"We choose to go to the moon in this decade . . ."

The small steps leading to the ' 'giant leap'' of Apollo 11 actually began with Project Mercury as the nation developed the technology to launch a man into earth orbit and bring him back safely. Step two was made by the Gemini Program as techniques for rendezvous and docking—essential for successful lunar landing missions—were perfected in earth orbit.

As the Apollo spacecraft came down the production pipeline, mission planners designed progressively more complex flights that would be way stations on the road to Tranquility Base. The road was not without setbacks, for on January 27, 1967 a fire aboard Apollo command module 204 during pad tests took the lives of Virgil I. Grissom, Edward H. White II, and Roger Chaffee—the crew that was to have flown the first manned Apollo mission.

After extensive redesign to lessen the probability of fire aboard the spacecraft, the first manned Apollo mission was launched in October of the following year. In a 10-day earth orbit flight, the Apollo command/service module was thoroughly wrung out by Walter Schirra, Donn Eisele and Walter Cunningham. The mission emphasized test-

(*Continued on Page 3*)

Has it really been five years?

Amid all the platitudes uttered about man's basic need to cross new frontiers, broaden his horizons and joust with the unknown, there was and is an overriding feeling among people around the Earth that Apollo 11 was more than an achievement of American technology. And, indeed, the first lunar landing was more than a simple vicarious sharing via Eagle's television camera of an adventure never before experienced by homo sapien.

Our descendants likely will venture to Earth's sister planets—if not in the twentieth century, perhaps in the twenty-first—but the landing at Tranquility Base will forever remain as the point in human history when earthman truly became Universal Man. The first men to land at Pandorae Fretum on the Martian surface will face dangers and Earth-breakaway far greater than those experienced by Apollo crews, but they will not have been the *first* to walk on another celestial body.

Millions of words, in news dispatches, editorials and telecasts described Apollo 11 as it was happening and attempted to set in perspective the significance of the flight after Columbia splashed down in the Pacific. The New York *Times*' John Noble Wilford, in his book *We Reach the Moon*, perhaps best captured the essence of Apollo 11 when he wrote:

''The true assessment of Apollo's significance may not be forthcoming for decades or centuries. Columbus could not see beyond the gold and spices he sought. Neither can we see with any assurance beyond the prestige, power and scientific knowledge that were the treasures sought for their nation by Armstrong, Aldrin and Collins...

''To reach the moon, to see the earth as a small planet—such extensions of man's dominion over nature cannot help but to have an impact on his image of himself and of what he can do. This is the hope and promise of man's first voyage to the moon. For Apollo, whatever its place in history, showed what remarkable achievements a society can accomplish, given adequate leadership, national resolve and personal courage.''

Showing his awareness of what Apollo 11 meant, Neil Armstrong said, ''I see it as a beginning, not just this flight, but in this progam which has really been a very short piece of human history—an instant in history—the entire program. It's a beginning of a new age.''

". . . landing a man on the moon and returning him safely to the earth . . "

Another assessment of Apollo 11 was made in a Philadelphia *Bulletin* editorial: ''Apollo 11 was programmed to reward hard work, reaffirm the nation's faith in the free enterprise system, so bright with promise for mankind, and redeem the late President Kennedy's commitment to the most hazardous and dangerous and greatest adventure on which man has ever embarked...'

''And second by second, over 195 perilous and fateful hours, it was all achieved.

''Surely, in all the 50,000 years of recorded history, never was so much required of a nation in so short a time.

''Never did a nation respond more fully.''

There are opposing points of view today about whether the nation should now be building Mars landing modules, and perhaps preliminary design studies for starships, or whether we should continue to focus space technology inwardly toward the damage man is doing to the only planet he has—for now.

