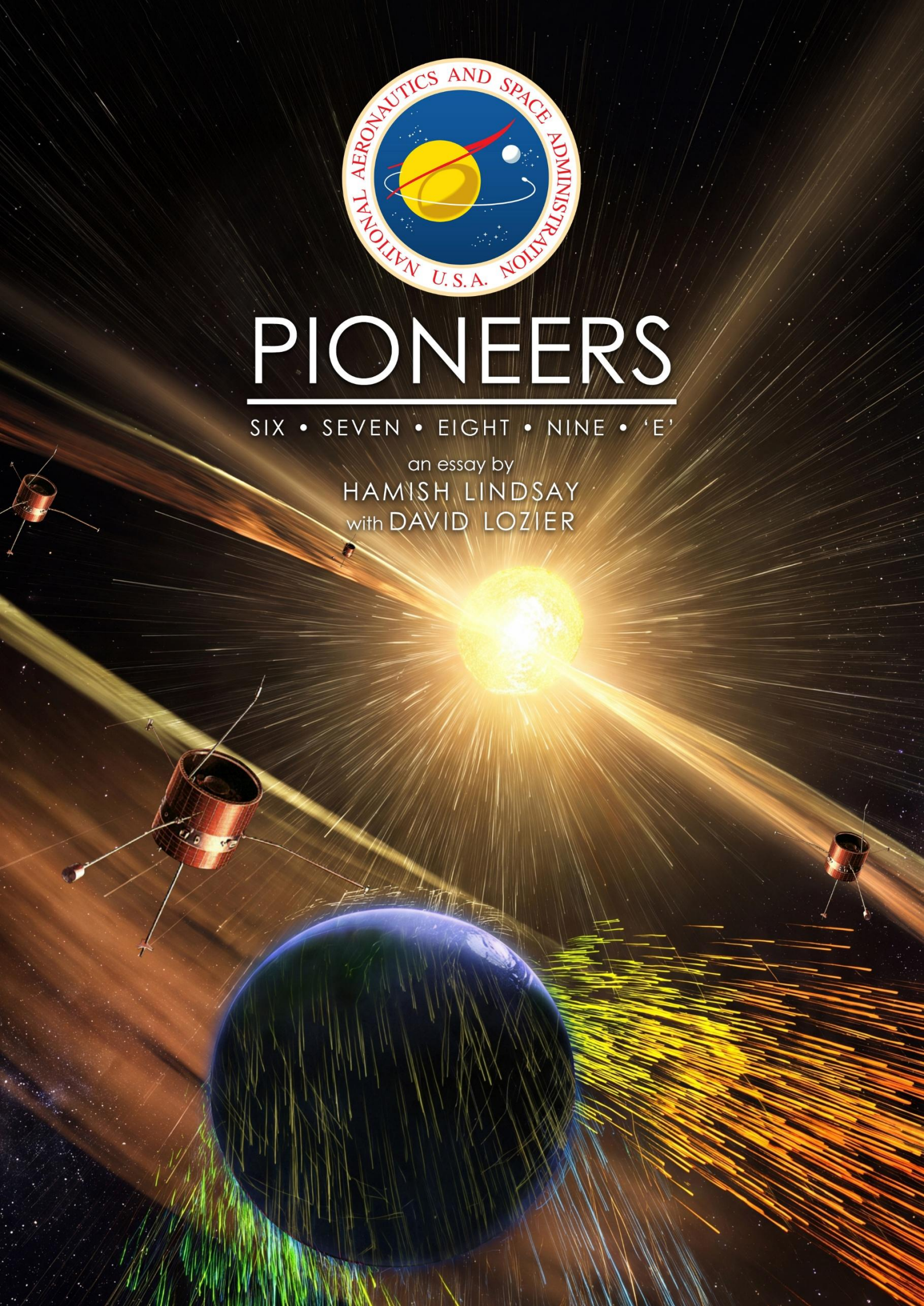
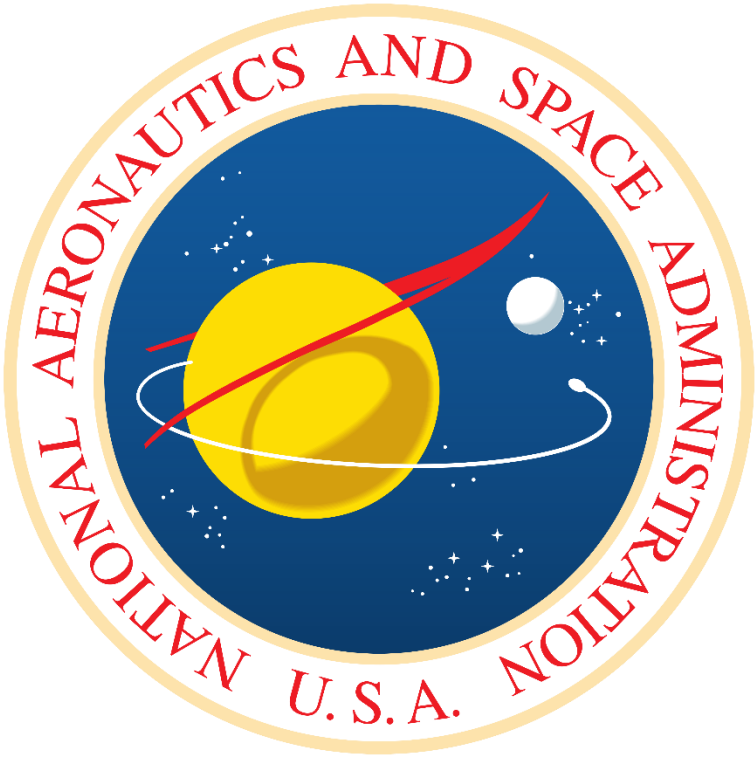

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION U.S.A.
PIONEERS
SIX • SEVEN • EIGHT • NINE • 'E'
an essay by
HAMISH LINDSAY
with DAVID LOZIER



“They figured there might have been some more contracts out there, if it hadn't lasted so long.”

