with the HSFBS B-29 late yesterday after one of its propellers tore loose and ripped into the fuselage of the four-engine bomber. The accident occurred 30,000 feet over Palmdale while the B-29 was preparing to launch the Douglas D-558-II (144) Skyrocket.

According to crew members, when an intense vibration was suddenly felt from the No. 4 engine, Pilot Stanley P. Butchart immediately nosed the B-29 downward and cut loose the 144, piloted by John B. McKay. McKay jettisoned his rocket propellants and glided to a safe landing on the Lake.

Almost as soon as the Skyrocket had cast off, the propeller pulled loose from the bomber's No. 4 engine, ripped up the nacelle of the No. 3 engine, then plunged through the bomb bay and crashed out the other side of the fuselage.

Because the pilot's aileron control cables were cut by the propeller, it was necessary for Co-pilot Neil H. Armstrong to bring the bomber home.

None of the seven men aboard the B-29 was injured. Crew members on the flight were:

Pilot - Butchart
Co-pilot - Armstrong
Engineer - Joseph L. Tipton
Scanners - Lester H. Booth
Norman K. Jones
Crew (144) - Homer H. Hall

Flying chase for the flight were Air Force captains Loren W. Davis and Iven C. Kinchloe.

A committee, composed of the following HSFBS personnel, was appointed today by Walter C. Williams, Chief of the Station, to investigate the accident:

Chairman - Donald R. Bellman
Kenneth S. Kleinknecht
Joseph A. Walker

1, the next minute you're at Mach 5, and the airplane responds quite differently under those two conditions. So you were continually having to do this. So we were [trying] to...develop a system that would avoid that requirement of continually changing gain. So the Minneapolis Honeywell system was designed and built for the number three X-15.

In addition to automatically changing the gains by very unique and complex, even surprising methods, which I won't burden you with—in addition to that, it would blend the aerodynamic and the reaction controls when you're outside the atmosphere. So in [number] one and two airplanes, when you're in the atmosphere you flew with the regular center stick, and when you're outside the atmosphere you flew with the reaction controls with a separate stick on the left side. With this system we hoped to be able to fly the same way all the time, with one stick.

This particular flight you mentioned, we went to somewhat above 200,000 feet, well outside the atmosphere, so that we were completely flying on reaction controls up there; aerodynamic controls were completely ineffective, like flying in a vacuum.

Then we had a system limit built into the flight control system that would automatically prevent you from exceeding 5gs. If you hit 5gs, it would automatically put controls in to hold it below 5gs, and one of the things I wanted to do was demonstrate that that part of the system worked. It had never been yet demonstrated in flight. That was my responsibility to do that. We tried this many times in the simulator without any difficulty, but when we really did it in flight, I couldn't [quite achieve 5 gs], so I [kept] pulling to try to get the g limiter to work.

In the process, I got the nose up above the horizon. We'd done this in the simulator, never had any problem with it. But I found when I did it in real flight, I was actually skipping outside the atmosphere again. I had no aerodynamic controls. That was not a particular problem, because I still had reaction controls to use, but what I couldn't do was get back down in the atmosphere...I [rolled] over...and tried to [drop back into] the atmosphere, but [the aircraft] wasn't going down because there was no air to bite into. So I just had to wait until I [fell low enough] to have aerodynamic control and some lift on the wings, [then] immediately started making a turn back. But by that time I'd gone well south of Edwards.

X-15 Conference

The Flight Research Center conducted and coordinated a conference on the progress of the X-15 project last Tuesday, January 30, 1962 for the Institute of Aerospace Sciences in Los Angeles. Personnel from North American Aviation, and Major White of the U.S. Air Force also participated in the conference, which was presented before a group of about 200 persons. Mr. Jack Fischel, Research Division, was the principle coordinator for the FRC.

SYMPATHY,

FRC employees extend their sincerest sympathies to Mr. & Mrs. Neil Armstrong in the loss of their daughter, Karen, 2-1/2 years old.

EX-PRESSIONS

MERCURY LAUNCH...

Paul F. Bikle and Joseph R. Vensel flew to Cape Canaveral to observe the Mercury orbital flight last week...Neil A. Armstrong went to see the Launch operation...Lyndell L. Manley went to Norfolk, Virginia to work on the Mercury Public Information news team aboard the USS Randolph.

It wasn't clear at the time I made the turn whether I would be able to get back to Edwards. That wasn't a great concern to me because there were other dry lakes available there. I wouldn't want to go into another one, but I certainly would if I needed to. [Eventually], I could see that we were going to make it back to Edwards, so I landed without incident on the south part of the lake.

BRINKLEY: Did any of these difficulties you had at Edwards [and] later with Dave [David R.] Scott and Gemini [8]—did any of these experiences teach you kind of grace under pressure? When you had later problems with Mr. Scott and Gemini [8], how did these things—

ARMSTRONG: Well, I always felt that the risks that we had in the space side of the program were probably less than we [had] back in flying at Edwards or the general flight-test community. The reason is that when we were out exploring the frontiers, we were out at the edges of the flight envelope all the time, testing limits. Our knowledge base was probably not as good as it was in the space program. We had less technical insurance, less minds looking, less backup programs, less other analysis going on. That isn't to say that we didn't expect risks in the space program; we certainly expected they would be there, were guaranteed that they would be there. But we felt pretty comfortable because we had so much technical backup and we didn't go nearly as close to the limits as much as we did back in the old flight-test days.

BRINKLEY: And to live out around Edwards at that time, you were right near the base?

ARMSTRONG: I lived about an hour drive away, south. Nobody lived close. A half hour is about as close as you could live. Big base.

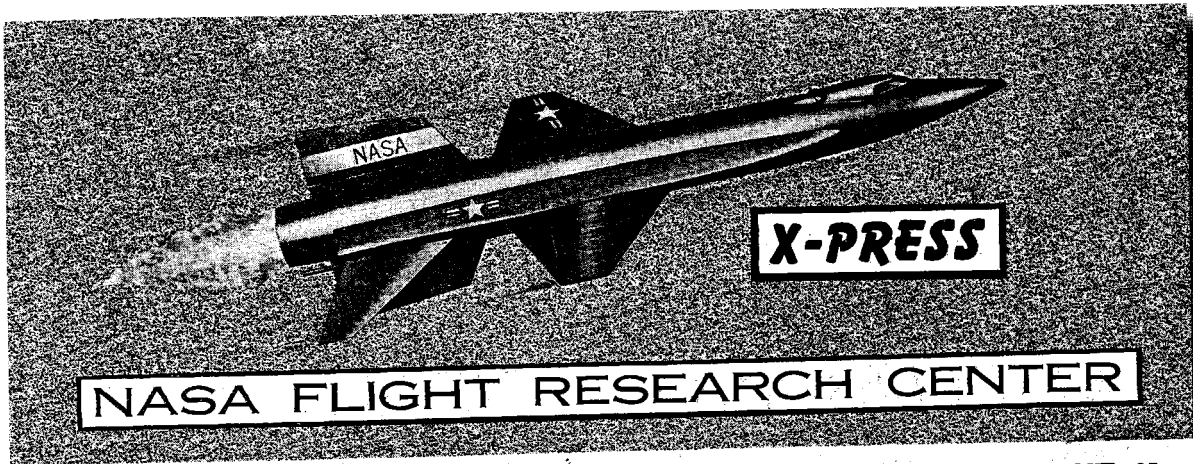
BRINKLEY: We were out at Edwards. I was just wondering if you could comment on the Air Force's X-20 Dyna-Soar [Dynamic Soaring] program and how did you decide upon the Douglas F5D-1 Skylancer as the suitable demonstrator for parts of the Dyna-Soar flight profile. And did you develop any procedures based on flying this aircraft?

ARMSTRONG: Yes, I did. The Dyna-Soar program, of course, was first intended to be a high hypersonic but nonorbital vehicle, and predominantly a research vehicle. It was originally scheduled to be launched on the Titan I. It later became obvious the Titan II might be available and be a better choice, and that gave increased performance, but still not orbital.

Then when the Titan III was introduced—or looked like it was going to be introduced—with additional [solid] rocket engines strapped on the side of the [missile]...why, it might be an orbital vehicle, and if it would be orbital, why, it could be an operational craft. The Air Force savored the idea of having an operational spacecraft and having their own manned space program separate from NASA. So the project grew and grew. Eventually it was not continued; it was canceled, perhaps because it grew too much.

The launch, unlike the Mercury and Gemini and so on, was a winged vehicle on top, and there was a question what kind of abort technique would be practical to try to use in case there was a problem with the launch vehicle, in the Titan. It was determined rather than a puller rocket, [a] pusher rocket [would be used], to push the spacecraft up to flying speed from which it could make a landing, but it wasn't known at that time what might be practical and how much thrust would be needed and how much performance would be needed.

We had the F5D aircraft, which I determined could be configured to have a similar



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X-15 SETS SPEED, ALTITUDE MARKS

Unofficial records for speed and altitude were re-written this month within an eight-day period at the Flight Research Center.

First to hit the news was Joe Walker who rammed the X-15 to Mach 3.31 (2196 m.p.h.) in a flight Aug 4. Walker's ten-minute dash in the rocket-powered research aircraft surpassed the late Capt. Mel Apt's 2094 m.p.h. mark established in the X-2 in 1956.

Eight days later, Major Bob White, flying 24 hours after an aborted run due to a nitrogen valve failure, pointed the X-15 craft skyward, peaking out at 136,500 ft.---almost two miles higher than the late Capt. Iven Kincheloe recorded in the X-2, also in 1956.

Both Walker and White were elated with the two history-making successes---along with the rest of NASA and the world.

Congratulatory messages were received by both pilots, including one sent to Walker by Col. Frank Everest in which the noted USAF best pilot asked Joe, "When are you publishing your book entitled 'Fastest Man Alive.'"



the fastest...



and the highest

The F5D flown by Armstrong to test launch-abort procedures for the X-20 Dyna-Soar. This was an Air Force research vehicle launched into orbit by a Titan IIIC booster. It would then re-enter and land at Edwards. (EC62-128)



glide angle or lift/drag ratio to the Dyna-Soar for similar flight conditions. [We] devised a way of flying the aircraft to the point at which the pusher escape rocket would burn out, so you would start with the identical flight conditions that the Dyna-Soar would find itself [with] after a rocket abort from the launch pad. So then, establishing that initial condition, you only had to work out a way to find your way to the runway and make a successful landing.

I worked on that project for a time and found a technique that would allow us to launch from the pad at Cape Canaveral [Florida] and make a landing on the skid strip [a runway at Cape Canaveral]. We practiced that, and I believe that Bill [William H.] Dana and Milt [Milton O.] Thompson both continued [that program] after I transferred from Edwards to Houston.... There was a NASA report written about the technique. It was a practical method. I wouldn't like to have to really do it in a real Dyna-Soar.

BRINKLEY: What other responsibilities did you have at the [Flight Research Center] other than being a test pilot?

ARMSTRONG: Our principal responsibility was engineering work. We did not do a lot of flying. It was program development, devising simulations, looking at the problems of flight, and trying to figure out ways we could test those things and devise solutions to those problems. It was a wonderful time period and it was very satisfying work, particularly when you found a solution that would work.

BRINKLEY: Did you know about the first call for astronauts that went out to military test pilots? I was wondering what your thoughts may have been when you learned about the astronaut program, when you first started realizing it.

ARMSTRONG: We were certainly aware of it, both through NASA—because NACA had become NASA by this time—and also from our colleagues in the military, good friends and people we flew with daily, some of whom had been invited to consider applying for that.... I knew a number of the Air Force people at Edwards who later transferred to Houston like I did. But I wouldn't say that I knew them very well, not nearly as well as I knew the other NASA pilots and NASA engineers, for that matter. They were on a different part of the base. We occasionally had meetings where we would be discussing the same subjects and we would see them probably more frequently in the air, when they were out on our wing tip with an F-104 [Starfighter].

JOE WALKER TO BE HONORED AT SETP BANQUET

HSFS pilot Joseph A. Walker will be designated a Fellow of the Society of Experimental Test Pilots tonight at the Society's first annual awards banquet. Others receiving the honor are George E. Cooper, of Ames; J.R. Baker, North American; Joe Cannon, Bell; George Jansen, Douglas; Bob Rahn, Douglas; Tony Le Vier, Lockheed; H.R. Salmon, Lockheed; C.H. Meyer, Grumman; M.R. Stanley, Northrop. Presentation of pins and certificates will be made during the banquet, which will be held at the Beverly Hilton Hotel in Beverly Hills.

The Society, organized in April 1956, will also honor as newly designated Honorary Fellows aviation pioneers such as Jimmy Doolittle, Air Force General Albert M. Boyd, Howard Hughes, and Navy Admiral F.M. Trapnell.

The country's top test pilots are members of the SETP, which is dedicated to promotion of air safety, continuous evaluation of the adequacy of flight equipment, exchange of information for improving testing equipment and high-speed aircraft escape procedures, and stimulation of interest in the youth of the nation in choosing careers in aviation. The Society is endeavoring to accomplish these objectives without affecting the competitive structure of industry, transgressing the boundaries of proprietary interest, or serving as a bargaining agency for the members.

Attending the awards banquet from HSFS, in addition to Mr. and Mrs. Joe Walker, will be Mr. and Mrs. Walter Williams, Mr. and Mrs. De Beeler, Mr. and Mrs. Joseph Vensel, Mr. and Mrs. Richard Day, Mr. and Mrs. Thomas Finch, Mr. and Mrs. Gerald Truszynski, Mr. and Mrs. James Love, Mr. and Mrs. Stanley Butchart, Mr. and Mrs. Neil Armstrong, and Mr. and Mrs. John McKay.



BRINKLEY: Do you have any thoughts on some of the early events of the space race, such as the launch of Sputnik? Do you remember your feeling, on hearing about Sputnik and Explorer 1? Were you conscious of the politics of the Cold War going on with the race into space at that time, when you were at Edwards?

ARMSTRONG: Well, before it was Dryden, before it was Flight Research Center, it was called NACA High-Speed Flight Station, and they were working on the problems of high-speed, high-altitude flight. They were looking ahead to days when we would fly hypersonically and high hypersonically and eventually even further, [hoping] to solve... the problems along the way that would allow that to happen. It wasn't something we talked a lot about, because in those days spaceflight was not generally regarded as a realistic objective, and it was a bit pie in the sky. So although we were working toward that end, it was not something we acknowledged much publicly. Not necessarily for fear of ridicule, but probably somewhat.

BRINKLEY: With Sputnik, do you recall where you were when you heard about that?

ARMSTRONG: Yes. The Society of Experimental Test Pilots was holding a symposium in the Beverly Hilton Hotel [California] in October of '57, and I was working on—I think I may have been program chairman; I'm not sure about that now—for the symposium. But in any case, I was very much involved in the symposium, and we were trying to find ways to get the Los Angeles press interested in the kinds of technical presentations that were being produced there, and get a little coverage of what our industry was doing and what was happening in the test-flight world. But it was a very hard sell, and it became completely impossible once Sputnik came across the sky, and all of a sudden we couldn't get any people to come listen to problems about airplanes flying.

AMBROSE: And your own reaction to Sputnik? Curiosity, or more than that? Or, 'God almighty,' or what?

ARMSTRONG: I don't remember exactly what my reactions were at the time, too much colored by intervening events. But I guess it was disappointing that a country who was

CREDIT UNION MEMBERS GATHER AT ANNUAL MEETING

The Annual meeting of the BSFS Credit Union was held on January 17, 1957. The annual treasurer's report and annual reports from all committees were submitted and accepted by the members in attendance. Reflected in the reports was the belief, expressed by the Board of Directors, that 1956 has been a successful year for the Credit Union, with members benefitting in numerous ways from the efficient operating procedures carried out by Credit Union personnel.

A dividend of 6 percent on shares held during 1956 was approved. All members were urged to take their pass books to the Credit Union office as soon as possible for posting.

It was voted to retain the current interest rate of 1 percent per month on an unpaid balance.

During 1956, it was reported, 216 loans were made for a total of \$108,211.33. A request was issued that all applications for loans be made before 11 a.m. on Tuesdays.

Election of officers was held with the following members selected:

<u>Board of Directors</u>		<u>Credit Committee</u>	
Ralph Sparks	President	Jack Nugent	Chairman
Henry Daniels	Vice President	*Pat Marash	Secretary
*Thomas Finch	Treasurer	*Bill LePage	
*Norman Hayes	Asst. Treasurer	*Ralph Fernula	
Helen Foley	Secretary	Martin Byrnes	
*Neil Armstrong	Publicity Chairman		
	<u>Supervisory Committee</u>		
	Stanley Butchart	Chairman	
	Arthur Lynch		
	*Donald Bellman		

One member is to be selected by the Board of Directors to fill the vacancy created by the resignation of Leslie Garbett.
(* Elected for two years.)

the "evil empire" in our minds at that time would be beating us in technology, where we thought we were preminent. At the same time, it was encouraging, because it demonstrated the kinds of things that we were interested in really might be achievable and perhaps it would encourage people to look at our world with somewhat more curiosity and perhaps approval than they had before. It did change our world. It absolutely changed our country's view of what was happening, the potential of space. I'm not sure how many people realized at that point just where this would lead. President [Dwight D.] Eisenhower, I think, was saying something like, 'What's the worry? It's just one small ball.' But I'm sure that was a facade behind which he had substantial concerns, because if they could put something into orbit, they could put a nuclear weapon on a target in the United States, because the navigation requirements were quite similar.

...That was an eye-opener, I think, to a lot of people. Maybe there was substantial interest in, 'Well, maybe we can get people up into space.' That was instantaneous, that possibility.

BRINKLEY: Here you are a test pilot and you're flying the most advanced aircraft in the world. What makes you at that point in time want to join the astronaut corps? What is it that made you decide, 'This is what I want to do'?

ARMSTRONG: It wasn't an easy decision. I was flying the X-15 and I had the understanding that

EX-PRESSIONS

FRENZIED PACE.....Joe Walker and Major Bob White are rapidly discovering "What Makes Sammy Run?". After the two set world altitude and speed marks in the X-15; they were besieged from all sides for television and radio appearances, feature stories, telephone interviews, etc...Both appeared on NBC-TV's "Today" show last Tuesday a.m., and Joe followed that with an appearance as the "Face in the News" on Ben Alexander's "About Faces" show which videoed Tuesday afternoon (ABC-TV)...Needless to say, the two should be well known by near 100 million ladies..... Keeping up the pace, Walker will guest star on "What's My Line" Sunday evening (Aug. 21) from New York...Watch the TV page for time.

GOOD READING...Additional reprints of National Geographic's fine article on NASA are available in room 139..... Speaking of literature, Richard Tregaskis, author of "Guadalcanal Diary," is winding up his book on the X-15 program, following the two recent flights...Information on when the book will be available will be published when received...

SLOW DOWN...Speed limit within the FRC fenced perimeter (mainly the aircraft ramp) is now 10 m.p.h....

STUDY HARD.....USC graduate study courses, to be given at Edwards this fall, are being formulated and will be published when complete....As many persons as possible will be enrolled in the program.....

GALS HEAR TALK.....WONASA members
(Continued next col.)



Volume 2, Issue 13

NACA HSFS, Edwards, California

October 4, 1957

POLIO, FLU IMMUNIZATION TO BE AVAILABLE FOR HSFS EMPLOYEES

On Monday, October 28, from 2:30 p.m. to 5:30 p.m., through the Bakersfield Public Health Clinic, first, second, and third polio shots will be offered at no cost to HSFS employees and their families at the Main Base Cafeteria. The cafeteria is located on the corner of Mojave Boulevard and Wolfe Avenue, diagonally across from the Civilian Personnel Office.

Infants must be 6 months or older and adults under 40 years of age. It will be the employee's responsibility to make arrangements for his family. Employees, with permission of their supervisors, may be excused from work for the time necessary to receive the shot.

A clinic will also be held at the Gephart School in Boron from 7 p.m. to 9 p.m. for any employees wishing to take their polio shots at that time.

NACA Headquarters has notified NACA facilities that sufficient vaccine has been obtained to make it possible to immunize all NACA employees against Asiatic flu at government expense. The vaccine will be available at HSFS about October 15 and will be administered by Nurse Elinore Irvin. All employees who desire to be inoculated are requested to notify Mrs. Irvin by October 15 so that a schedule can be set up.

FIRST HSFS UNITED FUND DRIVE NOW IN PROGRESS

HSFS' first United Fund Drive was officially opened this week. The single-package drive to solicit employee contributions for charitable and humanitarian or welfare agencies in this area will replace all other appeals usually conducted during the year. No further fund appeals (except for emergencies or disasters) will be made until September 1958.

Some of the agencies included in the United Fund are the Antelope Valley Community Chest, Red Cross, Boy Scouts, Girl Scouts, Crusade for Freedom, Salvation Army, Heart Fund, and Cancer Fund.

Joseph Vensel, Fund Campaign Manager, will be assisted during the drive (Sept. 30 to Oct. 11) by the staff of solicitors pictured below. The following Board of Directors will administer the Fund: Martin A. Byrnes, chairman; Ralph E. Haley, vice chairman; Florence P. Maresh, secretary; Elinore J. Irvin, treasurer; Edward J. Lynch, John G. McTigue, and Oscar N. Hayes, Jr.

As pointed out by Board Chairman Byrnes, an employee's contribution represents the whole of his charitable giving at home and at work for the entire coming year. The complete amount he contributes will go to the specific agency he names without any deduction for overhead costs, as is customary in professional fund raising campaigns.





Neil A. Armstrong
(left) and Center
Director Paul F.
Bikle.
(E-16107)

if I continued, I would be the chief pilot of that project. I was also working on the Dyna-Soar, and that was still a paper airplane, but was a possibility. Then there was this other project down at Houston, [the] Apollo program. Gemini hadn't been really much identified yet at that point. It wasn't clear to me which of those paths [would be best]. Recognize that people who are in this world see projects come and go. A project's established, it may run for several years, finally get canceled, and I had been assigned to aircraft test projects and never, never flew the airplane, because the need changed. I never got to that goal.

We sort of saw every project of this type as something that, 'it may go or it may not.' Although you learn a lot when you're on a program that eventually gets canceled, there's a lot more satisfaction in being in a program that really reaches its fruition. I can't tell you now just why, in the end, I made the decision I did,

but I consider it as fortuitous that I happened to pick one that was a winning horse. But there would be no way to predict that at the time, when it got to that fork in the road—in my case, a three-way fork.

BRINKLEY: Some of the other test pilots that didn't go into the Apollo program, that stayed at Edwards, that believed, 'We're flying our own planes,' and had that attitude, did you ever catch like, 'Space, that's for, like, the dog that went up, or the monkeys.' Is that kind of an attitude that prevailed?

ARMSTRONG: On the part of some, yes. At the time the Mercury program was started, it might well have gone that way. In a sense it did, in that they had a lot of monkey flights. But I believe that the reason it did not keep that characterization was that the Mercury crewmen insisted on making it an airplane-like device, have the same conventions as normal airplanes, so that your natural instincts were proper, and insist that the crewmen be able to perceive enough and see enough and have sufficient information available...that he could make reasonable choices about proper alternatives in how to control the craft in a manner that would maximize the ability to get toward the objective.

So I think that was a great contribution on the part of the Mercury guys, who were probably abrasive to some of the engineering managers in that time in their demands that the craft be built in this way. So that certainly was important.

DEPARTING FRC...

Many good-bys were said last Friday to Neil Armstrong, who departed FRC after his transfer to NASA's Manned Spacecraft Center at Houston.

BRINKLEY: What was the astronaut selection progress like, and what kinds of physical and psychological tests were you subjected to once you made that decision?

ARMSTRONG: Well, I don't think the community of flight medicine and flight physiology knew very much what they needed to do at that point. There were widespread predictions that humans could not survive in space for a variety of reasons, both physical and physiological. So they didn't really know exactly

what to test for, I think, so they did everything. They didn't miss anything, as far as I know. They did every test known to man. Not necessarily fun. Survivable.

BRINKLEY: How did your job now as an astronaut differ from being a test pilot? What were the first things that you realized were going to be different for you?

ARMSTRONG: Well, it was very different. There were some similarities in the sense that we were planning and we were trying to solve problems and devise approaches, but since we were trying to do an operational job, we were extremely focused. A research project tends to be more broad, generic—cover a range so that you have indications as to which might be the best path. The Apollo and Gemini programs—Mercury, I really wasn't involved in the early parts of that—but in the germination of Gemini and Apollo, we were looking for not a range of stuff, but the best method that we could find that would give us ability to go at the earliest possible time, maximum speed, and with the highest level of confidence. Quite a different responsibility, yet the skills, the engineering approaches, and the equipment available to us was really quite similar.

BRINKLEY: How did you feel when President [John F.] Kennedy made his great challenge to put a man on the Moon in that speech—not just yourself, but the whole team you were with? Was that a moment where you really—can you recall Kennedy's speech, and can you recall that kind of commitment that came out of President Kennedy?

ARMSTRONG: Well, yes, I certainly remember it, but it's a bit hazy because I've heard recordings of it so many times since, that you're not certain whether you're remembering or you're remembering what you're remembering. So I'm not certain what it was. And, of course, it's been colored by the fact that I read so many stories of how that process actually occurred and what led to his conclusion to do that. I guess I've been persuaded by historians that it wouldn't have been his first choice, but he didn't find any other good options to go against the Soviets with. The world was caught up in what the Soviets were doing. And he'd campaigned against [Richard M. Nixon] on that basis [the need to challenge the Soviets in space].

BRINKLEY: I guess I'm thinking of the youngness of all of you, and here's this young president saying that. Did you feel like he was part of the team, like he was a leader now—with President Kennedy, we really had a



X-PRESS

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1962 E

TWO FRC PILOTS SELECTED FOR NEW PROGRAMS

Neil Armstrong Selected For Gemini

Neil Armstrong, who has logged flight time in all types of flying machines, including everything from the paraglider to the X-15, will start training for another research flying venture this next month.

Mr. Armstrong was named as one of nine pilots to start training for possible flights in NASA's Project Gemini and Apollo. This training period will begin immediately and flights are tentatively scheduled for 1964.

The youngest of the X-15 pilots, Mr. Armstrong has made seven flights in the rocket powered aircraft. While conducting research flights in the X-15, he has flown at altitudes greater than 200,000 feet and at speeds in excess of 3,900 mph.

Winner of the 1962 Octave Chanute Award from the IAS for "outstanding contributions in both engineering and piloting capacity in the development of an experimental adaptive control system and the flight testing of that system in the X-15 number 3 aircraft," Mr. Armstrong completed the first 100 flights of this aircraft evaluating this control system.

Having been stationed at FRC since 1955, Neil Armstrong will be joining many old friends. During



Milt Thompson To Fly X-20 Dyna Soar

A NASA research pilot from the Flight Research Center, Milton O. Thompson, was selected as the only civilian pilot in the X-20 Dyna Soar program. The other pilots, all members of the U.S. Air Force, and stationed at Edwards AFB, are Maj. James Wood, Maj. Russell Rogers, Maj. Henry Gordon, Capt. William Knight and

The names of selectees were announced at the U. S. Air Force Convention held last week in Las Vegas.

Mr. Thompson, who joined the NASA in 1956, has specialized in research piloting. He was co-project pilot on the ALBOR and Vipercon projects, designed to air launch scientific payloads from

(Continued page 2)

An official announcement, made last month, named former Center pilot Neil Armstrong as commander of Apollo 11, the first Apollo flight that could land on the moon. If everything goes as planned, Neil could be the first man on the moon. Fred Haise, another ex-Center pilot, is back-up lunar module pilot for this flight

leader that wanted to put the space program on the forefront of the American agenda?

ARMSTRONG: Our concern always was, 'What will the Congress do?' Because the president can proclaim, but it's the Congress that makes things happen. So that's really where the question was. As it turned out, they were motivated to support the president in this area, which I'm not sure I necessarily would have guessed at that point, based on my recollection of priorities...

GT-8 Scheduled For Next Week

Gemini 8 will be launched on a three-day mission from Cape Kennedy, Fla., no earlier than March 15, the National Aeronautics and Space Administration announced last week.

Command pilot for the mission is civilian Astronaut Neil A. Armstrong, a former X-15 pilot. Pilot is Air Force Maj. David R. Scott. Gemini 8 will be boosted into orbit by the two-stage Titan II Gemini Launch Vehicle, generating 430,000 pounds of thrust. Scheduled liftoff is 11:40 a.m. EST.

The mission will include rendezvous with a Gemini Agena Target Vehicle (GATV) (modified Agena D), extravehicular activity by Scott, and 11 onboard experiments.

The Agena will be launched into a 185-statute-mile circular orbit by an Atlas Standardized Launch Vehicle approximately 100 minutes before Gemini 8 liftoff, or at 9 a.m. EST.

Gemini 8 will go into a 100 by 168-statute-mile elliptical orbit and rendezvous is planned during the fourth revolution, approximately five and one-half hours after liftoff.

After rendezvous, Armstrong will perform the first of four dockings with the Agena, in which the Gemini will be physically con-

GT-8 (Continued)

During the night, Scott will don a backpack contained in the spacecraft adapter. With the backpack is a T-shaped tether which he will attach to the original 24-foot tether. He will remain in the adapter section of the spacecraft until daylight before continuing the extravehicular activities. Gemini 8's adapter section, which is jettisoned before reentry, is an unpressurized, instrumented ring at the aft end of the spacecraft.

At daylight, Armstrong will undock the spacecraft and fly formation on the Agena at distances up to 60 feet.

Scott will then use a hand-held maneuvering unit which fires bursts of free-nitrogen gas to control his movements. This unit is similar to the one used by Astronaut Edward H. White II during the Gemini 4 mission.

Approximately four hours after the completion of extravehicular activity, the Gemini 8 will maneuver into a different orbit from that of Agena and then attempt to rendezvous with the target vehicle.

Six scientific, five technological and one medical experiment will be carried on Gemini 8. Technological experiments include mass determination, UVF-VUF polarization, night image intensification, power and evaluation and sensor observation. Scientific experiments are solarized light photography, frog egg growth, cloud top spectrometer, nuclear emulsion, and micrometeorite collection. The medical experiment is the bioassays of body fluids.

Landing of the spacecraft is

scheduled in the West Atlantic Recovery Zone at the beginning of the 49th revolution, after approximately 71 hours of flight, on the morning of March 18.

Scott is scheduled to open the hatch at 20 hours and 25 minutes into the mission while the vehicles are docked. He will spend one and a half revolutions, about two hours and 15 minutes, outside the spacecraft. Total elapsed time from hatch opening to hatch closing will be about two hours and 51 minutes.

In the first daylight segment he will remain on a 24-foot umbilical tether, with oxygen supplied from the spacecraft. He will perform a nuclear emulsion radiation experiment from the Gemini 8 spacecraft adapter, activate a micrometeorite experiment on the Agena, and use the minimum reaction power to loosen and tighten bolts on a work panel on the adapter.

BRINKLEY: Describe your training with the Lunar Landing Research Vehicle [LLRV] and the Lunar Landing Training Vehicle [LLTV]. What was it like to try to fly it, and how valuable was that experience during your mission?

ARMSTRONG: Start at the end and work back. It turned out to be very valuable. Originally, when they started first talking about lunar landing, it wasn't known what technique would be used to go there. I was at Edwards, and we started thinking about how you would simulate flying over the Moon. That was a natural thing for us because in-flight simulation was our thing out at Edwards. We did lots of in-flight simulations, tried to duplicate other vehicles or duplicate trajectories or duplicate this or duplicate

that, make something fly like something else. It was just what we did. Don [Donald] Bellman and Gene Matranga, two engineers, and myself, to some extent, started talking about how you might do this. Our first idea was...have the spacecraft carried on another vehicle and make that other vehicle be something that would create the conditions that would duplicate the lunar gravity and lunar vacuum and so on...and learn how it flies.

Then we decided that was going to be a pretty complicated project, and what we should do before we did that was build a little device, a little one-man device which would just investigate the qualities and requirements of flying in a lunar [environment]—to build the database from which we would build the bigger thing to carry the real spacecraft. So we actually devised such a craft. It looked like a tin Campbell Soup can sitting on top of some legs, with a gimbaled engine underneath it. That became the basis for a requirement for a bid to build the LLRV. It was not known at this time that there would be a Lunar Module. It was direct ascent and Earth-orbiting rendezvous and other strategies were still being considered. Matter of fact, the Lunar Module came after the Lunar Landing Research Vehicle

Fortunately, the characteristics and the size [and] in the inertias and so on of this training device were very much like the Lunar Module. That was strictly fortuitous. So it turned out that the people—this is after I'd left there—Joe Walker, Don Mallick, and so on, went through the project to fly this thing, and finding out what the characteristics of a machine flying in a lunar environment would be.

...At that time it was decided to go the lunar-orbital rendezvous method and build a Lunar Module, and it turned out that [the LLRV] was just about the right size. After that, they made the Lunar Landing Training Vehicle, which was designed to be even more [Lunar Module]-like, so it would give you a good representation. In fact, it did. All the pilots, I think, to my knowledge...thought it was an extremely important part of their preparation for the lunar landing attempt. As you may know, the Lunar Module was designed to be able to make an automatic landing, but to my knowledge no one ever did.

BRINKLEY: So the simulation—how close a simulation was this training to the actual landing? Were you in for any surprises when you actually had to land it differently than the simulation?

ARMSTRONG: It was harder to fly than the Lunar Module, more complicated, and subject to the problems that wind and gusts and turbulence and so on, introduce, that you don't have on the Moon. The systems were somewhat choppier or less smooth than the actual Lunar Module, both propulsion and attitude control systems were so. The Lunar Module was a pleasant surprise.

BRINKLEY: Do you mind discussing the incident you had with the Lunar Landing Research Vehicle when it crashed? What was your involvement in the investigation and recovery process in that? Were you part of all that?

ARMSTRONG: Well, it's fairly well covered in a variety of documents. Just say that for an unknown reason, the pressurization gas—I was conducting a simulated lunar approach and lost the pressure and gas to the attitude control rockets, and when you lost attitude control...it diverges—not very slowly. And there was very little time to analyze alternatives at that point. It was just because I was so close to the ground, below a hundred feet in altitude. So again, time when you make a quick decision. You departed.

I did not participate in the investigation of that, because I had otherwise assigned duties at the time, so others did that. We lost three of those vehicles, and it was a contrary machine and a risky machine, but a very useful one....

Apollo 11 Launch As Seen By Center Personnel

NOTE: Among Center personnel who witnessed the launch of Apollo 11 was Bill Dana, Pilot's Office, who brought back the following impressions. A comment by Jim Love is also included.
July 15

6:30 a.m. Thin overcast - asked myself, "Would they go with this weather (below X-15 standards)," but I knew they would. Very red-eyed, because it's 3 a.m. in California.

8:30 a.m. Tour buses leave reception center. Travel up route A1A to Cape Kennedy Air Force Station. This was the original portion of the Air Force Eastern Test Range. Here we see vast arrays of tracking antennas clustered as though they were a pre-historic forest.

We crossed the man-made causeway to NASA-owned Merritt Island. The first stop is Pad 37, the site of the fatal fire in January 1967. Here we visit the control room from which Apollo 7 was controlled during launch in October 1968. We note that it is about 20 times as large as the X-15 control room, but very similar in concept.

We travel past Pad 40, the site of the Titan III launches, to Pad 39A where Apollo 11 sits almost hidden between the bright-orange fixed gantry and the gray mobile gantry. The mobile gantry is even more impressive than the Saturn/Apollo itself. This is the vehicle that transports the Saturn/Apollo a distance of three miles from the Vertical Assembly Building (VAB) to Pad 39A on giant "caterpillar tractor" tracks. Because of the weight of the gantry and its load, the sandy soil of Merritt Island could not support it. A three mile road, 100 feet wide and 25 feet deep, was built from the VAB to the Pad out of special gravel mined in Tenn-

are assembled here in a vertical position from the many sub-assemblies brought in by barge and rail. The building is 546 feet tall and its base covers 8 acres. It can house four Saturn/Apollo's in various stages of assembly. As we visit it the day before the launch of Apollo 11, it already contains a nearly assembled Apollo 12, which is scheduled to launch in November.

This completed the tour of the Cape area the day before launch.

July 16

The alarm rang at 4:30 a.m. (1:30 a.m. Lancaster time) and we were struck with the thought that perhaps our overriding memory of Apollo 11 would be that of overwhelming drowsiness. A shave revived me, and we stepped out of our room into a sky of stars. This was a pleasant contrast to the previous morning and was read as a good omen for launch day.

After a quick cup of coffee, we boarded an "Official NASA Visitor" bus for Cape Kennedy. This put us in the select company of 10,000 other sleepy souls on 249 other diesel buses. As we approached the Cape, the dark VAB was not the outstanding edifice; it was a brightly lit Saturn/Apollo from which the movable gantry had been removed. In the darkness, the white gleaming Saturn was like a giant candle set on the table, Merritt Island.

We were in the stands by 7 a.m., 2-1/2 hours before launch, but even with 10,000 other spectators we were able to spot at least a dozen people we knew.

Countdown was amazingly orderly. We were surprised how late crew entry was. Neil did not get aboard until about 2-1/2 hours before launch and the other two after that.

When the big moment came (9:32 a.m. EDT), we knew there was a malfunction. The Saturn did not move for

have lost one or two engines.

The rest of the crowd, not being as well informed as I, remained ignorant of the malfunction and applauded at liftoff. An eternity later, as the Saturn cleared the gantry, we could hear Neil say, via the loudspeakers, "We have a roll program." The crowd applauded again.

* * *
According to Jim Love, who witnessed the launch from a different area, when the first stage ignited, the men who were responsible for it cheered with gusto. When the second stage ignited, the technicians responsible for it cheered even longer.

* * *
At an altitude of 8 or 10,000 feet, the Saturn passed through a local cloud and disappeared momentarily. It left a black, slow-moving shadow on the cloud which somehow reminded me of a phoenix rising from its own ashes.

No sound reached the viewing stands for 16 seconds after launch. When the sound did come, we had expected it to be a chest-rattling vibration, reminiscent of an X-15 engine run. Instead, it was a series of ear-piercing sonic booms from the supersonic nozzles of the Saturn's motor.

Soon the craft reappeared from behind the cloud, and we watched its contrail move down range. Staging occurred at a distance of 70 miles. The crowd viewed staging from the stands and applauded the departing Apollo.

Other than the extreme slowness of the liftoff, the biggest surprise was the brightness of the rocket exhaust. Although we were looking into the morning sun and had our sunglasses planted firmly on our noses, the glare from the rocket motors was painful to watch.

We knew the flight had to end successfully with such a perfect launch.

LLRV Accident Report Released

The investigation board has cited a loss of attitude control as the cause of an accident that destroyed the number one Lunar Landing Research Vehicle in Houston.

In the mishap last May 6, former Center pilot Neil Armstrong escaped with minor injuries when he ejected just before the crash and landed by parachute. The Lunar Landing Research Vehicle (LLRV), a flying simulator built to train pilots for landing operations on the Moon, was a total loss.

The NASA accident board found that the pilot was forced to escape a few seconds after the loss of helium pressure in the propellant tanks caused premature shutdown of the attitude control rocket system.

The mishap occurred when the vehicle reached a hovering position about 30 feet above ground. Due to a loss of thrust from the lift rockets, the LLRV started to descend, but when the pilot shifted controls back to normal Earth flight operations, it began climbing. Then, apparently because the pilot was warned too late of running low on propellant for his attitude control rockets, he lost control of the vehicle. The pilot immediately ejected, when the craft was about 200 feet above ground and beginning to nose up and roll over.

The board noted that the source of the trouble was the loss of helium pressure through the hydrogen peroxide tanks and the lift rocket system. This pressure forces the peroxide propellant from the tanks to the lift rockets and the small thrusters operated by the pilot to control attitude.

Normally the LLRV can be flown and landed safely with its gimbal-mounted jet engine and attitude control thrusters even after the propellant supply to the lift rockets is depleted, but this calls for quick action by the pilot as soon as warning comes.

The MSC Board said this action amounted to a "critical pilot task during
(Continued next column)



INTERVIEW . . . Following the recent flight, HL-10 pilot Jerry Gentry talked to reporters and television crews.

LLRV (Continued)
the heavy workload period which developed on this flight." It laid the basic difficulty on design deficiency because the helium pressurization for attitude control is not protected against loss through the lift rocket system.

The number one LLRV received its initial flight tests at the Flight Research Center. Over 150 successful flights were made here.

A full copy of the summary of the accident report is available in the Public Affairs Office.

Cover

The cover of this month's X-Press shows the new radar installation at Ely, Nevada. This is the radar that is providing all up range coverage for Center flights since the closing of the Beatty site. The dish of the antenna has a 29-foot diameter and is supported by a new pedestal. The new radar, built by the Radio Corporation of America, is extremely accurate and is capable of tracking orbital satellites.

Called the HAIR, High Accuracy Instrumentation Radar, the radar has already been used to track recent XB-70 and X-15 flights with excellent results. In the future, Center flights as well as those from other Government agencies will use the radar.

Rocket Engine Malfunction Mars First Powered HL-10 Flight

The first powered flight of the HL-10 lifting body was made late last month. Unfortunately, it did not last as long as planned.

The flight was planned to reach a top speed of 0.8 Mach or approximately 600 mph.

Following launch, research pilot Major Jerry Gentry activated the switches for the number one and three chambers of the rocket engine. Only the number three chamber ignited, so he went to the alternate flight plan that called for him to use chambers two and four. However, both of these chambers also failed to ignite.

Following preplanned procedures, the pilot elected to land at Rosamond Dry Lake. A very successful landing was made with no damage to the aircraft.

During the weeks preceding the flight, Gentry had made several practice landings at all of the alternate landing sites.

The flight is expected to be rescheduled for next month.

Viet Nam CARE Contributions Sought

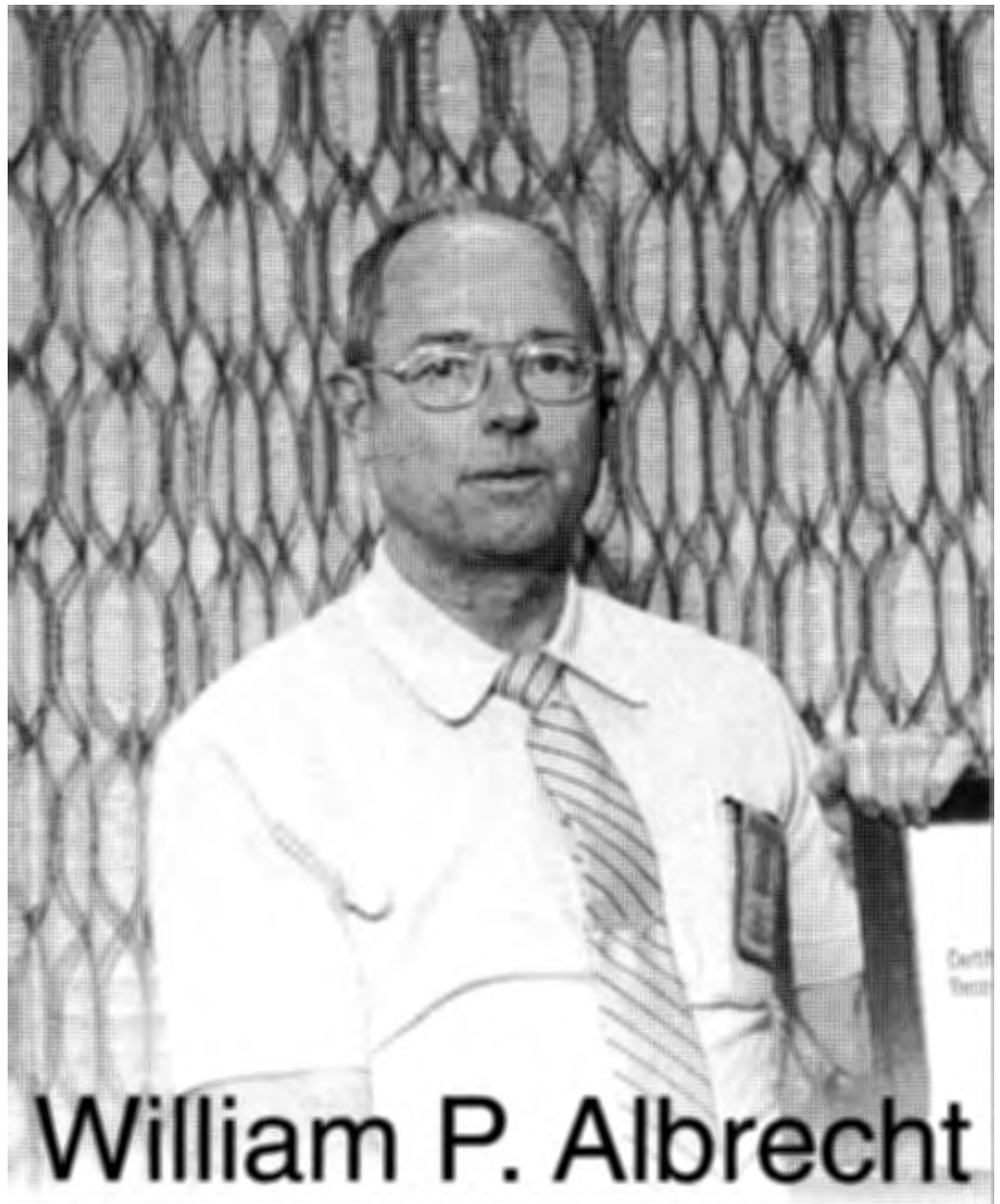
Flight Research Center employees and contractors now have a chance to contribute directly to the war against Communism in South Viet Nam. Through the cooperation of CARE, the Marine Corps Reserve Civic Action Program has undertaken to provide the South Vietnamese with medical supplies, food, tools, clothing, and other necessities.

Bruce Peterson, Center Research Pilot, and a Captain in the United States Marine Corps Reserve, explained the Civic Action Program is both a humanitarian effort and a means of winning friends who will deny Viet Cong guerrillas the support they require.

Information about the program can be found outside the cafeteria on a bulletin board, or by contacting Bruce Peterson.

-4-

On the day prior to launch, **Stan Butchart**, Flight Operations, placed a telephone call to **Neil Armstrong** to wish him a good trip. It took several minutes for Neil to come to the telephone and he greeted Stan by saying, "I'm sorry to be so long, but I was talking on the other telephone to the President."



Interviewed by Curtis Peebles
February 16, 2001

William P. Albrecht was among the large number of people who helped transform the X-15 from concept to reality. In many ways, the X-15 represented as great a leap into the unknown as the X-1 had more than a decade before. The vehicle flew at speeds and altitudes two or three times greater than those reached by earlier research aircraft such as the X-1A, D-552-II, or X-2. As operations engineer on the X-15A-2, Albrecht had to deal with the results of extreme heating experienced by the aircraft at high speeds, which, on one occasion, nearly caused the loss of the aircraft on its final flight. After reaching a speed of Mach 6.7, the heat generated burned through the aircraft's lower fin.

Albrecht's involvement with aerospace engineering began in the early years of jet propulsion. His background was different than that of most engineers, even at that time. He had only a brief technical school education rather than a formal university degree. He arrived at Edwards in 1951 as a contractor, but not for the NACA or the Air Force.

Rather, he worked on the Regulus I and II cruise missiles for the Navy. This was followed by work on the F8U-3, an advanced version of the F8U Crusader jet fighter. When this program was cancelled, he decided to remain at Edwards and join the newly established NASA.

NEW FACES

Ruby A. Parker - mathematics aide from Rosamond, assigned to Simulation and Computation
William P. Albrecht - flight operations engineer in Flight Operations, from Palo Alto, California
Murray Politz - aeronautical research engineer in the Aero Structures Branch, from Brooklyn, New York
Jo Ann W. Rogers - mail and file clerk in Research Files, from Palmdale

Q: Let's begin with your family background and how you became interested in aerospace.

A: I was in a family of three children. Dad was a book salesman. He was in the book business and became the chief salesman in the Macmillan Company in New York. I lived in New York. I was raised on Long Island and became interested in model airplanes and, in fact, models of all sorts—airplanes, trains, and such. That's kind of how it started. I took up a scientific academic curriculum in high school and went to Stewart Tech in New York City, which was one of these small trade schools. They taught aircraft mechanics—that sort of thing—and they taught some preliminary aircraft design, which is the course that I took. That ended after about six months and I was drafted into the U.S Army during the war.

Q: Then you served in the India-China-Burma Theater, in airport construction. Any specific incidents that stand out?

A: Well, a brief description of that assignment: We were assigned first in India, where we built concrete runways for the B-29s that would subsequently be used for strategic bombing of the Japanese. That ended when our regiment moved to Burma. And of course the objective there was quite different. This was no longer concrete airports—it was hacking dirt runways out of the jungle. The Japanese didn't like that, so they made life a little difficult for us. I think the most interesting event that occurred was not the operations in Burma, although they were certainly exciting, but the trip after the Burmese campaign when the Japanese were driven out of Burma down at Rangoon. Our regiment broke up, and a bunch of us were sent to Kunming (China). We flew to Kunming and then we took the old Burma Road, or Ledo Road, from Kunming up to Chungking. I don't think it's called Chungking anymore.

But when we arrived at Chungking we had visions of becoming another large regiment and trying to drive the Japanese out of the shoreline areas of China. However, when we got to Chungking we heard about the first A-bomb drop on Japan. And of course none of us knew really what all that meant. Several days later, when the second bomb fell and the

Former X-15 pilot **Bob Rushworth** is now Director of Flight Test at Wright-Patterson AFB. . . . **Meryl DeGeer**, Flight Operations, was married on Valentine's Day which prompted perennial bachelor **Bill Albrecht** to say, "If marriage is such a good deal, how come Cupid never got married?" . . . A bachelor party for **Meryl** was hosted by his best man, **Herb Anderson** and featured an educational lecture by Flight Operations engineer **Bob Baron**. . .

Operations' **Bill Albrecht** celebrated (?) a half century of clean living earlier this week at a surprise birthday party. The rest of Ops Engineering is betting that **Ron Waite** won't make it that far. . .

Bill Albrecht, Operations, spent a week skiing at Aspen. On returning to work, he presented his lecture course on how to identify highway patrol motorcycles while passing from the rear. . . . Also on the slopes were Deputy Director **Dave**

Japanese sued for peace, we of course were ecstatic—because we had been given to understand that we might be there for several more years, and it looked like at this point that we were going to go home. And indeed we did. We flew back to Calcutta, and we were on a boat from Calcutta to the States within a month. Those were happy days for us—not very happy for the Japanese, however.

Q: After the war you joined Chance Vought's Flight Test Division. How did this occur and what were your duties?

A: Well, after I got back from the war I thought I would probably never leave New York. But after a month I was so fiddle-footed I couldn't sit still and I started looking for a job in aircraft as a draftsman or something like that. The only place that was hiring at the time was Chance Vought, at least of the people that I interviewed with. Chance Vought was up in Bridgeport at Stratford, Connecticut. So up I went to Stratford and took up residence there. My first task was updating drawings based on EOs [engineering orders] and other engineering data that somebody else invented. So it was a very dull sort of job. I was simply copying somebody else's work. The boss of what was called the Drawing Change Group was an old German guy who was a real stickler for printing and the formalities of drawing. He finally got a hold of me and said, 'Hey, are you sure you want to do this sort of work?' I said, 'No, not really.' He said, 'How would you like to go down to the Experimental Department and operate as the liaison engineer.' I said, 'Boy, would I.' So that's what got me started into the world of flight tests and experimental work.

Q: So at the time you only had that few months of trade school?

A: Yes. It was a course in drafting with some very, very fundamentals of structure and aerodynamics. I have no sheepskin from a college.

Q: You worked on the XF7U Cutlass program at Naval Air Station Patuxent River. What events stand out in your memory?

A: I was sent down there as a sort of a field engineer—here at NASA, we would call it an ops [operations] engineer—with the first XF7U, and several flights were made. On the last flight for that particular airplane it fell in the Chesapeake Bay. We never recovered the body of the pilot although we spent, I guess it was, a month, six weeks hiring some fishermen from Smith Island across the bay. We strung chains and cables between pairs of boats and plowed through the bay, trying to snag the wreckage. It was really a futile effort from the start because we had only a very vague idea of where the impact occurred. But we did wind up picking up some pieces, which gave us some encouragement, and we identified the pieces as part of the first XF7U. But after six, eight weeks we gave up trying to raise the main fuselage and, of course,

Service Emblems Are Received

Service emblems have recently been given to Flight Research Center employees for government service.

The length of time and the employees are listed below:

Five Years

Helen Brooks
Christobal Flores

Ten Years

William Albrecht
Harold Bryan
Roy Bryant
Lynn Buttane
Ernest Dunn
Norman Gravatt
Robert Halasey
Wilma Harris
Willie Mayes
Charles Miller
John P. Smith
George Trott

Fifteen Years

Marion Brown
Ramon Jimenez
Carl Osborn

The twenty and twenty-five year emblems will be presented at the annual ceremony in October.

the pilot and the fuselage are still down there. That was the biggest event in that series of tests.

Q: What are your recollections about the early jet technology and the difficulties this posed, particularly in building a carrier-compatible aircraft?

A: Well, the XF7U was not the first carrier-type jet that Chance Vought tried to build. We built the XF6U, which was a single-engine airplane, and the XF7U itself. Both those aircraft suffered from lack of good, solid jet engines. Jet engines and afterburners were kind of a new thing. The afterburners were most unreliable. You could not guarantee that the afterburner would light any better than one out of three—something like that—at the start. I think that was probably the biggest problem with early jet technology. The engines were just unreliable. You could get the turbines going fine but if you tried to use full power, you were never sure that you were going to get it.

Q: And a carrier deck is a real short runway.

A: Yes. But of course for takeoff you had the burner going before they released the catapult—so you could probably count on getting off from that point of view. But in the air you couldn't reliably light the afterburner.

Q: You then moved on to the Regulus I and II programs. Again, what events with these stand out in your memory?

A: Well, again we started with a jet engine, in the Regulus. The Regulus I had a J-33 [jet engine], I believe. It was quite reliable, but of course it was not after-burning and Regulus I was not a high-performance machine. The Regulus I eventually wound up on submarines and some mid-size vessels, sitting on launchers on the afterdeck of cruisers. The Regulus II was a Mach 2 vehicle. It was powered at first with, I believe it was, a J-65, and eventually it was planned to have a J-79 after-burning engine. That was one of the better engines of the era, in my mind. The J-79 and the afterburner were much more reliable than we had seen in the XF7U or the F7U. One of the things that I recall was that in spite of the fact that it was an unmanned vehicle, it did not have a flight termination system of any sort. We crashed a few of them around various bits of landscape here in southern California and Nevada. At least two, I think, went into Death Valley. There was one that crashed over in the Central Valley on a ranch. That seemed to be acceptable at the time—safety being what it was then.

The Regulus II was quite successful as far as it went. However, in the case of the submarine deployed version—it required the submarine to come to the surface and remain a sitting duck on the surface while you rolled the missile out onto the launcher that was on the deck and raised the launcher and fired it off. That took 20-odd minutes, and during that time you were a sitting duck for enemy action if you were found. The Regulus died a sort of a natural death when the Navy became successful in popping Polaris missiles out from under the water which, of course, didn't require a submarine to surface. As soon as they got several successful pop-ups of their dummy Polaris, the Navy came to Chance Vought and said, 'Sorry, boy—you're out of business as far as the Regulus missile is concerned.'

Q: What was the time frame? When did you join the Regulus program?

A: That was in 1951, when I first came out to Edwards. We did our development test work here at Edwards using both Regulus Is and Regulus IIs equipped with landing gear so we could launch them and test them and then land them and use them again. The military

Regulus missiles didn't have landing gear. The Navy work, we did out at Point Mugu.

Q: What were conditions like at Edwards at that time? Was there still the 'Wild West' atmosphere of the early days?

A: In 1951, yes—there was a certain element of that. The base was nothing like what we know of now. The old tarpaper shacks prevailed and that's where people lived, including the military and civilians. It was called Kerosene Flats down there, somewhere in the vicinity of where the present main runway is. Lancaster was, I would say, about seven thousand people strong. That included the surrounding area and Palmdale. There were one or two nice restaurants in town. One of them I can remember had a large mahogany bar a la western style, with big mirrors and brass and that sort of thing. It was a really big deal when J.C. Penney moved a department store in Lancaster. Everybody just about celebrated. We also had but one traffic light, and that was at the junction of Sierra Highway and Lancaster Boulevard. But the Wild West atmosphere still prevailed. Ranching was also big at that time—raising hay and stuff like that—that required lots of water. Water pumping was done throughout the valley to keep crops growing. The water table at that time was quite high. It's somewhat depleted now, although so is much of the agriculture in the Lancaster area. I think the big crop they're growing now is carrots and onions. Alfalfa and hay have seemed to disappear.

Q: You spent 13 years at Chance Vought before joining NASA in October of 1959. What caused you to make the switch?

