Collins Aerospace
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ACOUSTIC EXHAUST TECHNOLOGY DEMO

CLEEN III Consortium Public Industry Day

May 2024

RTX

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Pratt & Whitney
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Raytheon
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STRATEGIC BUSINESS UNITS

ADVANCED STRUCTURES
Based in Charlotte, North Carolina

- Actuation
- Landing systems
- Nacelle systems
- Flight controls
- Pilot controls
- Propellers
- Naval composites
- Other highly engineered structures

AVIONICS
Based in Cedar Rapids, Iowa

- Aircraft sensors
- Avionics systems
- Cabin management systems
- Fire protection
- Hoist & winch systems

CONNECTED AVIATION SOLUTIONS
Based in Annapolis, Maryland

- Airport systems
- Applications, analytics & data products
- Business aviation flight support services
- Connectivity & network services
- Passenger & freight rail control systems

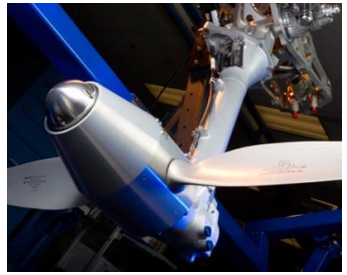
INTERIORS
Based in Winston-Salem, North Carolina

- Aircraft seating
- Cargo systems
- De-icing products
- Evacuation systems
- Galleys & galley inserts
- Interior systems
- Lavatories
- Life rafts
- Lighting
- Potable water systems
- Veneers

MISSION SYSTEMS
Based in Cedar Rapids, Iowa

- Communication, navigation & guidance
- Electronic warfare
- Ejection seats
- Intelligence, surveillance & reconnaissance
- Missile actuation
- Simulation & training
- Space solutions
- Strategic command and control
- Unmanned aircraft systems

POWER & CONTROLS
Based in Windsor Locks, Connecticut



- Air management
- Airframe controls
- Electric systems
- Engine controls

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SUSTAINABILITY AT COLLINS AEROSPACE

CONNECTED ECOSYSTEM

Providing end-to-end digital solutions to enable more predictable and fuel-efficient airline, airport and air traffic operations.

ADVANCED STRUCTURES

Ensuring our components and systems are designed to be the lightest, most energy-efficient and safest products made, reducing aircraft fuel consumption and contributing to overall aircraft energy efficiency.

ALTERNATIVE POWER SOURCES

Supporting 100% SAF-ready fuel propulsion system components, hybrid-electric propulsion and hydrogen propulsion concepts.

INTEGRATED SOLUTIONS

Creating new opportunities to design for sustainability with a holistic view of the aircraft and its systems.

↓ 15%  REDUCED GREENHOUSE GAS (GHG) EMISSIONS BY 2025 FROM 2019

10% RENEWABLE ELECTRICITY USAGE BY 2025

↓ 2.5%  REDUCED ENERGY CONSUMPTION BY 2025 FROM 2019

↓ 10% REDUCTION IN WATER CONSUMPTION BY 2025 FROM 2019

↓ 10%  REDUCTION IN WASTE SENT TO LANDFILL & INCINERATION BY 2025 FROM 2019

100% IMPLEMENT WATER, WASTE, GHG & ENERGY BEST PRACTICES BY 2025

By 2030: 46% reduction in our operational GHGs (from 2019) in line with the Paris Agreement

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New and expanded technologies & solutions

- Improvements in engine efficiency
- Aircraft system improvements
- Alternative Aviation Fuels
- Trajectory and ground operations improvements

Sustainable aviation

Solutions to help civil aviation achieve net zero CO_2 emissions by 2050.

Route and operations optimization

Providing end-to-end digital solutions to enable more predictable and fuel-efficient airline, airport and air traffic operations.

- Aircraft data management and connectivity
- Ground systems
- Improved air traffic management technologies
- Integrated avionics systems
- Weather sensing and processing

Lighter-weight, energy-efficient systems

Ensuring our components and systems are designed to be the lightest, most energy-efficient and safest products made, reducing aircraft fuel consumption and contributing to overall aircraft energy efficiency.

- High-density power conversion
- Nacelles
- More electric systems
- Environmental controls
- Landing gear systems
- Interiors

Sustainable aviation fuels

Supporting "drop in" Sustainable Aviation Fuel (SAF) with 100% SAF-ready fuel propulsion system components, such as fuel controls, pumps and engines.

Engine efficiency

Continuously striving to improve our current line of engines to deliver maximum performance and efficiency, reducing emissions in use

- Enhancing GTF architecture
- High-temperature materials
- Reducing propulsion system weight

Hybrid-electric propulsion

Optimally pairing aircraft engines with electric motors, battery systems and controls to reduce fuel needs and emissions.

- High-density machines
- Power distribution and safeties
- Energy management

Hydrogen propulsion concepts

Developing advanced concepts for hydrogen-burning aircraft engines and hydrogen fuel cell electric propulsion, as well as hydrogen storage and distribution systems, to result in zero-carbon emissions.