However the priorities finally sift out, the inspiration and excitement caused by the Apollo 11 adventure will not soon be forgotten. The voyage to Tranquility Base moved poet Archibald MacLeish to write:

Three days and three nights we journeyed,
steered by farthest stars, climbed outward,
crossed the invisible tide-rip where the floating
dust falls one way or the other in the void between,
followed that other down, encountered
cold, faced death—unfathomable emptiness...

Then, the fourth day evening, we descended,
made fast, set foot at dawn upon your beaches,
sifted between our fingers your cold sand.

"Now it is time to take longer strides . . ."

Even before President John Kennedy set the goal for a manned lunar landing before the end of the sixties, space flight beyond earth orbit was a gleam in the collective eye of planners in the National Advisory Committee for Aeronautics (NACA), the Army Ballistic Missile agency and other groups charged with getting the country into the space business. Project Mercury was well into the development stages at the time, but the idea of traveling in space to the moon or beyond in multi-man spacecraft had captured the imagination of the small group that would become the cadre of almost a half million people in government and industry at the peak of the Apollo effort.

While booster designers began the first studies of the Saturn family of launch vehicles, spacecraft designers had leapfrogged past the single-set Mercury capsule to what, at that time, was called the Advanced Manned Spacecraft—a three-man spacecraft capable of leaving earth orbit and carrying a crew to the moon and back. The Advanced Manned Spacecraft was renamed Apollo in July 1960, and in May 1961 President Kennedy asked Congress for an accelerated space program and set the oft-quoted decade goal.

Feasibility studies of how best to mount an expedition to the moon ranged from direct ascent with a superbooster to multiple launches of Saturn I boosters, each carrying segments of a lunar vehicle. Out of the myriad of studies emerged the Saturn V booster development program, while in the spacecraft area the direct-ascent scheme was discarded in favor of lunar orbit rendezvous, and the Lunar Excursion Module (later shortened to Lunar Module) was born.

While the command module design firmed up fairly rapidly around the familiar conical shape, the lunar module underwent growing pains. Graceful curved shapes in the ascent stage gave way to more pratical angular shapes, and one LM's five legs was amputated to make her a four-legged beast.

An exhaustive fly-and-fix test program for both the booster vehicles and the Apollo spacecraft modules was carried out at the same time rendezvous and docking methods were perfected in earth orbit by the gemini program. Apollo test flights ranged from command module pad abort launches at White Sands, New Mexico to a ground-controlled earth orbit flight of the lunar module which proved the performance of the two engines for landing on and lifting off the lunar surface. Included in the unmanned tests was a Saturn V launch which culminated in a command module being driven back into the atmosphere at near-lunar return spped to qualify the heatshield.

The planners of Apollo did not forsee the uses for the spacecraft beyond the lunar landing flights at the time they first focused on the decade goal. New opportunities for the Apollo command/service module came with the Apollo Applications Program—later renamed Skylab—in which the spacecraft would be called upon to lie dormant for long periods while docked to the nation's first orbital space station.

Six years after the landing at Tranquility Base, the Apollo spacecraft system will still be carrying men into space as half of the joint United States-Soviet Union Apollo-Soyuz Test Project.

And there are *three* spacecraft left.....

After being the first men on the moon, what do you do for an encore?

Former X-15 test pilot Neil Armstrong came into the Manned Space Flight program in the second group of nine astronauts selected in September 1962, while Edwin E. Buzz Aldrin and Michael Collins were in the third group, selected in October 1963. All three had Gemini missions behind them when they were pulled together to form the Apollo 11 crew and began training for the first lunar landing. The flight is history.

After the last piece of confetti had hit the pavement and all the world tours and public appearances were over, Armstrong, Aldrin and Collins either went briefly into management assignments in NASA or remained on the roster of active astronauts.

Today, all three have moved on to other phases of their careers.

Armstrong is on the engineering faculty of the University of Cincinnati as a professor of aeronautical engineering. Aldrin is in the engineering consulting business and lives in the San Fernando Valley on the outskirts of Los Angeles. Collins is now director of the Smithsonian Institution's National Air and Space Museum in Washington, D.C.

