See special feature on Apollo 11 in this issue

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Lewis played major role in success

Armstrong's Moon walk startled world 10 years ago

BY CHARLES MITCHELL AND NAZHA 'NICKIE' FADIL

At exactly 10:56 p.m. EDT 10 years ago today (July 20), NASA astronaut Neil Armstrong cautiously placed his left foot on the Moon and announced this mind-boggling, historical 'first' to a rapt world-wide audience. At 11:11 p.m., companion, Edwin E. Aldrin, Jr. backed down the ladder and placed his left foot on the Moon.

Armstrong's first hardly audible words from 250,000 miles away on that desolate satellite of planet earth were "That's one small step for man, one giant leap for mankind."

Good lucks and Godspeeds echoed from the launch control room at Kennedy Space Center to the astronauts as they roared upward. A cadre of Lewis persons, who made significant contributions to the mission, had reasons of their own that all would end well.

The decision to use liquid hydrogen, liquid oxygen in the Apollo launch vehicles was based on early rocket experiments at Cleveland. From 1945, a group of scientists and engineers here conducted research on high energy, liquid propellant rocket engines under Dr. Walter T. Olson. Joseph R. Dietrich, Everett R. Bernardo, and John L. Sloop, successively, headed this rocket section. Their first successful tests with liquid hydrogen were in 1954. Ed Rothenberg, Paul Ordin, Howard Douglass, Bill Rowe, and Glen Hennings were key researchers. In 1958, Dr. Silverstein, who had become Chief of Research here in 1949, had available to him the experience of the Cleveland group.

Walter E. Russell, now chief of the Fabrication Division, had more than a casual interest in the success of Apollo 11. He, along with a committee of fabrication specialists from other NASA Centers, reviewed materials and processes for fabricating the furnace-brazed thrust chamber of the spacecraft.

On the eve of the 10th anniversary of the event, Russell reflected on his work: "We were working on this type of research before President Kennedy's statement on getting a man on the Moon in this decade, but without a goal. After Kennedy's statement, we had a goal in mind. The money started flowing and a new sense of urgency permeated our work. No, I could not relax on the day of the launch. The mission to me was like a concerto. The finish had to be perfect or the whole mission was a flop. Ironically, a leading newspaper carried a story on the same day of the 'splashdown' that NASA funds would be cut.

"No question about it. Some very good benefits came as a result of the Moon landing," Russell continued, citing the medical, electronics and aerospace industries as directly benefiting from Apollo missions. Each flight built on the experience and knowledge learned from previous flights.

Melvin J. Hartmann, chief of Fluid System Components Division, and recent retiree Ambrose Ginsburg, chief of the division before his retirement, served on a committee to review problems associated with the engines' turbopump. Hartmann said of his involvement on the committee:

"Apollo 11 was, for us at Lewis, the climax of five or six years of intensive development to bring into being the J-2 and F-1 propulsion systems. The turbopumps in these engines were very advanced for their time and were a combination of the old and the newer design methods. Previous manned space flights had utilized turbopumps that were primarily designed from empirical rules laid down in earlier texts. Our efforts were to assist Marshall in applying design and analysis methods that were being used in aircraft turbine engines. We took part in many turbopump design reviews and failure investigations. One has to be very pleased (and a little relieved) when these efforts pay off in a mission such as Apollo 11. Turbomachinery engineering used in rocket engines in 1958 (when Lewis first considered liquid rocket engine research) seemed to be less advanced than that of the aeronautics industry. During the Apollo program the unlimited resources

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View looking south on Underpass Road. Center lane will become inbound at all hours effective later this month.

Office makes traffic changes

The Safety Office and Plant Protection Office are in the process of implementing major changes in traffic control at Lewis, including making the center lane on the DEB Underpass Road inbound at all hours.

