Side effect of the Apollo Applications Program

Project Voyager

This small write-up is dedicated to my wife, Estrella, and to my daughters, Raquel and Sara, for their unconditional support.

During the design and development of the Apollo program, NASA suggested a continuation with the so called AAP (Apollo Applications Program). This Program took into consideration the development of other projects based on the experience and lessons learned during the missions to the Moon.

Launch of the Voyager mission

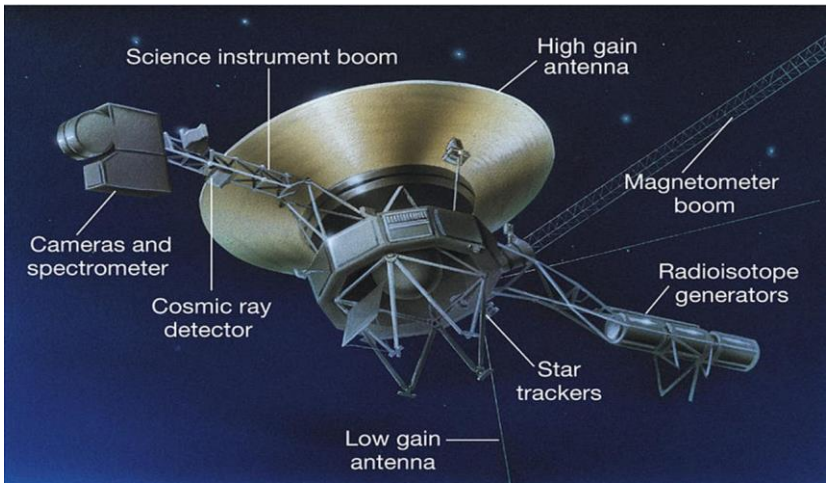
Although nothing had been decided as definite, there were several possibilities to study: The Grand Tour, the idea behind this project was to send several probes to the outer planets and visit them all. Earth Orbital Space Station, to make all kind of experiments in micro gravity. A permanently manned lunar base.

With the success of Apollo XI, the interest of American tax payers fell considerably, and many started to ask themselves what was the purpose of going back to the Moon once they had been there first and, apparently, there was no geological or strategic motivation in our satellite.

This lack of interest, only briefly recovered by Apollo XIII, was the main reason for an important reduction on NASA´s budget. All of the sudden, NASA could not afford the AAP.

And then, Gary Flandro, an aerospace engineer working at JPL (Jet Propulsion Laboratory) in Pasadena, California, found out that by the last part of the 70s, the outer planets would align in a way that a spacecraft, using gravitational assistance, could visit them all in a single flight. This type of alignment only happens once every 175 years.

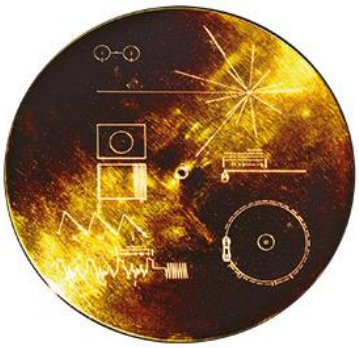
NASA thought this could be a good alternative to the Grand Tour and assigned JPL for the design and construction of a couple of twin spacecraft for this trip. And thus they became part of the Mariner Program and were assigned the names of Mariner 11 and 12. It was later thought that this new Program was so ambitious that it deserved a name of its own and it was changed to the Mariner Jupiter-Saturn Program. But the technology included into these S/C was way ahead of that of the Mariner family so, why not give it a whole new name of their own? Voyager Program had been born.



The design included high and medium resolution cameras, spectrometers, magnetometers, cosmic rays detector, star finder, high and low gain antennas and three Radioisotope Thermoelectric Generators (RTGs) to produce the necessary electricity.

The magnetometers, cameras, and spectrometers were located at the tip of long booms to minimize the possible interferences from the main body of the S/C where the transmitters, receivers, the modulation equipment, the recorders and the ancillary elements like batteries, etc. were located.

The RTGs used Plutonium 238 oxide due to its relatively low radiation and excellent conditions of average life and energy. Nevertheless, they were also located at the tip of a long boom to minimize interference with the scientific instruments.



And while the twin Voyagers were being developed and built, a team of scientists headed by Carl Sagan, were urgently trying to bind into a gold plated record: different types of music from all over the world, (from symphonic to rock n roll), greetings in 55 languages, greetings from General Secretary of the United Nations, and the theme "*Sounds of Earth*" composed of a mixture of characteristic sounds of the planet. It also contained 115 images with the location of the Solar System, units of measurement, and Earth, human body, and society features.