Collins is in a good position to keep an eye on the faithful Apollo 11 command module Columbia, for the spacecraft is on permanent display at the Museum, resting under the Wright biplane and the Spirit of St. Louis. A new home for the Museum is under construction on the Mall across from NASA Headquarters, and is scheduled to open on July 4, 1976 during the Bicentennial celebration. Columbia went on a tour of all 50 state capitals aboard a special van before going on display at the Museum. As command module pilot, Collins spent the entire mission period aboard Columbia while his crewmates aboard Eagle descended to land at Tranquility Base.

Lunar module Eagle, unfortunately, could not be returned as a space exploration artifact. The descent stage will sit forlornly for eons guarding the footprints in the dust at Tranquility Base, and the ascent stage was jettisoned into lunar orbit after bringing Armstrong, Aldrin and the first chunks gathered from another celestial body back to rendezvous with Columbia.

Academic life appears to agree with Neil Armstrong, left, as he chats with colleagues on the University of Cincinnati campus. At right, Mike Collins answers questions from children examining the Apollo 11 command module Columbia at the Smithsonian Institution National Air and Space Museum, where Collins is director. Aldrin (inset) is an engineering consultant in California.

"scientific exploration of the moon and planets . . . should be the ultimate objective . . !

Before Galileo first peered through his primitive telescope in 1609 to provide man's first accurate picture of the moon as a planet with mountains, valleys and plains, scientists of his era were convinced that the moon was a smooth crystalline sphere or a lantern-like body with internal fires gleaming through surface holes.

Conjecture and speculation about what the moon was really like grew with each new advance in telescope technology, but it was not until unmanned lunar probes, such as the Soviet Union's Luna series and the United States' Ranger, Lunar Orbiter and Surveyor spacecraft flew around and onto the moon that the true nature of the moon began to be revealed.

Unmanned spacecraft answered many questions about the moon but many other questions remained unanswered: Does the moon have a crust like earth's? Are the craters caused by impacts or are they volcanic? How old is the moon? Is the lunar interior hot or cold? Was there ever water on the moon?

Apollo 11's prime objective was to "perform a manned lunar landing and return." The crew of Eagle not only brought themselves back, but also brought back chunks of the moon for study back on earth after leaving an early version of a scientific station at Tranquility Base. These moon fragments and experiments, and those from the five visits to the moon that would follow, showed that the center of the moon's mass is on the side near the earth, that the moon was hot at some time and may be still hot at the core, that the moon's chemical composition is similar to earth's but in different proportions and that the moon was formed more than four billion years ago. *How* and *where* the moon was formed remains unanswered.

Further study of lunar rocks show that there was little or no water present when the rocks crystalized, nor had they been exposed to water since they were formed. Absence of water, coupled with an extremely low carbon content in lunar materials and complete absence of organic compounds, lead to the conclusions that life never began to evolve on the moon.

JSC's director of Science and Application Tony Calio wrote in the introduction to the *Apollo 17 Preliminary Science Report:*

"A storehouse of resources has been returned from the moon: almost 385 kilograms of lunar materials (obtained from six different landing sites on the near side of the moon), 37 drive tubes, and 20 drill stems. To date, only 10 percent of this lunar material has been examined in detail.

Approximately 33,000 lunar photographs and 20,000 reels of tapes of geophysical data have been collected. Thus, in four years of lunar exploration, our knowledge of lunar characteristics has been substanially increased, and vast resources of scientific data have been collected that will lead to a decade of data analysis.

"In the past decade, there have been two revolutions in planetary science studies. There has been a revolution in the new global tectonics describing the motions of continents and the generation and destruction of the sea floor. The Apollo program has lead to a revolution in providing the first deep understanding of a planet other than the earth through the development of new techniques of exploration, investigation, and analysis, and through the integration of the Apollo Program provided earth scientists with four years of anxiety, excitement and fulfillment. Apollo lessons may force a reconsideration of many of the techniques and models that currently used in understanding the early history of the earth.

