Mobility

With air traffic projected to double over the next two decades, the National Airspace System must be capable of accommodating an increased volume of people and goods. The Next Generation Air Transportation System (NextGen) will address this need through the expanded use of secondary and reliever airports, employing a new class of vehicles capable of short takeoff and landing (STOL), or vertical takeoff and landing (VTOL).

CESTOL aircraft can operate from runways with significantly reduced field lengths.

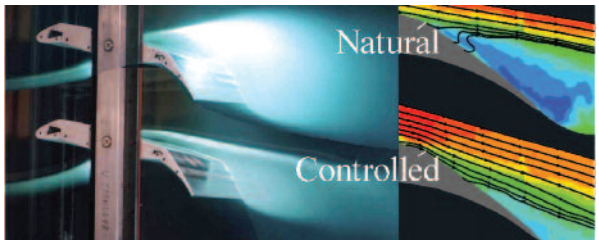
The Fundamental Aeronautics Program is conducting research to develop technologies that will enable new vehicle concepts that can alleviate future capacity problems in support of NextGen. These concepts include:

- Cruise-Efficient Short TakeOff and Landing (CESTOL) aircraft that cruise at high speed (Mach 0.8+) with low environmental impact, yet can take off and land on very short runways
- Advanced rotorcraft, such as large civil tiltrotors, that are capable of VTOL or STOL with vastly improved range and performance and reduced environmental impact

CESTOL Research

Research in support of CESTOL concepts seeks to develop powered-lift technologies to increase lift on an aircraft at low speeds, such as during takeoff and landing, while decreasing drag at high speeds to maintain efficient cruise. Powered-lift and active-control concepts can enable significantly shorter field lengths for a given vehicle weight.

The technology concepts being studied include steady and pulsed injection, vortex generators, upper surface blowing, and fluidic devices on flaps for purposes of circulation and boundary layer control. Advanced computational fluid dynamics (CFD) tools are being developed to improve modeling of complex high-lift systems and prediction of flow separation, with wind tunnel tests providing data for model validation. In addition, adaptive flight control methodologies are being developed to enable control of aircraft that have very different flying qualities during different parts of a mission.



Active flow control enables increased lift for takeoff and landing.

Advanced Rotorcraft Research

The challenges faced in rotary wing aviation are among the most complex and demanding of any configuration:

- Highly complex, three-dimensional rotor and fuselage structures
- Unsteady flows in speed regimes, from low subsonic to high transonic
- Dynamically stalled components
- Harsh operating environments
- Highly loaded propulsion systems
- A vehicle that is statically unstable

Nevertheless, expanding rotorcraft capabilities will help to increase capacity and reduce congestion at airports. These two key require-

A large civil tiltrotor offers the potential for significant increases in capacity and reduction in airport congestion to meet NextGen requirements.

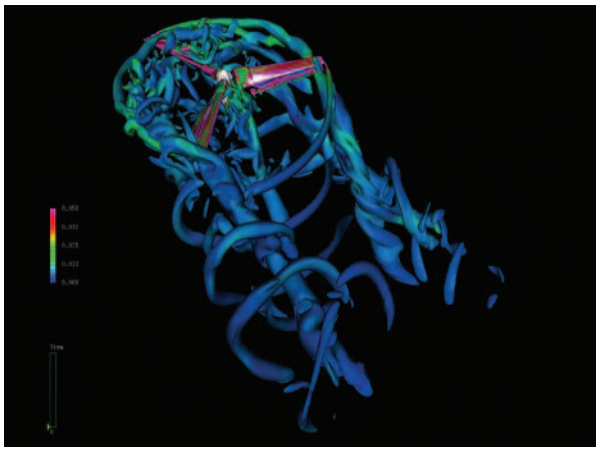
A wind tunnel test of the SMART rotor concept in the National Full-Scale Aerodynamic Complex, 40x80-foot wind tunnel, demonstrates the effectiveness of actively controlled blade trailing-edge flaps for noise and vibration control.

ments are tied to the development of NextGen. To this end, the Subsonic Rotary Wing Project focuses research in the most persistent technical challenge areas, producing advances in prediction-tool capability and technology in order to expand the role of rotorcraft in civil aviation. The result will be new configurations and missions that can be developed efficiently and confidently.

Technical Challenges

Studies are focused on areas that industry and other government agencies are not pursuing or cannot pursue alone. Without intending to predict where the design process will lead when truly effective design and analysis tools are available, several challenging but promising rotorcraft configurations have been identified to drive the required fundamental research. For dramatic breakthroughs in rotorcraft to be achieved, the technical challenges require an approach that integrates aeronautics disciplines. For example:

- **Integrated aeromechanics/propulsion system research** develops and demonstrates technologies enabling variable-speed rotor concepts. The technical challenge is to reduce main rotor tip speed at high-speed-cruise operating conditions with a variable-speed propulsion concept capable of 50-percent speed reduction from hover to cruise while maintaining aerodynamic efficiency. High-speed advanced rotorcraft concepts, noise reduction concepts, and efficient operations concepts depend on meeting this challenge.
- **Actively controlled, efficient rotorcraft research** assesses several active control rotorcraft concepts for effectiveness in the simultaneous goals of increased aerodynamic efficiency, dynamic stall control for high speed conditions, vibration reduction, and noise reduction. Research also will validate and improve the capability to predict rotorcraft behavior, including performance, airloads, flow field, structural loads, and acoustics through collaborative research in CFD and advanced experimental methods.
- **Quiet cabin research** develops and demonstrates advanced structural concepts and design evaluation methods for interior noise and vibration reduction using optimized combinations of new material, acoustic treatment, new structural design incorporating acoustic passive and active technology, reductions in transmission gear vibration, and active noise cancellation.
- **NextGen rotorcraft research** fosters, develops, and demonstrates technologies that contribute to the commercial viability of large rotary wing transport systems in NextGen.



Advanced CFD-based simulation tools are being developed and validated to predict the aerodynamic performance of rotorcraft.

Cruise-Efficient Short TakeOff and Landing (CESTOL) and large civil tiltrotor aircraft will significantly increase capacity in the future air transportation system by enabling operation from airports with shorter runways.