Lewis News

LEWIS RESEARCH CENTER
CLEVELAND OHIO

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Lewis shares in pride

Apollo mans moon

The Apollo program has been described at various times by astronauts, engineers, space agency officials and newspaper editorials as a magnificent "team effort." Indeed, the team which is accomplishing this complex program to explore the Moon comprises hundreds of thousands of government and contractor employees throughout the nation.

Among the shapers of history in the early years of the space program was Lewis' Director, Dr. Abe Silverstein. In 1958, when he was Associate Director of Lewis, Dr. Silverstein was called to Washington to help organize NASA, which was, as the successor of National Advisory Committee for Aeronautics (NACA), to be the nation's civilian agency for meeting the challenge of space.

Among the many missions conceived at that time was a manned journey to the Moon and back. Dr. Silverstein himself named it "Apollo" after one of the most versatile of the Greek gods. Dr. Silverstein recalls he chose the name after perusing a book of mythology at home one evening, early in 1960. He thought that the image of "Apollo riding his chariot across the Sun was appropriate to the grand scale of the proposed program."

In the late 1940's Lewis used very small thrust chambers in the range of 100 to 1,-00-lbs. thrust. Over the course of the next decade, rocket engineers and scientists experimented with a variety of thrust chamber designs to achieve high combustion efficiency and smooth burning; and they measured heat transfer rates within the thrust chamber and demonstrated how to cool the chamber and nozzle with liquid hydrogen. Since hydrogen, the lightest of the elements, in its liquid state boils at -423°F., and the oxidizer, liquid oxygen, is stored at -297°F., another major concern was how to handle the cryogenic propellants themselves.

By 1958, as the United States entered the space business, the Lewis Center had tested a fully cooled, liquid hydrogen-liquid oxygen thrust chamber at the, then, large scale of 20,000 lbs. thrust.

The experience Lewis propulsion experts gained in the field of high energy propellants later led to the development of the 15,000 lb. liquid hydrogen-liquid oxygen engine desinated RL-10. Two of these engines power the upper stage of the Atlas-Centaur launch vehicle that has been under Lewis management since 1962. (Atlas-Centaur launched the Surveyor spacecraft that landed on the moon, and the Mariner spacecraft that will fly by Mars on July 31 and Aug. 5.

Much of the same technology developed by Lewis for Centaur was particularly applicable to the J-2 liquid hydrogen-oxygen engines of the Saturn second stage (S-II).

Consequently a number of Lewis staff members — men by then well experienced in high energy propulsion systems — were called upon by NASA Headquarters to serve on the technical assessment teams which recommended the contractor to build the F-1 and J-2 engines. Dr. Silverstein chaired the Source Board which made the final selection of the F-1 contractor. Work began on the F-1 engine, the nation's largest, in 1958 and on the J-2 in 1960.

During the course of development of these engines, Lewis continued its technical support in the form of consultation with NASA's Marshall Space Flight Center, Huntsville, Ala. Melvin Hartmann and Ambrose Ginsburg, Lewis fluid systems engineers, served on a Marshall committee to review problems being experienced by the F-1 turbopump.

These and other specialists served as consultants on a J-2 review committee. Among the topics discussed and of particular interest to the Lewis men was the inducer, that compo-

(Continued on Page 3)

STEPPING INTO HISTORY — On July 21 astronaut Neil Armstrong is scheduled to place his left foot onto the lunar surface as seen in the practice session above. The right foot still rests in the lunar module footpad.

News gets 'new look'

At a time when fashions tend toward brevity, the "new look" for the Lewis News is adding length, rather than shortening up. The size change, effective this issue, presents a five-column, wider and longer newspaper, which folded will equal the size of standard correspondence paper.

The format provides a greater amount of copy per issue, more versatile copy layout, and with a slightly larger type face, should present a more pleasant and interesting appearance.

Some of the standard features will take on new names, and new ones will be added when possible, to continue "presenting the Lewis Research Center story in terms of its people, its purpose and its progress."

Four co-ops join staff

An excellent opportunity to earn while learning is available to college students at six universities through the Lewis co-op program. Four recent graduates of the program are beginning full-time careers at Lewis and Plum Brook.

Once on-board, students usually work one quarter and study one quarter, although this may be altered according to an individual's scholastic schedule. During the five-year program, the Lewis Training

from Cleveland State University with a bachelor's degree in electrical engineering.

Gregory Reck, a recent graduate from the University of Cincinnati with a B.S. degree in aerospace engineering. Reck is assigned to the Combustion Branch, Airbreathing Engines Division.

James Triner, who received his bachelor's degree in electrical engineering from Cleveland State. He now works in the Test and Evaluation Section of the Spacecraft Technology Division.