Pioneer project engineers, regarding the spacecraft’s extreme endurance.

PIONEERS

SIX•SEVEN•EIGHT•NINE•'E'

an essay by Hamish Lindsay with
David Lozier – Pioneer 10 Flight Director

Extracted from content available on the
Honeysuckle Creek Tracking Station
website, developed by Colin Mackellar

www.honeysucklecreek.net

Click or scan the QR code below to see the website:

Cover illustration: Original images from NASA. Illustration compiled by Glen Nagle.

Mission Facts

Pioneer 6
Launch date: 16 December 1965
Launch time: 0231:20 US EST / 0731:20 UTC
Launch site: Launch Complex 17A, Cape Canaveral
Launch vehicle: Thor-Delta E
Spacecraft mass: 62.14 kilograms
Average distance: 0.8 AU / 119,678,297 kilometres
Mission duration: 34 years, 11 months, 22 days
Last contact: 8 December 2000

Pioneer 7
Launch date: 17 August 1966
Launch time: 1020:17 US EST / 1520:17 UTC
Launch site: Launch Complex 17A, Cape Canaveral
Launch vehicle: Thor-Delta E1
Spacecraft mass: 62.75 kilograms
Average distance: 1.1 AU / 164,557,658 kilometres
Mission duration: 28 years, 7 months, 14 days
Last contact: 31 March 1995

Pioneer 8
Launch date: 13 December 1967
Launch time: 0908:00 US EST / 1408:00 UTC
Launch site: Launch Complex 17B, Cape Canaveral
Launch vehicle: Thor-Delta E1
Spacecraft mass: 65.36 kilograms
Average distance: 1.1 AU / 164,557,658 kilometres
Mission duration: 28 years, 8 months, 9 days
Last contact: 22 August 1996

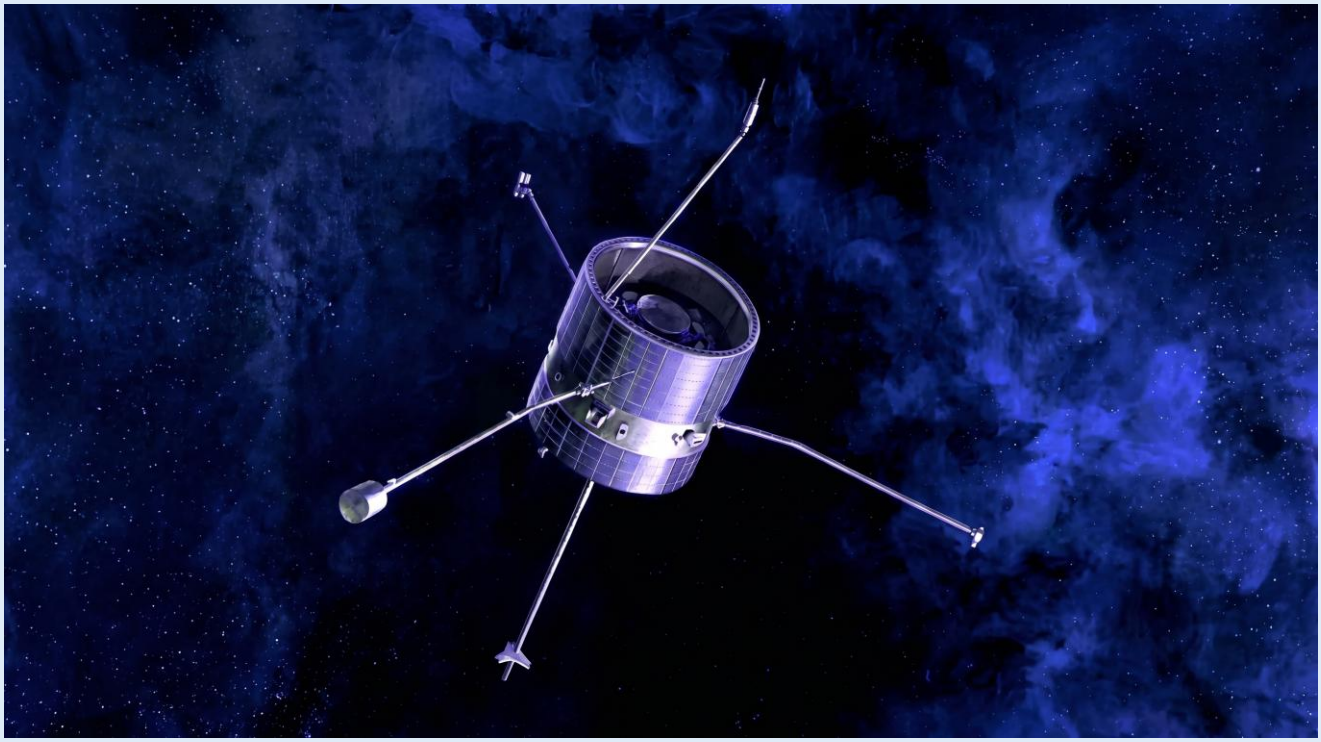
Pioneer 9
Launch date: 8 November 1968
Launch time: 0446:29 US EST / 0946:29 UTC
Launch site: Launch Complex 17B, Cape Canaveral
Launch vehicle: Thor-Delta E1
Spacecraft mass: 65.36 kilograms
Average distance: 0.8 AU / 119,678,297 kilometres
Mission duration: 14 years, 6 months, 11 days
Last contact: 19 May 1983

