NASA Aeronautics Research Mission Directorate Overview for the Environment & Energy Study Institute (EESI)

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November 18, 2020

NASA Aeronautics Strategies for Research

https://www.nasa.gov/sites/default/files/atoms/files/sip-2019-v7-web.pdf

Safe, Efficient Growth in Global Operations

- Achieve safe, scalable, routine, high-tempo airspace access for all users

Innovation in Commercial Supersonic Aircraft

- Achieve practical, affordable commercial supersonic air transport

Ultra-Efficient Subsonic Transports

- Realize revolutionary improvements in economics and environmental performance for subsonic transports with opportunities to transition to alternative propulsion and energy.

Safe, Quiet, and Affordable Vertical Lift Air Vehicles

- Realize extensive use of vertical lift vehicles for transportation and services including new missions and markets

In-Time System-Wide Safety Assurance

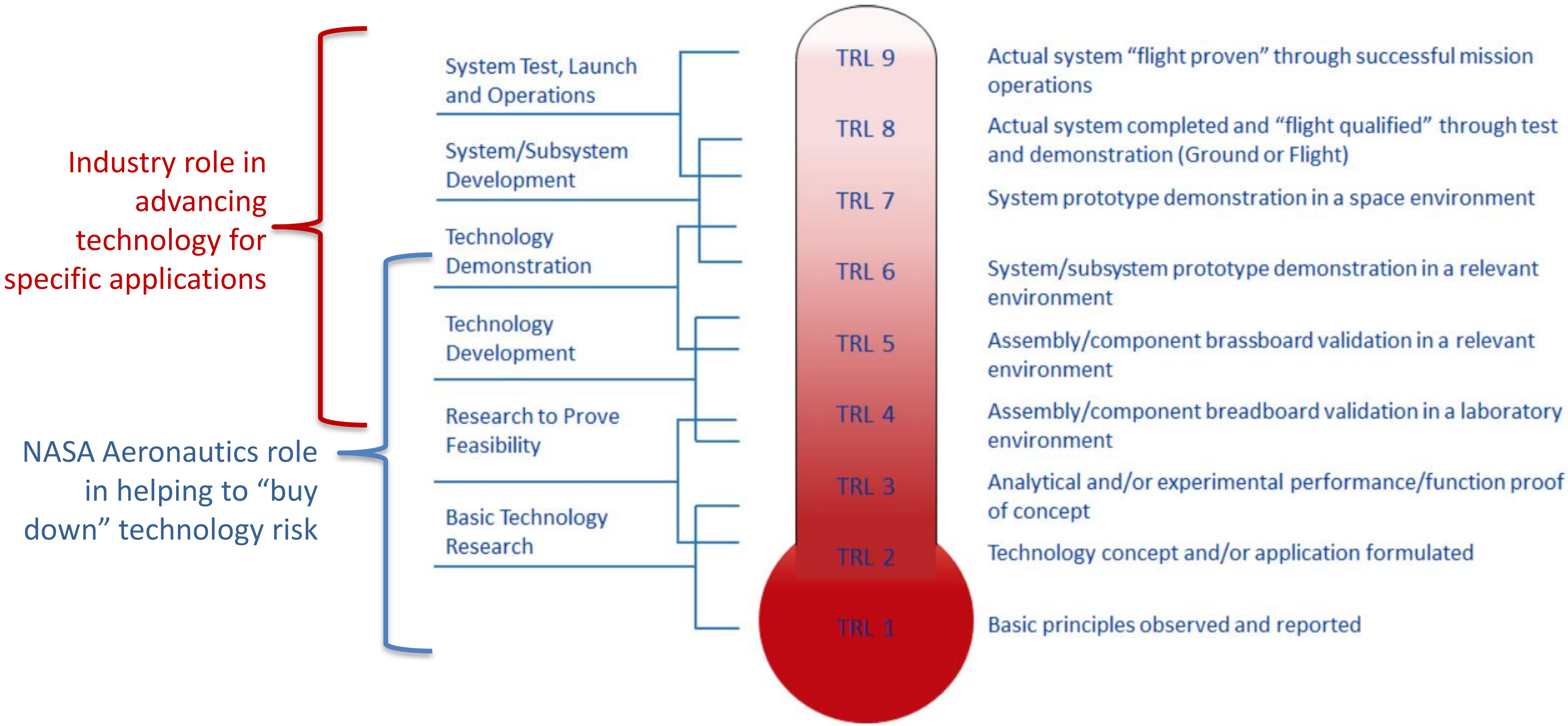
- Predict, detect and mitigate emerging safety risks throughout aviation systems and operations

Assured Autonomy for Aviation Transformation

- Safely implement autonomy in aviation applications

NASA Aeronautics Strategies for Research

Technology Readiness Level, TRL



Additional points –

- NASA & FAA coordination so that the right technical data and insights are available to support eventual certification and regulatory decisions
- Infusion of technology into a fleet takes time. Technology availability is only one piece of a broader business decision.

