Apollo 11

30 years after the first step on the moon

By Paula Korn

As America celebrates the 30th anniversary of Neil Armstrong's first step on the moon, it is a perfect opportunity to glance back at that watershed period of the U.S. space program.

It was a time of great energy, grand visions and strong passion. Our space program was at full-tilt.

The people of Boeing, North American Rockwell and McDonnell

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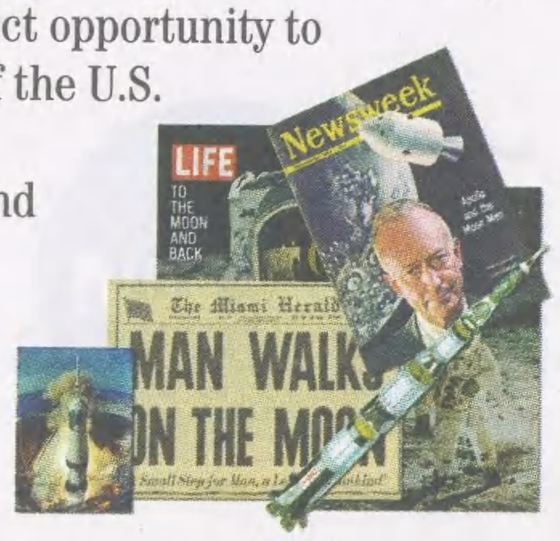


Boeing

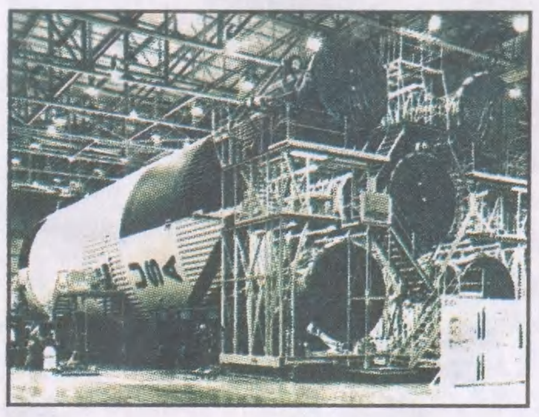
Wanted: 7.5 million pounds of thrust – Boeing delivered

By Mike Lombardi

Ten thousand Boeing employees supported Apollo 11 at plants across the country and at NASA sites in Houston, Texas and at Cape Kennedy (now, Kennedy Space Center).

In 1961, NASA awarded Boeing the contract to build the first stage of the Saturn V booster. Standing 138 feet high, the first stage, or S-1C, was responsible for creating the 7.5 million pounds of thrust necessary to get the entire vehicle off the launch pad and on its way to Earth orbit.

Approximately 75 percent of the structural weight of the first stage was fabricated at the Wichita site. Wichita employees fabricated the sections for the giant tanks that were to hold fuel and liquid oxygen in the 33-foot-diameter sections.



Before NASA could select a landing site, the surface of the moon had to be photographed and studied. Accordingly, Boeing teams designed and built the Lunar Orbiter satellite, which photographed more than 99 percent of the lunar surface.

In 1967, after the tragic fire that took the lives of three astronauts, NASA asked Boeing to help manage the Apollo-Saturn program. Boeing, acting as management consultant to NASA, was tasked with production planning and scheduling, testing, configuration management, logistics, mission analysis, and flight readiness and design certification reviews.

Although not part of the Apollo 11 feat, Boeing also developed and produced the Lunar Rover Vehicle. The lightweight "moon buggy" helped the astronauts of Apollo 15, 16 and 17 greatly expand exploration capabilities of the lunar surface.

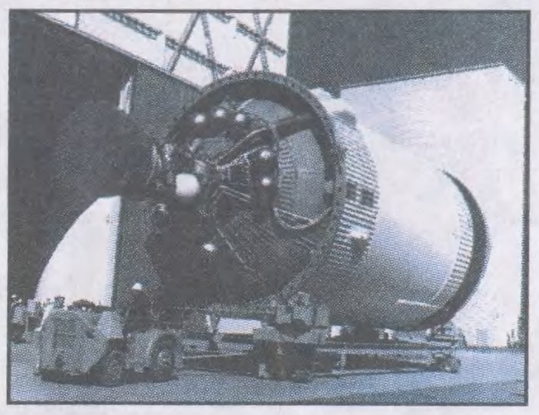
McDonnell Douglas

McDonnell Douglas' third stage took Saturn to escape velocity

By Bill Cole

The first step on the moon was cheered nationwide by enthusiastic McDonnell Douglas employees. The teammates had good reason to be proud: They designed and built the 58-foot-7-inch-long S-IVB third stage of the huge three-stage Saturn rocket that carried the astronauts on their historic journey.