"In decades to come, the analysis of Apollo data may indeed lead to a polar orbital flight around the moon or to a lunar base where men may explore the entire surface of the moon."

The moon, perhaps more than any other body in the solar system, can be a Rosetta stone for interpreting the early history of our sun and its planets. Our growing knowledge of the moon's surface and its early information will allow us to infer things about the structure and history of our own planet's crust, from which we draw nearly all the resources that support human life and progress.

small steps to giant leap

(*Continued from Page 1*)

ing of not only the basic spacecraft systems, such as environmental control, but primarily was for testing of the service propulsion engine that would be so critical in getting the Apollo lunar stack into and out of lunar orbit.

Perhaps the most daring of the steps taken toward the lunar landing goal was to "go for TLI" with Apollo 8—the second manned flight of the Apollo spacecraft and the *first* manned flight using the new Saturn V launch vehicle. Frank Borman, James Lovell and Bill Anders became the first humans to leave earth orbit and cross the quarter-million mile void to get a close look at the "dirty beach sand" of our planet's satellite—and also be the first to view the entire sphere of the earth from space. Few will soon forget the Christmas Eve 1968 telecast from Apollo 8 as the bleak, forbidding moonscape slid beneath the spacecraft while the crew read from Genesis.

Gumdrop and Spider became familiar call signs during March 1969 as James McDivitt, David Scott and Rusty Schweickart put lunar module Spider through the maneuvers in earth orbit that would be critical to a successful landing that summer. Apollo 9 was the first of two landing rehearsals using the all-up Apollo command/service module and lunar module.

The second rehearsal in May took Tom Stafford, John Young and Gene Cernan "down among the boulders" in a realistic precursor to the landing that included everything but an actual landing. Stafford and Cernan flew Apollo 10 lunar module Snoopy down to within nine miles of the lunar surface in a reconnoitering sweep over the Sea of Tranquility while Young orbited 60 miles above in command module Charlie Brown.

It remained for Armstrong, Aldrin and Collins to take up where their forerunners left off by making that final step and giant leap on July 20, 1969. A new benchmark in the history of man was etched when the blue Lunar Contact lights in Eagle's cabin lit up, and flight controllers in Mission Control breathed easier as Armstrong radioed, "Houston, Tranquility Base here...."