As it now stands, DEB Underpass Road's center lane is his

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'Perform a lunar landing and retur

WALTER RUSSELL

MELVIN J. HARTMAN

RICHARD J. PRIEM

These Lewis persons made major contributions to the success of first Moon landing.

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resulted in very rapid improvements so that today substantially improved design, analysis and experimental methods are available to the aircraft propulsion community. This rapid advancement would not have been possible without an all-out program such as Apollo.

"Highly advanced turbomachinery for the Space Shuttle main engine and aircraft engines such as the E^3 have become a possibility because of turbological advances associated with the Apollo program. The Nation's and Lewis' aeronautics and space programs have thus benefited. We have information and capabilities that should improve our ability to compete in the world markets and yes, to solve our energy problems.

Richard J. Priem, now head of Lewis' Combustion Technology Section, was part of a group which studied 'rocket screaming,' a phenomenon caused by strong resonant pressure waves which can destroy a rocket engine in seconds.

Leon M. Wenzel now of the System Dynamics Section, was involved with several others in a stability analysis of the ascent engine of the lunar landing module. He said:

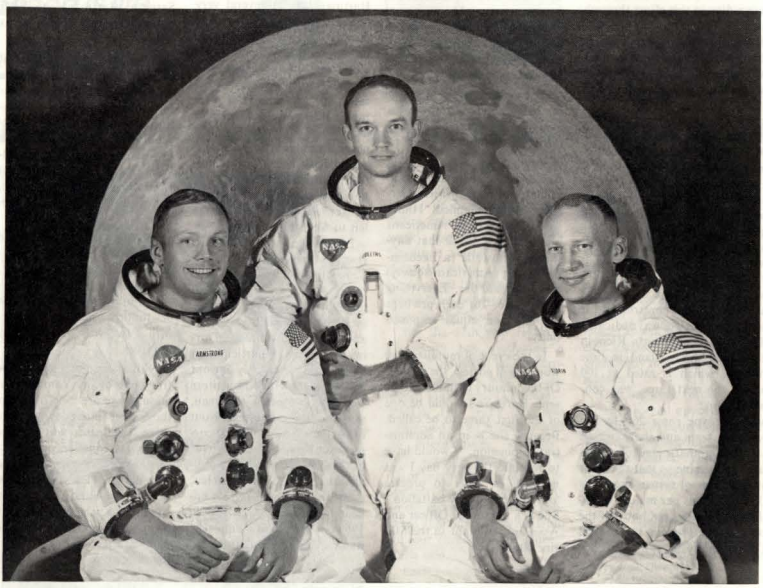
"I felt anxiety when the astronauts started the ascent engine - we had analyzed the engine's stability as best we could, but it was of necessity an educated guess in some respects.

"Perhaps never again will NASA have such a unifying purpose; it focused us and united the country almost as World War II.

Safety was always uppermost in the minds of the Apollo mission planners, especially following the spacecraft fire in 1967 which took the lives of three astronauts. Lewis staffers served as consultants to the Apollo Review Board which investigated that tragedy and helped recommend changes in the capsule to prevent future tragedies. Other staffers were involved in consulting work on fracture mechanics to improve the pressure vessels of the spacecraft.

The heady atmosphere prevailing on that humid night in July at Lewis' Observation Room reflected the close personal and professional involvement of so many of the Lewis staff.

Numerous potential problems for the mission had been tackled by the staff both analyt-

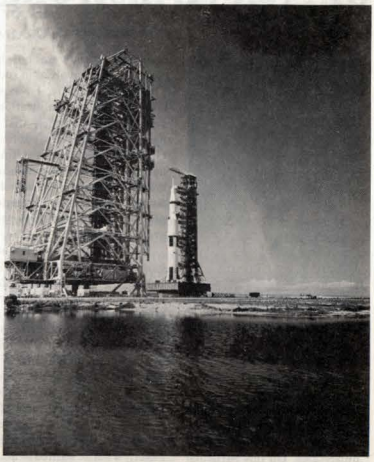


The Apollo 11 Crew (from left), Commander Neil A. Armstrong, Command Pilot Michael Collins and Lunar Module Pilot Edwin E. Aldrin, Jr.

n,' NASA told Apollo 11 astronauts

Then President Richard M. Nixon talks with astronauts on the Moon.

ture rival the very act of creation itself, as some claimed. NASA, Americans and world know this: Apollo 11 opened up space as man's last frontier to explore. Apollo accelerated technology to a pace never before achieved except through war. And man, the ultimate adventurer, found fresh perspective for himself and his fragile earth.