Technology to Help Enable the Next Generation of Subsonic Transports

Four Key Subsonic Transport Technologies

Create new “S” curve for the next 50 years of subsonic transports

Electrified Aircraft Propulsion

- Improved efficiency/emissions
- Mild hybrid systems promising for early 2030s

Small Core Gas Turbine

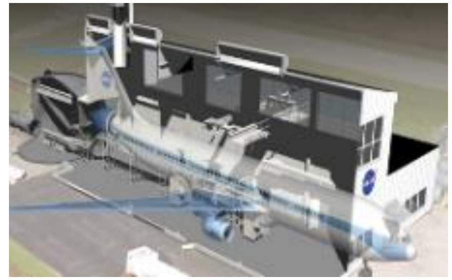
- Increased gas turbine efficiency
- Facilitates airframe integration – conventional or EAP

Transonic Truss-Braced Wing

- Increased aerodynamic and structural efficiency
- Propulsion system integration and high-rate production

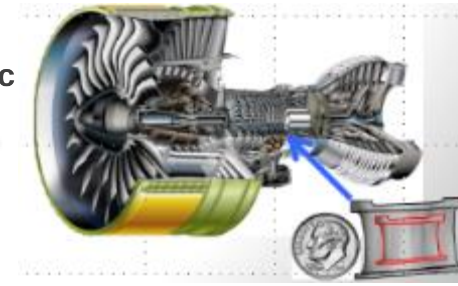
High-Rate Composites

- Critical to U.S. competitiveness via reduced delivery time
- Reduced time/cost to market with increased performance