Pioneer 'E'
Launch date: 27 August 1969
Launch time: 1759:00 US EDT / 2159:00 UTC
Launch site: Launch Complex 17A, Cape Canaveral
Launch vehicle: Thor-Delta L
Spacecraft mass: --.-- kilograms
Average distance: 0
Mission duration: 383 seconds after launch
Last contact: mission failure

Boosters
Solid fuel: 3 x Thiokol Castor TX-345-5

Orbital parameters
Perihelion: between 0.75 and 1 AU
Aphelion: between 0.99 and 1.2 AU

Spacecraft power
Solar cells: 79 watts (at the start of the mission)



The Pioneer solar orbiters were a spin-stabilised, solar cell powered spacecraft. Image: NASA

PIONEERS

SIX•SEVEN•EIGHT•NINE•'E'

The solar orbiting interplanetary Pioneers were managed at NASA's Ames Research Center during the 1960s.

During the period from 1965 through 1969 a series of five spacecraft were launched from the Kennedy Space Center (KSC). Four of the five were successfully inserted into orbits around the Sun with the fifth suffering a failure of the launch vehicle and thus was lost.

Pioneers 6, 7, 8, 9 and E were created to make the first comprehensive measurements of the solar wind, solar magnetic field and cosmic rays.

Designed to measure large scale magnetic phenomena and particles and fields in interplanetary space, data from the spacecraft were used to better understand stellar processes as well as the structure and flow of the solar wind.

The four spacecraft (6,7,8,9) also acted as the world's first space-based solar weather network, providing warning of solar storms which impact communications and power on Earth.

During the Apollo lunar landings, NASA used the fleet of Pioneers to provide hourly updates on the Sun's activity to Mission Control in Houston.

Their data guarded against the otherwise unexpected blast of intense showers of solar protons that could have endangered the lives of astronauts.

The four spacecraft, spin stabilised at 60 revolutions per minute, were launched into Solar orbits between 1965 and 1968.

After their prime mission to study the Sun's environment was completed, the spacecraft were then tracked only occasionally.

Pioneer 6 was launched on 16 December 1965, one day after the successful rendezvous of Gemini VI and VII.

Sometime after 15 December 1995 (30 years after it was launched) the primary transmitter (TWT) failed. During a track on 11 July 1996 the spacecraft was commanded to switch to the backup TWT, and the downlink signal was re-acquired. The spacecraft and a few of the science instruments were again functioning.

(At the time) Pioneer 6 held the record for the longest active spacecraft when Goldstone managed to lock on to its signal for about two hours on 8 December 2000 to commemorate its 35th anniversary.

Thor-Delta 5 launches from Launch Complex 17A with Pioneer 6, on 16 December 1965. Image: NASA/KSC

The thrust augmented Delta E, E1 and L variants were used to launch Pioneers 6,7,8,9 & E. Image: NASA/KSC

Pioneer 6-9 Spacecraft Operations Center, Ames Research Center, Building 244. Circa 1967. Scan: David Lozier
From left: Two unnamed controllers, Charlie Hall, Norm Martin and Ralph Holtzclaw

MISSION SUMMARIES

Pioneer 6

Pioneer 6 was launched on 16 December 1965 (02:31:20 EST night), one day after the successful Gemini VI/VII rendezvous.

Pioneer 7

Pioneer 7 was launched on 17 August 1966 (10:20:17 EST day). It was last tracked successfully on 31 March 1995. The spacecraft and one of the science instruments were still functioning. Pioneer 7 could only be tracked around perihelion because the electrical output from the solar array was degraded.

Pioneer 8

Pioneer 8 was launched on 13 December 1967 (09:08:00 EST day). Its primary transmitter (TWT) failed several years ago, but on 22 August 1996 the spacecraft was commanded to switch to the backup TWT, and the downlink signal was re-acquired. The spacecraft and one of the science instruments were again functioning.

