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SPACE SYSTEMS SYMPOSIUM (D1)
Cooperative and Robotic Space Systems (6)

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ON-ORBIT MANUFACTURE AND ASSEMBLY OF SPACECRAFT

Abstract

The current paradigm for deploying spacecraft, in which structures are first manufactured and assembled on the ground and then launched into orbit, imposes important constraints on the capabilities that can be fielded. Launch fairings limit the size and shape of space platforms and their payloads. The requirement to harden and test all structures to survive the launch environment further imposes mass and schedule penalties. As an alternative approach, the on-orbit manufacture and assembly of spacecraft may alleviate many of these constraints.

In this study, we first examined (1) space science and exploration missions in decadal surveys and other sources; (2) commercial satellites; and (3) national security missions, to identify those that may benefit substantially—from the perspective of science pay-off or cost-effectiveness–from on-orbit manufacture and assembly. A number of different benefits were identified including improving the quality and quantity of data measured by science instruments, increasing the performance of communications payloads, and enhancing mission resilience. For example, on-orbit assembly offers the possibility to deploy an optical space telescope with an aperture diameter that is a factor of four larger than that achievable with the current, terrestrially-based paradigm, resulting in our ability to identify exoplanets at a rate that was four times greater. On-orbit assembly can also facilitate the technology refresh of communications payloads midway through platform life in order to generate revenue growth. The ability to install different payloads through on-orbit assembly, and the on-demand ability to manufacture tools and repairs on-orbit, provide increased mission flexibility and resilience.

We next reviewed the state-of-the-art in on-orbit manufacture and assembly assessing the current status of RD. While several private organizations are investing in RD related to orbital manufacturing and assembly, government agencies—principally NASA, DARPA, and ESA—have played a leading role. We find that both on-orbit manufacture and assembly must overcome challenges posed by the harsh space environment including phenomena such as micro-gravity, day and night cycling, atomic oxygen, and radiation. While additive manufacturing has been conducted recently on the International Space Station, on-orbit manufacturing is assessed overall to be a nascent technology that faces important challenges. By comparison, on-orbit assembly is likely to make a nearer term impact due to the required technical foundations being laid by on-going activities in on-orbit inspection and servicing.