Electrified Aircraft Propulsion

synergistic



Small Core Gas Turbine

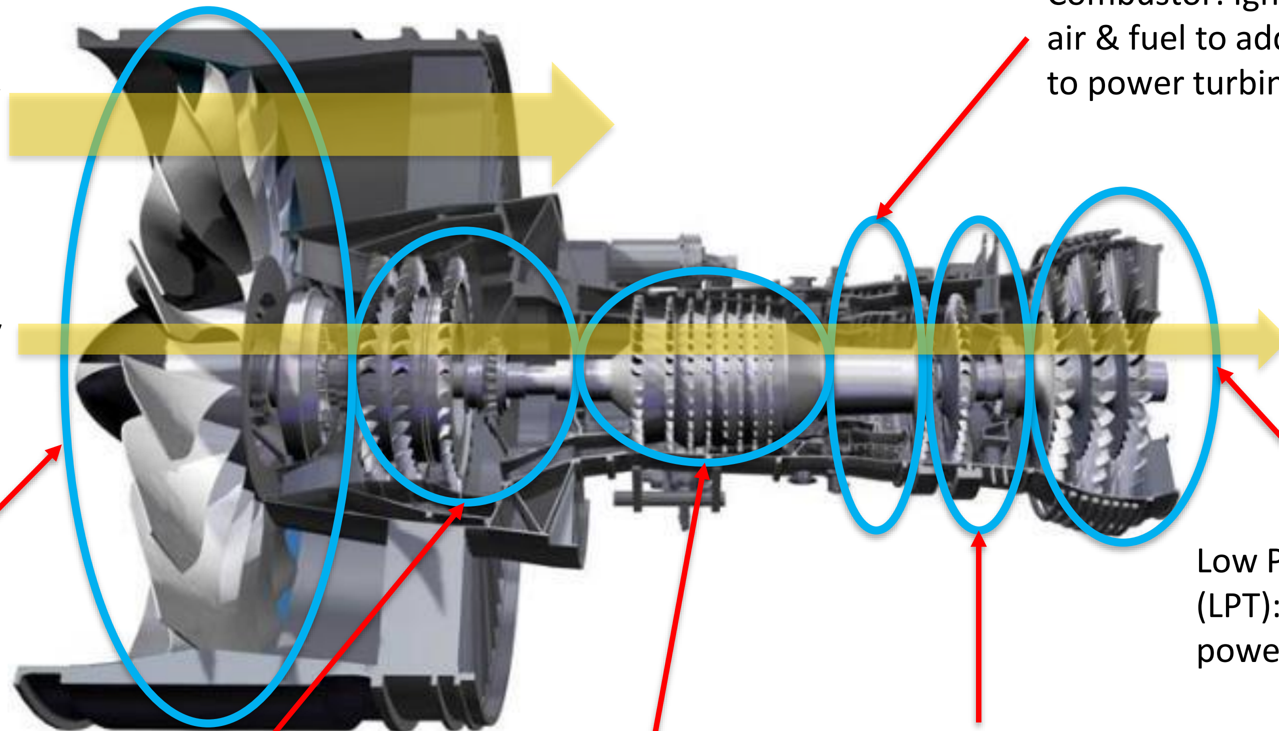
High-Rate Composites

synergistic

Transonic Truss-Braced Wing

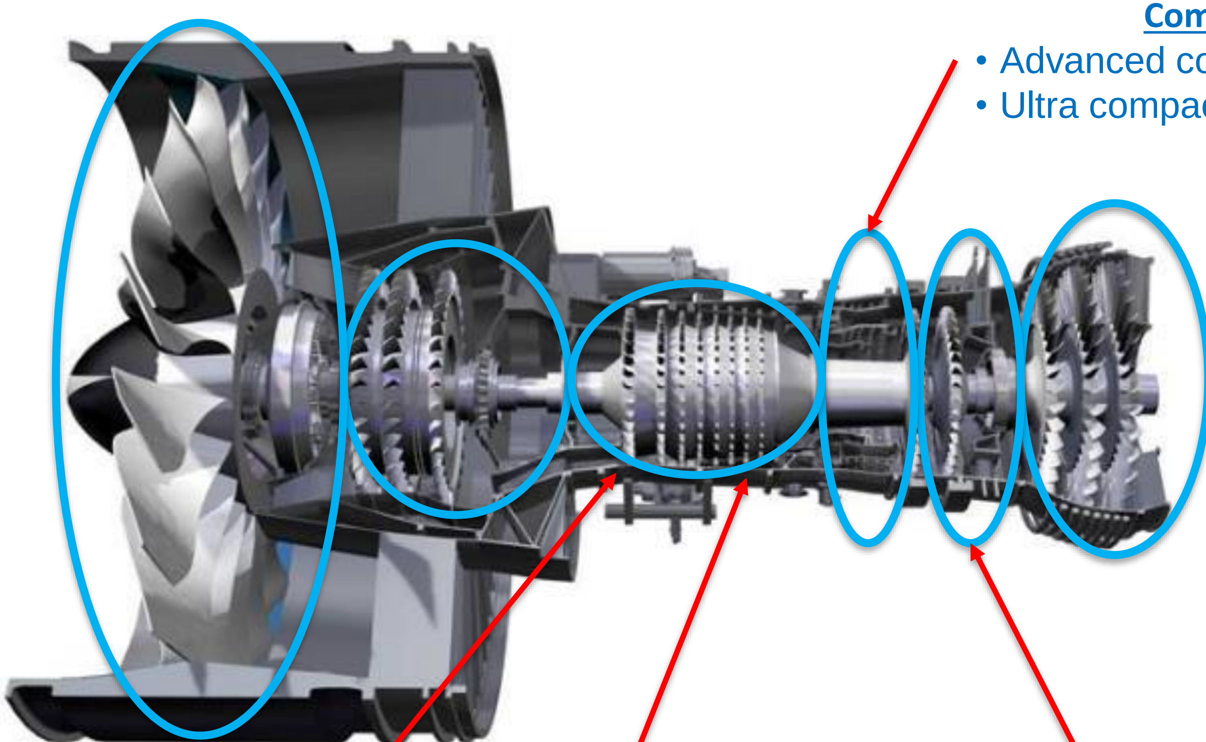
ARMD is advancing these key technologies to create market opportunities

Turbofan Engine Overview



Hybrid Thermally-Efficient Core Technologies

NASA has engaged industry to determine candidate technologies



Combustor
- Advanced cooling strategies
- Ultra compact combustor

HPT & LPT
- Power extraction for more electric airplane systems

HPC – Front Block
- Compressor operability, performance characterization, & aeromechanics
- Advanced casing treatments

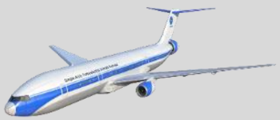
HPC – Rear Block
- Stator performance & stability at higher pressure ratios

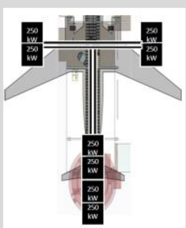
HPT
- CMC turbine blade development
- Advanced cooling strategies
- Advanced aero technologies
- Advanced materials and coating

System Level
- Advanced thermal management

Transport-Class, Electrified Aircraft Propulsion
Advancing Technical & Integration Readiness

