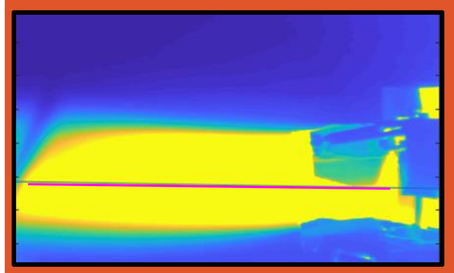
Requirements

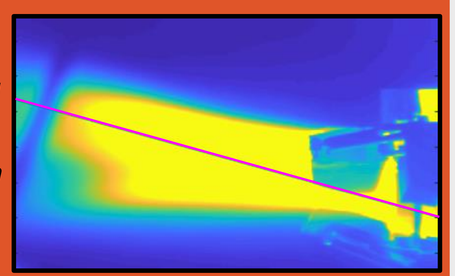
- The APOP team will modify a JetCat P100-RX to prevent windmill RPM at high Mach freestream conditions when the engine is powered off.
- The JetCat will be able to thrust vector in 1-2 axis with a 10° angle that is not a detriment to the overall straight line thrust.

Design Solution

- A TVC derived from the NASA F-18 High Alpha Research Vehicle (HARV) was scaled down using the initial design studies available from NASA. simulations were used to verify that the differences in nozzle pressure ratio and geometry would not invalidate the system.
- No existing solutions were found for the windmilling portion of the challenge, so the team brainstormed until settling on a “key” block that would hold the turbine shaft nut stationary, and could be retracted using the TVC. This can be seen in the cutaway figure to the right.



Infrared imaging of the unvectored (left) exhaust plumes, with vectoring angle shown

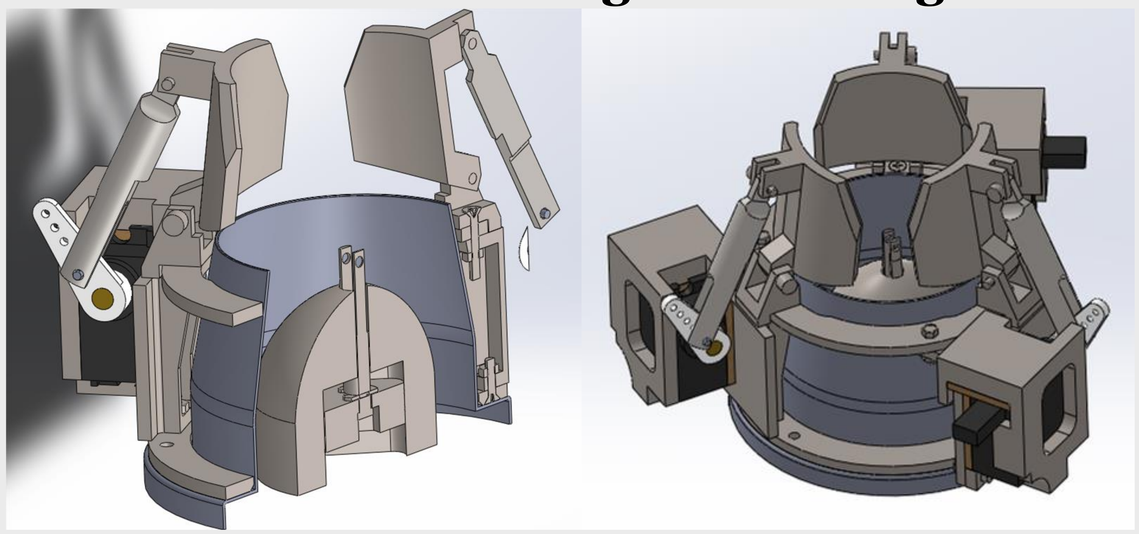


Infrared imaging of the vectored (left) exhaust plumes, with vectoring angle shown

Oregon State University

APOP

Aerospace Propulsion Outreach Program: A Gas Turbine Engine Challenge



Final Anti-Windmilling and Thrust Vectoring Package CAD model

An Annual Challenge

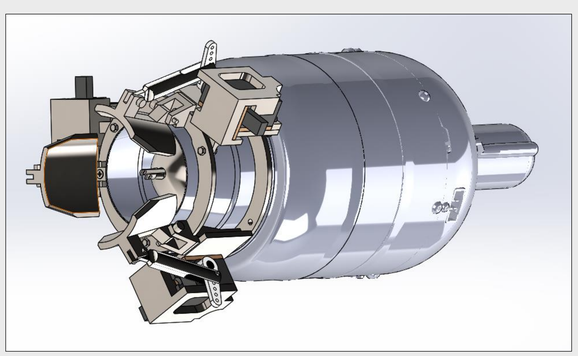
The Air Force Research Laboratory (AFRL) issues a challenge to participating universities each year to modify a small (22.5 lbf thrust class) engine. Past challenges have included designing an afterburner and improving the thrust to weight ratio.

This year’s challenge was inspired by a drone under the wing of a carrier aircraft:

Keep the engine from spinning while exposed to flight conditions, and develop a Thrust Vectoring Control (TVC) system for maneuverability.

Testing

- The un-vectored thrust of the engine was measured using an S-type load cell.
- Infrared videos of the CO_2 emissions (left) in the engine exhaust were used to visualize the flow leaving the engine and verify that 10° of vectoring was achieved.
- An industrial blower that provided a pressure face simulating the conditions in a high-mach free-stream was used while the engine was not running and the Anti-Windmilling mechanism was in place to verify that the engine would not spin.



CAD model of assembly mounted to engine

Photo of assembly mounted to engine

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PROJECT SPONSOR
Air Force Research Laboratory

Project status

- The Thrust vectoring assembly has been completely manufactured and tested. These tests have lead to further redesigns and testing.
- The anti windmilling assembly has been manufactured and tested. Further testing will be conducted to support future revisions.

OREGON STATE UNIVERSITY 2019 2020 APOP AIAA