Recruiter reminisces

Moonman started at Lewis

by
Dr. Robert W. Graham

(Ed. note: Dr. Graham, head of the Experimental Heat Transfer Section, Physics and Chemistry Division, was a personnel recruiter for NACA/NASA until 1959. This article gives his reflections of an interview with Purdue University senior Neil Armstrong in 1955).

If I had been asked, ten years ago at the completion of my recruiting assignment for NACA/NASA, which college student had impressed me the most in my interview with him, I would have unhesitatingly answered "Neil Armstrong."

DR. GRAHAM

Armstrong made a direct request as he opened the interview at Purdue University in 1955 by saying that he had always wanted to become a NACA test pilot. This handsome, clean-cut young college senior was articulate and self assured. His ambition was backed up by the fact that he learned to fly at the age of 16. I asked him what experience he had and he modestly stated that he had over 1,000 hours of experience flying high-speed jet aircraft with the U.S. Navy. He entered college at Purdue after his military service because he knew that a prerequisite for test pilot status was a degree in engineering.

In encouraging Armstrong to join the NACA ranks, I talked to him about the prospects in high-speed sub-orbital flight which was currently under study. Also, just a year before, the X-15 program had been approved, and we talked of the possibility that he might find an opening at Edwards Flight Research Center for test pilot training.

Armstrong's interest in flying was very great, and he said he would be willing to hire on in any capacity that might lead him to test pilot training. NACA salary offers in 1955 were not too competitive, and we were emphasizing the fringe benefits and advanced education assistance for applicants. Yet not once in this interview did Armstrong mention salary. His career flying interest seemed to overshadow all other considerations.

I was so impressed by the qualifications and determination of this young man that at the close of the interview I assured him that he would receive an offer from Lewis or Edwards. Lewis did accept Armstrong as a member of its flight crew in February, 1955 and a few months later he transferred to Edwards Flight Research Center in California.

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Editor .....

Lewis shares pride in Apollo program

(Begins Page One)

nent which draws the boiling cold hydrogen into the pumps. Previous research conducted on this component at Lewis' Plum Brook Station near Sandusky, Ohio, helped verify data of the Marshall Center that showed the inducers would permit a desired low pressure in the fuel tank.

Lewis also assisted a Marshall task group in achieving combustion stability in the F-1 engine. Dr. Richard Priem, experienced in advanced rocket combustion, was one of this group studying the "rocket screaming", a phenomenon caused by strong resonant pressure waves and which can destroy a rocket engine in seconds.

One other area of consultation with Marshall during the F-1 development was on fabrication of the thrust chamber. Walter Russell, a fabrication specialist served on the committee to review the materials and processes for the fabrication of the furnace-brazed thrust chamber and its jacket.

Staff members also lent their technical knowledge to other areas of the Apollo propulsion systems. Early studies were conducted at Lewis on the type or storable propellants to be carried on the upper stage of the Saturn V vehicle and on the spacecraft.

The Center's unique Zero-Gravity Facility was called upon to do two jobs for the Apollo program. In mid-1960, engineers used this facility to help solve the problem of restarting the Service Module's propulsion system in space. Using surface tension phenomena observed during these studies, Lewis engineers assisted in designing a retainer for the propellant in the fuel tank. This retainer would keep enough propellant at the bottom of the tank to ensure that propellant would enter the pump and restart the engine.

The Zero-Gravity Facility was used to help solve a similar problem in the SIVB third stage of the Saturn V for the Marshall Center. In flight when the SIVB engine shuts down, auxiliary hydrogen-peroxide thrusters are turned on to settle the sloshing propellants. During the coast phase the propellants are maintained in the bottom of the fuel tank by the thrust obtained when boiled off hydrogen gas is ducted through a small thruster system. Studies in the Zero-G Facility were able to determine the proper size of these various thrusters.

One of the astronaut's concerns about how weightlessness in space might affect fuel cell performance drew helpful information from Lewis too. Fuel cells are carried aboard the Service Module to provide electric power to spacecraft systems. Consequently, Lewis researchers investigated this area and made known to the Manned Spacecraft Center that the condenser of the fuel cell did not depend on gravity to operate properly. Lewis also was asked by MSC to determine the heat transfer characteristics of the condenser; this information was used in a computer simulation of the spacecraft's electrical power subsystem.

During 1967 Lewis engineers were consulting on the overall combustion and system stability of the Lunar Module ascent engine, the critical propulsion system for the Ascent Stage which returns the astronauts from the moon to lunar orbit. John Wanhainen, a chemical rocket expert, was part of a task group to overcome the high frequency combustion instability noted in the engine. Two other engineers, Robert Dorsch and Leon Wenzel, ran analog computer analyses of low frequency combustion instability characteristics.