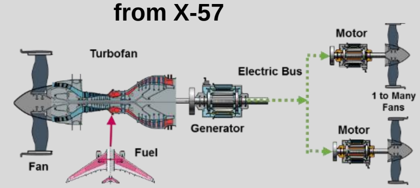
0 Early conceptualization & identification of KPP's/ technology gaps; component advancement; ground test capability gap assessment

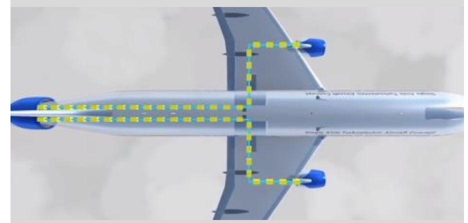




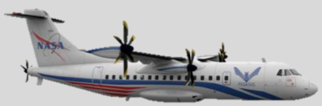

1 Ground testing of Key electrical components (work is ongoing but must accelerate)

2 Integrate in a flight system (likely existing airframe) – leveraging experience from X-57





3 Flight Experiments in relevant environment



- Key data informing product decisions
- Knowledge to support certification
- Learning to inform further fundamental research

2009-2015
TRL 1-2
NASA in-house & NASA-sponsored university/industry efforts advancing MW motors & inverters for EAP

2016-2018+
TRL ~3
NASA in-house & industry efforts raise the TRL level of motors and inverters

2018-2020
TRL ~4
NASA in-house & industry efforts leading to ground demo of TRL 4 level end-to-end power system

2021-2023
TRL 5-6
Flight demo of end-to-end MW EAP power system with application to transport aircraft.

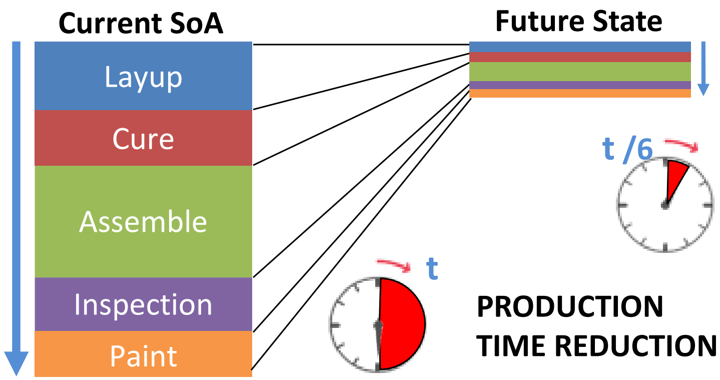
New project: Electrified Powertrain Flight Demonstration (EPFD) Project
To reduce the technology risks of a MW-class electrified powertrain by demonstrating key elements in a relevant flight environment

Project planning and formulation efforts underway

High Rate Composite Manufacturing

Game-changing manufacturing/delivery rate needed to meet single aisle demand

- Goal: enable 4-6X manufacturing rate increase for composite airframe structures (~15 ➔ ~100/month)
- Shift from focus on weight to balance rate, cost, & weight
- Demonstrate high-rate manufacturing concepts at full scale (TRL/Manufacturing Readiness Level (MRL) 3+)
  - Evolving State of the Art (SoA) thermosets
  - Thermoplastics
  - Resin Transfer Molding
  - Materials, processes, and architectures
- Demonstrate model-based engineering tools for efficient design, development, and certification
- Partner with Industry and FAA for realistic requirements
  - Leverage industry expertise and efforts



Rapid prototype and evaluation of manufacturing concepts, down-select at smaller scale, and mature concepts at larger scale

Transonic Truss-Braced Wing Technology

Non-linear Aeroelastics Test
- Verify modes & nonlinear behavior
- Validate high-fidelity finite element model

High-Speed Test (M=0.745)
- First high-speed performance test

High-Speed Test (M=0.745)
- Leverage first test & build knowledge

High-Speed Test (M=0.80)
- New design
- Higher cruise Mach

High-Lift System Test
- First high-lift TTBW test
- 8% scale model

TRL 1 — 2008 - 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020+ — TRL 6

Phase I – Phase II (2008-2014)
- Conceptual design studies (TRL 1)
- Reduce wing weight uncertainty (TRL 2)

Phase III (2014-2016)
- M=.745 High-Speed Design (TRL 2)

Phase IV (2016-2019)
- M=0.80 Design,
- High-Lift System Design (TRL 2)

Phase V (2020-2022)
- Buffet Test (TRL 4)
- High-Lift Test #2

University Leadership Initiative
Engaging the University Community

3 rounds of solicitations – seeking & awarding proposals addressing all Strategic Thrusts

- 13 awards with 47 universities
- 5 HBCUs and 5 MSIs
- 240 proposals submitted
- 191 different proposing Principal Investigators
- 1631 team members
- 1170 different people
- 20-50 students per team

Thank you