OVERVIEW OF NASA'S PROPULSION 21 EFFORT

Mary Jo Long-Davis
National Aeronautics and Space Administration
Glenn Research Center
Cleveland, Ohio
State-wide coalition focused on research and development aimed at three aircraft engine-related goals:

- more energy efficient
- quieter
- more reliable
Propulsion 21 Technologies

Turbine Engine Prognostics
- Disk Life Meter
- Sub-System Health Management

Active Controls for Emissions and Noise reduction
- Intelligent Combustor
- Active Noise Reduction

Active Structural Control
- Turbine Cooling Control
- Smart Containment System
- High Pressure Turbine Clearance Control

Modeling, Analysis and System Studies
- System Studies
**Objective:**
Develop materials models and sensors to measure remaining life in turbine disk materials at sustained high operating temperatures.

**Pit Formation and Growth Now Need to Be Understood**
Sub System Health Management

Objective:
Develop bearing diagnostics and health monitoring system for inter-shaft bearings to provide early detection of impending bearing failure. Demonstrate a conceptual monitoring system for a differential roller bearing.
Intelligent Combustor

Objective:
Develop a combustor incorporating advanced diagnostics and active combustor control to reduce NOx emissions by 85% relative to 1996 ICAO standards, while retaining the performance of existing combustors.

Lean blow-out precursor identification

New swirler concepts
Active Noise Control

Objective:
Use fluidic injection, shape memory alloys, and/or plasma actuators to enhance exhaust nozzle jet mixing to actively reduce jet engine noise. Incorporate active/smart concepts into acoustic liner design to increase liner acoustic performance.
**Objective:**
Develop and demonstrate innovative turbine system and component cooling technologies with active flow and temperature control, including prognostic / diagnostic sensors, for improved engine fuel burn and emissions.

**Advanced Cooling Concepts**
Cooled Cooling Air, Active Flow Control, Next-Gen Airfoil Cooling

**Thermal Management & 3D System Simulation**

**Sensors for Active Control & Prognostics**
Objective:
Develop an innovative “smart” softwall containment system that capitalizes on the anisotropic nature of composites.
High Pressure Turbine (HPT) Clearance Control

**Objective:**
Develop an HPT clearance control system that can adapt to changing environment/requirements.

![Diagram of HPT clearance control](image)
Objective:
Perform technology assessment and identify needed modeling improvements to handle adaptive technologies.

CO₂ Reduction (Fuel Burn)
(Baseline Engine is 2015 QAT/UEET)

Noise Reduction
(Baseline Engine is 2015 QAT/UEET)

NOx Reduction
(Baseline Engine is 2015 QAT/UEET)
Summary

- Propulsion 21 technologies contribute to reducing CO₂ and NOₓ emissions and noise
- Integrated Government/Industry/University research efforts have produced promising initial technical results
- Graduate students from 5 partnering universities will benefit from this collaborative research--> educating the future engineering workforce
- Phase 2 Efforts scheduled to be completed 3QFY06