A Piloted Orion Flight to a Near-Earth Object: A Feasibility Study

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ABSTRACT: The notion of a piloted mission to a near-Earth object (NEO) was first discussed and analyzed in depth as part of the Space Exploration Initiative in 1989 (Davis *et al.*, 1990). Since then, four other studies have examined the details of sending humans to NEOs (Nash, *et al*., 1989; Jones, *et al*., 1994, 2002; Mazanek, *et al*., 2005). The most recent assessment has been undertaken by the Advanced Projects Office (APO) within NASA's Constellation Program. This particular study team includes representatives across NASA and is examining the feasibility of sending a Crew Exploration Vehicle (CEV), the Orion spacecraft, to a NEO. Depending on the suite of spacecraft and integrated components, a mission profile would include two or three astronauts on a 90 to 120 day spaceflight; including a 7 to 14-day stay at the NEO itself.

The most significant advantage from piloted missions to a NEO is a strengthened foundation upon which the Vision for Space Exploration (VSE) and Exploration Systems Architecture Study (ESAS). In order to minimize the impact to current CEV development and to maximize the applicability and validity of this mission to Constellation test objectives, an unmodified Block II CEV is assumed.

Missions to NEOs reinforce the Constellation Program with an uncanny suite of benefits: operational experience beyond cislunar space (i.e., the manned CEV will be several light-seconds from the Earth); risk reduction for space hardware; confidence building for future mission scenarios; *in situ* resource utilization (ISRU) evaluation; as well as a rich scientific return. Further, in terms of Δv and propellant requirements, NEOs are more easily accessible than the Moon with mission lengths no longer than a fraction of an ISS expedition. This incremental step along the way towards Mars can serve as the next generation *Apollo 8* for the Constellation Program, marking humanity's first foray beyond the Earth-Moon system.

Our feasibility study examined four possible combinations of Constellation hardware that could be utilized to propel a manned CEV Orion to a NEO. The first section provides a general background on NEOs and their significance to the Earth. The next section suggests NEO mission scenarios (including robotic precursors). Finally, the last section concludes with the human and exploration science that can be accomplished at the NEO.