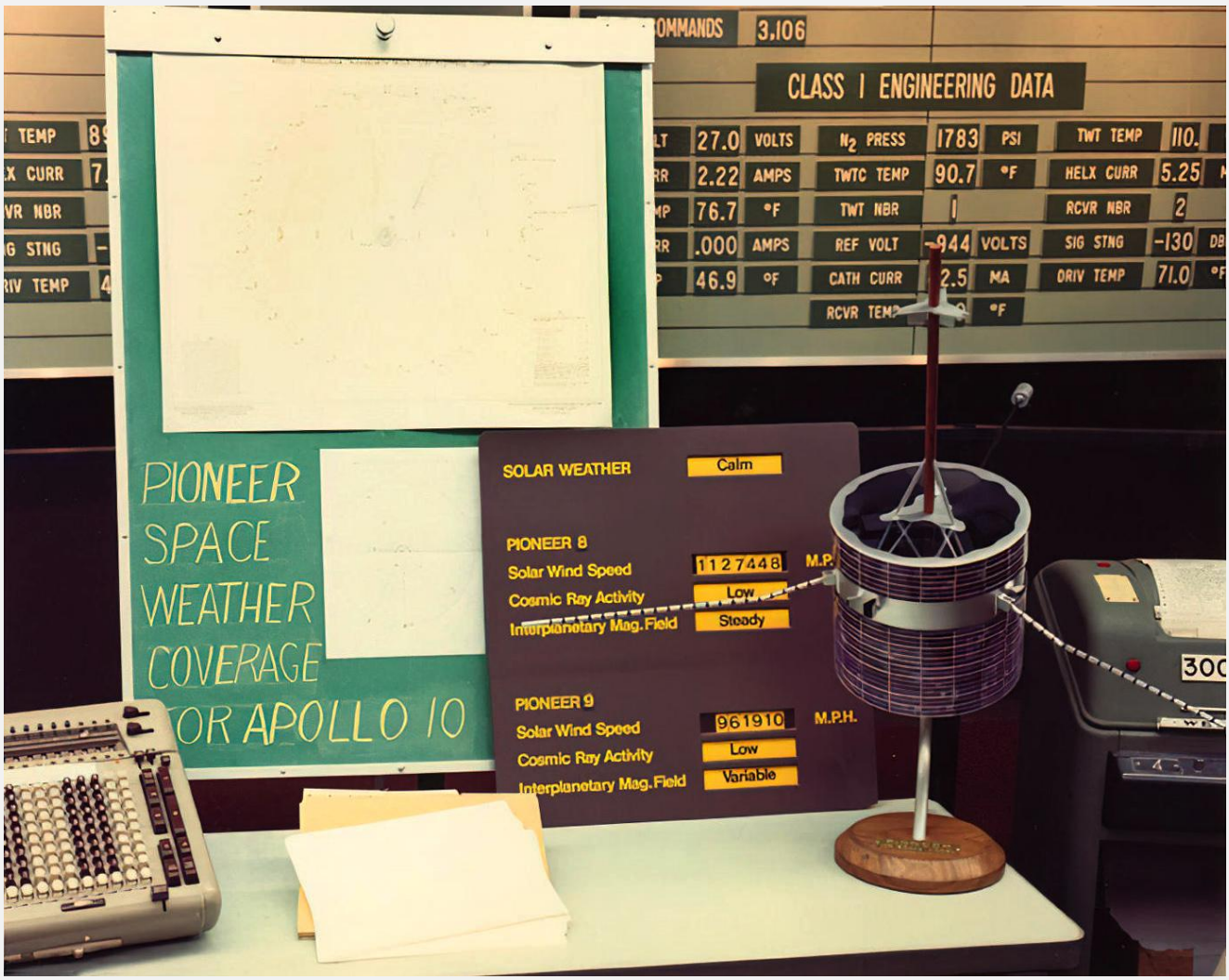
Sometime in the early 90s Ames turned over control of Pioneer 8 to the JPL DSN for use as a radio source in the training of new station operators and spacecraft controllers.

Pioneer 9

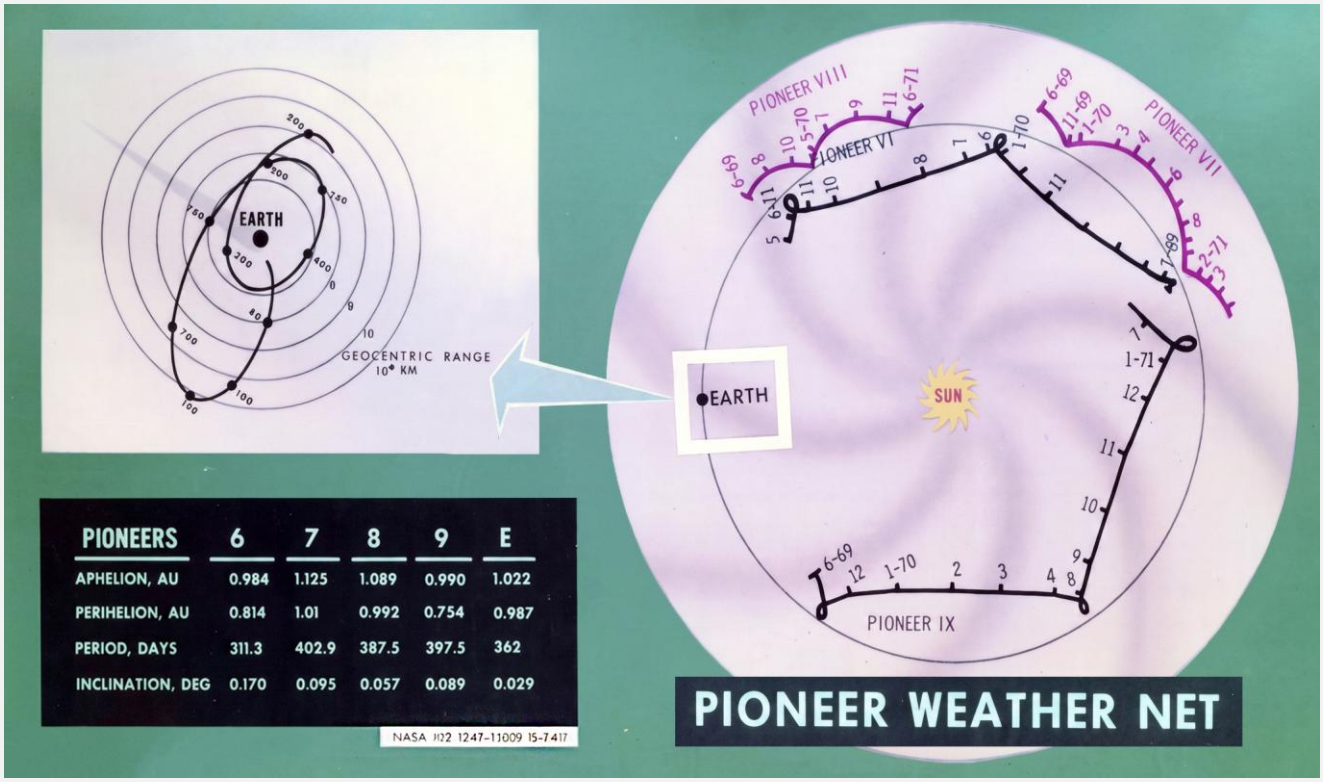
Pioneer 9 was launched on 8 November 1968 (04:46:29 EST night). The spacecraft failed in 1983. Many attempts to contact Pioneer 9 after the last track in 1983 were never successful. On 5 March 1987 NASA declared the spacecraft lost.