The Apollo 11 space vehicle is on its way to Launch Complex.

ically and with experiments in Lewis' unique facilities.

The Center's Zero Gravity Facility was called upon to do two jobs in preparation for the first Moon landing. The facility was used to help solve the problem of re-starting the service module's propulsion system in space. As a result of the study, engineers were able to design a retainer for the propellant in the fuel tank to ensure that enough propellant would always remain at the bottom of the tank to re-start the engine.

One of the astronaut's concerns about how weightlessness in space might affect fuel cell performance drew helpful information from Lewis, too. Fuel cells were carried aboard the service module to provide electric power to the spacecraft systems. Lewis researchers determined that the condenser of the fuel cell did not depend on gravity to operate properly, relieving the astronauts of at least one major concern.

The Center's 8 x 6-foot transonic and the 10 x 10-foot supersonic wind tunnels were used in extensive tests, including safety tests to support the Apollo 11 Moon landing.

For example, if a mission had to be terminated early, one of the options the astronauts had was to employ the launch escape vehicle. A model of the escape system was tested in Lewis' 8 x 6 tunnel to determine its stability under various flight conditions.

And some two years before the actual Moon landing, Lewis Center researchers were lending their expertise on the combustion and system stability of the lunar module ascent engine and the very critical propulsion system which returned the astronauts from the Moon to lunar orbit.

When the mission was completed: . . . "perform lunar landing and return. . .", the question lingered: Were the risks and expense worth the effort? Or did, in fact, the eight-day ven-

Astronauts footprints are very distinct in this photo.

Flight Controllers celebrate successful conclusion of the Apollo 11 lunar landing mission.

Apollo 11 television view on Moon.

Apollo 11 mission...

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Recalling the recruitment of Neil Armstrong for Lewis

BY DR. ROBERT W. GRAHAM

DR. ROBERT W. GRAHAM

In the early 1950's, I was involved in the Center's recruitment efforts at Purdue University and the University of Illinois. In 1955, Bill McCann (now retired) and I visited these universities. On this particular trip, the recruitment office requested that we try to interview candidates who would qualify as test pilots for the upcoming X15 experimental rocket powered plane.

At Purdue, a young man came in who said, that in addition to his aeronautical degree, he had 1500 hours of jet experience as a pilot with the Navy. Not only were these credentials impressive to me because of the need for a qualified test pilot, but I was impressed by his quiet, assured manner. He said that his life-time ambition was to be a NACA test pilot and all he wanted to know was how he could become involved in such a program. Frankly, I was so taken back by his qualifications and by his approach that I hardly knew what to say at first. Obviously, he was a real 'find' and so I told him with considerable enthusiasm that he would have no difficulty beginning in such a test pilot program with NACA.

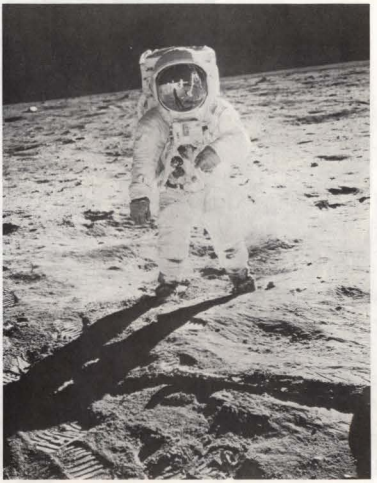
Even though I could not anticipate what would eventually happen to this person in his career, this particular interview always stood out in my mind as one of the most memorable that I ever conducted in the recruiting program. Frequently, in talks that I had to give to young people in schools, I cited this experience as an example of a young person who was completing his education and knew exactly what he wanted to do. It was also significant to observe that Neil Armstrong was not interested in the kind of salary offer NACA could make. He was primarily interested in the kind of challenge that a test pilot position would offer.

