Gas Turbine Technology Direction at NASA- GRC

ATS Conference

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Arun K. Sehra

Deputy Director of Aeronautics

NASA Glenn Research Center

Gas Turbine Technology Direction at NASA- GRC

- ***Overview of NASA-GRC Aeronautics Programs***
- ***Inter-agency Technology Alliance***

AST and HSR Programs Cancelled in 1999

AST

HSR

UEET

FY 2000

Program Funding & Goals

Base Program funding:

- **Funding $50 M/ year, Timeframe FY 00-- FY 04**

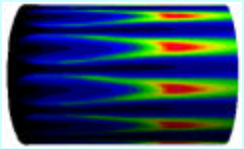
Program Goals:

Develop and transfer revolutionary propulsion technologies that will enable future generation vehicles over a wide range of flight speeds.

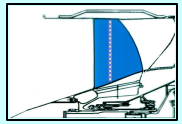
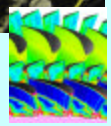
- **Dramatic increases in efficiency to enable reductions in CO_2 based on an overall fuel savings goal of up to 15%.**
- **70% NOx emissions reduction at take-off and landing conditions**
- **Technology Readiness to the Component Level (TRL 4-5).**

Investment Areas for Baseline Program

Combustion

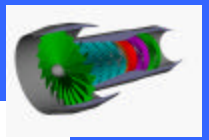
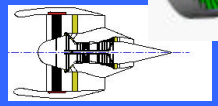




Turbomachinery

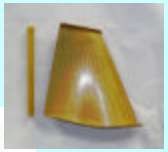





System Integration

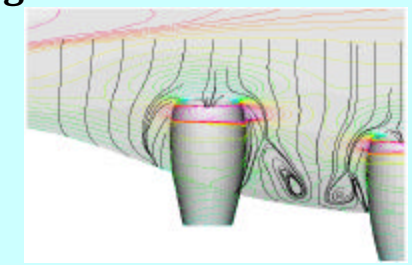


Materials and Structures

Propulsion/Airframe Integration



UEET

Objective
Combustion Emissions Reduction

Work with U.S. industry to provide technology readiness to reduce combustion emissions of future aircraft:

- **Demonstrate landing/takeoff NOx emission reductions in full annular low emission combustors (TRL 5) of at least 70%of the 1996 ICAO limits for future large and regional subsonic engine (55:1 & 30:1 Pr) combustors**
- **Demonstrate in large scale sector ultra low cruise NOx £ 4 EI to minimize atmospheric impact of future supersonic aircraft.**
- **Improve and validate the combustor design codes to reduce the design and development cycle time for low emission combustors.**