Pioneer 'E'

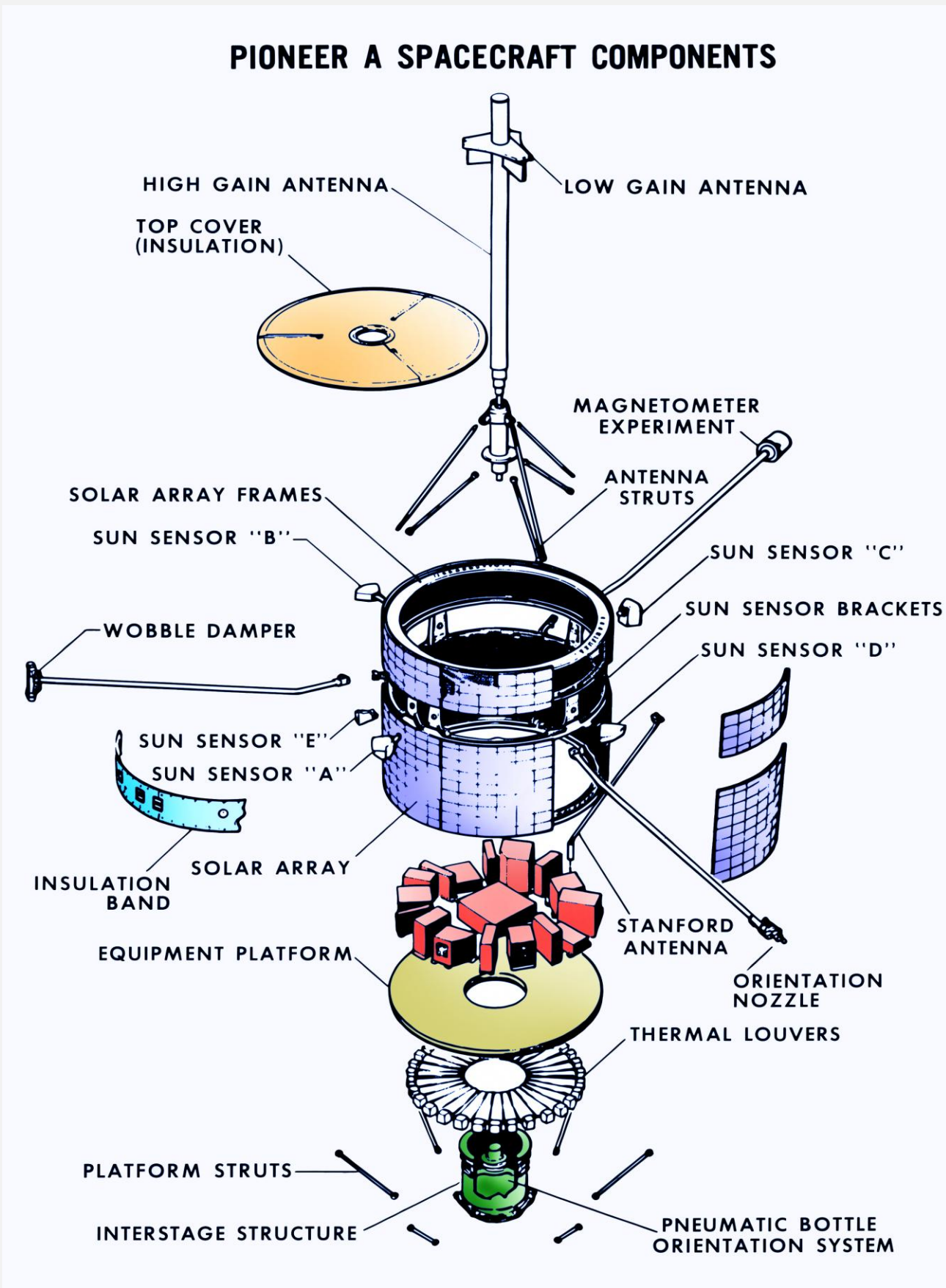
Pioneer E, a fifth spacecraft in the series was launched on August 27, 1969 (17:59:00 EDT) but failed to reach orbit when, at 383 seconds into the flight, the launch vehicle was destroyed after a hydraulics line rupture on the main engine bell control system of the Delta.



Pioneer 6-9 Apollo Solar Weather Coverage Ames Research Center May 1969.
"Look at that Friden calculator.... does division....wow!" Photo and notes: David Lozier



Earth-Sun-line-fixed solar orbits and orbital elements for Pioneers 6,7,8,9 and E. Source: David Lozier



An exploded view of the Pioneer spacecraft showing main subsystems. Graphic: NASA/JPL

- The vertical structure (top) is the stacked dipole (Franklin array) for telemetry transmission to Earth
- Small vanes (wobble damper) on the antenna (left) maintain orientation by solar radiation pressure
- The boom (upper right) contains the magnetometer sensor
- Folded boom (rear centre right) is for the Stanford two-frequency radar experiment
- Boom (centre right) contains jets used to apply torque.