A: Well, as I said earlier, we lost the big contract for Regulus II. Coupled with that we lost a contract for a Navy fighter. We lost that to the F-4, which was built by McDonnell. The Navy opted for a fighter with a crew of two and two engines. Chance Vought went into the competition with a fine airplane, the F8U-3, that flew very well—performed really, I think, better than the F-4 at the time. But it had one pilot and a single engine. The Navy apparently decided they wanted more reliability and they wanted the rear seat to take care of all the nav [navigation] and the avionics.

Q: The fire control radar—

A: Yes—fire control and things like that. So what caused me to make the switch was that after we lost the contract for Regulus and there was no more flight test out here—which included, at that time, Regulus and the F8U-3—we all went back. Our flight test group here at Edwards closed down. We went back to the main office, which had moved at that time from Bridgeport down to Dallas, Texas. I wasn't particularly happy with Texas, having spent some time in California. I was impressed with the mountains and the neat things to do out here. I wasn't much of a golfer and that's what they had most in Texas. But anyway, I wound up in the main engineering office doing paperwork designs and things like that, and it was kind of dull after having spent seven or eight years with the flying machines. So I decided to switch.

Q: You worked on the F-104 air-launch sounding rocket. What do you recollect about this program?

A: Well, that was a fun program. When the X-15 started to come around I was not assigned immediately. We only had one bird

WINTER FUN...

Bill Albrecht, Operations Engineering, recently returned from a week and a half in Sun Valley, Idaho. He reports the skiing was excellent.

and that was adequately covered without my getting into the act. The air-launch sounding rocket was really a fun program. We had this F-104 equipped with a launcher and I was part of the design team on that. We carried this rocket, which was called a Viper. It was designed for sled use. At the time, we had a sled track operating here at Edwards. This old rocket was fitted with a nose cone that contained a folded-up Mylar balloon with a spoonful or so of water inside it. It was launched by running the F-104 into a zoom to a near-vertical attitude, at which time the rocket was launched. When it reached its apex the nose cone was jettisoned and the folded balloon popped out, and almost instantly the water inside vaporized and filled the balloon. I forget what the diameter was, but it was quite large and you could track it with the radar. It was intended to be a meteorological study of winds aloft.



Q: When you arrived at the Flight Research Center the X-15 was making its early powered flights. What were your duties when you joined the program, and your recollections of these initial flights?

A: The early X-15 flights were done by North American, and then the first vehicle was turned over to Dryden. It wasn't Dryden then but the Flight Research Center. I was not a part of the early flights, I guess, for maybe the first six months or so. I was still working on the air-launch sounding rocket. But when the second vehicle came along, I was assigned to it. When it was delivered, I became the ops engineer for that vehicle.

The F-104 air-launched rocket was the first project Albrecht worked on after joining NASA. (E-6508)

Q: What were your specific duties with X-15 #2?

A: Specifically, it was basically what our ops engineers do [at Dryden] at the present time. That is, to manage the crew chief and his crew in terms of the technical aspects. They weren't working for us in terms of administrative assignments, but the ops engineer called the shots as to what to do to fix a problem, how to service and that sort of thing, scheduling of the work and reporting upstairs to the project manager and helping to sort out flight schedules and that sort of thing, based on the ops engineer's knowledge of what was going on downstairs.

X-15 #2 after the landing at Mud Lake, Nevada, November 9, 1962. (E-9149)

Q: What about the buildup to the Mach 6 and the 350,000-foot altitude? What do you recall about that series of flights?

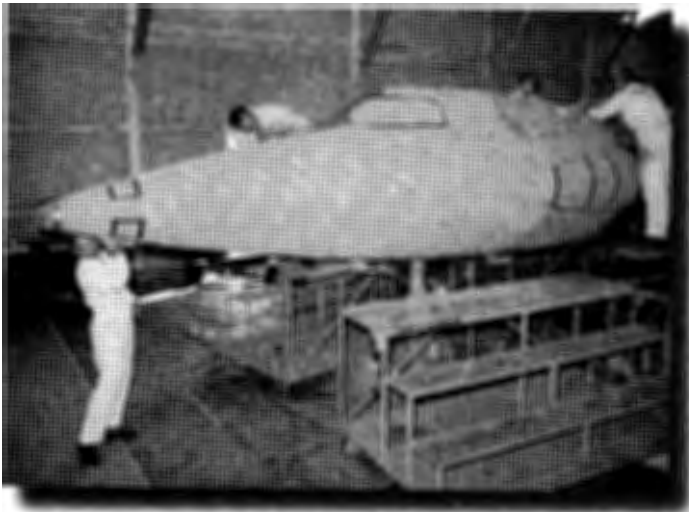
A: Well, they were fraught with little problem areas. As the envelope was expanded, things like structural damage, warping of leading edges of the wing—things of that nature—required little fixes here and there. Like the leading edge, for example; we put slots in and left a little gap there so that segments of the leading edge could expand without causing the leading edge to buckle. There were many little examples of that sort of thing. Although in the systems world, the problems



were because of the cryogenics. We had liquid oxygen and ammonia on board, both of which are very cold propellants. Whereas the structure suffered from heat, a lot of the systems suffered from the cold soaking. When you were carried up on the wing of the B-52, cold soaking would cause valves to freeze up and fail to operate. There were quite a few aborts and we'd come back home and redo the valves—redesigns in some cases; provide heaters in other cases, and that sort of thing. So there were quite a few little glitches that hampered the path to Mach 6 and 350,000 feet.

Q: The X-15 #2 was damaged in a landing accident. Following this the aircraft was modified. It was lengthened and external drop tanks were added. What do you recall about this specific vehicle and the operational and technical issues that arose?

The heat shield after it was applied to the X-15A-2. The coating would protect the aircraft's metal skin during the planned Mach 7+ speeds it would be subjected to. (E-16915)



A: Well, I was kind of in the thick of that. The fuselage was lengthened by about 29 inches, the intent being to provide room for a liquid hydrogen tank and a system to provide hydrogen to a scramjet. The scramjet design was in the making then, and Langley Field [now Langley Research Center] was up to their elbows in that one. The plan, of course, was that X-15A-2 would be outfitted with a scramjet to be mounted under the aft section in place of the lower ventral. As it turned out, the scramjet suffered greatly from technology development and that sort of thing and we never got around to flying a real scramjet, although we had the hydrogen system in the airplane. As we advanced beyond Mach 6 other things got in our way. We had some landing-gear problems. Due to stretching of the

fuselage the cables that operated the landing gear were now longer and so they didn't have quite the required allowance for expansion.

So we had several instances of nose-gear extension. We had a nose-gear extension at Mach 4 that so heated the tires that they just burst, and when we landed it looked like feathers hanging off the wheels. That sort of thing kept us on top of the engineering aspect of the thing. We worked, of course, with North American. A lot of the ideas came from our people, and North American developed the physical designs, which resulted in changes in the landing gear and other sorts of things. Our intention was to get to Mach 8. We finally got to 6.7 with the tanks and an ablative material, which we sprayed onto the aircraft and then painted it white.

We had trouble with the windshield cracking at the high temperatures. Also, when we put the ablative on we were concerned that perhaps during the ablative process the material would gas off and maybe cover with a film the windshield so the pilot wouldn't be able to see to land. The answer to that was to build what we called an 'eyelid.' We put this eyelid over one of the windows so that if for some reason the eyelid didn't work when you approached landing, hopefully you'd have the other glass clear. If the other glass was not clear you counted on the eyelid to open and give you at least one clear window. Those were the kind of things that stood in our way.

Q: Were the drop tanks ever an issue? In other words, you were at supersonic speeds when you dropped these large tanks.

A: We were at Mach 2 when we dropped the tanks. They were equipped with a rocket to separate them and they worked quite well, as a matter of fact. We were concerned at first, but of course we made a couple of flights with the tanks empty—at least one flight with the

tanks empty and jettisoned them at Mach 2 and they separated okay.

Q: Pete Knight made the Mach 6.7 flight and the X-15A-2 came back badly damaged. What are your recollections about this flight?

A: Well, that was the flight that we had a dummy model of a ramjet hanging below the lower ventral. I believe it was attached to the lower ventral directly—I'm not quite sure of that. But, in any case, it had this long spike. The shock off the spike contacted the aft fuselage and burned a hole in it, and along with that it caused severance of one of the hydrogen peroxide lines, so we had peroxide leakage in the back end also. That was the major damage that occurred on that flight.

Q: This was followed by the accident with X-15 #3 which killed Major Mike Adams. Although you weren't involved with that particular aircraft, what do you recall about those events?

A: Well, I was not the ops engineer for that aircraft. But we all shared different duties with the different aircraft, and I was involved in the control room monitoring and I was also involved in the accident investigation. My recollection in the control room was that there was a long period of silence when Mike was way up at altitude, and then finally transmission came through in a rather strained voice and he said, 'I'm in a spin.' There was not much that we could do in the control room. I believe Pete Knight was the mission controller for that flight and his response was, 'Watch your alpha,' [angle of attack] which was a big concern with that airplane as far as exceeding the alpha limits in getting the thing to flip. Well, it was already flipped, apparently, and it was in a flat spin.

Well, first of all, we didn't have any good information as to the flight path as it was descending in the spin. In fact, we didn't really know that it was a spin at the time. What we did was, with a large sort of a skirmish line we searched across the desert—the area where the fuselage impacted and where we calculated that the canopy might have been—and we came across the film cassette out of the gun camera that was in the cockpit. Using that film, which had a good view of what we call the 8-ball—the attitude indicator—the lab set up a model of the X-15 and, frame by frame, moved the model according to the dictates of the developed film out of the cockpit camera. What they got at the end was a picture of an airplane doing a flat spin not on a vertical line but on an angular descending line. So that confirmed that it was a spin.

I was part of the investigating team, and one of the interesting things that I think about right now as I'm talking is that here was a case of an accident causing a death of a pilot, and there was no major agency-wide investigation. The investigation was done solely within Dryden and local people. That was kind of interesting. It didn't make any impression at the time, but when you

Valentine's Day Dance Tomorrow; Buy Your Tickets Today!

The "Hearts A Go-Go" will be held at the Knights of Columbus Hall in Lancaster at 9:00.

Tickets are available from the following: Bobby Andrews, Della Mae Bowling, Betty Callister, Sandy Illian, Molly De Haan, Gertrude Kelly, and Boots McNally.

Tickets are \$1.75 per person.

Contrails:

The "Keep your powder dry award" goes to Scoutmaster **Bill Albrecht**, Flight Operations, for taking his Boy Scout troop camping at Morro Bay over the rainy Thanksgiving weekend. . . . Public Affairs Officer **Ralph Jackson** served as one of the judges for the Lancaster Christmas parade. . . . Former HL-10 pilot **Pete Hoag** has been transferred to Southeast Asia. **Jerry Gentry** will join him early next year. . . . The son of **Betty** and **Marvin Callister**, Flight Operations, has returned from Vietnam. . . . A visitor to the Center last month was **Al White**, first man to pilot the XB-70. . . . Two new research fathers are **Tom Sisk** with a baby daughter and **Don Berry** with a boy who has six older sisters. Keep swinging **Kolf**. . . . **Kenneth Szalai**, Flight Dynamics, received his Master's degree in mechanical engineering from the University of Southern California in December 1970. . . . **Terry Marshall**, Flight Mechanics, will wed **Kathy Baldwin**, a Lancaster school teacher, in April. . . .

think now of a rather minor UAV incident causing repercussions all the way to Headquarters and an intra-agency investigating team, why, it's quite different. It just indicates the difference in cultures between then and now.

X-15 DAMAGED AT MUD LAKE

On Friday, at 10:23 in the morning, November 9, 1962, the number Two X-15 was dropped from a B-52 launch aircraft 18 miles northwest of the dry lake called Mud Lake. This dry lake is close to the town of Tonopah, Nevada and is 190 miles from Edwards.

FRC pilot Jack McKay was at the controls for his seventh flight in the series of research flights that are being conducted with this rocket aircraft. After ascertaining that everything was ready, Jack McKay released from the B-52,

After the rocket engine was ignited, it became apparent to both Jack McKay and NASA 1, Major Robert Rushworth, USAF, the ground controller, that the engine was not advancing to full power. Reverting to alternate plans, the pilot shut down the rocket engine and prepared for a landing at Mud Lake. As the X-15 left its trail of jettisoned propellants in the air, it was joined by the number one and two chase planes piloted by two other X-15 pilots, Joseph Walker, NASA, and Major Robert

continued on page 3

This was not the first time that J McKay had landed at Mud Lake. Only days earlier, he had prepared for this possibility by flying a simulated X-15 landing pattern at Mud Lake in an F104 so configured so as to closely approximate the X-15 landing characteristics.

After touching down on the dry lake bed, the left landing gear collapsed causing the 14,000 pound aircraft to go into a left skid. This skid continued for about 2,500 feet resulting in the collapse of the nose gear and the right wing tip digging into the lake bed.

Sensing the complications that were about to arise, veteran research pilot McKay made a split second decision and jettisoned the canopy. Soon after the canopy was blown off, the aircraft rolled over and landed on its back.

As soon as the decision was made to land at Mud Lake, the emergency equipment began to put into operation the planned procedures for an event of this nature. Captain Paul J. Balfe, USAF, in an H21 helicopter took up a position that would enable him to remain as close as possible to the landed X-15. Aboard this helicopter was Dr. (Capt.) Lynn B. Rowe, USAF, the flight surgeon. From its orbit in between Mud Lake and Edwards, the USAF C-130 aircraft carrying a flight surgeon, paramedics, NASA X-15 specialists and a vehicle containing the necessary equipment for rescue, headed for Mud Lake.

Also on Mud Lake was a fire truck with 1,000 gallons of water to dilute and render harmless the various chemicals that are used in the X-15. NASA 8, a specially adapted jeep on the lake bed was manned by two NASA X-15 specialists, Robert Anderson and John Gordon, both Rocket Aircraft Technicians.

As the X-15 started to slide down the dry lake, the H21 helicopter landed next to the damaged aircraft and unloaded the first two men to reach the downed aircraft, Dr. Rowe and TSgt. Charles L.

Manes, USAF. They were soon joined by Curtis C. Lyons from the fire truck and the two X-15 specialists, Robert Anderson and John Gordon.

About three minutes after the X-15 had first landed, the C-130 aircraft, piloted by Captain Gay E. Jones, USAF, had landed at Mud Lake and its crew members were assisting in the rescue operations.

As the helicopter was hovering over the downed aircraft dissipating the toxic ammonia fumes, Jack McKay was being cut loose from the retaining straps that held him in his seat. Five minutes after the rescue personnel reached the pilot, Jack McKay was out of the airplane. He was assisted through an opening estimated to be no larger than 10 or 12 inches.

He was then taken to the hospital at Edwards Air Force Base where he remained under observation until Tuesday, November 13. After complete examination, he was found to have no serious injuries but painful bruises on his back.

The manner in which this whole rescue operation took place reflects highly the training and pre-planning that is necessary for the X-15 program.

ies pretty much—although there was a certain nostalgia that came to be in Dryden's culture then, and everybody that was associated with the program believed that it was a really successful program and they were happy about everything except for Major Adams.

Q: Overall, what do you see as the major operational challenges of the X-15?

A: Major operational challenges were dealing with cryogenics and dealing with the very hot and very cold—very hot outside, very cold inside.

Q: You then moved on to the YF-12A program. What were your specific duties?

Q: Or even the Apollo 1 fire a couple of months before.

A: Yes. That's right. Yes.

Q: What do you recall about the final year of X-15 flights before the program ended?

A: Well, X-15A-2 was still hoping to get a scramjet—at least I had hoped that they would still get it. We never even serviced the hydrogen system, although we had vacuum jacketed lines and all of the paraphernalia that goes with hydrogen in the airplane. As the time went on it became apparent that the scramjet was not going to appear. I think they were going to make the 200th flight and the program ended with the 199th, because the day of the 200th was a snowstorm, and as a result we didn't fly the 200th flight. And that's where it ended.

Q: What was the mood at the Center after the X-15 program ended? End of an era or eager to move on?

A: Well, there was maybe a little bit of both. At the time we were also involved more and more with lifting bodies. And of course that was looking to the future and they had been flying and producing results. People just turned their attention to the lifting bodies

A: Well, I was the ops engineer for one of the two YF-12s. My specific duties were those of the ops engineer—the care and feeding of the machine, the directing of modifications to create hardware to run the various scientific experiments that were planned for the airplane. I was also involved in the control room operations and played the part of controller sometimes—other times I was on one of the monitors.

Q: What were the operational and hardware issues with this program?

A: One of the issues that we came up against was measuring the thrust and things like that—getting the right kind of data. Again, we were interested in dealing with heat, although we did not have ablative material on the airplane itself. We did have an experiment; it was referred to as the ‘cold wall’ test, and it was a cylinder that was slung on a pylon on the lower center line underneath the belly of the airplane. It had a coating of ablative material and a nose cone of ablative material, and it was equipped with pyrotechnics to blow that covering off. It was chilled with liquid nitrogen on the ground before takeoff, and the liquid nitrogen was put inside the cylinder. After takeoff and achieving the Mach 3 speed the ablative material was blown off and instantly exposed the super-chilled cylinder to the heat of Mach 3. And of course data was taken at that time. I have no real idea just how successful the data gathering was and what all it meant to the future, but as far as the experiment, the physical aspects of the experiment, it worked pretty nice.

Q: The YF-12 took a lot of preparation. It was a very specialized aircraft. What do you recall about this?

A: Well, so did the X-15 and so did the lifting bodies. I don’t think there was any surprise to the Dryden people, certainly not to the mechanics and the crew chiefs that tended the Blackbird. They were dealing with similar things that were dealt with in the X-15 as far as hot structure and so forth. I don’t think that that was really a very big problem. We understood what it took to service complicated vehicles and, of course, the Blackbird had been flying for some years and they weren’t really experimental. The equipment that we applied to them was experimental but the airplanes were not, really. One thing that comes to mind on the YF-12A—we did over-stress it in a sideslip and we broke the lower ventral. The YF-12 had a ventral that folded to land and, of course, it was extended in flight. And we broke that thing badly and that was kind of a lessons-learned sort of thing.

Q: One aspect of flight research that tends to be overlooked is the contributions of the people on the ground. As you said, these vehicles require a great deal of preparation. Could you give some examples of these kinds of contributions by the crew chiefs and the mechanics?



Mike Adams and the X-15. (E-1651)

Final frames from the cockpit camera as X-15 #3 broke up in flight.



Ramjet Contract

Awarded For X-15

The National Aeronautics and Space Administration has selected Garrett Corp., Los Angeles, Cal., for negotiation of a contract to design and develop the engine for NASA's Hypersonic Research Engine Project.

The contract is for approximately \$15 million and calls for final design, development, construction and testing of small research ramjet engines. The engine will have a design weight limitation of 800 pounds with dimensions compatible with mounting it beneath the aft fuselage of the X-15 No. 2 airplane.

Liquid hydrogen fuel is specified for the research engine which must be capable of operating at flight speeds between Mach 3.0 and 8.0 (2,000 to 5,000 miles per hour). Mach 1 is the speed of sound.

The contractor will be required to deliver the first flight engine to NASA within 29 months.

The ramjet engine differs from current aircraft engines, such as the turbojet, in that there are no rotating parts. It must be in motion through the air to begin operation. Operation depends on air being rammed into the inlet. Fuel is introduced into the internal air flow to add energy through combustion. The expanded gases are released through a nozzle to provide thrust.

Because of their fuel economy at hypersonic speed (above 3,500 mph), ramjet engines are expected to be useful for hypersonic transport aircraft, boosters, and for spacecraft flying within the atmosphere.

Garrett was selected for this second phase of the Ramjet Project on the basis of its nine-month preliminary design study completed under Phase I. Two other companies participated in the nine-month competition -- General Electric Co., Cincinnati, and Marquardt Corp., Van Nuys, Calif.



The X-15A-2 after Knight's Mach 6.7 flight. Unexpected heating burned through both the spray-on heat shield and the metal fuselage. The vehicle never flew again. (ECN-1834)

Center To Participate In NASA Ramjet Program

A new research project to study the feasibility and design concepts on an advanced hypersonic ramjet engine is being organized by the National Aeronautics and Space Administration. The Langley Research Center will have direction of the initial phases of the program with support from the Flight Research Center, Lewis Research Center and Ames Research Center.

The project seeks the eventual construction of a scaled research ramjet test engine as a means of advancing the technology of air-breathing propulsion.

The main object of the project is to determine the potential of the ramjet as a propulsion system for hypersonic -- more than five times the speed of sound -- flight missions. The ramjet powerplant is expected to be useful for the hypersonic transport aircraft, boosters and spacecraft while flying within the atmosphere at these speeds. Many engineers and scientists foresee great advantages in the use of ramjets at hypersonic speeds because of reduced weight and improved flight efficiency.

In its simplest form, the ramjet
(Next column)

has no moving parts. Unlike the turbojet which has a mechanical compressor, the ramjet compresses air by ramming it into the front of the engine at high speed. Burning fuel is added to the compressed air and expands through the tail pipe to produce thrust. The ramjet operates most effectively in the hypersonic speed ranges.

The NASA project will probably use hydrogen as a fuel. It will be concerned with supersonic as well as subsonic burning, and will provide information on ramjets operating in a speed range from Mach 3 upwards in the hypersonic range.

NASA engineers expect the project to provide much of the technology necessary for eventual development of a practical engine. The first phase of the work will be concerned with study, fabrication and experiments with small laboratory equipment. Later phases include actual flight tests on the X-15 at speeds possibly as high as Mach 8. This phase of the program will be managed by the Flight Research Center. A model of a typical ramjet was mounted on the X-15 #2 for display to the President.

A: Well, in addition to crew chiefs and mechanics you should also include avionics technicians. We've had a lot of contributions by all of those people. Here's one example from one of our avionics techs. He wrote me a little letter and he said, 'The B-52 typically experiences relatively long periods of time between flights or engine runs. Normally during these times external power is applied to the aircraft for long periods of time for maintenance operations. Due to the increasing difficulty of procuring spare parts for [B-52] zero eight, I recommend the following circuit breakers be pulled during post-flight procedures to lessen operating time on unused systems....'

Anyway, the suggestion here was to pull the circuit breakers after a given flight if you weren't planning to use these systems for post-flight or any other checkout during the long

X-15 Number 2 Repair And Modifications Announced

Repair plans for the X-15 number 2 that was damaged last year during a landing at Mud Lake, Nevada were announced by NASA last week. Not only will the research aircraft be repaired, but additional modifications will be made that will extend the speed capability. This will be the first major modification in the X-15 configuration since it was designed.

The contract for the work was given to North American Aviation

by the USAF Aeronautical Systems Division and amounted to about five million dollars. Delivery of the aircraft to the NASA Flight Research Center is expected in February, 1964.

The main reason for the decision to repair the aircraft was based on the needs of the research program. It was also decided that it was possible to make some modifications to the X-15 that would

(Continued on page 2)

also increase its utility for conducting aerospace and aeronautical experiments.

The major modification to the aircraft is the addition of two drop-pable propellant tanks that will increase the propellant capacity of the X-15 by 13,500 lbs. The X-15 now carries about 18,000 lbs. of ammonia and liquid oxygen. This increased propellant supply will increase the engine run time to approximately 145 seconds in comparison to its present time of 83 seconds at full throttle. The added engine time will theoretically raise the X-15's speed capability to about 5300 m.p.h. or eight times the speed of sound. However, structural and aerodynamic heating restrictions may lower the actual speed increase. The present maximum speed of the X-15 is 4104 m.p.h.

As yet, the operational procedures for recovery of the external tanks that would be jettisoned from the X-15 in flight have not been finalized. A parachute-type device is under consideration.

Additional work is being performed to accommodate the increased heating. An ablative material that dissipates heat by burning itself up, will be used on some parts of the X-15.

Consideration is being given to the possibility of testing ramjets with the X-15. Various ramjets, jet engines that depend on air compressed by high speed flight, could

be attached to the lower portion of the vertical tail and be tested in flight.

Physical changes to the aircraft include the strengthening of the landing gear which will make the X-15 stand 19 inches higher on the ground. It will be lengthened 29 inches with the installation of two 50 gallon spherical tanks in the fuselage. These tanks will be used for the storage of fuel for use in the anticipated ramjet study.

Modifications are also being made for the installation of camera equipment for use in the star tracker experiments that will be performed in the X-15.



THE WHITE KNIGHT WITH MATCHING AIRCRAFT AS SEEN BY CENTER ARTIST, LEE LYTTON.

interval sometimes between flights. During those periods of time, power would be on the airplane and you'd be running amps through some of these systems—an example is engine oil pressure indicators, fuel flow indicators, the aileron trim, bleed air manifold pressures—a whole bunch. So we acted on that recommendation by this electrician and we've saved a lot of time being inadvertently put on systems that were just idling while you were checking other things. That's just one example.

There were lots of examples. During the X-15 program the canopy was so designed that if the pilot landed and was somehow disabled—it was a crash landing or something like that—if the crew hastily flipped up the canopy and a certain hose had not been cut, then the incapacitated pilot's ejection seat might be launched inadvertently.

So a suggestion had been made to provide some sort of a guillotine device in the back end of the canopy that could be operated externally by a lever and would cut the hose. This would prevent an inadvertent ejection of the pilot. We built that guillotine device into the canopy and we used it a couple of times when the pilot couldn't get out of the airplane for some reason—like the canopy was stuck and we had to pry it or something like that. We'd cut that hose to begin with, just to make sure. Those are the kind of things.

Most of the things that come from the shop people were to help you to improve the safety of the crew. Special tools—every mechanic has special tools which he built for his own use, inventions, basically, to accomplish even a very small procedure that engineers write into the books but they don't tell you how to actually do it. So there are a lot of special tools and things like that. Yes, we depend a lot on input from the technicians.

Q: Dryden also has extensive shop facilities. Could you give some examples of their contributions—equipment that was fabricated in-house rather than by a contractor?

A: The shop technicians do their share in making suggestions. Quite frequently a design appears in the machine shop or the metal shop created by some engineer who has the right idea in mind but calls for blind holes and things like that that cannot be fabricated. The shop contributes heavily in that sort of thing. They will come back with, 'Hey, why don't we make it like this.' Almost invariably the engineer says, 'Hey, not a bad idea. Let's do it that way.'

Q: I'm sure there have been many characters over the years among the ground personnel. Could you provide examples?

A: Well, one of the characters I remember was Duke Littleton, who was the crew chief of the X-15 #3. One of his hobbies was to keep rattlesnakes. He kept them in his garage in cages, but he'd occasionally go to the local pet store and buy a little white mouse for food for his snakes. He'd buy several of them sometimes. After several months of this he showed up at the pet shop again and he said, 'I'd like to buy two more of those

little white mice.' The clerk at the store said, 'You must have a lot of white mice by now. What are you doing with them?' He said, 'Oh, I just feed them to my rattlesnakes.' And, of course, the clerk was irate and he wouldn't sell him any more mice. But Duke was kind of a character.

Q: When I talked to you earlier you commented that you 'manage programs rather than people.' Could you give some examples of this, such as situations that developed, how you've dealt with them and the lessons learned?

The forward fuselage of X-15 #3 in the desert northeast of Edwards. (E-17845)



A: Well, I don't manage programs—I manage operational issues that are created by the programs or that accompany programs. The programs are managed by Code P, which is the projects organization. Their managers really manage the programs and they're responsible for them. They look to Operations for guidance with regard to safety issues, how to get things done, and so forth. That's the area that I have some interest in. But I don't manage programs per se.

Q: Could you give any examples of situations and how you dealt with them?

A: Well, let's jump back to the X-15 for a little bit. We had this problem with the landing gear and the nose gear extending at high Mach number and, of course, creating a severe hazard for recovery because, first of all, you didn't know what all was going to melt inside the nose wheel well from the heat. The tires didn't exactly melt but they were destroyed. They were incapable of operating as tires. When the first event like that occurred there was, as you can imagine, a lot of concern and a lot of theories and so forth. The initial theory was that somehow the forward lip of the nose gear door had extended downward enough to catch the airstream and the airstream opened the door. I maintained that the lip did not scoop up air—that the door operated as a kind of a compound bar because the inner skin was aluminum and the outside skin was Inconel. It operated as a compound bar and bowed so that in the center where it was being held by the up-lock hook, the door was bowing out and it unhooked, and that's what dropped it. Once we demonstrated that in the loads lab, the fix was sort of simple—a stronger hook, some spring load in the hook, which we added with cone washers that operate like a spring. That seemed to fix it. But that's the kind of thing where Operations was able to come to the aid of the project.

Q: So, in other words, the Inconel stainless steel and the aluminum had different expansion rates. So one expanded more than the other and created a bend that triggered all these events.

A: Right. The bowing of the door put a load on the up-lock hook sufficient to open the hook and drop the gear. The Inconel expanded and was hot and the inner skin that was aluminum was cool and didn't expand as much.

Q: All right. Well, thank you very much.

Newspaper Quotes

No news media likes to make a mistake; all hate to admit it. But the following clippings indicate somebody "goofed" somewhere.

From the Los Angeles Times, August 4, 1962:

"The first report was electrifying.

"An X-15 rocket plane had landed on Sepulveda Blvd., near the old San Fernando Mission.

"Sirens screamed and newsmen raced for the scene.

"It was an X-15 for sure--the first of three research craft that have been topping speed and altitude marks out of Edwards Air Force Base.

"But it was lashed to a truck that was returning it to the North American Aviation factory for modifications.

"The confusion came when a California Highway Patrol escort was relieved by a Los Angeles police escort.

"Someone reported there was an X-15 'down' on Sepulveda Blvd.

"He forgot to mention that by 'down' he meant truck-borne on Sepulveda, not crashed."

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If you are ever down in Houston, Texas, you might visit the Bellaire movie theater. They have a wonderful "Triple Horror Show."

From the Houston Chronicle, August 1, 1962:



The United Press International sends out their stories by teletype. Perhaps the teletype operator couldn't find the "r" button.

From Matt Weinstock's column in the Los Angeles Times, August 9, 1962:

"In his recent 59-mile-high flight in the X-15, Maj. Bob White encountered yawing, a side to side motion, and last week, pilot Joe Walker went up in another X-15 equipped with automatic control equipment to check this problem.

"Reporting this flight, UPI referred to it as an "udder-flapping test," which fascinated Jim Wales. He thought the cow had already jumped over the moon."

Ill-fated Duck Pass Veterans Reach New Lows in Exploration

ORGAN MUSIC UP, then UNDER. ANNOUNCER: As we left our intrepid explorers, all veterans of the Ill-Fated Duck Pass Expedition, they were sinking to a new low in the investigation of geomorphological phenomena.

Albrecht had even brought one lone ski pole as a means of defense against the lurking unknown.

As you may recall, this brave outfit was nearly stranded when they woke up "deep in snow, in the wilderness at Duck Pass."



Ill-Fated Duck Pass Expedition Members Albrecht, Ayers, Capasso and Layton.

Yes, leaving kith and kin behind, and forgetting the lessons of past adventures, our heroes, Bill Albrecht, Ted Ayers, Vince Capasso and Gary Layton descended deeper into the waiting abyss of the (Music Up) GRAND CANYON!

Yes, it was a cold day in mid-February but the group was well-prepared for the decent. Bill Al-

according to Layton. Well, the Duck Pass Expedition has been exhonored. They actually did find the bottom of the "bottomless" Grand Canyon.

And, they have a word of advice: "Do it in the winter, it's duck soup." MUSIC UP, then UNDER. ANNOUNCER: Now a word from our sponsor...



AFTER ALMOST A FULL WEEK OF CANCELLATIONS DUE TO BAD WEATHER, PROSPECTIVE X-15 PILOT MIKE ADAMS IS PREPARED FOR ALL EMERGENCIES.

Mike Adams' First X-15 Flight Planned

Major Mike Adams was scheduled to make his first flight in the X-15 this past week and to become the 12th man to pilot the aircraft.

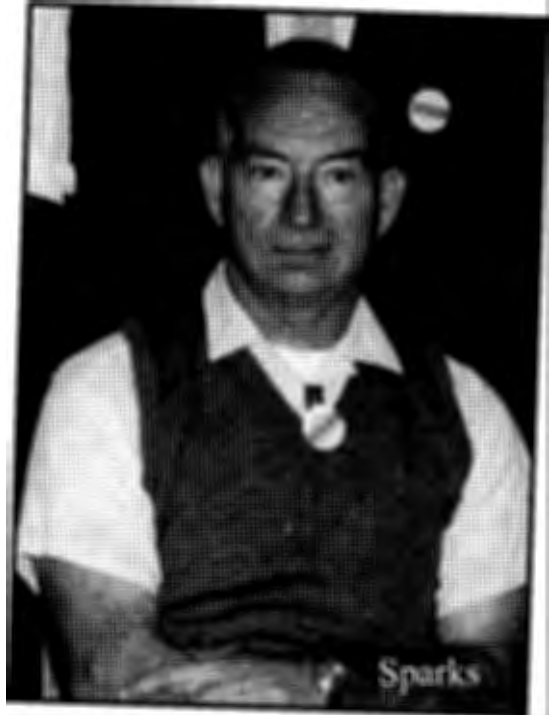
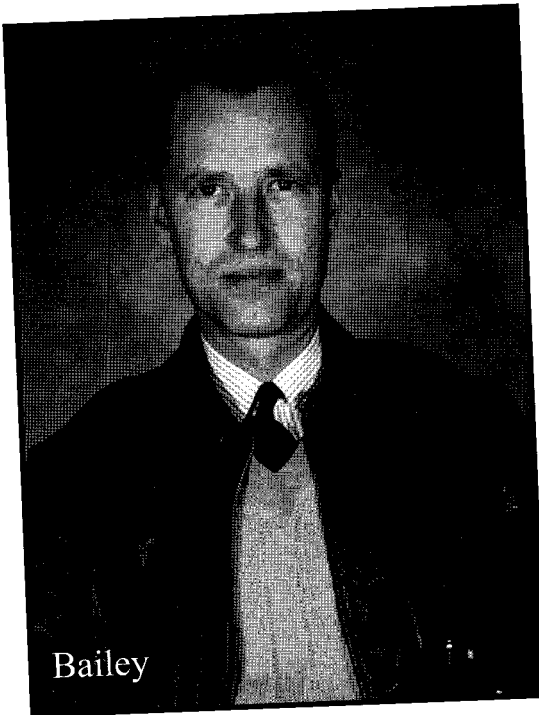
The flight had been postponed several times earlier due to adverse weather conditions.

The flight plan called for the 36-year-old pilot to be launched near Hidden Hills, a dry lake bed on the California - Nevada state line. After launch, he was intending to reduce power and climb to 74,000 feet where he would perform several moderate maneuvers

to better acquaint himself with the behavior of the X-15. Planned maximum speed was approximately 2700 miles per hour.

Major Adams was selected for the X-15 program last spring following the transfer of Capt. Joe Engle to NASA's Manned Spacecraft Center, Houston, Texas. Formerly assigned to the Air Force's Manned Orbital Laboratory program, Major Adams requested and was granted release to transfer to the joint NASA-USAF X-15 research program.

Clyde Bailey and Ralph Sparks



Interviewed by Dr. Michael Gorn
March 30, 1999

With a top speed of Mach 6 and a maximum altitude of 350,000 feet, the X-15 required a new approach to the traditional research-flight profile. Previous rocket aircraft, such as the X-1 series, the D-558-II, and the X-2, had been launched in the vicinity of Rogers Dry Lake. If the pilot was unable to start the aircraft's engine or if the aircraft suffered some other malfunction, he could jettison fuel and glide to a landing on the Rogers lakebed. If the rocket ignited as planned, the pilot would fly the research profile, and glide back to Rogers. This permitted a safe recovery at any point in the flight.

With the increasing speeds reached by research aircraft, however, flights could no longer be accommodated within this localized area. At Mach 3, it was barely possible for the X-2 to be launched within glide range of the Rogers lakebed, fly the research mission, and still return to land at Edwards Air Force Base. The fatal crash of Captain Milburn "Mel" Apt on the X-2's final flight in 1956 was the result of his immediately turning back toward Rogers, apparently believing that if he did not do so, he would be too far away to reach the lakebed. The turn was made at a speed of Mach 3 and resulted in inertial coupling, which sent the aircraft out of control.

The Mach 6 speed of the X-15 resulted in development of an altogether different profile, one that would allow pilots to take advantage of the numerous dry lakebeds scattered across the deserts of California and Nevada. The X-15 would fly a straight-in approach. The vehicle would be dropped over a lakebed several hundred miles uprange from Edwards. If the rocket failed to ignite or if it shut down early, the pilot would glide to a landing on the nearby lakebed. If the problem appeared at a later stage of the engine burn, the pilot would land at one of several lakebeds farther downrange. The specific lakebed utilized depended on the flight plan, the burn time, and the X-15's speed when the failure occurred.

For Joe Walker's maximum altitude flight of August 22, 1963, on which he reached 354,200 feet, the "drop lake" was Smith Ranch in Nevada. In the event the engine failed to ignite, or should a problem occur in the first 44 seconds of the burn, Walker was to land back at Smith Ranch. If the failure occurred between 44 and 62 seconds, he would land at Mud Lake. Grapevine Lake would be used in the event of engine problems from 62 to 78 seconds into the burn, and Cuddeback Lake if problems occurred between 78 and 81 seconds. Should engine shutdown occur after 81 seconds, the aircraft would have enough energy to reach Edwards. This multi-lakebed strategy offered the advantage that whenever a problem might occur, the X-15 pilot would have a lakebed available for an emergency landing. Despite such a wide range of landing options, however, in-flight problems still constituted emergency circumstances.

The most serious landing accident involved NASA pilot John B. "Jack" McKay on November 9, 1962, in X-15 #2. After launch, the engine produced only 35 percent thrust at full throttle. McKay shut down the engine and jettisoned fuel in preparation for landing on Mud Lake. As he was about to touch down the flaps failed to extend, resulting in a high-speed landing. This proved too much for the left landing skid, which collapsed. The left stabilator and left wingtip dug into the lakebed surface and the X-15 began to turn sideways. McKay realized that the aircraft was about to flip over and jettisoned the canopy so he could get out once the X-15 stopped. McKay suffered several crushed vertebrae, leaving him an inch shorter in height. The X-15 #2 was badly damaged by the rollover. McKay returned to flight status and made 22 more X-15 flights, though the injuries he suffered in the crash landing eventually forced him to retire. X-15 #2 was rebuilt as the X-15A-2, which was intended to be used to reach Mach 8 and test a scramjet engine.

McKay's hard landing was the exception. Other emergency landings on the downrange lakebeds resulted, at most, in only minor damage to the X-15. The biggest challenge was returning the X-15 to Edwards. The aircraft had to be partially disassembled, loaded onto a large flatbed truck, and driven across Nevada and California to Edwards. Like the Mach 6 flights, these road trips could be adventures.

SPARKS: Whenever X-15 landed up in Nevada, it would be my job to get it back. Clyde and I'd go up there and finally get it loaded onto a flatbed and haul it back. One time, we had come down through Death Valley in the middle of the afternoon. Some of the escort cars were running out of fuel, so we stopped at Death Valley Junction. I told the guys, 'Go on in and have a cold one, and I'll put gas in all the vehicles out here.' So a big black Cadillac pulls up. The guy jumps out, raises the hood and—he's got a suit coat on—and starts taking the radiator cap off. The service station man yells at him, 'Don't do that! Don't do it!' So the guy turns around and looks at him and still takes it off. That rusty anti-freeze went all over him and his black car. I think he was burnt pretty bad, but I didn't get to stay around there. I got gassed up and got back on the road. Those were hard times. This tractor truck that we used couldn't make it over the mountains without overheating, so we put a 15-gallon barrel behind the cab, filled it with water, put a pump in it, and sprayed water over the radiator.

The X-15 wing following the accident. A large scrape is visible through the letter 'F.' Score: X-15, 1, camper, 0. (E-15346)



BAILEY: [One time] Sparky and I were bringing the X-15 back from Mud Lake. That was one of our emergency landing sites. We're coming back [with a] 40-foot flatbed and the X-15 on top of it. I'm riding in the back in another vehicle with radio control so I can talk to Sparky and the guy up ahead. This car was barreling along, headed in our direction. I'm off on the left-hand side of the road to stop this individual, but it wouldn't stop. It was a camper and went underneath the wing of the X-15—so it sliced the top off the camper. And this guy went on into Tonopah. Well, we waited for awhile on the side of the road and pretty soon, the Highway Patrol came out there.

SPARKS: They arrested me.

BAILEY: They said, 'You hit another automobile—you hit an automobile with a camper.' These people didn't come back, just the cops. So we told them we were government.

'Send us the information; we'll take care of it.' So, about two or three days later, I got a call from these people in New Jersey. What had happened — they had rented this unit over in L.A. at the U-Rent-It, and they went camping and so forth. The woman was driving, and she drove under the wing of the thing. And this [the wing] was Inconel X; there was no way you could damage this thing. The man said, 'My wife was driving.' He said, 'Do you realize that you ran into our camper? It took the whole roof off.' He said, 'What are you going to do about it?' I said, 'Well, I'll tell you what. You ran into a \$70 million dollar airplane.' He said, 'That's okay. That's okay.' And he hung up. That was the end of the conversation.

Sparky and I were cruising along—we tried to stay on government roads, like go through Death Valley and government reservations, and so forth—and we're cruising along about 70 miles an hour with this airplane on the back of this thing. All of a sudden, this F-104 comes over the top of the hill right across us, barrels on around. Joe

Walker [radios us and] says, 'How fast are you guys going?' I said, 'I don't know. We're probably cruising 50.' [Walker responded] 'Like hell you are! You're doing 70 miles an hour.'

SPARKS: We were bringing the X-15 back from being overhauled out at North American [Aviation, in Downey, California]. At that time the [14] freeway was partially in but, of course, we couldn't go on the freeway; we had a wide load. So they [the California Highway Patrol] ran us up the old Highway 99 to cut across, and we came in over at Frazier Park. We stopped and had coffee at Frazier Park, and the California highway patrolman came over, and he says, 'Can you drive a little faster?' He says, 'I'm supposed to be off duty, but I got another appointment.' I said, 'Well, I was thinking about doing 70, maybe 80.' And he said, 'Well, you just put it down on your pad; I'll stay in front of you.' Well, we came in Highway 138 and one of the Southern California Edison people recognized us. He knew I was probably involved, and he came over and talked to me that night about it. He said, 'God! You guys were moving!' We had a big, old diesel we borrowed from the Air Force, and that thing really wanted to get hot and going.

BAILEY: We stayed at some pretty fancy-type places. We stayed at a hotel in Tonopah. It was three or four stories high. The emergency escape system, if you had a fire, was the center of every floor was cut out about six feet in each direction, and it had a 2x8 [inch board] laid across the rails on both sides and a rope. So if the place caught on fire, you crawled out on the 2x8, grabbed the rope—it had knots in it so you wouldn't slip—and let yourself down to the first floor. Talk about unclean conditions.

[Tom] Raczkowski and I were sitting, having dinner there one day, and this great big, mangy dog comes out from the kitchen, comes right on over, and as Radz and I were watching, watered Radz's leg.

From Mud Lake to Edwards is Long Hop

Take one powerless X-15, a host of recovery personnel and equipment, a 335-mile trek across some of Nevada and California's most historical terrain, and you have an interesting account of the problems involved in bringing back the X-15 when the engine fails to operate.

Last week, for the first time since the project began almost three years ago, the X-15's engine malfunctioned after launch and the pilot, Pete Petersen, set the research vehicle down on Mud Lake, near Tonopah, Nev.

Fortunately, this possibility had been foreseen by project officials, and an emergency crew was waiting on Mud Lake. However, there still remained the problem of getting the X-15 back to Edwards.

Necessary recovery equipment was flown to the scene and a crane was brought from nearby Nellis AFB. Friday morning, a day and a half after the emergency landing, the caravan was on its way back, traveling down Highway 95 to Beatty then through Stovepipe Wells, Emigrant Gap, Trona and Johannesburg.

Since the California Highway Patrol decreed the X-15 couldn't travel after 4 p.m., the crew spent the night in Trona, arriving at Edwards on Saturday before noon, apparently none the worse for wear.

NASA photographer Gene Childress accompanied the caravan, recording the photographs with this article.

Petersen? He was back at Edwards in an Air Force C-130 shortly after the landing. Incidentally, this was scheduled to be Pete's last mission in the X-15 since he is due to report to Miramar Naval Air Station in San Diego next month. However, there is a possibility he may get a sec-

(Cont. page 4)

Mud Lake

ond chance, provided the No. 1 X-15 can be readied for flight prior to Feb. 1.

Personnel associated with the X-15 project threw a stag party for Petersen in Rosamond following his "record" three-minute flight. As a going-away gesture, he was presented with a movie camera, projector and screen.



Return of an X-15 from Mud Lake. (E-7814)



Getting an X-15 back to the Flight Research Center after an emergency landing on a remote lakebed was an adventure. Pictured are a few of the sights and interesting people recovery crews met along the way. (Top to bottom, E-7817, E-7816, and E-7850)



"Use or Lose" Leave Reminder

Federal leave policy provides that annual leave can be accumulated to a maximum of 30 days (240 hours) which can be carried over from one leave year to the next. Balances in excess of the above will be lost as of the end of the leave year.

Thought For The Day....

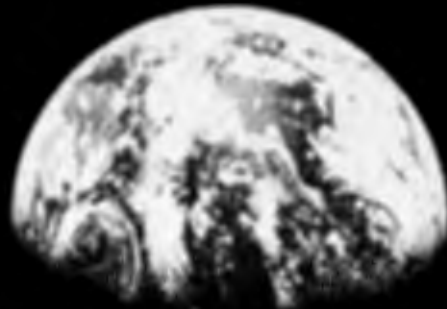
(from Flight International)

In view of the plans for a Mach 3 supersonic airliner, the traditional military lead in speed performance may be usurped by the airlines. Pilots are now saying that they get their Mach 1 pin in the F-100, their Mach 2 pin in the F-104 and that they will get their Mach 3 pin in economy-class with TWA.

-2-



Section II



A Man on the Moon

The U.S. program represented the same mission as the Flight Research Center during the 1950s: a series of often risky, and expensive, test flights. Unlike the FRC's identity had become linked to the X-15 program. Located in California, the center also was isolated from the rest of NASA, and moreover, where else, as well. When President John F. Kennedy announced the goal of landing a man on the moon, this became NASA's primary objective. Other activities, such as astronomical research, would become secondary. On its surface the Apollo program had nothing in common with traditional FRC aeronautical research activities. The Apollo capsule made a ballistic re-entry and splashed down in the ocean under parachutes. The crew was rescued by the U.S. Navy. This was in contrast to the conventional aircraft approach of X-15 flights, which ended with a landing on a lakebed runway, after which the rocket plane was towed back to the hangar by a ground crew. Despite this contrast, the FRC was to play a key role in the Apollo program.

Among the many demands facing the Apollo astronauts was final touchdown on the moon's surface. The Lunar Module (LM) would land in a vacuum, rendering wings and parachutes useless. It would use rocket engines for lift and steering. Additionally, the LM would operate in a gravitational field one-sixth that of Earth. How were astronauts to be trained for such a mission? Various means were proposed: helicopters, a tethered vehicle, and even ground-based simulators.

What the FRC proposed was an effort that would represent the marriage of its traditional flight research role with the new demands of a lunar landing. The craft that resulted was the Lunar Landing Research Vehicle (LLRV), an assemblage of pipes, rockets, and a jet engine that was less like an airplane than a flying steam calliope.

NACA 33 - Edwards Rocket Base 1 (two innings)

In a game that saw 26 men go to bat in the first inning--the first 13 men scoring--and 17 men in the second inning as the boys really teed-off on some slow-ball pitchers, the NACA wrapped this one up in a hurry. By mutual agreement, the game was called and forfeited after an hour and a half. The same team that had lost only 4-1 to North American two days earlier just couldn't find the stopper as the NACA pounded out some 26 hits, including a number of homers and triples.

North American 9 - NACA 8

In a good, close ball game--the lead was either tied or exchanged six times--that was highlighted by a top-of-the-seventh NACA two-run rally, making the score 8-7, the NACA lost its second game of the season as NAA scored 2 runs in the last of the seventh to win 9-8. Bryant, Holleman, Musick, and Pen-gilley, along with others, did well at the plate. Bill Furr, the losing pitcher, was relieved by Jim Newman in the seventh.

SIDELIGHTS: Leading extra-base slugger so far is Bryant with 3 homers, 1 triple, and 5 doubles in 18 times at bat.

WANTED - To join car pool from Lancaster, vicinity of 3rd Street East and Avenue I (Tamarack Fair). Contact Paul Werve, ext. 41121.

LLRV Ejection Seat Undergoes Testing

Leaping up in the air from a cloud of smoke and belching fire out of its seat, a human-sized dummy was catapulted up last week in a demonstration of an ejection-seat system. Built by Weber Aircraft Corporation, the ejection seat will be used in the Lunar Landing Research Vehicle that will be delivered to the Center this spring.

The demonstration dramatically showed the zero speed-zero altitude capability of the system. From a stationary position on the ground, the dummy was lifted to a high enough altitude that enabled him to separate from the seat and allowed his parachute to open fully. He then descended slowly to the ground.

The whole time sequence was less than a minute.

MORE ADDITIONS...

To FRC's still-growing staff include Hal Pittman and Dorothy Baie, both assigned to Data Systems Division, and Ronald J. Wilson, now with Flight Operations.

IBM 704 NEAR READY...

Vince Marcalus, head of the Programming and Data Processing Branch, reports installation of the IBM 704 machine is near completion. FRC is expected to accept the 704 within the next two weeks...(X-PRESS hopes to prepare a feature article on the 704 for the next issue.)

FIRST CHILD...

Genevieve and Earl Montoya (Manned Flight Control Branch) are beaming over their first child, Kevin Joseph, born Feb. 19...Kevin came in at 5 lbs. 3 oz. and was 19" long.

Bell Studying Simulator

Results are expected next week from Bell Aircraft Corp. concerning the design and development of a lunar landing simulator to be used in conjunction with Project Apollo.

FRC recently awarded Bell a \$50,000 study contract to submit a proposal for such a simulator. Results of the study will be incorporated in a proposal being prepared by Hubert M. Drake, Advanced Projects Office, which will be presented to NASA Headquarters and Manned Spacecraft Center next week.

Donald R. Bellman, head of the project, Lloyd J. Walsh, contracting officer, and Gene Matranga, aerospace technologist, recently returned from the Bell Corporation in Buffalo, N.Y. where they discussed the contract and design concepts for the simulator.

Lunar Research Vehicle Engine Tests In Progress

A CF700 turbofan engine has begun a series of vertical test runs at the General Electric plant in Lynn, Massachusetts in preparation to being installed in NASA's Lunar Landing Research Vehicle with minor modifications, this is a basic J85 turbojet engine that delivers slightly over 4,000 pounds of take-off thrust.

The engine will be delivered to the Bell Aerosystems Company who is prime contractor on the Lunar Landing Research Vehicle. This engine will be used to provide vertical lift equal to five-sixths of the vehicle's gross weight. By counteracting the portion of the earth's gravity represented by weight, a comparable effect of the moon's gravity can be simulated.

The lift for the remaining portion of weight will be provided by small rocket engines, similar to those employed on the X-15. These will be pilot controlled.

Delivery of the vehicle to the Flight Research Center is expected in the Spring of 1964.



Hubert M. Drake

Interviewed by Dr. J.D. Hunley, April 16, 1997

Among the programs with which Hubert M. "Jake" Drake was involved were the early work on what became the X-15 and the Flight Research Center's Apollo lunar landing effort. When the possibility of building a hypersonic research aircraft was first raised within the NACA in late 1951 and early 1952, the different NACA centers responded by making their own studies of potential configurations. The most advanced of these was done by Drake and L. Robert Carman, at the High-Speed Flight Station.

Unlike the other studies, Drake and Carman looked not only at an initial research aircraft, but also at a complete five-phase hypersonic research program that would lead to development of a winged orbital spacecraft. One concept they envisioned was of a large launch aircraft powered by five large rocket engines. Carried on the launch aircraft's back would be a smaller research aircraft with five smaller rockets. The combination would take off and climb to the planned launch speed and altitude. The smaller vehicle would be released to conduct its research mission.

Their report was submitted to NACA Headquarters in August of 1953. Dr. Hugh L. Dryden, the NACA director, and Gus Crowley, one of his deputies, rejected the proposal as too futuristic. In retrospect, the concept was beyond both the technological state of the art and the political realities of the time. But their concept of a two-stage winged vehicle would continue to influence ideas about reusable space vehicles. Years later, the shuttle concepts of the late 1960s and early 1970s would be very similar to the vehicle



Don Bellman (right) was the LLRV program manager. Bellman, Ken Levin of Bell Aerosystems (center), and Flight Research Center Director Paul Bikle examine an early-concept model of the ungainly craft. (E-8679)

that Drake and Carman had imagined nearly two decades before. Their idea of a multi-phase effort to achieve piloted orbital flight reflected the conventional wisdom of the time, which held that spaceflight would be an extension of aviation.

This perspective was reflected in the “round 1, 2, and 3” program concept. Round 1 was the X-1, D-558-II, and X-2 research airplanes, the X-15 would be Round 2, carrying a pilot to the edge of space, while the Round 3 X-20 Dyna-Soar would achieve orbital flight. Inherent in this approach was the implication that human spaceflight was a distant possibility, and in such a scenario it would take a great deal of time to develop, test, and fly each vehicle and repeat the process for the next step toward space.

The process by which humans became a space-faring civilization, however, turned out very differently, both in terms of technology and in the time frame required for success. Small, simple capsules became the vehicles that first took humans into space, launched using converted ballistic missiles. The time frame would not be one of decades, but rather of only a few years. The launch of the Soviet satellite Sputnik 1 in October 1957, followed by the orbiting of cosmonaut Maj. Yuri Gagarin in the first piloted spacecraft, Vostok 1, in 1961, accelerated the process. Faced with the Soviet Union’s lead in space, and the resulting political climate in the United States, President John F. Kennedy decided that America would have to directly challenge the Soviets in space. He chose a goal of landing a man on the moon within the decade of the 1960s.

Well before Kennedy announced the lunar goal, however, it had been apparent to many within NASA and the aerospace industry that the moon would be the next logical goal for the space program. The initial funding request for Apollo had been made in 1960, with a lunar landing as the program’s eventual goal. This was a year before any human had gone into space.

How to put a man on the moon was also an open issue. A preferred approach was first to build a space station, which would house an assembly crew. The crew would build

the landing spacecraft in Earth orbit and the completed spacecraft would be launched on a direct flight to the moon. A variation to this approach would be to launch several rockets carrying the spacecraft and fuel into Earth orbit. These would dock in orbit, the fuel would be pumped into the landing spacecraft's empty tanks, and then it would be launched directly to the moon. The other approach was to avoid orbital assembly, and build a huge rocket that would fly directly from the Earth to a lunar landing. In the end, none of these methods were used.

Instead, a single launch of a Saturn V booster carrying two specialized spacecraft was used for Apollo. The Command and Service Module carried the crew to and from the moon, while the Lunar Module made the actual lunar landing. This division allowed the spacecraft to be optimized for specific roles. The alternative was to build a single spacecraft for multiple roles, which posed many problems from engineering and operational viewpoints.

As the 1960s were beginning, none of this was clear. It was, however, clear that numerous skills, such as rendezvous and docking of two spacecraft, had to be mastered before a man could go to the moon. The most basic of the challenges was how to make the landing itself. In the following interview with Dr. Hunley, Drake discussed his role in meeting those challenges.

A: [The 1960s], of course, was a period when all sorts of exciting things were going on. We were concerned about the starting of the Apollo program. The X-15 was operating. There were several meetings in the middle of the year, just from some of the work of one group that I was on the ad hoc group for manned lunar landing by rendezvous techniques. It was the one that ended up recommending the lunar orbit rendezvous [method]. But preliminary to this, we had done some work on rendezvous.... In looking at the outset, [in] the early '60s, we didn't really know whether the big mission was going to be a space station or lunar [landing] or whatever. And looking over these, rendezvous was a big problem area that we could expect for any mission, so [we had] an outline of what we thought the Flight Research Center could do in the various parts of the lunar mission from the boost phase, parts of which we could almost simulate with the X-15—pilot control, and zero g. X-15 tests could address concerns about re entry, low L/D [lift over drag] vehicles, that sort of thing. We went through all of these and had proposals for work on all of them.

Well, [Chester] Wolowicz, [Ed] Videan, and I had done some simulation of the rendezvous problem in late 1959, I think, or early 1960. It was recorded in a TM [technical memorandum]. So we were looking at various things, and one rather idiotic proposal that I put together was a ground simulation of orbital rendezvous problems using a ground effect machine out on the lakebed. Do it at night when you had nothing for reference except lights and stars. It was fine, it would be a pretty reasonable cost—except there was always too much dust.

When the lunar program was chosen, it was obvious we hadn't thought too much about takeoff and landing of the vehicle on the Moon, and it was of interest because of being in a totally different environment in terms of gravity. So it was more or less logical to think of some way of simulation in flight. Being a flight-test center, we didn't consider anything else but to simulate it in flight. I looked at it that, at first, maybe we'd need two or three jet engines supporting the vehicle. My initial thought was we would take a complete mock-up of whatever they were going to land on the Moon and use that. A few back-of-the-envelope calculations indicated no way were we going to be able to do that. The estimated weight was somewhere in the order of 12,000 pounds or so. To get that kind of thrust and the kind of control that you would need would require several engines. The more engines you had, the more chance of failure, and you were

supporting yourself with the engines.

