MAJORITY OF SATELLITES EXCEED DESIGN LIFE

By KRISTINE L. FERRONE
The Aerospace Corporation

The 2019 Satellite Lifetime Study surveyed design and actual life of U.S. military, civil, commercial, and foreign commercial satellites launched between 1980 and 2018. The scope was limited to free-flying, Earth-orbiting satellites with mass greater than 100 kg and design life greater than 1 month. Design life is determined from requirements documents or published values. End of life is defined as the loss of the primary mission (primary payload failure, bus failure, out of operational orbit) or retirement. Actual life is defined as the time between successful launch and end of life and does not include secondary missions.

MISSION ASSURANCE SUMMIT

SPACE PROGRAM LEADERS ADDRESS THE FUTURE OF MISSION SUCCESS

By ALISON BAUERLEIN
The Aerospace Corporation

Leaders from every major U.S. space program gathered at The Aerospace Corporation’s office in Chantilly, Virginia, in mid-November to discuss the challenges facing the future of space. The Mission Assurance Summit aimed to spark discussion of the new operational demands and security threats in space.

“What we’ve always called ‘mission assurance’ is no longer just about the success of an individual launch,” said Steve Isakowitz, Aerospace president and CEO. “It’s about creating resilient architectures and capabilities while also unfailingly delivering the individual space vehicles, ground functionality, and launches that build those architectures. I’m pleased that the space community came together to focus on how we can jointly keep ahead of emerging threats, innovate solutions that incorporate resilience, and allocate the resources needed to build a new space enterprise.”

Participants included government executive leaders from Air Force Space Command, members of the Intelligence Community, the Missile Defense Agency, NASA, NOAA, the Space Development Agency, and the Air Force Space and Missile Systems Center.

“NOAA’s satellites play an important role in helping protect lives and property,” said Dr. Neil Jacobs, assistant secretary of commerce for environmental observation and prediction at the National Oceanic and Atmospheric Administration. “Given our reliance on space, it’s more important than ever that the public and private sectors work together to assure the success of NOAA’s mission. With that goal in mind, the Mission Assurance Summit was a great example of how the civil, military, intelligence, and commercial communities can work together to bring innovative approaches to mission assurance.”

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How to Adopt Additively Manufactured (AM) Structures

By BRETT E. SOLTZ
The Aerospace Corporation

AM structures are being used in a growing number of space system applications. Although AM can be attractive from design, schedule, and manufacturing perspectives, variability in material properties can be significant. This variability poses a concern that needs to be managed to ensure mission success.

A practical approach on how to adopt AM structures for national security space programs has been published. The degree of testing required is dependent on the type of hardware and is typically defined in existing standards. Verification may include performance, functional, vibration, shock, acoustic, thermal, pressure, and structural testing during qualification and acceptance. Verification requirements for AM hardware are no less than traditional hardware requirements, especially when new technology and manufacturing techniques are involved.

A flight-critical assessment provides insight into the consequences, including system failure, degraded performance, or instrumentation failure. System-level impacts could arise from contamination, impact damage, loss of conductivity, or loss of integrity or stiffness. Understanding how a part’s failure modes can affect system-level performance is a key step in determining the extent of qualification and acceptance testing that is required for AM structures.

Similar to other process-sensitive hardware, proof testing of flight-critical AM structures is recommended to verify manufacturing and to ensure as-built hardware will survive a mission without failure or degradation. Less structural verification effort is required for nonflight-critical structures. The scope of structural verification activities should be based on the criticality of the AM part and the risk tolerance of the program.

As AM technology and process monitoring advance, AM hardware could become even more repeatable and robust compared to traditional manufacturing methods. If this future state is achieved, an update to test requirements would be warranted.

This study was published as TOR-2019-02060.

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CONTRAST-BASED MISSION ASSURANCE

By LEE JASPER
Space Dynamics Laboratory
Utah State University

In the space industry, missions are built with objectives driving all aspects, based on a requirements-driven model that considers technical, cost, schedule, and other resourcing.

Conversely, small satellites are typically designed in a multiconstraint environment. Focus is placed on designing a concise outline of how small satellites and restricted missions are developed. A framework has been established that provides an alternative path from traditional requirements-driven development.

The framework develops a process in which scope and requirements are tradeable attributes. The methods for understanding the balance between scope and constraint, recognizing divergence from that balance, identifying methods to address alterations, and establishing a new balance are being researched.

The framework is based on agile software development concepts but is also derived from multiple programs and missions (big and small) that have gone through similar practices to achieve success.

Key design practices are starting to be adopted and described (e.g., “the spacecraft can survive a tumble,” “full-system power resets periodically occur”), which help increase vehicle resiliency.

The trades between the margins (e.g., excess capability by design) presented in the system and the level of characterization allow for various approaches to help ensure the mission is successful. Ongoing research is exploring how this tradespace can expand outside of traditional practices.

This work was sponsored and performed in coordination with the Air Force Research Laboratory.

