



Harrison Storms Bio and the story of Downey's role in the Space Race

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Harrison Allen 'Stormy' Storms Jr American Engineer. Born 15 July 1915. Died 11 July 1992. North American engineer managing the X-15, XB-70, and Apollo projects.

Storms grew up in Chicago, the son of a traveling salesman for Gilbert and Bennett door-wire. His mother was deeply involved in community activities to compensate for her husband's absence. In common with many boys of his generation, Storms caught the aviation bug, which he vented in producing exquisite airplane models. After his picture appeared in the *Chicago Tribune*, he was hired by the parks department to teach other kids model building for \$5 a night. He wanted to be an artist or doctor, but his father steered him into engineering. He met his future wife in college, and she inspired him to become serious about his studies. He graduated near the top of his class in aeronautical engineering, and was accepted by Caltech for graduate school. He married, and brought his wife with him to Pasadena.

To help pay for college, he worked nights at the Caltech wind tunnel. There he performed work for the various Los Angeles aviation companies. His dedication in solving an aerodynamic problem with the engine cooling intake for the P-51 Mustang caught the attention of Ed Horky, an engineer at North American Aviation. Storms joined North American, and as Horky climbed up the engineering management ladder, Storms went with him. Dutch Kindelberger and Lee Atwood, the team that ran North American, were impressed with Storms, who mixed a measure of artistic temperament with his engineering skills.

Storms contributed to the North American fighter designs that made it the premier combat aircraft maker of the 1950's - the F-86 Sabre and F-100 Super Sabre. In 1957 he was named Vice President and Chief Engineer of North American's Los Angeles Division, responsible for the company's bomber and fighter business. At that point the most important corporate priority was moving into the transonic arena, and Storms designed,

pitched to the government, and sold the aerodynamically-similar F-108 Rapier interceptor and B-70 bomber. It was a clean sweep of the most important Air Force design competitions of the late 1950's. These two designs were to have become the basis for the Air Force of the 1960's. The defeat of Boeing in the B-70 competition was especially unprecedented. North American, and Storms, were riding high as the premiere contractor to the US government.

One contract Storms had won for North American that his management was not happy with was the NACA order for three X-15 experimental suborbital spaceplanes. North American wanted high-volume aircraft production contracts, not relatively tiny development projects with minimal profits. But Storms saw that after Mach 3, the next step in aviation was outer space. And the contract taught him how to work with NACA, which was very different from the Air Force.



The Air Force set very broad requirements for its aircraft (range, warload, top, cruise, and landing speeds, etc) and then relied on the creativity of the engineering teams at the competing aviation companies to find the aerodynamic and technical solutions. NACA was run by aerodynamicists who set out the aerodynamic solutions and even specified materials, internal systems, and powerplant designs in detail. They expected the contractor only to do the detailed design, development, and construction to those detailed requirements. This went the entire grain of the aviation industry.

But Storms saw the way NACA worked, and the way to win the competition. Cater to every detailed technical wish of NACA precisely. If you believe their technical decisions are incorrect, provide what you believe is a better solution as an alternative, but make sure your baseline proposal meets their design and detailed requirements in every way. Do not allow your own engineers to propose their own design at variance with NACA's requirement.



It was these principles that won Storms the contract for the X-15, and would help him win the other major manned spacecraft contracts of NASA, NACA's successor, in the future. Storms led the company's proposal effort for the Mercury manned space capsule, but he couldn't convince his management that this was an important project for the company. McDonnell, under the personal leadership of its eponymous founder, put its entire corporate resources behind the proposal, and ended up winning. Storms vowed to get it right next time, and his bosses realized their mistake as space seized the imagination of the American people. Congress responded and space became a larger and larger proportion of government expenditures.

In November 1960 Storms, having brought his Los Angeles Division more development contracts than they knew what to do with, was asked to take over the nearly-defunct North American missile division in Downey. Since 1947 the division had been developing the Navaho, a Mach-3 intercontinental cruise missile. The Navaho had originated as an American version of the German A9 winged version of the V-2. In a decade of development, it had changed from intermediate to intercontinental range, from rocket boost-glide to rocket boost/ramjet cruise. In the process North American had become the pre-eminent company in rocket engines, for the booster rockets, and inertial and stellar navigation, for the guidance system.