Assembled in Huntington Beach, Calif., the critical third stage was fired twice during the mission. It was used once to propel the Saturn vehicle and its crew into orbit around Earth, and a second time to put the craft on a trajectory to the moon.



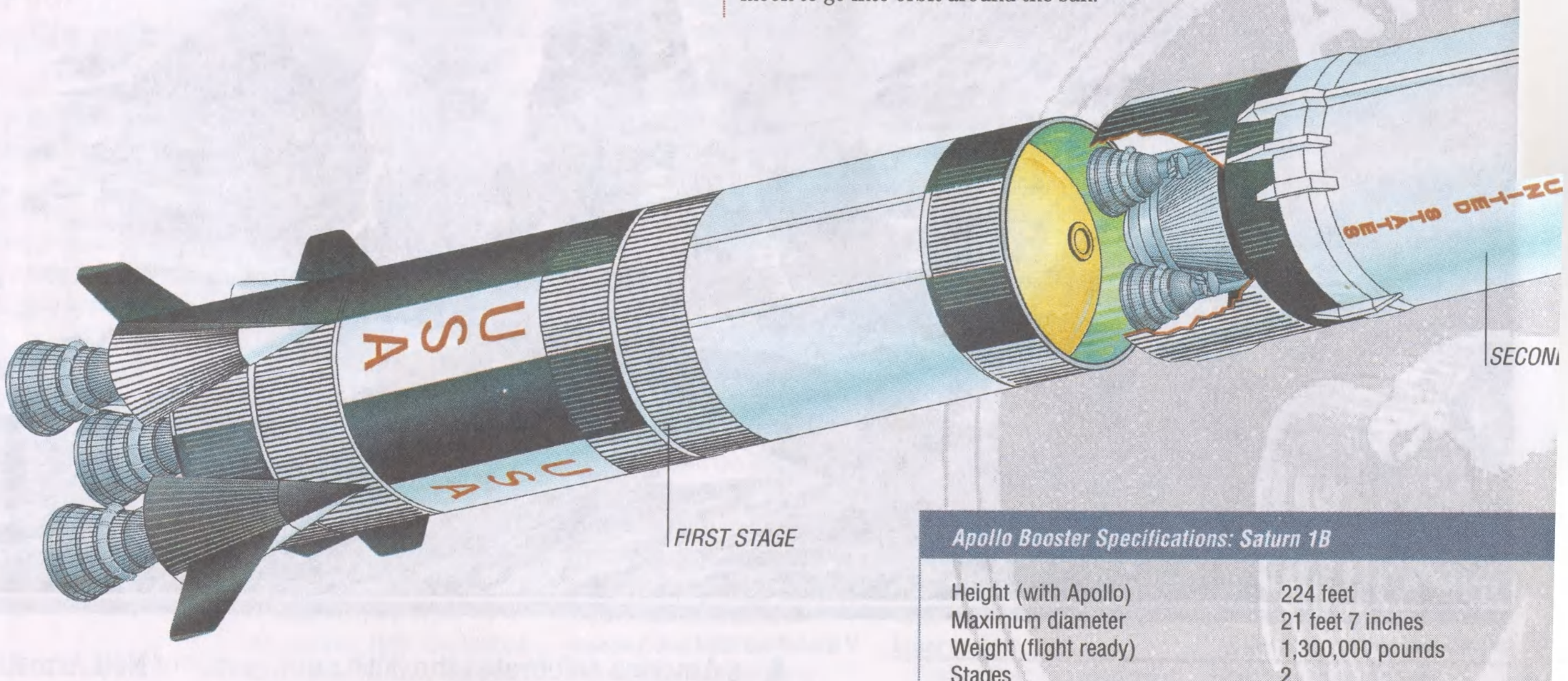
As the mission neared the moon, the S-IVB was then involved in a series of crucial maneuvers. First, the Command Module was separated from the third stage. The module turned around to dock with the Lunar Module, still attached to the forward end of the S-IVB. Then, slightly more than four hours after launch, the Lunar Module and Command Module were separated from the S-IVB. The McDonnell Douglas rocket stage, its mission completed, glided past the moon to go into orbit around the sun.