- Fuel cells
- Engine
- Hydrogen storage
- Distribution
- Sensing

Raytheon Technologies

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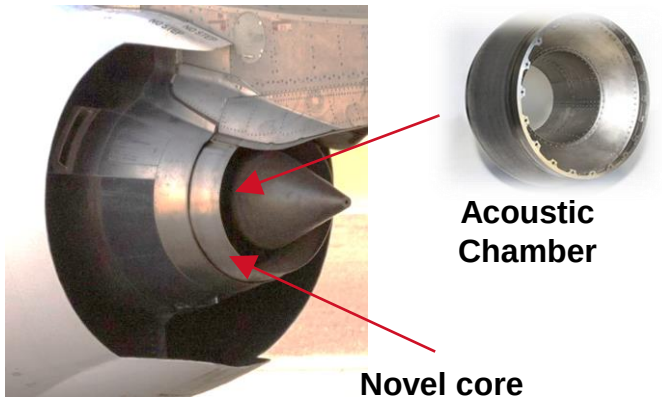
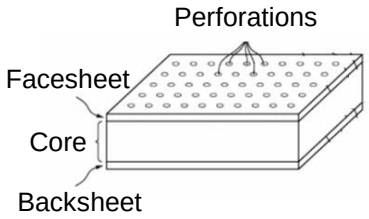
Advanced Acoustic Exhaust





Benefits:

- Noise Reduction: 0.9-1.5 EPNdB

Risks / Mitigations:

- Novel core producibility with exhaust relevant materials is unknown / Perform fabrication trials
- Close tolerances of bonding skins / Assess build repeatability

Objectives:

- Demonstrate an advanced acoustic exhaust
- Advance manufacturing maturity/producibility of novel cores

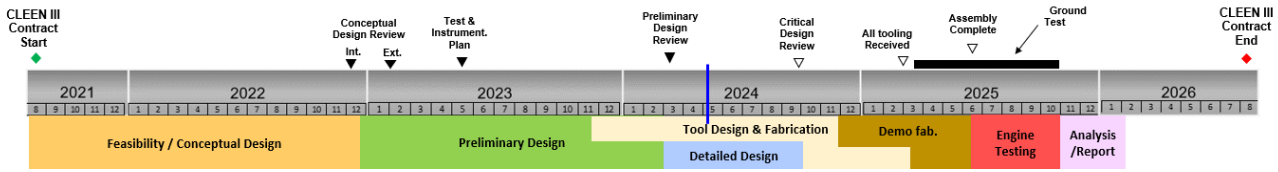
Work Statement:

- Novel core geometries tuned to exhaust tones
- Manufacturing feasibility studies with relevant alloys
- Flat panel mechanical and acoustic property tests
- Demonstrator design, fabrication, and acoustic testing

Progress Update:

- Demo Preliminary Design Review
- Demo fabrication & assembly planning
- Tooling designs
- Sandwich panel mechanical, thermal, acoustic tests

Schedule:



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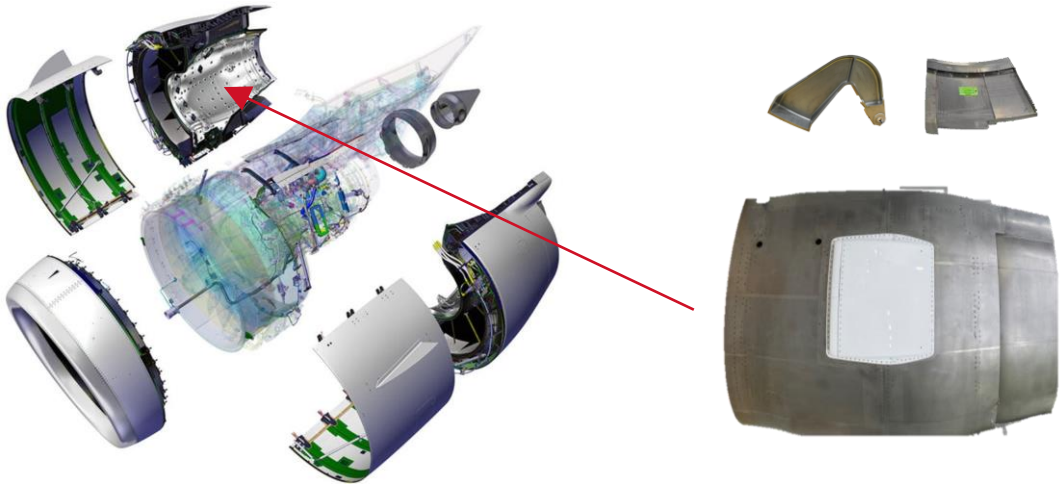
Acoustic Titanium Inner Cowl



Benefits:

- Fuel Burn Improvement (TSFC): 0.3-0.5%

Risks / Mitigations:

- Quality of large VSPF skins a function of many variables / Perform fabrication trials, create & validate process models
- Additive primary & secondary structures are low maturity / Design, build, assess relevant parts

Objectives:

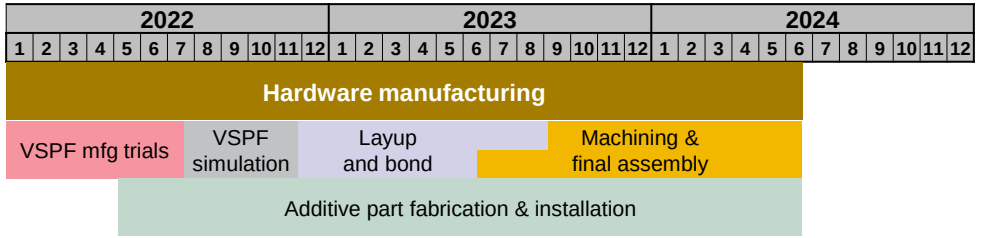
Advance manufacturing maturity/producibility

- Acoustic bond panel assemblies
- Additively manufactured hinges & fittings

Work Statement:

- Vacuum super-plastic forming (VSPF) manufacturing trials
- Vacuum super-plastic forming process simulations
- Additive part TRL/MRL advancement

Schedule:



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THANK YOU!