APOLLO 11 FIFTH ANNIVERSARY
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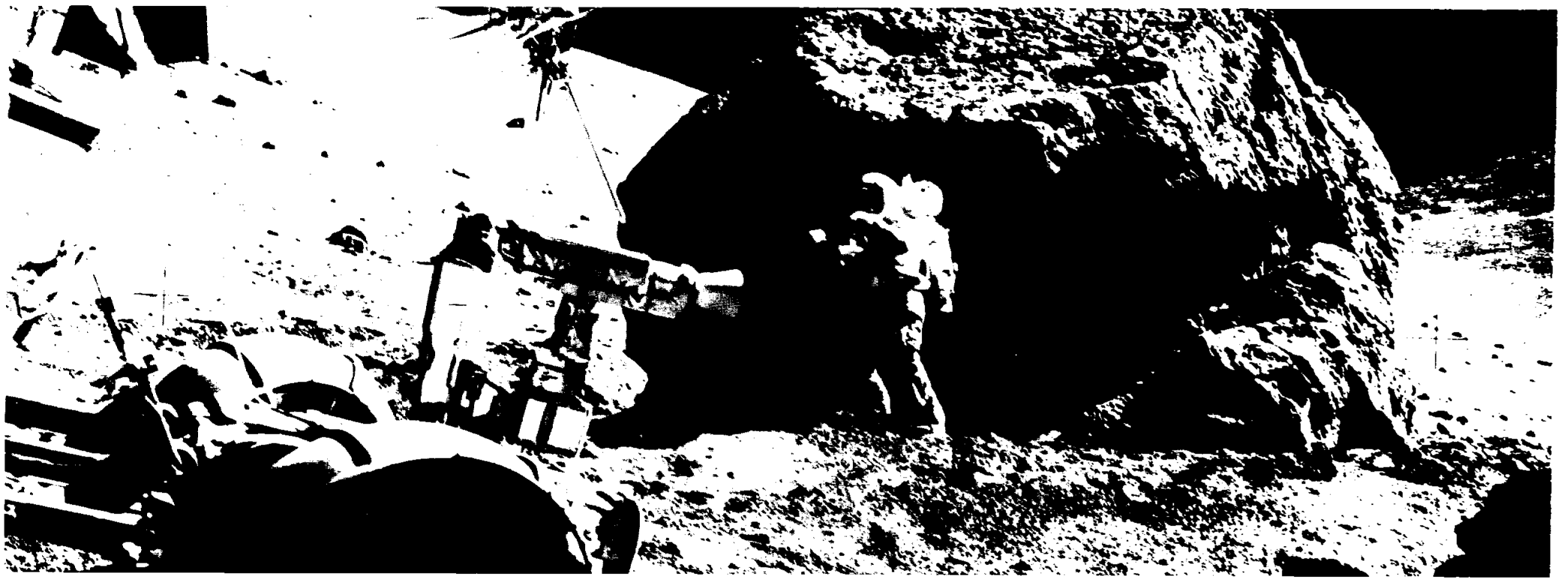
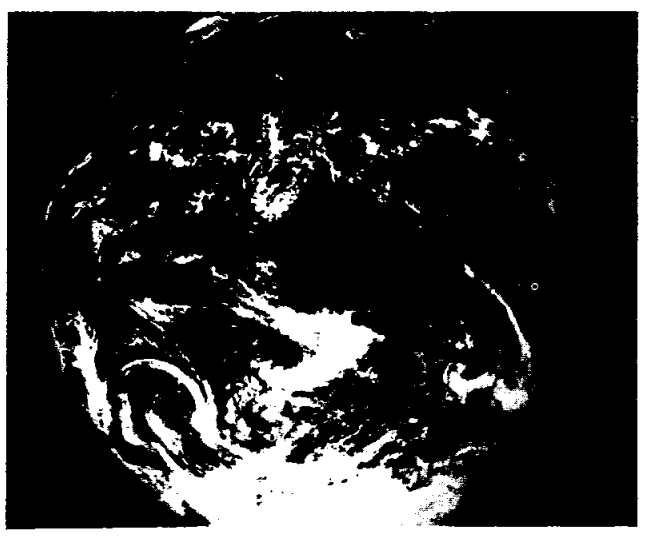


Apollo 11 met the goal by proving that the nation could land men on the moon and bring them home safely, but the extensive exploration and sampling of the lunar surface at widely-varying sites were carried out by the five landing crews that would follow.

Scientific experiment stations left at the landing sites became progressively more sophisticated, EVA periods became longer and went first to two periods each mission and then to three. The final three landing crews had far-ranging mobility to explore features beyond the close lunar horizon which was provided by a combination of the electric-powered Lunar Roving Vehicle and suitcase-size communications gear that allowed voice and data flow directly to earth without dependence upon relay through the lunar module.

Continual refinement of guidance techniques through the Apollo 10 and 11 experience brought pinpoint landing to full maturity in November 1969 when the Apollo 12 lunar module Intrepid touched down less than 200 meters from the targeted landing site—the Surveyor III spacecraft which had had sat for almost three years on the inner slope of a large crater in the Ocean of storms.

While command module pilot Dick Gordon passed overhead aboard Yankee Clipper every two hours, Apollo 12 commander Charles "Pete" Conrad and lunar module pilot Alan Bean made two EVAs around the Surveyor Crater site emplacing the first Apollo Lunar Surface Experiment Package (ALSEP) and snipping off portions of the Surveyor spacecraft TV camera system for analysis back on earth.