Before and after the mission, McDonnell Douglas employees played a critical role, not only in landing the first man on the moon, but in events leading up to and following the moon mission.

By designing and building the Mercury and Gemini spacecraft that preceded Apollo, and providing training to the astronauts, employees helped to make the moon mission possible. Also, the successful splash-down of the Apollo 11 capsule did not mean the end of the McDonnell Douglas effort. A team of McDonnell Douglas scientists would later help to analyze the lunar surface rocks and materials the astronauts brought back from the moon.

Believe it or not

McDonnell Douglas employees took the day off to marvel at humankind's first moonwalk — but they had to trade their normal United Nations Day holiday for the privilege. McDonnell Douglas founder James S. McDonnell, widely known for his frugality, said it was appropriate that employees share fully in the historic events. But it took a special employee ballot to approve the vacation by trading for another. Teammates voted to work their normal Oct. 20 United Nations Day holiday in exchange for the July 21 "National Day of Participation," proclaimed by President Richard Nixon.



Saturn V illustration: Neil Hill

Apollo Booster Specifications: Saturn 1B	
Height (with Apollo)	224 feet
Maximum diameter	21 feet 7 inches
Weight (flight ready)	1,300,000 pounds
Stages	2
Propellants — 1st stage	RP1 (kerosene), liquid oxygen
2nd stage	Liquid hydrogen, liquid oxyge
Maximum payload (low Earth orbit)	40,000 pounds
Maximum 1st-stage thrust	1,600,000 pounds
Engines —1st stage	8 H-1
2nd stage	1 J-2
Saturn 1B horsepower	24,000,000

North American Rockwell met multiple challenges

By Bob Howard

North American Rockwell played a dominant role in the Apollo 11 moon landing and in every Apollo flight. The company was the principal contractor to NASA for the Command and Service Modules, the Launch Escape System, the Spacecraft-Lunar Module Adapter and the Saturn V second stage (S-II).

North American Rockwell was the predominant supplier of propulsion systems for the massive Saturn V launch vehicle and was the only major contractor with hardware in almost every segment of the Apollo-Saturn stack (the Saturn launch vehicle and the Apollo spacecraft). The stack stood 365 feet high, weighed 6.4 million pounds and generated some 7.5 million pounds of thrust at liftoff.

North American Rockwell employee Robert Becker said, "When I recall Apollo 11, I remember each individual giving their best no matter what their job title. Classifications such as technician, inspector, engineer or supervisor were secondary to the challenge we all faced — we were going to the moon!"

Each day, a new crop of problems sprang up and each day solutions were found. Inventing as they went, teams at Reusable Space Systems in Downey, Calif., performed the engineering, design, manufacturing and exhaustive preflight testing of the Command and Service Modules.

Another major achievement was the design, development and construction of the huge second stage of the Saturn vehicle — 33 feet in diameter and 81.5 feet in height.

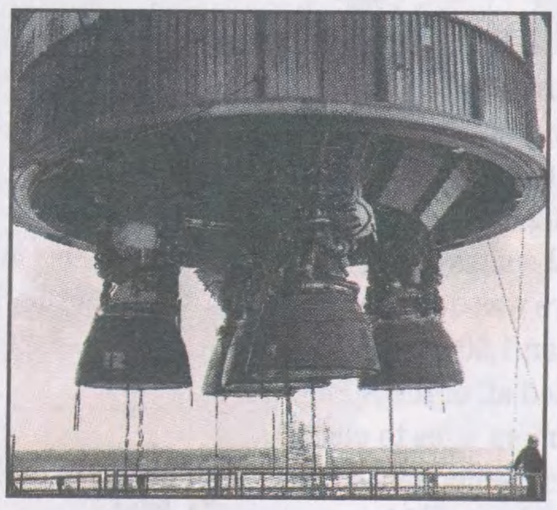
Rocketdyne: The energy behind the mission