Entire North American divisions - Rocketdyne, in Canoga Park, for the engines, and Aeronutronics, across the parking lot from the missile division in Downey - had been created to support the mammoth project. But by the time the enormous development work was completed, and the subscale

Santa Susana field lab nuclear laboratory, test firing of missile.



prototype version of the system was in flight test, the simpler rocket-powered Atlas intercontinental ballistic missile, powered by the same Rocketdyne engines developed for Navaho's boosters, was nearing flight test. Atlas was cheaper, smaller, and nearly invulnerable to interception. So Navaho was cancelled.

But in the course of the project North American had developed the Mach 3+ high speed flight aerodynamics and structures experience that was instrumental in winning the F-108, B-70, and X-15 programs; the division had become the leading rocket engine builders, with Aerojet only a second source; and Aeronutronics was one of the two major inertial navigation makers (the other being Northrop, which had to develop a similar system for its Snark subsonic intercontinental cruise missile).

With the loss of Navaho, the only work in the plant there was the final production of the Hound Dog, an air-launched cruise missile. But Navaho had delivered into Storms' hands the perfect technical tools and qualifications needed to make North American the leading space contractor. Storms wheedled millions out of the his bosses to renovate the plant, to install impressive executive and presentation rooms which he knew were essential to impressing the government officials and making North American a credible potential contractor.

By the Kennedy announced the Apollo program to land on the moon, Storms had positioned the Space Division well. First he managed to win the S-II second stage of the

Saturn V moon rocket. This gigantic stage was nearly as large as the first stage, but one third the fuel mass, since it used the then-unflown cryogenic propellants liquid hydrogen and liquid oxygen. The stage had to carry those propellants in tanks and push them with engines that could total no more than 7% of the total stage mass. To meet this objective, Storms proposed a common bulkhead between fuel and oxidizer tanks and the use of internal insulation. The approach won him the contract, but when the competition for the Apollo spacecraft itself came up, he had already exhausted the division's proposal funds.

He went to corporate management and asked for additional funds to make a proposal. They were still against committing the company in this new area, divorced from their traditional aircraft business, but gave the green light for Storms to spend a million bucks on the proposal. Even though North American had not even won earlier Apollo study contracts - they had been awarded to Martin, Convair, and General Electric - he bet his career on winning the Apollo spacecraft. He spent five times the amount the corporation had authorized to produce a credible proposal, trusting that with the lag in the company's accounting system this would not be noticed until he had either won or lost the contract.

His approach of kowtowing to NASA's technical directions almost carried the day - North American came in a close second behind Martin in the official source evaluation board score. The other bidders had carried over much of their own approaches from their earlier design studies into their final proposals. But still Martin was first, and loudspeakers at the Martin plant announced to the staff that they had won the Apollo contract.

But the reputation of North American carried the company over the top to the award by the time it was publicly announced the next day. North American, and Storms were the premiere manufacturer of Air Force jet fighters in the United States. They had won and were developing the Mach 2.5 A-5 naval attack aircraft, and the Mach 3 F-108 fighter and B-70 bomber. NASA felt Storms' work had been outstanding on NASA's own X-15. Storms was a close personal friend of NASA's Bob Gilruth since they were both young engineers, trying to solve a P-51 Mustang aerodynamic problem in World War II.

By comparison, Martin had no significant aircraft in production. Its last major product line, flying boats, had become extinct. Its recent experience was the Vanguard orbital launch vehicle (which had humiliated the United States by blowing up on the pad when trying to match the Soviet Sputnik) and the Titan ICBM (which was a secondary backup to the Atlas). So the astronauts, the NASA administrator - all ex-fighter pilots - and the NASA technical staff - fans of the X-15 work - all believed North American to be more credible.

After the Apollo fire, a story came out that there had been a dark corrupt aspect to the award as well. North American's lobbyist, Fred Black, was intimately connected with

Committee hearing on the
Bobby Baker investigation,
May 12, 1964



Bobby Baker, special assistant of Lyndon Johnson, and also Senator Bob Kerr, chairman of the Senate space committee, as well as political mentor of NASA administrator James Webb. Baker was also connected with the Mafia, and the word from Black was that the North American's NASA proposal would be favorably considered if they gave the vending machine concession in their sprawling factories to a certain Mafia-connected vendor. This advice was duly followed. But it strains credibility that such a decision would be thrown on a presidential level over a vending machine contract; and of course whatever similar concessions the losing bidders may also have been required to make is lost to history.