When I returned to Cleveland with the interview form in which I recommended that Neil Armstrong be hired by our agency, his qualifications made a great impression on the management here. Irving Pinkel, who was then the Division Chief in charge of flight operations at Lewis, decided that he should go to Purdue and give Armstrong the official offer in person.

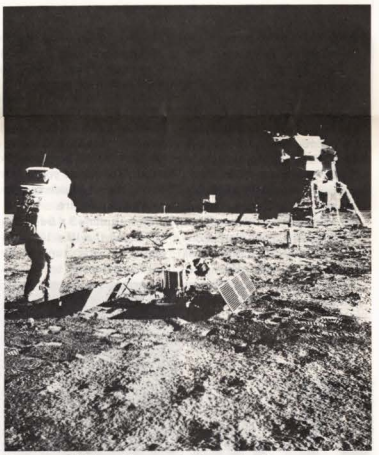
After I found out that NACA had hired him, I was very interested in following his career. He spent a short time here at Lewis and then was given the opportunity to become a part of the X15 program at Edwards Airforce Base in California. I noted that he later flew the X15 in some of its record-making flight missions. Next, I became aware that he had applied for the astronaut program and soon was assigned as one of the Gemini mission pilots. From that particular program, he went on to the Apollo program. Then, as we all know, he was selected to be the Commander of the historic Apollo 11 mission, the first flight to the moon.

I have had the thrilling experience of talking with him twice since the moon landing; once here in Cleveland at the Lewis Center and the second time in New York City at a meeting of the American Society of Mechanical Engineers, where he received a medal for his space exploits.

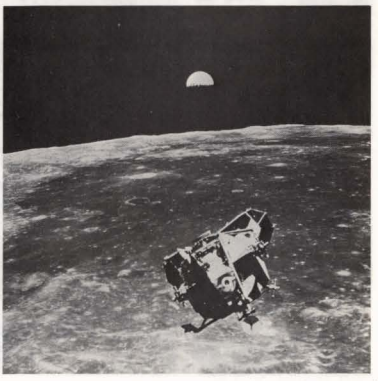
During the live television broadcast of the Apollo 11 moon landing, I felt a strong personal identification with the mission. Fourteen years earlier, I wouldn't have imagined that a young Purdue graduate being interviewed would become the first man to set foot on the moon.



Astronaut Edwin E. Aldrin, lunar module pilot, walks near the lunar module during Apollo 11 extra vehicular activity.



Astronaut Aldrin performs activities on the Moon.



Lunar module ascent stage photographed from the command service module.

Ten years after Apollo...

BY EUGENE CERNAN, APOLLO ASTRONAUT

ASTRONAUT CERNAN

EDITOR'S NOTE:

The following was written by former astronaut Eugene A. Cernan, the last man to set foot on the Moon as a member of the Apollo 11 crew. It is reprinted in the Lewis News from the 1978 report of Rockwell International Corporation as a special feature on the meaning of the space program.

It took a national goal made reachable by the effort and dedication of thousands of Americans and an expenditure of $20 billion over the better part of a decade to land 12 men on the moon and bring back 800 pounds of lunar rock. Ten years later, I am frequently still asked, "Was it all worth it?"

My answer is yes. Absolutely, without qualification. The Apollo Program was worth every penny and every ounce of energy it took to get man to the moon and back. It not only was the greatest technological endeavor of all time, it perhaps may also have been the greatest human endeavor in the history of mankind. That first lunar landing spirited more pride, earned more respect and gained more friends for the United States of America from countries the world over than any other one thing to have happened in my lifetime.

