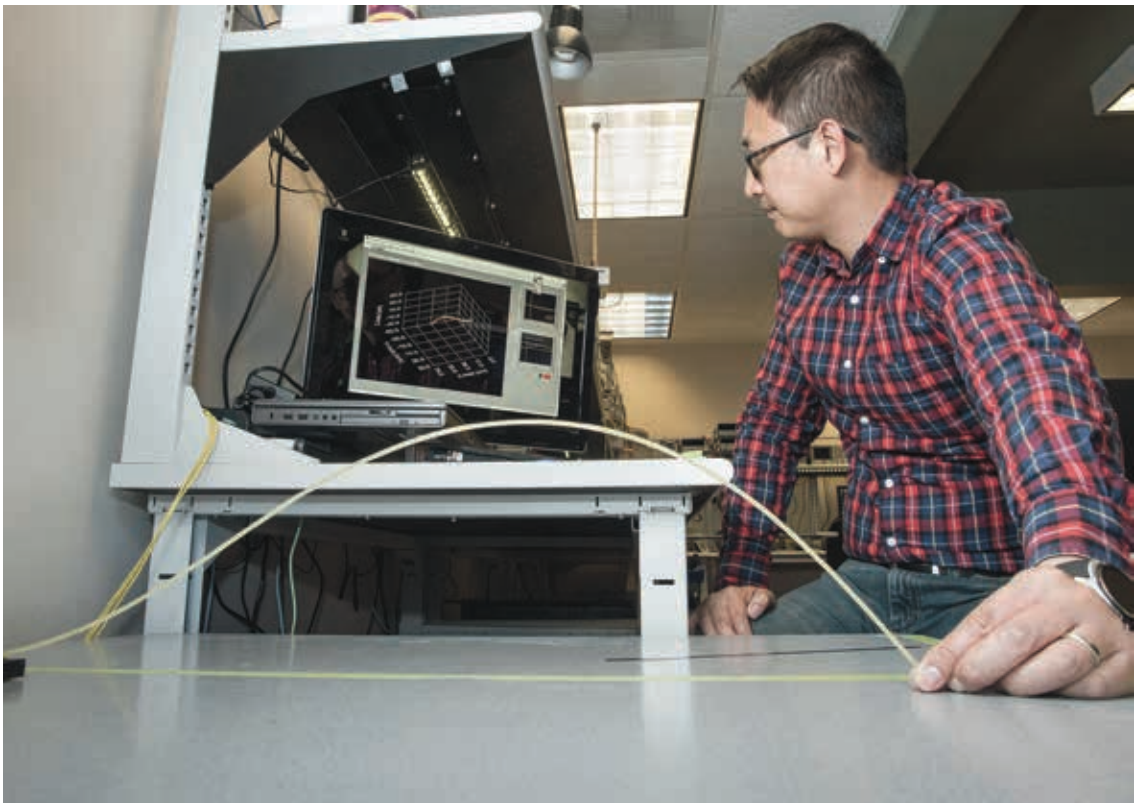
NASAfacts

# Fiber Optic Sensing System



Patrick Chan demonstrates one way that the Fiber Optic Sensing System is used by bending a fiber with a 3D representation of the fiber's shape as it bends. (NASA / Ken Ulbrich)

A Fiber Optic Sensing System (FOSS) developed for aeronautics research at NASA's Armstrong Flight Research Center in California has the potential to solve a number of technical challenges not only for the agency, but also for industries as diverse as medical, power, beverage and automotive.

In the past, collecting aerodynamic data from research aircraft and transmitting it required infrastructure including miles of wires, harnesses to keep those wires in place and bulky sensors that added weight and complexity to aircraft systems.

Armstrong researchers have been working on a simpler, lightweight solution for the system's electronics that were nearly table sized, but soon will fit in a container the size of a box of cookies.

FOSS has the potential to be game changing in the way flight instrumentation is envisioned. High-speed monitoring and sensing technology is enabled with efficient algorithms for use in determining strain, shape deformation, temperature, liquid level and operational loads – in real time.

FOSS uses up to a 40-foot, hair-like optical fiber that provides up to 2,000 data points. The system processes information every quarter inch along the fiber at rates up to 100 times per second, representing a sizable improvement compared to previous implementations of the technology.

**Flight research**

It is this real-time processing capability that led to NASA's incorporating FOSS on the unmanned X-56 Multi-Utility Technology Testbed aircraft.

The X-56 is tasked with investigating flexible wings to improve safety, efficiency and ride quality. FOSS will enable researchers to see dynamic changes on the wings that could result in flutter by quickly collecting strain data.

The vision and ultimate goal for FOSS are that it will collect information on how aerodynamic forces affect an aircraft in real time and then feed that information directly into the aircraft's control system for fuel efficiency, safety and create a more comfortable ride for passengers.