Storms bulldogged the Apollo program with his usual rough management methods. Those working for Storms had to learn to talk back to his personal verbal assaults. Once they had stood their ground, Storms let up. But he was an unparalleled leader in getting his lower management and troops to execute. But even Storms couldn't manage two programs of this magnitude. The S-II program was moved to a separate division and a new factory on the Pacific for manufacture of the enormous stage (which was then transported by barge through the Panama Canal to Cape Canaveral).

Storms oversaw an expansion of his workforce from 7,000 to 30,000, and raided the aerospace industry for the top-quality engineers and managers he would need to get the whole thing organized. Almost immediately the heavy hand of NASA supervision and micromanagement - and endless changes - to the design were felt. This way of working was very different from that of the Air Force, and very difficult for the North American engineers to accept.

The very first controversy was the cabin atmosphere for Apollo. North American felt a pure oxygen atmosphere was too dangerous; but NASA demanded it nevertheless. Contract Change Notice Number One for the Apollo spacecraft, drawn up at Storms' insistence, ordered North American, in writing, to provide the capsule with a 5 psia pure oxygen atmosphere.

The next major point of contention was the hatch. North American wanted to provide a hatch that opened outward, and could be blown by explosive bolts, to allow quick crew egress in an emergency. NASA was more worried about the pressure integrity of the spacecraft on the long lonely trip to the moon and back, far from any quick return to earth. They wanted a hatch that opened inwards, and would be self-sealing by the internal cabin pressure (but unopenable), even if unlatched. There was no way NASA wanted an explosive hatch that could conceivably go off in some way in the middle of deep space. Astronaut Gus Grissom, who claimed the hatch on his Mercury mission "had just blown", was also pushing for the inward-opening hatch. So another of the early

change orders instructed North American to provide a capsule hatch according to NASA's wishes.



ON CAMERA — Division President Harrison Storms, right, is interviewed by CBS-TV reporter Bill Stout in Simulation Center during S&ID portion of network space program presented Monday. Title was "T-Minus Four Years, Nine Months, 30 Days."

The original contract had been issued without NASA knowing the way the spacecraft was going to get to the moon - the "mode debate". The assumption for the original design was that it would use the "earth orbit rendezvous method". A first launch of a Saturn V would place a gigantic trans-lunar injection stage into low earth orbit. A second launch would place the Apollo, with the rocket stages and landing legs attached, necessary to land directly on the lunar surface and then return to earth.

There were however factions inside NASA and the President's office that wanted either a smaller, two-man version of Apollo that could be sent to the moon and back in a single Saturn V launch. Others wanted to make a single Saturn V launch of the existing Apollo capsule together with a detachable small "lunar excursion module". The Apollo would place itself and the LEM in lunar orbit, but the LEM would take two of the crew to the lunar surface and then back up to the Apollo for the trip home to earth. After a year of contentious debate, the LEM alternative was chosen. Storms fought the decision, since it meant "his" spacecraft would not actually land on the moon any more; but he was finally ordered by NASA to lay off. He then attempted to bid on the LEM contract; but was again told to forget it, North American already had too much of the Apollo pie as it was. Grumman ended up building the LEM that would take Americans to the lunar surface while Storms' spacecraft remained above in lunar orbit..

The continual detailed design changes by NASA engineers and astronauts led to venomous conflicts between NASA and Storms. NASA's quality and traceability standards were also unprecedented, and difficult for engineers and workers trained in Air Force and Navy practices of the 1950's to accept. The result was constant tension and claims for contract cost increases from North American. Every NASA change meant delay, rework of spacecraft already built, and scrapping of materials or equipment already fabricated. And meanwhile Storms was being held to the original program schedule, necessary to meet Kennedy's promise to land on the moon before "the decade was out"... which translated to first flight of the Apollo spacecraft by November 1966.

Storms had been running his career full throttle since World War II, with long days and working weekends which left little time for his wife and kids, ensconced in a nice home in Palos Verdes. When North American founder Dutch Kindelberger died in August 1962, it turned out that there would be no room for his long-suffering wife in the funeral

entourage. She attempted suicide, giving Storms the final wake-up call to the shambles his personal life had become. Storms paused briefly; bought his wife a new house which he supposed would placate her; and then drove ahead with the Apollo development just as hard as ever.

