Scope Title:

Airframe Noise Reduction

Scope Description:

Innovative methods and technologies are necessary for the design and development of efficient and environmentally acceptable aircraft. In particular, the impact of aircraft noise on communities around airports is the predominant limiting factor on the growth of the nation’s air transportation system. Reductions in aircraft noise could lead to wider community acceptance, lower airline operating costs where noise quotas or fees are employed, and increased potential for air traffic growth on a global scale. In support of the Advanced Air Vehicles Program (AAVP), Integrated Aviation Systems Program (IASP), and Transformative Aeronautics Concepts Program (TACP), improvements in noise prediction and noise control are needed for subsonic, transonic, and supersonic vehicles targeted. Solutions are sought that target airframe noise sources and the noise sources due to the aerodynamic and acoustic interaction of the airframe and engines. Innovations in the following specific areas are solicited:

- Prediction and/or mitigation of aerodynamic noise sources including those from the airframe, propulsion-airframe interactions, or aeroacoustic integration effects associated with high-aspect ratio truss-braced vehicles.
- Concepts for active and passive control of broadband aeroacoustic noise sources for conventional, truss-braced, and other advanced aircraft configurations. Technologies of interest include adaptive flow control and noise control enabled by advanced aircraft configurations, including integrated airframe-propulsion control methodologies.
- Innovative design approaches or technologies, including acoustic liner or porous surface concepts, to reduce airframe noise sources and/or propulsion/airframe
aeroacoustic interactions. However, engine nacelle liner applications are specifically excluded.

- System-level noise prediction methodologies for operational aspects (as opposed to certification conditions) of high-aspect ratio, truss-braced subsonic transports, or technology variants thereof.
- Fundamental and applied computational fluid dynamics techniques for aeroacoustic analysis which can be adapted for design purposes.
- Prediction and/or mitigation of aerodynamic noise sources including those from the airframe and those that arise from significant interactions between airframe and high-bypass ratio and/or small-core propulsion systems.
- Prediction of sound propagation from the aircraft through a complex atmosphere to the ground. This should include interactions between noise sources and the airframe and its flow field.
- Innovative source identification techniques for airframe (e.g., landing gear and high-lift systems) noise sources, including turbulence details related to flow-induced noise typical of separated flow regions, vortices, shear layers, etc.

**Expected TRL or TRL Range at completion of the Project:** 2 to 5

**Primary Technology Taxonomy:**
Level 1: TX 15 Flight Vehicle Systems
Level 2: TX 15.1 Aerosciences

**Desired Deliverables of Phase I and Phase II:**

- Research
- Analysis
- Prototype
- Hardware
- Software

**Desired Deliverables Description:**

Concepts, technologies, and tools that enable rapid assessment of the noise impact of novel engine/airframe configurations, mitigate component noise issues associated with novel aircraft configurations, and/or aid in the development and optimization of noise control approaches for component noise sources that enable new aircraft configurations such as truss-braced wing and small-core turbofan engines.

Phase I deliverables can include laboratory demonstrations that establish proof of concept of noise reduction technologies, or applications of novel computational tools with limited scope that demonstrate the potential for success on problems of greater scope.

Phase II deliverables can include system or subsystem demonstrations concurrent with the establishment of a realistic path to concept production, or incorporation of novel computational tools into existing modeling toolchains with validation cases to document capabilities.

**State of the Art and Critical Gaps:**

State-of-the-art technologies for noise reduction on conventional transport aircraft are generally passive and do not
incorporate advanced material systems or adaptive mechanisms that can modify their performance based on the noise state of the vehicle. Advanced material systems for airframe noise control are still in their infancy, especially in the context of certifiability and robustness. Novel material systems that could be applied to component noise sources on the aircraft are needed, such as shape memory alloy actuators, or active or adaptive systems. In addition, future aircraft designs, such as high-aspect ratio, truss-braced configurations, are envisioned that either leverage noise benefits of complex geometrical configurations or introduce noise challenges with engine/airframe integration. Efficient computational tools that enable rapid-turn evaluations of multiple configurations at the design stage are lacking. Numerical methods to study complex engine/airframe configurations are complex and difficult to leverage at the aircraft design stage where configuration details are not specified. Improvements to numerical methods and models for studying the noise aspects of advanced airframe configurations, including engine integration, would ease consideration of acoustics in the design, rather than leaving acoustics to the late design stage where noise control solutions are costly and less effective. Improved tools would also enable more rapid evaluation and development of novel noise control approaches that may be needed for these novel aircraft configurations.

Relevance / Science Traceability:

AAVP: The Advanced Air Transport Technology (AATT) and Commercial Supersonic Technology (CST) Projects would benefit from noise reduction technologies that could reduce the aircraft noise footprint at landing and takeoff. Configurations with novel engine placement, such as above the fuselage, can reduce the noise footprint, but technologies are needed to efficiently model the performance and noise impacts of these novel engine installations. In addition, novel configurations and technologies such as truss-braced wing and small-core turbofan engines will introduce new noise challenges that must be addressed to enable their successful deployment.

TACP: The Transformational Tools and Technologies (TTT) Project would benefit from tool developments to enhance the ability to consider acoustics earlier in the aircraft design process. The TTT project would also benefit from the development and demonstration of simple material systems, such as advanced liner concepts with reduced drag or adaptive material and/or structures that reduce noise, as these component technologies could have application in numerous vehicle classes in the AAVP portfolio, including subsonic and supersonic transports as well as vertical lift vehicles.

References:

AAVP - Advanced Air Transport Technology (AATT)
Project: https://www.nasa.gov/aeroresearch/programs/aavp/aatt

AAVP - Commercial Supersonic Technology (CST)
Project: https://www.nasa.gov/aeroresearch/programs/aavp/cst

TACP - Transformational Tools and Technologies (TTT)
Project: https://www.nasa.gov/aeroresearch/programs/tacp/ttt