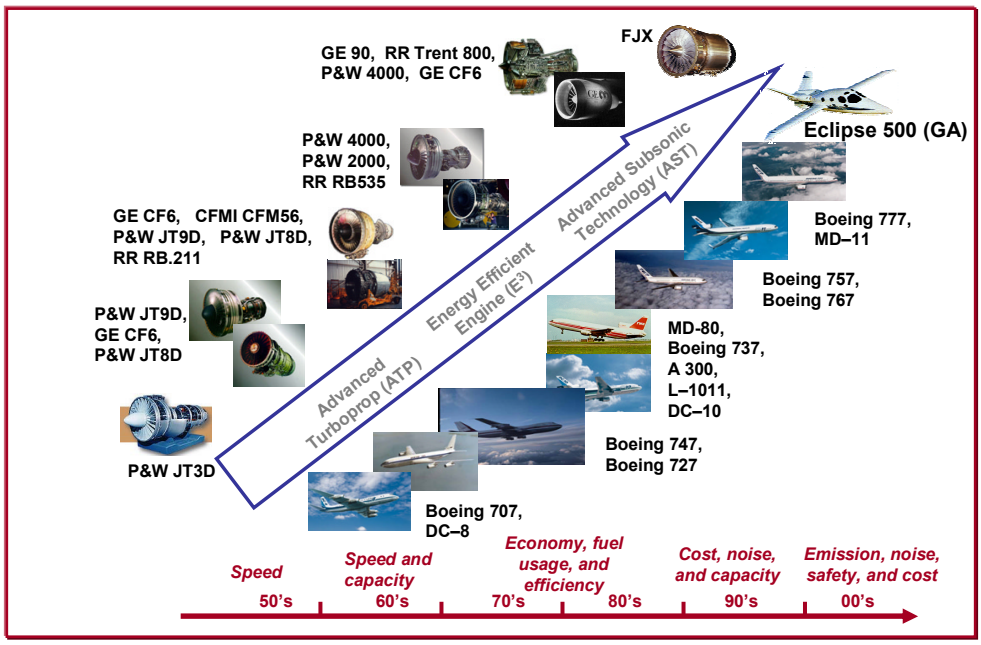
NASA GRC/AERONAUTICS OVERVIEW

Presented to the
Industry/Government Team for Development of NPSS
October 9, 2002

Arun K. Sehra
Director of Aeronautics

Propulsion System Leads the Aviation Revolution (Milestones in Aviation)