In September 1965 Storms paid the ultimate price for his drive. He suffered a heart attack following a crisis over failure of the S-II stage during a proof test. They could keep him in the hospital for only two weeks, before he checked himself out and returned to the plant. NASA was demanding Storms' head, as well as that of his lead managers, over the stage failure. After North American corporate officers reviewed the situation and discovered the situation created by NASA's continual change orders and demands for weight reductions, they backed Storms. But to placate NASA, somebody's head would have to roll. After fighting the matter for weeks, Storms finally agreed to replace the S-II project manager, Bob Parker, with a retired Air Force officer liked by the NASA Tiger Team, Bob Greer. In a tacit admission of the political nature of the change, Parker's competence and key role, Greer kept Parker on as his second-in-command.



COMMENDATION — Harrison Storms, S&ID president, accepts Certificate of Commendation on behalf of S&ID. Award was made Tuesday night by Downey Mayor Stephen Skinner as highlight at premiere of film, "With Their Eyes on the Stars."

Apollo development, driven by Storms and Joe Shea on the NASA side, continued at the mad pace necessary to meet Kennedy's deadline. Finally, in January 1967, after construction of 20 mock-ups, 22 boilerplates, 8 "Block I" spacecraft prototypes, and two successful unmanned test flights, the first manned Apollo was nearly ready for launch. A final run-through was being conducted on the pad with the crew aboard. For the test, the cabin was pressurized to 1.1 atmospheres with pure oxygen - compared to the 0.3 atmospheres pressure it was designed to operate at.

Oxygen at this pressure made almost anything highly flammable, but these kinds of tests had been conducted throughout the Mercury and Gemini programs without incident.

A cable sparked, a fire developed, and the crew died of smoke inhalation before they could get their non-explosive hatch opened. At first North American figured they were covered, since they were only executing NASA's specific design instructions.

But facing increased government expenditures for Vietnam and President Johnson's social programs, NASA had already faced weakening political support. The fire brought the critics out in droves. They unearthed NASA's Tiger Team report at the time of the S-II problems. Disgruntled quality inspectors told stories of intentional shoddy work (later found to be untrue). The vending machine issue, with the Bobby Baker, Lyndon Johnson, and Mafia connections was dredged up. NASA administrator James Webb - just barely - managed to keep the Apollo program going based on the nation keeping the promise made by the martyred Kennedy. But heads would have to roll.

Those selected to take the fall were Webb himself, Shea, and Storms. William Bergen, who headed the team making the losing Martin proposal for the Apollo spacecraft, was brought in to replace Storms. The new management made a few changes to revert back to the configuration Storms had proposed at the beginning of the program - nitrogen/oxygen atmosphere at launch, quick opening hatch. The 18-month delay for the redesign allowed NASA and all of its contractors to do a bottoms-up review of the design and materials fabricated so far. The spacecraft that had caught fire was an early test model, designated Block I. The design that would fly to the moon, Block II, had many changes anyway. The spacecraft that would take astronauts to the moon was essentially Storms' Block II.

Storms had to watch the launch of Apollo 11 to the moon from a friend's boat as a private citizen. He watched the first moon walk on television in his living room, like most Americans. Storms was asked to act as a consultant on North American's space shuttle proposal, but kept well out of sight of NASA. It was believed that North American's willingness to take the fall for the fire ensured the eternal gratitude of NASA's top managers, and thereby the space shuttle contract that the company received three years later.

In the years just prior to his death, Storms worked with author Mike Gray to give his side of the Apollo story. This appeared in print as Storms' biography, *Angle of Attack*, and was subsequently filmed as a part of Tom Hanks' *From the Earth to the Moon* miniseries.

Editing- Larry Latimer

Bibliography and Further Reading

- Lay, Beirne Jr, *Earthbound Astronauts*, Prentice-Hall, New Jersey, 1971. ISBN: 0132223074. A book that unusually interviews some of the American 'Chief Designers' - the industrial managers and engineers behind the Apollo spacecraft and Saturn booster. [More at amazon.com...](#)

<http://xplanes.free.fr/x15/B.html>

Dr. Harrison A. "Stormy" Storms, Jr. was the chief engineer on the X-15 project until he left to join the moon project as North American's vice president, Program Development, in charge of the development of the Apollo spacecraft. Storms had previously served as Chief Engineer for the XB-70 Valkyrie, a task honored by the American Institute of Aeronautics and Astronautics (AIAA) 1970 Aircraft Design Award.