By Paula Shawa and Tim Harmon

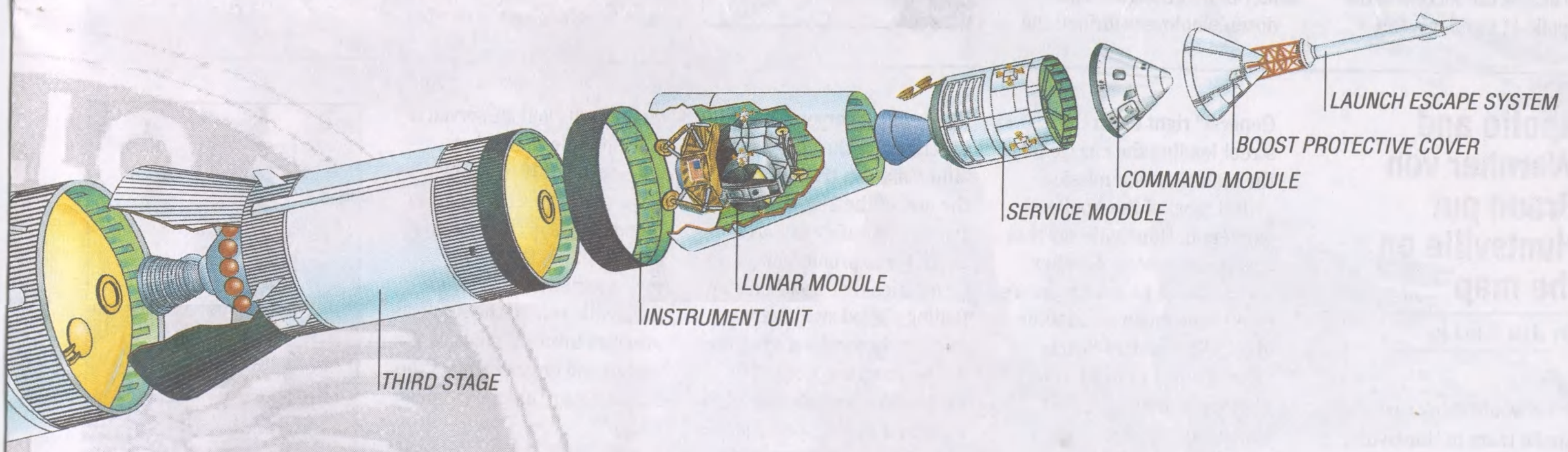
Rocketdyne Propulsion & Power engines literally started and brought to a safe conclusion the Apollo 11 mission.

Canoga Park, Calif., provided 30 Rocketdyne engines for the Saturn V launch vehicle and Apollo spacecraft, beginning at the base of the rocket with the F-1 engines that powered the first stage, and ending at the top with the reentry control system for the Command Module.

The primary propulsion for each of the three Saturn stages came from Rocketdyne: Five F-1 engines powered the first stage, firing for 2.5 minutes to lift the Saturn V to 38 miles altitude; a cluster of five J-2 engines boosted the second stage, allowing the Saturn V to reach an altitude of 115 miles and a near-orbit velocity of 15,400 mph; and a single J-2 in the third stage accelerated the stage and Apollo spacecraft into Earth orbit at 17,500 mph. The J-2 restarted for a critical second burn that hurled the Apollo spacecraft outward from the Earth at a velocity of approximately 25,000 mph to embark on the three-day journey to the moon, approximately 238,857 miles away.



Along with a number of smaller engines for the second and third stages, Rocketdyne also provided the ascent engine for the Lunar Module and the reentry control system for the Apollo Command Module. Unlike most of the vehicle and spacecraft propulsion systems, the ascent engine had no redundancy: If it didn't fire properly, astronauts Neil Armstrong and Buzz Aldrin would have been stranded on the moon.



Apollo Booster Specifications: Saturn V

Height (with Apollo)	363 feet
Maximum diameter	33 feet
Weight (flight ready)	6,200,000 pounds
Stages	3
Propellants — 1st stage	RP1 (kerosene), liquid oxygen
2nd stage	Liquid hydrogen, liquid oxygen
3rd stage	Liquid hydrogen, liquid oxygen
Maximum payload (low Earth orbit)	270,000 pounds
Maximum payload (trans-luner injection)	100,000 pounds
Maximum 1st-stage thrust	7,500,000 pounds
Engines — 1st stage	5 F-1
2nd stage	5 J-2
3rd stage	1 J-2
Saturn 5 horsepower	160,000,000

Saturn V Construction Record:

Total vehicles constructed	15
Unmanned flights	2
Manned Apollo missions	10
Skylab orbital booster	1
Backup units (later used as exhibits)	2

Kennedy Space Center: The massive infrastructure

By Ann Beach

Few remember the incredible human effort required to design and build the infrastructure that supported the Apollo program's spacecraft and launch facilities.