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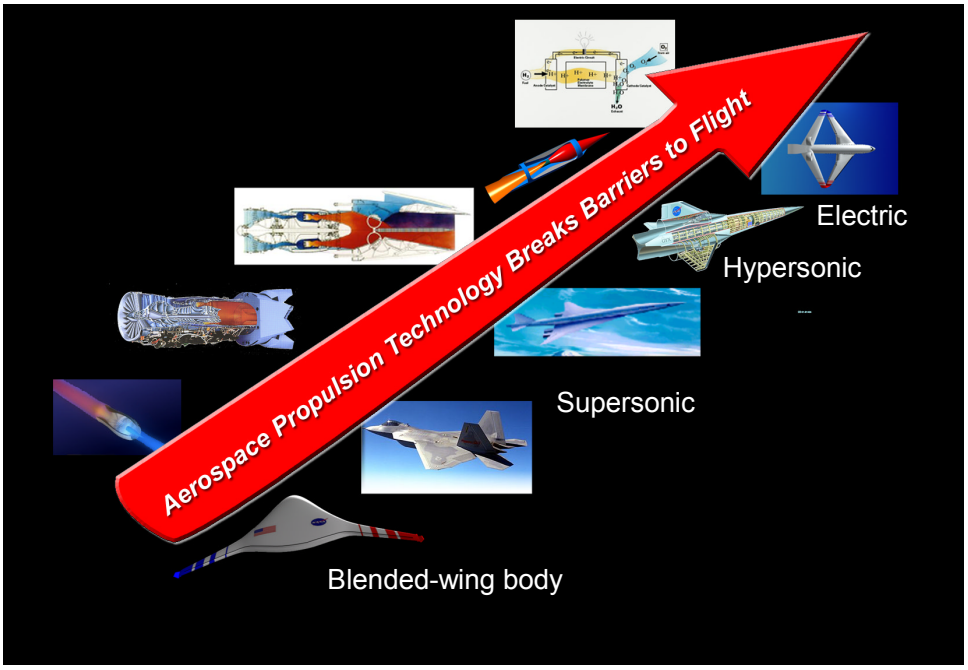
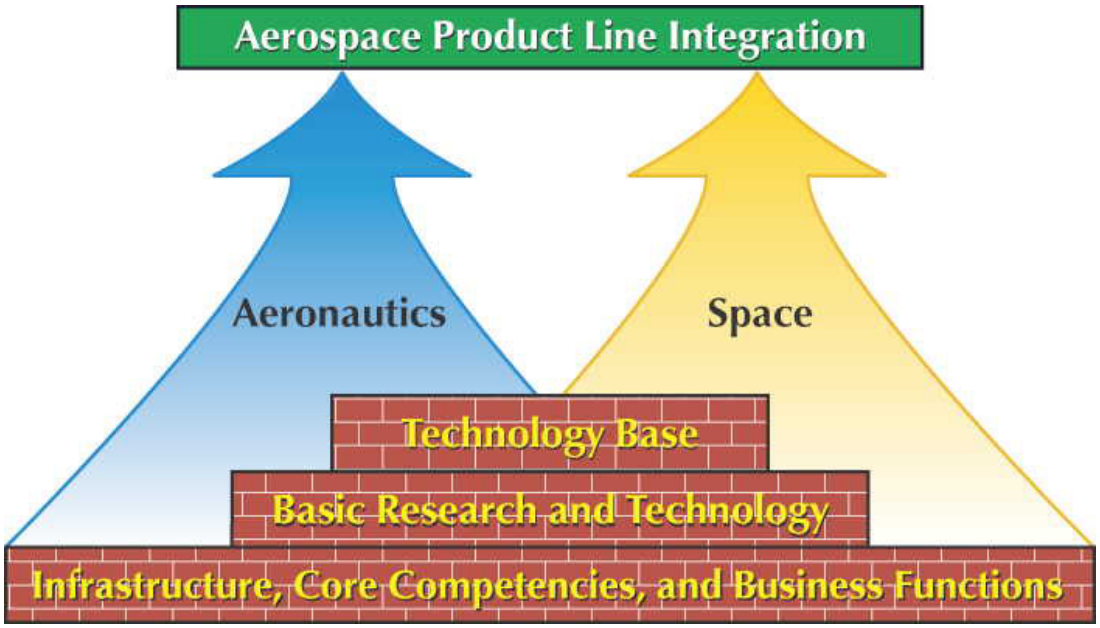
Propulsion System Leads the Aviation Revolution (Future Directions)

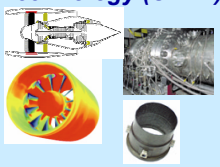


GRC Technology Infusion



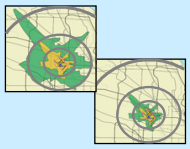
GRC Aeronautics

Ultra Efficient Engine Technology (UEET)



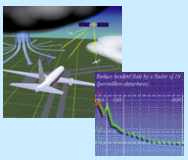
On-going

Quiet Aircraft Technology (QAT)



On-going

Aviation Safety



On-going

Aviation Capacity

On-going

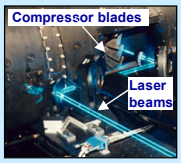
Small Air Transportation System (SATS

On-going

FOCUSED PROGRAMS

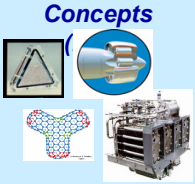
Fundamental Research

Laser Anemometry Used to Measure Detailed Flow Field



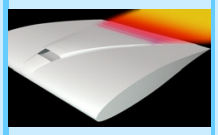
On-going

Revolutionary Aeropropulsion Concepts



On-going

21st Century Aircraft Propulsion

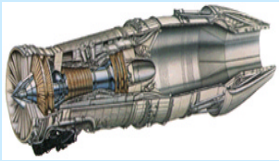


New Start FY 02

Computing, Information & Communications Technology (CICT)