At any rate, what evolved in my mind was to reduce this to one engine and down around the 2,000- or 3,000-pound weight; we could get the pilot and give him the experience, which is what we really wanted to do. We felt that the pilot would fly this thing. So I guess it was probably around the end of 1960 we got into actually my talking with various people like Milt Thompson about whether it could be done. We decided this was something that maybe the [Flight Research] Center should get behind and push. By that time everybody was getting cranked up on Apollo, and [the program] had the promise of having some multiple applications. ...this was where we actually formed a group. And they made the preliminary results of the study, basically what I had been doing before. Now, at this time period I was not there. I was back east in this ad hoc group of lunar landing rendezvous study. I was there from the first part of June [1961] until sometime in July.

This really cranked up a lot of interest in the whole problem both of rendezvous and the lunar landing. And initially they said, 'Well, come back a year from now; we'll talk about it.' But after about two or three months there was a lot of interest. Langley had their big facility that they were using as a simulator and the pilots thought it might serve engineering purposes, but it certainly didn't give them the simulation that they wanted. Initially, I wasn't enthusiastic enough about it to actually put anything in writing. I don't think [there were] any descriptions of the simulator until we got to the point where we had convinced our own management that it could be a viable program. The big excitement of that time, in 1960 and early 1961, was in rendezvous, because they had not decided how the mission was going to be done. I kid around that they didn't know whether they were going to the Moon by train or by truck. In our study we looked at this rendezvous where you'd fire off a half dozen big rockets and assemble something in orbit and then go to the Moon and land on the Moon and take off on the Moon and come back. One of them, the lunar orbit rendezvous, which was the one that was ultimately chosen, was not initially favored. It came out third after Earth rendezvous and direct ascent rendezvous, but cooler heads finally prevailed.

When we were looking at this, the idea [was] getting off six of these great big rockets—not the size of the Saturn V, but the size of the Saturn I—in a short length of time. They were lined up like telephone booths on the launch pad. Well, now we can't even predict when the Shuttle will go off within a day or so; how could we count on getting six of them off and then rendezvous and assemble?

We were much more in favor of hooking up two small pieces that come up together; you have one thing to do. Anyway, that was the subject of a lot of study before they finally chose the procedure they did. I think everything was going on at the same time. They were doing decisions on Apollo. They were doing decisions on which simulator to use, which companies. We were flying the X-15 at the same time. So that loaded us up. And, of course, in 1961, the Russians were orbiting their Gagarin flight. Well, of course, they filed for a record. The FAI—the Fédération Aéronautique Internationale—certifies records; their regulations and rules didn't have anything to cover this. So they had a big meeting in Washington. I attended it, and I think [Wendell] Stillwell was with me, to review the FAI certification process. Well, they put together a tentative group of regulations, and the Russian flight didn't satisfy any of them, or very few. They wanted to certify one orbit. He hadn't completed an orbit because he landed short of the takeoff point. The requirements were that they couldn't throw away any of the airplane or the vehicle. You had to land in the vehicle. He didn't land in the vehicle; he parachuted. They had to give a complete description of the vehicle. They didn't say anything. So it's right in the middle of all of the rest of the stuff that's going on, just another thing.

We didn't have any feeling of being overworked because it was one of the cases of—

well, it's like when the X-1 went supersonic. You couldn't wait to get to work, work all day, take stuff home, and work on it at home. I don't see that enthusiasm much today. I guess fellows down at the flight [line] are probably closest to it, but it was a great time.

Q: And you were conceiving the Lunar Landing Research Vehicle as a simulator; is that correct?

A: Yeah. And this was after the basic approach that we were interested in had been chosen. This was the first time we were willing to commit to it in a drawing. It didn't come out anything like that. See, this was January of '62, and that was well after. It was well after most of the discussion here, January '62. We were just ready to talk to Bell on that. The work statement from Bell was sometime in March of that year. The general idea was right, but it got more practical.

Nobody knew what the thing was ultimately going to look like. This is the final vehicle. This is a little bit more complex. But the considerations of practicality made the thing considerably more complicated. For example, on our initial sketch we just assigned weights in making the analysis to come up with approximate size. Here, they have to consider the actual thing and balance the vehicle. We avoided all that by putting everything right in the center.

Q: The original drawing was much more elegant looking than the ultimate "flying bedstead."

A: Right. And it's the same way, any time you do it on the back of an envelope; you can put boxes in for various things, a simple thing like the ejection seat, but it had to save the pilot even if the thing was upside down and 30 feet off the ground. These kinds of specifications led to an extremely complex system.

Q: Now, the process you've been describing makes it seem like it's accurate to say that this program for the Lunar Landing Research Vehicle did originate there at Dryden—

A: I should qualify that. Like any idea, people that are involved get the same idea around the same time everywhere. The problem was there and the need to attack it, but it was not evident until the decision was made that we were going to go ahead and do this. Everybody has something to do, everybody's busy. So you don't do unnecessary things until you can see a need that has to be fulfilled. And, of course, we can make studies, do them on our own time and all that sort of thing. But if it's something that involves hardware, then you have to have an ultimate mission in mind or it has to be so inexpensive that you can virtually do it on your own time.

The initial reaction control handling quality was done that way [in the late 1950s]. We built an Iron Cross in the hangar. This took, maybe, a hundred hours and some effort in the shops to build the thing. But we could see a need for it because the X-15 was coming and [so was] the F-104 reaction control airplane. So we did have some justification, but not enough justification to build a whole vehicle for that. Actually, the X-15, F-104, and so forth were the research vehicles that could and actually did lead to some investigations of handling qualities for the space vehicles. But I would say I would have been surprised if the same thing had not occurred to other people at about the same time.

Q: Well, in fact, aerospace historian Dick Hallion, in a book on Dryden, mentioned a Dr. A.A. Griffith [in England] who had a "flying bedstead" earlier than this.

A: Yes. That was one that was a VTOL [vertical take off and landing aircraft]. We were looking at it from a standpoint of handling qualities and, yes, the things that I guess you'd say characterize this as opposed to Griffith's bedstead were that this was designed to simulate landings under a one-sixth-g situation, comparable to the Moon. Griffith's vehicle was designed for takeoff and landing in a 1 g field and there was no intent to simulate another environment than that. I didn't even think of his thing when we were working on the LLRV. But of course VTOLs were flying. There were many of them that had flown in that time period. So we didn't look on the VTOL part of the thing as a particular problem. We knew we could do it. We were more interested in, really, the development of handling quality under this one-sixth-g situation. I don't know that this would be a make-or-break problem. I think the landing on the Moon would have been done even if we hadn't built the simulator. I think having the simulator, however, gave the pilots a lot more confidence, and probably—may well have given them a better combination of control authority and so forth than they would have had without it.

Q: That's certainly what Neil Armstrong indicated. Now, how much of the actual design came from Bell and how much was conceived by the Dryden engineers?

A: I think virtually all of the practical design was Bell's. If you look at the progress reports, you'll get a good feel for that. I haven't gone through them recently but as I recall, there were redesigns. The initial engine was changed. They started out with the J 85 [engine]. Then they went to the CF 700, which was a fan version of the J 85. That introduced additional side forces, things like that. And it was the same way for the X-15 and for the lifting body. To my way of thinking anyway, the ideal function of NASA would be to set up the requirements: "What is this thing gonna do?" "How much power should it have?" Electrical power, for example—that kind of thing—and then leave the contractor alone. If he has problems, he can discuss them with NASA. For example, you can't, in the initial setting up of the specifications, anticipate everything, but when problems come up, the contractor has suggestions and they should be considered because he has probably a lot more hands-on experience with the hardware. Questions that are in the research area, NASA would be the one that should specify—that should do the recommendation and possibly even design the instrumentation, so there wasn't anybody any better and this sort of thing. But in terms of the actual flight hardware, it had to be the manufacturer, because if you aren't doing it, actually doing it hands-on, you don't know the problem, and you're liable to make a decision that could produce a dangerous situation.

Q: In regard [to] the electronic fly-by-wire system that was used on the Lunar Landing Research Vehicle—was that something that was designed specifically for this vehicle, or was it more or less off the shelf?

A: I can't answer. I don't recall. I would think that they went to a modification of an off the shelf piece of equipment, but I don't know. I would be surprised if there were not an off the shelf piece of equipment that would work over the extremely low speed flight range that we were working, but I can't remember. See, when they were working with the contractor, I was no longer involved in it except peripherally. Don Bellman was managing the program, I recall, and these questions will all come up with him. My involvement was relatively small. I got the progress reports, so I knew generally what was going on, but I didn't participate in the actual program or its progress.

Q: I understand that Wayne Ottinger was the rep at the Bell plant for NASA, and he

probably will remember a lot of the people who were involved in the later detail design.

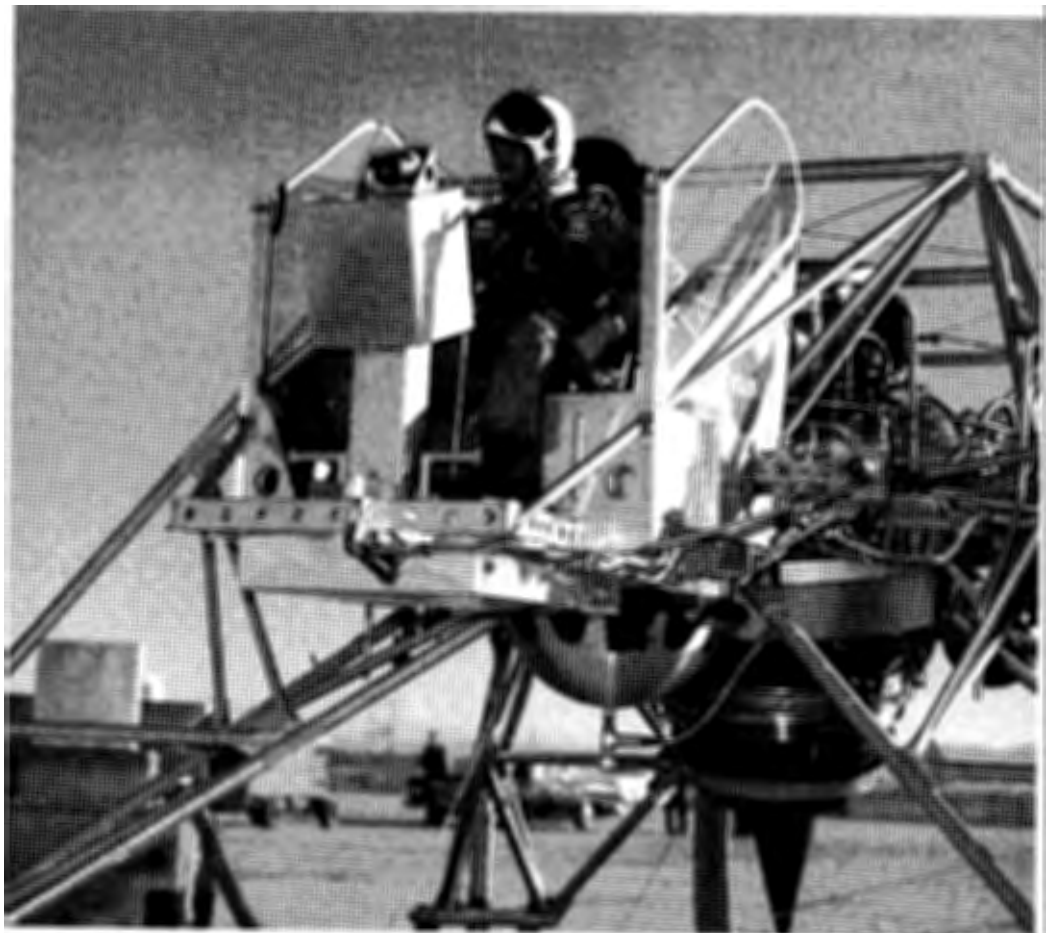
A: The people that were involved from the Flight Research Center were primarily the operational people. The vehicle has no aerodynamics. It had no load problems. If it's gonna hit the ground, it's gonna either hit it gradually enough for a normal landing or it's going to hit so hard that it breaks; and by that time the pilot is long gone; he's not going to go down with it. So basically, it was an operations project.

Q: Of course, we did lose one of the Lunar Landing Research Vehicles with Neil Armstrong as pilot and two of the Lunar Landing Training Vehicles [LLTV].

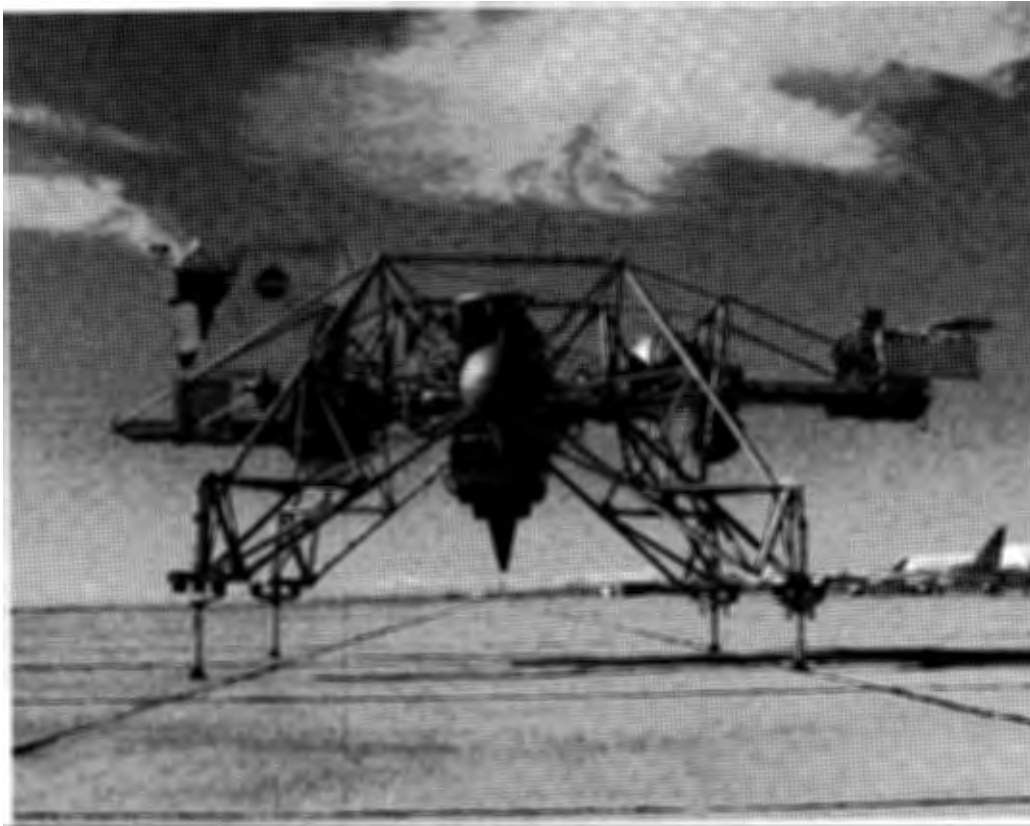
A: Interesting, because on the basis of number of flights per vehicle and so forth [the LLRV/LLTV] was probably the most dangerous vehicle we operated. I'd say the para-gliders were the most crash prone, but they crashed so slowly that nobody got hurt. But from the number of flights that were made and the vehicles lost—this was a very difficult vehicle to design for its survival. You worried more about the survival of the crew.

Q: We lost three out of five. No one was [killed].

A: I did a survey when we were just planning the X-15. We had a big argument with Kelly Johnson in the aerodynamics committee because his view was that flying the X-15 mission with an unmanned vehicle would be less expensive, safer, and you'd get more information. We had a big roundtable argument on that. Then in the course of that period of time I did surveys on the record from some of these missiles—the Regulus I and Regulus II; Lockheed's X-7, for example—that were being held up as examples



NASA research pilot Joe Walker during an early LLRV flight. At this time, the vehicle had side panels, which protected the pilot from hydrogen peroxide droplets. (ECN-453)



The LLRV later in the test program. By this stage, the cockpit configuration had been altered to provide better simulation of the view from the Lunar Module. Testing with this model was conducted at South Base, site of the original NACA unit. In the background are a B-47 and a B-52. (ECN-1582)

of the kind of thing you'd be in competition with. The Regulus had something like 250 flights, total, experience with the vehicle. The maximum flights with one vehicle were something like 10—relying on memory now—and the average was three flights per vehicle. The minimum was zero. And they used 150 vehicles to get 250 flights. Of course, they had some left over. And the X-7, Kelly Johnson's pride and joy, had a better record, but it was limited—still a very limited program, something like 14 vehicles or something like that. I don't remember. And none of these covered things like piloting problems, stability and control as it relates to the pilot. So we went through those sorts of things. But even those missiles had better records than the LLRV. So it was basically a very risky vehicle.

Q: I think I mentioned that Neil Armstrong said he was never comfortable flying it, but he was certainly glad he had.

A: I think that was one of its virtues, because you didn't relax, and of course, the flight period that the vehicle was simulating was a very limited time, and you wanted to be completely keyed up for that two or-three minute period. I mean, you were fortunate it wasn't going to be three hours doing this landing, only two or three minutes.

Q: You mentioned at the beginning of the interview that you had talked with Milt Thompson about the basic idea.

A: Actually, I talked with all the pilots, because the pilot in a vehicle like this, to us, was the important part; and next to him came the things that were going to save him, like the ejection seat and stability augmentation and so forth. And we wanted any inputs that we could get from them. The pilots were closely involved in everything that we did relative to the lunar mission or to any of the spaceflight missions. Early in the spaceflight program, even before the lunar mission was selected as a mission, we had gotten the

pilots involved in a program with the Navy, considering how well they could control launch vehicles under the high accelerations. And I think, Ed [Videan] and [Joe] Walker and [Milt] Thompson were the main movers in that program. My only input was to design the launch accelerations, what they would actually program into the centrifuge. We found the pilots could fly it fine. We couldn't convince anybody to let them fly the Saturn V, but the acceleration was not a limitation.

Q: Of course, it [the acceleration] did limit arm movements and that sort of thing.

A: Yes, but you design equipment for that; as a matter of fact, that's what stimulated it first. We had the X-15 coming along and it had something like 4 g capability, horizontally. So there was concern about whether the pilot could control it or not with normal controls, so we were going to design a hand controller for the X-15. So that problem led us to doing simulations in the centrifuge, which resulted in the side-arm control for the X-15.

Q: Now, this period you're talking about in the centrifuge would have been what, around 1960 or the same time we're talking about for the—

A: Earlier than that. I don't recall. I don't know whether there was a technical note put out or a report at a conference.

Q: Let me ask you a different kind of a question. You mentioned earlier that in the process of talking about this project you finally convinced the management at the Flight Research Center to support this program. How did that come about? Was it by talking with the center director or—

A: It was more a matter of—when we initially started, the decision had not been made... about the rendezvous. We knew that any major mission that was proposed would involve the rendezvous. So that was the first thing; everybody thought, well, what can we do in that. We ran static simulations using displays and so forth. Then the choice of the lunar mission, of course—well, we had the question of what are the various problem areas of that. And we had already looked at the acceleration and takeoff in the centrifuge. We had done enough work with the rendezvous to know it was not a handling problem so much as it was a mechanical problem. Everything was going to be done so slowly; if it's wrong, you can back off and try again, back off a little bit and try again. It was not a problem working on it.

But now this new thing was the lunar landing and takeoff. Takeoff didn't bother us any because it was just a small acceleration compared to what we had been talking about before. So the only thing was the landing itself—what is lacking in the landing? Well, practice is one thing. And so I would hesitate to say it was a matter of convincing our management, this sort of discussion about, 'Well, what can we put together that would do this?' Well, discussion came after I had done some thinking about it and came in with the idea of what we could do. It didn't take much convincing. Paul was, 'Well, can you do it?' It was that sort of thing.

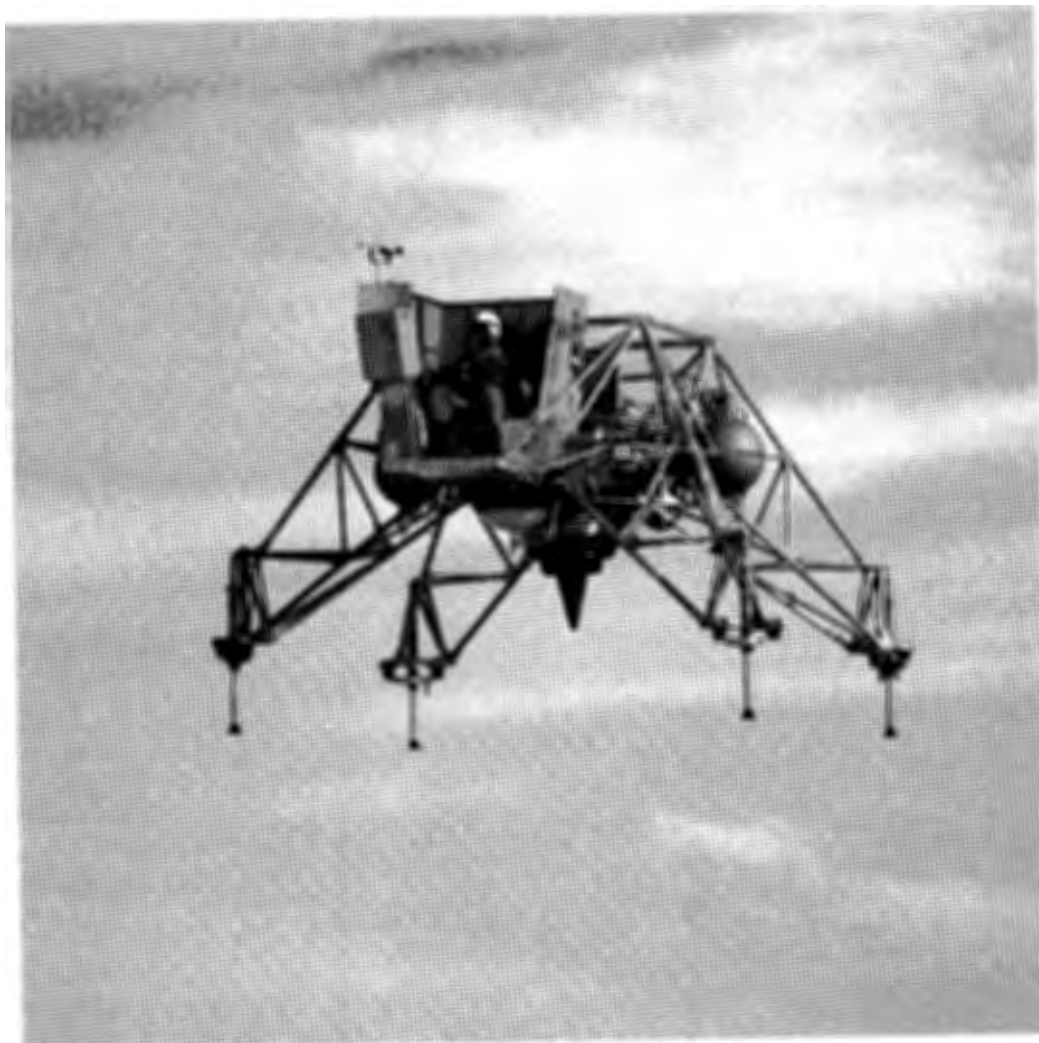
Q: That's Paul Bikle you're talking about.

A: Yeah. I forget the time period when we flew the [M2-F1] lightweight lifting body, but it was in there somewhere. That was one example also of something that could be done relatively easily and inexpensively. Well, initially, we thought this might be easy and inexpensive, but then when we dug into it a little bit, even to the extent of this first

sketching out, we could see it was going to be a couple million dollars, at least, and a much more risky thing than the lifting body program.

Q: It was interesting with the M2-F1 that Tommy Toll [chief of the Research Division at the Flight Research Center] was okay with the Pontiac tows [of the M2-F1], but when they proposed towing it behind the Gooney Bird [the R4D aircraft], he opposed it.

A: It's a matter of what you're accustomed to. Tommy came out of the wind tunnels. He's familiar with automobiles and gliders. He wasn't really an airplane guy. So to the airplane people, towing the [M2-F1] lifting body is fine. I remember we had just moved to the new facility [built in 1954] and they hadn't connected us with the main runway yet. The lake was wet, and the R4D was supposed to take us to a conference. It was in the hangar. So they off loaded everything, real lightweight. I think they started it up at the hangar and took off right from the apron and then landed at the [Edwards] Main Base. So the ability to tow the [M2-F1] with the R4D was not a major decision on the part of the operations people. They had no question—'Go ahead and do it.' I always thought that the auto tow was much more logical. Automobiles were right up at the top of its performance to get that thing off the ground.



Never the most graceful of flying machines, the LLRV was nonetheless a critical tool in training the crews of the Apollo missions. (ECN-453)

Section III

U. S. AIR FORCE

The Lifting Bodies

Though America was not alone in its search for an improved means of the use of powered aircraft, the means used to reach them were quite different. The complex, subjected airplanes to heavy g-forces during ascent. The descent had to be parabolic to a minimum in its curve, and making a precise touchdown was difficult. Most significantly, a capsule could not be flown again; it became a museum exhibit at mission's end. The solution was akin to throwing away a jet engine at the end of its first flight. The cost of a single space mission, however, was as great as an entire fleet of airplanes.

As concepts for a new spacecraft began to take shape, many engineers harkened back to ideas about spaceflight that existed before Sputnik, envisioning space activity centered more on routine operations. As initially conceived, these ideas reflected aviation rather than missile technology in that a vehicle would be flown many times, rather than both booster and spacecraft being discarded after a single mission. A vehicle able to generate significant lift during re-entry would subject the crew to much lower g-forces. Because the vehicle produced lift, it could be steered to a precise landing point. Rather than splashing down in the ocean, it could make a horizontal landing on a dry lakebed or even a concrete runway, like a conventional airplane. And once the mission was over, the spacecraft would be towed back to its hangar, refurbished, and placed on the launch pad for its next mission to space.

The X-15 program gave a hint that such a concept would be possible. The X-15s reached the edge of space and were flown again a few weeks later. The process was

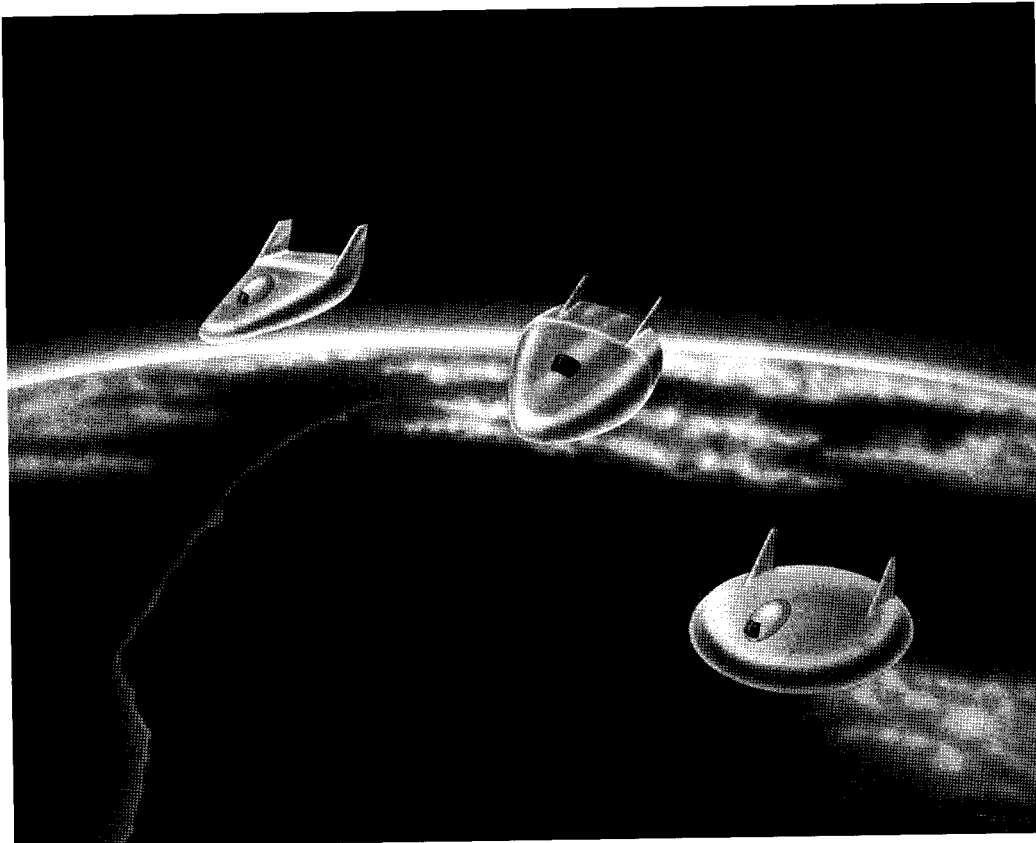
repeated on a regular basis for nearly a decade. The aerodynamic, structural, and heating data produced by the X-15 research flights would serve as important guides in designing the type of reusable spacecraft envisioned by the nation's aerospace leaders. The technological challenges of building such a spacecraft, however, were

not to be underestimated. The X-15 had a top speed of Mach 6; an orbital re-entry took place at a maximum speed of Mach 25 to 28. The Inconel X[®] skin of the X-15 would not survive the re-entry heating of an orbital flight, incredibly resilient though it was. New materials would have to be developed. A much more capable flight control system than that of the X-15s also was needed. The aerodynamics and thermodynamics of orbital re-entry were unknowns as well. The X-15 had experienced heating problems that shattered windshields and caused skin to buckle. The most serious problem occurred during the X-15A-2's Mach 6.7 flight, when excessive heating burned through its steel skin, nearly causing the aircraft to be lost. While the X-15 experience could serve as a guide, a much better understanding of hypersonic aerodynamics and related phenomena was needed.

Even before the launch of Sputnik, ideas were being formulated for how such a reusable vehicle might be built. The X-20 Dyna-Soar was a delta-wing vehicle that would skip on the atmosphere during re-entry, like a stone skipping on the water of a lake. In terms of design, the Dyna-Soar represented a traditional aircraft approach. A very different type of vehicle began to attract attention at both the Ames and Langley research centers. The concept for it grew out of wind-tunnel tests of the high-speed aerodynamics of cone-shaped warheads. Researchers discovered that a warhead at a small angle of attack would generate a small amount of lift.

Different approaches were taken to transforming this concept into an operational vehicle. At Ames, the cone was cut in half, giving it a flat top. A flattened aft fuselage was added to the original half cone. Vertical fins and other control surfaces were added so it could be flown. These Ames designs included the M-1L and the M-2. (The "M" stood for "manned.") The M-1L bore a cone shape with an inflatable boat tail that increased its lift-over-drag ratio (L/D) for landing. The M-2 also had a half-cone shape, but was much less bulky. Due to its large fins, the M-2 also was referred to as the "Cadillac." At Langley, researchers were considering a lenticular vehicle, which had a disk-shaped fuselage, fins, and horizontal stabilizers.

These so-called "lifting body" concepts produced lift through airflow over the vehicle's



An artist's concept of the three original lifting bodies. From left are the M-2, the M-1L, and the lenticular vehicle. (EC62-0175)

body rather than over wings. This absence of wings was seen as an advantage, as it resulted in a shape more suitable to withstanding the heat of re-entry. Lifting bodies would re-enter at a high angle of attack, allowing the crafts' underside to take the brunt of the heating. Once the vehicle had slowed, it would nose over and make a steep descent, like the X-15, and land on the lakebed. Due to the lifting bodies' higher drag, the amount of lift the initial vehicle designs could produce was lower than that of the X-15. This made piloting more difficult. The X-15's L/D was 4.5. This meant that it would fly 4.5 feet forward for every foot of altitude lost, and was considered low for an aircraft. In contrast, the M2-F1 lifting body had an L/D of only 2.8

The first step in lifting-body development was simply proving such a vehicle to be capable of low-speed flight. In the early 1960s, the idea of an airplane without wings received much the same reception from engineers as an airplane with a jet engine had in the early 1940s. Air Force engineers had focused all their attention on winged re-entry vehicles, like the Dyna-Soar, viewing lifting bodies as susceptible to control difficulties. The question became one of how to prove a concept that few accepted as actually practical.

Dryden engineer R. Dale Reed was among the few who believed that lifting bodies constituted viable space vehicles. A radio-controlled model airplane enthusiast, Reed saw free-flight tests of a model lifting body as a means of selling the feasibility of the concept to center officials. He began with small, paper lifting-body models flown down the hallways of the Flight Research Center headquarters building. Despite questioning looks by other engineers, Reed was encouraged by these early flights of the paper models and built a balsa wood free-flight model of the M-2 shape. Launching the model by hand, he found that it had good stability. To increase its flight time, Reed launched the model from



From left, Richard C. Edredge, Dale Reed, James O. Newman and Bob McDonald with several of Reed's research models. Throughout his years at Dryden, Reed made extensive use of model aircraft to test new concepts. This began with the early lifting bodies and continued on through the X-33 and X-38 vehicles. (ECN-2059)



Inside the "Wright Bicycle Shop," from left, Grierson Hamilton, Bob Green, and Ed Browne work on the M2-F1 fin. (E94-042509-13)

the roof of the three-story headquarters building. The final step was to tow the M-2 model aloft with a large radio-controlled model airplane, cut it loose with a timer and let the lifting body glide to a landing. Reed's wife, Donna, filmed the flights with a movie camera.

Slowly, interest at the FRC began to build among other engineers. Dick Eldredge joined the effort, and worked with Reed to map out a low-cost piloted lifting-body flight program. Their plan was to build wood or fiberglass shells of the M-1L, M-2, and lenticular shapes, which could be attached to a common steel-tube internal framework. This was a larger-scale extension of Reed's model tests. These would also be proof-of-concept vehicles, meant to test the stability of a lifting body at low speeds and during landing. The vehicles would not have the refinements needed for a vehicle operating at transonic or supersonic speeds. Instead, they would be initially towed aloft behind a high-powered vehicle. Once the vehicles' landing stability was proven, they would be towed to higher altitudes and speeds with the FRC's C-47.

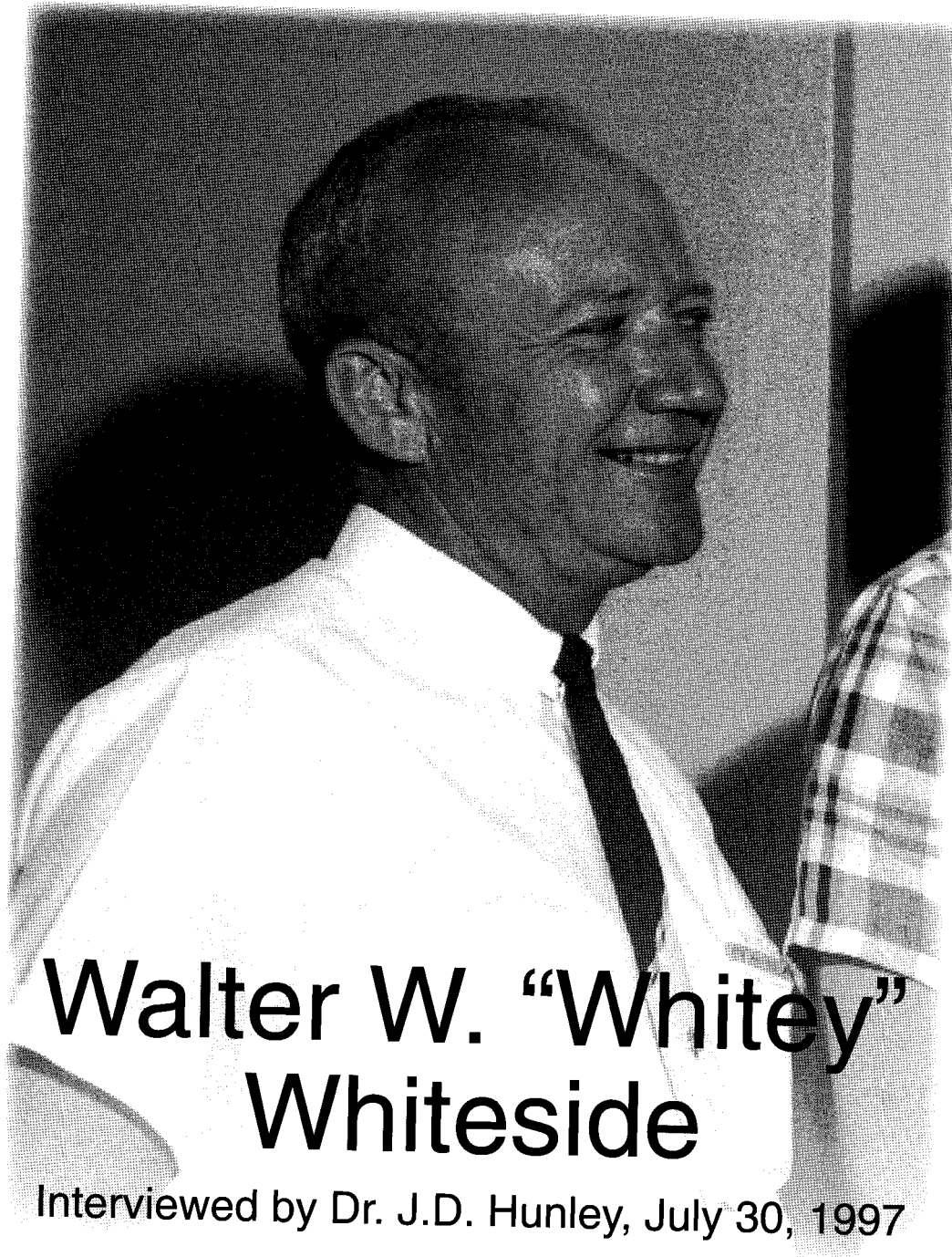
To gain the support of center managers, Reed felt one of the NASA research pilots should be involved with the project. He and Eldredge approached Milton O. "Milt" Thompson, who was assigned to both the X-20 Dyna-Soar and the X-15 programs. Thompson had also been a pilot on the Paresev, a research aircraft built in house at the FRC to flight test the Rogallo Wing. The kite-like Rogallo Wing could be folded up like a capsule's parachute but, once deployed, could be controlled like a conventional wing. This allowed the capsule to make a horizontal landing. Reed and Eldredge asked Thompson if he would be willing to be their lifting-body pilot, assuming the program

was actually approved. Thompson immediately agreed, for he was aware that the X-20 was having technical, budgetary, and political problems, and was not confident it would ever fly.

Thompson also suggested that the support of an originator of the lifting-body concept would go a long way toward gaining approval for the program. Reed called Alfred Eggers, at the Ames Research Center, who had first developed the lifting-body concept (even before the launch of Sputnik). Eggers agreed, and he and Reed arranged a meeting at the Flight Research Center with its director, Paul Bikle.

Reed and Eldredge's test plan, together with Thompson's backing, convinced Bikle to support the lifting-body program. Eggers agreed to provide whatever wind-tunnel testing was required to develop the vehicles, providing Bikle took responsibility for their design, construction, and flight test. Thompson recommended that the first vehicle tested be the M-2 shape, as he believed it to be the most potentially viable. The vehicle was given the designation of "M2-F1" (for Manned 2-Flight 1). Its construction would be paid for out of the center director's discretionary fund. The vehicle was officially only a full-scale "wind-tunnel model," so NASA Headquarters would not need to be made aware of it. But, as Bikle noted, if the model "just happened" to end up being capable of flight, that would be something outside the control of center management.

To keep the cost of building the vehicle down, an in-house effort, like that of the Paresev, would be undertaken. A corner of the fabrication shop was walled off with a curtain, and a sign was put up reading "Wright Bicycle Shop." Here a team of engineers, working on their own time, began assembling the internal framework, metal fins, and other components. The wooden shell of the M2-F1 was built separately, by another group led by Gus Briegleb at the nearby El Mirage airport. Briegleb was one of the few people still manufacturing wooden gliders in the early 1960s. When Briegleb was asked by Bikle—himself a champion sailplane pilot—to participate in the M-2 program, Briegleb was enthusiastic. While these two teams were assembling the vehicle, a third team examined its stability and control characteristics. The vehicle was finished four months after construction began. Total cost was about \$30,000, far less than it would have cost had it been built by a contractor under more conventional funding circumstances. The next step was to be far more difficult: proving that an airplane without wings could fly.



Walter W. “Whitey” Whiteside

Interviewed by Dr. J.D. Hunley, July 30, 1997

“Whitey” Whiteside was one of many colorful characters to be found at the Flight Research Center during the 1960s and 1970s. The youngest of six children, he was overhauling cars by the age of 12. His was a hard existence, living with various family members, working from 2 to 6 a.m. washing dishes in a bakery, going to high school, and “causing havoc around town,” as Whiteside later said. His brothers finally arranged Whiteside’s U.S. Army Air Corps enlistment in 1933. Initially, he was assigned as a mechanic at the Army depot on North Island in San Diego. He fueled and serviced aircraft coming out of overhaul, and flew as a passenger during check flights.

With the outbreak of war in Europe, he was reassigned to a B-17 unit in the regular Army Air Corps. By Whiteside’s own account, he was “into all kinds of hot water all the time,” and bounced from place to place. A turning point in his life came in 1940, when he was part of an attempt to set a transcontinental speed record in a B-17. Among

the people who saw the aircraft land at Wright Field (now Wright Patterson Air Force Base, Ohio) was Paul Bikle. The future Flight Research Center director was just a GS-1 civilian engineer, newly married and with a slide rule in his pocket.

After the outbreak of World War II, Whiteside spent several years overseas. On returning to the United States, he ended up at Wright Field. Now a newly commissioned lieutenant, he maintained the base's hodgepodge of some 120 airplanes. He had finally found his niche, saying later, "I just loved everything about Dayton and research and flight testing and everything." Bikle was now working in flight test, in an office down the hall from Whiteside. Over the decades to follow, Whiteside frequently worked with Bikle on various projects. When Whiteside became the assistant director of aircraft maintenance at Edwards Air Force Base, Bikle served as the technical director at the Air Force Flight Test Center at Edwards.

In September of 1959 both men again found their futures inextricably linked. That year Walter C. Williams, who, as chief of the High-Speed Flight Station, had overseen activities at the desert facility since the 1946 arrival of the first group of NACA engineers, was named assistant director of the NASA Space Task Group. Bikle was selected to take over as the new chief of the High-Speed Flight Station, and, as he had before, soon brought Whiteside along.

Whiteside played an important role in the early testing of the M2-F1 lifting body. The initial ground tows were made to check the vehicle's stability and control, without running the risks inherent in an actual free flight. The problem was that the M2-F1 weighed about 1,000 pounds, and had to be towed aloft at a speed of at least 100 miles per hour. None of the available trucks or vans had the necessary performance capacity to do the job. Whitey was also an enthusiastic hot-rodder and dirt bike rider, and he knew just the kind of vehicle that the engineers needed.

NEW FACES AT the FRC this month are:

Boyd H. Stringham - Instr.
Ronald Carr - Instrumentation
Donald D. Fry - Instrumentation
Andrew C. Nash - Instrumentation
Glynn E. Smith - Instrumentation
Ernest A. Bahr - Flight Opns.
William P. Harris - Flight Opns.
Walter W. Whiteside - Flt. Opns.
Joseph T. Washko - Research
Warren S. Wilson - Research
Ozzella L. Stella - Research
Mary A. Taylor - Research
Danielle L. Rosenberg - Admin.
Continued next page

Q: You were born in 1914 and grew up in the San Joaquin Valley. Is that correct?

A: That is correct.

Q: Now, about when you came to Edwards—do you remember the date, or at least the year?

A: I was at Edwards several times before World War II, and after World War II, and during.

Q: When was the last time you came here?

A: The last time I came here was when I came back from Japan in about 1960.

Q: But not 1959? That was when Paul Bikle came to Dryden.¹

A: Yes.

Q: And you were already at Edwards.

A: I was at Edwards. I was sitting across the desk from the colonel out there. I was the

¹ Whiteside joined NASA in March 1960.

maintenance officer for the Air Force side of the house. Paul Bikle was there at the Air Force facility. When he moved down to NASA, he says, 'Come go with me, Whitey.' We had been together off and on at a lot of places. We had fought World War II together. And when World War II was over we were on Guam together, in B-29 outfits bombing Japan—Paul Bikle and I. So when we came back to the States, I stayed in the Air Force and I was the Wing Staff Maintenance Officer at Edwards Air Force Base.

Bikle Leaves for Soaring Meet

Leaving for Europe this week to compete in the World Soaring Championship was Paul Bikle, FRC director.

Being staged in Cologne, Germany, the glider meet will feature top pilots from 27 countries, including two champion pilots from the U.S. in addition to Bikle.

Competing in the meet, which is held every two years, will be teams from West Germany, Poland, Czechoslovakia, Yugoslavia and England—reported to be among the top countries in soaring.

The championship will be held from June 4 to June 20 and will be judged on a series of "tasks" assigned to performers by judges each day. The meet is under sponsorship of Federation Aeronautique Internationale.

Bikle, who has been soaring actively since 1947 and pursuing the hobby since 1934, won the West Coast Soaring Championship in 1959 at a meet held at El Mirage Airport in East Antelope Valley. He also won the Southern California championship at Elsinore last year.

Q: Well, do you remember about how long you worked for the Air Force that time at Edwards before Paul Bikle moved and called you over to NASA? Would it have been a couple of years?

A: A couple of years. Yes.

Q: And you had indicated to me you wanted to give proper credit to Paul Bikle. I wondered if you would just describe him as a person and as a manager and describe your relationship with him over the years, and especially in the NASA period.

A: Well, like I say, he was a civilian in our B-29 operating off the islands out there, bombing Japan. Bikle was the kind of a person that just knew how to do things, and people recognized him. It didn't matter if he wore civilian clothes or GI clothes or what. The point was that he was where the action was. He was just that kind of a person. Started out life that way and stayed that way.

Q: You worked very closely with Paul Bikle over the years. I know you worked with him in his hobby as a sailplane pilot. I wondered if you could just discuss how you and he got

together on the sailplanes, and what you did together, and what your personal relationship with him was.

A: Well, sailplanes, of course, had annual national and international contests. And Bikle would tell me months ahead of time—or at least weeks ahead of time—that a contest is going to be in Elmira, New York this year, or it's going to be in Europe or wherever it is. And I would go home and deal with my family and arrange things. I would go wherever the contest was, and I would be his crew chief at these sailplane contests. On occasion, for example, his wife and kids would get in the station wagon, and I would drive them from California to New York if that's where it happened to be. Then they'd get to go see all their folks, and I'd go with Paul and do the sailplane thing. I just want to point out that he won international contests as well as national. He was a world-renowned sailplane pilot. And being tied in with the Air Force and NASA facilities over the years, he would modify his airplane and his pressure suits. He set world altitude records. He did all kinds of marvelous things with sailplanes. He was known worldwide for his sailplane capability.²

² Whiteside's son, Bill Whiteside, remembers Bikle would pick a time to compete and other pilots would select times around that, as Bikle knew situation and weather. At one contest, when Bikle's turn came to fly, he said he would pass and picked a later time instead. There were

Q: I wonder if you could describe his management style at NASA. What kind of a manager was he? How did he deal with subordinates? How did he handle organizing flight research at the NASA Flight Research Center?

A: I thought he was superb, myself. Because I had seen his actions and his reactions and seen things work that he had planned. I thought he was a very brilliant man. I think largely everyone that had any clue at all about what he was doing and why he was doing it were behind him 100 percent. That's the way it seemed to me. I never saw or felt any dissatisfaction about anything he did. But he was a very great originator and a steady stick relative to methods of how to conduct flight test programs. He gave classes at the local schools about flight tests and engineering, and trying to encourage young people too. These were voluntary, free things that he did.

Q: Was he the kind of manager that looked over your shoulder a lot and wanted to know exactly what you were doing and kind of made decisions for you? Or was he more informal and let you do your job, and just wanted to know what you were doing in a general way?

A: Yes. He'd have a meeting of the minds somewhere down the track and say how are you doing, or what are you doing, and what are your plans, and so forth. I wouldn't say that he looked over anybody's shoulder, in my opinion. I was in a very privileged position with Paul Bikle for many, many years. And I may be biased in what I think. A lot of years have gone by. I'm in my eighties now. And looking back across Paul Bikle or looking back across life, I might see things a little different.

Q: Well, let me ask the question a little different way. Did you ever hear any comments from your boss, Joe Vensel, as to whether Paul let him do his job pretty well or whether he supervised him pretty closely—anything like that?

A: Paul had been Air Force for many years. Joe Vensel had been civil service. He came out here from Langley Field with everybody else. I loved old Joe dearly. I sat in the same office with him. I was his right arm. But obviously what was going on over at NASA and what was going on with the Air Force—naturally there would be differences of opinion about conducting things and whatnot. I don't ever recall him being disturbed, or quitting early, or anything like that. I think they respected one another. They gave each other differences of opinion. If there was any conflict there or any overrun, I don't know. Looking back across all these years, I know there [were] hurt feelings and whatnot—Langley people coming out here, Air Force people meshing with them just like I did. I have no doubt that lots of people resented me. They thought I was the old man's favorite import or bat boy or whatever. They sent me out with a blank check to buy the

no other times available, around the new one he chose, to which the other pilots might switch. His son asked, "Why did he do that?" and Whitey replied, "They don't call him 'the fox' for nothing."

Mr Bikle Selected For Soaring Award

Center Director, Paul F. Bikle has been selected to receive the Lillienthal Medal for 1962 as awarded by the Federation Aeronautique Internationale (FAI). This award, named after one of the first glider pilots, is to be made in ceremonies this fall in Mexico City. Announcement of the award was made by the National Aeronautic Association (NAA).

The Lillienthal award, soaring's highest honor, is presented once a year for remarkable sporting performance in soaring or eminent service for a long period of time. Mr. Bikle holds the world absolute altitude record of 46,343 feet and a total altitude gained mark of 42,305 feet. Both of these glider records were established in 1961.

A veteran of over 20 years as a soaring enthusiast, Mr. Bikle has competed in nine U. S. National Championships and represented this country twice in world competition.

It was also announced by the NAA that the Montgolfer Award will be presented to balloonist Donald Piccard in recognition of his record balloon flights.

The FAI will also present a 1st award, in the form of gold medals, to the two Soviet Cosmonauts, Andrian Nikolayev and Pavel Popovich, for the first twin orbital flights last year.

Pontiac.

So there had to be human, natural differences of opinion relative to the instrumentation section, or the pilot's office, or how things were done or whatnot. People wouldn't have come to me to talk about their complaints if they had any relative to Paul Bikle, because they knew that he and I were lockstep on about everything—that we were personal friends. So I don't like to render an opinion back across NASA's history because I wasn't around NASA until Bikle went there and he told me to come over there. So if there were interfacing problems or personality problems, I don't think I paid that much attention. I was the fair-haired boy, if you want to know the truth.

Q: Well, I didn't have any sense from them or anyone else that there was any real tension.

A: He'd give you enough rope to hang yourself, whether you were instrumentation or who you were. And then if he had to he'd stop and say, 'Hey, don't you think we ought to re-think this?' And 'Let's sit down and talk about it.' I mean, he was a hands-on operator. But he didn't pay that much attention to instrumentation or the Motor Vehicle Department.

His primary interest was getting the job done—research and development. Housekeeping, he had other people do that. And they had plenty of skilled people out there. They had wonderful people out there. I might have a minor disagreement relative to the metal they were using constructing something. But the machine shops and all that—they ran their own business. They were tremendously capable people. And I thought the whole facility was a well-organized facility when I went over there. They all thought of me as the fair-haired boy that was the boss's kid and that I could do no wrong. So they kind of gave me a wide berth until they found out that I was just a plain old worn-out GI that loved to do things in the field of research and development.

Q: I wonder if you would describe De Beeler as a person and manager. How much dealing did you have with him?

A: I had very little [contact] with him—not enough to really have an opinion. I don't think you take anybody that you meet when they're 45, 55, or 65 years old and expect them to change much. I had managed Air Force people for many, many years at different levels and in different types of functions...I had no disagreement with De Beeler.

But I can understand that he felt...like time was passing him by. Bikle was smart enough to use Beeler to run him back and forth to NASA Headquarters, and gave him probably a free hand relative to functional management and whatnot. But Beeler might have felt left out in that because there probably was a time when he came from Langley Field that he ran flight test. I don't know. I don't know about the interpersonal conflicts, if there were any. I thought De was more of a pencil pusher, talk to Headquarters, and coordinate things, management functions.

Q: I think that's right.

A: Paul Bikle was research and development. He'd walk right in and sit down on a pilot's desk and cross his legs right up on his desk and sit there and get all the pilots around and talk about, 'How do you think we ought to do this?' This is my opinion. But what I'm saying is that he was a hands-on person and Beeler was not. Beeler, because I was Bikle's boy, never spoke to me but coming and going. I don't mean he didn't treat me nice or that he didn't respect me or anything, it's just we didn't have anything going together, unless Paul was on vacation.

Q: But I wonder if you would say a little bit more about Joe Vensel, and what kind of a manager he was, and some stories about him that would illustrate what kind of a person he was.

A: Joe was one of the original NACA test pilots. I don't know if he did Navy aviation or Army Air Corps or what his background was before he got to NACA. But when he got to NACA he was one of the primary pilots. Joe was, in my opinion, a plodding, methodical person—dig things out, come up with a good solution—a very likable, a very bright [guy]. But he was older than me. I think that by the time Paul Bikle got to NASA, Joe wasn't too far from retirement, and he felt kind of hesitant about asserting himself much relative to his opinions. This is my opinion. And he was no dummy. He was a very bright man. I loved old Joe. But I think he was on his downturn somewhat to where he didn't feel like fighting back if he had much difference of opinion. This is my opinion of what it was like then.

Q: You worked fairly closely with Joe Walker, I think. What can you tell me about him, and what kind of a person and pilot he was?

A: Oh, I think he was tops. Joe Walker and I got along real fine. He would flare up with me or anybody. He was just a very vociferous... Joe expressed himself. If he had it to say, he said it. And it was a delight being around Joe Walker. He would slam papers down on his desk and say, 'Damn it! I told him not to do that.' He was full of life.

Q: Well, he certainly has a reputation. How about Milt Thompson? He overlapped with you, I guess, pretty substantially.

A: Yes. Milt had a tremendous capability in the area of flying. I've always had a great respect for him and his capabilities and whatnot, his sense of humor—everything about him, I liked. I liked Milt. We were very good friends.

Q: What can you add to the score of Bill Dana stories or descriptions, or whatever you have to say?

A: He was a Bakersfield boy. And my niece is in Bakersfield. My sister lived in Bakersfield. My nieces went to school with him. I was really pleased when they told me that they knew Bill Dana, because he's quite a guy. He's an outstanding pilot, thorough; research all the aspects of anything. He didn't go off half cocked. He looked at everything and got all the answers. I've got the highest respect for Bill Dana. He's a tremendous individual.

Q: And I think you knew Tom McMurtry fairly well, didn't you?

A: He's so quiet and unassuming, or he was in those days. He's not going to blow his own bugle—somebody will have to blow it for him, is the expression I'd use. He's a tremendous individual. I wouldn't fault a one of those pilots. I wouldn't have any faults with any of them, myself. I thought they were all outstanding.

Bye-Bye Beanie Night Is Set For December 1

BYE-BYE BEANIE night will be celebrated December 1, as the Center's employees will gather to honor Joe Vensel, Chief of Flight Operations. Mr. Vensel will retire on that day after 32 years of government service.

A special dinner has been planned for that night. It will be held at the Knights of Columbus Hall in Lancaster. A no-host social hour will begin at 6:30 and precede the dinner. Entertainment honoring (?) Mr. Vensel will be presented following the dinner.

The price of the catered, roast beef dinner is \$3.00 per person. This includes a donation for a going-away gift for Mr. Vensel.

Tickets may be procured from all time and attendance clerks and/or Betty Callister, Gertrude Kelly, Boots McNally, Sandy Illian, Bill Dana, Bruce Peterson, and John Mancke.



Q: You worked, I know, a little bit with Chuck Yeager, both in the Air Force and with the lifting body program. What is your opinion of Chuck?

A: Chuck and I go back to many air shows where I was the aircraft maintenance officer and I had the motherships that dropped Chuck. I flew many flights where we'd drop Chuck. Then when the National Air Show came along I would get my troops. I was an officer then. I was in charge of bomber maintenance. Chuck would tell me a month ahead of time—we're going to be at so-and-so this year. I would start picking out my boys to take care of the B-29 mothership. And he would go down and get the X-1 people, whoever was involved. Then we'd all plan to go to the National to put this aircraft on exhibit. It was Dayton, Ohio where the air show was that year. Well, I'd get the B-29 ready. And the Bell or NACA people would mate the X-1 to the mothership.