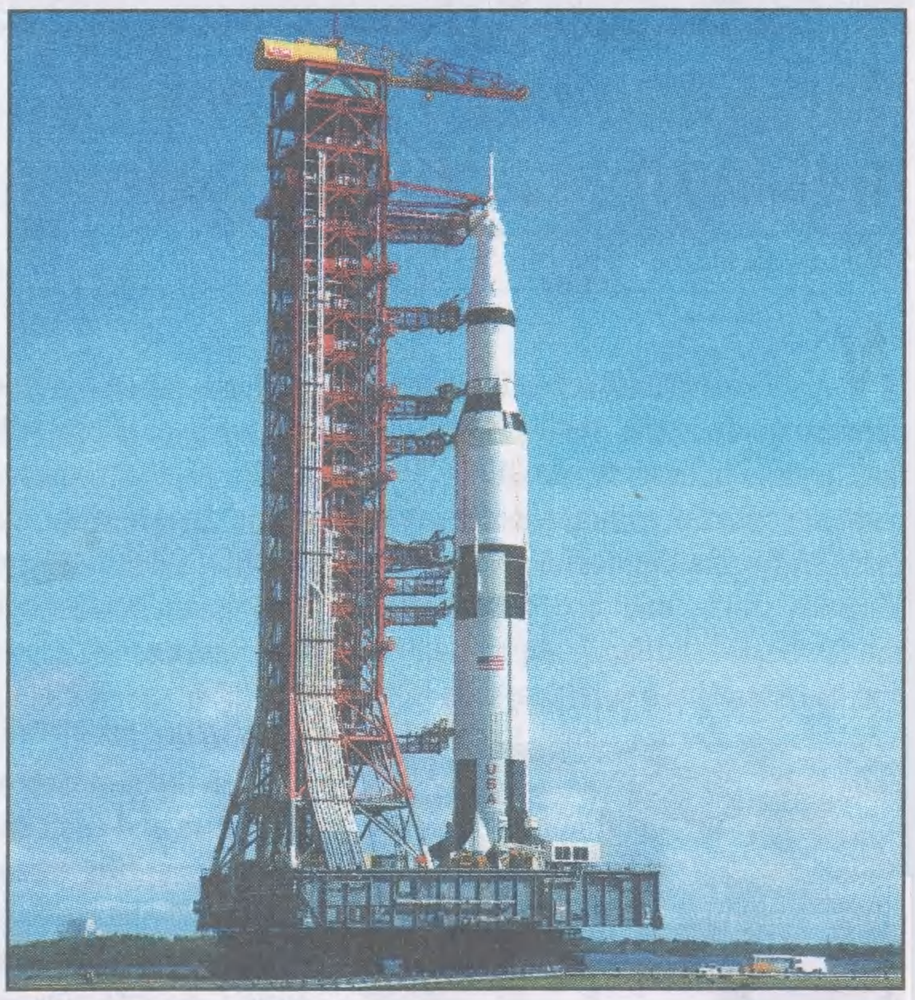
Long before 1969, thousands of engineers, scientists, architects and others began the work that led to building the complex of buildings, launch pads and transport vehicles to support Apollo.

Before sending the Command and Lunar Modules on their space journeys, engineers tested the pressurized spacecraft in one of two 33-foot-tall altitude chambers built in the Operations & Checkout Building high bay at Kennedy Space Center.

During those tests, the astronaut crew stayed inside the vehicle to operate the environmental and life support systems. When the Apollo program ended, the chambers were no longer used for testing, but one was recently renovated to accommodate pressurized elements of the International Space Station.

To accommodate the 363-foot-tall Saturn V, the largest vehicle ever flown, NASA constructed the 565-foot Vehicle Assembly Building, also at Kennedy Space Center, where the rocket could be erected in a vertical position. There, in one of the world's largest buildings by volume (129,482,000 cubic feet), the rockets were assembled on top of a mobile launch platform.

