

A CASE STUDY: JAXA'S "KAGUYA" (SELENE) MISSION

AGI SOFTWARE SUPPORTS AMBITIOUS INQUIRY INTO MOON'S EVOLUTION

Challenge:

JAXA needed to confirm Collision Analysis (COLA) results generated by its newly developed SELENE Flight Dynamics System.

Solution:

Using AGI software, JAXA compared the graphical and analytical output of both software systems.

Results:

AGI products saved a significant amount of time deciding which cases to analyze for COLA.

Not since NASA's Apollo program has a mission to the Moon been so highly anticipated. The Japanese Aerospace Exploration Agency's (JAXA's) SELENE and Engineering Explorer "KAGUYA" (SELENE)—launched by the H-IIA Flight 13 rocket on 14 Sept. 2007—is Japan's first large lunar explorer. While the Apollo program made major strides in space flight and returned a wealth of scientific data in the form of soil mechanics, solar wind, heat flow, and more, JAXA hopes SELENE will provide unprecedented insight into the Moon's origin and evolution. The observation of plasma, the electromagnetic field, and high-energy particles should also help determine if the Moon can be used for future human endeavors. JAXA's Flight Dynamics Division employed AGI's analysis software to assess the accuracy of its newly developed SELENE Flight Dynamics System.

SELENE carries 13 scientific instruments and consists of a main orbiter and two small satellites (Relay Satellite and VRAD Satellite). Once the main orbiter came near the Moon in mid-October 2007, it was placed in a peripolar orbit at an altitude of 100 km. The Relay Satellite was placed in an elliptical orbit at an apolune of 2,400 km.

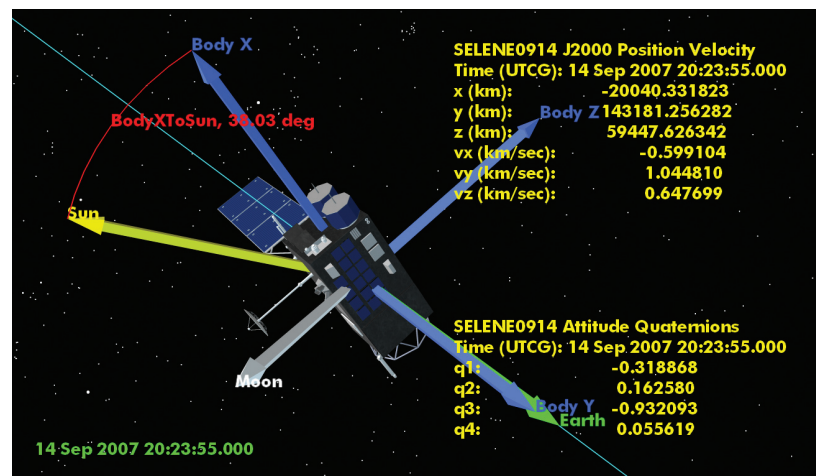
JAXA needed to run Collision Analysis (COLA) to ensure that the H-IIA and its payload were not passing closely to a manned orbital object. Preliminary analysis showed the estimated maximum error of the vehicle's orbit period to be rather large, and therefore a vast number of cases had to be run and analyzed. JAXA used STK's 3-D visualization capabilities to quickly "think through" the cases. For example, if the orbit vector of the launch vehicle and the eccentricity vector of habitable objects is normal, the collision risk increases.

3-D visualization was augmented with calculations derived from AGI's STK Professional Edition and STK/Conjunction Analysis Tools. These products' output were carefully compared with JAXA's internally developed system. "AGI software showed very similar solutions to ours, considering the Earth, Sun, and Moon gravity properly," says Ms. Chikako Hirose, an engineer in JAXA's Flight Dynamics Division, Space Tracking and Data Acquisition Department, Space Transportation Mission Directorate.

JAXA developed the SELENE Flight Dynamics System specifically for this major lunar mission. AGI's trajectory design and spacecraft maneuvering software, STK/Astrogorator, confirmed the system's results. "During critical mission phases, STK/Astrogorator reconfirms orbital maneuver plans and monitors attitude parameters," Hirose says. "Since this was the first mission for the SELENE Flight Dynamics System, we felt more secure when two tools showed the same results."

Hirose says using AGI software saved JAXA a significant amount of time when deciding which cases to analyze for COLA early on in the mission, and is currently an invaluable aid in confirming the results of its internally developed system. "Comparing the orbit propagation, solar phase angle, and other variables between these two programs greatly reduced the risk of human error and potential program bugs."

For additional details on SELENE, including HDTV movies taken of the Moon, the Earth rising, the Earth setting, and more, visit www.selene.jaxa.jp.



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