On the more tangible side, Apollo and our other space programs have produced hundreds, if not thousands, of benefits and technical innovations that have materially enriched all of our lives. Specifically, handheld computers, live global television, freeze-dried food, medical monitoring equipment and electronic wristwatches are just a few of the advances—already taken for granted—to have come from the space program. As a resident of the Gulf Coast in Houston, I have seen firsthand the value of early hurricane warnings from weather satellites that permit swift evacuation and save potentially thousands of lives.

The scientific lunar data collected on six Apollo missions has put to bed most of the myths about the moon that had existed since man first discovered his nearest neighbor in space. Geologists had never even been able to agree about the physical characteristics of the lunar surface until we landed there and brought back samples. Now there is a general belief that the moon and the earth share a common origin. We know most of the same elements found on earth also are found on the moon. We know it would be possible right now to extract iron and oxygen from lunar rock in useable form, both of which could be important factors should we decide to establish colonies on the moon or elsewhere in space someday.

I am not one of those who believes he has seen a UFO (unidentified flying object) but I do believe our studies of the moon can tell us something about the possibility of civilizations that might have existed, or may still exist, elsewhere in the universe.

Statistically, science tells us there is an infinite number of other solar systems. This indicates to me there could be an infinite number of suns and earths like our own and thus possibly an infinite number of other civilizations.

I am frequently asked whether the billions spent on space couldn't have been better spent here on earth. Well, of course there has never been a single dollar spent in space—all of that money helped create jobs and products right here on earth. However, I would like to put the cost of the space program in a relatable perspective—one with which we can all identify.

The entire cost of America's space program at the peak of Apollo, in 1966, including the money spent on all of NASA's unmanned programs such as the weather and communications satellites, cost each American about $30 a year. When we consider that at that same time each of us in this country spent something like $130 a year on such items as alcohol, tobacco and cosmetics, and spent as much as $22 per person a year to feed the cat and the dog—and I'm not saying that any of these items might not be personal necessities—I truly believe most people would willingly support the $17 per person a year spent on space today, looking upon it as an investment in the future of America.

I am often asked if I would like to fly the Space Shuttle and, of course, I would. But who is at the controls is not the important thing. The American pilot, even the entire world, literally lived the history of Apollo. We all shared the emotion, the adventure, the excitement, as well as the pride. So, too, will it be with the Space Shuttle.

It is impossible for me to look up at the moon in the darkness of an evening almost eight years after it was my home for more than three days, and not ask myself, "Did it really happen?" And yet, I know it did because once you have walked on the moon, you can never unwalk. It is a responsibility that you must long endure. I can still vividly recall looking back home at earth as it set atop the mountains in the valley of Taurus-Littrow. I could see from pole to pole, and from ocean to ocean, and across the majesty of the continents. It became very clear to me that it was all just too beautiful and too perfect to have happened by accident. There obviously are a great many things we can't understand about our universe, although slowly we are learning more about it and about ourselves.

Those of us who went to the moon made a good start at finding some new answers but when we returned, we also brought back many new questions. I fully expect that Space Shuttle and the generation of spacecraft that follows will supply more of the answers that we continuously seek.

It is hard for some people to realize that the Shuttle can bring back 30,000 pounds of cargo compared to 200 pounds for Apollo. And, unlike the Apollo program in which most of the hardware was expended on the mission, almost every element of the Shuttle system is recoverable and can be used again, reducing substantially the cost of space launches.

We truly are in an age of challenge. With that challenge comes opportunity. The sky is no longer the limit. The word impossible no longer belongs in our vocabulary. What we can create in our minds we can make happen. We have proved that we can do whatever we have the resolve to do. The limit to our reach is our own complacency.

The black shadow of the Apollo 11 lunar module is silhouetted against the surface of the Moon.