Mission scientists, meanwhile, were preparing the specific tasks for each of the Voyagers. The consensus was that 1 would explore and study Jupiter, Saturn, Uranus, and Neptune, while 2 would focus especially in Jupiter´s moon Io and Saturn's moon Titan which were of especial scientific interest, the first due to its volcanology and the second due to its atmosphere.

OK then, everything ready. Voyager 1 would depart on August 20th and Voyager 2 on September 5th. But…

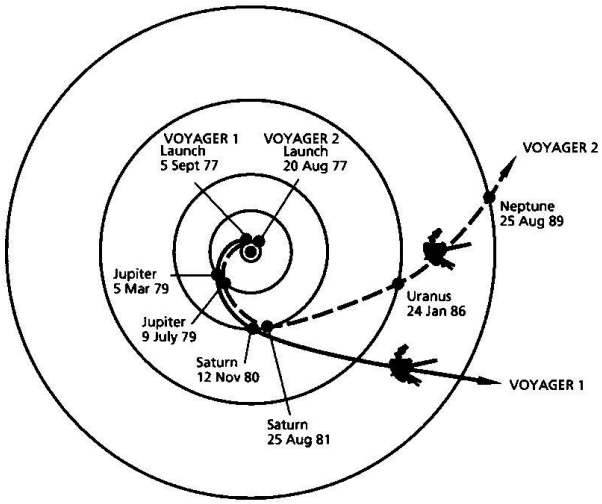
To fulfill the different missions, the trajectories of each SC had to also be different, and thus 2 would reach Jupiter prior to 1. NASA mission specialists thought that 1 should be the first to reach Jupiter and not 2.

Solution? Change the names before launch. That way, 2 became 1 and vice versa. And so Voyager 2 was launched August 20th, 1977 and Voyager 1 September 5th, 1977.

Moreover, if 1 had an impending failure which endangered its mission, 2 which was behind could change its trajectory and assume the study of Io and Titan.

Voyager 1 reached its closed approach to Jupiter on March 5th, 1979 while 2 did it on July 9th that same year.

Closest approach to Saturn occurred on November 12th for Voyager 1 and August 25th for Voyager 2.



Here, Voyager´s 1 trajectory was drastically changed to allow an encounter with Titan. This drastic change took the SC away from the Ecliptic plane in a northern direction at an angle of 35 degrees.

Voyager 2 followed the original plan reaching Uranus on January 24th, 1986, and Neptune on August 25th, 1989. After this last encounter, it also left the Ecliptic plane in a southern direction at an angle of about 48 degrees.

Both SC are in the process of abandoning the Solar System and begin their travel through interstellar space. In fact, 1 entered into such space on August 25th, 2012. Their velocities are: Voyager 1 – 520,000,000 km/year, Voyager 2 – 470,000,000 km/year. 1 is almost 20 light hours away while 2 is at more than 16 light hours away.

The Voyagers are, no doubt, the SC that have returned greater scientific data. Their exploration of the four gaseous planets are equivalent to explore four different Solar systems. Among the 48 observed moons, they discovered the first active volcanoes outside Earth at Io, and evidence of a subterraneous ocean in Europa, (moons of Jupiter). Also, the atmosphere closer to that of Earth at Saturn´s moon Titan. The frost moon Miranda at Uranus. Frost geysers at Neptune´s Triton and rings in all the planets.

Two weeks after liftoff, Voyager 1 took the first iconic photo of the mission: an image of the Earth Moon system at a distance of twelve millions of kilometers.

Additional facts:

1. The launch was at the Kennedy Space Center using a Titan III-E.
2. The initially estimated life to accomplish the mission was five years.
3. The amount of generated electric energy diminishes with time as the RTGs consume their fuel. To be able to keep communications with Earth selective instruments were shut down.
4. Around year 2020 the last scientific instrument will be shut down but the S/C will still be able to communicate until around 2025.
5. Following this selective equipment shutdown sequence, the Voyager 1 gyroscopes were set off line in 2016. From then, S/C stability was controlled with the propulsion system.
6. To keep communications with Earth proper aspect angle had to be maintained, this was accomplished by the small orientation motors. But after 40 years of usage, they were so deteriorated they couldn´t be used anymore so, on November 28th, 2017, the SC position was adjusted by using the main trajectory motors. These motors hadn´t been turned on since the encounter with Saturn, 37 years ago. The maneuver, was controlled from Earth by using 10 millisecond impulses of the main propulsion system. The correction was a success. The commands took 19 hours and 35 minutes to reach the SC.

Note: All photographs depicted in this essay are from public Internet publications and, in no way, they will be used to collect any income.