Advanced Full Annular Combustor Test

UEET

Objective
Highly-Loaded Turbomachinery

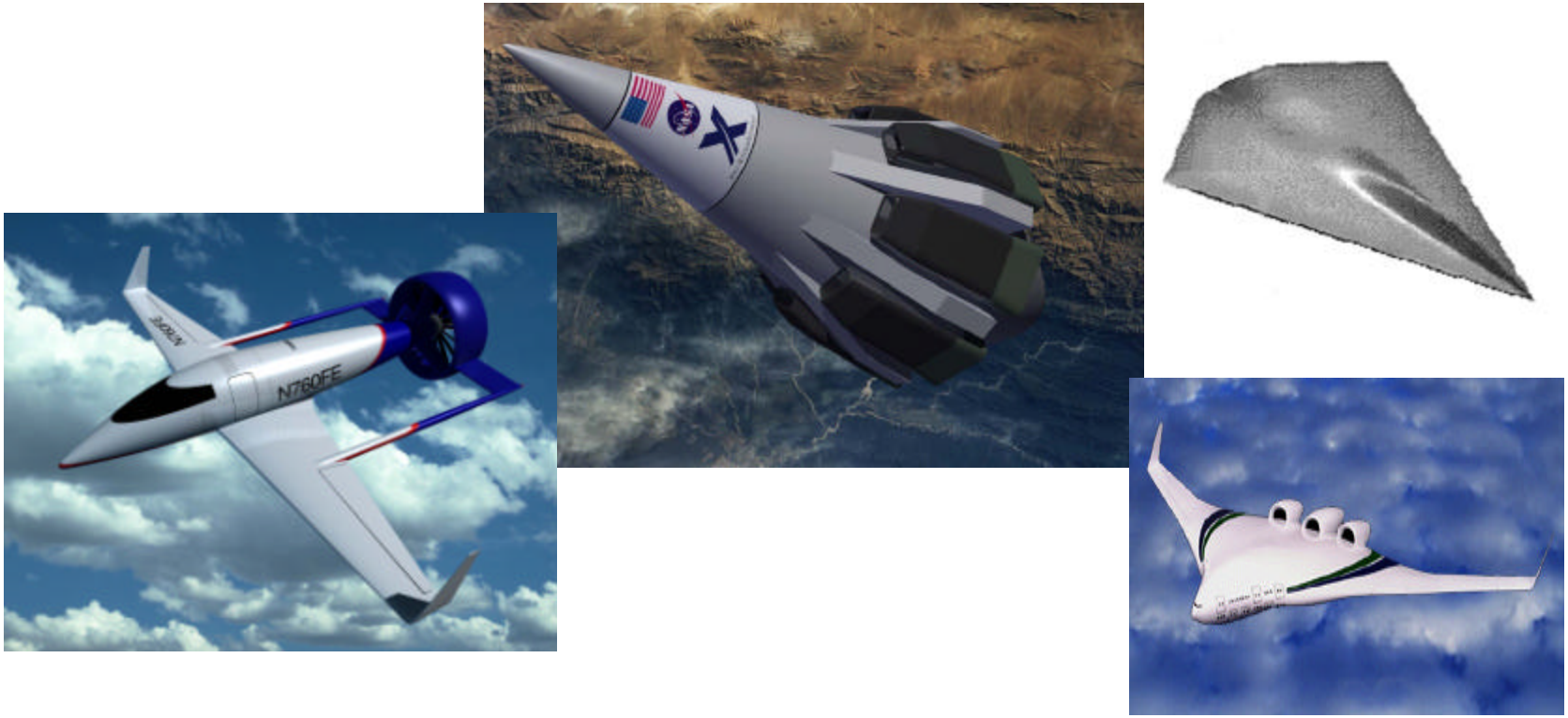
Develop and demonstrate through component tests and analyses the turbomachinery technologies required for light-weight Fans, high pressure (HP), and low pressure (LP) spools for high-performance, high-efficiency and environmentally compatible propulsion systems.

Objectives
Materials & Structures for High Performance

- **Develop high temperature disk and airfoil materials for high-performance, high-efficiency propulsion system**
- **Develop ceramic matrix composite (CMC) material system and process for low NO_X combustor liner and turbine vane**
- **Expand the use of polymer matrix composites (PMC's) in engine structures**
- **Decrease weight of supersonic exhaust nozzle through innovative lightweight material, structural, and aerodynamic concepts**

Objective
Propulsion Airframe Integration

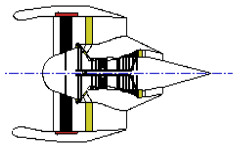
Goal: Reduce aircraft CO_2 emissions by developing advanced technologies to yield lower drag propulsion system integration for a wide range of vehicle classes.

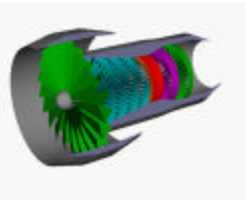


UEET

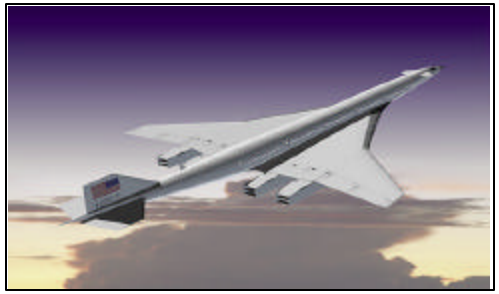
Objective

Systems Integration & Assessment





- **Provide guidance to the development of UEET technologies through system trade studies.**
- **Perform high fidelity system simulations to reduce development time.**
- **Assess the effects of engine exhaust products on the atmosphere and humans.**



INTER-AGENCY TECHNOLOGY ALLIANCE

PROPULSION AND POWER GENERATION PROGRAMS

Workshop on Inter-Agency Programmatic Alliances
GOTCHA FEST--Aug. 31, Sep. 1 and 2, 1999
(Goals, Objectives, Technical Challenges, and Approach)

WORKSHOP OBJECTIVE:

A NASA GRC/DOD/ DOE/ Industry workshop at GRC to identify potential areas of collaborations among current and planned aeropropulsion and power generation programs at NASA, DOD, and DOE

Workshop Participants:

Over 100 participants from GRC, Air Force, Navy, Army, DOE, and 11 aerospace companies

Programs Reviewed:

Ultra Efficient Engine Technology (UEET- NASA)

