Copernicus—Advanced Trajectory Design and Optimization System

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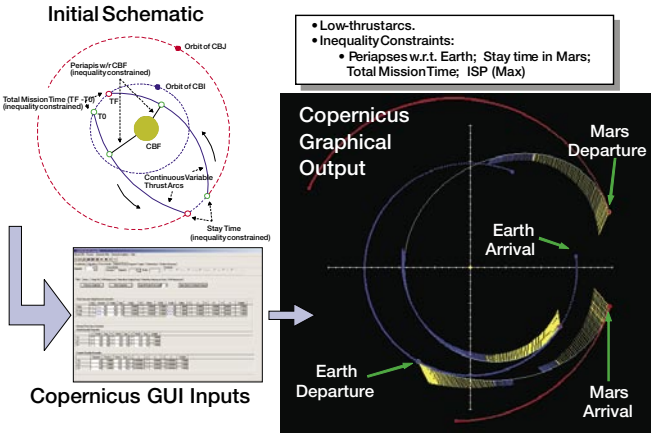
Future space mission design and planning will involve multiple spacecraft, destinations, gravity field flight, and multiple or hybrid propulsion systems. These missions will require complex trajectory design and optimization, fast and high-precision results, large multidimensional trade spaces, and analysis of both mission design concepts and mission operations. The Copernicus Project has responded to these future mission design demands through the initiation and ongoing development of a general, robust, efficient, and practical trajectory optimization system that can be used for timely and accurate solutions to both human and robotic exploration studies.

The Copernicus tool is capable of generating engineering solutions to lunar missions, Earth neighborhood libration point missions, interplanetary missions—including missions to satellites of the outer primary planets, asteroids, and comets—powered flight maneuvers, and a host of other types of missions. The power of Copernicus lies in a standardized methodology used to solve problems coupled with an integrated graphical output providing immediate feedback to the user regarding the goodness of the solution. This approach allows Copernicus to produce high-precision solutions for a large range of complex missions with a faster response time. This tool can be used by mission designers, researchers, and students and has already been employed in a number of NASA studies.

The insert example shows a conceptual view of the solution process for a low-thrust, variable-specific, impulse round-trip Earth-Mars mission with constraints on stay time at Mars and overall mission duration. An initial schematic of the problem (upper left) is mapped out by the analyst, who provides the simple-to-use graphical user interface (GUI) with appropriate mission inputs (lower left). A graphical output of the solution, which is shown on the right, includes the transfer orbit and indicators of thrust magnitude and direction during the trip.

This project reflects a collaborative effort between the Aeroscience and Flight Mechanics Division of Johnson Space Center (JSC) and the University of Texas at Austin. This symbiotic relationship allows JSC to take advantage of research and development advancements in academia while the university establishes a direct involvement in NASA projects. Current plans include inclusion of Copernicus in the Simulation Based Acquisition site, where it will be available to both NASA and approved contractors.



Conceptual view of the solution process using Copernicus.