So I'd fly the engineer's position. We didn't take any more people than we absolutely had to go to a national show, you know. I would have the right airmen with me to load and unload the X-1 off the mothership. And say [the air show] was Vandalia, Ohio. We'd park it a way back against the fence where we wouldn't have anybody around us. We'd jack the mothership up and lower the X-1 onto the ground, pull it out from under the B-29, and then set the B-29 back on the ground. Then, when the show was over, we'd go reverse this operation.³

Q: You weren't at Edwards at the time that Chuck broke the sound barrier, were you?

A: Nope. I think I was still at Wright Field then. We all worked out of Wright Field. Even Chuck worked out of Wright Field.

Q: But you didn't know him at Edwards at that time.

A: Not really. Chuck was an 18-karat fighter pilot. And I was always in bombers. So our paths didn't cross until work put us together.

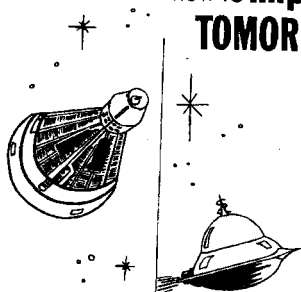
Q: Right. But you did have relationships with him then.

A: Oh, sure. Yes. He'd come to me and borrow my motorcycle or when I was on the flight line. I was a maintenance officer over at the airport. He'd come to me because I had a Model A Ford and he had one. And he might want a part for his or I might. But no, I didn't work with him. He was up in Fighter Operations there at Edwards. We were both officers together. I guess we were probably captains together and majors together. I don't remember the sequence.

He would come down and walk right in my office and tell me, 'Whitey, we're going to drop next Tuesday.' And 'can you do this or can you do that.' But he did the same thing before I got there with a master sergeant named Don Plumleigh. There were functional people in the Air Force just like there were at NASA that were all woven together with Yeager and everybody, you know. I came out there after he had gone

³ Bill Whiteside recalled his father describing flying with Yeager in a flying wing (either an XB-35 or YB-49). Yeager was relaxed, one earphone off, feet up, probably listening to country and western music on the radio, and Whitey mischievously adjusted the fuel flow. Whitey had just made the change when Yeager came on the intercom and said, "Knock it off, Whitey." Yeager just had an innate sense of what the airplane was doing.

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supersonic. But I'd been to Edwards many times. We were doing other things with other airplanes in Burbank or Seattle, or wherever we happened to be. All of us out of Wright Field, including Chuck, were roving bandits for accomplishing the Air Force purpose. Climb out of one airplane of one manufacturer and climb in 10 minutes later of another manufacturer and go fly the hell out of it, and maybe stay three weeks in Buffalo with it. It was tremendous—the way that all these folks interwove themselves into the contractors and the construction and the flight tests.

And there were smart people all along the line masterminding all this, like General [Albert] Boyd, Colonel Fred Ascani, and so forth. It just worked real good. Call you up at one o'clock in the morning and say, 'I'm in Sacramento. Come and get me.' Or 'I'm in Schenectady,' or whatever. But it was a catch-as-catch-can-type operation that worked real good, I thought.

Q: Right. Well, you lived in a fascinating era. Are there any other memorable people you worked with at the Flight Research Center that you'd like to mention?

A: Okay. NASA types. Well, always Joe [Walker], of course. He was the most vocal and the most noticeable. I had the mother-ship and he had a mothership. Before I went to NASA, I would give him built-up wheels and tires or turbo superchargers, and they would bring [replacement parts] back to me. We interfaced with one another when we were all in the old South Base [area of Edwards]. I don't know about manpowerwise. I don't think we went and worked on each other's airplanes. But we knew the guys that drive up and down the flight line looking for tires. Whatever they needed, we would give them. And when they got theirs, why, they'd give us back one. I don't recall any disrespect or hard feelings or anything. There weren't that many people out here. And we all had to work. I put in many a night working all night—putting an engine in, getting ready to do this or that. NASA did too.

Q: Okay. Let me ask you a different question. You weren't there but about a year. But how did the Center change in the year after Paul Bikle left? Did the way the Center operated change a lot? Or did things pretty much continue the way they had except with a new director?

A: I wouldn't have felt it or sensed it, I don't think, because I was out of the loop after that. I was running the radios, talking to the pilots when they were flying, and doing whatever was necessary to be done around there.

Q: Let me go back a little further to the beginning of your NASA career. You indicated earlier that there was a difference between working for the Air Force and working for NASA. Can you characterize how they were different, other than the fact [that] the one was civil service entirely and the other was a mixture of civil service and career officers and enlisted people?

A: The floor mechanics and crew chiefs that I knew at NASA had been in the military at one description or another and the functions were very similar. They were cooperative. They were eager. If anything, I sensed more willingness to get things done. And

. **Einar Enevoldson**, Pilot's Office, thinks **Tony Hitzenhammer**, Data Systems, has a funny name. USMC 1/Lt. John Bikle, son of **Paul Bikle**, Director's Office, has been awarded the Air Medal for combat missions as a helicopter pilot in Vietnam. Departing the Center last month was **Jim Welsh**, X-15 Research Office. Last month's Contrails reported the engagement of **Larry McLain**, Research Division. According to a recent want ad, he is now selling his collection of Playboy magazines, 1961 - 1967. **Major "Pete" Knight**, has been notified that he has won the Harmon Trophy for his X-15 flights. He will receive the trophy from the President sometime later this year. Visiting in Hawaii last month were **Juanita Taylor**, Range Systems, to attend her daughter's wedding; Mr. and Mrs. **Bill Dana**, Pilot's Office, to deliver a speech; and Juanita, Proprietress of a Rosamond business establishment. While there, the Dana's saw former X-15 pilot **Col. Bob Rushworth** and his wife. Bob was on rest and recuperation leave from his present job of flying F-4's in Vietnam. **Jack Nugent**, Flight Mechanics, has won the Exchange Council's contest to name the Center's Cost

there certainly was no laggard or sloughing off or anything from the working people—the aircraft maintenance people.

And the radio shop. I car-pooled with Stan Novack and guys like that that were—he was the head of the communications radio shop. [Roger J.] Barnicki—the personal equipment man. You couldn't ask for a more diligent, hard-working guy. He had great people working for him. That was a hand-picked organization that I can't fault in any way. All I can say is that if they deteriorated any or if new ones came in or old ones left or something, it just happened without any knowledge on my part. I have a high level of respect for the Flight Research Center the way I knew it.

Q: Do you remember who were the directors of maintenance at the Flight Research Center during the years when you were there?

A: Well, the overall foreman was Clyde Bailey. He came out here from Langley Field. Who all he brought with him, I don't know. But I don't recall if he brought in local people or not.

Rocket Seat Slated For M-2 Tested

A realistic, however unsuccessful demonstration of the capabilities of the ejection seat that will be used on the M-2 vehicle was held last week at the USAF experimental track branch.

The test, a contractual demonstration was to demonstrate that the various components would accomplish their required activities in the proper sequence. The required actions all performed, however, not in the proper manner so that another demonstration will be scheduled for a later date.

The system, made by Weber Aircraft Corporation of Burbank, California, was designed to have the capability to safely eject the pilot at speeds from zero to one hundred knots and at altitudes of ground level to 10,000 feet. This range will cover the expected flight areas of the present M-2 vehicle.

The system consists of a standard aircraft ballistic ejection seat, already in use on the USAF T-37 aircraft, that has been modified to provide the NASA desired capability. In order to provide for zero altitude, zero speed ejection, a rocket catapult, manufactured by Rocket Power, Inc., and a seat-man separator have been added. A standard 28 foot parachute provides the safe descent portion of the ejection

system.

The static test, conducted by Weber Aircraft, was an actual demonstration with the ejection seat and component parts mounted in a stationary vehicle. A standard dummy wearing the parachute was positioned in the seat to act as the simulated pilot.

Seat ejection force was provided by the rocket catapult which boosted the seat and dummy along fixed guide rails to ensure proper trajectory. The total rocket burn time was approximately .4 seconds but this was sufficient enough force to eject the dummy to over two hundred feet above the vehicle.

After ten inches of seat travel, the seat-man separator ignited, starting the process of separating the dummy from the seat. Approximately 5/8 of a second after catapult initiation, the dummy physically began automatic separation from the seat. This action also served to pull the lanyard on the parachute which started its deployment through the use of a pilot chute.

However, instead of the intended man-seat separation, the dummy failed to separate soon enough from the seat resulting in a late parachute opening.

Had the test been completely successful, the dummy would have been safely descending in a fully operating parachute six and one-half seconds after initiating the ejection procedures.

Q: I think there were lots of local people.

A: Most everybody out there was ex-military. That's where they got their aircraft aeronautical-type training and everything. When the war was over they went to work at Langley and they came to Edwards. But that's where they came from. And they'd swap around a little bit, maybe. But there was a tremendous group of capable, cooperative people under Clyde Bailey and throughout the facility. The same thing with Ed Videan and his communications people and so forth. And I have nothing but great respect for the whole facility—even the janitors. No kidding.

Q: Yes. I guess you probably knew Jack Russell pretty well.

A: Oh, sure. I've got great respect for that man. Great individual. That guy gave them a lot more than he got paid for, I'll tell you. He was a launch panel operator. He flew in the motherships. There was no extra pay for that or anything, just part of his job.

Q: What were the living conditions like out here between 1959 and 1972? Had Lancaster grown very much from the early days by then? Was housing very readily available, or was it still pretty scarce? What was it like just living around here then?

A: We transferred out here from Wright Field in 1950. And, there again, Paul Bikle said, 'Whitey, would you come out to Edwards?' I was still in the military, and he had taken over the job as technical director. Bikle was in the Air Force side of the house. So we transferred out here from Wright Field. And there was no housing on the base. We just stumbled up on a little place in Rosamond that would do. The one in Rosamond was just four walls, and we were extremely grateful to get it. We lived there until they built housing on the base. The one that they built on the base was entirely suitable. We had a three bedroom.⁴

Q: And then when you moved to NASA, obviously you had to move off base, I presume. What kind of housing did you find then?

A: Well, when I moved to NASA I went to Palmdale and bought a house. And so I can't really comment with any degree of knowledge or recollection about Lancaster. I think Palmdale probably had more vacancies than Lancaster. Now that's just a guess on my part. I didn't live here. I don't know.

Q: And you've already commented on the period when you were in the Air Force, that there was a great deal of cooperation between NASA and the Air Force down at South Base. Did that continue after 1959? Was there still a lot of cooperation in the new facilities NASA occupied in 1954?

A: Paul Bikle had been the head engineer at Edwards, working for the Air Force, when he moved to NASA. With him over there knowing everybody and with me over there knowing everybody back at the Air Force where I came from, I thought we had real

⁴ Bill Whiteside said the address was 1401 Community. His father planted a cottonwood twig in the backyard and watered it, and it became the largest cottonwood at Edwards.

M-2 Holds Rocket Firing Tests

A static test firing of one of the rockets mounted in the rear of the M-2 Lifting Body was made last week on the edge of the lake bed.

The rockets, secured from the U.S. Naval Station, China Lake, produce 240 lbs. of thrust and can be fired for 10 or 11 seconds. They use a solid propellant.

The rockets will be mounted on the rear of the vehicle to be used at pilot discretion to cushion the landing touchdown.

good cooperation. I could go over there and get wheels and tires or anything I wanted anytime I wanted it. In addition to being retired, I used all their facilities, like their commissary and their dentists. You couldn't help but sense the fact that they're civilian and military. And they each have their own prideful manner of doing things and what-not. But I didn't see any lack of cooperation.

Q: And that extended to the lifting body program, where the Air Force was a partner in that all along. Many of the pilots were Air Force. The motherships were still Air Force, weren't they?

A: Yes. And that's where Joe Vensel and Joe Walker and Paul Bikle came in at their shiniest, as far as I'm concerned. They blended the Air Force people right into our place. They willingly came over there and ate lunch and visited with us. And they had the run of the place. This is my recollection—that we had a very cohesive Air Force/NASA relationship for many years there. Originally there was maybe looking askance once in awhile. But NASA flew chase for Air Force and Air Force flew chase for NASA. It was interwoven, in my opinion.

Q: And I guess you retired about at the end of the lifting body program. So you experienced that whole program.

A: Yes.



The M2-F1 rocket test fires its landing rocket on the lakebed. If the vehicle was descending too fast, the rocket would slow the descent. (E-10254)

Q: Would you say that the lifting body program was the highlight of your NASA years, or did you have much to do with the X-15 flights in those years?

A: Well, up until Vensel left I was his right arm. He'd say, 'Why do you do this? Why do you do that?' So I would go talk to somebody or go down [to] the hangar or go to Los Angeles. I was his go-fer, you might say.

With the X-15, I might come in at three o'clock in the morning and check out weather. I'd go out and check the lakebeds the day before a flight. We'd get in the old Gooney Bird [R4D] and make sure people hadn't exploded a bomb where we intended to land. I was the out-of-the-area guy that kept my finger on the pulse of equipment available to us to make a successful flight. I used motorcycles and airplanes

and cars and everything else, so that Joe Vensel could come in at four o'clock in the morning of a launch flight and say, 'Whitey, is everything ready?' And I'd say yes. So I was the fixer-upper, make things happen in the facility or [the] launch.⁵

Q: And did you go out to the distant lakebeds where landings were made sometimes, and check those out?

A: Oh, Joe Vensel had to know the status of those landing lakebeds. The day before, I had to know it so I could tell Joe Vensel. I might telephone or I might drive out there.

⁵ Bill Whiteside said that his father would sometimes come home and say, "I have a real problem taking my pay today." He'd been out checking the lakebeds or flying in the C-47. One day he came home and said he had an especially hard time taking his pay, as he had flown in the backseat of an F-104B. He was a big fan of Kelly Johnson and the F-104, thinking it was the greatest plane around. He was about 50 then, and it was a tremendous thrill.



The Pontiac Catalina convertible and the M2-F1 in an FRC hangar. The Pontiac was used for support activities, such as tire testing, after the M2-F1 program ended. (EC92-04152-01)

Or Bill Dana and I or most anybody might fly out there and see. It was my responsibility. I was responsible to Joe Vensel.

Q: Mud Lake and places like that?

A: Yes. I would go out there with a radio vehicle. And when I got there and the runway was dry enough to land on for tomorrow's flight, we'll say, I'd immediately call him on the radio and say, 'Schedule it.' I was the eyes and ears of off-base facilities.

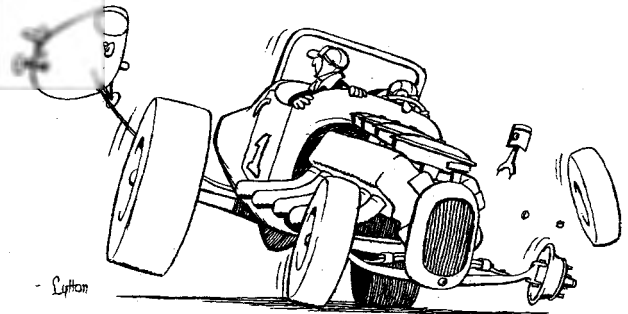
Q: I think you indicated that you drove just about all the Pontiac tow flights for the M2-F1. So they must have not done that when they were flying the X-15, or you couldn't have done both things.

A: You couldn't do them at the same time. It just isn't logical to have those two things going together at the same time.

Q: Do you remember any other programs that were going on between 1969 and 1972 when you retired, besides the lifting body?

A: I always raced desert motorcycles. I rode motorcycles back and forth to NASA. I've always been a go-fast nut. So when it came time to tow the M2-F1—Bikle came to me and said, 'Whitey, we need a tow car to tow the lifting bodies.' I had followed the races and I knew where all the shops were. I'd had cars of my own that went fast and motorcycles that went fast. So I broke loose and just took off and went all over southern California looking for what can put the most horsepower to the ground so that it can tow something out on the lakebed. And the Mexican road race had been won by Pontiac [for] two years at this point in time. And I knew Troy Rutman and all the guys that were involved with this kind of thing.

So I made the rounds. And I ended up in the Motoday building down in North Hollywood with the Pontiac West Coast management staff. And I said, "This is not for publication, but the government wants to buy a tow vehicle of the caliber that you've been letting your out stations build and publicize. We can't publicize this. We want to buy a car and



STEP ON IT WHITEY, HE'S GAINING ON US!!

build a car that will do, and we don't want to spend a whole lot of money."

So to make a long story short, I went around to all the speed shops. And I found out what tires will withstand 180 miles an hour and what wheels. And so we bought a whole bunch of wheels and tires so that you could change the Pontiac to go 150 miles an hour or 130 miles an hour. We only bought three or four sets, so you could change them. In 30 minutes you could make the Pontiac tow something 100 miles an hour or 150 miles an hour. I took it and had roll bars put in it so people could go with me—or so at least I could go.

So I talked to Troy Rutman and I explained what we were doing. 'We're going to tow things out in the boonies. And the engine's going to get tired.' 'How soon is it going to get tired?' He said, 'Well, of course, you know we only run them one Sunday, and then we take them apart and put them together again.' And I said, "We can't afford that. What can I do horsepowerwise, tirewise, brakewise, coolingwise, transmissionwise—what can I do to make this thing start up the biggest part of the time without spending a lot of bucks on it? We can't publicize it.' So he gave me a whole lot of points and I followed through on them. And that's how come I had two sets of tires, and so forth. But the Pontiac got tired after we made a certain amount of runs with it, just like he told me it would. And when it got tired, I pulled the engine out and sent it in and had it done by them. And they brought it right back up to snuff. By this time it's getting kind of grumpy. And you don't want to be towing a guy and have him in the air and have the engine blow up on you. So

Con-Tracks:

According to **W. W. Whiteside**, Flight Operations, there were three Wright Brothers. One of them is still awaiting landing clearance in the traffic pattern at J. F. Kennedy International. Winning

you anticipate things like this.

So I did all this. And I drove the Pontiac doing various things. [Then] of course, the Gooney Bird started towing the M2-F1, and the Pontiac was through. So we put it over in the corner and had no further use for it. Except once in awhile they would say something like, "Hey, Whitey, go down to the far end of the base where Fitz is going to take off with the lifting body."⁶

Q: That would be [Fitzhugh L.] Fulton I presume?

M-2 Begins Flight Test Program, 7 Successful Flights Completed

Flight testing of a wingless vehicle, referred to as a lifting body has begun at the Flight Research Center this past month. The tests are being conducted by center engineers to study the low speed flight characteristics of the vehicle, called the M-2.

The vehicle being tested is a lightweight research vehicle, however, its configuration is representative of a class of reentry vehicle that has been under development in NASA research centers over a period of about six years. The objective sought through this class of

vehicle is the attainment of maximum ratios of useful volume to surface area in order to reduce structural weight, as well as to reduce problems of aerodynamic heating while reentering the earth's atmosphere from a space mission. These vehicles, which have application to space ferry missions, are capable of maneuvering flight and of horizontal landing at a predetermined location on land. The vehicle under test was planned by personnel of the Flight Research Center in accordance with a con-

(Continued on page 3)

A: Yes. Fitz would come to me and tell me, 'I want you to be down there and I want you to track me, because I want to check my acceleration.' So I'd have the Pontiac down there with 165-mile-per-hour capability. I'd be right out on Fitz's wing when he'd release his brakes. He'd look over at me and beep his radio. And the Pontiac had a radio, of course. And I thought originally that, boy, I can stay with him for about halfway to liftoff. I was totally wiped out by how fast that big B-52 took off with something hung under the wing. The Pontiac didn't have a chance. By the time that I got to

6 Bill Whiteside recalled watching the car being built. It had the skin off when it was being worked on. He also recalled a time when his father took the headers off and started up the car in the driveway of his home. Because of the sound made by the engine, the entire neighborhood came out.

150 miles an hour he was long gone. We had a lot of fun in those days.

Q: And he, of course, was the pilot for the majority of the X-15 launches. And did he also fly the lifting body flights a lot?

A: If no one's written a book on Fitz, they're missing him. Because he's so quiet he's not going to tell you anything unless you pump it out of him. Tremendous, tremendous gentleman, pilot. Just—he's my hero. He's the way that they ought to be built.

Q: But he did fly a lot of the lifting body mothership flights?

A: Oh, yes. Oh, yes. Tom McMurtry, I think, liked that part of it too. And he flew with Fitz a lot. Very gifted bunch of pilots. Of course, they were hand-picked over and over until they finally made their selection. Bill Dana would have to be way up at the top and Fitz Fulton would have to be at the very top in my book. I don't want to hurt anybody's feelings, but Fitz fought wars and retired from the Air Force. And Fitz is just outstanding. I've never known anybody that I respect as much as I do him—in all areas.

Q: Okay. I think we've got most of the Pontiac story, unless there's more you want to say about that.

A: Only that we used it for many purposes after it no longer was needed. So for the lifting body, people would do different tests with it, like tire testing for one thing. You don't run many tires to 200 miles an hour and then 60 miles an hour. And we used it, like I said, for the pictures. They would send me out if it was doubtful about a lakebed at Tonopah, Nevada or wherever. They'd tell me to jump in the Pontiac and go out there. I could come in on the side roads and drive stakes in the ground and see if the lakebed was suitable or not, rather than exposing an aircraft to go out there and land and maybe get stuck. We had an airplane get stuck out there once.

Q: And whatever finally happened to the Pontiac?

A: They put it out on Wallops Island [Wallops Flight Facility, Wallops Island, Virginia]. They had wet and dry runway tests back there. And they'd put different tires on the Pontiac and go 100 and slam on the brake. But it stayed at Wallops Island for a long time. I don't think anybody ever really needed the top end of it like I built it for. And they might have loaned out that big engine and put a smaller one in. I don't know. But it died at Wallops Island some years ago.

Q: Is there anything else that I haven't asked you about that you'd like to tell about your years, particularly at NASA? Any people we haven't mentioned that you want to single out?

A: In mass, in total, I would say that when I worked there it would have been hard to find a more respected and respectable, capable, dedicated group of people than was

NASA Seeks Lifting Body Study Contract

The National Aeronautics and Space Administration is requesting proposals for a six-month preliminary design study of a manned lifting reentry vehicle. The Flight Research Center's Procurement and Supply Branch this past week submitted the request for proposals to 16 industrial firms. The competition is open to all qualified companies.

The study is intended to investigate a vehicle that has as its sole mission the investigation and basic research involved with the reentry of a manned lifting body from orbital flight. As such, the study vehicle would be of limited complexity with a one-man crew and minimum cost.

The primary objective of the study is to determine problem areas and their influence on design and to provide accurate estimates of the weight, cost, and developmental schedule of such a research vehicle. To assess the problems and verify these estimates, the contractor will be required to perform a detailed preliminary design of the vehicle.

For purposes of the study, the design mission of the lifting body research vehicle would consist of a launch from Cape Kennedy with a global flight to a landing on a dry lake bed near NASA's Flight Research Center. To ensure low costs, the study mission details are specific in the proposal requests.

Closing date for the submission of proposals is March 1, 1965. Two separate fixed price contracts for approximately \$150,000 each are expected to be awarded by April 1, 1965.

out there when I was there—clear down to the janitors, the lady in the cafeteria. Other people may see it different. But that's a personality thing as far as I know.

Q: Oh, I think you've given me a lot that is of value. So I really appreciate your taking the time.

A: My pleasure.

Eight Industrial Firms Bid On Lifting Body Study Contract

Procurement Officer, Steve Kucharik has reported that a total of eight industrial firms have responded to the Flight Research Center request for bids on a manned lifting body study. The request for bids was issued in January and the closing date for bids was March 8.

The eight industrial firms included McDonnell Aircraft Corporation, Douglas Aircraft Company, General Electric Company, North American Aviation, Northrop Corporation, General Dynamics, Lockheed California Company, and the Martin Company.

The study is intended to investigate a vehicle that has as its sole mission the investigation and basic research involved with the reentry of a manned lifting body from orbital flight.

For the purposes of this study, the design mission of the lifting body research vehicle would consist of a launch from Cape Kennedy with a global flight to a landing on a dry lake bed near the Flight Research

-3-

Walter W. Whiteside, as assistant to the Director of Flight Operations, is concerned mainly with ground communications to aircraft. "Whitey" has had a very interesting and happy life at the Center since his arrival in March, 1960. Before coming to NASA he spent 26 years in the Air Force, retiring as a major. Whitey, who is currently renovating a Model A Ford, will be moving up the coast with his wife to live near Pismo Beach. His future activities include digging clams, fishing and riding sand dunes on his motor bike.

EX-PRESSIONS

CONGRATULATIONS...

Rioters Can Lose Employment Rights

The Personnel Office reports that the recently enacted Public Law 95 can have a major effect on employees involved in rioting. It states that an individual shall be ineligible for federal employment for five years if convicted by any Federal, State, or local court of competent jurisdiction of —

- (1) inciting a riot or civil disorder;
- (2) organizing, promoting, encouraging, or participating in a riot or civil disorder;
- (3) aiding or abetting any person in committing any offense specified in (1) or (2); or
- (4) any offense determined by the head of the employing agency to have been committed in furtherance of, or while participating in, a riot or civil disorder.

Say Goodbye To:

It's gone. Just like that. Without giving us a chance to wave goodbye or anything, they came and picked it up in a big airplane for delivery to NASA Langley.

No longer does the Center have its own Pontiac convertible. No longer can we lie to visitors and tell them we use it to take the secretaries out to lunch. No longer can we drive along the lake bed and pass the airplanes in flight.

Purchased originally in 1962, the Pontiac was used to tow the M2-F1 lifting body on the ground. Because of the M2-F1's weight, a lot of power was required to get it up to flying speed. For this reason the Pontiac was selected, because of its powerful engine. But its basic engine still wasn't enough.

So the Pontiac was taken to a garage specializing in increasing performance. Special racing tires were added. When fully modified, including roll bars and radio equipment, gasoline mileage wasn't so good, about 4 miles per gallon.

But by itself, according to driver Walter Whiteside, it was capable of hitting speeds of almost 140 mph. With the 1000-lb. M2-F1 lifting body in tow, it could get up to speeds of

(Continued next column)



Joe Vensel (left) shaking hands with Walt Williams in 1956. Whiteside worked closely with Vensel before and after coming to NASA in 1960. (E56-2461)



The Pontiac and M2-F1 on the lakebed, ready for another tow flight. Whiteside's background came in handy when a tow car was needed for use in the program. (ED96-43663-1)

Three Pilots Make Their First M-2 Flight At FRC

Three pilots, including the first man to fly faster than the speed of sound, made their first flights in the M-2 lifting body research vehicle this past week at the Flight Research Center. The three pilots, Air Force Colonel Charles "Chuck" Yeager, NASA's Bruce Peterson and Donald Mallick, underwent the familiarization flights in the unique vehicle under the direction of NASA's M-2 project pilot Milton Thompson and project leader Victor Horton. Until this time Milt Thompson had been the only man to have flown the M-2.

Col. Yeager, who is now the Commandant of the Aerospace Research Pilots School at Edwards, made history when he became the first man to exceed the speed of sound. He piloted the Air Force-NACA X-1 to a speed of 700 miles per hour, Mach 1.06, on October 14, 1947. His top speed in the M-2 probably did not exceed 125 miles per hour.

No stranger to flight in unique vehicles, Bruce Peterson is the current project pilot on NASA's paraglider. He has made more than 120 flights in the unpowered research vehicle with which NASA is evaluating the flex-wing concept for possible use in the recovery of

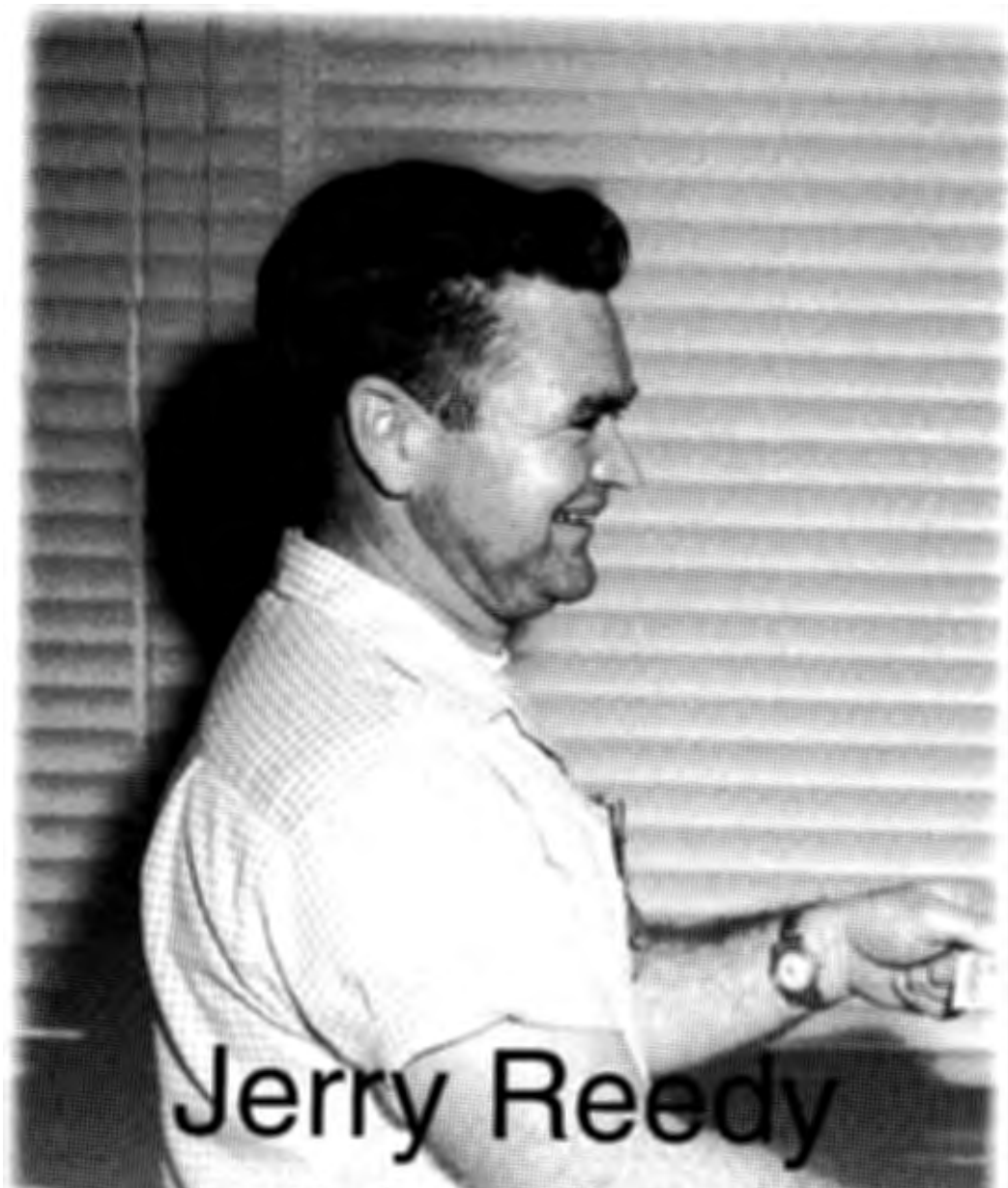
space vehicles and rocket boosters.

Don Mallick, a research pilot formerly with NASA's Langley Research Center, is also currently assigned as co-project pilot on the airborne variable stability program that the Flight Research Center is conducting with the Jetstar aircraft.

The M-2 was towed to an altitude of about 12,000 feet by another aircraft, a C-47. It was then released for glide flight back to earth. The lifting body concept is under study by the Center and other NASA facilities as a possible future space vehicle that is capable of landing on earth under pilot control.

Co-Ops Return To School

Eight students from Iowa State College are returning to their school after spending six months at the Flight Research Center as part of the NASA Co-op Student Trainee Program. The students, Richard Woodward, John Merris, David Klinger, Eugene Strand, Allen Clark, Sheryll Goecke, Emma Jaycox and James Cooper worked in various technical capacities at the Center. After six months of school, the students will return to the Center for another six months of on-the-job training.



Jerry Reedy

Interviewed by Curtis Peebles, April 4, 2001

Jerry Reedy was among the many people working long hours behind the scenes to make research projects undertaken at the Flight Research Center possible. One of the most important resources that pilots and engineers could call upon was the experience of the machinists, technicians, and mechanics at the center. This had been true from when the NACA facility was first established at Muroc Army Air Field, and continues to the present day. In many cases, technicians have worked at the center for three and four decades without interruption. The first research aircraft Reedy worked on was the X-1E. He began working at Dryden in 1957, first as a NACA employee, transferring to NASA when it was established, and finally as a contractor. The end result of a career like Reedy's is that ensuing support personnel have a body of experience, an "institutional memory," to draw upon for each new project to which they are assigned. The task at hand may be something no one has ever attempted, but with the magnitude of experience Reedy and others like him had contributed to the knowledge base, potential solutions soon present themselves. In 2006, Reedy was awarded a NASA Exceptional Public Service Medal for "a lifetime of innovative technical achievements on generations of NASA flight vehicles, from the X-1E and X-15 to the space shuttle orbiter."

New to the Station during the past two weeks are:
Evelyn C. Swope, clerk typist in Personnel from Boulder, Colorado; Don L. Wilson, an Aero Test Technician in Experimental Stability and Control; Alan F. Gaffaney, Aero Test Technician from Orinda, California; Lt. Ronald Tambor, Aeronautical Research Engineer, previously stationed at Mitchell Field; Jo Ann H. Dougherty, clerk typist in Procurement and Supply, from Lancaster; Barbara E. Starr, of Palmdale, a clerk typist in Flight Operations; Sylvia M. Wright, clerk typist in the Library, living in Lancaster; Jerry S. Reedy, living at Edwards, an aviation metalsmith; Nancy L. Haley, clerk typist in Procurement and Supply from Lancaster; and Natalie Tambor, Library clerk, living in Lancaster, formerly of New York.

Q: Let's begin with your background. I understand as a child you built real airplanes?

A: Yes. I used to come home from school, and there would be a flap or an aileron or something lying on my bed. I'd ask my Dad, 'What's that flap doing on the bed?' He said, 'Son, that's gotta be fixed before you go to bed tonight.' So I had to help him out a lot, I guess, and he helped me out a lot too.

Q: This was in the 1940s?

A: Yes. About 1942 and up to 1945. In 1945 my father bought 350 AT-11s and some AT-6s [trainers]. He restored them and sold them to South America. So I had to help them a lot on those.

Q: What was your education?

A: Well, I finished high school and then I went in the service. When I got out of the service I put two years into college. Then I went to welding school, and then NASA sent me to aircraft and missile welding school to get certified. Then I came back and I did welding there. Then I was over [at] the sheet metal shop for quite a few years. When they asked me if I wanted to take over the sheet metal shop I told them that the only way I'd take it over is if they'd let me keep working on the airplanes and do things that I'd been doing before. So they agreed to do that, so I kept that. Then I told them if I had to I'd take my homework home at night and do my paperwork, and then I could do my other things at work.

Q: I understand the first project you worked on was the X-1E. Could you describe what you did?

A: Yes. When I first hired in here I came here at about three o'clock in the afternoon to see if I could get a job. They said, 'Yes. When can you go to work?' And I said, 'Well, right now.' And they said, 'Well, it's almost quitting time. Be here in the morning at seven.' So I came back at seven and I did my physical at the Air Force. Then when I came back they called me out to the X-1E and wanted to know if I could put a floorboard in it... The control cables and everything [were] open. So I looked at it and wheels started turning in my head, and I said, 'Yes. I can do that.' They said, 'Okay. Go ahead and do it.' So I went ahead and I made it all up. Then I had a boot made for the stick and [it came] out real good. Then later on I found out that they had money bet that I couldn't do it, because three other people had tried starting it and they never got it finished.

Q: And, of course, with the cables exposed there was always the possibility of them getting jammed from something falling in there.

A: Yes. They would take the catwalk [in the B-29] back to the X-1E when they put the pilot [in]. If the crew chief dropped anything out of his pocket down inside of the aircraft it would get under the cables. They'd have to cancel the flight because they couldn't find it.

FOUND: Blue and silver
Parker pencil. Contact
Tom Baker, ext. 41701.

WANTED: To join car pool from
J-14 and 10th Street West in
Lancaster. Contact Elva
Lilley, ext. 46931.

FOR SALE: Apartment size G. E. electric
range, white, 4 burners, full size oven.
Used about 1 year. \$70. Jack Alpers,
49361 or Windsor 7-3842.

ATTENTION SINGLE FELLOWS!

WANTED: To share two bedroom house
(furnished) at 44143 N. Fig Street,
Lancaster. \$70 per month (rent,
utilities, and cleaning woman twice
a month). Only nominal references
required. Call: Whitehall 2-3057
See: Alan D. Brown
(Research Engineering)

WANTED: One-year old dachshund (male) needs
a good home with children to play
with. Has had shots, etc. See
Bob Rhine, Photo Lab, ext. 46211.

'SKYROCKET' STORY TO BE ON TELEVISION

The Douglas "Skyrocket" D-558-II project story will be presented on "Navy Log" on
Wednesday, May 8, immediately following the "Disneyland" series.
Much of the film work for the presentation was done at EAFB last November.

Then they'd have to take the pilot out and then walk back up and then come back and land.

Q: You couldn't just put a floor in there. It had to have clearance. It couldn't jam the cables.

A: That's right. Also, it had to fit the seat too. So it had to drop down to go underneath the seat and go up to where the rudder pedals were.

Q: So it wasn't just a flat plate.

A: No. It wasn't a flat plate. Also, the sides of the aircraft are rounded and it tapered to the front; you had to add structure in there to hold that up too. So it took a little while but it worked out real good. It is still in there today.

Q: When exactly did you start working here?

A: It was in June 1957.

Q: That was toward the end of the D-558-II program.

A: Yes.

Q: Did you do any work on it?

A: Not the flying one. But they had a lot of panels missing, so when they shipped them out of here they wanted to put all the panels and stuff back on that was missing. So we did a lot of panels to get them ready to go to the museum.

Q: You also worked on the B-29 drop planes, is that correct? What did that involve?

A: Well, part of it was that one of the props came off and went through the side of the airplane. There was still some major stuff needed to be done on that that they hadn't finished. I did a lot of work on that and just a lot of routine maintenance and stuff over the years till they got rid of them.... All the time I was here, any panels to be replaced or instrumentation or anything [that was] put in it—we had to do that, and keep up the maintenance on it as long as they had them.

Q: What did you do in connection with the X-15 program?

A: I did a lot of maintenance on the X-15. But when they first came here we got the B-52, and the pylons to hold the X-15 [were] NASA's responsibility and the aircraft was Air Force's responsibility. So I maintained those. At the time, the Air Force kept the airplanes in their hangars. So we had to go down there to work on them. So we took our tool box stuff, stayed down there and worked on them. Then when they came up here, I worked on the X-15's. They told me they needed a work stand for the seats because they had to extend the stabilizer arms—so when they blew the seat out, that the arms would come out and stabilize it at high altitude. So they asked me to make a work stand. So I made a work stand for that. Then after that I had maintenance on all three of them, all the time we had them. Then we did some leading edge work on it. So I had to make some segments out of Inconel-X for the leading edge.

Q: Was that when the skin got too hot, and expanded?

A: They cut the leading edges, and then we made some special segments to go on there so it could expand.

Q: On Pete Knight's flight—the Mach 6.7 flight—there was the burn-through on the lower fin. Could you describe what happened?

A: Yes. We made this ramjet out of about 3/8 [inch] plate steel. It was a dummy ramjet and we hung it on the bottom of the X-15 to see how it would work. When it came back, we pulled it down in the old paint hangar and got to looking at it. I don't know really what happened, but it burned a hole through that 3/8 plate like a cutting torch went through there...Kind of amazing how it burned through that 3/8.

Q: What were some of the other things you did on the X-15—just a few examples?

A: A lot of the instrumentation. In fact, the biggest part of the instrumentation had to be added. There wasn't much room in it to add a lot of instrumentation. They had the instrumentation bay, and everything had to go inside there. So it was quite a job, because only one guy at a time could get in there, so we had to share it with everybody else.

Q: You had to shoehorn equipment in.

Base Devises New Civil Defense Plan

Arrangements have been completed for NASA employees to join with the Air Force Flight Test Center in a Civil Defense Survival Plan.

AFMTC Civil Defense officials have established a plan to evacuate all Edwards personnel and dependents to the Borax Mine in Boron in the event of an emergency. Since no funds are available to stock food supplies and other necessary items, a base-wide collection will be made from military and civilian personnel on Jan. 2.

FRC employees who wish to participate in the plan are requested to contribute \$1. This will provide sufficient supplies for the employee's family for a period of 14 days.

Payments should be made on Jan. 2 to the employee's time and attendance clerk or to the Administrative Management Office. A roster will be maintained listing all persons who join the plan.

Further information on this plan may be obtained from the Administrative Office.

PARESEV TUMBLES...

Bruce Peterson, aeronautical research pilot, received minor injuries last week when the FRC paraglider went out of control and crashed on Rogers Dry Lake during vehicle tow tests.... The PARESEV is being rebuilt and is expected to fly again next month...Pilot Milt Thompson had made several successful free flights the day before the accident, being air-launched from a Super Piper Cub as high as 2200 feet.



The Paraglider was used to determine whether a spacecraft could be landed using a delta-shaped fabric wing. The research vehicle was assembled by Dryden engineers and machinists. (E-7914)

EX-PRESSIONS

FARESEV...

Stands for paraglider research vehicle and you'll be hearing and seeing more about this odd-looking vehicle later...It was built by FRC from a design by Charles Richard of the Vehicle and Systems Dynamics Branch..FARESEV will investigate flare characteristics of a similar recovery system designed to return spacecraft and boosters to Earth...Research Pilot Milt Thompson has been selected to pilot the vehicle..The project is being managed by Vic Horton...(X-PRESS had no available pictures of FARESEV this week).

PARAGLIDER IDEA TOPIC OF MEETING

The engineer who conceived the idea of recovering the Saturn booster by means of a paraglider will be in Antelope Valley this month to address the local chapter of the Institute of the Aerospace Sciences.

Francis M. Rogallo, head of Langley Research Center's 7by10-foot wind tunnel, will speak to local IAS members and guests on March 28 at the Antelope Valley Country Club starting at 8 p.m. Dinner will be preceded by a social hour at 7 p.m.

The paraglider is one of several systems being studied as a means of recovering the huge Saturn booster, now under development by NASA's Marshall Space Flight Center at Huntsville, Ala.

The Saturn would be attached to the paraglider and, prior to release, would be folded longitudinally between the booster's outer tanks. After ejection, the booster would be guided to a pre-selected landing area.

Further information may be obtained from Jim Martin, ext. 28291.

USE THAT LEAVE...

Paul Bikle, Center Director, in a recent memorandum encouraged supervisors to use a liberal annual leave policy during December..With the wet lake bed conditions and prospects for more rainy weather, it's a good time to use that leave you might otherwise lose.

IN TIME FOR HOLIDAYS...

Mr. and Mrs. Leslie Leer (Bendix employee at the Ely high range site) are the parents of a new son, Leslie Lewis IV, born Dec. 3 and weighing 6 lbs. 5 oz...Leslie is the Leers' first child.

BACK FROM SCHOOL...

FOR SALE - 1957 Plymouth 4-door station wagon, 18,000 miles, power steering and brakes. Good condition. \$2295. Don Wilson, Ext. 41971.

WANTED - To join car pool from Lancaster, vicinity of 15th Street West and Avenue J. Ray Jackson, Ext. 45191.

FREE - Black cocker spaniel puppies (males), 6 weeks old. Florence Doull, Ext. 43261.

FOR SALE - Toy poodles, 6 1/2 weeks old, pedigreed, AKC registered. \$150. Jean Simpson, Air Force Repts office, or 1244 Avenue H-12, Lancaster.

A: Yes, and then if somebody else had a little more prerogative than you—so we'd try to get out there early in the morning, to get in there before somebody else got in there.

Q: The paraglider research vehicle was NASA's home-built research aircraft. What was your involvement?

A: Howard Curtiss did the welding on it and I did the biggest part of the fitting of the pipes and stuff to make it. The machine shop made some of the cable pulleys and stuff, and we made the whole framework out of 4130 tubing and put tricycle landing gear on it. But at first Milt Thompson came to me and he says, 'Hey, Jerry, can you make one of these?' And he showed me a picture of a lawn chair with three little wheels on it, like a triangle with wheels on it. It had a parawing on top and it had a tilt stick coming down to steer it with. I laughed, and he said he went back to this college to see about this and he wanted to know if we could build one. I said, 'Yes, we can build one.' And he said, 'Well, we don't want it built out of a lawn chair.' They pulled it by car to get it in the air.

Q: One story I heard was that the blueprint for the framework was chalk marks on the floor. Was this true?

A: I don't remember exactly, but I'm sure it was because most everything we did, there was hand waving. They'd just do it on a piece of brown paper bag—just a rough sketch, and then we would get it made and then engineering would okay it.

Q: So, very little in the way of formal blueprints.

A: It was 'do it and get the job done.' If it works, that's it—if it doesn't, we'll do it again.

Q: Don't worry about reams of paperwork, in other words.

A: No, no. We got a lot done too. And in most cases it worked. Sometimes we didn't and we'd modify it and go again.

Q: And direct contact between the engineers and the shop people.

A: Direct contact. Sometimes they would call you on the phone and they'd ask you how you would do it and then you'd tell them how you thought you would do it. Sometimes they'd say, 'Okay. You go ahead and do it. We'll cover you later on the paperwork.'

Q: The M2-F1 lifting body was also home-built. What was your part in that?

FRC PARAGLIDER

A demonstration flight of the paraglider for members of the press was made on Sept. 13 at the FRC. The Paresev (Paraglider Research Vehicle) is being used by FRC engineers for study of its flight characteristics and the possible use for future vehicles.

Although there are similar parawing concepts, the Paresev is the first manned vehicle designed to be towed aloft and released like a conventional glider. As such, its flight program is providing much valuable flight data from the three following main areas: flare and landing capabilities; stability and controllability; and pilot training.

Having no power plant of its own, the paraglider was towed to an altitude of 5000 feet by a Stearman Biplane. Released, the craft was flown back to the Rogers Dry Lake bed in three minutes by FRC's project pilot, Milton O. Thompson.

The unique vehicle, weighing 660 pounds with pilot, is constructed of tubular steel and is topped by 150 feet of dacron, which serves as its wing and control surface. Pilot Thompson controls the flight path by tilting this wing up and down, and from side to side, causing the paraglider to follow a selected course on its glide to a flared landing. The paraglider is certified by the F. A. A. as an experimental aircraft.

Possible uses of the paraglider concept include recovery of future spacecraft and rocket boosters.

Paresev was built at NASA's FRC by FRC personnel. It was designed by Charles H. Richard of FRC's Vehicle and System Dynamics Branch. The Project Leader for this unique vehicle is Victor W. Horton.

Other members of the Paraglider Project include: Frank Fedor, Dick Klein, LeRoy Barto, John Orahood, Garry Layton and the members of the Maintenance and Manufacturing Branch.

An examination has been announced and applications are being accepted by the Civil Service Board, NASA FRC, for the position of Research Instrument Systems Mechanic. For further information, see the Personnel Officer.

Receiving his check out in the paraglider last week was Major Virgil "Gus" Grissom from NASA's Manned Spacecraft Center in Houston. Starting with some familiarization flights in a glider at Tehachapi, and then some actual flights on the lake bed being towed by both automobile and airplane, Major Grissom was always under the watchful eye of FRC's Milt Thompson, his mentor during this check out procedure.

A: A lot of that was metal work too. It had a metal tube frame in it and then the outside [shell] was made out of real thin plywood. It was started here and it was finished over at [the] El Mirage [airport]. A lot of woodwork went in it. We mounted the little rocket on the back, and made the canopy and stuff like that for it.

Q: The story I heard was that one corner of the hangar was walled off with canvas, and a sign that said "Wright Bicycle Shop" was put up.

A: I don't know who did that, but it did say bicycle shop—yes.

Q: What did you do on the XB-70?

A: I did a little instrumentation work, but I did a lot of work on the afterburner cans. They had them done back in Florida or Alabama—I think it was Alabama. When they got out here they wouldn't pass inspection. So we didn't have a big enough drill press, so we had to use a drill press at the Air Force. It had to drill out all the old rivets, and then put them back in. But we had to have a special rivet gun. It heated the rivets up to a certain temperature and then drove them. So they had a bucking bar with an electrode in it and the rivet gun and when you pulled the trigger it made contact. It heated up the rivet and you could drive it. We had to do every one of those over that they sent out here.

Q: It was a special, high-temperature metal.

A: Yes. So that's why you had to have a special gun made to drive the rivets, otherwise you couldn't drive them. I think that was one of the problems back there, because they [the rivets] were all bent over when we got them and they wouldn't pass inspection when they got here.

Q: I understand there were a lot of problems with the number one aircraft, such as the skin peeling off in flight. Do you remember anything along these lines?

A: I don't remember too much about the skin peeling off. In the number two aircraft they spilled some acid. Somebody didn't say anything when it was being built and it ran down in the wing root and ate that away. I don't remember what they did, but the manufacturing people went in there. I don't know whether they added something or what, but it was done when they were building it and nobody down at the factory said anything, I guess. When that etching acid ran in there, it started eating the material away.

Q: You talked about installing instrumentation. This was the recording equipment, the instrument panel cameras—things like that. What all was involved putting it in the aircraft? You had to connect it up?

A: The electrician did all the electrical part and we mounted it so they could get the wires run to it and then position it where they wanted it in the aircraft. I remember I mounted some rakes on panels that went underneath the airplane.

Q: You mentioned once that you saw Joe Walker the morning of the XB-70 accident.

A: Yes. Joe Walker. I met him when I first came here. I had the antique car and he al-

XB-70 To Become Joint AF/NASA Project

The 2000-miles-per-hour XB-70 jet will be flown in a joint project for the aeronautical research programs of the Air Force and the National Aeronautics and Space Administration, beginning next spring.

NASA and the Air Force have made an agreement for extended XB-70 flight research to obtain supersonic operational flight information which is impossible to get in ground facilities.

Information collected in the joint program would be more fundamental in nature than the design configuration data being obtained in the Air Force's flight evaluation program. The joint flight program is scheduled for first priority. Both NASA and AF pilots will be used.

Objectives of the joint program are to obtain information on aerodynamics, structures, and operational factors concerned with flight of large transport-type aircraft at speeds up to 2000 m.p.h. Among the items of interest are skin friction, stability and control, drag, boundary layer flow, air loads, thermal environment, sonic boom, landing and crew workload.

The new program expands

NASA's interest in the XB-70. NASA assisted Air Force in the conceptual and development phases of the project. NASA recently installed more than \$2 million worth of scientific instruments, recording equipment and other gear in the two XB-70 airplanes to obtain information about flight characteristics of large supersonic aircraft. This information is of value to the national supersonic transport program. NASA has \$10 million for the work in its FY 1966 budget.

The NASA Flight Research and the Air Force Flight Test Center will have joint responsibility in managing the XB-70 experiments.

C. W. Harper, Director of Aeronautical Research in NASA's Office of Advanced Research and Technology, said the XB-70, built by North American Aviation, Inc., is the only existing airplane approximating the size and weight of the projected supersonic transport and able to fly at speeds up to 2000 m.p.h. XB-70 No. 1 reached a top speed of more than 2000 m.p.h. Oct. 14, 1965. Two XB-70s were built and are flying regularly.

Extensive military and com-

mercial flight experience has preceded development of all classes of commercial airliners, but even military flight experience in the supersonic range is relatively limited, Harper explained.

Flight research in the XB-70 program will be concerned with a variety of problems of operation, safety, stability and control. The joint NASA-USAF effort will use an assortment of special gear, including thermocouples, boundary-layer rakes, cameras, microphones, accelerometers, and other instruments in the two XB-70 aircraft, together with data analysis and reporting.

ways attended antique car rallies that we had. So I knew Joe pretty well. I was over at the maintenance office early one morning, right after I came to work, and I was standing there looking out. It was really, really nasty weather. It was bad, cloudy and real windy. He came along and he said, 'Hey, Jerry, it's a bad day to fly.' I said, 'Yes. Are you going to fly?' He said, 'I've got to fly. They're going to take some pictures.' I said, 'Boy, it's a bad day to even take pictures, looks like to me.' He said, 'Well, we've got to get it over with.' That was the last time I talked to Joe. Joe was really, really a good guy as far as I'm concerned. The public liked him. He was a well-known figure around here in those years.

Q: What was the mood after the accident? What was the feeling?

A: It was real sad, really. It was really, really sad. For quite awhile it was sad. People didn't say a whole lot because it came as a shock, I guess. It [the photo flight] was supposed to be for [General Electric]. All the aircraft that were flying [in the formation] had GE engines. Joe was a good pilot. He was a good guy, a real good guy—good pilot. The F-104 evidently just porpoised up into the back of the XB-70. I don't know really, really what happened—whether wind currents or—you get odd weather when you get that close behind the airplane. They had to get pretty close to get all the airplanes in.

Q: You touched on this earlier, but what were the procedures during the 1960s on fabricating equipment? I get the sense it was fairly casual.

A: When I came here we never had much equipment or a lot of tools. You had to make a lot of your own tools and stuff to do jobs with. So I had a couple hundred pounds of bucking bars. They didn't have hardly any bucking bars here because when it was NACA, it was kind of operating on a shoestring because they didn't have the budget that they had later on.

Q: What's a bucking bar?

A: A bucking bar is to buck rivets with, to hold the airplane together.

Q: You put the bucking bar on the back so this keeps the rivet from going back out.

A: Yes—and put the rivet in and use the gun to drive the rivet.

Q: But almost anything that you needed you made.... And it took a lot of give. People had to communicate with each other and get the job done and that's what they did.

Q: And forget the paperwork.

A: Yes. You know, you had the paperwork eventually cover it, but it wasn't the idea it takes three months to get the paperwork to do an hour's job.

Q: What did you do on the YF-12A program?

A: The YF-12A? When I first went on that program I had to go into the systems. I went to school to Lockheed and the Air Force, and I worked about a year with the Air Force and

Lockheed before they'd give NASA an airplane. But when they did give us an airplane—my understanding was that we had to build them an instrumented airplane before we

Center Begins Joint YF-12 Program

A joint NASA/Air Force YF-12 flight research program has been initiated at the Flight Research Center. Gene Matranga is project manager for the Flight Research Center.

Under terms of the program, the Air Force will make available the two YF-12A aircraft presently in flyable storage at Edwards. Also included will be necessary spare parts and associated ground equipment, base support at the Edwards installation, and Air Force maintenance personnel.

NASA will budget for and fund the test program in an amount estimated at \$10 million through Fiscal Year 1974. NASA has requested funds for the program in Fiscal Year 1970, and, in addition, will use about \$4 million made available by completion of the X-15 and XB-70 flight programs.

Recent termination of the XB-70 program has left NASA and certain portions of the Air Force research and development community without a suitable

supersonic cruise research aircraft. The two YF-12A aircraft will help fill this research and development gap for both agencies.

The Air Force is seeking additional data on operational factors, development of procedures and establishment of limitations relating to command and control problems, and establishment of possible bomber penetration tactics against an interceptor with the YF-12A performance and capability.

NASA is seeking data on altitude-hold at supersonic speeds, boundary layer noise, heat transfer under high-speed conditions, airframe propulsion system interactions involving effects of engine inlet performance, and other performance and handling characteristics.

The new program is divided into two phases, with Phase I under Air Force control. This phase began with the recent signing of the Memorandum of Understanding, and will last for approxi-

(Continued next column)

mately two and one-half years.

For the NASA-controlled Phase II, one of the YF-12A aircraft will be loaned to the Center about six months after Phase I begins. Air Force will provide maintenance and air crew personnel for both aircraft for the first six months. Thereafter, NASA will provide most services and personnel for its on-loan aircraft. Contractor support will be provided for both phases of the test program. Joint USAF/NASA support provided will include mission planning, data reduction, reporting, test operations, and range and chase aircraft as required.

could get one. So I instrumented that aircraft, along with some Air Force personnel. Then we got ours, and then I did all the instrumentation on ours. But I think shortly after we got our YF-12A the Air Force crashed theirs. But when we got ours we had to go inside the fuel cells and cut holes and run tubing to run wires to the instrumentation on the other side of the wing. It was hard, hard work but, boy, I enjoyed it. I enjoyed every minute I worked on the airplane.

Q: What were the demands of working with titanium and heat-resistant, non-metallic materials on that aircraft?

A: It's real funny. The titanium is really strange because on that type of airplane they had two types of titanium. They had titanium A and titanium B. The B you could work with a little—it was forgiving—you could fold it and get a radius on it. But the A was really, really hard to work with. It would break. As far as drilling, you had to have special drills to drill it at real slow speeds. So we had a drill motor that had two speeds on it so we could drill it. Then we had to use titanium and stainless rivets in them.

Q: One story I heard was that you couldn't use pencils on the titanium because the graphite would etch the metal.

A: Yes. On the titanium you had to have a special pencil to write on it. Also, you couldn't use any cadmium plating. All the tools had to be chrome-plated, or if they were cadmium we had to strip all the cadmium off of the tools. I saw where somebody had put a cadmium washer on the aircraft. When [the aircraft] came back, the whole bolt was gone and there was a hole where it was put on.