Apollo 13 started off well enough that April Day in 1970; launch and translunar injection went like digital clockwork, but two-thirds of the way to the moon an explosion in Odyssey's service module changed the outlook from one of lunar landing to one of survival.

As life-giving oxygen and electrical power drained from Odyssey over the next several hours, lunar module Aquarius was converted from an exploration vehicle to a lifeboat. She bouyed the shipwrecked crew of james Lovell, Fred Haise and Jack Swigert to earth on a free-return sweep past the moon, sustaining them until the dormant Odyssey was wakened to bring them through the atmosphere and home.

After Aquarius was bade farewell, there was a hiatus in lunar missions while the causes of the explosion aboard Odyssey were sought. Fixes were made in the service module cryogenic storage tanks and in January 1971 exploration of the moon began again.

Apollo 14 lunar module Antares, piloted by Alan Shepard and Ed Mitchell, landed in what had been the Apollo 13 landing site-the Fra Mauro region. Shepard and Mitchell erected the second ALSEP and investigated the geology of the area during two EVA's, assisted by a wheelbarrow-like carrier for the instruments and geology tools. Before closing Antares' hatch for the final time, Shepard drove a golf ball with a makeshift club down the Fra Mauro fairway for another space first. Stu Roosa kept a vigil in orbit aboard command/service module Kitty Hawk while waiting for the explorers to return from the surface.

High mountains and a deep canyon made the Apollo 15 landing site perhaps the most spectacular of all. Lunar module Falcon, flown by Dave Scott and Jim Irwin, settled down to a landing in a valley between peaks of the Apennine range and near the meandering Hadley Rille. Scott and Irwin were the first crew to be equipped with the electric-powered lunar roving vehicle, and the J-mission LM allowed much longer stay-times on the lunar surface.

Like Padre Island campers in a dune buggy, Scott and Irwin loaded their geology instruments and tools aboard the rover and roamed at speeds up to 10 kilometers an hour to the base of the mountains and to the edge of the rille in three EVAs.

Command module pilot Al Worden was more than a spacecraft caretaker in lunar orbit, for the Apollo 15 service module was fitted with an extensive array of scientific and photographic instruments and a subsatellite to be cast into orbit around the moon for gathering magnetic field data. During the trip back to earth, Worden made the first transearth EVA to retrieve film casettes from the scientific instrument module (SIM) bay.

The final two Apollo lunar landing missions were similar in equipment and objectives to the first J mission: Rover for mobility, a LM campable of sitting for three days on the moon, three EVAs, and gathering of orbital science data with SIM-bay instruments.

John Young, Ken Mattingly and Charles Duke were assigned to the Descartes landing site. While Mattingly went about his orbital science tasks aboard Casper, Young and Duke descended to Decartes in Orion to log more than 20 hours EVA time and 27 kilometers travel in the Rover.

Gene Cernan and geologist Jack Schmitt likely were the last Americans to set foot on the moon for years when they closed out their final EVA from lunar module Challenger at the Taurus-Littrow landing site. Before rejoining command module pilot Ron Evans aboard America, Cernan and Schmitt gathered 115 Kilograms of lunar samples—including the high-glass content "orange soil" which excited not only Schmitt, but the investigators back in the Lunar Receiving Laboratory.

As last man on the moon Cernan reflected on the meaning of it all after his return to Earth: "Perhaps the moon can tell us something about the possibilities of the existence of some ancient civilization—not necessarily on Earth or on the moon, but possibly within our own universe. The moon, relatively untouched for perhaps four billion years, has been a part of the learning process of what is behind us, and perhaps also what is ahead of us."

Behind the six crews that landed on the moon are five surface scientific stations that still relay data to scientists on Earth, and the heritage of Apollo will answer questions about the geophysical makeup of our spacecraft Earth, as well as about our nearest neighbor, for years to come.

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