The Pioneer 9 launch crew, circa 1968. Image: Ames Research Center photo A-41559

1. Charlie Hall (Pioneer Project Manager), 2. Charlie, Bob Hofstetter (Launch Vehicle Integration),
3. George Nothwang (Integration and Test Manager), 4. Al Wihelmi (Instrument Engineer),
5. Dave Lozier (Launch Vehicle and Trajectories), 6. Joe Lepitich (Instruments Manager),
7. Ralph Holtzclaw (Spacecraft Manager), 8. Bob Edens (Ground Data System Engineer).
Scan: David Lozier. Key: Colin Mackellar

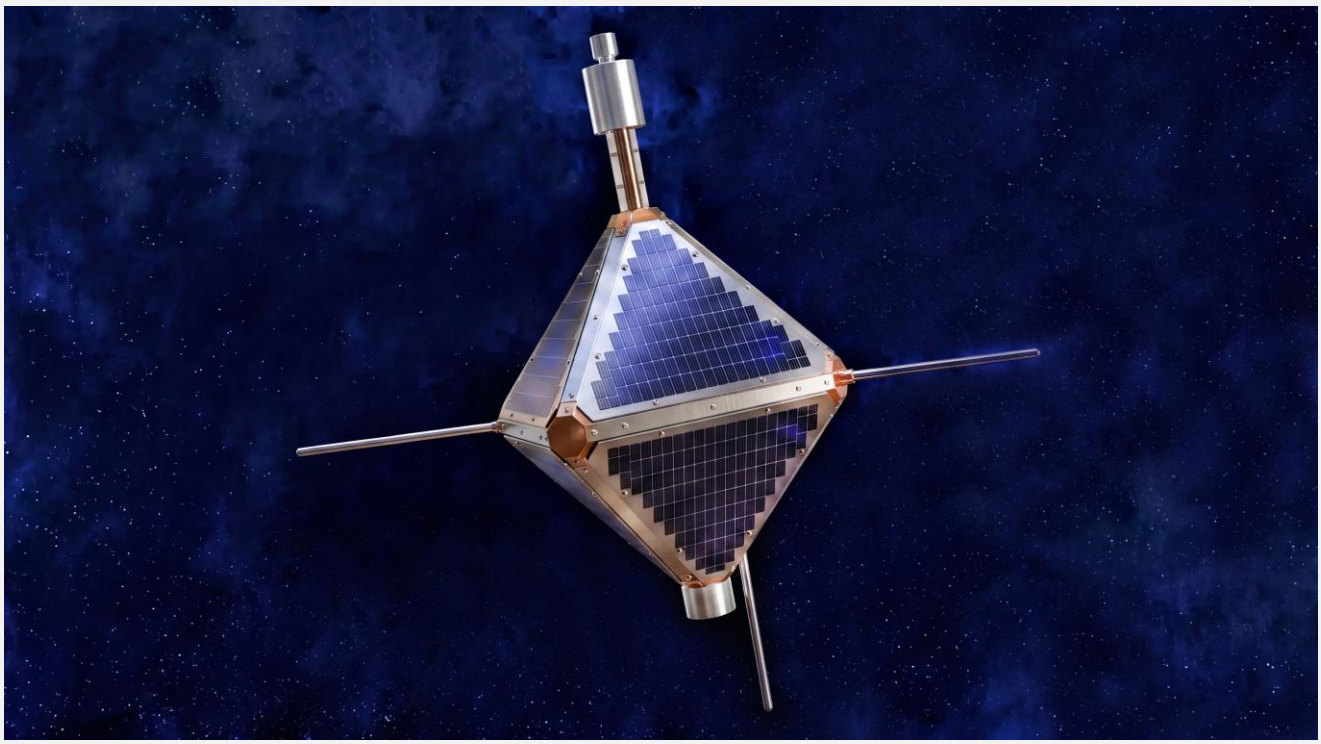


Illustration of a Test and Training (TETR) satellite. Image: Glen Nagle

What is often overlooked is the fact that for Pioneers 8, 9, and E, two spacecraft per launch were to be orbited.

Goddard, the Delta launch vehicle management center, came to the Pioneer Project and asked if they could include another small 18.14kg (40 lb) payload on the rocket. It would be placed on the second stage down by the engine bell in a spring loaded deployment container.

After second stage shutdown and separation from the third stage/Pioneer combination, a timed command to eject the TETR (Test and Training) would be executed. The small payload was intended to provide a radio beacon for the Apollo Tracking Network to test and train the station equipment and personnel.

Both TETRs for Pioneer 8 and 9 were successfully deployed but although the Delta-E for Pioneer E was equipped with a TETR, both spacecraft were lost when the launch vehicle failed.

Mike Dinn, in his recollections of the Honeysuckle Creek station operations stated that,
"the TETRs were never used because they had the Surveyors and the Lunar Orbiters radio links to train on before the Apollo missions were ever launched."

Hamish Lindsay,
"From memory Honeysuckle Creek did track these spacecraft at various times. We tracked Pioneers 10 and 11 for many hours, particularly from 1974 when we joined the Deep Space Network, until we closed down in 1981.