Q: One story I heard was that Lockheed found out that the chlorine in the Burbank water system was causing welds to fail immediately. They were washing the metal in the tap water and there was a reaction with the chlorine in the water.

A: You're supposed to use distilled water to wash it with.

Q: What about like the fiberglass on the wings' leading edges?

A: The YF-12C [SR-71A] had plastic panels—what they call plastic—which were really made out of pressed asbestos. But we had an experiment they called a 'cold wall' that they hung on the bottom of the [YF-12A]. They had this cold wall—like a big old cannon mounted on the bottom—that hung down, probably six, eight inches. It was about 12 or 14 inches diameter. We had to chill that down as cold as we could get it and then go up to altitude and blow [the cover] off and see how long it took for the metal underneath it to heat up. Lockheed had come up with some rubber to glue the bottom of the airplane—high-temp red rubber—because when that tile blew off it would punch holes in the fuel cells in the wings. So they put that rubber on and it didn't work. They couldn't figure out what to do. So they had a bunch of engineers from Lockheed come up.

One day I was going to eat in the chow line, and Bill Albrecht was there with maybe 10 or 12 people from Lockheed. They were sitting there talking and I'm just standing in line and bobbing back and forth against the wall. Then Bill says, 'Hey, Jerry, have you got any

Con-Trails:

Vic Horton, Flight Operations, went to school for survival training prior to flying in the YF-12 program. He dislocated his shoulder while falling out of a life raft. **Bill LePage's**, Flight Operations, son has won his Army Wings and is on his way to Asia as a helicopter pilot. **Ralph Pernula's**, Data Systems, son is the starting center on the University of Wyoming's football team. Receiving Special Achievement and Quality Increase Awards last quarter were **Bea Corrington** and **Claude Favreau**, Administration; **David Gardner**, Research; **Geraldine Markey**, Biomedical Programs; **Charles Blake**, Data Systems; **Allen Klom-mhaus**, **Robert Allen**, **Clarence Haley**, **Alfred Walsh**, **Charles Linn**, **Ralph Cissell**, and **Larry Barnett**, all of Flight Operations.

YF-12 Cold Wall Flights Ended

October marked the completion of the flight phase of the YF-12 Cold Wall, hollow-cylinder experiment and the YF-12 inlet airframe interaction flight-test program.

YF-12 No. 935, which carried the Cold Wall, will continue to fly lower surface boundary layer research missions until it is put into storage at the Dryden Flight Research Center in January. Prior to this, it is scheduled to taxi-test a new landing gear control system the week before Christmas.

The Center's other YF-12, No. 937, is being modified with the Co-operative Air Frame Propulsion Control System (Co-op). The system, which will be flight-tested in March 1978, utilizes integrated control technology

combining the autopilot, auto-throttle and inlet control into a single coordinated system.

The integrated unit will permit supersonic cruise aircraft to maintain Mach number and altitude with much greater precision than was previously possible, test researchers report.

Co-op is designed to minimize "Mach and altitude excursions" induced by atmospheric disturbances on supersonic aircraft. Such excursions can cause aircraft performance loss and create air traffic control problems.

Additional plans in the overall YF-12 program call for the aircraft to be flown by almost all the Center's research pilots. Currently only Fitz Fulton and Don Mallick, along with flight engineers Vic Horton and Ray Young, are flying in the triple-sonic craft.

"Our research pilots gain valuable experience and broaden their background by flying a large variety of aircraft," explained John Manke, Chief of Flight Operations. "We want the opportunity to provide our pilots the experience of flying this very unique, high performance aircraft."

Propulsion Branch of Research's Propulsion and Performance Division, indicated that an important part of the program would be a special seminar to report on data obtained from the YF-12. The seminar is now in the planning stage, according to Albers, and is scheduled to be held here next summer.

Basic purpose of the YF-12 program, which began here in 1969, is to obtain information from sustained cruise flight at Mach 3 (approximately 2000 mph) and at altitudes in the 80,000 foot range. Data obtained from the program is being used to provide the technology necessary for the development and operation of future supersonic aircraft.

NASA

National Aeronautics and
Space Administration

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U.S. AIR FORCE

STAR

The cold wall experiment, beneath the YF-12A. The rectangular area on the plane's belly, the copper screen/RTV protective coating, was Reedy's idea (ECN 15248)



Following a May 10, 1967, crash, the M2-F2 lifting body was repaired to make it flyable again. The Dryden metal shop assisted in the effort by producing a large number of ribs. (E-16781)

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Damaged Lifting Body to be Partially Restored

Authorization has been given by NASA's Office of Advanced Research and Technology to partially restore the primary structure of the M2-F2 lifting body to permit its removal from the inspection jig and return to the Flight Research Center.

After the M2 lifting body was damaged in a landing accident on May 10, 1967, Northrop Norair made a detailed inspection to determine the extent of the damage.

The inspection required removal of the outer skin and portions of the secondary structure. The primary structure was placed in a jig to check alignment and to determine what parts were reusable. The M2 is still in the inspection jig pending completion of the inspection, which is expected in the next 60 days.

The M2 structure is expected to be returned to the Flight Research Center in late summer where it will remain pending a decision from the Associate Administrator, NASA Office of Advanced Research and Technology, on its future. This decision will depend on the results of studies, now underway, which will define the future research work required for lifting bodies on the basis of the flight results and other experience obtained from both the M2 and HL-10.

idea how to fix that?" I said, "Yes, Bill, I know exactly how to fix it." He said, "You do? How would you do that?" I said, "Well, I already figured it out, Bill. First I'd put RTV¹ on the bottom of the aircraft, then I'd put a copper screen on it and then just build up the copper screen with red RTV, which is real high-temp."

He says, "You think that would work?" I said, "Yes, I know it would work, Bill." He says, "How would you attach it?" I said, "I already figured it out. I've got metal stuff cut and everything. I already know what to do." He says, "Well, I'll let you know this afternoon." He called me about two o'clock in the afternoon and I already had all the parts cut and everything. He said, "Go ahead and do it." They did it and it worked perfect. I got 50 dollars for doing it, so it worked out perfect. After that what would burn off, we'd just add more back on and come back.

Q: Were there any other projects that spring to mind?

A: Well, the HL-10 lifting body [at Dryden] on the pedestal—we completely redid that. It went down to L.A. and they dropped it 65 feet—it hit upside down.² When they brought it back, I understand that they wanted \$3 million dollars to restore it. ...at the time I was over at the sheet metal shop and I said to pull it down there, and in our spare time we'll restore it. They sent a guy out from Smithsonian and it [the HL-10] evidently belonged to them because he wanted to see what [we] were going to do. And he asked me not to drill any new holes in it. I could utilize anything in it that was already there to mount it.

Q: When the M2-F2 crashed—Bruce Peterson's accident—the structure was very badly damaged. Were you involved in the restoration and the conversion to the vehicle?

1 RTV stands for "Room Temperature Vulcanizing," a flexible plastic material that comes in a tube and is used for sealing, as adhesive, or in forming gaskets.

2 The HL-10 was to be displayed hanging from the ceiling of a museum. As the lifting body was being raised, the accident occurred.

A: No. I think they sent it back to be done at Northrop. I know we made a lot of ribs. We used to make our own ribs and then we'd heat-treat them. At times like that we'd get a lot of people involved when we were slack on work. We'd teach them a little bit of metal work too, or at least get them to help us.

Q: So you could do repair work or any work that was necessary on a project without having to go to the contractor.

A: Yes. Also, in the 1960s, 70s, and maybe clear up in the 80s, the capability here was fabulous. You could get anything made—anything, I don't care what it was—or any problem solved. They had engineers and people that could solve any problem or make anything. And I mean they could make anything.

Q: You could do it all in-house.

A: It could be done right here. We had the knowledge. Then later on—I hate to say this—but later on, it got where it got more [tight] and they didn't give the people the privilege of going out and doing the job—more paperwork and more safety.

Q: You touched on this earlier. How have the processes you go through to make modifications changed between now and the way it was when you started here? More paperwork?

A: Yes. Modifications back in those days were hand waving, more or less, and verbal—how to do it—or if you knew how to do it, go ahead and do it. If it works, we've accomplished something—if not, we'll do it till we accomplish it. But nowadays I don't think they start anything till they get the paperwork. But years ago—I've been called by the Center Director to do new jobs, like that sign in the front of the main building [on the Dryden campus]. They wanted to take the "worm" [the NASA insignia from 1975 to 1992] off before Administrator [Daniel S.] Goldin came out here. So I got a call and they wanted to know if I could take care of that problem for them. I said, 'Sure, I can.' So I put all new stainless up there, and made a "meatball" [the NASA insignia before 1975 and after 1992] out of aluminum that stood out about an inch and a half, two inches and then put the meatball decal on that part of it and then put the lettering on. And it's still there and it looks good. Also, Howard Curtiss and I made all the stuff to mount the X-1E on the lawn—it was a lawn at the time; now it's rocks.

Q: Okay. What are the project or projects that you thought were the most fun that you worked on over the years?

A: Well, they've all been really fun. I've enjoyed it, or I wouldn't be here now. I enjoyed everything I've worked on. But the hardest and the one I felt I accomplished more on was the SR and the YF-12. It was really, really hard work. But a lot of times I stayed over on my own and [did] work just to get the job done because I enjoyed it so much. The time went by so fast that the day was gone before you realized it. I just liked to keep going and I kept doing it.

Q: And was that the most demanding or difficult as well, do you think?

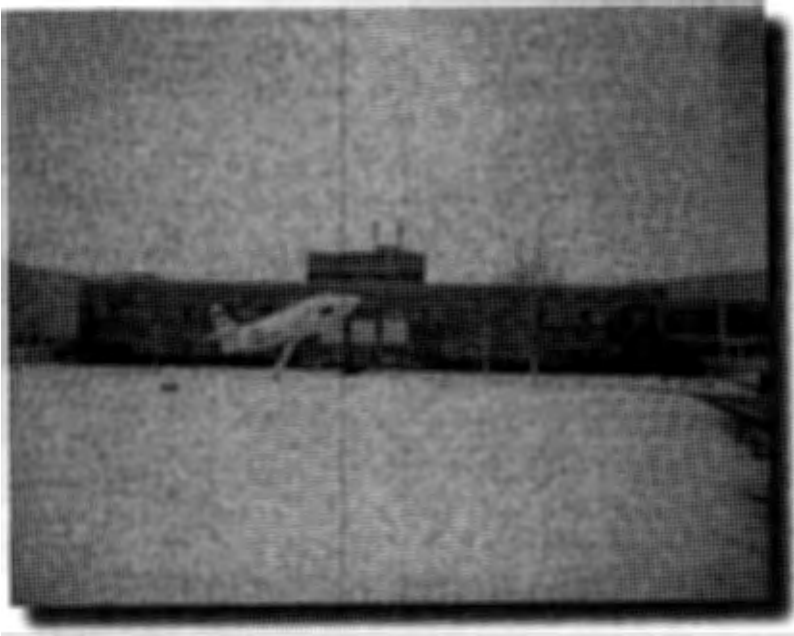
Only One More Week To Go For Summer Picnic

Next Friday is the last opportunity for all employees and contractors of the Flight Research Center to obtain tickets for the 1967 summer picnic at reduced prices. If the tickets are purchased at the entrance of the park they will cost more.

Admission tickets will be required for all persons five years and older. If purchased at the Center from the division time and attendance clerks, they will cost 50 cents apiece. If purchased at the park, they will cost 75 cents per person.

The picnic, which is sponsored by the Flight Research Center's Employee Exchange Council, will begin at 10:00 a.m. on August 5, at the Soledad Sands Park. Families planning on attending should bring their own lunches. Free refreshments will be served.

A full schedule of activities is planned that should provide plenty of fun and exercise for the whole family. Don't forget to bring bathing suits as there is a large swimming pool and a wading pool for the small ones.



The X-1E – the first aircraft Reedy worked on – on display in front of the Headquarters building on a snowy desert morning. Reedy built the floor on the aircraft as his very first job. (E-7939)

Paresev Goes To Museum

The Paresev, Paraglider Research Vehicle, which began its flight test program at the Flight Research Center in 1962, was transferred earlier this week to the Experimental Aircraft Museum.

The aircraft is actually being legally transferred to the National Air Museum of the Smithsonian Institute. However, the Smithsonian, while awaiting the completion of their new building in Washington, D. C., has loaned the Paresev to the EAA for display in the EAA's museum in Wisconsin.

The Paresev was constructed by Center personnel and officially registered as an experimental vehicle with the Federal Aviation Agency on February 12, 1962. Flight testing began almost immediately.

The Paresev was designed as a low-cost vehicle to make manned flights utilizing the Rogallo wing concept which was being considered for use as a recovery system of manned space capsules such as the Gemini spacecraft. The system was not used for this purpose however.

The Rogallo wing, triangular in shape, was connected to the Paresev by a universal joint. The pilot controlled the craft by tilting the wing fore and aft to control the rate of descent and from side-to-side to turn. A conventional stick and rudder system was used by the pilot on the latter version of the Paresev.

Initial flight testing was accomplished by towing behind a ground vehicle. This led to air tows using a bi-plane, a L-19, and eventually HC-1 Boeing helicopter. The Paresev was air towed to an altitude of approximately 10,000 feet where it was released for free flight. Landing speed was approximately 40 mph.

Flight testing continued through 1964. Over 100 manned flights of the Paresev were made.

Milt Thompson and Bruce Peterson were the project pilots on the program. In addition, NASA pilots Neil Armstrong, Jack Kluever, Gus Grissom, and Bob Champine also flew the experimental craft.

The EAA's Air Education Museum is a non-profit, tax-exempt institution that was established in 1955.

The Paresev will join such aircraft as a replica of the glider built by Octave Chanute, a 1912 Curtiss pusher, a Fokker triplane, a Sopwith Camel and a Nieuport 24. Over 50 such aircraft are on display at the Museum.

Paul Poberezny, President of the EAA, accepted the Paresev from the Center.

A: You know, really, if you look back—I don't remember any really, really difficult jobs. I always got in and tackled them and most times everything came out good.

Q: What do you see as the importance of the in-house fabrication? Flexibility?

A: Flexibility. If you can get the people to feel that they're really involved in it instead of just shipping them down there or something on a piece of paper—it was a lot better when you could talk to the engineer. They had a lot of schooling but no hands-on experience, so that it made a lot of difference when they came down [to the sheet metal shop].

Q: So they might have an idea, but they didn't know the practicalities of making it.

A: Of making it—the radiuses to use. Because the metal has to have radiuses to bend or it will crack, or it's stressed.

Q: Also, the difficulty of getting a part inside an airplane that is already completely filled with wires.

A: Oh, yes. I've had a lot of problems where you had to use a mirror to get in to do some welding. You're actually welding behind you or something. It's kind of a technique after you get used to it. But it's backwards from what you're really doing, because the mirror is in an area where—

Q: It reverses the image.

A: Yes. But all the years I've been here—I guess that's why I don't leave—be-

cause I enjoy the people, I enjoy the work. There's no place like it, really.

Q: What do you see as the key ability required for your position?

A: Well, I don't know. A person can just give me something and I guess the good Lord gave me the capability to see right away how to do it—how to solve the problem.

Q: Intuitive engineering?

A: I don't really know what it is. They just bring me something and they say, 'We need this, we need that,' and that's all they say.

Q: Puzzle-solving ability?

A: Yes. As long as it's something to do with metal and stuff like that. As far as electronics, it's a little more difficult to do anything. You could bring me a carburetor in four, five, six different pieces, and I could weld that dude back together and the parts missing, I could make to go in there.

Q: With no blueprints, no instructions.

A: No. I can read blueprint stuff. But a lot of times the stuff that you do, there's no blueprint or it takes the guy days to get it to the blueprints, when I can have a job done in a day.

Q: Okay. Thank you very much. It's been a pleasure.

The HL-10 lifting body makes its first flight. Reedy was involved in its repair after it was dropped while being put on display. (E-16207)



XB-70 To Carry NASA Instrumentation For SST Program

The XB-70 Valkyrie eased its main gear down on the runway at Edwards this past Monday following its first flight which originated at Palmdale.

Built by North American Aviation, the builder of the X-15, the XB-70 is a USAF project. The aircraft was designed to be capable of speeds up to three times the speed of sound.

The Flight Research Center is spending about 2 million dollars on instrumentation to gather test data during the XB-70 flight test program for possible application to the supersonic transport program. The program will not interfere with the other portions of the flight test program.

Main areas of consideration include aerodynamics, structures, and operations. William Andrews is the head of the Center's Supersonic Research Section and has been following the XB-70 closely during these last months.

GE Wins Center

Study Contract

Bernard J. Maybrat of the Center's Research Support Unit has announced that the Flight Research Center has awarded a \$82,500 contract to the General Electric Company, Cincinnati, Ohio, to conduct a study of the flight instrumentation for use on a research ramjet to be carried on the X-15A-2 aircraft.

Under the terms of the contract, General Electric's Advanced Engine and Technology department will be responsible for the conceptual design of advanced instrumentation for application in the X-15 ramjet research program.

A major portion of the instrumentation is the development of a thrust/drag measuring device and appropriate sensors to measure the net thrust or drag that is transmitted to the X-15 aircraft from the ramjet. The design of this device will also provide the capability to jettison the ramjet from the X-15A-2.

Included in the study is the selection of available instrumentation components, design of advanced components requiring further development, and formulation of an overall plan for providing the flight instrumentation. Some additional parameters to be measured include temperatures, pressures, gas composition, fuel flow, vibration,

(continued next column)

Center's Two YF-12's Make Joint Flight

For the first time, both of the Center's YF-12 aircraft were airborne at the same time last week.

A large test fixture has been installed on the bottom of YF-12 No. 935 to study the effects of extremely rapid heating. Liquid nitrogen is carried on the inside of the fixture to keep the metal at

extremely cold temperatures. An ablative-like material is used to coat the fixture and protect it from the high temperatures caused by the high speed of the YF-12.

The aircraft is flown to high speeds and the external covering is exploded off the test fixture, exposing the metal fixture to very high temperatures.

Because other aircraft are unable to fly as fast as the YF-12, the Center's second YF-12, No. 937, was used to fly photo chase.

Because of the summer temperatures, take-off was made very early in the morning.

Joe Walker was Dryden's chief pilot at the time of his death in 1966. He had flown the X-1E, X-3, X-15, and LLRV, and was scheduled to fly the XB-70. (E-1937)



SERVICE AWARDS

THIRTY-FIVE YEARS

FITZHUGH L. FULTON JR.
ALTON B. HALE JR.

THIRTY YEARS

WILLIAM R. WINTER, M.D.
CHARLES W. RUSSELL
HERBERT L. HATCHER
GENE A. KENNER
RUSSELL EDDINGTON
STANLEY C. PLAMOUS
VICTOR CARRELLO
GUSTAVE A. SWANSON

TWENTY-FIVE YEARS

ISAAC T. GILLAM IV
RALPH B. JACKSON
LeROY E. BARTO
HAROLD P. WASHINGTON
TERRY J. LARSON
ROBERT D. REED
HARRIET J. SMITH
JERRY S. REEDY
ALFRED B. WALSH
DONALD L. MALLICK
JOSEPH D. HUSMAN
ROGER J. BARNICKI
JAMES M. BLACK
HARRY CURLEY
CLARENCE E. COOK
JOHN H. TANNER
LEO R. WEBB
BEATRICE H. CORRINGTON
JACK T. TOLLIVER
WALTER P. REDMAN
JAMES M. EDGEWORTH

TWENTY YEARS

LeROY P. FROST
HENRY STEIGINGA
THEODORE G. AYERS
JERALD M. JENKINS
LUMIR J. EHERNBERGER
BRUCE G. POWERS
RONALD J. WILSON
RAYMOND L. WHITE
BOLESLAW SZUWALSKI
JOE P. MISPLAY
CLARENCE HALEY
DOMINIC MASSIMINO
WILLIAM J. RUSSO
DAVID W. STODDARD
WILLIAM R. YOUNG
JOHN R. RIFENBERRY
KENNETH T. COWDIN
EARNEST R. TAYLOR
WILLIAM R. PETERSON
MARTHA L. BROWN
JOHN W. WRIN
FLOYD E. CUMMINGS
REUBEN P. NELSON
JAMES E. HICKMAN
JAMES A. FERGUSON
JOHN M. BRUNO
CHARLES H. BAILEY
RUSSELL D. GILBERT

Center Participates In D-558 Skyrocket Dedication At Local College

A plaque dedicating an actual D-558 Skyrocket to "The Youth of Antelope Valley" was unveiled by Mr. De Beeler, Associate Director of the Flight Research Center on May 10 at the Antelope Valley College. This closed the ceremonies that officially dedicated the D-558 Skyrocket that was donated to the school by the NASA Flight Research Center last December. Also active in the presentation besides Mr. De Beeler, were John McKay, Center research pilot, Mr. Al Carter, Douglas Aircraft representative, Rear Admiral Turner Caldwell, USN and Bill Bridgeman, former Douglas pilot.

There were three D-558 Skyrocket aircraft built by the Douglas Company for the US Navy. The other two are now on display at the Smithsonian Institute in Washington, D. C. and at the Air Museum in Claremont, California. This particular version, the last one built, now stands on the college's new campus.

All five participants in the program had active parts in the actual research program of the aircraft. Mr. Beeler was instrumental in the concept and research program for the National Advisory Committee for Aeronautics - NASA's predecessor - and Mr. Carter was the Engineering Manager of the Flight Test Division for Douglas. Admiral Caldwell, Jack McKay and Bill Bridgeman flew the aircraft during the program.

The flight log books of the aircraft were turned over to the



Pictured around the dedication plaque are Adm. Caldwell, School President Clyde McCully, Mr. Carter and Mr. Beeler.



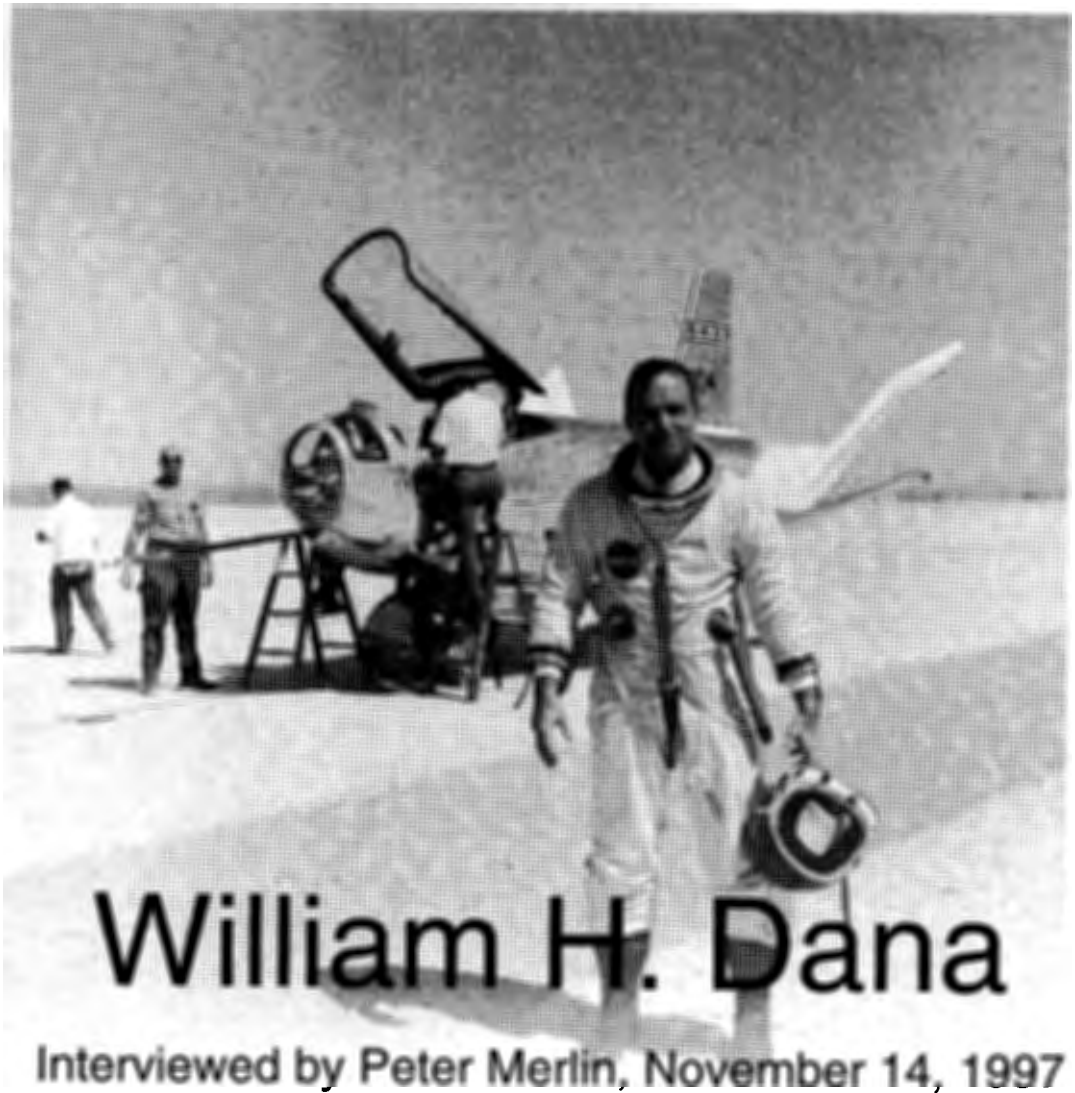
Three men who piloted the D-558; Bill Bridgeman, Adm. Caldwell, USN, and Jack McKay, NASA.

school by Admiral Caldwell, signifying the actual dedication. The plaque was then unveiled by Mr. Beeler. This plaque is now mounted in front of the aircraft.

The Skyrocket, that was given to the school, is the sister ship of

the Skyrocket that was the first aircraft to fly faster than twice the speed of sound. During the D-558 phase II flight program, conducted nearly 10 years ago, world flight records of a speed of 1327 mph and an altitude of 83,235 were established.

The research program of the Skyrocket was a proving ground for many aeronautical concepts that are now accepted as common usage in most modern day aircraft.



William H. Dana

Interviewed by Peter Merlin, November 14, 1997

William H. “Bill” Dana was among those at the Flight Research Center who experienced first-hand the transition from air to space. He was born in Pasadena, California, in 1930 and grew up in Bakersfield. As a child, he saw B-25s and P-38s flying overhead. The first U.S. jet squadron was operating out of the Bakersfield airport in the fall of 1945. One day, Dana also saw a Northrop XB-35 flying wing over Bakersfield. This exposure to aircraft sparked an early interest in flight.

After graduation from high school in 1948, he received an appointment to the U.S. Military Academy at West Point, New York. He graduated in 1952, during the Korean War, and was commissioned as a lieutenant in the U.S. Air Force. He completed his flight training the following year and received his wings just a few days after the armistice was signed. He served in the Air Force until 1956, flying F-84s and F-86s. Dana completed his Air Force commitment in 1956 but wanted to continue flying. The idea of test flying appealed to him, and he enrolled at the University of Southern California as a graduate student. While Dana was at USC, the Soviets launched *Sputnik 1*, setting in motion events that would transform U.S. space activities.

Dana received his master’s degree in aeronautical engineering in June 1958, and like other new graduates, began looking for a job. He interviewed with Lockheed, North American Aviation, and others. In September 1958, Dana set up interviews at Edwards Air Force Base with General Dynamics in the morning and with General Electric in the afternoon. Dana’s interview with General Dynamics was completed promptly at noon,

CONGRATULATIONS...

Wedding bells rang for Bill Dana of the Pilots' Branch. Mrs. Dana, the former Miss Judy Miller of Seattle, Washington, and Bill are now residing in Lancaster, California.

so rather than going directly to the second interview, he drove around the base. In the process, he happened to drive up to the NACA High-Speed Research Station. This came as a surprise, for Dana did not know the NACA even had a facility at Edwards.

The first person he met was the personnel officer, who showed Dana around the building and the hangar. Dana saw two or three F-104s, an F-107A, and an F-102A.

These were all aircraft Dana had heard about but had never had a chance to fly. Dana was offered a job on the spot as a stability and control engineer, with the understanding that he would transfer to the pilot's office once a position opened up. Dana accepted the offer the same day and asked when he wanted to report for duty. He had to move from his apartment in Van Nuys up to the Edwards area, so he replied that he could start on the first of October. He went to the interview with General Electric, but told them he had taken a job with the NACA. Dana later observed, "GE didn't have a hangar full of F-104s."

This chance encounter led to a flying career lasting more than three decades. Dana witnessed the last two X-1E flights. He worked on the X-15, initially as an engineer, later as a chase pilot, and finally as a project pilot, making sixteen flights, including two at altitudes above 50 miles. He also made the 199th X-15 flight in 1968, bringing the program to a close.

Dana also was deeply involved in the lifting-body programs. Following the success of the M2-F1 flights there was a change in focus at the FRC. Rather than build the lightweight M-1L and lenticular vehicles as planned, NASA Headquarters instead approved a heavyweight-lifting-body program. The two initial vehicles would be a modified version of the M-2 shape, called the M2-F2, and a new Langley design called the HL-10. Both would be launched from the B-52 and be capable of reaching speeds approaching Mach 2. After the M2-F2 was damaged in a landing accident, it was rebuilt as the M2-F3. The Air Force also became involved with lifting bodies, building the X-24A. This vehicle was later modified into a new shape, emerging as the X-24B. Dana would make the last powered flight of a lifting-body vehicle when he flew the X-24B. This also was the last flight of a rocket-powered manned vehicle at Dryden.

Q: I wanted to ask you some questions about your career and some of the programs you worked on and the folks you worked with. I guess to start off with, when did you first start working at Edwards?

A: I came to NASA the day NASA was formed – October 1, 1958. It transitioned from the National Advisory Committee for Aeronautics to the National Aeronautics and Space Administration. Just coincidentally, that was the day I picked to come to work.

Q: So was that the High-Speed Flight Station at that time?

A: Yes, it was the High-Speed Flight Station under the old administration and the new one. Then not too

NEW FACES

Two newcomers, one former employee, and an ex-Army lieutenant are this week's New Faces.

From Bakersfield is William H. Dana, an aeronautical research engineer assigned to Stability and Control.

In Instrument Operations is Byron L. Coburn, an electronic equipment mechanic from Los Angeles.

A former employee, now assigned to the Instrumentation Division, is aeronautical research engineer George F. Schwartz, Jr., from Albuquerque, New Mexico.

Now serving in a civilian capacity is former Army lieutenant John P. Smith, an aeronautical research engineer in Data Reduction.



SIGN OF THE TIME

Removing the wings of NACA to make way for the new NASA emblem are Doll Matay and John Hedgepeth.

SIGN UP NOW FOR POLIO SHOTS

Friday, October 10, is the deadline for polio inoculation sign-ups. In line with the policy of no-sign-up, no-shot, all employees desiring inoculations are urged to register immediately with HSFS nurse Elinore Berger. An accurate count is necessary so that sufficient vaccine may be arranged for.

The inoculations are being made available at no cost to HSFS employees only by the NASA as a follow-up to the two clinics held previously by the Public Health Department. (The Department recently announced discontinuation of the clinics.) Mrs. Berger will administer the shots in the Station dispensary in accordance with a schedule to be posted on Station bulletin boards.

long after I came to work, it became the Flight Research Center.

Q: What were some of the earliest programs that you were involved with?

A: Interestingly enough, I spent a year in engineering before I transferred to the pilot's office. And my first assignment was as a simulator pilot on a rudimentary performance simulation of the X-15.

Q: What did you do after that?

A: I was project engineer on stability and control of an F-107 fighter we had [at the FRC]. I was just barely getting my teeth into that project when I was transferred to the pilot's office in September of 1959. When I got to the pilot's office, it consisted of chief pilot Joe Walker, and Stan Butchart, Jack McKay and Milt Thompson. So there were four other pilots in the office. We also had a Navy pilot named Forrest Peterson. Commander Forrest Peterson was assigned to the [FRC] pilot's office as the Navy X-15 pilot. So I guess there were actually five pilots in the office when I got here.

Q: Were you living in Lancaster at the time?

A: Yes. I lived at Lancaster from the time I came to work in 1958 until we built a house in Tehachapi in 1972. So I lived in Lancaster 14 years.

M2 Makes First Supersonic Flight

The M2 Lifting Body was scheduled to be flown by Flight Research Center pilot Bill Dana on its first supersonic flight earlier this week. A top speed of almost 700 miles per hour was attained for the seven minute flight.

Q: I'll bet you saw it change a lot over those years too.

A: Well, Lancaster had about 25,000 people when I came to work here. Palmdale had about 8,000.

Q: So was the X-15 the first flight program that you were in for a long time?

A: The first flight program that I flew was a variable stability F-100. It was an airplane designed and modified by the Ames Re-

THE L-19 WITH THE TELESCOPES INSTALLED IN THE REAR SEAT CENTER COMPLETES FIRST PHASE OF PILOT VISIBILITY REQUIREMENT STUDY; MAY AID FUTURE VEHICLE DESIGN

Landing an airplane is no minor feat for the normal person. However, Flight Research Center engineers have completed the first stages of a program that makes this task even harder. The program, really not intended to increase the pilot's workload, is designed to evaluate how much visibility a pilot requires to fly an aircraft through all phases of flight including take-off, navigation, and landing.

Present day aircraft have large glassed canopies for pilot visibility requirements. However, this same amount of glassed area on vehicles of the future that are capable of orbital flight and atmospheric reentry would create serious problems for the vehicles. The glass area would require some sort of heat shielding to protect the glass from the heat generated during reentry, and still provide enough visibility for the pilot to land the vehicle. This would create weight restrictions along with design problems. By reducing the required amount of exposed pilot visibility area, the severity of these problems can then be reduced.

Current possible solutions under study to this problem include the use of telescopes, small television

type devices or viewport covers that can be jettisoned after reentry. The Mercury capsule was not faced with this problem as it turned around prior to reentry and did not require pilot visibility for landing.

To evaluate pilot visibility requirements, Flight Research Center engineers configured a light two place aircraft, an L-19 supplied by the Army, with two wide angle monocular telescopes. These telescopes were mounted in the aircraft in such a manner that it allowed the evaluation pilot, Center research pilot Bill Dana, to fly the aircraft from the rear seat using the optical system as his only source of visibility. Another pilot then flew in the front seat to act as a safety pilot, if needed.

The optical system consisted of the two wide angle, with one-to-one power, telescopes mounted, not in parallel as in a normal pair of binoculars, but with their axis convergent to the pilot at an angle of 55 degrees. A sheet rubber viewing hood was installed which eliminated any other source of visibility to the pilot. As installed the system resulted in only 10 square inches of exposed glass area but still afforded the pilot

(Continued on page 3)

L-19 Continued

140 degrees of horizontal visibility and 90 degrees vertically.

According to program manager Paul Chenoweth, about 40 flights were made with the aircraft using the optical system. One flight was even made after sundown with no added problems. During these flights, pilot Dana reported that he was able to accomplish all of the normal phases of flight including take-off and landing with little restriction due to the use of the optical system.

Based on the results of the first phase of the program, plans are being made to configure a high speed jet aircraft with a similar optical system for evaluation.

Once SST flights with the A-5A were completed, it was returned to North American in late 1963 bearing holiday greetings. (E-10750).



search Center. Then they got out of the fighter aircraft business. In 1960 we brought the variable stability F-100 down from Ames, and I was the project pilot on it for probably the entire time it was here. Then I went into a supersonic transport experiment where we flew an A-5A Vigilante up and down the airways at almost Mach 2, determining where the traffic control snags would be in handling a supersonic transport. Almost concurrently with that I did a fly-by-optics program, first in an L-19 liaison airplane. Then we transferred the optics over to an F-104. And I flew and landed it using an optical path rather than a window.

Q: Was that the monocular landing program?

A: Yes, that's correct. And from there—I guess from the Vigilante and from the F-104 optical program I was assigned to the M2-F2 lifting body. But before it ever flew I was offered a position on the X-15 and accepted that, and felt that I had to give up the M2-F2 assignment because I just didn't have the time to do both programs.

Q: So tell me a little bit about your experience with the X-15 program. How were you selected for that initially?

A: I have no idea why I was picked for the X-15. It's possible that because I had shown interest in both the X-15 and the M2 lifting bodies that I was considered motivated to do that kind of work. And that's the only reason I could give you why I was selected. But I was. And I accepted the X-15 assignment without fanfare. I just said, 'Yes, I will do it,' and never regretted it.

Q: And what year did you join the X-15 program?

A: It was probably in the spring of 1965 that I was assigned to it and forced to drop off the M2-F2. And it wasn't until November 4th of that year that I finally flew my first flight. I was the eleventh of 12 pilots to fly the X-15. I entered X-15 pilot training with Air Force Captain Pete Knight. He flew a little bit before I did and was the tenth man to fly the airplane. But Pete and I flew concurrently all the way to the end of the program, literally. I flew 16 flights in the X-15, reached a Mach number of about 5.5 and an altitude of about 307,000 feet.

Q: So that's about 59 miles, more or less.

A: More or less, yes.

Q: So then you earned your Astronaut Wings

VOL 5

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January 4, 1963

ISSUE 1

FRC Receives New Addition To Aircraft Inventory

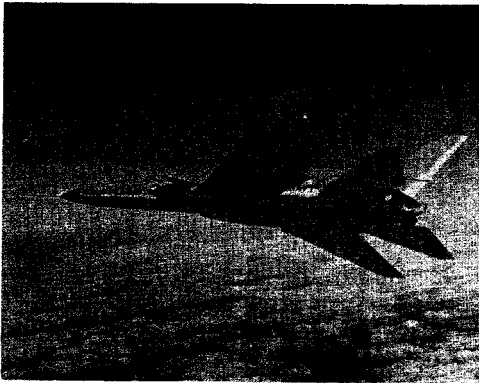
A-5A For SST Studies

A new addition to the stable of aircraft currently in use by the Flight Research Center is the A-5A(A37) jet aircraft that is on loan from the United States Navy. This aircraft will be used in support of FRC studies being conducted for the projected supersonic transport.

The jet aircraft, called the Vigilante, was delivered from the Columbus, Ohio division of North American Aviation, builder of the aircraft, where minor aircraft modifications were made.

As the A-5A is capable of sustained supersonic flight, the primary use of this aircraft will be to study the problems that may be encountered in the terminal area of traffic control operations with transport aircraft of supersonic speeds.

Working in close cooperation with officials of the Federal Aviation Agency, engineers of the Flight Research Center will plan and conduct supersonic flights with the aircraft on assigned federal airways and into high air traffic density areas, such as Los Angeles. The results of the air traffic control of these flights, and the flights themselves, are expected to provide the basis for the formulation of future control plans that will be necessary for the safe operation of commercial supersonic jets.



The 76 foot long aircraft will be instrumented with the standard handling qualities instrumentation that is used on most research aircraft. Among these instruments will be devices for measuring and recording angle of attack, sideslip, degree of control movement, and roll rates. Specialized instruments that will later be mounted on the B-70 for measurement of skin friction will be pre-tested on this aircraft.

The use of these added instruments will also allow Flight Research Center engineers to evaluate the low speed characteristics of the A-5A in different landing approaches as they would apply to a supersonic transport.

In anticipation for actual flight by the FRC, training began this past Fall. William H. Dana, the assigned research pilot to this project, spent several weeks at the U. S. Naval Air Station, Sanford,

A-5A cont.

Florida where he underwent pilot checkout procedures and flew several flights in an A-5A.

Bill LePage has been assigned as crew chief for the aircraft and will attend school for 6 weeks in preparation. Four other FRC personnel will be involved in special training for care of the aircraft and its systems.

The two place aircraft is powered by two General Electric J79-8 jet engines, each producing 10,900 pounds of thrust without after burner and 17,000 pounds thrust with after burner.

Capable of flight at speeds at Mach 2, the Vigilante was flown to an altitude of 91,450 feet in December of 1960. This established a world's altitude record for land-based jet aircraft carrying a payload of 1000 kilograms.

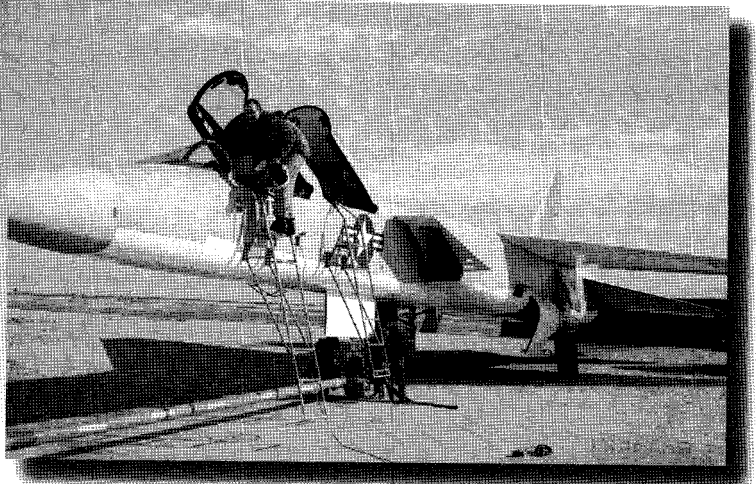
Five FRC personnel received a total of \$220.00 under the FRC Incentive Awards Program. A singular award of \$100.00 was high for the group.

Bernard Gregg received \$100.00 for his suggestion on increasing the reliability of the TV system on the B-52 launch aircraft.

Two awards were made to David Stoddard for his suggestions concerning installation of a portable shut-off valve in the liquid nitrogen service line and an adjustable gauge and reference indicator for the liquid oxygen service trailer.

A check was given to Lewis Stults for his improved method of High Range tracking data selection and distribution. A timer for engine runs earned Charles Kodai an incentive award for his efforts. Chester Bergner received an award for a hydrogen peroxide jettison adapter.

Dana and the A-5A, one of the first projects he worked on. (E-10630)



Center Completes Simulated SST Flight Program

Engineers and pilots of the National Aeronautics and Space Administration's Flight Research Center working with members of the Federal Aviation Agency are completing the final phases of a study of the possible flight conditions that may exist with the operation of supersonic transports. The NASA program investigated possible air traffic control problems and will provide actual flight data for the planning of future supersonic transport flights.

An A5A "Vigilante" aircraft was used during the program to simulate the proposed supersonic transport, as it closely simulated the actual performance of the supersonic transport up to an altitude of 50,000 feet. The A5A is a two-place jet aircraft built for the US Navy by North American Aviation. Because of the Navy's interest in the national supersonic transport program, the A5A was loaned to NASA. The 70 foot air-

craft is capable of flight at almost twice the speed of sound and has been flown to an altitude of 91,000 feet.

Center research pilot William H. Dana made approximately 21 flights along federal airways that entered Los Angeles. These flights followed two flight plans that were based upon earlier NASA studies, one for a variable-sweep wing configuration and the other for a delta-wing canard configuration.

Starting at an altitude of about 50,000 feet and a speed of Mach 1.7 (1.7 times the speed of sound), the simulated supersonic transport portion of the flight began with a deceleration to a speed of Mach 1.4, where a descent to lower altitudes was initiated. During this descent, the aircraft was slowed to subsonic speed above 30,000 feet and reached an altitude of 20,000 feet at a speed of about 340 m.p.h., not much faster than present day jet transports.

According to FAA official Joe Tymczyszyn, air traffic controllers reported that they experienced no added difficulty in descending, integrating or landing the simulated supersonic transport at the Los Angeles Airport along with other arrival traffic. However, the subsequent take-off and climb out did present more difficulty due to the increased performance of the aircraft. Special consideration had to be given to the faster rate of climb, critical fuel usage and the possible sonic disturbance.

Program manager Donald L. Hughes stated that in order to acquire operation flight data, cruise portions of the simulated supersonic transport flights were also made. This included several night operations and a round trip flight between Los Angeles, California and Albuquerque, New Mexico, at a cruise speed of Mach 1.5.

on that one.

A: Yes, you've got that right.

Q: What was a typical X-15 flight like then?

A: Well, there were two different types of flight. In an altitude flight you'd launch, light the engine, and pull up to some pre-assigned pitch attitude, usually 25-40 degrees, and hold that pitch attitude until burnout. The airplane would coast over the top at somewhere from 200,000 feet to 300,000 feet, depending on the pitch attitude selected. By the time the engine quit you were almost in space. And you were in space shortly after that and just coasted over the top ballistically with no control over your flight path. You just maintained your attitude while the airplane went where it would like a baseball goes where you throw it.

Then there was the heating research mission in which you pushed over at somewhere between 60,000 and 80,000 feet, and came level, and flew along fast at low altitude in the atmosphere. That flight remained in the atmosphere the entire time, was flown with aerodynamic controls, and didn't use ballistic controls. And it usually was a shorter flight than the altitude mission. The typical altitude mission went about 11 minutes, with about four minutes of that in the traffic pattern. I remember some of my heating flights were seven or eight minutes total from launch to touch down.

Q: So the X-15 was basically a flying laboratory?

A: That's correct. It was a research airplane and it did research into a number of disciplines, including stability and control, weightlessness, heating, structural loads. It did a whole raft of different research experiments, both in and out of the atmosphere. Then later in its career it did a lot of piggyback work. By the last year of my participation in the program we were doing piggyback work carrying experiments. They were mostly space related and included high-altitude cameras, taking pictures of the stars, or even looking downward from high altitude. We did Apollo-related research. Looking at a horizon scanner for the Apollo was one mission I remember.

Q: I notice that occasionally the X-15 aircraft would be severely damaged, as in the explosion during a static engine firing, or when the aircraft was damaged at Mud Lake. But yet they always rebuilt the airplanes and continued to use them. That doesn't look like something that they would do these days.

A: The rebuilding of an X-15 was interesting. It's hard to say whether it would be done today or not. It would probably depend on how much national consequence there was to not rebuilding the airplane. But X-15 #3 blew up on the engine test stand before it ever flew. And it was decided almost immediately to rebuild it. It's interesting to note that when they did rebuild X-15 #3, they equipped it with a self-adaptive flight control system which included command augmentation, and self-adaptive dampers, and several autopilot modes. So it became the controls research airplane of the three X-15s. It's interesting that only X-15 #3 was allowed to go significantly above 250,000 feet, significantly above the design altitude, because it had the autopilot modes, including a heading hold mode, and was very stable when out of the atmosphere.

Q: What was it like preparing for a flight in terms of suiting up and getting ready in the pre-flight?

A: An X-15 flight day was an interesting day. Traditionally they had sent a weather ship uprange with some other pilot in it than the mission pilot to check the condition of the lakebeds, and to check the weather to make sure the pilot could find his way to the uprange emergency lakebeds if need be. I believe I established a tradition of flying my own weather flight. That way I got practice. The day of the flight I got to look at the actual weather and, equally interesting, I got to look at the flight day winds. Because winds in the traffic pattern could affect your touch-down accuracy. So I'd come out about sunrise and fly an uprange flight, do some practice landings at the uprange lakebeds, check the winds and weather, and then come back down, park, get out of my flying suit and into my pressure suit, and climb in the X-15. And usually I was in the X-15 by, say, eight o'clock in the morning, strapped in and ready to go. Then we'd fly it usually 45 minutes to an hour uprange before we turned around and pointed it back at Edwards and launched.

Anybody that's followed the program closely knows that we always launched over a suitable dry lake to which we could proceed if the engine didn't light. Then there were three or four intermediate dry lakes along the way that we'd use when the rocket engine had run long enough that you couldn't get back to the launch lake, but didn't have enough energy to proceed forward to Edwards. Then we would go to an intermediate lake.

Q: I've read some of our documents regarding the selection of lakebeds and how they were tested for hardness and load-bearing ability. Apparently they took a light plane up there.

A: Traditionally we used two airplanes. We had an R4D, which was the Navy version of the DC-3 [or C-47]. That was one of our lakebed sampling airplanes. And the other

Cuts, Bruises, And Sprained Ankles -- All In A Day's Fun!

The annual Flight Research Center summer picnic was enjoyed by over 400 employees and families. As evidence, over 576 bottles of pop and 108 gallons of other refreshment were consumed.

Results of the day included many cuts and bruises, one youngster hitting another over the head with a swimming float, at least one sprained ankle, and several pulled muscles.

Highlight of the day was the crushing baseball defeat of "Perry's Peruvian Princes" by "Jackson's Juggling Jailbirds."

A well done to the Exchange Council for a well planned event.

Dana Scheduled For First X-15 Flight

NASA's Bill Dana - not Jose Jimenez's Bill Dana - was scheduled to make his first flight in the X-15 this past week. If completed, he will have become the eleventh man to fly the rocket-powered aircraft.

Prior to his first flight, Mr. Dana spent several months in extensive preparation for the flight. He and Air Force Captain William "Pete" Knight were selected earlier this year for the X-15 program. Captain Knight made his first X-15

flight several weeks ago.

Mr. Dana's flight plan called for him to be air-launched from the B-52 near Hidden Hills, a dry lakebed on the California-Nevada state line. After igniting the rocket engine, he was supposed to reduce his power control setting to approximately 50% and climb to a maximum altitude of 74,000 feet. After hitting a planned top speed of about 2700 miles per hour, he was slated to perform several control

(Continued on page 4)

Dana (Continued)

maneuvers designed to familiarize himself with the X-15. The 125-mile trip normally takes about nine minutes.

A native of Bakersfield, California, Mr. Dana is a graduate of the U.S. Military Academy, at West Point. After serving as a jet pilot with the Air Force, he obtained his master's degree from U.S.C. in 1958.

Prior to entering the X-15 program, he was assigned to several Center research programs. He has flown the lightweight lifting body, and was project pilot on the supersonic transport program.

was an Aero Commander 680F that we took uprange. We took one of those two airplanes up, usually the Gooney Bird [R4D] because it had the wide tires and the low footprint. And we'd do a touch-and-go on the lakebed and see how it felt and then fly by and look at our tracks where we'd touched and gone, to see how soft it was. Then if we were convinced it was hard enough to support the weight of the C-47, we would land and park. We had two different tests we used. We had a steel ball—I guess it was probably four or five inches in diameter—which we dropped from a height of six feet, and then measured the diameter of the indentation caused by that ball. That gave us some feel for the hardness of the lakebed. Then we had a spike, probably 30 inches long, that we drove into the lakebed to see that there was resistance to the driving force all the way down—to make sure there wasn't just a thin crust and mud beneath it. So those were usually the two tools we used to determine the hardness of the lakebed.

Q: It was the steel ball that I had heard of. I guess if it left an imprint three and a quarter inches or less it was suitable hardness. Do you know about how much that thing weighed?

A: I'm going to take a guess—12 to 15 pounds is about like a high school shot put. But I don't even remember the diameter of it.

Q: None of the documents I saw have that. I guess the planning of the high range flights encountered a lot of different obstacles, including various air spaces and other aspects of getting the aircraft from point A to point B. There were a lot of references to flights out of either Delamar Lake or Mud Lake that would have to cross through controlled air-space. Do you remember any special concerns with that?

A: No, I don't. I filed a flight plan every time I went uprange and went uprange under instrument flight rules, and then got clearance to the launch point, and clearance to descend, flew my approach. Then if I wanted to shoot another approach at that same lakebed I had to get clearance to climb back up in the area of positive control which, interestingly enough, was 24,000 feet in those days, rather than 18,000 feet. I don't ever remember going uprange below 24,000 and coming back below. But I remember when I'd shoot multiple ap-

"Use or Lose" Leave Reminder

Federal leave policy provides that annual leave can be accumulated to a maximum of 30 days (240 hours) which can be carried over from one leave year to the next. Balances in excess of the above will be lost as of the end of the leave year.

proaches at a lakebed, quite often I'd start the second and third approach below 24,000 feet so I didn't have to get an air traffic clearance back up into the area of positive control. But I don't ever remember fighting with air traffic controllers over permission to fly up there. The weather flight I flew was very early in the morning and there wasn't much traffic. When I practiced, that was usually during the work day. Either before or after lunch I'd fly uprange sometimes. But I just don't remember traffic control being that big a problem in those days. I think traffic control was less constraining in the X-15 days than it is now. But the FAA is a lot better staffed to handle things like that now. I think you'd still probably get pretty good service out of FAA if you wanted to go uprange now.

Knight Makes First X-15 Flight; McKay Goes Over 50 Miles

The first of two pilots selected last spring to fly the X-15 made his first flight in the rocket-powered aircraft last week. Air Force Captain William (Pete) J. Knight piloted the craft in the 151st flight in the joint NASA-USAF X-15 research program.

The other new X-15 pilot, NASA research pilot William Dana, is expected to make his first X-15 flight within a short time.

Captain Knight, Mansfield, Ohio, was selected as one of the original pilots for the since cancelled X-20 DynaSoar. He is presently assigned to the Air Force Flight Test Center at Edwards.

Captain Knight was air-launched from the B-52 near Hidden Hills, a dry lakebed on the California-Nevada state line. After igniting the X-15's rocket engine, he reduced his power control setting to approximately 50%. He then climbed to a peak altitude of 74,000 feet where he performed several familiarization maneuvers, such as, turns and rudder pulses. His maximum speed was 2,761 mph.

Earlier in the week, NASA research pilot Jack McKay became the second civilian to fly higher than 50 miles. He piloted the number three X-15 to 300,000 feet, almost 58 miles high. The fifty mile mark is the criteria used by the military for the awarding of astronaut wings.

Dana and X-15 #3 on the lakebed. He made the 199th and final X-15 flight. (E-16809)

Q: Did you ever work with the X-20 Dyna-Soar program?

A: Yes, I did. I was assigned for over a year as a pilot consultant on the Dyna-Soar. I traveled to Boeing probably once every third month to fly the simulator and look at pilot displays.

Q: Any thoughts on whether that was a good project?

A: Oh, the X-20 was an excellent program. It should have been flown, and it was canceled for political rather than scientific reasons. Had it been flown, why, the Space Shuttle designers would have had a lot more information from which to do their design.

Q: So you made one flight in the M2-F1 lifting body?

A: That's correct.

Q: And was that in preparation for flying the M2-F2?



200th X-15 Flight Draws Close

PROJECT 1226 stands poised to reach another milestone in October. Nine years after its first flight, Project 1226 - it's now called the X-15 - could make its 200th flight in the near future.

Last month, the X-15 made the 198th flight, and the 199th flight is scheduled for early this month. The exact schedule for the 200th flight has not been finalized, but there is an excellent chance the flight could occur in October.

The X-15 aircraft has already made more pure rocket-powered flights than any other rocket-powered airplane. Using total flight time as a basis for comparison, the X-15 has already flown more than one and one-half times around the world in less than 30 hours.

How long the flight program will continue is not definitely known. At the present time, the number one X-15 is carrying a high priority experiment, and the number of flights remaining depend upon the results obtained from the experiment.

Regardless of how many flights are made, the flight research program has far exceeded the original goals established for the X-15 in 1954.

It is difficult to establish a definite date as the birth date of the X-15. However, as far back as 1952, Center engineers as well as engineers from other government facilities were attempting to identify all the major problems and possible solutions that could occur in the development of an advanced research airplane and aid in the advancement of aeronautics. The jump in flight performance from the research aircraft of those days to the proposed X-15 type aircraft was significant: from Mach 3 to Mach 7 and from 130,000 feet to several hundred thousand feet.

By mid-1954, a formal technical proposal and operation plan had been formulated by NASA's predecessor, the

National Advisory Committee for Aeronautics, and presented to other government agencies. The Air Force and Navy agreed to the proposal and, in December 1954, a Memorandum of Understanding was approved assigning responsibilities for the forthcoming joint research venture.

The Memorandum was also responsible for stating the principles of the program which were based upon the resolution adopted by NACA's Committee on Aerodynamics on October 5, 1954. In part, this resolution stated . . . 'The necessity of maintaining supremacy in the air continues to place great urgency on solving the problems of flight with man-carrying aircraft at greater speeds and extreme altitudes. . .

Construction of the number one X-15 was completed in October 1958 by North American Rockwell. Following the contractor demonstration flights, the X-15 began a flight program to gradually expand the flight envelope to the design goals of 250,000 feet and a speed of six times the speed of sound. (The original speed goal of Mach 6.6 had been lowered be-

cause of an increase in basic weight of the aircraft.)

In the spring of 1962, Joe Walker piloted the X-15 to its design altitude of 50 miles. Earlier, Major Bob White had flown the number one ship to the design speed of over six times the speed of sound. Following these flights, it was decided that it was possible to safely increase the maximum altitude of the aircraft. Accordingly, a new series of flights was started that eventually reached a peak altitude of 354,200 feet in the summer of 1963.

Interspersed with and following the altitude flights were an extensive series of flights to obtain aerodynamic, particularly heating, data at altitudes of approximately 100,000 feet. These flights, maybe not so glamorous as the record flights, were some of the most demanding flights made in the X-15 research program. It was during this series that the number two ship made its 22nd flight with Major Bob Rushworth at the controls. This flight attained skin temperatures of over 1300 degrees F., the highest temperatures ever measured on the bare skin of the X-15.

