

## Development of Liquid Propulsion Systems Testbed at MSFC

Reginald Alexander, Graham Nelson

As NASA, the Department of Defense and the aerospace industry in general strive to develop capabilities to explore near-Earth, Cis-lunar and deep space, the need to create more cost effective techniques of propulsion system design, manufacturing and test is imperative in the current budget constrained environment. The physics of space exploration have not changed, but the manner in which systems are developed and certified needs to change if there is going to be any hope of designing and building the high performance liquid propulsion systems necessary to deliver crew and cargo to the further reaches of space.

To further the objective of developing these systems, the Marshall Space Flight Center is currently in the process of formulating a Liquid Propulsion Systems testbed, which will enable rapid integration of components to be tested and assessed for performance in integrated systems. The manifestation of this testbed is a breadboard engine configuration (BBE) with facility support for consumables and/or other components as needed. The goal of the facility is to test NASA developed elements, but can be used to test articles developed by other government agencies, industry or academia. Joint government/private partnership is likely the approach that will be required to enable efficient propulsion system development.

MSFC has recently tested its own additively manufactured liquid hydrogen pump, injector, and valves in a BBE hot firing. It is rapidly building toward testing the pump and a new CH<sub>4</sub> injector in the BBE configuration to demonstrate a 22,000 lbf, pump-fed LO<sub>2</sub>/LCH<sub>4</sub> engine for the Mars lander or in-space transportation. The value of having this BBE testbed is that as components are developed they may be easily integrated in the testbed and tested.

MSFC is striving to enhance its liquid propulsion system development capability. Rapid design, analysis, build and test will be critical to fielding the next high thrust rocket engine. With the maturity of the BBE testbed, MSFC propulsion engineering will bring forward a national capability that enables growth of both commercial and government interests.