

SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND
DEVELOPMENT (D3)

Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and
Development (3)

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THE PROMISE AND REALITIES OF ADDITIVE MANUFACTURING IN SPACE

Abstract

Additive manufacturing (AM), also referred to as three-dimensional (3D) printing, is a set of layer-by-layer processes for producing 3D objects directly from a digital model. Since its inception a few decades ago, the AM industry has grown to almost *3 billion as of 2012, and is poised to grow to more than 6.5 billion by 2019*. While the field has great promise for terrestrial applications, its promise in space has the potential to radically transform the space enterprise.

By enabling manufacturing of hardware to occur entirely in space, AM has the potential to: (i) reduce the amount of payload that must be transported into space thus lowering launch costs, (ii) allow the design and manufacturing of materials and parts that cannot be created in a terrestrial environment (e.g., gossamer sails, trusses, and other structures that can only function in zero gravity), (iii) allow the design and manufacturing of materials and parts that cannot handle vibrations and other structural loads of a rocket launch, (iv) transform operations and logistics planning (via the ability to launch broad categories of materials that can be manufactured in situ into a range of parts with a wide variety of functionality) including on-orbit repair and maintenance that has the potential not only to increase life of satellites and spacecrafts, but also offer the promise of reducing space debris, (v) eventually build fully-functional spacecraft entirely in space using in-situ resources from extraterrestrial planetary bodies. Building on ongoing work at the National Academy of Sciences', this paper discusses not only the potential of AM in space, but also current developments in the United States and Europe, the limitations of current space-based techniques and technologies as applied to space, and the efforts and investments required - technological, institutional, and legal - to make the dream a reality.