By the time the X-15 had made its 100th flight in early 1964, it had accomplished most of the original goals. However, the airplane had so successfully demonstrated its ability to fly at extreme altitudes and speeds that many scientific experimenters throughout the country had requested permission to have their experiments carried on the X-15. In order to accommodate the most pressing of these experiments, the X-15 continued to fly. Over 25 experiments dealing with such subject matter as star tracking, horizon scanning, micrometeorite collection, and the like have been carried during the past several years.

Even though the prime purpose of these recent flights has been to carry the experiments, aerodynamic data has been collected on every flight.

Last fall, the number two ship,

A: I don't remember exactly why it was decided that I'd fly the M2-F1 plywood lifting body. Jerry Gentry was getting ready to fly the M2-F2. And he and I were selected to fly the M2-F1 and were both supposed to get multiple flights. By the time I was selected, I was no longer an M2-F2 pilot. But I probably had been in training for the M2-F1 flight when I was still an M2-F2 pilot and was going to be allowed to fly the flights just as a reward for having worked hard on the M2-F2. Anyway, the day of the flight came in July of 1965. And it was raining that day. We were out on the lakebed with the C-47 and the M2-F1, and there was enough rain on the lakebed that there was mud caking on the bottoms of my boots. I remember walking around with half an inch of mud on my boots. I suggested to Milt [Thompson] that we wait for a more suitable day. But he pointed out that the cloud base was above the release altitude so we wouldn't be flying on the tow line in the clouds. He just

equipped with extra propellant tanks and a protective ablative coating, increased the speed mark to 4520 mph, 6.7 times the speed of sound. It was this ship that was to have been used for the flight test of the experimental ramjet that is now under development. But budgetary considerations have limited the X-15 flight tests and restricted the ramjet to theoretical ground testing.

There probably won't be a 300th flight of Project 1226. Some time later this year - or perhaps it will be delayed until next year the number one X-15 will be retired from active flight test and take its well-deserved place in the Smithsonian Institution - and history.



Dana and the X-24B, in which he made the last powered flight by a rocket-powered research aircraft, in September 1975. The boots he wore in this picture were a non-standard pink. (E-29038)

didn't think it was raining hard enough to cancel.

So I climbed in the M2 and took off behind the C-47, spent probably about twenty minutes on the tow line, released at 10,000 feet, started a turn back to the dry lakebed, and pushed the nose over to pick up final approach speed. When I pushed the nose over, water ran from the belly of the M2-F1 up into the nose window. The water in the nose window formed a giant lens and the lens de-magnified what I saw through it. So I was looking through this big lens at the lakebed and the lakebed runway. The lakebed runway looked like it was four to five miles away. So I decided immediately that I wasn't going to be able to land using the nose window as visual reference. I went about setting up attitude and air

speed and figuring out what I was going to look at while I did my flare and landing. When I looked back through the nose window again to see what was going on, the water had all gone away. And to this day I don't know where that water went to. But the nose window was clear again, and I flared and landed. I was supposed to get other flights in the M2-F1, but circumstances just worked out that I wasn't allowed to.

Q: Did you have any initial misgivings about flight in the wingless aircraft?

A: Well, I certainly did when Milt was doing tow tests. Milt was being towed by a 1963 Pontiac convertible that we bought especially to tow the M2-F1. I wasn't so sure how it was all going to work out when Milt was doing the ground tows. But when I saw him on the tow line behind the C-47 and he was still upright, then my reservations kind of went away and I became a lifting body fan.

Q: The M2-F3—was that the first of the heavyweights that you flew?

A: No—the M2 was still being rebuilt when I finished the X-15 program. And I flew the HL-10 for a year just learning how to fly lifting bodies and getting ready for the M2-F3 when it came along. So I was a project pilot, along with Pete Hoag, on the HL-10 in 1969 and 1970 before the M2-F3 was ready.

Q: Were there similarities between the HL-10 and X-15 flights?

A: Yes. The HL-10 landing pattern was just about identical to that of the X-15. It felt very comfortable. The HL-10 was a nice-flying airplane, particularly by the time I got in it. On first flight the HL-10 had had flow separation at high angle of attack over the vertical fins. And it didn't fly very well at

X-15'S Depart Center

The number one X-15, famous for hypersonic speeds and towering altitudes, has made its final flight. Unmanned and without power, the X-15 departed the Center in the middle of the night inside of a C-133 transport.

Along with its crew, X-15 pilot Pete Knight was on hand to make sure the famous aircraft was put aboard safely. It arrived at noon the next day at Andrews AFB, where it was shipped by truck to the Smithsonian Institution in Washington, D. C.

The number one X-15, which made the first and final flights in the program, will be displayed between the Wright Brother's Kitty Hawk Flyer and Lindberg's Spirit of St. Louis.

Accompanying the number one ship were crew chief Herm Dorr, Ed Nice, Don Hall, and Ed Sabo who will install the X-15 in the museum. Formal ceremonies marking the turnover will be held in early June.

high angle of attack. They spent a year or a year and a half modifying those fins and doing wind tunnel tests. They put camber in the vertical fins so they could go to a higher angle of attack without flow separation and made it a truly nice-flying airplane. And that was the HL-10 that I flew, and it was an absolute pleasure to fly.

Q: And the M2-F3 then must have followed that. Did it handle significantly differently from the HL-10?

A: Yes, the M2 didn't have as good a glide ratio as the HL-10. It flew its final approach at about 25 degrees, and I think the HL-10 was somewhere around 18 or 20 [degrees] at 300 knots. So the M2 flew steeper and it really did not have as good handling qualities as the HL-10. It was certainly airworthy and it proved that by flying 26 flights as the M2-F3. So it was airworthy, but it just wasn't as good flying or as good a glider as the HL-10.

Q: And then did you get into the X-24 program?

A: I served as a chase pilot for the X-24A. And I was named as a project pilot on the X-24B, but I really never flew it until the program was over. I got a couple of powered flights, as a matter of fact, just as a courtesy after the program was over. But I really was never a part of the X-24 program.

Q: And you flew the last powered flight of the X-24B?

A: Yes, that's correct. That was in September of 1975. I flew the last rocket-powered flight flown out of Edwards.

Q: We have the videotape of the pre-flight for that and also post-flight, after you've exited the aircraft. And I noticed your flight boots appear to be a little bit non-standard.

A: Yes. Well, those flight boots were kind of famous. I had gone to pick up a new pressure suit in probably '67 or '68—from the David Clark Company in Worcester, Massachusetts. The contract called for black flying boots to go with the pressure suit. The company gave me white boots. And I didn't think it was fitting for a NASA pilot to be wandering around in white boots. So I told them I didn't accept the boots—I wanted a pair of black boots. So the company eventually got me a pair of black boots and then gave me the white boots as a gift. But they were painted pink with yellow daisies on them. And I did fly those boots a couple of times, including the last powered flight of the X-24B.

Q: Now once we finally came around to having a Space Shuttle, where they abandoned the idea of using a lifting body configuration, how did you feel about that after all the lifting body work—then you go to a more conventional—

A: I was disappointed, to say the least. We put a lot of effort into the lifting bodies. And we were very proud of them and thought they were nice-flying airplanes. They had good volume to them for their size. They had a lot of volume compared to a wing fuse-

HL-10 Modifications Under Consideration

Flight Research Center personnel and representatives of Northrop Norair have casted molds of the leading edges of the HL-10's outboard vertical fins. The plastic molds have been sent to the Northrop facility where new leading edges for the HL-10 may be fabricated.

The new leading edges will be slightly curved so as to force more air over the HL-10's control sur-

faces while in flight.

Following the HL-10's maiden flight last December, it was discovered that insufficient air was flowing over the control surfaces. Additional wind tunnel studies were conducted at NASA's Langley Research Center to verify this and then to suggest possible changes.

Langley has suggested two different modifications: the curving of the leading edges or thickening

of the entire inside surface of the tip fins. Data received from the wind tunnels is now being evaluated in the Center's HL-10 simulator. Following the simulator studies, one of the two modifications will be made to the HL-10.

Dana was named project pilot for the M2-F3. One of the changes made to the aircraft for the project was the addition of a center fin, the standard "NASA" marking on which was quickly modified in honor of Dana's new assignment. (E-20462)



lage. But there was an interesting requirement for the Space Shuttle—that it was required to have a payload bay 15 feet in diameter and 60 feet long. And that payload bay of that size and shape just suited itself better to a fuselage and wing than it did to a lifting body. There's no reason the Space Shuttle could not have been a lifting body. It probably would have been heavier than the present shape is if you'd had to enclose that 15-by-60 payload bay in the interior of a lifting body.

Q: Of all the lifting body designs that were studied, which of them was considered the best possibility for a Shuttle-type vehicle?

A: I can't answer which lifting body would have been the best for a Space Shuttle. I think the M2 was automatically voted out because of its poor glide ratio, its poor performance. NASA, and Dryden in particular, were looking at the HL-10 as a Space Shuttle candidate. I think Langley looked at that too, because the HL-10 was Langley's design. So I know that Dryden looked at the HL-10 as a Space Shuttle candidate, and I don't remember anything that disqualified it. I think it flew very well even as a big airplane, and would have made a fine Space Shuttle. I don't know that NASA ever looked at the X-24, which was an Air Force shape. I

100th Lifting Body Flight Flown

Late last week Flight Research Center pilot Bill Dana flew the 100th flight in the lifting body program, which was begun over seven years ago.

Earlier this week, the re-configured X-24B, the newest of the lifting body shapes, was accepted by the Government in ceremonies held at the Denver plant of Martin Marietta. The X-24B is expected here early next week.

The 100th lifting body flight was made in the M2-F3, a modified version of the M2-F2 that made the first heavyweight lifting body flight on July 12, 1966, with Center pilot Milt Thompson at the controls.

Six months later, Bruce Peterson flew the HL-10 on its maiden flight. It was this flight that disclosed the serious flow separation problems that required additional wind tunnel studies and subsequent modifications. The HL-10 did not return to active flight status until some 15 months later.

In May of 1967 the M-2 was severely damaged in a landing accident. The next year, following several months of "inspection" by the Center and Northrop, a decision was announced to partially restore the M-2. Modified with a new center fin, the redesigned M2-F3 was returned to the Center and made its first flight in 1970.

Following minor modifications to the leading edge of its vertical fins, the HL-10 returned to active flight status in March of 1968 and continued through June of 1970. The first of the lifting bodies to use a rocket motor for propulsion, the HL-10 flew to an altitude of 29 kilometers (90,000 feet) and a speed of 1975 kilometers per hour (1220 mph).

An Air Force-designed lifting body, originally called the SV-5J, later changed to X-24A, was delivered in late 1967. With USAF Major Jerry Gentry at the controls, the X-24A made its first flight on March 17, 1969. Center research pilot John Manke piloted the X-24A on its final flight on June 4, 1971, prior to its conversion to the X-24B.

As of this time, it is planned to continue flying the M-2 for the rest of this year's flying season. Several other pilots will probably be checked out.

The X-24B turnover ceremonies marked nine months of work to convert the lifting body to the new and longer shape. The X-24B was accepted by a representative of the Air Force's Flight Dynamics Laboratory. Center Deputy Director De Beeler and project pilot John Manke officially represented the Center at the ceremonies.

Following delivery, the new shape will be readied for flight, now tentatively scheduled for next spring.

don't know whether they looked at it or not for the Space Shuttle. But in any case, ultimately the payload bay drove them to a wing and fuselage.

Q: Did you work with the Lunar Landing Research Vehicle at all?

A: No, I didn't. I checked out in a helicopter, hoping for a shot at that program.

Q: The biography we have on you probably lists only about half of the things you actually worked on, if that. It does mention that you worked on the YF-12.

A: No, not really true. As the YF-12 program came to a conclusion, they gave everyone in the pilot's office one ride in the YF-12, one ride to Mach 3. And I got my one ride. Then on the fifth landing of the Space Shuttle, in the approach and landing tests, the Space Shuttle landed on the main runway. And it got into an elevator rate limiting situation which caused pilot-induced oscillations in both pitch and roll. So because of those pilot-induced oscillations, NASA—including Dryden—started a massive campaign to understand pilot-induced oscillations, to see what had caused them in the Space Shuttle and what we could do to correct them.

Dryden flew a multitude of airplanes looking for pilot-induced oscillations, including the Calspan total in-flight simulator and the Dryden F-8 Digital Fly-By-Wire with time delays added to its control system. Another airplane they looked at because they didn't think it would be susceptible to pilot-induced oscillations was the YF-12. They wanted pilots who hadn't flown the airplane a lot so that the pilot experience wouldn't cover for aircraft deficiencies. So Einar Enevoldson and I were selected as the two novice pilots in the YF-12 who would look at pilot-induced oscillations. We went out in a flying suit, not in a pressure suit, and flew simulated flame-out landings and conventional power-on landings for a whole tank of gas looking for pilot-induced oscillation. I was unable to get any in the YF-12, and my memory of it is that Einar was not able to get any either. So I got two flights in the YF-12 and that was all. I really shouldn't have it in my bio because I didn't fly it except as a guest pilot.

Q: Was that in the YF-12A—or—

A: Yes, it was in the YF-12A—the 935, which was a true YF-12.

Q: Right, of course the YF-12C being an SR-71.

Bill Dana To Receive Haley Space Award

Bill Dana, Dryden Flight Research Center pilot, has been selected to receive the 1976 Haley Space Flight Award, presented by the American Institute of Aeronautics and Astronautics.

Dana will accept the award at the International Astronautical Federation Conference on Friday, October 15 at a banquet in the Grand Hotel in Anaheim.

The award, named in honor of Andrew G. Haley, one of the founders of the American Rocket Society, is given "for an outstanding contribution by an astronaut or flight test personnel

to the advancement of the arts, sciences or technology of astronautics."

Dana will receive the award for his "outstanding contribution to the M2-F3 Control Systems Research in 1972 and continuous contributions as a test pilot on many aerospace vehicles."

Dana served as pilot on the manned lifting body program at Dryden Flight Research Center at Edwards, flying the HL-10, M2-F3, and X-24B lifting bodies. Prior to this, he was project pilot on the X-15 research airplane program, making 16 flights in the rocket-powered aircraft.

Dana Becomes Third Pilot To Fly X-24B

Flight Research Center pilot Bill Dana became the third man to fly the X-24B when he made his first flight in the experimental craft this week.

The former X-15 pilot is X-24B co-project pilot for the Flight Research Center working closely with prime project pilots John Manke and Lt. Col. Mike Love.

Dana and the X-24B were air-launched near Lancaster and then used the XLR-11 rocket engine to climb to a maximum altitude of 71,000 feet and peak velocity of 990 mph.

Following engine shutdown, he maneuvered the X-24B to a landing on the dry lakebed.

A: Yes, it was—they said it was a modified SR-71. But it had SR-71 systems and, probably most importantly, it had SR-71 fuel. So it would go a lot longer than the YF-12 would.

Q: Yes, it was actually the number two SR-71A. But they put a bogus serial number on it so that it would stay in the sequence. Because the [three] YF-12As that they built [had] tail numbers 06934, 935, and 936. So in order to make it stay in the sequence they gave it 937, which was actually assigned to a different aircraft.

Q: And your bio also says you worked on the Convair 990—

A: Yes, I flew co-pilot on the Convair 990 right up until I ended my flying portion of my career. I was co-pilot to Gordon Fullerton on that and was looking forward to the simulated Shuttle landings. But I never got that far in the program.

Q: Do you have any anecdotes about some of the people you worked with such as Milt Thompson, Dick Day, Hubert Drake, and Neil Armstrong?

A: Well, all of them were certainly heavyweights. It was by the force of Milt's personality, along with Paul Bikle and Dale Reed that we flew the M2-F1, which I think you can see really opened up the management acceptance of the lifting body shape. The shape didn't look like it would fly or at least it didn't look like it would flare and land horizontally. And I think watching the M2-F1 flare and land horizontally, it was pretty hard to deny that the shape was airworthy. So I think that Milt in great measure influenced the acceptance of the lifting body as a credible return-from-space vehicle.

Paul Bikle was one of the best leaders that I've ever seen in aerospace. Paul was a very bright man. He had come up through the ranks in engineering and was eventually chief civilian engineer at the Air Force, and was asked by NASA to take over the Flight Research Center and did so. I think the quality that made Paul so effective was that he knew what was worth doing and what wasn't. There are a million ideas out there. Ideas are the easiest thing in the world to find. It's the good ideas that are difficult to locate. Paul had a nose for what was worth doing and what wasn't and did it. He was principal participant in the X-15 and the lifting body programs and many other research programs we had here.

Neil Armstrong—another very good mind—a good X-15 pilot, a good NASA, or NACA research pilot. Then I think he proved his quality to the world on the Gemini 8 mission and the Apollo 11 mission. And I don't think it was by accident he was selected for the Apollo 11 mission. I think he was selected because people felt he was capable of doing that job.

And you asked about Jake Drake. Jake

Automotive Engineers Aerospace Vehicle Flight Control Systems Committee. When **Bill Dana**, Pilot's Office, received his new HL-10 pressure suit, he also received new white boots. He said he'd wear pink ones before he'd wear white ones. He did. New bridegrooms include **Bob Cook**, **Ray Kellogg**; both of Data Systems, and **Norm DeMar**, Flight Operations. Apollo 12 has not really received its proper agricultural recognition for planting a Bean on the lunar

was another one of the really fine minds that came out of Dryden. My understanding is that it was Drake's idea from start to finish [for] the concept of a Lunar Landing Research Vehicle. The problem had been that if you used rockets for lift on a lunar landing simulator that was to be flown in Earth's gravity, why, you needed six times the rocket thrust to lift that airplane off the Earth that you would have needed to operate in lunar gravity. And therefore when you tilted the airplane, you had six times as much acceleration for a given tilt angle on Earth as you would on the Moon. This would have rendered it ineffective as a trainer because it just wouldn't have been representative of the lunar lander.

Jake Drake's concept was to build a Lunar Landing Research Vehicle that would carry five-sixths of the weight of the vehicle on a jet engine that was gimbaled and stabilized so that the jet engine was always pointing straight down. And then you'd only use the lift rockets to carry one-sixth of the weight of the Lunar Landing Research Vehicle. When you tilted it to translate, you had the right amount of thrust to simulate operating in lunar gravity. And everyone that ever landed on the Moon flew either the Lunar Landing Research Vehicle or the Lunar Landing Training Vehicle, which was an operational version of the LLRV. As far as I know, everyone said that they were a high-fidelity simulation of the lunar landing. And that was Jake's idea from start to finish. He was so far senior to me, and he was here for such a short time after I got here, that I don't know what some of his other good ideas were. But he carried a reputation with him of being an original and visionary thinker.

Dick Day was another visionary. He was a very practical man. He had been a World War II bomber pilot who came to the NACA in 1951 as a research engineer and got access to the Air Force Flight Test Center's analog computer. He added a cathode ray tube for an attitude indicator and a rudimentary pilot's stick for a control device, and had himself a simulator. He was able to program in the handling qualities of an airplane such as the X-2, and thus had a simulator that could fly like the next flight of a vehicle. That gave the test pilot the first opportunity in history to assess the stability and control and performance of an airplane before that airplane ever flew with those flight conditions. So he invented the engineering simulator.

He also was instrumental in discovering the causes and corrections for inertial roll coupling, which had been experienced by the Douglas X-3 research airplane and by the F-100A with its original designed vertical tail, two of which were lost due to inertial roll coupling. Dick determined that roll coupling was the cause of the loss of those F-100s and helped design the vertical tail that went on production F-100s. So those are five of the best minds that I've been exposed to here at NASA. There are other good ones. But those were five of the very best and were the people that have made it such a privilege to work here through the years.

Two New X-15 Pilots Named

Two new pilots have been added to the X-15 research program. The two pilots, Air Force Captain William J. Knight and William H. Dana, are expected to make their first flights this fall.

Dana, 34, is a civilian pilot-engineer at NASA's Flight Research Center. He has served as project pilot on a variety of flight programs including the study of supersonic transport operating procedures. Dana, who received his

masters degree in aeronautical engineering from the University of Southern California in 1958, has also piloted NASA's M2-F1 light-weight lifting body.

Capt. Knight, 35, is attached to the Air Force Flight Test Center at Edwards AFB. A 1964 graduate of the Aerospace Research Pilots School, Capt. Knight was project pilot on the F-5 NATO fighter. He was also selected as one of the

original pilots for the now-canceled X-20 DynaSoar Program.

Both aviators, who have served as chase pilots on previous X-15 flights, are undergoing an extensive training program, both on the ground and in the air.

Dana and Knight will join the current four X-15 pilots: Capt. Joe H. Engle, USAF, John B. McKay, NASA, Maj. Robert A. Rushworth, USAF, and Milton O. Thompson, NASA.

The two new X-15 pilots will become the 10th and 11th men to fly the X-15, the world's fastest and highest flying aircraft.

Q: And what was Joe Walker like?

A: Joe was very bright also. Joe was a real aviator, and he was a doer. Joe got things done. When a modification was needed to a research airplane, Joe was there to see that that modification was done and done to his satisfaction. He was a perfectionist. And the programs he worked on were usually successful, and he was usually successful. I don't think I've ever seen a picture of Joe Walker where he's not smiling.

Q: Yes, he looked like he really enjoyed his work.

A: Joe had one of the nicest sets of teeth of anyone. They were straight and large. And he smiled easily, and he was a very happy-looking man when he did smile.

Q: He and Joe Engle.

A: Yes, Joe Engle's another good smiler.

Q: So what would you say Paul Bikle's management style was like? What characterized his style of managing the Center?

A: First of all, Paul didn't sit in his office and wait for reports on how everyone did. Paul was out in the hallways talking to everyone, including managers, including engineers, including mechanics and janitors. Paul talked to them. He knew what was going on every day. But that wasn't really the quality that made Paul great. As I said, the quality that made Paul great was that he knew what a good idea was and he knew what wasn't. And he didn't waste our time following a lot of blind alleys. He was instrumental in the X-15, the lifting bodies, probably in the Lunar Landing Research Vehicle—although I was not on that program and can't tell you how much Paul affected it. But Paul just knew what was worth doing and what wasn't. And that's what made him a great man.

Q: Since you first came to work here, have you seen many changes in the style of management?

A: Well, yes, I have seen changes in the style. But it isn't the human beings that have changed, Pete. Human beings are just the same as the day I came to work here. We didn't have congressional oversight; we didn't have much Headquarters oversight when I first came to

Center Lights Up The Sky!

Last week the Center began a unique series of tests that literally lit up the skys.

Powerful flares, rated at two-million-candlepower each, were dropped from the C-47 as it cruised above the lake bed. The flares used parachutes to slow their rates of descent and burned for three minutes.

Center pilots, Bruce Peterson and Bill Dana, were airborne in two F-104 aircraft. They were using the light from the flares to illuminate the lake bed in order to enable them to make simulated lifting body approaches.

During last week's tests the flares were used in different combinations and from different altitudes. The pilots each made several touch-and-go landings.

Reports from the preliminary test seem good according to the pilots. Further tests will be made later.

At the higher drop altitudes, the flares should be visible throughout the local area.

work here. The Dryden Flight Research Center was given a certain amount of money every year to do research, and it was pretty much up to the director where that money went and what it was used for.

Now that isn't the case. Congress pretty much tells us what we'll spend money for, and Headquarters is there to see that we spend it for that. So there isn't the freedom of choice that there was when I first came to work here. And that's both bad and good. Congress has probably kept us from squandering money on some of our poor ideas, but they may have prevented us from spending the appropriate amount of money on some of our good ideas. So it's hard to say whether that's a good or a bad change. But it is a change.

Q: Have the various center directors had particularly different management philosophies, or are they pretty similar?

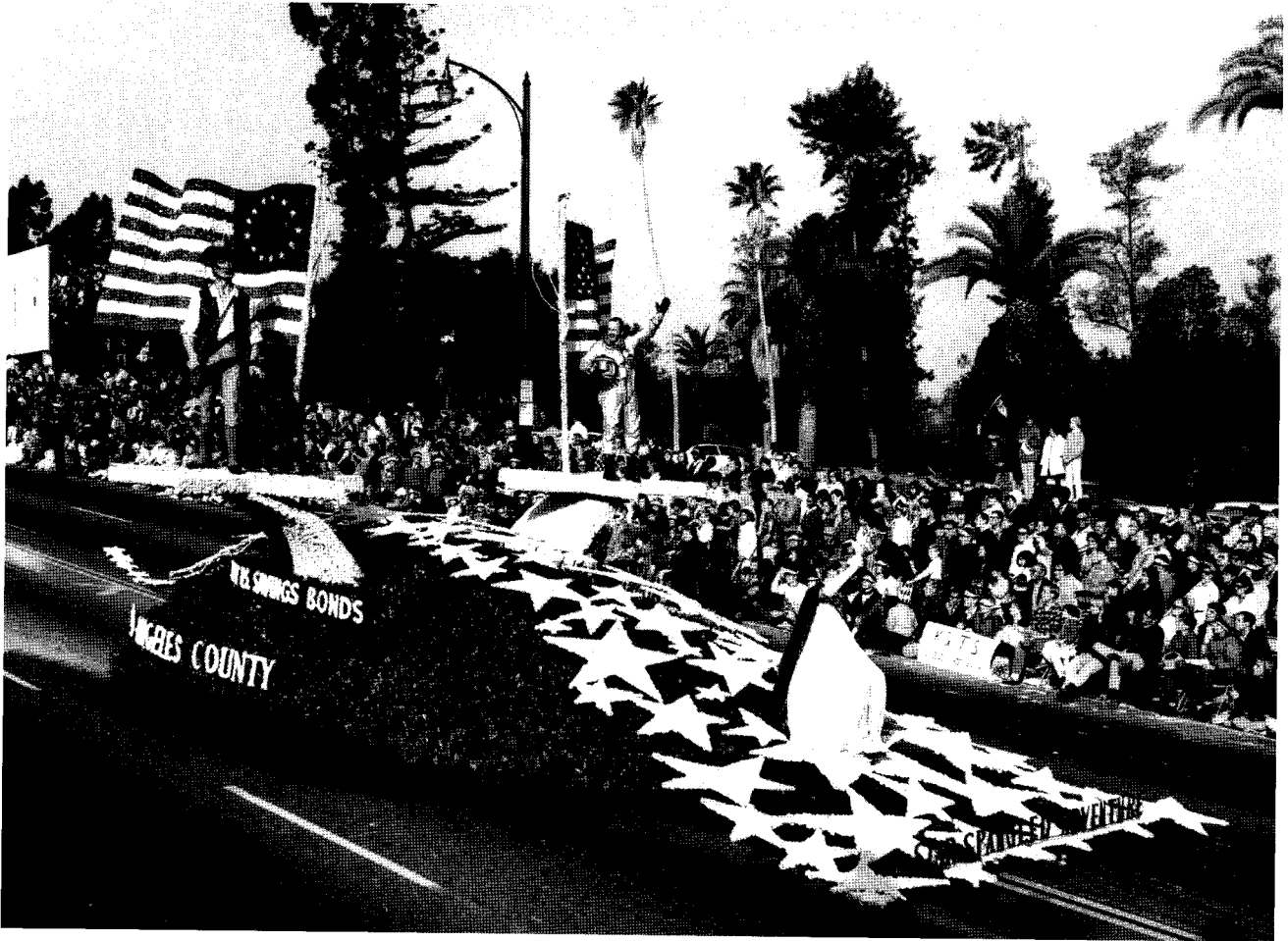
A: Well, the different directors we've had have had different marching orders when they came in. For example, when Paul Bikle retired and Lee Scherer came in, Lee came in from the space program. And he had marching orders to line Dryden up to be a recovery team for the Space Shuttle and to support the Space Shuttle. Lee did that, and he did that very effectively. Other managers have had other marching orders, and the Center has done different things under different managers. But there hasn't been a one of them that hasn't been a bright man or a hard worker. I think we've had good leadership throughout. And if some rose a little farther to the top than others, why, that's just the way human nature and statistical mathematics work.

Q: What do you feel are some of the most important projects that the Center has participated in?

A: Well, certainly the X-1. I think the day the X-1 flew supersonically is one of the major milestones in aviation history. I think you'd have to say the X-15 was important because it has to be considered one of the steppingstones into space. The X-1 and perhaps others and the X-15 are undeniable steppingstones toward the Space Shuttle. The Lunar Landing Research Vehicle—I've already talked in detail about the contribution of that. That required great vision and it required great persistence, to make that happen. And that was a successful program. It was used, as I said, by every astronaut that ever landed on the Moon and praised by every one of them. Our support of the Space Shuttle system—even though we weren't a big player in the Space Shuttle program—I think has been significant. Providing the landing site, providing the lighting for runways—we had done some research into night landings of low lift/drag ratio vehicles before the Space Shuttle landed at night. I think our design and development of the digital flight control system has been a major contributor to aeronautical research. So those are some of the ones that jump immediately to mind. That isn't to say there may not have been other programs here that were of equal value.

Q: I think that's about all the questions I can think of, and I certainly thank you for your time.

A: You're welcome, Pete.



Bill Dana riding on one of the 1968 Rose Bowl parade floats. He was that year's Grand Marshal (E-10750)

Section IV



Between the late 1950s and the end of the 1970s, space activities played a central role at the Flight Research Center. The X-15 program consumed the bulk of the facility's efforts and manpower. Indeed, the FRC's identity in the early part of the 1960s was tied directly to the X-15. While the X-15 program ended in 1968, lifting-body research continued the space-related activities into the mid-1970s. YF-12 operations continued the center's traditional high-speed flight research to the end of the 1970s.

An observer in the 1950s could have predicted that the quest for space was going to be a dominating factor in the work of the FRC. Well before *Sputnik 1* was launched, NACA efforts were increasingly—if quietly—focused on spaceflight activities. In some ways, all the elements were already in place. The X-15 program was in development, the lifting-body concept was emerging, and many of the technological ideas later used in the U.S. space program already had been formulated. As yet, however, these ideas were not fully defined.

What even the most visionary observer could not have imagined was the unexpected way this future took shape. First was the time frame. NASA's "round-1-2-3" concept called for a step-by-step effort that would take the United States from the edge of

space through longer and longer suborbital flights, and finally into orbit. The vehicles that were to make these ever-faster-and-higher flights were to be extensions of existing aviation concepts. As for a landing on the moon, this was seen as something for a distant future. The unexpected factor was the rapid advance of ballistic missiles in the 1950s; what had been viewed as an impractical technology was transformed by Cold

War necessity into an operational reality. In the process, the technology needed to put a human into orbit also was created. Just as rocket technology had made piloted space-flight possible, it was the launch of *Sputnik 1* by a Soviet ballistic missile that made it necessary. Space was a way for the two Cold War rivals to demonstrate their respective technological and military capabilities.

For a time, the competing technologies of capsules and aircraft continued in parallel. The X-15 made its initial test flights, and the Air Force worked on the X-20 Dyna-Soar, even as development of the Mercury capsule began. It was another Soviet achievement in space, the launch of *Vostok 1* with cosmonaut Yuri Gagarin, which again altered the course of the future. Though President Dwight D. Eisenhower had not directly confronted the Soviets in space, his successor, John F. Kennedy realized that minimizing Soviet accomplishments was no longer politically viable. The United States accepted that it was in a race with the Soviets in space and was running that race to win. The result was Kennedy's decision to throw down the gauntlet of an American lunar landing being achieved before the end of the decade.

The enormity of the Apollo program, in terms of the effort required, its abbreviated schedule, and the nature of its goal, overshadowed all else. The X-15 faded into obscurity, and the X-20 was cancelled in December 1963, before it ever flew. The future of

Lifting Body Study Awarded To Martin

The Martin Co., Baltimore, Md., has been selected by the National Aeronautics and Space Administration to make a study of the costs, crew size and complexity of a flight research program using a manned lifting-body vehicle.

The study contract will be negotiated with Martin by the NASA Langley Research Center, Hampton, Va. The contract is expected to cost about \$450,000.

Wingless lifting bodies which rely on their shape alone to provide aerodynamic lift for flight in the Earth's atmosphere, are being studied by NASA's Office of Advanced Research and Technology for possible use in a variety of future manned space missions. Their added lift and maneuverability provide a number of advantages over current space vehicles.

In conducting the study, the contractor is required to consider an HL-10 lifting-body concept capable of carrying one, two, four, six or eight crew members. The HL-10 is considered representative of advanced lifting entry vehicles.

NASA has specified Titan II, Titan III and Saturn 1B as potential launch vehicles. For study purposes, the Flight Research Center would be a probable landing site.

Although NASA's approved flight programs do not include such an effort, the research must be performed well in advance to permit

(Continued on page 2)

freedom of choice if such a program becomes needed.

Thus far, all U. S. manned spacecraft have been landed in the oceans, but future mission planners will need the option of landing at other locations such as large dry lake beds, and will want a spacecraft able to fly long distances inside the atmosphere before maneuvering to a safe touchdown under a pilot's control.

Lifting body vehicles are considered potentially useful for a variety of future missions in space; for example, spacecraft inspection, repair and reconnaissance; logistic and re-supply of advanced space stations; search and rescue; manned interplanetary missions, and as an upper stage of a recoverable launch vehicle.

The HL-10 concept was evolved through extensive research at Langley. The letters "HL" stand for Horizontal Landing, while the numeral 10 indicates the place in a series of research models.

NASA Requests Proposals For Space Station And Shuttle Craft Studies

The National Aeronautics and Space Administration has requested proposals from the aerospace industry for design and planning studies of a space station program for the mid-1970's, including various concepts of reusable space shuttle craft.

Major efforts of the studies will be preliminary design and planning of a 12-man Earth-orbital space station which could be developed by 1975. It would be designed to have an operational life of 10 years, subject to resupply of expendables and rotation of crews with logistics vehicles. The space station is envisioned as the initial element of a large space base.

The work will include a conceptual design of a 50-man space base made up of specialized modules assembled in low Earth orbit in the late 1970's and early 1980's. The space base would be a centralized facility in orbit comparable to a scientific and technical research, development, and operations center on Earth.

Scientists and engineers of many disciplines could utilize its unique features, such as weightlessness, vacuum, Earth viewing, and unobstructed celestial viewing for a large variety of research and applications activities.

Modified Apollo and Gemini spacecraft will be considered as initial logistic systems or shuttle craft for the space station design in the event an advanced space shuttle would not become available for the early phase of space station operations. Various concepts of advanced space shuttles such as lifting bodies will be evaluated to identify the most economical means of supplying a large space base. Each of the shuttle concepts would be capable of land landing at precise locations.

spaceflight seemed to belong to the capsule. The accelerated time frame of the Apollo program also altered existing ideas about how to put a man on the moon. The conventional wisdom at the time of Kennedy's announcement had called for building a battleship-sized rocket to launch a massive spacecraft on a direct ascent for a lunar landing. But the engineering reality of building such a huge rocket and large spacecraft, in the time frame Kennedy envisioned, rendered the concept out of the question. The idea of launching several boosters, enabling a large spacecraft to be assembled and fueled in orbit, was similarly problematic. Instead, the task of landing would be divided between two spacecraft. The Apollo Command Module would take astronauts to and from lunar orbit, while the Lunar Module would make the actual landing. This in turn led to development of the Lunar Landing Research Vehicle, which would be used to train astronauts for the landing. Development of the LLRV was to constitute the FRC's primary involvement with the Apollo program.

In one respect, the fact the FRC had a minimal role in the Apollo program allowed its personnel to think beyond the immediate requirements for a moon landing to future possibilities in space. The activities undertaken during this time reflected ideas that had first originated with the round-1-2-3 concept a decade before. Although the goal was no longer putting an aircraft into orbit, the work undertaken at the FRC reflected the concept of a step-by-step progression. Rather than a simple faster-and-higher progression, however, this approach actually involved a series of tests that would address different elements of the equation. Research with the X-15 would provide data on high speeds and altitudes. The M2-F1 research would prove the concept of a lifting body, and that a vehicle resembling a bathtub really could fly. The heavyweight lifting bodies were refined vehicles, with configurations that could actually withstand re-entry. They would fly in a limited performance envelope, however, below altitudes of 100,000 feet and at speeds of less than Mach 2, to keep costs low.

As a result of this work, the stage was set for development of a reusable orbital spacecraft. X-15 flights provided the first real-world hypersonic aerodynamic and heating data. Some of the results were expected while others, such as the absence of laminar airflow at hypersonic speeds, ran counter to earlier wind-tunnel predictions. Energy management principles required for atmospheric re-entry also were proven during the X-15 program, as were experiences with localized heating, airframe buckling, and in-flight landing-gear extensions. The

different lifting-body designs illustrated that it was possible to build unconventional vehicles capable of both withstanding re-entry and making controlled low-speed landings. This could be done not only on the lakebed, as with the X-15, but also on a concrete runway, as demonstrated with the X-24B.

In some cases, the most valuable contributions of the X-15 and lifting-body research came in showing what did not work. The ablative heat shield applied to the X-15A-2 provided, in theory, a simple method for refurbishing a space vehicle after flight. In practice, however, the procedure was clumsy, difficult, and time-consuming. The various heavyweight lifting bodies did not need heat protection for their relatively slow flights. The X-24A was wind-tunnel tested, however, with a simulated ablative heat shield—a layer of white glue and sand applied to the aircraft's underside—and chicken wire giving the shield texture. The tests showed that added surface roughness greatly increased vehicle drag. Painted with the textured coating, the craft would have been

much more difficult to fly and land. These experiences made it clear that either ceramic or metal tiles would be required on a reusable spacecraft.

Just as political realities had shaped the decision to abandon the round-1-2-3 approach in favor of capsules, and made it necessary to directly confront the Soviets in space with the Apollo program, so too did political considerations shape development of the emerging spacecraft. When the lifting body program began, the vehicles were envisioned as being used for taking crew and supplies to a space station. Fulfilling this role required a relatively small vehicle, akin in size to the X-20.

But by the early 1970s, the number of tasks a "space shuttle" would be required to fulfill would increase dramatically. In addition to crew rotation and re-supply, the vehicle would also have to carry large space station components and satellite payloads. It would have to serve not only NASA missions, but military and commercial space activity as well. The space shuttle would have to replace all existing expendable boosters. This created the perception that a shuttle would require a payload bay 15 feet wide and 60 feet long and the capability of carrying in excess of 50,000 pounds of payload. This was the equivalent of the volume and weight capacity of a railroad boxcar.

The same political imperatives affected not only the type of vehicle to be built, but also its overall configuration. The high levels of funding that the U.S. space program had initially enjoyed had begun to fade even before the first moon landing. The initial shuttle concepts called for two piloted stages, a configuration dating to the early 1950s. The first stage would accelerate to a specific speed; the second stage would then separate, ignite its engines and head toward orbit. The first stage would turn back and land. Because the second stage would contain internal fuel tanks, it would be a large vehicle. This, in turn, meant that the first-stage vehicle had to be larger still. Both shuttle stages would be completely reusable to keep operating costs low.

But the same reduced funding that dictated multiple roles for the spacecraft also meant that money would not be available for this pair of advanced, technically demanding, and fully reusable vehicles. Instead, a simpler, semi-reusable configuration evolved. The shuttle vehicle would carry three liquid-fuel engines fed from a very large external drop tank. To supply the additional thrust for liftoff, a pair of solid rocket boosters would be attached to the sides of the external tank. At liftoff, both the liquid and solid rockets would ignite. The solid rockets would burn out in about two minutes, separate from the tank and parachute to an ocean splashdown. They would be refurbished and used again on subsequent flights. The shuttle would continue on toward orbit using the remaining fuel in the external tank. Just before reaching orbit, the now-empty external tank would be jettisoned to burn up on re-entry. The shuttle would fire small rockets to provide the final velocity needed to put itself into orbit.

As the shuttle concepts evolved at the end of the 1960s and into the 1970s, FRC personnel provided their insights to designers. One issue that sparked a major controversy was the use of landing engines. Many believed that the shuttle would have to be equipped with jet engines in order to make a powered landing. Milt Thompson and other pilots and engineers pointed to more than twenty years of experience with rocket aircraft making unpowered landings on the lakebed. They argued that landing engines did not increase safety, but rather diminished it due to the complexity, weight, and level of risk the engines added.

The final test came (and the issue was settled) when two powered landing flights were made with the HL-10. The lifting body was fitted with small rocket engines, and Air Force test pilot Peter Hoag made the powered approach. The results were eye-

. . . Security Captain **Bob Risley** is recovering from surgery. . . . Departing the Center this month is **Patti Apprill**, Public Affairs. . . . **Dean Webb**, Research, was a first-place winner in a recent Knott's Berry Farm photographic contest. . . . **Audrey Kosick** is the new receptionist in the lobby. . . . The **HL-10 lifting body** inflight over the Tehachapi mountains is the color cover of the new Kern County telephone book. . . .

opening. Due to the flatter trajectory of a powered approach to the runway, Hoag had a harder time hitting the planned touchdown point. By contrast, the steep unpowered approach allowed a pilot to aim directly at the runway, flare, and make the touchdown. The idea of landing engines was dropped. Subsequently the X-24B completed two unpowered, precision landings on Edwards Runway 24.

President Richard M. Nixon gave his approval in 1972 to develop the shuttle. FRC engineers began to assemble the aerodynamic database that would be used in its design. This was built on data from the X-15, XB-70, and YF-12 flights, as well as on any wind-tunnel or other research data that might apply. The margins for error had to be determined for each data set. FRC engineers also were involved in developing the instrumentation packages that would be flown on the orbital shuttle missions.

Once the prototype shuttle, named *Enterprise*, was completed, it was moved from the Rockwell International assembly plant through the streets of Palmdale and Lancaster, and finally to the Dryden Flight Research Center at Edwards. The shuttle was to begin the Approach and Landing Tests (ALT). These would serve several goals. The shuttle's subsonic aerodynamics, such as its lift-to-drag ratio, could be measured. More important was that the vehicle's computer fly-by-wire system could be tested in actual flight. The shuttle was totally dependent on its redundant computer system for stability and control. Should these suffer a total hardware or software failure, the vehicle would be lost.

The shuttle would undergo preliminary tests during the ALT that were similar to those of earlier research aircraft. First would be high-speed taxi tests of the shuttle and its launch aircraft down the Edwards runway. These would be followed by unmanned captive-carry flights to test the shuttle's aerodynamics and systems. Next would come

manned captive-carry flights, with a crew on board to operate the systems. These would follow the actual launch profile with the exception of the actual separation. The final step would be free flight of the *Enterprise*.

The shuttle launch profile was radically different than that of the B-29s, B-50s, and B-52s that carried its research predecessors. The X-1s, D-558-IIIs, X-2s, X-15s, and various lifting bodies had all been dropped from underneath their motherships. The *Enterprise* would be carried aloft on the back of a modified 747 airliner. Once the pair reached the launch altitude, the 747 would nose down into a shallow descent. The shuttle commander would fire explosive bolts, and the pair would separate. The shuttle would be mounted at a nose-up angle, which would cause it to develop enough lift to separate cleanly. Despite the calculations, the possibility of the shuttle striking the 747's tail was on everyone's minds.

The five free flights had three different profiles. The *Enterprise* would initially be fitted with a tail cone to reduce the turbulence on the 747's vertical fin and improve the shuttle's lift to drag ratio. The shuttle would land on the lakebed, with its long runways. This would provide a greater margin of safety for the first, second, and third free flights. On the fourth flight, the tail cone would be removed. This would cut the shuttle's lift to drag ratio nearly in half, causing it to descend more steeply. Like the previous three flights, however, this mission would also touch down on the lakebed.

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The fifth and final free flight had a much more demanding profile. Once the shuttle became operational, the landing site for the shuttle would be Kennedy Space Center. A long and wide runway was built amid the swamps and alligators, and it had a much smaller margin for error than the lakebed at Edwards. The fifth flight would make a landing on the concrete runway at Edwards to demonstrate the shuttle could successfully accomplish this demanding task.

Two crews were selected for the ALT flights. The first was Fred W. Haise (a former Dryden research pilot) and C. Gordon Fullerton, and the second was Joe H. Engle (a former X-15 pilot) and Richard H. Truly. The crews would alternate; Haise and Fullerton would make the first and third manned captive-carry missions and first, third, and fifth free flights, Engle and Truly the second manned captive-carry mission and the second and fourth free flights.

Shuttle Study Contracts Near

The National Aeronautics and Space Administration has selected two aerospace industrial firms for final negotiations of parallel 11-month contracts for definition and preliminary design studies of a reusable space shuttle vehicle for possible future space flight missions.

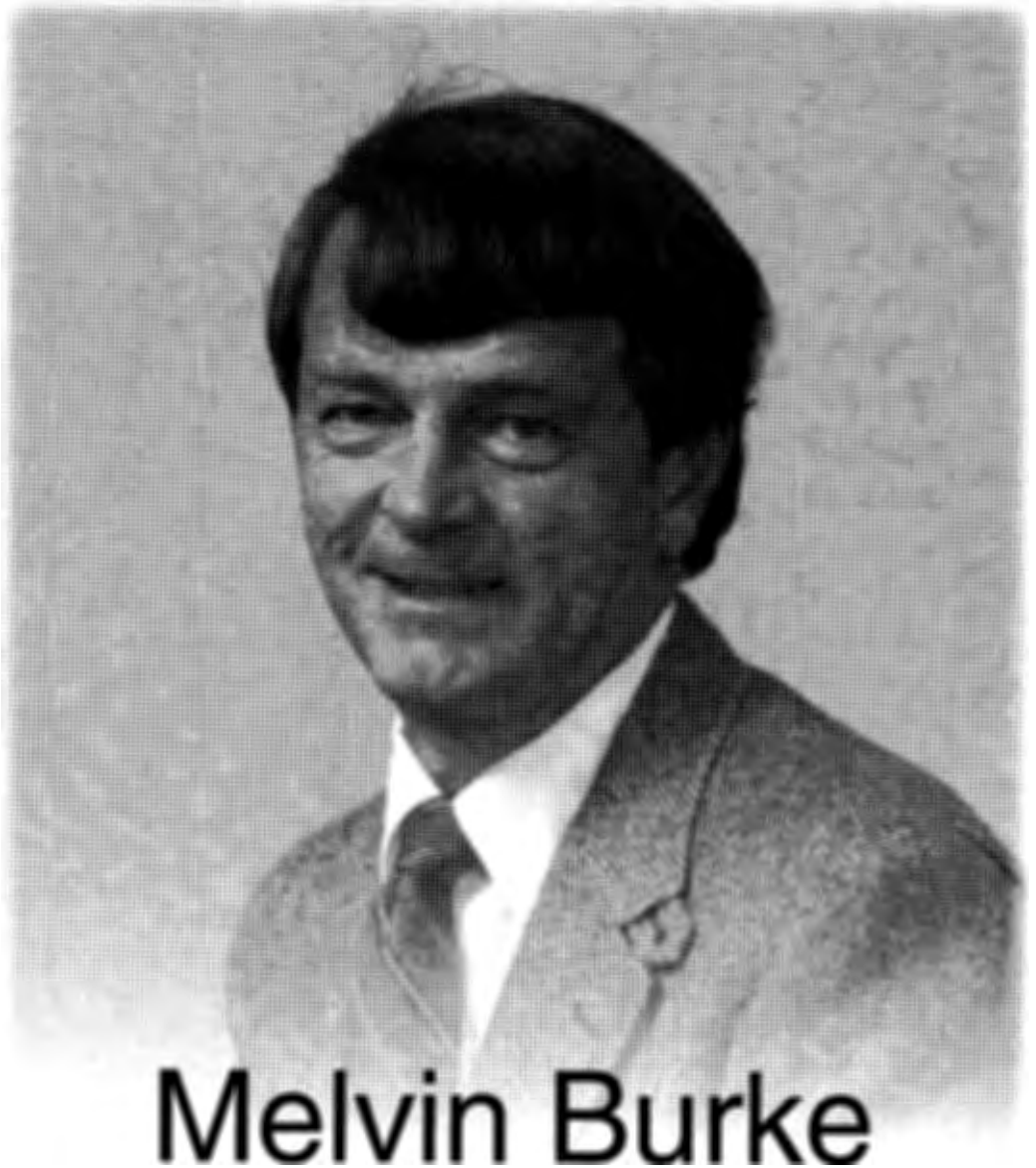
Fixed priced contracts will be negotiated with McDonnell-Douglas Corp., St. Louis, and North American Rockwell Corp., Space Division, Downey, Calif. valued at approximately \$8 million each.

NASA has also selected three aerospace firms for final negotiations of parallel 11-month Phase B design definition study contracts for the space shuttle main propulsion system. The studies will be managed by the Marshall Space Flight Center, Huntsville, Ala.

NASA will negotiate fixed price contracts with Aerojet Liquid Rocket Co. of Aerojet General Corp., Sacramento; Rocketdyne Div. of North American Rockwell Corp., Canoga Park, Calif.; and Pratt & Whitney Div. of United Aircraft Corp., West Palm Beach, Fla. to define requirements for the shuttle engine, to provide a prototype engine design to meet technical requirements.

Winning Incentive Awards last month were **Al Harris, Jr.**, Flight Operations, and **Jim Craft**, Data Systems. Former X-15 pilot **Bob Rushworth** has returned to this country following his tour of duty in Vietnam. On his last flight mission, his F-4 aircraft was damaged by enemy ground fire. Another X-15 pilot, **Pete Knight**, visited Sweden last month to fly some of the new Swedish aircraft. According to a NASA Headquarters bulletin, the Hertz Rent-A-Car Company offers a 20% discount to NASA employees. ID cards are necessary to obtain the saving. **Meryl De-Geer's**, Flight Operations, advice to young co-op engineers is, "Don't spend all of your money on wine, women, and song; save some to spend foolishly." **Richard Eubank**, Administration, received a \$35 Incentive Award from the Center last year. This same idea, a handling device for moving bulky items, has been adopted by the Goddard Space Flight Center and he will receive a second check.

. . . **John Manke**, Pilot's Office, comes from a town in South Dakota that is so small that they closed the town zoo when the local pigeon was run over by a car... According to **Ron Waite**, Flight Operations, the arrival of one more F-8 and we'll delete the final A in NASA. . .



Melvin Burke

**Interviewed by Curtis Peebles, February 9, 2006
(Original questions and responses amended
by interviewee in March 2006)**

Melvin Burke's background is similar to that of many of the engineers who worked on the space projects of the late 1950s through the 1980s. He was a child of the Depression and grew up in the Midwest. He was first introduced to electronics while serving in the U.S. Air Force during the Korean War. Burke attended Michigan State University, graduating with a degree in physics. He worked on the ground support equipment used with the Thor ballistic missile. This booster was later used to launch the first U.S. moon probes, the Corona photo reconnaissance satellites, and the first U.S. weather and communications satellites. He worked at AC Spark Plug on the Titan ICBM inertial guidance system and the Polaris submarine navigation system. Like many others in the early 1960s, Burke grew tired of Midwestern winters and joined the migration to the Sunbelt. And like many of those arriving at the Flight Research Center to work on the X-15, his first impressions of Lancaster were mixed.

Q: You were born in White Cloud, Michigan. Could you describe your early years?

A: I was born in 1932, in the Great Depression, my parent's first son. My sister was born three and a half years before me and my brother nearly 6 years after me. My father was a printer and full-time permanent jobs were rare. Consequently, we moved a number of times and I had the opportunity to attend several different schools. I remember the first school I attended was in Whitehall, Michigan, when I was 4 years old. We moved to Muskegon, Michigan, before I turned 5 and, even though I had started school in Whitehall, Muskegon would not allow me to enter their schools until I was 5 years old. When I did start school I attended the Moon School, which was about two blocks from where we lived. Muskegon was a medium-size city with a daily newspaper, the Muskegon Chronicle, where my father worked as a linotype operator. We lived in Muskegon until I was midway through the fifth grade. At that time we moved to a farm near Greenville, Michigan.

We only lived on the farm for a couple of years but I certainly remember the hard work involved with farming. It was a large farm, 360 acres, and even though I was young, I was expected to do my share. We had 24 cows that had to be milked by hand morning and evening as there was no electricity. My father and I handled the milking and most of the farm chores. I think he milked about three cows to my one. We processed the milk through a hand-powered separator, separating the cream from the milk. We sold the cream to a local creamery that made butter from the cream; the skim milk was fed to our pigs. We raised beans, corn, oats, wheat, and hay. Most of the work was done with horses as World War II was ongoing and gasoline was in short supply. The grade school my brother and I attended was a two-mile walk from the farmhouse. It was a two-room school, one room for classes and a small room for coats. We walked to and from school every school day. In the winter that took an effort but in the spring and fall it was an enjoyable hike.

We left the farm and moved to Fremont, Michigan, where I attended junior and senior high school, graduating in 1950 when I was 17 years old. During my freshman and sophomore years in high school, I attended school for only part of each year. I was fortunate to have been appointed a page in the Michigan state senate and lived in the YMCA in Lansing, Michigan, some 120 miles from home. It was pretty heady stuff for a 13-year-old, living on his own, eating all of his meals in restaurants with a lot of free time. Even though the senate was in session only 3 or 4 days each week, we reported to work Monday through Friday and normally spent about 7 hours each day there. The senate session lasted from the first week in January through mid-April. Fremont High School allowed me to study on my own and to take end-of-semester and final exams. Luckily, while not achieving any academic accolades, I was able to pass and keep up with my class. Other than having been a page, my junior and senior high school years were quite uneventful. I participated in sports, was a member of the student council and generally followed the routine of a typical small-town teenager.

Q: How did you become interested in engineering?

A: When I was in the service during the Korean Conflict, I worked with a Philco Tech-rep in Japan and Korea. His name was Willis Swanson and he spent time showing me how to do the math necessary to design circuits and antenna for different transmission and reception frequencies. I was 18 or 19 years old at the time and was so impressed with his knowledge and what he could do, I vowed when I got out of the service I was going to go back to college and get involved with science. In 1953 and 54, the last two years I was in the service, I was stationed at Pincastle Air Force Base in Florida where, a number of years earlier, the initial glide flights of the X-1 had taken place. I was not aware of that fact at the time; my only interest was in getting out of the service and starting college.

Q: Where did you attend college?

A: On graduating from high school I started college in the summer with the goal of becoming a certified public accountant. When the Korean Conflict started in June, 1950, I decided to enlist in the Air Force and did so at the end of July of that year. By the time I got out of the service in 1954, I was married and jointly, with my wife, we decided to enroll in Michigan State University. I initially enrolled in Electrical Engineering but, during the first year of engineering at Michigan State mandatory classes included a great deal of shop work. I did not care for foundry casting and machining types of work (never could relate them to electrical engineering) and, as I was more interested in theory and math, I transferred to the Physics Department. I dropped out of school after the first quarter as my wife was expecting and I needed to work to meet the financial obligations of a family. Following the loss of our child, I re-enrolled at Michigan State in the spring of 1956. I received a BS in physics in March, 1959. I also took graduate courses at Marquette University and at UCLA.

Q: What did you do before you arrived at Dryden in 1961?

A: Douglas Aircraft: I accepted a position with Douglas Aircraft in Santa Monica as a test engineer in April, 1959. While I was at Douglas, Scott Crossfield piloted the X-15 on its first glide flight. The buildup to this flight was well covered by the Los Angeles evening news on television. Of course, I never dreamed that within a relatively short period of time I would be working on that vehicle. The job at Douglas was not overly exciting. I was in a section with 7 other engineers and about 14 technicians. We, the engineers, would design test programs to verify various components of the ground support equipment for the Thor IRBM were meeting their design specifications. We would draw the circuit diagrams for the test to be conducted, write the test procedures and monitor the test as the technicians conducted them. We would then analyze the results and write a report describing the component tested, its performance specifications, the test set-up and the results of the test.

AC Spark Plug: I was recruited in the late summer of 1959 by AC Spark Plug (now AC Delco). We left Santa Monica bound for Milwaukee, Wisconsin in October after completing the contract I had signed with Douglas. AC was located in both Flint, Michigan and in Milwaukee. The complex in Michigan was primarily concerned with automotive parts. While the facilities in Wisconsin worked on government (DOD) projects. AC-Milwaukee worked very closely with MIT and was under contract to build the inertial guidance system for the Titan ICBM. I saw this as an opportunity to participate in state of the art technology. I participated in the development of the Titan system and the Ships Inertial Navigation System (SINS) used on the early Polaris submarines. I was assigned to the Gyro Engineering Department where I tested gyros and accelerometers. All new hires went through a 10 day orientation course where we not only learned about General Motors and AC but also received technical instruction on the theory of inertial guidance and how the systems AC built worked. General Motors was a good company to work for and the work at AC was very interesting but, the Milwaukee weather was terrible. We were on an extended work week, every other week we would get a Sunday off. The extended work week was necessary to meet the critical production schedules for the ICBMs as the Cold War was at its height. It seemed that on every one of my Sundays off it was either raining or snowing.

NASA-FRC: When President Eisenhower established NASA in 1958, the technical challenge and glamour of being involved with its space programs was very attractive. One week I noticed an advertisement in Aviation Week where NASA was looking for an engineer with a background in inertial guidance. The position was at Edwards AFB in California. Sick of the Milwaukee weather, especially the winters, my wife and I decided

I should apply for the position. I submitted an application and after a couple of weeks I got a telegram from NASA's Flight Research Center offering a job to me. I accepted and we headed West in the summer of 1961. As we drove through Barstow and Mojave, we realized how desolate the desert was, the towns were small with very few stores, nothing like we were used to in Milwaukee. We were getting concerned that we had made a mistake. When we got to Lancaster, where, it had been recommended we look for housing, we saw a town that actually had a Sears store and my wife practically cried with relief. The main grocery store was Vons & Shopping Bag located on the corner of 10th Street West and Avenue I.