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SATELLITES EXCEED DESIGN LIFE
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For the U.S. military and civil satellites, design life more than doubled for class A satellites while remaining constant for classes B and C satellites. In recent years, design life for U.S. military and civil satellites has clustered around long design life (>11 years) and the experimental range (1–3 years) with the overall trend of fewer satellite launches.

The design life for commercial satellites increased by greater than 50% for satellites with cost <$300M and remained flat for satellites with cost >$300M. The launch of high-cost satellites began only in 1994. For commercial satellites, large constellations, including Globalstar and Iridium, dominated the 5–8 year design life category in the 1995–1999 launch range.

With respect to actual life, ~87% of U.S. military and civil satellites and ~75% of commercial satellites met or exceeded their design life. There is a high number of “too early to tell” satellites: These were launched too recently to determine if they will reach their design life. Due to this large number (49 U.S. military and civil, 379 commercial), the percentage of satellites that reach or exceed design life could be altered significantly over time as they reach their end of life.

U.S. military and civil satellites also experienced a higher mean actual life and greater success rate than commercial satellites of the same design life group.

The study will be published in a soon-to-be-released report titled “2019 Satellite Lifetime Study.”

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HOW WELL DO WE KNOW HOW OUR SYSTEM WORKS? (e.g., analysis, testing)

- General Approach: Purposeful design attributes/programmatic approaches reduce need for more extensive testing; need some basis for trust that things will go as planned
- General Approach: Closest category to current standards, with purposeful flexibility built in; more room to negotiate constraints when a problem is identified
- General Approach: Heavy emphasis on project elements such as testing to verify how the system will work; constrained resources will impact response to verification results
- General Approach: Purposeful design attributes/programmatic approaches reduce need for more extensive testing; need some basis for trust that things will go as planned

Trades of technical margin and higher assurance in consideration of constraint-based missions.

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Steve Isakowitz, president and CEO, The Aerospace Corporation, provides opening comments reflecting on the need to expand mission assurance to include resilient architecture and capabilities, while unfailingly delivering space vehicles, ground systems, and launches.

MISSION ASSURANCE SUMMIT
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This year’s theme, “Achieving Enterprise Mission Success,” focused on emerging mission assurance challenges that increasingly include complex integration across different domains and layers with a diversity of partners. The discussion covered a range of topics, including the need to build resilient space architectures and encourage production agility in order to address emerging threats to space systems.

“The U.S. is moving toward a new generation of space systems that is designed for a contested environment, can serve multiple missions, and can rapidly incorporate design, technology, and capability enhancements into production,” said Derek Tournear, director of the Space Development Agency. “To deliver on every element of this undertaking, we will need to build interoperability and resiliency into the enterprise and make sure that our constellations and architectures work together to achieve the mission.”

The two-day conference opened with technical presentation sessions on progress in agility, resilience, and innovation to include advancements with enabling tools (i.e., model-based engineering) and strategies (i.e., defensive cyber operations). The following day focused on an executive session that challenged our most senior government and industry leaders to provide insights into the priorities for ensuring that programs meet the needs of national security space.

“Mission assurance requires us to not only deliver capability that works in the space environment, but to deliver critical and timely capability that works under the stress of warfighting,” said Lt Gen John “JT” Thompson, commander of the Space and Missile Systems Center. “We’ve got to change our legacy paradigms of mission assurance—and get faster at it—across the space enterprise.”

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FIRST AEROCUBES DEFINED USING MBSE
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This fast-paced AeroCube project provided an ideal pathfinder for MBSE implementation.

This opportunity to come together as a space community allows us to explore the many areas where collaboration can reap rewards for the warfighter, the mission, and the nation,” said Maj Gen Michael Guettel, deputy director of the National Reconnaissance Office. Leaders representing government and industry presented on the need for innovative and responsive architectures and a radical departure from traditional paradigms in order to prepare the national security space to continuously outpace threats.

“The summit provided a much-needed chance for the national security space community to re-examine what mission assurance means,” said Lt Gen David “DT” Thompson, vice commander of Air Force Space Command. “The focus of mission assurance must shift from systems to warfighters. What matters most is if the soldiers, sailors, airmen, and Marines in the field can rely on the space capabilities they need to execute their missions.”

This fast-paced AeroCube project provided an ideal pathfinder for MBSE implementation.

A report containing the lessons learned from the pilot MBSE project is released under OTR 2019-01065.

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2020 EVENTS

January 6–10 AIAA Science and Technology Forum, Orlando, FL
January 27–30 Reliability and Maintainability Symposium, Palm Springs, CA
February 4–6 Microelectronics Reliability and Qualification Workshop, El Segundo, CA
March 2–5 Ground System Architectures Workshop, Los Angeles, CA
March 7–14 2020 IEEE Aerospace Conference, Big Sky, MT
March 24–26 Spacecraft Thermal Control Workshop, Torrance, CA
March 31–April 2 32nd Aerospace Testing Seminar, Los Angeles, CA
April 20–23 Space Power Workshop, Torrance, CA
May 5–6 Space Parts Working Group, Torrance, CA
May 5–7 Systems Engineering Forum: Applying MBSE across the Enterprise, Chantilly, VA
May 13–15 45th Aerospace Mechanisms Symposium, Houston, TX