Paper ID: 81262
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IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Human Space & Exploration (8)

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ELEVEN COUNTRIES, AN INTEGRATED SPACECRAFT: THE STORY OF INTERNATIONAL COLLABORATION THAT BUILT THE ORION SPACECRAFT AND POWERED THE SUCCESS OF THE ARTEMIS I MISSION

Abstract

The quest to return humans to the Moon in the next step towards humanity's exploration of space is more alive than ever. After a great deal of achievements, failures, and lessons learned, the Artemis I mission set off to the Moon on November 16, 2022, with the goal of testing a new rocket, the Space Launch System, and a new spacecraft, Orion: designed, assembled, and tested across two continents, and 11 countries. Behind this mission, decades of experience with the International Space Station, Autonomous Transfer Vehicle operations, and many other program collaborations built the know-how on how to succeed together in the toughest environment — deep space. The Artemis I mission proved to be an incredible success, meeting 161 total mission objectives, including 21 developed during the flight based on outperforming spacecraft. It was also a case-study in international collaboration, given that ESA, NASA, and industry partners Airbus and Lockheed Martin for the first time had to design, build, test, and fly a fully integrated human-rated spacecraft, with most critical functions dependent and interconnected across U.S. and European systems. The U.S.-built Orion Crew Module and Crew Module Adapter and European-built European Service Module (ESM) shared critical interfaces and commodities, from propulsion, avionics, active/passive thermal, electrical power generation, storage and distribution to the software that managed it all. In this paper, we will describe relevant aspects of the integrated spacecraft design, providing context for the challenges that the team faced in all phases required to get Orion ready to fly, and provide a direct account of how the joint team formed, trained, and supported the operations of the successful Artemis I mission. We will also explore the evolution of the partnerships,

given that these allow a multi-national effort to sustain the program production, share costs, leverage a broader base of engineering expertise, and build more diverse capabilities over the long haul to support the Artemis goals and objectives. Lastly, we will cover critical lessons learned and how the Orion Program has implemented these in preparation of the next Artemis missions to repeat the success of Artemis I. The purpose of this paper is to document knowledge we gained and lessons we learned through the development of an integrated Orion spacecraft, since it is imperative we build on this now, at the dawn of the Artemis Program, an international endeavor to push human space exploration.