We were not sure if we wanted to settle in Lancaster so, we rented a house. Few houses had air conditioning, most had an evaporative cooler. The output was more than sufficient to cool our house during the hottest part of the summer. The aerospace industry had recently suffered the cancellation of several contracts and many people had left the area, leaving a large number of homes vacant. It seemed that at least 40% of the houses in Lancaster had been repossessed and were owned by the banks and mortgage companies. Anyone who was employed could move in by just assuming the payments of the people who had vacated the homes. We only stayed in the first house we rented for about 6 months. We moved to another rental as we still were not sure about staying. Our neighbor on one side worked at the rocket site and on the other side at US Borax. Milt Thompson, his wife and family lived two doors down from us.

Of course, there were no freeways, only two lane roads. To get to LAX you had to drive down Sierra Highway (US-6), get on Sepulveda Boulevard and follow that all the way to the airport. One thing that was helpful was the fact that the traffic was very light back then. Still it was usually about a 3 hour drive each way. It was not uncommon to get stuck behind a hay truck and this slowed the trip down even further. The Flight Research Center had a contract with Avis Rental Car and the agent was a Union 76 gas station on the corner of Sierra Highway and Lancaster Boulevard.

There was no gate to go through to get to the main base complex at Edwards or to the Flight Research Center. It was still necessary to have a base sticker on your car but I am not sure why this was a requirement. Anyone could and many did use the base roads as a cutoff to what is now Hiway 58. The sled track was still in place so, if you wanted to drive in from the back way, you had to take a lengthy detour around the sled track. The Air Police did, however, regularly patrol Rosamond Blvd. I remember one time when we were driving in very early one morning to support an X-15 flight a pickup truck went sailing past us like we were standing still. A few miles ahead, we saw the Air Police had the speeding pickup stopped. It looked like Joe Walker's pickup and some time later I asked Joe if that was him. Joe acted a little embarrassed, and acknowledged he had been going a little too fast and was stopped for speeding. When the Air Police saw who it was they had just waved him on, telling him to slow down a little. Rosamond was not much of a town but it did have several bars. We, members of the X-15 team, frequented Juanita's after nearly every flight because it seemed, nearly every flight set a new speed or altitude record and the word was out to stop at Juanita's to celebrate. I only stopped a couple of times as I soon joined a carpool of non-drinkers.

Q: You worked on the X-15 program. What were your duties?

A: *Program Status:* When I arrived in July, 1961, the planned flights using the XLR11 rocket engines, which burned alcohol and liquid oxygen, had been completed. The project team was starting to expand the flight envelope to gather the research data needed in the Mach numbers above Mach 3.5. This required flying with the Reaction Motors (Thiokol) designed rocket engine (frequently referred to as the XLR-99 engine or just -99). This engine had a restart capability and the thrust level could be varied by the pilot with an

adjustable throttle. The -99 engine was capable of up to 57,000 pounds of thrust. It burned anhydrous ammonia and liquid oxygen. It had been flown in X-15 #2 only. The engine was installed in X-15 #1 but had not yet flown in that aircraft. X-15 #3 was not in flight status as it was being rebuilt by North American and the Honeywell Adaptive Flight Control System was being installed. Each aircraft had an experienced engineer assigned as the Lead Flight Operations Engineer; Ron Waite had X-15 #1, Bill Albrecht # 2 and John McTigue # 3. (When McTigue went to work on the lifting body program, Vince Capasso was assigned to X-15 #3.) They were supported by a team of specialized systems engineers covering the rocket engine, the APU, stability augmentation system (SAS), the Ball Nose, the Inertial Flight Data System (IFDS) and other subsystems on the aircraft. All of these systems engineers were in the Operations Engineering Branch managed by Perry Rowe. Incidentally, Bruce Peterson was one of these Flight Operations systems engineers at that time. This branch was part of the Flight Operations Division under Joe Vensel. The systems engineers for the Ball Nose and IFDS were the exception, they were in the Data Systems Division under Ed Videan.



Burke in 1962, soon after he and his family moved to the Mojave Desert from the Midwest. (E62-8126A)

The X-15 pilots were Joe Walker, John “Jack” McKay and Neil Armstrong, all of NASA, Major Bob White and Captain Bob Rushworth of the USAF and Lt. Commander Forrest Petersen of the US Navy. We were a small team and I had the opportunity to work closely with the pilots and got to know them well enough to at least form lasting impressions of them. Joe Walker was a gregarious person with a quick temper. He did not hesitate to let you know that the cockpit of the airplane was his territory and you had better not change things without his approval. Even with his quick temper, once he let you know how he felt, he immediately recovered to an even disposition. Jack McKay was also a very outgoing person who did not get excited easily. While flying the X-15, he did not appear to trust the instruments totally and felt more comfortable with his own natural flying abilities. Jack was very helpful to those of us supporting the program. He was also a standout at Juanita’s after each flight. Neil Armstrong always impressed me as more of an engineer than a pilot. He seemed to analyze every aspect of a flight until he had a complete understanding of why things happened the way they did. Neil was very much more introverted than the others in the Pilot’s Office but, he did participate in the after flight

stops at Juanita's. Bob White, I am sure was an excellent pilot but, he came across as a very aloof person. He never had much to say and I do not recall that he ever participated in the after flight stops. A person who was difficult to get to know. Bob Rushworth was a very much down to earth easy to talk to guy. While not overly outgoing he certainly was not an introvert either. He was always friendly and helpful to those of us who played supporting roles. Forrest Petersen, besides being an exceptional pilot, was also a very friendly person. He was easily accessible and more than willing to discuss the performance of your system during his flight. He also was a great one to make it to Juanita's after a flight. The pilots were great to work with and I, for one, have very good memories associated with each one of them.

My initial assignment: One of the problems inhibiting the expansion of the flight envelope was the reliability of the X-15 Inertial Flight Data System (IFDS), often referred to as the 'stable table'. This system provided flight data to the pilot during the mission. It was not uncommon for the inertial height indicator to be reading between 30,000 and 100,000 feet at the end of a flight with the aircraft sitting on the lakebed. An inertial system was the only on-board system that could provide the pilot with real time information regarding his speed, altitude and attitudes (pitch, roll, and yaw) at the extreme speeds and high altitudes the X-15 was capable of achieving, thus its performance was critical. Radar data on speed and altitude could be radioed to the pilot but would not be available if there were a communications problem. An on-board system was a requirement. The engineer responsible for the system, Jay Christiansen, had been selected to fill a position at NASA's Ames Research Center but was being held at the Flight Research Center until a suitable replacement for him was hired. I was his replacement and we worked together for about two weeks before he left.

I had two junior engineers working directly for me on the IFDS, Malcolm Brown and Jim Coleman, both quite capable but inexperienced. The Center had established an Inertial Systems Laboratory under Ken Cowden. Ken had four instrumentation technicians working for him and they maintained the systems, replaced failed components, calibrated and tested the systems in the laboratory. Ken reported to Truman Pugh who also supervised a very capable instrumentation repair and calibration laboratory. Ken's people did not work outside of the laboratory. That is, installation and testing of the IFDS on the aircraft were performed by other technicians, Harvey Price and Walt Redman.

Harvey and Walt worked for Bob Cook, who was leader of a section of technicians who installed, tested, and removed all instrumentation in the Center's aircraft. Within the Data Systems Division, Bob Cook and Truman Pugh were both at the same level. However, they were in different Branches and these Branches were different than the one I was assigned to. I did not supervise any of the technicians associated with the IFDS, just the two junior engineers, even though I was responsible for the system. Generally, in spite of the way the IFDS support was organized things moved along smoothly. Once in a while a little extra diplomacy was required as Ken Cowden was very independent and was not always amenable to taking technical direction from engineers.

The IFDS: The system had been built by Sperry Gyroscope Company in Great Neck, New York. Six 'A' and two 'B' systems were built. The 'A' systems were built for flight while the 'B' systems were strictly for laboratory use and fit checks in the aircraft. Each system included an inertial measurement unit (IMU), a computer, a set of pilot's displays and the necessary interconnecting cables. The IMU had four gimbals to prevent gimbal lock when the vehicle was maneuvering. It provided attitude data to the pilot's 3 axis ball display. The inner gimbal contained three stabilizing single-degree of freedom gyroscopes, three accelerometers, and the necessary supporting electronics. The computer was an analog device using electromechanical integrators to transform the accelerometer outputs to velocity and position data. The computer provided data to a set of displays in the cockpit. These displays included total velocity, vertical velocity, and vertical height

(altitude). The system was designed to be a 'local vertical' system, that is, no matter where on the range the X-15 was flying, vertical velocity and height of the aircraft were always referenced to the surface of the Earth directly below the aircraft.

Because the system generated a lot of heat when it was operating, it was necessary to supply external cooling through a set of heat exchangers mounted on both the IMU and the computer covers. When the aircraft was unmated on the ground a cooling cart was used to supply the cool air blown through the heat exchangers. Mated to the B-52 or during free flight, liquid nitrogen flowed into a plenum chamber on the X-15 where it was converted to cold gaseous nitrogen. This gaseous nitrogen was blown through the heat exchangers. The heat exchangers were like radiators with very narrow or small passage ways and were subject to condensation and freezing, blocking the flow of cool air. Without cooling, the system could operate for about 10 minutes without damaging the components. Keeping the cooling air flowing and at the proper temperatures was a touchy balancing act and during carrier flight prior to launch required a significant amount of attention of one of the X-15 Flight Operations systems engineers.

IFDS Operation: As mentioned earlier, the IFDS was so unreliable that it was actually limiting the expansion of the X-15 flight envelope. To try and ensure that we had a reasonably accurate operating system, we performed a series of tests on the system prior to each flight. The computer and the IMU were individually tested in the laboratory by Ken Cowden and his team of instrumentation technicians. The IMU and computer were then connected together and a simulated operational test was conducted in the laboratory. When the system had successfully completed these tests, it was moved to the hangar and installed in the X-15.

Prior to mating the X-15 to the B-52 and following the installation of the system in the X-15, the system was given a complete operational check in the hangar including a 15 minute drift run in the inertial mode. This provided an insight into the static performance of the system and we established stringent limits on the allowable drift rates for the system to meet before proceeding to the next step. Up to this point, the system could be more easily replaced than in the mated configuration should it fail any of the tests. The IFDS was one of the last systems tested before the vehicle was moved out of the hangar to the mating area. It seemed that this testing always occurred in the late night or early morning hours and we spent many nights at the Center either waiting to gain access to the vehicle so that we could test the system or actually performing the tests.

On the day before a flight, we would always check with the crew chief to get an estimated time of when we would be allowed on the vehicle to make our system test. Usually we would be told it would be 8 or 9 that evening, which would allow us to go home for dinner. The crew chief had the telephone number of the IFDS technicians, Harvey Price and Walt Redman, and would call about two hours before we could get access. Whoever got the call would then telephone the others who had to go in for the test. For the first year or so after I got to the FRC, I always went in to participate in the test. I recall one time when the system failed the test; we isolated the problem to the computer. There was no spare computer available so, I had Harvey and Walt bring the failed unit into the IFDS lab. Neither Harvey nor Walt were lab technicians and were familiar enough with the interior of the system to make repairs. Consequently, I tore down the computer, replaced the ailing component, reassembled it, verified the computer was operational and had them reinstall it. The inspector who witnessed my work and the testing reluctantly signed off on the unit, not happy that an engineer was doing 'technicians' work. We worked nearly all night but finished in time for the vehicle to be mated in the wee hours of the morning and complete a successful flight as scheduled.

Following mating, the B-52/X-15 combination would be moved down the taxi strip to the servicing area where final servicing of the aircraft was completed. The Flight Operations Engineer in charge of the X-15 being serviced sat in a mobile command vehicle;

using a check-list he monitored the servicing activities. After servicing was completed and just prior to B-52 engine start, the IFDS was turned on from the launch control panel in the B-52. This was done by either of our two launch panel operators, Stan Butchart or Jack Russell, depending on who had the flight assignment that day. A long erection cycle was initiated. When first assigned the responsibilities of the system, I regularly went up into the B-52 with Harvey and/or Walt, to monitor the system performance as it was turned on and before the start of B-52 taxi. We had to carry gas masks as frequently when the servicing hoses were disconnected from the X-15, a small amount of ammonia was spilled. The gas evaporating from the spilled ammonia seemed to always find its way up into the B-52 and the launch panel operator's position. I can tell you a slight whiff of this clears your sinuses immediately! Actually, a small concentration of this could be toxic so, when a spill occurred, you immediately put on the gas mask.

When the B-52 engines were started, the technicians and I would exit the aircraft and I would immediately head for the FRC control room where I had a regular seat. Most of the systems engineers sat at work stations which displayed critical data on the performance of their system(s). The IFDS had no such workstation as no data was transmitted down from the IFDS. Should a problem with the system develop, my job was to diagnose the problem based on information from either the launch panel operator or the X-15 pilot describing what they saw. Based on that information, I had to analyze what was happening inside of the system and recommend either an abort or continuing with the launch. This decision had to be based on safety of flight considerations. If, based on my analysis, I felt the system would provide the information necessary to safely complete the flight, I would recommend proceeding. The data required for the pilot to safely fly the mission was established during simulator training and was specifically identified during the pre-flight briefing.

The erection cycle initiated prior to B-52 engine start would last for nearly the entire carrier flight until just prior to the start of the X-15 APU's and the power transferred to the aircraft's internal buss. At that time erection was terminated and the system was placed in the inertial mode. This was a critical time for the system and several times we had a system failure when the power was transferred or when the system was placed in the inertial mode of operation.

Improvements to the IFDS: In addition to the testing, I initiated a revision to the operational procedures. Before the procedures were revised, the technicians carried a book with a red cover that described every detail of the system and all of the test and operational procedures for the system. This red book weighed between 7 and 10 pounds and it was not needed for the turn-on and initiation of the erection cycle. The new procedures that I wrote simplified the operation for the technicians and eliminated the need to carry the 'Red Book' everywhere. The additional testing and simplified procedures did not solve the root cause of the IFDS's problems but, through the rigorous testing, did help improve the system reliability sufficiently to allow the expansion of the flight envelope to continue. For my work on this system, I was honored to receive in the spring of 1962 the first Sustained Superior Performance Award ever made at the Flight Research Center.

Spare parts for the system were extremely expensive. They were being "sole sourced" to Sperry by the Air Force and Sperry was charging as much as \$7,000 for printed circuit boards. At least one system always seemed to be back at Sperry for overhaul. At each overhaul, many of the printed circuit boards were being replaced, unnecessarily I thought. I felt the cost of these overhauls was too much and, following my checking with my staff, which had now grown by two senior engineers for a total of four engineers, and Ken Cowden, it was decided to stop the routine of sending the systems out except when the gimbal bearings, a gyro or an accelerometer needed replacement. I found that we could get identical replacement circuit boards built in the San Fernando Valley for as little as \$250, eliminating the need to sole source their procurement to Sperry. I asked Jim Love,

DFRC's X-15 Program Manager to see if we could get funds transferred from the Air Force so we could locally purchase the printed circuit boards that we needed in the future. Jim worked with the X-15 SPO at Wright Field and was successful in obtaining the funding.

In addition to finding a new source for the printed circuit boards, we sent a system to Holloman AFB in New Mexico, where the Air Force had established their principle inertial systems laboratory. We felt we needed to have the system thoroughly tested to try and understand why we were plagued with such erratic performance. We asked them to include environmental tests. During these tests it was found that the accelerometers in the system, purchased from Sperry of England, were sensitive to low temperatures. The accelerometers would 'ring' when low temperatures were reached inside of the IMU. This ringing resulted in a bias output, either a positive or negative voltage indicating an acceleration or deceleration. This bias caused errors in total velocity, vertical velocity and inertial height. The errors were particularly large in vertical velocity and inertial height due to the fact that the mechanization employed to convert the vertical acceleration measured by the IMU into vertical velocity included a positive feedback loop to remove the effects of gravity. This positive feedback makes it basically unstable. Perhaps the sensitivity of the accelerometers could be corrected but, to do so would have required they be sent to England and we elected to seek another source for replacement accelerometers. We did not make this decision until we verified the ringing problem with several of the systems in our own laboratory. No direct replacement could be found with exactly the same mounting base as the originals, requiring that we design a mounting bracket for the new accelerometers. The accelerometer problem turned out to be the root cause of the poor performance of the IFDS.

During operation of the IMU in the laboratory the covers were removed and ambient temperature air was blown by a fan into the system. In the hangar a regular aircraft cooling cart provided moderately cool air for the system. The temperature of the air coming from the cooling cart was cool but never super cold as was the gaseous nitrogen when the system was in flight during the carrier or free flight portions of the mission. Consequently, there was no way we would have ever discovered the temperature sensitivity problem without the tests at Holloman. Once the accelerometers were changed, the system began to meet the performance specified in the initial design specifications.

Introduction of the Digital System: At the same time that we were putting on the big push to improve the reliability and performance of the original analog system, the Dyna-Soar (X-20) program was cancelled by the Air Force. A digital system had been developed for this vehicle and four systems built. I was able to get a great deal of data on the systems and finding them to be suitable for the X-15, worked with the X-15 Program Office at Wright Field to obtain them. Through the Program Office, a contract was given to Honeywell in St. Petersburg, Florida, where the system had been designed and built, to modify them for the X-15. This required the development of new software, mounting bracket design, and cooling system work. The digital system was first installed in X-15 #1 and following its successful performance it was installed in #3. The digital system provided very accurate flight data reliably to the pilot during flights. X-15 #2 retained the upgraded analog system, which also performed well for the remainder of the program.

Q: What were some of the events you remember?

A: *Dedicated Personnel:* While not a specific event, the dedication of all of the Flight Research Center personnel to getting the job done was special. This was not just the crews assigned to the aircraft but everyone in the Center whether they worked in procurement, personnel, or whatever, there was always that positive attitude, if there was a job to be done the people would find a way to do it. It was a stimulating environment to work in. I

read someplace that when the X-15 program started at DFRC, it started the large influx of contractor personnel to support Dryden's work. I do not remember this being the case.

As I recall, we had on site one or two tech reps from North American Aviation, one from Reaction Motors, one from the pressure suit manufacturer, one from General Electric, and one from Sperry. The North American Aviation representatives were augmented by several additional engineers when a flight was scheduled but all including the on site regulars disappeared following Joe Walker's record altitude flight. Walt Holmes, a North American marketing representative, continued to pay visits to the Center even after the X-15 program had concluded. Honeywell had a tech rep, Bill Peterson, on-site to support the adaptive flight control system in X-15 #3 when that aircraft became active. Bill eventually became an employee of Dryden, working in Flight Operations. I worked with Bill's cousin Dick Peterson during my TDY assignment with the Mission Analysis Division, where Dick was a branch chief. Some years later Dick served as the director of the Langley Research Center. Sperry sent several engineers to the FRC to try and solve the IFDS problems in late 1961. They spent a couple of months with us and contributed little towards improving the performance or reliability of the system. Honeywell sent two engineers out to help with the integration of the digital system. One of these engineers stayed on for the remainder of the program. A number of personnel were at the FRC from Bendix to support the X-15 High Range.

The real influx of contractor personnel came about much later and was especially prevalent with the start of the Shuttle activities. Later still, when Dryden became a division of Ames, the performance of complete center functions was transferred from civil service personnel to contractor personnel. Previous to that time contractor personnel were on board to support their company's system for particular programs. During the ALT and the first flights of the Columbia, the majority of contractor personnel at Dryden were as a result of support contracts through JSC, KSC, or GSFC.

New X-15 pilots: As the initial pilots transitioned out of the program, new pilots were brought in. I had to give each new pilot an extensive briefing on the X-15's IFDS and inertial systems in general. I remember giving this briefing to Joe Engle, Pete Knight, and Bill Dana. All had an instant grasp of inertial guidance principles. By the time Mike Adams came on board, I had already transferred to the Research Division and was no longer directly supporting X-15 operations. While Milt Thompson was selected as an X-15 pilot at the same time as Joe Engle, I do not recall that he participated in the inertial systems briefing.

Cracked windows: On two flights of the aircraft one of the two windows on the aircraft cracked. This caused the window to become opaque, severely limiting the pilot's visibility to one side of the aircraft only. Chase pilots called out information and the X-15 pilot made a precision landing in spite of the curtailed visibility. This performance speaks highly of the skill of the X-15 pilots.

Flight aborts: The X-15 was a very complex system made up of a number of equally complex subsystems. Malfunctioning or marginal performance of any of these subsystems was sufficient cause to cancel or abort a flight. There were also numerous aborts due to the weather. Weather flights were made by both Air Force and Dryden pilots to evaluate the weather at the launch site and emergency landing lakes. It seems, looking back, that we had a large number of aborts either for weather or subsystem problems. One abort that was a result of an unusual incident occurred when Jack McKay inadvertently pulled the 'green apple' located between his legs under the seat. This was the first step in ejecting, the next step, would have caused the canopy to be fired (released) and the rest of the sequence would be automatic. Jack was told not to touch anything else and the B-52 landed without further incident, the seat disarmed and the flight rescheduled for another day.

Pasadena overflight: Neil Armstrong while testing the Honeywell Adaptive Flight

Control System in X-15-3 made his famous overflight of Pasadena. It was one of those rare times that Paul Bikle allowed a visitor access to the control room. As I recall, it was Neil's first mission above 200,000 feet and he had obtained permission for his wife to be present during the flight. The Honeywell system had many features one of which was a 'g' limiting capability. This 'g' limiter was set to limit the aircraft to 5 'g's' during reentry on this flight. Neil was monitoring the cockpit 'g' meter to see that the system functioned properly. Unfortunately, there was a calibration problem with the 'g' meter and Neil kept increasing the angle of attack looking for the 'g' limiter to 'kick in'. His angle of attack got too high and by the time he realized his altitude was increasing rather than decreasing and he was overshooting Edwards. I remember the control room communicator, I think it was Joe Walker, kept warning him, "Neil, watch your angle of attack". It was exciting for several minutes with much concern over whether or not he had enough energy to get back to Edwards. Naturally, his wife being in the control room did not help matters.

X-15A-2's record speed flight: While I was no longer directly responsible for the IFDS or ball nose by the time Pete Knight made the record setting flight in the X-15 A-2, I was vitally interested in the performance of both systems. There was a concern over whether or not the ball nose (flow direction sensor for angle of attack and sideslip) would continue to function at the predicted peak temperatures expected to be reached on this flight. Working with Jon Ball, the engineer responsible for the flow direction sensor, we decided that the most realistic test that we could perform would be to operate the system while it was positioned in the exhaust of the Center's F-100. The engine was run with the afterburner ignited for several minutes with the ball nose operating just fine. I do not remember how high the temperatures got on the ball nose or how long we operated at the high temperatures during the afterburner test, but they were as high as or higher than predicted for the X-15 speed flight and the system was cleared for the flight. The system did freeze for a few seconds at maximum heating during the X-15 mission but recovered and functioned properly for the remainder of the flight.

Jack McKay's Accident: On launching over Mud Lake, Nevada, the engine failed to reach full power and Jack had to jettison the fuel and oxidizer and land at Mud Lake. It was very tense in the control room during Jack's descent to the lakebed. When the landing gear collapsed and the airplane rolled over there was a great deal of concern for Jack's safety. I was impressed on how calm everyone remained and how quickly recovery activities were initiated.

Joe Walker's Accident: We were well into the X-15 follow-on program when Joe was involved in the XB-70/F-104 midair collision. I remember hearing in the hall that midair had occurred. I immediately went to Jim Love's Office. Jim was the X-15 Program Director and he had a speaker that was tied in with the FRC's air to air/air to ground communications system. Several people were in the office listening. It was confirmed that Joe was involved but one of the aircraft had reported seeing a parachute. We were all hoping that Joe had made it down safely and it was not until an hour or so later when we learned Joe had not survived. Everyone in the Center was very depressed. Joe had always seemed bigger than life itself and in spite of Joe's temper, everyone really respected him. I think everyone felt a real loss. The accident had occurred in the morning and the rest of the day was a complete washout.

Q: Several of the X-15 flights exceeded 50 mile altitudes. Do you remember any specifics of the flights?

A: *Altitude Predictor for Joe Walker's record altitude flight:* There was a great deal of concern on the part of the flight planners that as flights approached 400K feet, the angle of attack required for re-entry would cause the vehicle to bounce right back out of the atmosphere and too steep of a reentry would create too much heating on the vehicle with

potential catastrophic consequences. They wanted some assurance that Joe would not reach this altitude and placed a limit of 375K feet on the vehicle. Joe's flight was planned for 360K feet and since most of the flight following engine shutdown would be above the atmosphere, I felt that, no matter what orientation the pilot placed the vehicle in after engine shutdown, it was going to closely follow a simple ballistic trajectory and the peak of this trajectory could be predicted based on his vertical velocity and altitude at shutdown.



The X-15 #3 shortly before Joe Walker's flight to 354,200 feet on August 22, 1963. The flight made use of an altitude predictor to prevent an altitude overshoot, which would have made re-entry difficult. (E-10282)

I approached Warren Wilson who was head of flight planning, having replaced Dick Day who had transferred to Houston to participate in the Apollo program. I suggested to Warren that we could design an altitude predictor that would tell the pilot when to shut the engine down to achieve his desired altitude. After I explained our approach he indicated he would be willing to evaluate it in the X-15 simulator. I gave Jim Black, my lead engineer on the IFDS, the equations that I wanted him to mechanize and he proceeded to build it. The test of the device on the simulator was successful and a second one was built and installed on the aircraft for Joe's flight. During the flight, Joe shut the engine down when the predictor indicated he would reach 360 K feet.

Unfortunately, radar showed he reached 354,200 feet not the desired 360K. Assuming radar was correct, this was still less than a 2% error. Those of us involved were delighted with the performance except for Joe who was unhappy and was quick to let us know about it at the party that evening. The altitude predictor continued to be used on high altitude flights with good results.

Ball Nose problems: At low dynamic pressures, below 4 lbs/square foot, i.e. very high altitudes, it was found that the Ball Nose would wander slightly, oscillating around zero degrees angle of attack and side slip. Initially this was of some concern to the pilots as accurate display of angle of attack and side slip were critical to a safe reentry. As soon as the dynamic pressure increased, the system again functioned just fine. We tried adjusting the system gain to get better response but, the transducers in the nose just could not sense

pressures this low. As long as the system began functioning again sufficiently early for the pilots to set up their angle of attack for reentry, they accepted this short term wandering.

Q: You then went to the Lunar Landing Research Vehicle (LLRV). What were your duties on this project?

A: As a collateral duty I participated in the design reviews of the vehicle with my primary responsibility being on ensuring the systems for providing flight data to the pilot proposed by Bell would do the job. Bell asked us to provide the radar altimeter and I worked with Teledyne Ryan in San Diego to develop this system. Due to a severe limitation on travel funds, we were forced to fly in the Center's Aero Commander to attend the preliminary design review which was held at the Bell Aircraft facility in Buffalo. There were four of us who made the flight with Joe Walker as our pilot. It was interesting flying across the country with Joe. It took us two full days to get from Edwards to Buffalo and while traveling we had to make a number of pit stops. At each stop, the press, usually local television crews, were there to meet and interview Joe. At that time Joe was probably the most famous test pilot in the world, setting all kinds of records in the X-15 and was good press material.

Q: The LLRV was a very unusual vehicle. What were some of the design issues you had to deal with?

A: *Radar Altimeter:* It was not known whether or not the radar altimeter would operate properly at very low altitudes. This was because the signal would be transmitted and reflected back through the exhaust plume of the jet engine as it impinged on the ground. The effect of this exhaust plume i.e. super heated gases on the signal was an unknown. Radar altimeters had never been operated in this environment before. We had the manufacturer run some ground tests and we evaluated the performance of the system during tether tests of the LLRV. The results of all tests were fine and as far as I know the system never gave problems during LLRV flights.

Q: It used an early fly-by-wire system. What were the specifics?

A: I was not really involved with the control system, as I had no specific responsibilities in this area. It was strictly an on/off set of rockets, I do not recall the size of the rocket engines but, they were various sizes some quite small. Their thrust was generated by passing hydrogen peroxide over a silver catalyst, producing steam. I did make a trip to a rocket engine company located at the Van Nuys Airport in the San Fernando Valley with Don Bellman, the LLRV Program Manager. As I recall this company manufactured some very small rocket engines which burned monomethyl hydrazine and Don was looking into small thrusters to provide attitude control for the vehicle. Since this fuel was extremely hazardous to work with I think Don preferred using something we were more familiar with and, even though it too was hazardous, elected to go with hydrogen peroxide rocket motors.

Q: What incidents involving the LLRV stand out in your memory?

A: It was not really an incident but, an example of the "can do" attitude of the Center and Paul Bikle's philosophy. We had contracted with Bell to build two LLRV's. When funding got to the point where Paul did not feel there was enough money for Bell to assemble the 2nd vehicle and properly test it, rather than overrun the budget, he ordered the company to ship the pieces to the FRC. Our Civil Service mechanics and technicians assembled

this vehicle and did all of the preliminary testing that one would have expected only the contractor to be able to do.

Q: What recollections about Paul Bikle do you have?

A: *Outstanding Person to Work For:* I have the greatest respect for Paul Bikle, he was one of the finest individuals I ever had the opportunity to work for. He was a “hands-on” manager who understood flight research. As near as I could tell, Paul knew nearly everything going on at the Center, he spent little time in his office, working with both engineers and technicians in their offices and on the hangar floors. He had one of the smoothest running highly motivated organizations I have ever seen. At his weekly project review meetings you better know the status of your project because if you tried to bluff Paul would catch you. Everyone that I knew in the Center and outside the Center respected Paul.

I remember the first X-15 post flight debriefing I attended after I started working at the Center in 1961. I had to report on the performance of the IFDS (which was not good). I knew very few people at the Center and really had not had time to get to know the system and certainly didn't know why it had performed badly. I had reported to work on July 25th and the flight was on August 10th. I did not sit at the main conference table but elected to take a seat in the second tier of chairs surrounding the table. I managed to stumble my way through a report. While I was talking, I noticed a short plump bald headed guy with a big cigar who kept turning around to see who was reporting. Our badges then were little round (about one and a half inches in diameter) plastic covered metal pins with a yellow strip which had NASA-FRC printed on it. Our organization (Data Systems) was printed above the yellow strip and below it was our name (or, it may have been the other way around). The short plump fellow was really straining trying to read my name. Everybody accepted my report without comment and after the meeting I asked one of the engineers who that guy with the big cigar was. He replied why that's Paul Bikle, the Center Director. It was not long before I had a chance to meet Paul and I was truly impressed and can honestly say appearances can certainly be deceiving. Paul was a brilliant man.

Security incident: One interesting incident occurred when, during an X-15 flight I took some visitors from Honeywell to the roof of the main building where you could see the exhaust trail of the X-15 when it was launched over Mud Lake. Before launch a YF-12 made a landing on the main runway. This was right after President Johnson announced that they were being tested at Edwards. I commented that according to the *LA Times*, they had been testing them in Nevada and had just transferred them to Edwards and the *Times* was probably right as I had not seen them until the previous week.

About a month later I received a phone call from Paul's secretary, Pat Marsh, telling me that Paul wanted to see me at 4:00 that afternoon. I explained to her that I had a car pool and they would not want to wait for me. A few minutes later she came back on the line and said don't worry, Paul will give you a ride home. At 4:00 I walked into Paul's office to find two Air Force colonels sitting with Paul. Paul introduced us and said that these two gentlemen would like a word with me. Well, it was more than a word. They accused me of violating security regulations by discussing the [Blackbird] program with people not cleared. Since, at that time, I was not cleared for this program, I explained that the only thing I had discussed was the article in the *LA Times*. Their comments were to the effect, that by saying I had not seen the vehicles before President Johnson's announcement, I as a NASA scientist was confirming that they [the YF-12s] were being tested in Nevada. They spent about 45 minutes warning me of the penalties that I could suffer for these 'violations of security'. They finally left with saying that no charges would be pressed at this time but, warned me to keep my mouth shut in the future.

Paul and I went downstairs and out into the parking lot, climbed into his VW Bug and started for home. Paul laughed about the whole affair, telling me not to worry about it and

said that all of these “spooks” were crazy. He went on to tell me the story about when he was working at the AFFTC he was named as their representative on the U-2 program. He said he would get a phone call telling him to be at some street corner in Los Angeles at such and such a time to be picked up. He said he asked them how he would know them and their response was don't worry, we know you. He would precede down to the specified place at the specified time and sure enough a car would pull up to him and the back door would be opened for him to climb in. The windows in the back were covered and there was a covered partition between him and the driver. They would drive around for an hour or so, making many turns and finally they would stop and he would be hustled into a building where he would be given a briefing. At the conclusion of the briefing he would be returned to his car in the same manner that he was taken to the meeting.

When we got to my house, he again said don't worry nothing will come of this and nothing did. Eventually, I was asked to provide some technical support to that program and was granted the appropriate clearances for it.

Transfer to Research: I was interested in Guidance Systems Research and with the X-15 Inertial Flight Data System problems resolved (it was now as functional and reliable as other X-15 systems), Paul suggested that I transfer to the Research Division where he thought we needed this kind of research performed. A new branch was established in the Research Division under Hal Walker who was Assistant Director of Research for Flight Dynamics and I transferred there to manage that branch in June, 1965.

Later years: In 1983 my wife and I returned to Lancaster to attend a party for some close friends celebrating their 50th wedding anniversary. The couple, Lee and Sarah Jenne were also good friends with Paul and Ann Bikle, who were also in attendance. Lee and Sarah were early residents at Edwards, as were Paul and Ann. At that time, civilians were allowed to live on the base. Paul worked for the Air Force and Lee worked for JPL at their facility at Edwards. Both had families of the same age and the ladies became close friends.

We stopped at the table where Paul and his wife Ann were sitting to say hello. It was obvious that Ann's health was failing. Paul still appeared healthy; he had been warned a number of years earlier that he had some arterial blockage and needed bypass surgery. Paul's response was reported to be: What is the life expectancy with and without the surgery? When he found out it was about the same, he elected to change his life style, giving up his cigars and starting an exercise program. It was not many months after the party that we heard Ann had passed away and soon after that Lee also passed away.

We lost personal contact with Paul but through Sarah kept track of his status. She told us that after Ann died, Paul was lost for companionship. He had been estranged from his oldest son for a number of years. His youngest son no longer lived in the Antelope Valley and he was hard pressed for adult companionship. Finally Paul went to live with his youngest son where he eventually did have a heart attack and passed away.

I spent several years in the Research Division leading the Guidance and Display Branch....My old organization in Data Systems Division was renamed the Guidance and Display Systems Branch and was led by Jim Black. Following are some of the projects that we developed or supported within my organization.

Moving Tape Displays: As part of the X-15 follow-on program, the Air Force Flight Dynamics Laboratory had a moving tape display concept that had been approved for X-15 #3. This was a concept they wanted to evaluate for possible application in lifting reentry vehicles. The pilots were not in favor of this concept as they would be required to actually read the tape display whereas they normally could glance at the positions of needles on circular displays as part of their scan pattern and based on the position of the needles know whether or not they were getting into problem areas. However, the project had been approved and the FRC needed to have an interface between the project and the X-15 and my organization was given that responsibility. We worked with the AF Flight

Dynamics Lab and their prime contractor Litton Systems. X-15 #3 was the designated test bed.

Honeywell advanced computer: Having worked with Honeywell in reconfiguring the X-20 system for the X-15 and the subsequent integration of the system into the X-15, I had established a number of contacts within that company. These contacts made an effort to keep me abreast of any new technology they were working on. They were finalizing the construction of a prototype ferrite core memory computer (ALERT) which offered a major step forward in terms of computational speed. While still slow when compared with today's computers, even our PCs, and with limited memory, it was very advanced at that time. It offered 4096 words of memory with a processing speed of one megahertz. I briefed their senior management on our interest in energy management and indicated that we felt their computer could provide us with the computing capability needed for the energy management solution. We suggested our energy management and/or flight path optimization programs would make excellent test beds for their computer. Over a period of time and following several meetings on the subject, we negotiated a loan of their computer to use in our program. The computer was installed in X-15 #3 and first flown in September, 1966. It was programmed to provide boost guidance and energy management information to the pilot using data obtained from the IFDS. Flights gathering research data were initiated in April, 1967. The computer was on board during Mike Adams' ill fated flight. The computer was severely damaged but, the memory was intact and we were able to get some valuable data from it for the Accident Investigation Board.

Optimum Flight Path: Techniques for optimizing the flight path for aircraft had been under investigation for some time. Dynamic, real-time solutions utilizing atmospheric measurements offered the potential of fuel and/or time savings when changing from one state to another over conventional hand-book methods. Larry Taylor, Harriet Smith and Ken Iliff, FRC researchers, had been working with a Professor Balakrishnan from, I believe, UCLA or USC and had investigated optimum climb profiles using Balakrishnan's epsilon method. The equations had been programmed on our simulation of the ALERT computer and on F-104 simulation runs showed promise of significant improvement in the time required to climb from take-off to cruising altitude. Our intention was to eventually install the ALERT in one of the Center's F-104s to validate the fuel and/or time savings. Additionally, we planned to investigate other techniques utilizing this computer and had to abandon them when the computer was lost in Mike Adams' accident. While it was installed in the X-15, it was programmed to provide optimum boost guidance commands to the pilot. We had a number of successful flights before the accident.

Energy Management: There was a great deal of interest in providing on-board energy management guidance to the pilot of un-powered lifting reentry vehicles. Bill Cockayne of Bell Aircraft had been investigating a predictor concept that computed the extreme dimensions of the ground area attainable by the vehicle. This concept was customized for the X-15 and we planned to evaluate it using the ALERT computer. A model of the X-15 was programmed in the computer and, as reentry was set up, using the initial conditions provided by the on-board systems, the model was rapidly flown through a maximum range and a maximum cross range. This information could then be displayed as a cardioid that varied in size depending on the vehicle energy level. Landing sites would be programmed into the computer and any of these sites that fell within the cardioid could be flown to. We had a successful evaluation of this on the X-15 simulator, using a ground based digital computer to simulate the ALERT. Data flights were initiated in April, 1967.

Monocular project: Again, we were pursuing our interest in lifting reentry vehicles. It had been suggested that an indirect viewing system may be necessary for landing lifting reentry vehicles. A monocular viewing system would require a very small opening; indeed it could be deployed after the reentry was completed before the final approach to a landing. We obtained a rather large system that had been used in a tank and mounted it on

a vehicle so it could be driven around and asked the pilot's office to evaluate whether or not they thought it provided enough cues to land a vehicle. Following a successful series of tests with the pilot's office participating, we worked with Operations Engineering to design an installation in an F-104B. We obtained Center approval to install the system and proceed with flight evaluation. Several flights were made with several pilots participating.

Strapped down inertial guidance system: With our interest in "high speed" computers, came an accompanying interest in gimbal-less inertial measurement units. A gimbal-less system offers a significant weight saving. Previous strapped down systems had used special purpose computers to solve the coordinate transformation matrix. Frequently this matrix was hard wired into the computer for improved speed of the solution. These systems had not been flown in aircraft and we were interested in investigating problems associated with this application. We were also interested in investigating the use of a general purpose airborne computer to solve the transformation matrix. We were successful in obtaining two surplus systems from an Air Force reentry vehicle flight test program. Again, we were intended to use the ALERT computer in the F-104 aircraft. We were able to complete a successful simulation program before terminating the effort with the loss of the ALERT in the X-15 accident.

I subsequently became Hal Walker's deputy in April, 1968. We divided the duties of managing the Flight Dynamics research efforts between us. Hal handled the theoretical/analytical functions including handling qualities, while I oversaw more of the system related activities, including guidance and navigation, pilot displays and flight controls. Even before becoming Hal's deputy I was getting more interested in flight control and flight control systems. On the day that we lost X-15 #3 I was in Cambridge, MA at NASA's Electronics Research Center participating in a meeting of NASA's Advisory Committee on Guidance and Control. We were reviewing the material assembled from Gemini 8 regarding the control problems experienced by Armstrong and Scott.

Q: You joined the Shuttle Approach and Landing Test (ALT) program for the last two flights. What were your duties?

A: Actually, I did not join the ALT program until some time after I left the F-8 Digital-Fly-By-Wire (DFBW) program. I had a number of assignments prior to joining that (the ALT) program including:

NASA Headquarters: Frank Sullivan was very upset when he heard that I was no longer managing the DFBW project. He wanted me to come back to NASA Headquarters and work with Pete Kurzhals, who was overseeing the DFBW Program from Headquarters. Headquarters kept a tight control of the budget and provided justification for the program and progress reports on it to Congress. Pete was on a temporary assignment at headquarters from Langley and would be returning to Langley sometime in the future. Frank wanted me to take Pete's place and felt we needed a period of overlapped assignments. First though, the Mission Analysis Division (MAD), a headquarters division located at Ames because of the proximity to the universities in the Bay Area, needed short term help from someone with flight research experience and I was asked to go up there. Beeler agreed and I actually spent about 4 months working with the MAD people. Since my home base was DFRC, following the TDY at MAD, I returned to DFRC still Hal Walker's deputy.

After my return to DFRC, I received a letter from Dr. Seymour Himmel, who had replaced Neil as Roy Jackson's deputy. In the letter Sy said that Frank Sullivan needed help in his office and he, Sy, had discussed the possibility of a "career advancement" assignment for me with Lee Sherer, who by that time had been named FRC's Center Director. Sy said Mr. Sherer had agreed that it would be a good temporary assignment for me, broadening my experience. I was asked to respond as early as possible to this offer.

Following acceptance of the offer, I moved my family to the Washington area in August, 1972. Kurzahls and I worked together for about six months, completing the support of one congressional budget cycle before he returned to Langley. I then became acting chief of the Guidance and Control Branch at NASA Headquarters, responsible for some 8 major programs out of the 20 programs the Division carried. These programs were being conducted at all of the NASA Centers plus JPL. Needless to say, I was extremely busy as when Pete left I was a single person branch. DFBW was one of the smaller of these programs and because of the workload I was carrying, had little time to devote to the Dryden Programs. Frank Sullivan decided to retire midway through my tour at Headquarters. Based on Frank's recommendations, Pete Kurzahls was offered and accepted the position as Frank's replacement.

My one and one-half year tour was due to be completed at the end of January, 1974. With two children in school I felt it would be beneficial for them to leave in December, minimizing the time they would be out of school due to the long Christmas break. Consequently, shortly after Pete took over the Division in the summer of 1973 I asked him to start finding a replacement for me. He offered to make my position permanent but I felt it was a dead end job and declined. Since Langley and the Flight Research Center had both sent people in for tours at Headquarters, it was now Ames' or Lewis' turn. The individual selected as my replacement was Jay Christensen from Ames, the same person I had originally replaced on the X-15 on the IFDS. Jay moved to Headquarters in early September to work with me. We moved back to Lancaster in December, 1973.

Center Development: Returning from the 17 month NASA Headquarters assignment, I was assigned to work in the Center Development Office under De Beeler who, in addition to being Deputy Director of FRC was overseeing this office. Jim Adkins was in the Office with me and, since his last position had been abolished, he was evaluating the option of taking an early retirement. He had 30 days from the abolishment of his last position to make a decision and finally on the last day he elected to retire.

Outlook for Aeronautics/Outlook for Space 1980-2000: In early 1975 Jim Fletcher, NASA's Administrator, decided that it would be prudent to have studies conducted on the future of aeronautics and space to help guide NASA Management on where best to invest their research money to ensure the US retained technical dominance in the 2000s. These studies were the Outlook for Aeronautics and the Outlook for Space. De assigned me to participate in these studies as Dryden's representative. I had very little to do with the Outlook for Space study as Dryden's space interests were tied to MSFC, JSC and KSC and Dryden was dependent on these Centers for space related projects. I did attend two of the study's meetings, which were totally dominated by JPL. Dr. Carl Sagan was the JPL spokesman and it was apparent that their study would focus on planetary exploration.

The Outlook for Aeronautics study team consisted of representatives from ARC (3), LaRC (2), LeRC (2), JSC (1), NASA Hdqs.(3), DoD(2), FAA(2), and I represented Dryden. The team was led by Dr. Leonard Roberts, Chairman, Director of Aeronautics at Ames and Robert Bower, Alternate Chairman, Director of Aeronautics at Langley. I actively participated in this study which lasted from August, 1974 through September, 1975. We met with senior technical and management people from some 75 companies, government agencies, and universities, soliciting their views of the future (1980-2000). Based on the study, a comprehensive report was written by the team and released by Dr. Fletcher in 1976.

De Beeler decided to retire and did so while I was involved with the Outlook for Aeronautics Study. Lee Scherer decided to refocus the efforts of the Center Development Office more into advanced planning and named me as a Special Assistant to the Center Director for Advanced Planning. On De Beeler's retirement, Lee Scherer moved Dave Scott into the Deputy Center Director position. I continued to report to the Center Director when Lee accepted the position as KSC's Center Director and Dave became the FRC

Center Director. Dave brought in Gerald (Jerry) Griffin, former flight controller at JSC as his Deputy. I don't remember how long Jerry stayed at the FRC, I believe it was at least a couple of years before he moved on to KSC as Center Director and eventually back to JSC where he replaced Chris Kraft as the Center Director. When Jerry left, his replacement at DFRC was from Ames. Ike Gillam transferred in from NASA Hdq. as the ALT program manager when Dave became Deputy Center Director and was elevated to Center Director when Dave left Civil Service.

ALT: When Ike became Center Director, he asked me to take over as the Shuttle Project Manager. This was in 1977 with two ALT flights remaining. The ALT team was operating out of the North Base facilities. JSC was responsible for the Orbiter, assigning flight crews, establishing flight schedules, controlling the vehicle when it was airborne, and assessing the results of the flights. KSC was tasked with all ground handling of the vehicle, this included maintenance, movement of the vehicle, mating/de-mating and servicing/de-servicing. While he was the FRC Project Manager for Shuttle, Ike retained his office in Building 4800, interfacing with the JSC and KSC managers through trips to the North Base and Shuttle facilities, participating in meetings which included scheduling, pre and post flight, crew briefings. Before Ike would formalize my assignment as DFRC's Shuttle Project Manager, it was necessary for me to go to North Base and be interviewed by KSC's site manager. Evidently I passed the interview because shortly after the interview Ike solidified my appointment. I kept a low profile during the remaining two ALT flights ensuring DFRC's assigned responsibilities were met. DFRC was responsible for providing: base support which included coordinating AFFTC support, overseeing the maintenance contract for maintenance of the 747, radar, radio and telemetry support through GSFC, and flight crews for the 747.

747 Shuttle Carrier Aircraft: A used American Airlines 747 aircraft had been purchased by NASA and extensively modified by Boeing to carry the Space Shuttle Orbiter. It was assigned to JSC but the original primary flight crew was DFRC personnel, Fitz Fulton and Tom McMurtry, pilots with Vic Horton and Ray Young as flight engineers. JSC contracted with American Airlines to provide the maintenance of the aircraft and since the aircraft was based at Dryden in Area A, the maintenance crew worked out of our facilities. Rather than have a JSC employee placed on site to oversee the maintenance crew, JSC asked Dryden to perform this function for them. Herb Anderson was the Flight Operations Engineer assigned to the aircraft and he oversaw the activities of the maintenance crew. He was assisted by Ed Browne, who provided quality assurance inspection of work done by the maintenance crew. This team was in-place throughout the ALT Program.

Sometime after the delivery of the *Enterprise* to MSFC, the American Airlines maintenance contract expired. Rather than renew the contract, JSC elected to use Serv-Air, the contractor they had for maintaining their aircraft in Houston and replaced the whole maintenance crew. Herb had an outstanding relationship with the AA crew and was quite upset with JSC for changing contractors. When we moved the *Columbia* to KSC for STS-1, Herb did not hide his displeasure over the change in contractors from Joe Algranti, who was in charge of aircraft at JSC. Joe asked me to have Herb removed which I was very reluctant to do and I continued to procrastinate about taking any action. Finally, Joe, ignoring all chain of command protocol, went directly to Ed Browne and told him that he wanted him to take over as technical monitor of the SCA maintenance contract. That did not sit well with Dryden and I was told by Flight Operations management to ignore Joe and keep Herb on the job. Since the maintenance contract was a JSC contract, I felt it was their decision if they wanted to change the technical monitor of their contract. I did not feel they had the right to name a Dryden employee contract monitor without getting approval from Dryden but, they could certainly request a change if they saw a problem with the one they had. I called Joe and explained to him that we could not have Ed Browne, a Dryden employee, as the TM of their contract and if Herb was unacceptable to him, I

would assume the responsibility of that role.

This suited Joe just fine and he wrote a letter to Dryden to that effect. It did not make our Flight Operations management very happy but they reluctantly accepted me as the TM in addition to my responsibilities as Shuttle Program Manager. By this time JSC had three pilots and two flight engineers 747 SCA qualified. They shared flight duties with the Dryden crew, frequently mixing crews.

Q: The last two ALT flights were the tail cone off missions. What were the specifics?

A: Based on wind tunnel data and calculations made by Boeing engineers the tail of the 747 had a very limited structural life due to the turbulent air flow from the Orbiter impinging on it. Consequently, a tail cone had been designed and placed on the Orbiter to minimize the turbulent air flow and subsequent damage to the 747 tail during carrier flights. The first three ALT flights had been made with the tail cone on and all data obtained on the low speed handling and performance characteristics of the vehicle were from this configuration. There would be no tail cone on the orbiter when it returned from orbit and it was important to know these characteristics prior to committing to the Orbital Test Flight phase of development. To get the required data, it was necessary to fly with no tail cone during the last two ALT flights. The fourth ALT flight included a planned lakebed landing while the fifth and final flight was planned for the main runway at Edwards. For that flight, we had to set-up the Microwave Scanning Beam Landing System (MSBLS) parallel to the main runway.

Q: The fifth flight was the runway landing, with the PIO. What were the causes of this?

A: PIO of course stands for pilot induced oscillations and is frequently caused by the pilot being out of phase with the control system. In this case, there was an extensive time lag between the time the pilot made a control input and the time the control system responded. The pilot, Fred Haise, would make a control input and when he did not get a timely response he would put in a stronger command. The resulting vehicle response from the first command was fine but then came the response from the stronger second command and the pilot would start making inputs to correct for the second command's response. Each cycle would result in larger and larger changes in attitude(s) of the vehicle. By removing his hands from the controls, the control system would automatically damp out the oscillations. The problem basically was associated with the time delay from the pilot input through the computer to the actuators and finally moving the control surface.

Following the last ALT flight, the KSC on-site personnel prepped the *Enterprise* for transport to the Marshal Center where it was to undergo some vibration testing and fit checks with the external tank. When these tests were completed we then transported the *Enterprise* to KSC and checked out their Mate/De-mate (MDD) facility. I was at KSC for the arrival of the 747/*Enterprise* and participated in the de-mating of the vehicles. The arrival of the *Enterprise* was a big event at the Cape. It seemed like every KSC employee and contractor employee turned out to see the landing and taxi to the Mate/De-mate facility. The *Enterprise* was used for a number of tests including fit checks at KSC before eventually finding its way to the Smithsonian. As I recall the trip to the Smithsonian included a Public Affairs grand tour of several cities before it finally reached Dulles.

Q: You worked on the STS-1 and -2 landings. What were your duties?

A: There was a lot of work to be done after the ALT Program was completed and before the Orbital Flight Test Program began. I continued as Dryden's Program Manager for the Shuttle, initially I reported to Ike Gillam. This placed the Shuttle program above other

Center programs priority wise, or at least it gave that appearance. DFRC senior management, particularly Flight Operations objected to this and it was moved into the Projects Directorate. Organizationally, I now reported to Gene Matranga, who had replaced Milt Thompson as Director of Projects when Milt became Chief Engineer. Gene pretty well ignored the Shuttle and, as far as I can remember, he never held a staff meeting that I was asked to attend and he and I never spoke about the shuttle project.

Deke Slayton was the Orbital Flight Test Manager and it was Deke who I reported to programmatically. I was responsible for ensuring the Landing Site/Equipment was ready and that we were prepared to provide the necessary support. I had to walk a very narrow path to obtain Center support as Dryden's Flight Operations Management resented the interference that this outside program was having with their day-to-day flight activities and placed many roadblocks in my path. Dryden was not allocated any additional personnel positions to support the Shuttle Program and supporting Shuttle took resources away from Dryden Projects. I do not remember that Ike ever stood up to his senior managers and told them that the Shuttle Program was a National Program and directed them to support it. At one point, the problem with Flight Operations Management got so bad that Ike called me into his office and told me that I had to go and meet with them, somehow make amends and ask for their support. Ike was unwilling to direct them to provide support.

Fortunately for me, the attitude of the Flight Operations Management did not prevail throughout all of the Flight Operations [FO], the 747 flight crew members were outstanding as were many of the FO personnel assigned to the Program. Besides the flight crews, personnel from FO who provided outstanding support who I can specifically remember included Herb Anderson, Mike Arebalo, Charlie Baker, Jim Phelps, Gary Trippensee, Jim Edgeworth, Herman Dorr, and Ed Sabo. The majority of the personnel at Dryden was excited to be a part of this National Program and gave me nearly all of the support I could ask for. I worked closely with JSC and KSC to identify the support requirements and provided the details of the requirements to the various Dryden functional areas so they could develop plans on how to meet the requirements and estimate the resources needed.

Range support to Shuttle was a GSFC responsibility and our range people had a direct link with the GSFC people. Looking back at the events of the time, it is kind of interesting that I was never asked by DFRC senior management to provide a status report on our preparations for the Orbital Flight Test Program yet, the Manned Space Flight Management Council, asked that I attend their meetings and brief them on the SCA and Landing site status on a regular basis.

Delivery of the Columbia: A special road had to be constructed along the West shore of Rosamond dry lake to provide the connection between Rosamond Blvd. and the road from Plant 42 to move the orbiters to Dryden where they would be mated to the 747 for transport to KSC. The Dryden facilities people, if I remember right Ski Markey, worked with the AFFTC, KSC, Rockwell, and the Corp of Engineers to get this done. Due to heavy rains, some repair work had to be completed on this road just before the *Columbia* was due to be moved to our facility. Finally the day of the move came. It was late in the afternoon when the *Columbia* finally reached the taxi strip leading to the Dryden ramp area and to Shuttle Area A. When the Rockwell move team reached what was thought to be Dryden's property line, they refused to move the *Columbia* onto Dryden property until NASA accepted the responsibility for it by signing the DD250. This document transferred custody of the vehicle from Rockwell to NASA. I seemed to be the only person available to sign this document on NASA's behalf and, even though I did not think I had the authority to do so, I went ahead and signed just to get Rockwell to continue the move to DFRC's Shuttle Area 'A'. As I signed the DD250, I remember looking at the price that had been typed into the value line of the document. It was \$1 billion and I thought to myself, nothing better happen to this vehicle while it was in our custody or I would have to work many lifetimes to pay for it.

A number of tiles were still missing and it was felt that the areas where they were missing had to be covered to avoid a possible zipper effect caused by airflow during the flight to KSC. We dispatched people to Lancaster to buy every tube of RTV available. RTV was the material that was used as adhesive to bond the tile to the Nomax isolation pad isolating the tile from the skin of the orbiter. Once the holes were patched the Orbiter was mated to the 747 aircraft and a short test flight was made to verify the recent patches would stay on for the ferry flight. I don't remember whether it took one or two test flights before we were cleared to go but, eventually we were ready.

Moving the Columbia to KSC: The 747/Orbiter combination had to be flown at relatively low altitude to keep from cold soaking any fluids on board to the point of freezing as there was no heat supplied from the 747. The 747 consumed large quantities of fuel flying at these low altitudes and required several stops for refueling before getting to KSC and, since the mated pair was such an impressive sight, NASA wanted them seen by as many people as possible. On this flight JSC provided their Gulfstream II to carry personnel who were thought might be required enroute for any contingency that might occur. Deke asked me to accompany the move as the 747 was my responsibility even though I had a Flight Operations Engineer, Herb Anderson, making the trip. Our 747 maintenance crew flew on the 747 while Herb and I were on the Gulfstream. Our first scheduled stop was San Antonio, TX, however as we started to cross Texas, a series of thunderstorms was reported around the San Antonio area and we diverted to Biggs AFB, adjacent to Ft. Hood at El Paso, TX. The Army sent a unit over to the base and placed guards around the aircraft.