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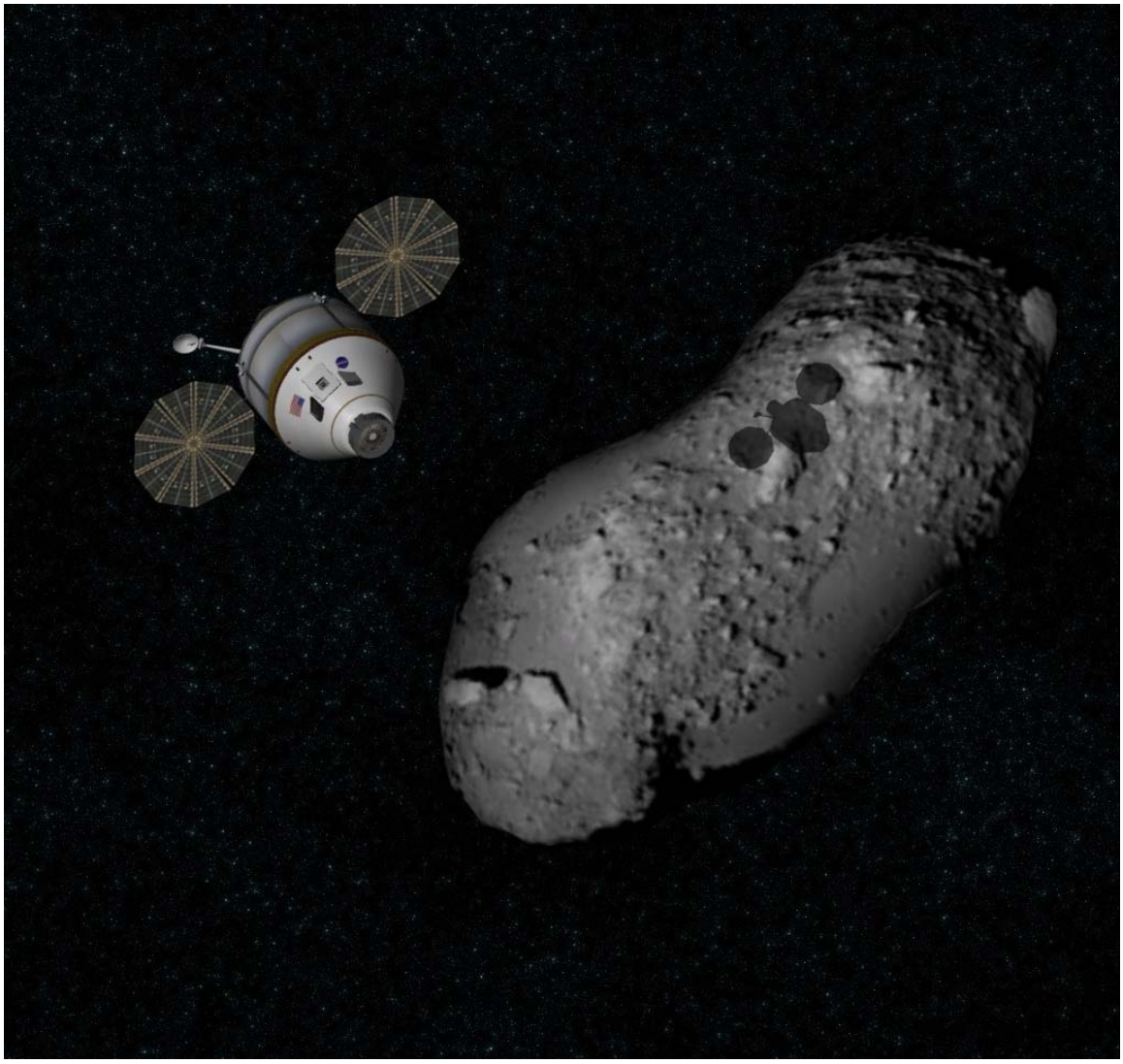

Figure 1: Rendezvous and proximity operations of the CEV Orion at a NEO. A minimalist, low-end mission would possibly include telerobotic sample collection for a few grams of the asteroid (NASA, JAXA).