The Center's 8x6-foot transonic and 10x10-foot supersonic wind tunnels were used in extensive tests on models of Saturn booster stages. The first such tests were made in the late 1950's when engineers studied base flow and heating tests on the SIB booster, the eight-engine first stage of the Saturn I. The 1/45th scale model had real, working rocket engines of 250 lbs. thrust each. Data were taken over a range of speeds from takeoff to Mach 3.5 and of altitudes from sea level to 150,000 feet. This simulation of actual flight conditions provided valuable information on the pressure and heat loads experienced on the base and engine's compartment of the SI vehicle.

In the 1964-1966 period base flow and heating also were studied in both wind tunnels for the SI C first stage of the Saturn V. Also, the force required to move the engine nozzles for directional control had to be measured. These measurements helped determine the size of the actuators required to gimbal the engines.

In all manned missions, safety of the public, the astronauts, and the operating crew, is a major concern to the NASA. In case a mission must be terminated early, one of the first options the astronauts have is to employ the Launch Escape Vehicle and Tower which stands atop the Command Module. This escape system propels the Command Module out and away from the Saturn V. During 1964 tests were made on the system in the Lewis Research Center's 8x6 tunnel at the request of the Manned Spacecraft Center. In the tunnel, a model of the escape system attached to the Command Module was released at various angles to determine its stability under simulated flight conditions.

Safety was the subject that brought I. Irving Pinkel, now Lewis' Assistant Director for Aerospace Safety, to serve as a consultant to the Apollo 204 Review Board. In that capacity and as a member of the team which investigated the causes of the spacecraft fire which took the lives of three astronauts early in 1967, Pinkel helped to recommend changes in the capsule to prevent a future tragedy.

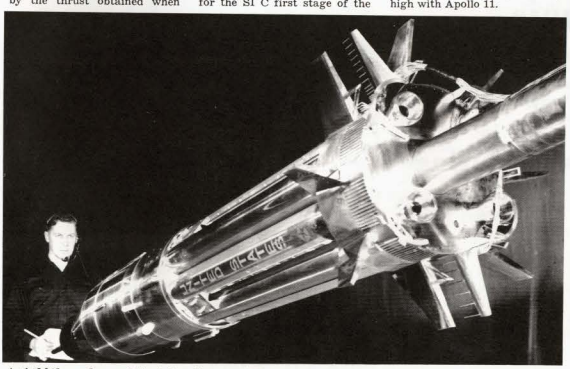
Through extensive consulting on fracture mechanics, Lewis professionals have assisted in improving both the more than 140 pressure vessels of the Saturn V, and the SII fuel tank. Particular contributions by Lewis materials scientists to the construction of pressure vessels included improved test methods, and methods of design and analyses based on new concepts in fracture mechanics technology. Other materials scientists and engineers provided fracture research data on the critical weldments of the SII fuel and on the tank material itself; they also recommended cryogenic proof tests, and suggested flight conditions to reduce win loads on the vehicle.

Thus, Lewis scientists and engineers, like thousands of others who have served the Apollo team, have their hopes riding high with Apollo 11.

On July 21 astronaut Neil Armstrong is scheduled to plant the American flag on the lunar soil, in view of millions the world over via direct TV broadcast.

Lewis technicians checked out a model of the one and a half million pound thrust Saturn booster which was being readied for base heating problem studies in the Center's supersonic wind tunnel.

Dynamic stability tests of the Apollo command module and its launch escape system were performed in the Lewis 8x6-foot transonic wind tunnel. Scale models were used in the tests.



A 1/20th scale model of the Saturn 1-B launch vehicle was finally checked before aerodynamic and load tests were conducted in the Lewis 10x10-foot supersonic wind tunnel. Lewis supported Marshall Space Flight Center in the Apollo Saturn testing.

'We came

Even with a high glare, astronauts Armstrong and Aldrin are seen just after they planted the American flag on the lunar soil.

Government and industry launch control team members rise from their consoles to view the liftoff through a window at a 3½-mile vantage point.

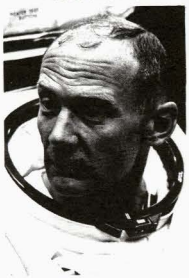
The tension is evident as Eugene Manganiello, Lewis Deputy Director (foreground), Jerry Kennard, and Dr. Seymour Himmel, Assistant Director for Launch Vehicles (standing) watch live TV transmission of the Apollo 11 liftoff.

ARMSTRONG

in

peace

Former President Lyndon Johnson becomes another spectator as he watches the liftoff of the mission which he supported so vigorously as Vice-President and President.



ALDRIN

Locally celebrating was the Wilbur Carpenter family on Ruple Road. Peggie, 19, and Kurt, 16, made and displayed this greeting for Lewis employees.

for all mankind'

Apollo 11 rises through a pillar of flame to clear its mobile launcher at Pad 39A, Cape Kennedy, July 16.

COLLINS

Vice-President Spiro Agnew (center) makes notes as he discusses the mission with NASA Administrator Dr. Thomas Paine. At left rear is astronaut James McDivitt.