New Start FY02

Revolutionary Turbine Accelerator (RTA)



On-going

BASE R&T

ADVANCED SPACE TRANSPORTATION

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GRC Space

Communications

Modeling/Analyses
Antennas
Solid-state devices
Digital communications
Vacuum electronics
Satellite/terrestrial networks
Spectrum Management

Space Transportation

Advanced Concepts/Analyses
Airbreathing Propulsion
Propulsion Materials/Structures
Subsystems (Power, Actuators)
Propellants
Vehicle Health Management

Microgravity Science

Fluid Physics
Combustion science
BioScience and Engineering
Acceleration measurements
Flight exp. development & operations
Space Station utilization

Power

Architecture/Analyses
Generation
Storage
Distribution/Control
Environmental durability
Space Station support

Space Propulsion

Modeling/Analyses
Electric
Chemical
Thrusters/Controls & Electronics/Feed Sys.

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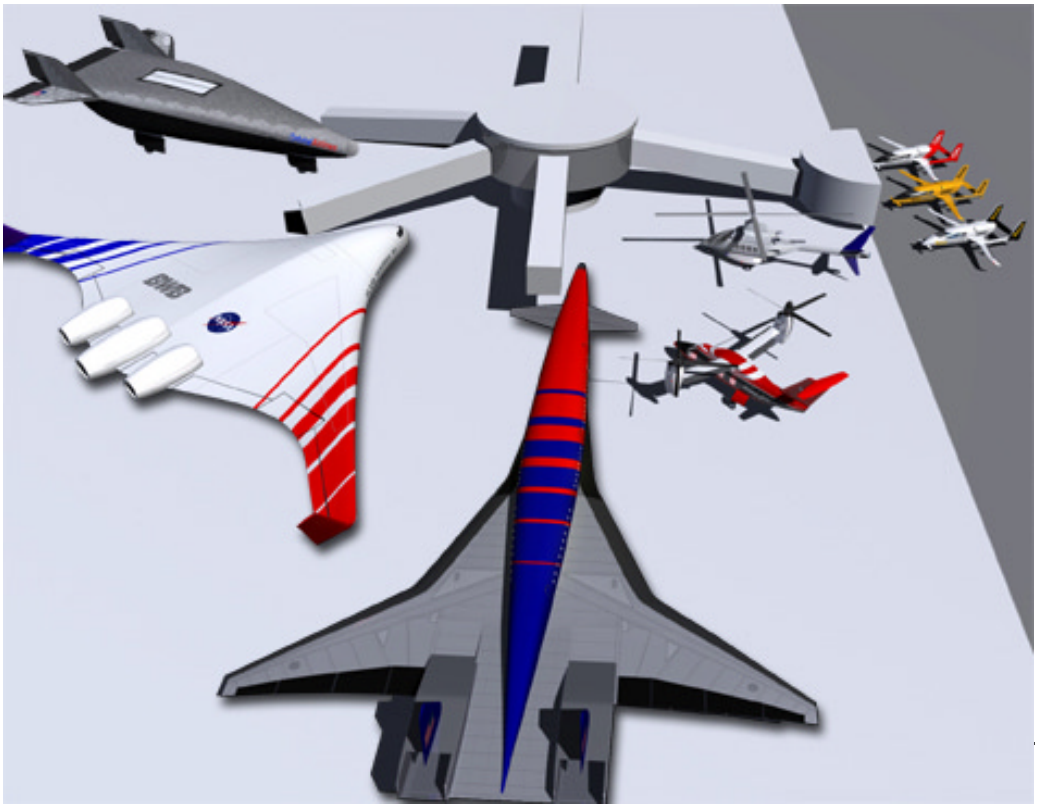
Terminal of the Future



