

A CASE STUDY: ARTEMIS ACHIEVES UNPRECEDENTED ORBITS

STK/ASTROGATOR USED FOR MISSION DESIGN

Solution | Space Mission Design and Operations

Challenge:

ARTEMIS flight dynamics engineers needed to design orbits never before attempted on spacecraft near the end of their design lifetime on a tight budget.

Solution:

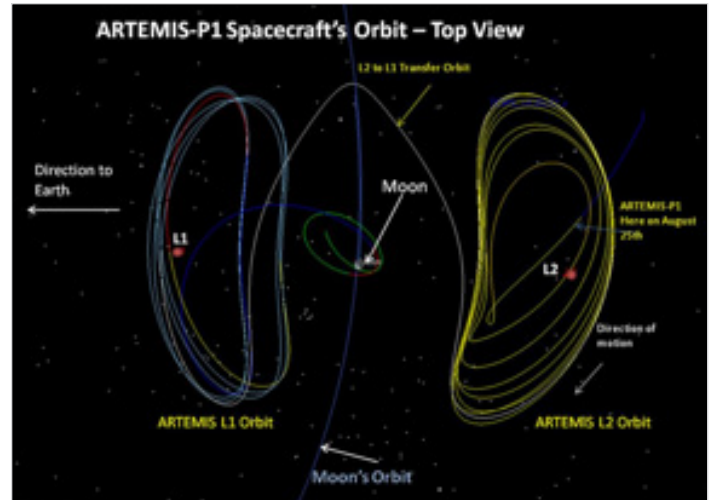
Flight dynamics engineers used STK/Astrogator to navigate around Earth-Moon libration points.

Results:

STK/Astrogator transitioned from three-body to four-body orbital dynamics and the two THEMIS spacecraft achieved Lissajous orbits around the Earth-Moon L1 and L2 libration points.

In efforts to extend the life and utility of two THEMIS spacecraft, NASA's ARTEMIS (Acceleration, Reconnection, Turbulence and Electroynamics of the Moon's Interaction with the Sun) mission is making history. The THEMIS spacecraft were launched in 2007 to study Earth's aurora. Upon completing that mission in 2010 and being renamed ARTEMIS P1 and P2, they have recently found a new home around the Moon. But getting there hasn't been easy, considering their age and limited propellant. NASA Goddard Space Flight Center (GSFC) engineers used AGI's STK/Astrogator to devise a complex series of low-thrust maneuvers and Earth and Moon gravity assists to achieve Lissajous orbits around the Earth-Moon L1 and L2 libration points. On June 27, 2011, P1 entered lunar orbit. P2 followed on July 17. ARTEMIS is the very first mission to navigate around Earth-moon libration points, and is a collaborative effort by UC-Berkeley and NASA's GSFC and Jet Propulsion Laboratory (JPL).

Because NASA GSFC had previously used STK/Astrogator to design Sun-Earth libration point missions, including the Wilkinson Microwave Anisotropy Probe and James Webb Space Telescope, engineers extended its utility to Earth-moon libration point orbit. STK/Astrogator was able to transition from three-body to four-body orbital dynamics.



Using AGI products helped the team overcome three challenges:

1. Flying new orbits
2. Minimizing propellant usage for P1 and P2
3. Reusing software for fiscal responsibility and mission reliability

STK/Astrogator was used extensively to design each orbit maneuver, which totaled nearly 100 maneuvers over a two-year operations timeframe. First, engineers modeled impulsive maneuvers and defined them in the Earth-moon rotating frame consistent with libration point targets. Then, they passed STK/Astrogator impulsive maneuver states into the operational software which converted each into a finite maneuver, allowing the team to validate the post-facto finite maneuver parameters to ensure that the libration point targets were achieved. Because the operational software had no models for the Earth-moon rotating frame, STK/Astrogator was critical to the maneuver planning process.

The ARTEMIS mission has broken new ground in the field of orbital mechanics, proving that if you can design it, you can fly it.

Learn more: nasa.gov/artemis.



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