Dynamic ASE Modeling and Optimization of Aircraft with SpaRibs, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

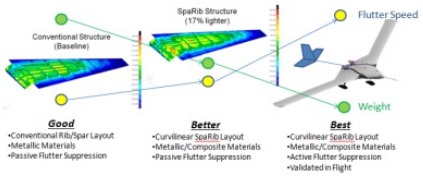
ABSTRACT

In aircraft design, reducing structural weight is often a prime objective, while various constraints in multiple disciplines, such as structure, aerodynamics and aeroelasticity should be imposed on the aircraft. Therefore, engineers need optimization tools to incorporate the multidisciplinary constraints using appropriate fidelity during the early stages of concept design. Classic structural design of aircraft structures is based on the concept of a "wing box" that uses simple components such as straight spars and ribs, quadrilateral wing skin panels and straight stiffeners. A new design philosophy, using curvilinear SpaRibs has been introduced based on emerging manufacturing technologies such as Electron Beam Free Form Fabrication and Friction Stir Welding (FSW). In those innovative technologies, the wing structure is manufactured as an integrated part instead of using mechanically fastened structural components. This design approach makes it possible to design curved substructure that is a hybrid between spars and ribs, therefore called "SpaRibs". These can be designed to have favorable coupling between bending and torsion, and can improve the buckling resistance of local panels. The ability to tailor the bend-twist coupling has been shown to offer substantial improvement in aeroelastic behavior without a weight penalty (or alternately, a weight savings without aeroelastic problems). In this program we will advance this technology to a TRL of 5-6 (or to 6-7 in a Phase III) by designing a subsonic transport wing with better aeroelastic and aeroservoelastic performance, and by designing a test article and test program suitable for proving the performance benefits in flight.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: This technology has the potential to improve the performance of aircraft in subsonic, transonic, and supersonic flight regimes, especially those



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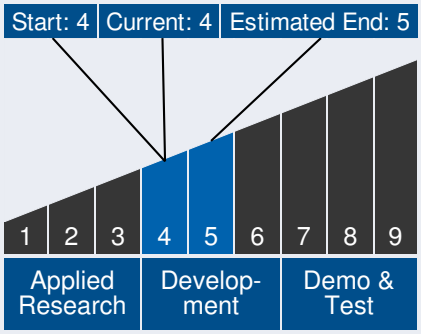
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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vehicles whose performance is significantly impacted by aeroelastic phenomena such as flutter or unfavorable static aeroelastic interactions. As such, this could impact any NASA-sponsored aircraft program. The most immediate application would be to the X-56A program, but follow on applications are likely to include future technology demonstration aircraft such as low-boom demonstrators, HALE configurations, planetary exploration aircraft, etc.

To the commercial space industry:

Potential Non-NASA Commercial Applications: As with the NASA applications, this technology increases aircraft performance for multiple classes of aircraft, so this technology may be applied to aircraft including subsonic transports, UAV's, fighters, supersonic transports, bombers, military transports, and reconnaissance aircraft. A successful flight test program in Phase III could pave the way to widespread adoption of this technology (in whole or in part) by Boeing, Northrop-Grumman, Lockheed-Martin, and a host of smaller airframers.

Management Team *(cont.)*

Principal Investigator:

- Myles Baker

Technology Areas

Secondary Technology Area:
Materials, Structures, Mechanical Systems and Manufacturing (TA 12)

- Structures (TA 12.2)
  - Innovative, Multifunctional Concepts (TA 12.2.5)

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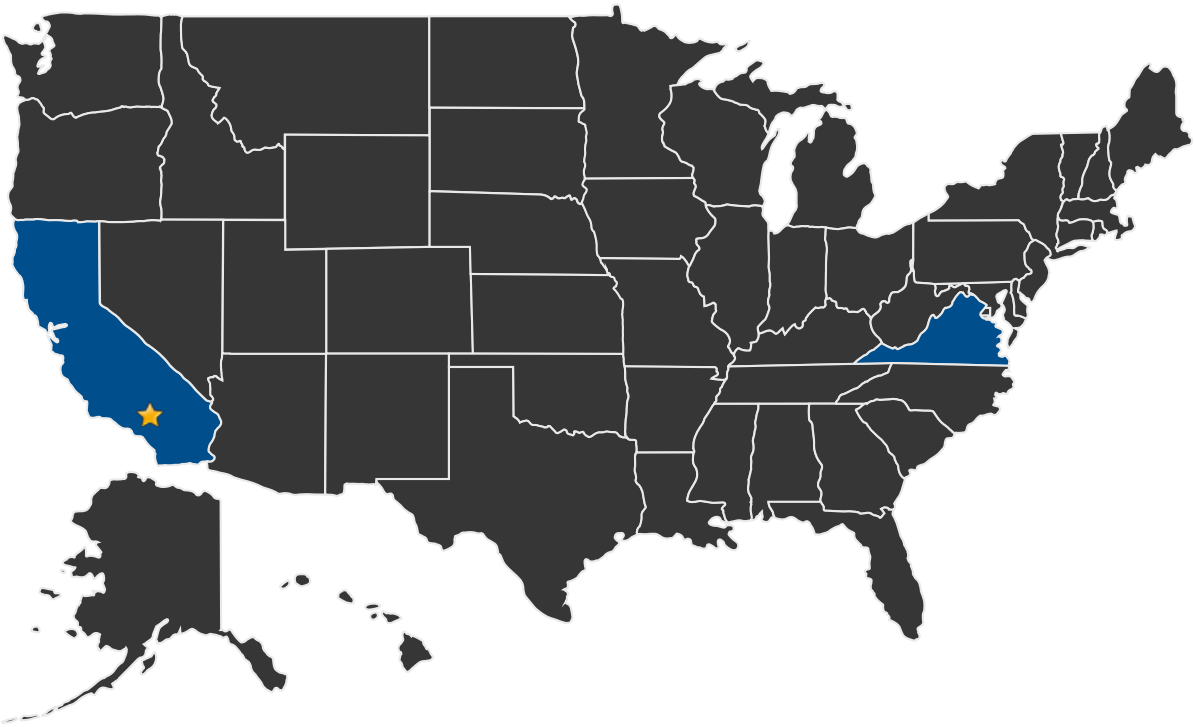
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Armstrong Flight Research Center

Other Organizations Performing Work:

- M4 Engineering, Inc. (Long Beach, CA)
- Virginia Polytechnic Institute (Blacksburg, VA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/17797)

DETAILS FOR TECHNOLOGY 1

Technology Title

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