Propulsion Systems Base (NASA)

Integrated High Performance Turbine Engine Technology (IHPTET -DOD)

Versatile Affordable Turbo-Engine (VATE-DOD)

Advanced Turbine System (ATS) and Beyond

(Next Generation Gas Turbine, microturbine--DOE)

Workshop on Inter-Agency Programmatic Alliances
GOTCHA FEST
(Goals, Objectives, Technical Challenges, and Approach)

Technology Areas Reviewed in Breakout Sessions:

Combustors Compressors Turbines Materials & Structures

Design Tools & Engine Simulation Core and Engine Testing Instrumentation & Controls

Workshop Outcome:

-Identified technology requirements for each program

-Identified technologies that are common to more than one program

-Prioritized areas of technology collaboration among various programs

Next Step:

Develop detailed Technology Alliance Plans by March 00

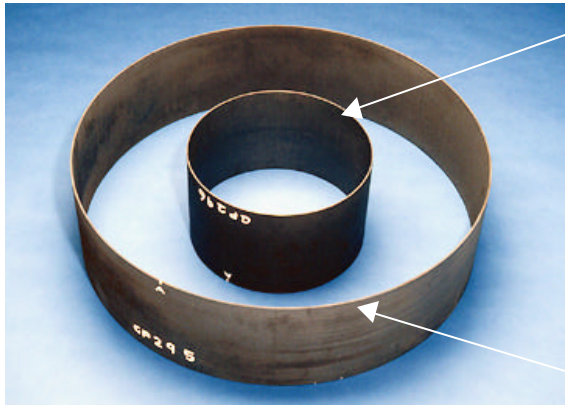
Potential Areas of NASA-DOD-DOE Programmatic Collaboration

(NASA (UEET, PS Base), **DOD** (IHPTET, VATE), **DOE** (ATS, NGGT, MT)**)**

Areas of Collaboration	Payoff
• Development of high temperature (up to 2700 deg F) materials (CMCs) with Thermal Barrier and Environmental Barrier Coatings	– Reduced fuel consumption (15%) – Increased engine thrust/ Wt (15%) – Reduced CO2/ NOx emissions
• Testing of advanced concept UEET components in IHPTET Engine Demonstrator	– System level validation of advanced concepts (TRL6)
• Advanced instrumentation and controls for intelligent engine (Engine Health Monitoring and Active Control)	– Improved reliability and safety – Reduced fuel consumption (10%) – Increased engine life
• Development of high fidelity, probabilistic design/life prediction/ simulation methods	– Reduced program/ maintenance cost – Reduced design/ development cycle time – Reduced risk

Ceramic Matrix Composite (CMC) Combustor Liner Testing at Solar Turbine

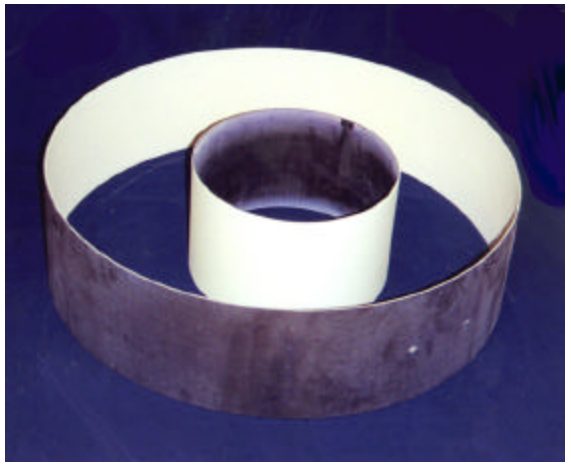
- CMC combustor liners being field tested in Centaur engine at Bakersfield
- Outer liner fabricated using commercially available CMC tested about 5000 hr
- Inner CMC liner fabricated using NASA-EPM developed manufacturing process has been tested for more than 3000 hr
- Both liners tested for more than 4000 hr with Environmental Barrier Coating (EBC) developed in NASA's HSR-EPM program



NASA-EPM Process

Tested for more than 5000 hr

Commercial Process



With EBC, tested for more than 4000 hr

Some Potential Areas for Future NASA/DOE Collaborative Activities

Materials

- CMC system with 2700^{o}F Environmental Barrier Coating for combustor liner and turbine vane applications
- Advanced Thermal Barrier Coatings
- Advanced turbine airfoil alloys

Combustion

- Low NO_X combustion technology
- Active combustion control
- Validation of combustion codes

Advanced Analytical Tools

- Numerical Propulsion System Simulation
- Probabilistic Methods