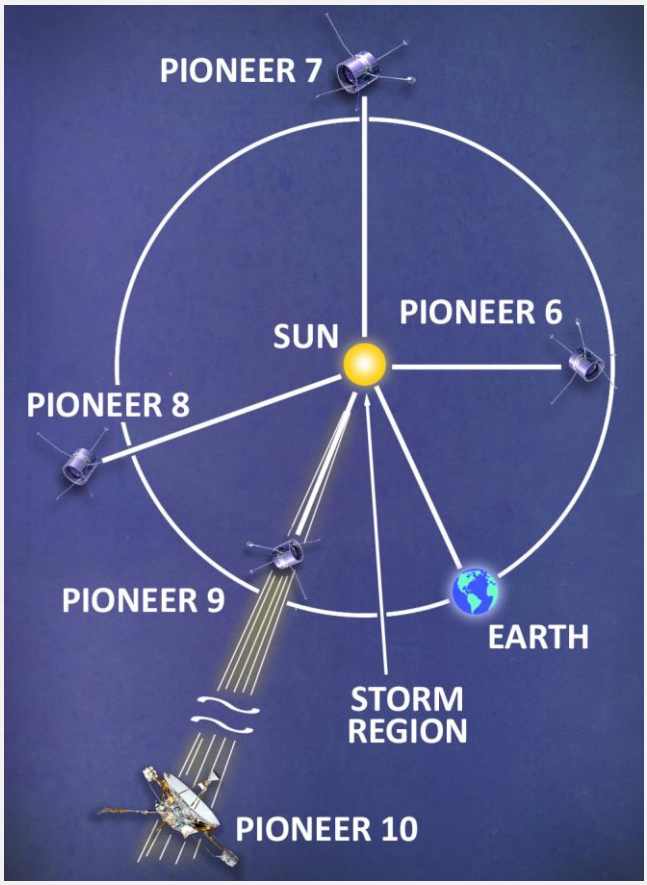
Tidbinbilla continued tracking them until they ran out of consumables and began to drift.

In these days of sophisticated technology and high speed computers it is interesting to note that between 1964 to 1968 the spacecraft real-time data from the tracking stations was sent by teletype to twenty machines clattering away producing octal codes with a group of operators standing by converting the coded data with slide rules to plot the results.

By the time Pioneer 10 appeared on the scene they had Xerox Sigma 5 computers generating the engineering and scientific data for the displays and recording on magnetic tapes.

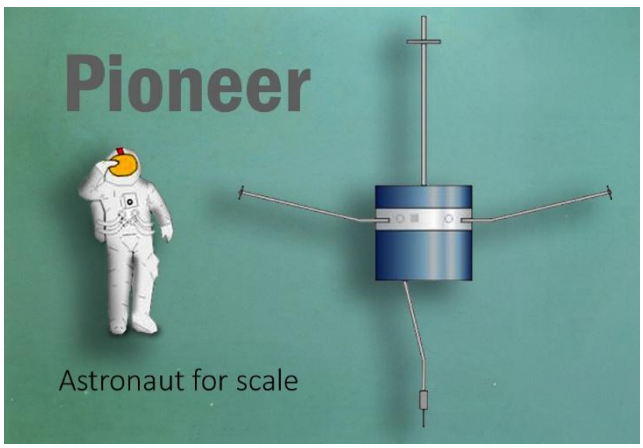
Ames also had Sigma 5s to offline process telemetry tapes received from the tracking stations as well as real-time display of spacecraft and instrument health in the Pioneer Operations center."

Pyramidal TETR deployment canister near engine bell and TETR spacecraft rendition
"Dave Lozier in the back disinterested and looking at his fingers, Ugh". Photo and notes: Dave Lozier :-)