We ended up spending two nights at El Paso due to weather problems. On the first night a number of the guys decided to go to Juarez, Mexico, just across the river from El Paso for dinner. Herb Anderson and I elected not to go and ate near the motel in a fast food place. After dinner the wind was picking up quite strong as a front approached, so Herb and I decided to go out to the base to check on the condition of the aircraft. It was a cold night and when we got to the 747/*Columbia* we saw the guards were fully exposed to the



The fifth and final ALT flight ended in a landing on the concrete Edwards runway. The *Enterprise* experienced pilot-induced oscillations resulting from a timing delay in computers. (EC-77-9055)

wind and were chilled. We opened the wheel well door at the nose gear where there was a ladder leading up into the electronics bay of the 747. From there, another ladder led to a trap door that opened into the first class cabin of the aircraft. While the main cabin had been stripped of all seats, wall panels and insulation to save weight, we had retained several rows of seats in the first class area. We had decorated this area with a number of pictures that had been taken during the ALT program. We invited the guards to come up two at a time to briefly get out of the wind and to see the inside of the Shuttle Carrier Aircraft. I walked around the cabin with them explaining the pictures that were mounted on the panels.

When the second group came up, I neglected to close the trap door and while walking around pointing out the pictures, I stepped right into the open space where the door should have been closed, falling until my arms caught the sides of the opening. This kept me from falling all the way down and possibly seriously injuring myself. As it was, I managed to crack two ribs in the fall. The next day we were invited to see a B-25 that was in the process of being restored and, following that, most of the people spent the rest of the day resting.

We finally left El Paso, spending the next night in San Antonio. Even though it was a relatively short hop from El

Paso to San Antonio, we were obligated to stop there to meet public relations commitments. The Gulfstream landed ahead of the 747/*Columbia*. As we were circling for our landing, the other aircraft was across the city from us and we could see what a sensation it was causing. Cars were stopping in the middle of the freeway, people jumping out to get a better view of this phenomenal sight that the 747/*Columbia* made flying. It was something to see. Dick Scobie was piloting the 747 at this time and made a perfect landing at Kelly AFB just outside of San Antonio. I did not mention it earlier but, Deke flew chase on the 747 in a T-38 for the entire trip. We opened up the 747 and a hatch in the

Phase B Shuttle Studies to To Be Awarded

Proposals from industry for preliminary definition and planning studies of a space shuttle system for transportation between earth and low orbit have been submitted to NASA Headquarters.

Several Center engineers are participating in the evaluation of the various proposals.

The two stage, fully reuseable space shuttle is a logistic vehicle for manned Earth orbital operations including placement, maintenance, and retrieval of experimental modules and satellites; delivery of propulsive stage and payloads; delivery of propellants to a space station or orbiting vehicle; and short duration special purpose orbital missions.

The reuseable shuttle will significantly reduce space transportation costs.

(Continued next column)

It will approach an airline type environment for crew, passengers, and payload; and operate with short turn-around times compatible with a high launch rate and low operating costs compared to present systems.

The vertical take-off, horizontal landing shuttle could be in operation by 1977 or 1978. High performance liquid hydrogen-liquid oxygen fueled engines will make up the space shuttle's main propulsion system.

Proposals were submitted to the NASA Office of Manned Space Flight.

From the proposals, up to three firms will be selected for parallel 11-month Phase B studies under fixed price contracts. The Phase B contracts will be managed by NASA's Marshall Space Flight Center and Manned Spacecraft Center.

top of the airplane where one could see the Orbiter. We kept the vehicles open while hundreds of guests paraded through.

We were now two days behind schedule, with still two days to go to reach the Cape as another overnight stop had been scheduled either at Atlanta or New Orleans. I had a family commitment that I was very reluctant to break so, I approached Deke and told him that I would like to drop out and return home to meet this commitment and since Herb was along, I thought I was surplus. When I talked about keeping the family commitment, Deke's response was, "Mel, I think you have your priorities right. While we would like to have you accompany us, go ahead and go." The *Columbia* eventually reached KSC on 25 March 1979.

Preparing for STS-1: It is a matter of record that over two years lapsed between the

delivery of the *Columbia* to KSC and the launch of STS-1 on April 12, 1981. This was not a period of rest for those of us working on the Shuttle Program at Dryden. Al Harley, the KSC on site manager, his assistant Don Sharp and Denis Bessette, my deputy, and I worked closely to get the site ready for the processing of the *Columbia* when it returned from orbit. Al had a contingent of 20 KSC-Rockwell people supporting him on site. Our DFRC team in Area A included Chuck Brown, Shuttle Facility Manager; Mike Arebalo and Jim Edgeworth, Airfield Support Coordinators; Charlie Baker, Convoy Coordinator; Russ Eddington, Quality Assurance; Chippy Hernandez, Contractor Liaison; and seven Serv-Air contractor personnel for Mate/De-mate Device maintenance. Serv-Air also had the contract with JSC to maintain the 747 Shuttle Carrier Aircraft and had a team of 5 mechanic/technicians led by Jerry Eudy. Herman Dorr, Jim Phelps and Gary Trippensee provided additional help as Airfield Support Coordinators and Ed Sabo was added as a Convoy Coordinator starting with pre-landing activities and ending on the departure of the 747/*Columbia*. During this period, we provided support on a 24/7 basis.

While we had a good relationship with Al Harley and Don Sharpe, initially it seemed there was a constant struggle over who was responsible for what. We finally reached an agreement that any piece of equipment that came in contact with the Orbiter was KSC's, anything to do with the astronauts was JSC's, and everything else belonged to us. Even though a piece of equipment or a function belonged to KSC or JSC, supporting KSC or JSC still fell on Dryden's shoulders as the host organization at the landing site. Of course, Deke had the overall responsibility assisted by his very able deputy, Tom McElmurry. Tom was a retired Air Force colonel who during the ALT program had been allowed by JSC to fly NASA T-38s. He was finally grounded during OFT when it was discovered he was and had been totally deaf in his left ear. Tom and Deke were a tireless team, always available to help and provide guidance where they could or to offer advice if asked. Both traveled frequently between Houston, the Cape, and Edwards.

At least 6 months before the scheduled launch, controlled madness seemed to set in. Rehearsal, rehearsal and more rehearsals. It seemed every functional element conducted separate rehearsals and some part of the Dryden organization was involved. Of course, the launch slipped, the winter rains came and the lakebed got wet, requiring additional delay.

KSC Support: A complete set of ground support equipment/vehicles had to be readied, including procedures to maintain and operate them. Toxic and explosive fumes needed to be purged from a returning Orbiter and massive volumes of cool air were essential to prevent damage to the electronic systems on board. Diesel generators were required to provide the electrical power necessary to run the purge and cooling units. KSC had designed the units and purchased the major elements of each unit except for the generators. These they found either in storage or surplus and had them shipped to DFRC.

When we received them they were in pretty bad shape and our mechanics were required to completely refurbish them. We also assisted KSC in getting the complete units mounted on flatbed semi-trucks. Eventually a convoy of vehicles was assembled that would rush to the Orbiter as it came to a stop following landing. If I remember correctly, the convoy included the Convoy Commander's vehicle, the Purge vehicle, the Cooling Unit, a SCAPE van, a giant mobile fan, the Astronauts Mobile Lounge, a stair truck, and the tow vehicle. The convoy was mainly staffed with KSC contractor personnel; however several of our people did participate in the convoy activity. Once all of the vehicles were ready, an extensive training program was undertaken to ensure the time required getting the purge and cooling units connected to the Orbiter and operating met the critical time required.

JSC Support: JSC specified what landing aids were required during Shuttle operations. We were responsible for the operation of the landing aids during training flights and the actual mission. The ground based landing aids for STS-1 consisted of the Microwave

Scanning Beam Landing System (MSBLS) and the Precision Approach Path Indicator (PAPI) lights. During ALT the MSBLS had been activated and data taken validated its performance. It was a required system for the OFT Program and was thoroughly checked out before STS-1. We assumed O&M responsibility for the system following the completion of ALT. We had an agreement with the Air Force that allowed us to semi-permanently keep the MSBLS systems setup to support landings on the lakebed runways designated for the Shuttle. PAPI lights were identified as a landing aid requirement after ALT was completed. These lights provided the pilot with visual information on whether he was on glide slope or above or below it. We had to set up the PAPI lights for each training flight and for the mission. JSC had a Gulfstream II that had been modified to simulate the Orbiter for training. This aircraft was flown on a number of training missions both at Dryden and at White Sands in New Mexico. At White Sands a contingency landing site had been established by JSC, staffed by JSC contractor personnel. KSC was responsible for providing the spares and depot level maintenance for the systems. Both JSC and KSC asked us to assume the responsibility for the systems at White Sands. DFRC's Range Manager (I have forgotten his name and could not find it in my personal notes) and I, along with our range maintenance contractor's on site manager Bill Montgomery, made a trip to White Sands to evaluate what we were being asked to do. After looking the situation over, our Range Manager indicated he did not feel we should accept the responsibility for the White Sands operation; we told JSC and KSC that we did not want to take over the function.

We also had to maintain a facility for the flight crews that had been set up during the ALT Program between Building 4800 and the Air Force Fire Station adjacent to the taxi strip. As I recall, this facility consisted of four double wide trailers connected together. It was divided up into bedrooms, bathroom facilities and a kitchen. Our biomedical facility, managed by Dr. William (Bill) Winter, was in the same area. Bill was a competent medical professional who had retired as a Navy Flight Surgeon before coming to work at Dryden. Earlier, he had played a key role in the development of Dryden's RPRV capability. He and his staff always provided exceptional support during the entire period that I was associated with the shuttle. Another individual I do not want to forget to mention who I could always count on to provide outstanding support, it seemed 24 hours each day, was Joe D'Agostino. Joe was in charge of Dryden security and, even though frequently the support help we needed was not necessarily a security matter, I could count on Joe to make sure it was provided.

STS-1 was hectic! About ten days before launch we were invaded by the press. Los Angeles television stations began setting up for local and network coverage of the landing. Scaffolds were built along the edge of the lakebed adjacent to the taxi strip leading between the main Dryden complex and Area A to elevate the cameras and reporters so they had a better view. Generators were set up to provide power; cables seemed to run in every direction. It was early April and with early sunsets; bright lights were turned on for reporters to provide their live reports for the evening news. The whole area seemed surreal.

In addition to the television people, newspaper, magazine and radio reporters from all over the world arrived and had to be taken care of. Ralph Jackson and his team maintained excellent control over this menagerie, passing out continuing up to date releases, responding to questions and requests for interviews. I was asked to be interviewed daily, sometimes several times a day. Usually they wanted the interview scheduled live for the evening news. Every morning John Yardley, NASA's Associate Administrator for Manned Space Flight held a Mission Team teleconference that I was required to participate in. During the teleconference every one of the sites supporting the STS-1 mission was required to give a status report. The workday for me ran from shortly after 6 in the morning until 8 or 9 in the evening.

Finally launch day arrived. We had been supporting the countdown from our control room continuously from the time the countdown started. All on our end was in readiness. Our technicians had all of their equipment checked and were ready to support should an abort once around (AOA) be called as was all of our support teams including the AFFTC. KSC had chartered at least one and possibly two commercial jets to transport their people and their contractors to Dryden immediately following the launch and verification that the Orbiter had sufficient energy to reach Edwards. Their contractor personnel were brought in to move the Orbiter from the lakebed to the MDD and to process it for its return flight to the Cape. (At this time we had not been trusted to tow the Orbiter from the lakebed even though Charlie Baker and Ed Sabo had towed more aircraft and other flight vehicles than the KSC people had ever seen).

Since there was a possibility of an Abort-Once-Around, it was important to get them on site as soon as possible to get the purge and cooling units attached and operating to minimize the damage to the electronic systems on board the Orbiter. People who needed access to Area A needed to have the proper badges to gain entry. Normally, to have access to Area A, one had to participate in a training session which included both classroom and site walk-down to become familiar with the facilities and hazard areas. We had two guard stations, one to pass through to enter Area A and a second that allowed one access to the MDD area. This station was a safe distance from the MDD and was activated when an Orbiter was in the facility. When one entered through this station you had to leave your badge with the guard. This was to ensure that we knew who and how many were within the hazard area in the event of an incident. In order to minimize the last minute congestion, we had prepared a training film covering the requirements needed for access and sent this film to KSC. They, in turn, provided us with a list of their personnel who needed access and who had been trained so we could have badges available for their people on arrival.

The night before the landing I had gone home about 11 PM, ate a nice late dinner that my wife had prepared for me, showered, changed clothes and returned to Dryden. I knew it would be practically impossible to get any rest at home and that the traffic would be a nightmare in the morning. It was about 1 AM when I drove back out to the base and already the traffic was noticeably heavy. I checked with several of our people, found everything was moving along smoothly, and headed for the control room.

As I recall, by the time Shuttle came about, the old X-15 control room had been totally reconfigured and we now had two control rooms, one called the Gold Room and the other the Blue Room. They were identical to each other, with an observation area for visitors between them. If I remember correctly, we were using the Gold Room and I went in and sat down. We had people at the consoles communicating with Houston and the Cape. All was quiet from the Orbiter as the de-orbit burn was scheduled for some time later. Not much happening there so, I went down to the Shuttle area (Area A). We had a trailer there in which I had a second office and it was in this trailer where our airfield support coordinators fielded phone calls, coordinating support when they were not out actually providing support themselves. On the North wall of the Shuttle hangar a concrete block lean-to type building had been attached. In the building was a large room in which the KSC Operations Director and his staff monitored the work done on the Orbiter as it was prepped for its return to Kennedy.

I went over to this facility and found they were communicating with the Cape, reporting the status of the MSBLS and the PAPI. These were the principle ground based systems providing landing cues to the pilots. By this time the JSC Gulfstream was up flying approaches, checking the performance of these systems. I returned to Building 4800 and the control room about the time the de-orbit burn had taken place. That was it; the crew was now committed to landing the Orbiter at Edwards. I then went down to Ike's office where he was entertaining several VIPs in the Executive Conference Room which was connected

to his office. Since I had no functional assignments during the landing operations, I had been tasked to escort Dr. Alan Lovelace, NASA's acting Administrator, during the landing activities and, immediately following the landing ensure that he got to his airplane for his return to Washington, DC. About ½ hour before the landing I escorted Dr. Lovelace up to the visitor's area outside of the control room. Here we could hear the communications taking place and had a view of the radar plotting boards that would show the track of the Orbiter from the time it crossed the coast of California until it landed on the Edwards lakebed. We watched the operation from this vantage point and just before the Orbiter turned on final, I showed him a back stairway to the roof of the building which we climbed to watch the landing. Immediately following the landing I escorted him through the crowds to where he made some statements to the press and then on to his airplane which was parked on the ramp at DFRC. Dr. Lovelace very graciously thanked me and departed.

By the time I got back to the roof, the service vehicles were positioned at the Orbiter and the crew was being escorted off. Nearly everything we had planned and worked to make happen through detailed rehearsals over several years had been successfully completed and now we only had to support the de-servicing of the Orbiter, the mating to the 747 and departure to KSC to complete STS-1. To my surprise, I was named "The Man In The News" by the Editors of the *New York Times* on the day of the landing. This surprised me as I did not seek that publicity and I am not sure I could have avoided it. This publicity did not benefit my career at Dryden as there was a good deal of resentment on the part of some of the senior management over this.

Q: The ALT and early Shuttle flights brought huge crowds to Dryden. What do you recollect about this?



From left, Gordon Fullerton, Fred Haise, and Great Britain's Prince Charles after the fifth ALT flight. (E77-8862)

A: By the 4th ALT flight, the crowds were getting much smaller and handling of the crowds was well under control. The 5th ALT attracted more attention because Prince Charles was going to be there to witness it. Security was very effective and few people ever did get to see the Prince.

STS-1: The crowds that arrived for STS-1 were a different story altogether. I do not know the actual number of people who watched this event but I think it was estimated close to ½ million people came out to Edwards that day. We anticipated very large crowds for this event and knew that it would require support from many outside of DFRC. It was all DFRC could do to handle the VIPs and the press. In fact, Ralph Jackson, Dryden's PAO, had major support from the other NASA centers for the press. My project team worked with Cal FEMA, CHP, Kern County Sheriff's Department to help them prepare for the crowds expected to descend on the base. I participated in the AFFTC Commander's staff meetings to brief the general and his staff on shuttle status and support needed. The general assigned Dick Scobee, who subsequently became an astronaut and commanded the ill-fated flight of Challenger, to be my counterpart at the AFFTC. Dick did an outstanding job, working with me developing plans and coordinating Air Force support. In addition he was instrumental in securing Army medical/first aid support for crowds.

Q: Any unusual experiences during the shuttle landings?

A: *The only black mark on our STS-1 support record:* There were residual hypergolic fluids on board the Orbiter when it landed. There was a danger of a spill of these fluids while prepping the Orbiter for transport back to KSC. Sumps were built around the Mate/de-Mate Device where the orbiter was prepped to wash any spills into. Immediately prior to the landing, we were required to pump the sumps dry to minimize any incidents should a hypergolic spill occur. No one thought to specify where the fluids from the sumps should be pumped to and on landing, our engineer responsible for ensuring they were pumped had them pumped and drained all of the waste right out onto the lakebed. This was directly in the path of the on-ramp where the orbiter had to be towed. The lakebed was marginally dry from the winter rains and the Orbiter was already sinking into the surface. It was impossible to tow the Orbiter through the fluids from the sumps without potential damage to the vehicle. We overcame this problem by scrounging every sheet of 5/8ths inch plywood that we could find and placed these on the lakebed, covering the fluids. The Orbiter was successfully towed over the plywood even though the plywood cracked as the Orbiter passed over it. The whole episode caused well over an hour's delay in getting the orbiter into the MDD.

Chris Kraft: The day following the landing of STS-1, Chris Kraft, JSC Center Director, flew into Edwards to see first hand the tile damage that had occurred. I met Chris at his plane and accompanied him to the Shuttle Area. Before starting, I mentioned to Chris that an old acquaintance of his, Harvey Price (one of my X-15 Inertial Guidance System Technicians) had recently retired. Harvey had married one of Chris' high school sweethearts right after World War II was over. Dottie, Harvey's wife, had passed away some time before STS-1. We knew her quite well as she and Harvey had taught my wife and myself bridge. Chris asked how Harvey was doing and I told him I thought he was doing quite well. Chris said he should give Harvey a call and asked if I had his phone number. We stopped at the guard's desk at the entrance to Building 4800 and looked the number up in the Lancaster phone directory. He used the phone in the lobby, called Harvey and spoke with him for about 10 minutes. I was really impressed that as busy a man as Chris was, he would take the time out of his schedule to call Harvey just to check on how he was doing.

Hollywood: During the preps of the orbiter for ferry back to the Cape, I had the pleasure of providing Clint Eastwood with a tour of the Shuttle Area. Because of the danger

Columbia's landing at Edwards attracted not only press and public, but also celebrities. Actor Clint Eastwood was given a tour of the shuttle area by Dryden Center Director Ike Gillam. (ECN-15248)



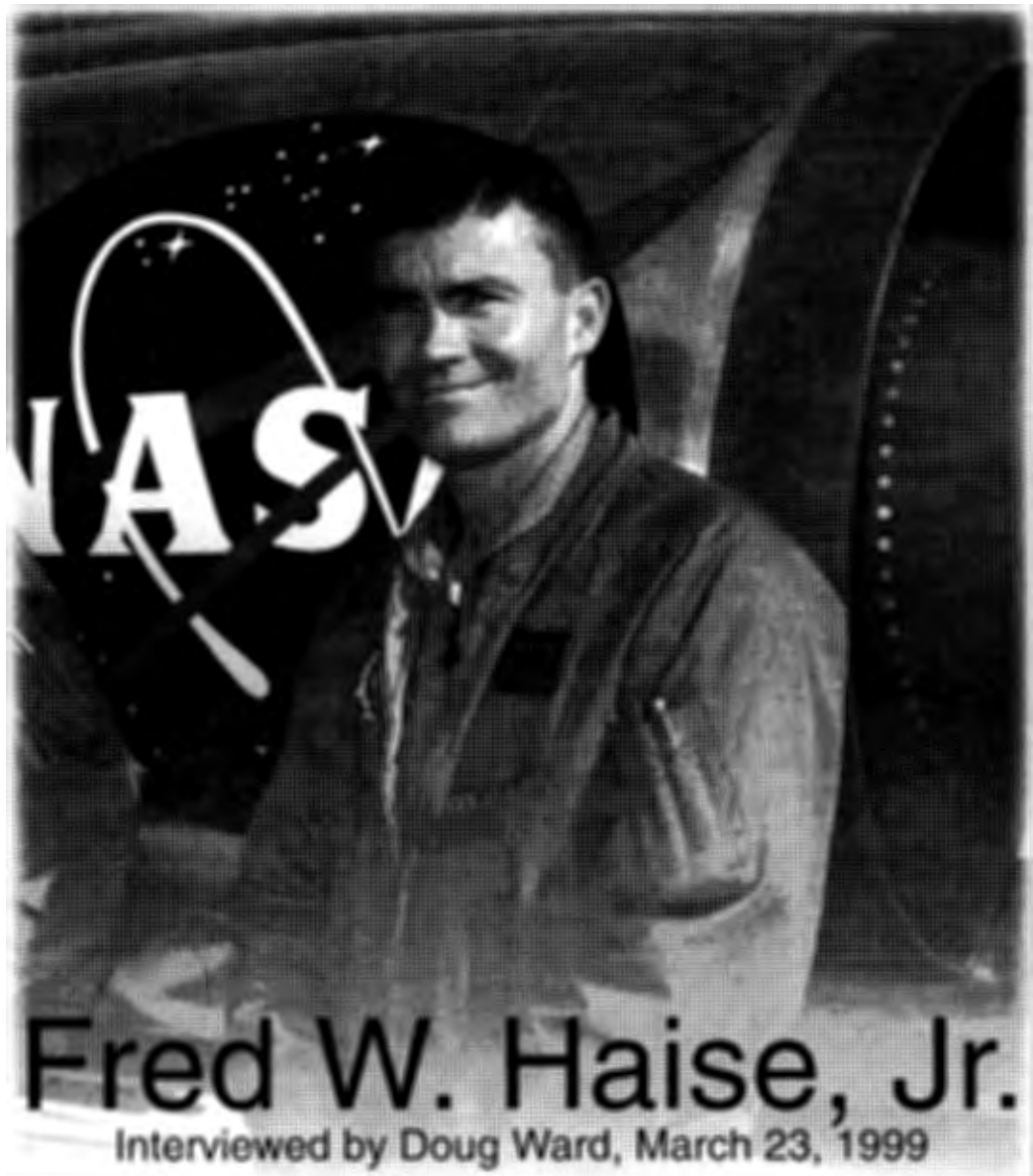
associated with the de-servicing activities, the technicians were still working in SCAPE suits. Consequently, we could not allow Clint to get very close to the Orbiter. I explained to him what was being done and why we could not get close. He indicated he understood and was very gracious about it. I went ahead and briefed him on the activities that were still scheduled to be completed before ferrying it back to the Cape. I was impressed with Clint; he paid very close attention to what I was saying and seemed to understand.

Bad News: The day the *Columbia* was finally ready to be ferried to KSC, the mated pair was towed up and parked at the DFRC ramp. Many of the Dryden and contractor employees gathered at the back of the facility to view the vehicles and watch the departure. I was under the 747 with one of my team members going over some final preps when Ike Gillam came up and asked to speak with me. We walked away to the side of the vehicles where Ike said he just received some very depressing news. He went on to say that he had a call from Washington informing him that Dryden was no longer a Center but was now or would be a division of Ames in October. I asked him what his status was and he replied that he was being reassigned to a position in Washington. He added that John Manke would be the Director of the Dryden facility.

Q: You spent 20 years at Dryden. Looking back at that time, what memories stick out? (Over and above what you have already described.)

A: *Great Place to Work:* It was great working at the FRC. This was especially true under Center Director Paul Bikle, when it seemed we were always working on the leading edge of technology. Paul did an excellent job of keeping us isolated from the politics of headquarters. This isolation seemed to end with Paul's retirement.

Outstanding Employees: I will always be impressed with the Dryden employees that I had an opportunity to work with. They embraced every challenge with a 'can do' attitude and were never afraid to go the extra mile to ensure project success. Every program that I was associated with, from the X-15, LLRV, DFBW, through the Space Shuttle owes a large portion of their success to these people.



(Excerpted from the Johnson Space Center website)

Fred Haise followed much the same path to space as Neil Armstrong had. Both had enlisted in the navy in the early postwar period. Both flew early jet fighters in the military and returned to school to complete their engineering degrees. Haise and Armstrong both worked at the Lewis Research Center (now Glenn), before transferring to the Flight Research Center (now Dryden). They were both selected as astronauts and flew a lunar mission.

Haise was involved in the initial development of the lifting bodies. He flew the variable stability T-33 to simulate the M2-F2's flight characteristics. He also made a car-tow flight in the M2-F1 lifting body on April 22, 1966. Haise also flew the F-104, F5D, T-33, C-47, and T-37 in various support and research roles. And he flew handling evaluations on different types of light aircraft, including the Piper PA-30, Cessna 310, and Aero Commander. While at the Flight Research Center, Haise attended the Air Force's Aerospace Research Pilot School at Edwards, and was the outstanding graduate of Class 64A.

Haise is most famous as the Lunar Module pilot on *Apollo 13*. What was to have been the third manned landing on the Moon turned into a struggle for survival when an

oxygen tank exploded. This caused the loss of power in the Command Module, forcing the crew to rely on the limited battery power of the Lunar Module. *Apollo 13* looped around the Moon, returned to the Earth, and made a successful splashdown.

Haise joined the emerging shuttle program and became part of its management. As the *Enterprise* neared completion, Haise was selected as one of the two crew commanders who would conduct the Approach and Landing Tests. This marked both his return to Edwards, and the culmination of his early work on the lifting bodies a decade before.

Q: Fred, thanks for coming by. You came to NASA from a background, if I read the biography correctly, that had an aviation touch with the Navy, the Marine Corps, and the Air Force. How did you happen to be involved with all of them?

A: Well, it—I went into the Naval Aviation Cadet Program, is the way I entered the aviation business, as an enlisted person, a cadet. And when you graduate and are commissioned and receive your wings..., you're given an honorable discharge from the navy. Then I served in the marine corps for a tour; and, when I left the marine corps, I—in reserves, I went to the Air National Guard. So I had a retirement from the US Marine Corps, an honorable discharge. And then during 1961, I was recalled into the Air Force in the Tactical Air Command from the Air National Guard in Ohio for the Second Berlin Crisis. And after that 1-year assignment, I again received [an honorable discharge] certificate from the Air Force.

Q: Okay. And of course that grew in part, I'm sure, out of your educational background starting in junior college but then on to the University of Oklahoma in Aeronautical Engineering.

A: Well, the path was kind of devious. I got interested in the newspaper business and worked on the high school paper [as] sports editor, then the first 2 years of college I was in journalism and worked summers for the local paper in my hometown in Mississippi, the Biloxi-Gulfport *Daily Herald*. And the Korean War came along, and I wanted to enlist and serve. And at the time, the only program I could get into that would lead to a commission, which was my primary goal, was the Naval Aviation Cadet Program. So—and accidentally I ended up in the flying business, which I loved. And that changed my whole career path, because at that—from there I went back to school to get an engineering degree to become a test pilot. And that put me back at the University of Oklahoma for 3 years.

Q: Oh okay. So did the—was the exposure to flying kind of coincidental? Or was that some deep-seated desire that you've had since you were a kid?

A: No. It was purely accidental. I had never—when at the time I signed up for the program, I was 18 years old. I had graduated from high school at 16 and [had] had 2 years of college at 18; and like most 18 year olds, I think you jump into things without thinking ahead very much because I had never been in an airplane—even in a commercial airliner. I had never flown at all. I just wanted to be commissioned, to be a commissioned officer; and I began to get a little worried in the preflight part of the program, where many of the other people in the program talked about their light aircraft, private flying experience and I didn't know the first thing about an airplane. But like I said, I took to it and I really loved the experience.

Q: Flying is sort of intuitive in a sense, isn't it? It's not one of those things that you're necessarily better adept at doing simply because you've had experience. But some

people seem to have the knack for it and the rest of us don't.

A: Well I think there's, there's certainly a hand-eye coordination facet that, you know, is true of anything that requires some dexterity that way—be it sports or flying. I guess there's a physiological part of it that's a little different—that's a different experience from the standpoint of the g's you might feel or the tumbling or rolling or those kind of things that are a little different than most.

Q: Yeah. What sorts of aircraft were you initially involved with?

A: Well at the time I went into flight training in 1952, I did the basic in the old Navy SNJ, which is—the equivalent Air Force [airplane] would be the Texan T-6.

Q: Right.

A: And advanced training in those days was the Hellcat, the Grumman F6F, the one that, you know, won fame in the Pacific War.

Q: Prop and radial engine.

A: Prop—radial. Both of them—both of them prop aircraft that [I] had qualified...ship-board on two occasions. And then to qualify in jets, it was a very short program of, like, 20 hours' conversion into the navy TV1/TV2 series, which was an air force T-33 Shooting Star trainer version. ...Going in the marine corps, [my] first squadron, was in Banshees, McDonnell F2Hs. The squadron, before I left, had converted to Grumman F9F-8s, the swept-wing Cougars.

Q: So your associations with Grumman began a long time ago.

A: Well, if you look at the whole flying, I've flown about 80 types of aircraft. So I've had an association with just about every aviation builder...

Q: You also had, I think, about 7 years of experience, with NASA before you came into the astronaut program, as a NASA research pilot. I guess starting at Lewis?

A: That's correct. I had met a fellow in the Oklahoma Air National Guard (in fact, my squadron commander), Stanley Newman, who had earlier in his life had worked as an engineer at Langley, and he was the one that put the thought in my mind that I should become a NASA research pilot. So even before I finished the University of Oklahoma, I was already scouting around, made visits to Langley and Ames and Edwards, which were then at that time the premier flight test center of all the NASA centers. But there simply were no openings, and there was a long waiting list.

So I ended up applying and being accepted at Lewis Research Center, which had research programs but more catered to testing of systems using aircraft as the vehicles to test new propulsion systems. We carried aloft...Ram jets hung under airplanes. We had a zero-g aircraft facility. In fact we had the second one in the country behind the Air Force at Wright-Patterson, with an old navy AJ2, where we did early testing to fix the configuration of propellant tanks in the Centaur rocket, where the screens would be, for instance.

Q: So you were using it for engineering, but later it became a very valuable tool for astronauts.

A: Oh yes. Absolutely. The one we had, just the bomb bay we used for these experi-

ments. [It] was too small for the, really,—the purposes later I experienced when I became an astronaut with the larger 707, where you had a much bigger area to free float within.

Q: Right. I was of the impression that we didn't happen on to the use of zero-g aircraft until some time during the Gemini Program. But obviously it was for engineering purposes, at least—it was well before that.

A: I think we inaugurated the AJ2 Program in 1960.

Q: Well, as a NASA research pilot, I'm sure that you had exposure to and knew a number of the astronauts that were selected in groups before you. Let's see: Neil [A.] Armstrong would have been one of them ahead of you.

A: Yeah. Neil, in fact, followed the same path through NASA that I had. Neil was about 2½, 3 years ahead of me. He started at Lewis Research Center then went to NASA's Flight Research Center (now Dryden Flight Research Center at Edwards), and from there entered the astronaut program. And I just—I followed literally the same route, but about 3 years behind Neil.

Q: Did you find that made the transition from becoming a research pilot to becoming an astronaut any smoother? Was it—was that a particularly good route to go in your estimation?

A: Well, I think in the development—when you're in the portion of a program that's the development program, which it was—still was—when I entered *Apollo* and certainly for my early years in shuttle, I think having a background as an experimental test pilot of any sort (be it a company pilot or with NASA) helps in the sense of your being—having experience to be part of... the design evolution of the vehicle. Because that's a role that you play. In the case of my NASA experience, except for the Lifting Body Program I had some participation in, most of it was for the design (if you will) and implementation of the experiments or use of the aircraft, which often required modification....

...My experience at Flight Research Center, I'd hoped to fly the X-15, rocket ship; and clearly within that office, it was on seniority. And when I left Flight Research Center to join the astronaut program, I was still two people away from getting my turn to have flown the X-15. It so happens, I'm glad I left because I would have never made it by the time that program ended....

Q: Well of course, at the end of Apollo you moved into a shuttle management and flight test position. And, is that the sequence that really precluded your flying in Skylab, the fact that you were on one of the late crew assignments and then moved into Shuttle?

A: No. The only choice I had in that time period was to be a—I was asked by Chris if I would consider being a member of the Apollo-Soyuz crew. And I—in my discussion with Chris (I don't remember the exact words), but basically what I felt I could do the Agency better because of my past experience and Edwards experience with... some degree with winged reentry vehicles, that I could serve better by skipping that and going on to Shuttle. And in fact, ...to support the shuttle management. And so I actually... left the Astronaut Office for about 3½ years to work under Aaron Cohen in the Orbiter Project Office, to work through that whole involvement of early design of Shuttle.

Q: And of course, in a lot of respects the shuttle was much more of a test pilot's vehicle than any of our previous spacecraft had been.

A: Certainly from—yeah. Certainly from a stick and rudder, as we'd say, piloting role of view, clearly it's a winged vehicle. Certainly entry at least, entry through landing. Going uphill it's much the same vernacular as previous, except the stack configuration's different. And the wings and the tail feathers of the fin [are] really an encumbrance on ascent. You'd just as soon not have them. They're kind [of] in the way. You got to worry about them not being overstressed. But certainly for entry, landing, it's a piloting machine.

Q: And of course the shuttle introduced us, from an astronaut's point of view, into a totally new regime of having to come back through the atmosphere at hypersonic velocities and then to begin to fly it at supersonic and land at subsonic with a lot of new computer technology involved.

A: Well that I didn't mention it, but the—you mentioned it just now. Referring to computers. That was the other technology jump, I would say, in Shuttle was to get the sync [synchronized] set or redundant set of four computers to work together and actually by data comparison to do voting of both the sensors on the ends as well as the computational aspects of what was going on within the computers. But clearly the control system was the most complex that had been devised to that date because it almost was—it was several control systems.

There was one control system for very early entry, where the air was still very thin and you're at a very high angle of attack, and in some axes, more use of the rocket engines than aerodynamic surfaces. Then a blending, in an intermediate range, of a combination of aerodynamic surfaces and rocket engines were needed. And finally to a pure aerodynamic stage, which probably didn't truly happen to be [like] a normal airplane, including the rudder even in the mix, to below Mach 5. So from there on, it was reasonably conventional as we would think of an airplane control system.

Q: Of course you mentioned that you were out of the Astronaut Office for 3 years as a manager. This was the period of time, as I recall, when the approach and landing tests were beginning to take shape under Deke Slayton. And from your vantage point in management, I wonder what your perception was of Deke as a manager, [who] previously had been your boss in the astronaut corps, now he's a colleague, manager over an important part of the Shuttle Program.

A: Well I frankly was very happy with Deke to volunteer for that role, which is what he did, because of his background. I mean, we had no one, in my mind, that was at Johnson Space Center at the time that was better suited to take on that role. And I think it was reflected in the way the program went. We missed the first free-flight release from the 747 only 2 weeks from a schedule that had been made several years before.

We completed the program (I forget), it was like 4 or 5 months earlier than we'd planned—which is almost unheard of in a test program, certainly something as complex as the orbiter (even that vintage orbiter) was. And I think that was Deke's leadership in pulling together both the contingent of NASA, which involved a lot of integration of Kennedy Space Center people and Dryden NASA people, as well as the contractor Rockwell in that phase.

Q: You know, certainly, it would not—to the outside viewer—have been the norm of the Shuttle Program, which was experiencing very highly—widely publicized delays

and schedule problems and budget problems. And yet as you point out, the approach and landing test phase came through very nicely in both those respects.

A: Now it was—to me it was just remarkable. I mean, I'd been involved in the test business before, and one example is: We did have a problem on Joe Engle and Dick Truly's second flight—second free flight, where they had a leak in a hydrazine tank on the APU [Auxiliary Power Unit] system, which did damage some wire bundles. And they turned that around, if I recall, in 9 days' ... including weekends, which caused Gordo [Charles. G. Fullerton] and I, we really, even for the simple kind of flight plan we had to fly, we were pushed to be ready with the training to make that next flight. Turn[ed] it around in 9 days flat.

Q: You flew (what?) two of the captive flight tests and three of the free flights?

A: Yeah. I flew a total of five of the total eight flight program. ... Again we cut the captive short. We only did three; originally I think we had five of those planned, but we got what we needed in three. And then we flew five free flights. Gordo Fullerton and I flew three of the five.

Q: Right. And Fullerton was your second in command on all of those?

A: That's correct.



Haise (left) and Fullerton have breakfast before an ALT flight (E77-32672).

Q: Did that require you getting back into the Astronaut Office?

A: Oh yes. No, I'd cycled back into the Astronaut Office probably about a year before that first free flight. And in that role, we went back to the more traditional role, even before flight, of being a participant in the testing of the real hardware at Palmdale [California] (in that case), involvement with the software development and the discrepancies

that were showing up in the loads, both through our simulation, which could accurately work that because we had real IBM [AP]-101 computers that were being used in the simulation of Shuttle.

So when the new software load came, the problems we saw in the simulator were identical to what you would see in the real vehicle or in SAIL [Shuttle Avionics Integration Laboratory], which is [an] avionics test facility here at Johnson Space Center. So we had all those kind of involvements working with Mission Control people again and in that same time frame, defining the flight plans, procedures; and with the Test people at the NASA and the contractors, where the vehicles were being put together.

Q: While it's not unusual in an aircraft program, in a space—in the space program, it was a bit of an anomaly to fly a vehicle manned for the first time. We'd always done unmanned test flights. Was this any particular concern or consideration from your point of view?

A: No. Certainly not for the approach and landing test. It would have been very difficult to have devised a scheme, in my view, to have flown that program unmanned. I guess you could've used an RF link and really had a pilot on a stick on the ground like they have flown some other programs. But to totally mechanically program it to do that, and inherent within the vehicle, would have been very difficult for that part of the program. There was on the orbital program initially a planned unmanned flight. Again it was of great complexity, and handling the myriad of potential system problems you—would occur to automate that. One of—one of the (call it) “vehicle shortcomings” that showed up in approach and landing tests, things we missed, was in redundancy management. So there was a lot of lessons learned... that were put into improvements, if you will, into the orbital version. But even with that, with a crew aboard, even though they might not be aboard on the day of launch to fly the vehicle, to be there in a systems diagnostic and be able to handle the multitude of things that you could work around, just inherently made the success potential of a flight a lot greater.

Q: Was the astronaut corps, and particularly John W. Young and Robert L. Crippen who were scheduled to fly the first orbital mission, were they among the strong proponents for doing it with a crew onboard at first flight?

A: Absolutely. And the Program Office were all—Charlie Duke, at that time, was working (I think) for Mr. Donald C. Cheatham. And Charlie set off on and did a study—on that manned versus unmanned with the pros and cons. That was reviewed, you know, at least through Bob Thompson here at Johnson and I'm sure followed up in Headquarters reviews. That kind of sold that as the baseline.

Q: You had a chance to observe—I don't know how close you were—to the—or how much knowledge you have of the Russian system, but on the surface at least, the Russian space shuttle, the *Buran*, looks almost like a carbon copy of NASA's orbiter.

A: Well I'm sure—again I don't know that much personally. In fact, I've never been to Russia. But you're right; it's clear it's a carbon copy from the—pretty much the mold line aspects. Which has great advantages. It's obviously a vehicle configuration, aerodynamically, you know would work. It eases a lot of their cost and time for wind tunnel testing, to some degree, in considering variations and things that you do in simulations (closed-loop simulations). So it short-cut to a great degree of (call it) homework they might have had to do from just the aerodynamics and control—guidance and control aspects.

Now as far as the systems onboard [go], I have no idea how much they replicated the guts of computing systems or environmental systems. Probably have very little similarity to shuttle for all I knew.

Q: Yeah. And of course on the other hand, too, the similarities in the mission or the role you have for an intended vehicle will have a lot to do with shaping what it looks like.

A: Yes. We were driven on Shuttle by—within the design phase—what were called design reference missions. If I recall, there was five of them, and one of them had an A and B variation. They had some resemblance to what you might consider real missions, but the—but at the same time, some aspects of design reference missions I'll say [were] falsified to the degree you'd probably never fly the mission that way. But were meant to challenge the design, to make the design margins encompass virtually—a mission set you might fly. And different designs pushed different aspects of the design. And so by having this set of them, you kind of covered the spectrum of what you might ultimately have to face in flying the vehicle through (what I call) the “real” missions.

Q: Describe for us the way the free-flight test off the back of the 747 worked and what the vehicle was like to fly for the first time. How did it compare with the simulators and so on?

A: The real flights on the back of 747 were unusual in a couple of respects, one a real surprise. When we first rode on top, you couldn't see the 747, no matter how, you know, you'd lean over and try to look out the side window or—it just—you couldn't view any part of it.

Q: Not even a wingtip?

A: Not even a wingtip. So it was kind of like a magic carpet ride, you know. You're just moving along the ground and then you take off. And something below you, you knew it was there, but you couldn't see what was taking you aloft. It was also deceptive sitting up that high. Things always looked like it was going slower than it was, for your taxiing and particularly the first takeoff I really thought Fitz had rotated too early. It didn't look like we were going fast enough.

Q: Fitz—Fitz—

A: Fitz Fulton, who was flying—

Q: —who was flying the 747.

A: Yeah, he was the 747 pilot at that time. And when he rotated, I said [to myself], “We're not going fast enough to make it off the ground.” In other aspects, airborne there was not too much unusual. The unusual thing we faced, though, that we—I don't think we thought of, frankly, late in the program, approaching flight, was to have to do a taxi test backwards from the way you would normally do it in an airplane.

In an airplane, you have a jet engine or a reciprocating engine, and you normally approach flight test by first of all doing some taxi tests around the ramp and then some runs down the runway, progressively getting faster and faster. And finally you reach the day in the test program you take off and start doing the flight test portion. Well we had no way of doing taxi tests, because the orbiter—our orbiter, *Enterprise*, had no engines.

And so we were going to have to face doing taxi tests from the upper end of the speed spectrum backwards. In other words after we landed at 190 knots or so, somewhere down that rollout we were going to do taxi tests. And we did it by each flight—first flight starting it at a very low speed. Didn't touch anything till we got down slow. The lakebed allowed that [with] a very wide expanse on the Rogers dry lake at Edwards Air Force Base. And then each flight, step it backwards up the speed spectrum to check out braking and nose wheel steering at progressively higher speeds. So that's the way, a very unusual way, taxi tests were done on Enterprise.

The only other concern that I had, and it was because we did it differently in terms of aircraft preparation, [was] flight tests. Normally you do full loads on control surfaces in a flight aerodynamic load sense to integrate the whole control system before you fly by using weights and things [on the ground]. And here we're going to we didn't have that luxury. But we did have the advantage of being on top of the 747, so through very small control motion on top of the 747 we were getting real air loads, although not through—we couldn't do it through full control sweeps. Structurally, the stanchions couldn't have stood that with the orbiter on top. So we did that testing—part of the testing a little bit different than the normal protocol in an aircraft program.

Q: Was that a cost factor?

A: No. I think it was just the ability to productively do that within the facilities that we had at hand. But as far as the handling, that question you asked: To me it handled, even at the first flight, it was very clear it handled better in a piloting sense, a piloting rating sense, than we had seen in any simulation—either our mission simulators or the Shuttle training aircraft. The term I use is: it was tighter. Crisper, in terms of control inputs and selecting a new attitude in any axis, and being able to hold that attitude, it was just a better-handling vehicle than we had seen in the simulations, although they were close.

The landing also was a pleasant surprise from the standpoint of ground effect. Ground effect is a phenomenon you run into... when you get within one wingspan height of the ground, you start running into air-cushioning effects, which can, depending on the vehicle's shape or configuration, it can be very different. In fact our variations we had to consider in the orbiter, looking at the worst-case aerodynamic variations: on one side we called it the "vacuum sweep," where if you got down low it would actually tend to suck you into the ground. And if you were at too high a sink rate when that happened, you'd end up with a hard landing.

The other extreme was one that would "balloon" you. You'd come down and get this cushioning, and it would actually balloon you back up into the air, which of course was a different kind of problem. Now you were sitting back up in the air with speed bleeding off, no engine to compensate, and you're likely to run out of airspeed from a stall standpoint or sink rate standpoint before you could effect a second attempt at a landing.

It turned out the Shuttle, in my view, was a perfect vehicle. ...If you get set up with the right sink rate, coasting along, you can literally almost go hands-off, and it'll settle on and land itself very nicely. In fact the landing gear people were somewhat chagrined through most of that test program because we were not landing hard enough to get them good data for the instrumentation they had on the landing gear struts. Although I solved their problem on the fifth flight (the fifth landing flight) where I landed on the runway and bounced the vehicle, and my second landing was about 5 or 6 foot a second. So that gave them the data, and they were very happy with that—although I wasn't.

Q: Would you say it performed more like a heavy bomber-type aircraft or more like a high-performance fighter in its reaction to the controls?

A: Well, to me the handling characteristics were—they were certainly not as crisp as a fighter. Just [because of] the inertias involved in the size of the vehicle. They're frankly better than a lot of transports, though the only bomber I've flown was a B-57. But they were better than the (call it)—the "average" 707-type of transport or certainly earlier versions I've flown like a DC-3. So it's kind of in between in that respect. It had very large control surfaces, mainly driven by the requirements for control uphill at high Mach—higher Mach. And in fact, if you sized the surfaces only to do the landing part of the mission, the elevons would've been much smaller. But—so they were very effective in that speed regime because of their sizing.

Q: Its one negative feature might be that when the nose gear comes down and you touch down, the wings are at what's called a negative angle of attack. Tip downward. I presume that's because they couldn't make the nose gear longer for weight or whatever reason. Is that correct?

A: It was—it actually was for weight. And it's kind of funny the first time you de-rotate or try to put the nose down. For a little bit you almost think you don't have a nose gear because it goes down so far. It does present a problem more today—in today's flight operation where the vehicle's heavier with actually [having to follow] a ritual on de-rotating to get the nose gear on. I've never been on an airplane that you actually had to worry about a sequence to do that effectively.

Because if you do de-rotate too fast, too early while you're still at high speed, the effect of the negative lift—putting pressure down on the tires—can conceivably blow the tires. So you have to go to a point in pitch to hold and wait till you get below a certain speed to then continue the de-rotation to effectively get the nose gear on the ground. And at the same time, you can't hold it off too long, while it's still too high, or else you'll lose the ability to arrest the fall [through]. And if it—if you kept it up too long, it would fall through and damage the nose gear from the standpoint of hitting down too hard. So you've kind of got to work in between [with] a scheme of getting the nose gear on the runway.

Q: Of course, you didn't have a feature that has since been added to the orbiter; that being a drag parachute.

A: That's correct. Yeah, we had it—we had that on the original vehicle's original design in proposals received. And that fell out early when we got into what we considered were serious weight problems, and we went through (I recall) at least several weight scrubs. And the drag chute was one of the things that got thrown out early in the development program.

Q: Before *Skylab* reentered Earth's atmosphere prematurely, you were scheduled to command a Shuttle mission (as I recall) that would have rescued *Skylab*. Now, what happened with all of that?

A: Yes. I was scheduled at that point to fly the third orbital flight. (I was going to command it.) Jack Lousma was my crewmate at the time and, quite appropriately, Jack [was] there because he had flown a *Skylab* mission. And what happened obviously was the—there was a miscalculation, I guess, on the solar effect on our atmosphere, which was raised, causing more drag. So... the *Skylab*... [predicted time] for reentering was moving to the left in schedule, and our flight schedule (including the first flight) was going to the right. So at a point..., they crossed and that mission went away. And from

there it became really a rescue team established [in] a control center to effectively try to handle the demise of Skylab in as safe a way as possible. To put it in[to] unoccupied ocean.

Jack and I were together, I don't know how many months in that training cycle. And really when that mission went away, which I was very enamored with, and just seeing, you know, the younger team that had come in of younger astronauts in 1978 that joined the force, considering where I was in age and life, having that experience in the Orbiter Office and an interest in getting into aerospace management, an opportunity came along to join Grumman [Grumman Aerospace Corporation] that I just felt it was the right time to start my next career. And so I left the program in '79 for that purpose.

Q: Well you continued to have a close association with NASA and the space program then with Grumman and the International Space Station, although it was called Space Station Freedom at that time.

A: Yes. I had several contracts I worked with NASA on (as a contractor from Grumman) initially with the Shuttle Processing Contract. I... headed the team, part of the Lockheed initial team, to handle the ground turnaround of shuttles back in '83, [when] we started on that contract. I then moved in...about '87... I moved to Reston, Virginia... to head the integration contract that Grumman had won on the Space Station Freedom at that time with the NASA contingent that was stationed at Reston.

The only—the other major program that I was involved with is under the service company I headed for Grumman, later Northrop-Grumman. We had a contract here at Johnson Space Center for the institutional computing systems, personal computers purchased with a COT software [and] for a while the mainframes, although most of them departed to Marshall at a point. Most of the networking around the Center. And the telephone system. So that contract umbrella'd the institutional site computing services.

Q: Would you like to see the country set a next role of going on to Mars, or perhaps going back to the Moon first?

A: Well that, I certainly would like to see a continuation of the things that will provide us the capability to move outward in technologies, if nothing else in the interim, which also is at a fairly low ebb today.

You know, somewhat philosophically over the years, I've come to think of the space program as really the means that (very, very long term; it may be thousands of years, maybe a million years), it is the mechanism to establish the human race elsewhere. We think we live on a big object called the Earth, but it's really a very small object. It's a single spacecraft. There is no—we don't have a backup for Earth that we all live on.

I couple that with a thought... you know—we uniquely were given the capability of all the creatures I know, the Creator uniquely gave us the capability to do this. And it just seemed almost divinely ordained that we should use this capability to ultimately preserve the race. That's one of the things the Creator gave us [the talent]—for that consideration. And it's up to us to use—to somehow focus and to use our talents in that vein, rather than a lot of talent and resources we use in other veins that consume a lot of resources.

Q: Well I think on that philosophical note, we'll end it. And I thank you very much for coming by.

A: Thank you.

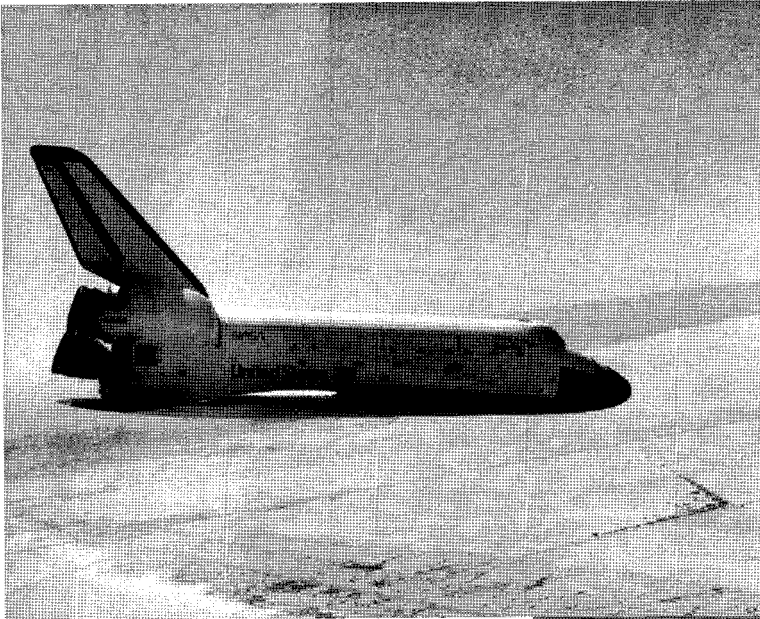
Section V

Epilogue

The successful completion of the Approach and Landing Test flights was only a single step in the shuttle program, the evolution of which proved extraordinarily difficult. Some have argued that the task was actually harder than flying to the moon. The control difficulties on the fifth ALT were traced to a 200-300 millisecond delay in the shuttle's computer system. The delay was analyzed using the F-8 Digital Fly-By-Wire (DFBW) aircraft, which was, by then, using the same AP-101 computers as the shuttle.

To establish what had befallen the orbiter *Enterprise* on its last ALT, variable delays were programmed into the F-8's AP-101 computers, and the F-8 made simulated shuttle landings to test the effects of the lag between the control input and the airplane's reaction. On one flight, with a delay of 100 milliseconds, the F-8 began to pitch up and down as it climbed away from the ground. It was alternately pointed at the runway and the sky, and it took five cycles before the aircraft was back under control. The solution to the shuttle control problem was to add a suppression filter, which prevented the pilot from over-controlling the shuttle. This filter was tested on the F-8 DFBW aircraft before being added to the shuttle software.

The difficulty with the control system was only one of the issues plaguing shuttle development. The main engines and the heat shield tiles were constant sources of problems. And unlike on earlier first flights with research aircraft, there would be no incremental envelope expansion or speed build-up with the shuttle. The first launch would go directly into orbit and there would be no unmanned shuttle launches before committing to a manned flight. Indeed, the shuttle marked the first time, in both the



Columbia on final approach to a lakebed landing, April 14, 1981. (EC81-15103)

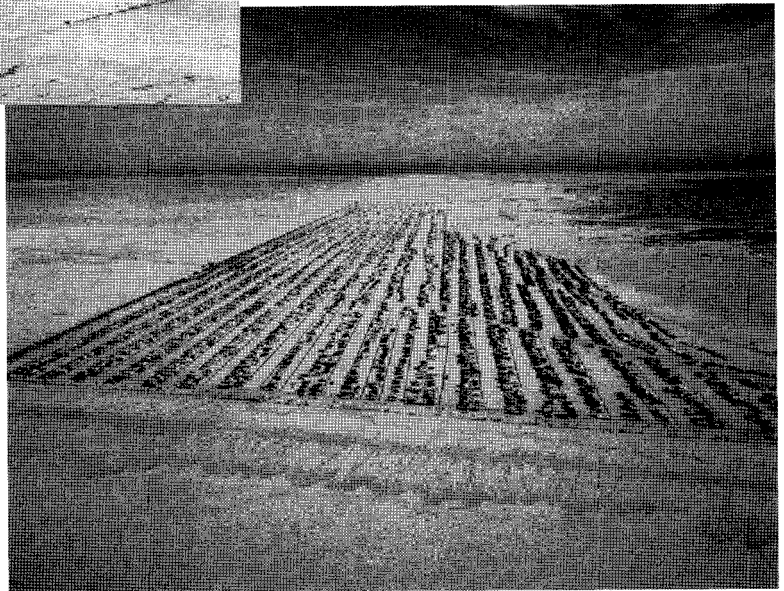
U.S. and Soviet space programs, that a new manned spacecraft would be flown with no unmanned test launches.

Some four years would pass between the initial taxi tests of the shuttle/747 and the first orbital flight. It was not until April 12, 1981—ironically, the 20th anniversary of Gagarin’s spaceflight—that *Columbia* roared off its launch pad and into orbit.

Two days later, a crowd numbering 320,000 gathered at Rogers Dry Lake. *Columbia*’s retrorockets fired over the Pacific Ocean, and the vehicle began a long descent toward the lakebed. This was the first Mach 25 re-entry of a winged spacecraft. The shuttle’s development effort was being put to the ultimate test of a full-envelope re-entry, with no second chance and little margin for error. A great deal of tension permeated both engineers and the assembled crowd as the minutes dragged by.

Columbia announced its arrival overhead with a sudden double sonic boom. Sharp-eyed spectators could spot a tiny delta-wing vehicle against the blue desert sky. The rapidly descending shuttle was joined by T-38 chase planes. Just above the lakebed runway, *Columbia*’s landing gear extended. A chase plane pilot called out the shuttle’s altitude to the orbiter crew as the large black-and-white vehicle descended toward the lakebed. The main wheels touched the dry clay surface, raising a rooster tail of dust. The shuttle’s nose lowered, until the nose wheels too were rolling on the hard, packed surface. *Columbia* came to a gradual stop out on the vast expanse of Rogers Dry Lake.

It had been in this sky, and on this lakebed, that work with the X-1 series, the D-558-II, the X-2, the X-15, and the lifting bodies had, over three decades, built the knowledge base required to bring *Columbia*’s landing to fruition. In that effort, aircraft had been damaged and destroyed, pilots and crewmen had been lost. Their memories live on in the minds of those who worked alongside them and in the street names of Edwards and Dryden. Events in the larger world, as well as social and political change, had all influenced the future in ways that could not have been anticipated by pilots and



View of the crowd at the lakebed viewing site. Crowds numbering in the tens of thousands regularly turned out to welcome the shuttles home. (ED06-0045-3)

engineers when the round 1-2-3 concept had first been developed.

The three decades that followed would see both great successes and terrible tragedies. On this day, however, it was clear that the future had been discovered, beyond the sky.

About the Author

Curtis Peebles has worked at the NASA Dryden Flight Research Center since November 2000. He is employed by Tybrin Corporation. A freelance writer since 1977, he has written 16 books, including *Road to Mach 10: Lessons Learned from the X-43A Flight Research Program* and *Flying Without Wings* (with the late NASA research pilot Milt Thompson), as well as more than 40 articles on various aspects of Cold War aerospace history. He received a B.A. in history from California State University–Long Beach in 1985. Peebles is a Fellow of the British Interplanetary Society and a member of the Flight Test Historical Foundation.

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