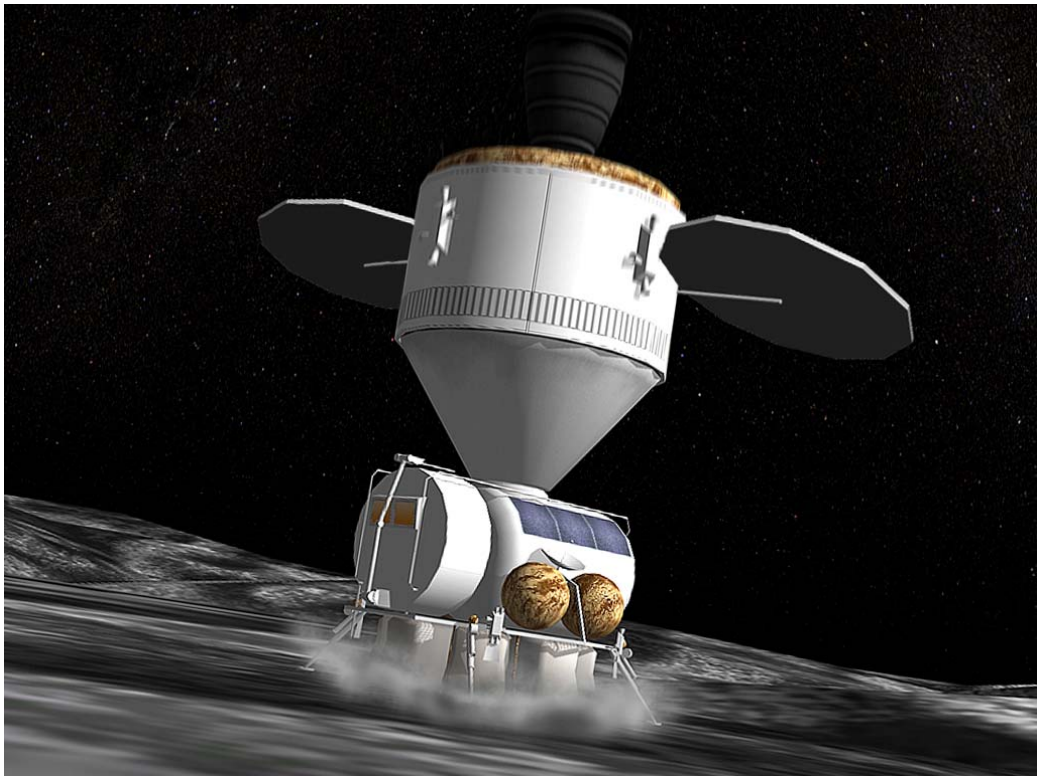

Figure 2: A higher-end mission using truncated LSAM components docked to the Orion, could anchor and berth itself to the NEO (DigitalSpace).

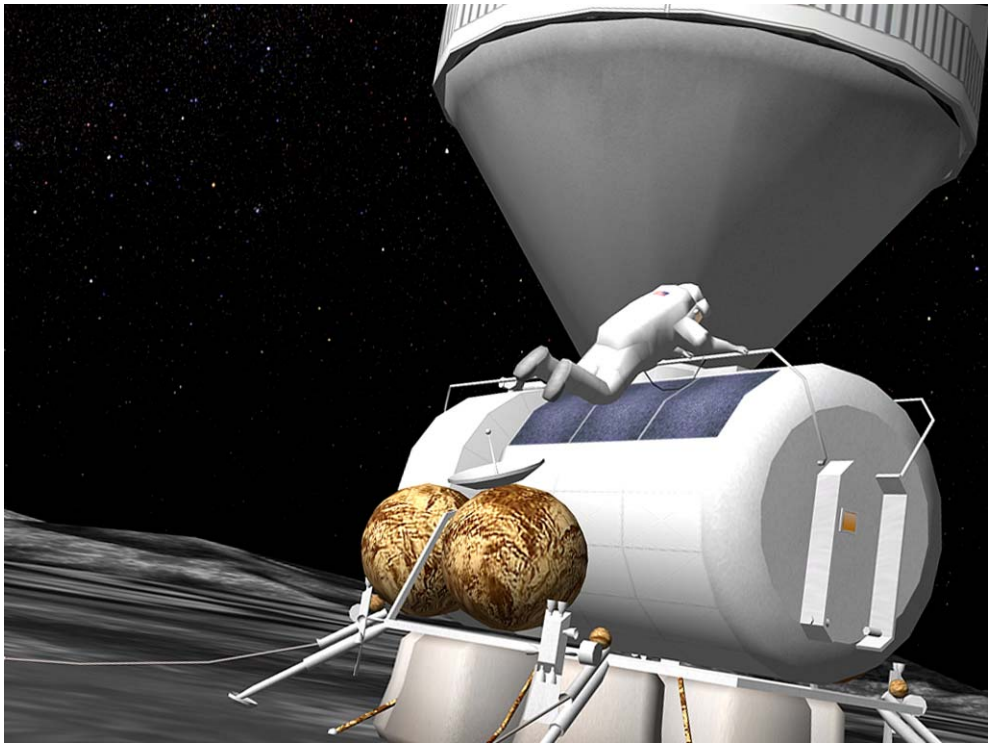

Figure 3: EVA at the NEO, using the LSAM as an airlock. An EVA at the NEO could enable the collection of up to 100 kg of sample for return to Earth (DigitalSpace).

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