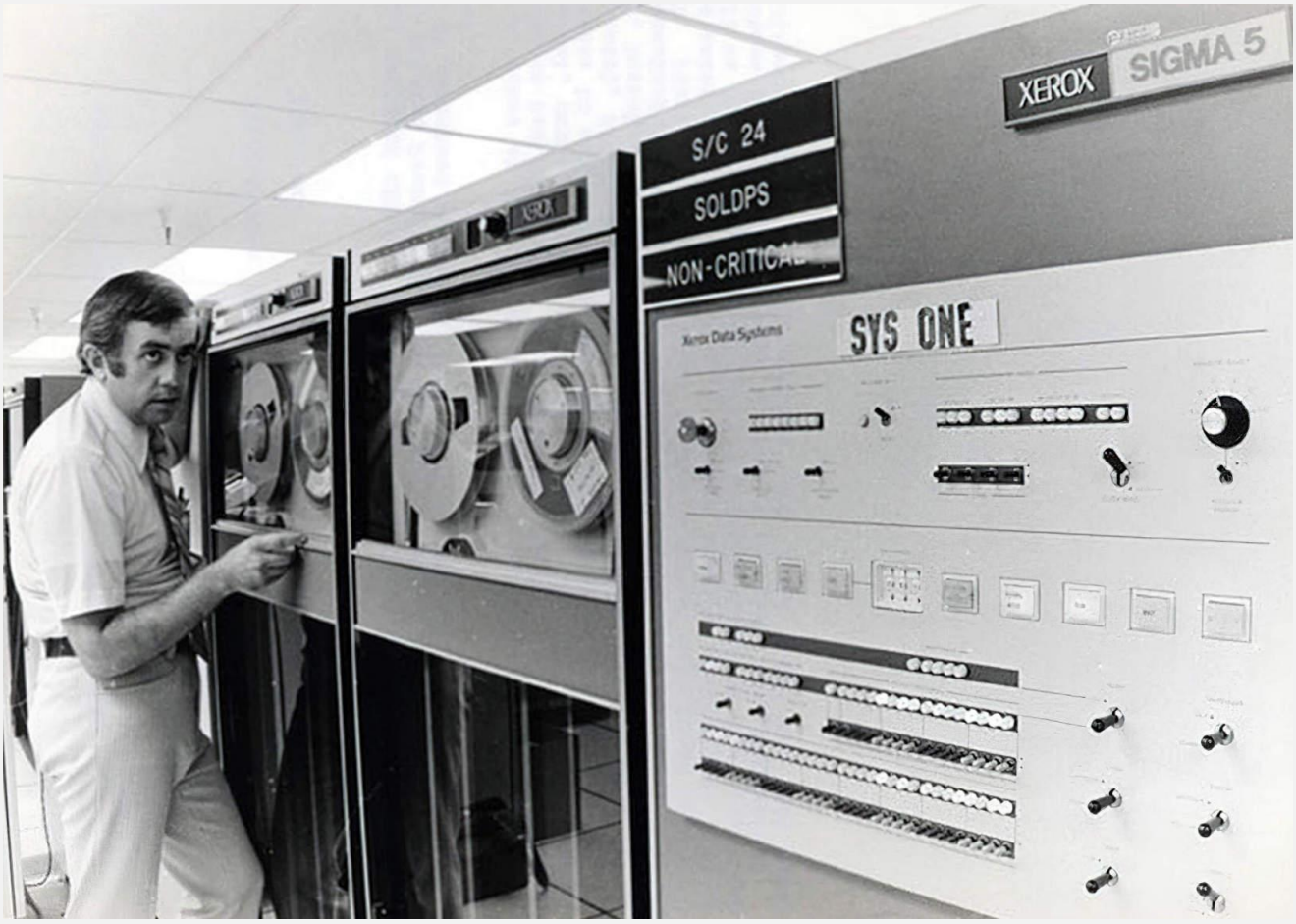


Left: Diagram depicting the relative positions of the Pioneer 6,7,8 & 9 spacecraft. Source: NASA

Essay by Hamish Lindsay, 2012-2014
With content from honeysucklecreek.net created and developed by Colin Mackellar.
Unless specified, illustrations and captions by Hamish Lindsay, Colin Mackellar, and Glen Nagle.
PDF formatted by Glen Nagle.



Above: Dave Lozier at the teletypes, circa 1973.
Below: Dave at the Sigma 5 at Ames Research Center, circa 1973. Photos: David Lozier



DAVID LOZIER

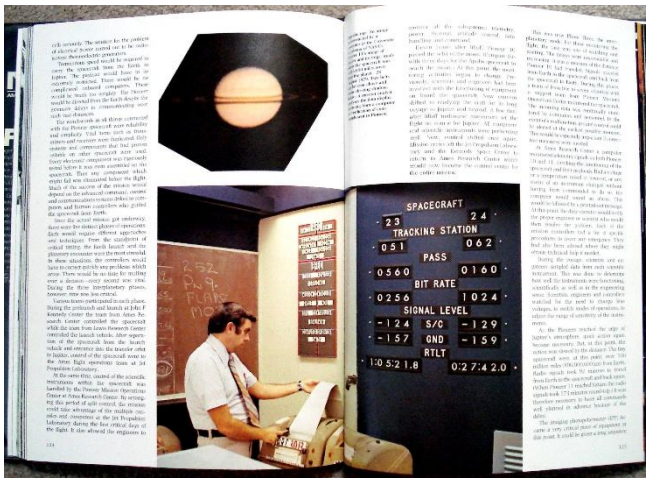
PIONEER 10 FLIGHT DIRECTOR

"I had the great fortune to be part of the Golden Age of Space Exploration", says David Lozier.

"Marci Smith came into the office one day and said 'you're in the history books'. I asked, *'what do you mean'?".*

She said she was in a bookstore and found this book in the marked down clearance section. It was a commercial publication from England. History of NASA, and in one section there were pictures and a discussion of the Pioneer 10/11 missions. For some unknown reason they had selected a photograph of me looking at some printout from a teletype.

"I was in the history books!"



David at the teletypes. See photo on previous page.

I was a freshman at Lewis and Clark High School in Spokane Washington on 4 October 1957 the day that the Soviet Union launched Sputnik. Sputnik thrust the nation into the 'space age' and the nation responded.

My mother hauled me out of bed that night, took me out in the backyard, and told me to stare up at the heavens. Amongst all the stationary stars there was a little point of light moving across the sky from one horizon to the other.

"Look, this is your future." she said.

All I remember was the desire to go back to bed.

I majored in Mathematics/Computer Science and towards the end of 1965, since I wasn't going on to graduate school, l I knew I would soon need to find a job. The Washington State University placement office gave me a list of the companies that would be interviewing around this time and one of them was NASA.

I signed up and that's how I met Don Shilling from the Ames personnel division. He heard I was a programmer and asked me to fill out a SF-57 application for Federal employment. Later in November I got a call from Don, and he was wondering where that application was. I told him I still had it but never filled it out and he said *'please'* complete it and send it right away. The idea of working for NASA was seductive, so I did.

I was home at my parents when a call came in from Ames. It was Bob Hofstetter from the Pioneer Project. They had launched Pioneer 6 on 16 December, but they still needed a computer programmer to debug and finish their trajectory codes. They were planning additional Pioneer launches and he asked, '*How would you like to go to work for us?*' I said it sounds great. Bob said they would send an offer and he hung up. What the hell was a *'trajectory?'*

On 7 February 1966 I became a civil servant at NASA Ames on the Pioneer Project.

For the next 38 years I had the great fortune to be part of the Golden Age of Space Exploration. We sent four spacecraft around the Sun, two to Jupiter and Saturn, a Venus orbiter that lasted 14 years and four probes into the atmosphere of Venus. Lunar Prospector was my last mission before I retired….

WEBSITE

Click the website link above or scan the QR code to read all of his fascinating story in a 16mb PDF file which he's kindly assembled.

ABOUT THE AUTHOR

Hamish Lindsay (1937-2022) worked at the Muchae, Carnarvon and Honeysuckle Creek space tracking stations between 1963 and 1981.

He wrote many essays on the history of human spaceflight and was the author of the book, Tracking Apollo to the Moon.