When completed, the platform and rocket rose more than 400 feet in the air and weighed 18 million pounds. The assembled vehicle and platform exited the building through one of four high bay doors that are each 456 feet tall and take 45 minutes to open.



Houston: Three great companies performing as one team

By Rhonda Hewitt

A spirit of cooperation was present three decades ago when workers representing Boeing, North American Rockwell and McDonnell Douglas teamed together in Houston, Texas, to ensure the success of the Apollo 11 moon mission.

In 1967, Boeing in Houston was awarded NASA's Technical Integration and Evaluation contract. With the goal of improving communications among the sites where hardware was developed, more than 1,300 employees integrated all of the Apollo development sites to ensure that each component of the space vehicle would perform as one when finally mated.

Equally important were events managed by McDonnell Douglas. Two dozen employees formed the Booster Flight Control team in Houston. Members of the team were stationed at the NASA Manned Spacecraft Center in Houston to monitor the systems on the large stages of the Saturn S-IVB rocket, used to boost the Apollo 11 spacecraft toward the moon.

McDonnell Douglas also managed the Apollo flight crew operations prime contract. In the event the Lunar Module became disabled during its return to lunar orbit, a backup Command and Service Module would assume operation. The 59-member McDonnell Douglas team helped build the Command and Service Module, developed its flight procedures, and trained all the crews involved in all of the Apollo missions landing on the moon.

North American Rockwell employees in Houston were involved in each stage of the Command and Service Module's development, including design, testing and flight monitoring. During Apollo missions, employees worked alongside NASA flight controllers in the mission evaluation room as subsystem specialists, monitoring and helping with problem resolutions.

Apollo and Wernher von Braun put Huntsville on the map

By Jim Keller

You would think that the Apollo team in Huntsville, Ala., would have found it intimidating to have "the General" right down the street leading the charge for the historic moon mission.

But most of the Apollo 11 workers in Huntsville say that wasn't the case of Wernher von Braun as he led America's race to the moon as director of NASA's Marshall Space Flight Center in Huntsville. They say von Braun didn't lead by intimidation, but more by being a hands-on, team player. Under his leadership, everyone knew exactly what the goal was…to land a man on the moon by the end of the 1960s and return him safely to Earth.

All three premerger companies that now make up Boeing played significant roles in Huntsville during the Apollo program. Rockwell/Rocketdyne provided development and test support for the powerful propulsion systems for the Saturn V rocket.

McDonnell Douglas served in a liaison role in helping develop the S-IVB, the last stage of the Saturn V. Boeing helped develop the first stage booster of the Saturn V rocket. Another significant Huntsville role in the Apollo program involved much of the design and engineering of the Lunar Rover Vehicle or "moon buggy."

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Douglas played a major role in this adventure of a lifetime: landing men on the moon. Today, Apollo is the single program that most graphically illustrates the strength of the new Boeing.

From October 1968 through July 1969, the United States launched five Apollo missions: Apollo 7 made the first manned Earth orbit; Apollo 8 made the first orbit of the moon; Apollo 9 and 10 tested the Lunar Module; Apollo 11 landed men on the moon. In 10 months, a team of more than 300,000 workers from 20,000 companies in 50 states focused their innovation, daring and speed on this unprecedented history-making effort.

Boeing built the first stage of the Saturn V launch vehicle, integrated the overall 363-foot rocket and designed the ingenious Lunar Rover Vehicle. North American Rockwell designed and built the Saturn V second stage and the Command and Service Modules; and its Rocketdyne division built all the main engines used on the Saturn V rocket. McDonnell Douglas built the Saturn V's third stage.

From any perspective, the Apollo program was a unique challenge of engineering and imagination. It was a problem-solving venture of the highest order — an achievement as yet unsurpassed. For a moment in time, the residents of Earth abandoned their conflicts and looked outward at the moon, where fellow humans left footprints on the previously untouched lunar surface.

Walter Cronkite summed it up this way in his recent book, "A Reporter's Life": "Of all of humankind's achievements in the twentieth century, the one event that will dominate the history books a half a millennium from now, will be our escape from our earthly environment and landing on the moon."

The new Boeing continues to imagine and plan for space-based exploits in the next century, including advances in science and technology derived from the International Space Station, the commercial development of space, and further exploration of the solar system and the far reaches of the universe.