**The future for FOSS**

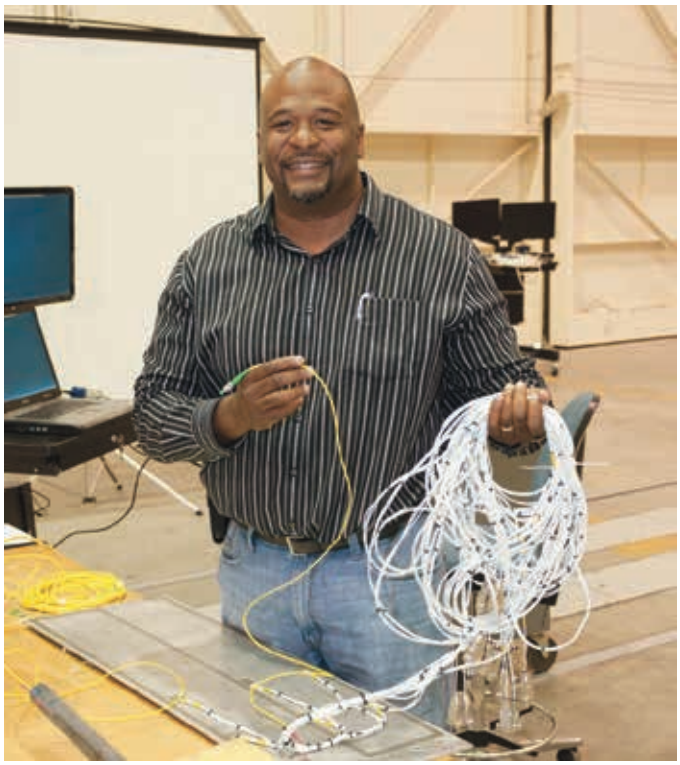
When FOSS and its complexity required for robust aircraft and spacecraft systems are simplified, it is anticipated that commercial interest will grow for the FOSS technology. Oil, gas, dairy and other industries have inquired about a simpler system that can help with a number of different applications.

NASA's Aeronautics Research Mission Directorate's Flight Demonstrations and Capabilities project and Transformative Tools and Technologies project have funded development work to advance the FOSS technology.

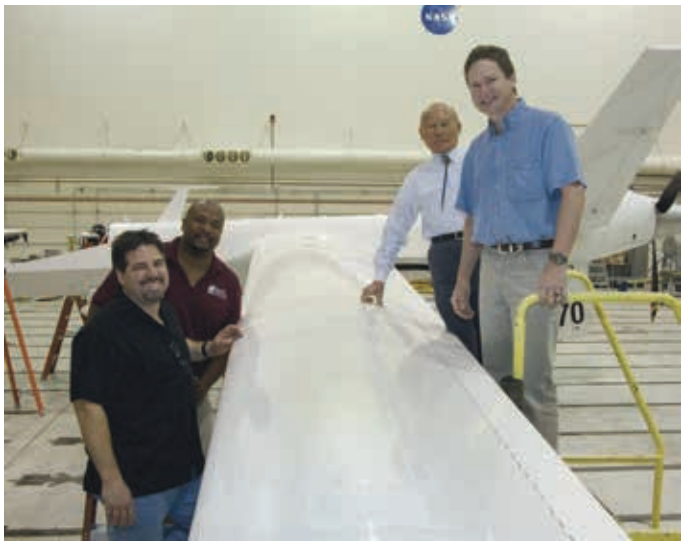
FOSS is also being refined for launch vehicles, with a focus on monitoring liquid fuel levels, temperatures and strain on spacecraft.

Armstrong, NASA's Langley Research Center in Virginia, NASA's Kennedy Space Center in Florida, NASA's Johnson Space Center managed White Sands Test Facility in New Mexico and NASA's Engineering and Safety Center in Virginia are partnering on composite overwrapped pressure vessels, or COPV, tanks from Space X. The tanks, which are instrumented with FOSS, are expected to be tested at NASA's Marshall Space Flight Center in Alabama.

The fiber optic system will be examined for effectiveness of the COPV. The FOSS would provide real-rime data on strain and temperature in the unforgiving environment of cryogenic liquids and extreme pressures. Information gathered from that research could improve models and the design of rocket COPV systems.



The metallic panel has conventional and fiber optic sensors. The white bundle of cables contains 100 conventional strain gages, the single yellow cable about 350. Armstrong aircraft have been used in validation of fiber optic sensors. (NASA / Tony Landis)



NASA's unmanned Ikhana aircraft was the first to fly with the fiber optic wing shape sensor. That team included, clockwise from left, Anthony "Nino" Piazza, Allen Parker, William Ko and Lance Richards. (NASA / Tom Tschida)

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