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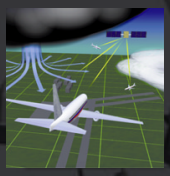
NASA's Aeropropulsion Vision For 21st-Century Aircraft

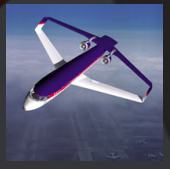
25 Years Goal to Revolutionize Aviation



Reduce Accident Rates: 10x (90%)
Make a safe air transportation system even safer

Reduce Emissions: NO_x 5X (80%), CO_2 2X (50%)
Protect local air quality and our global climate

Reduce Noise: 4x (75%)
Reduce aircraft noise to benefit airport neighbors, the aviation industry, and travelers



Increase Capacity: 3x
Enable the movement of more air passengers with fewer delays

Increase Mobility: Intercity 3x (67%) , Transcontinental 2x (50%)
Enable people to travel faster and farther, anywhere, anytime

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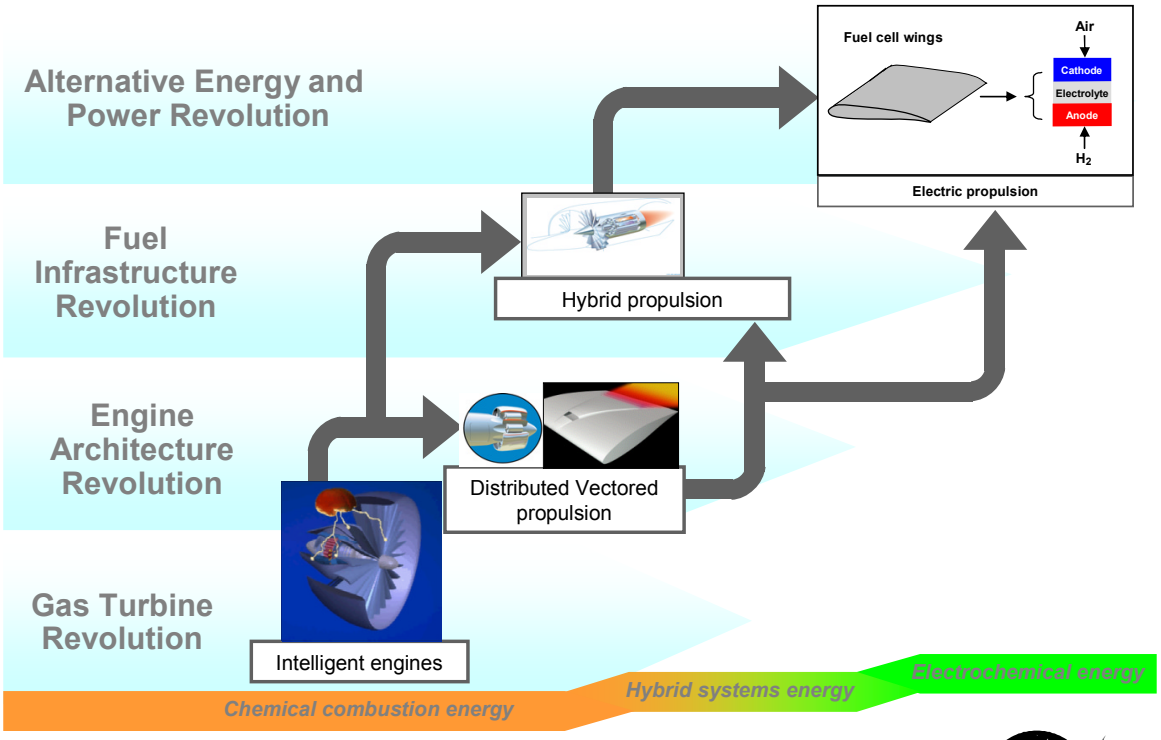
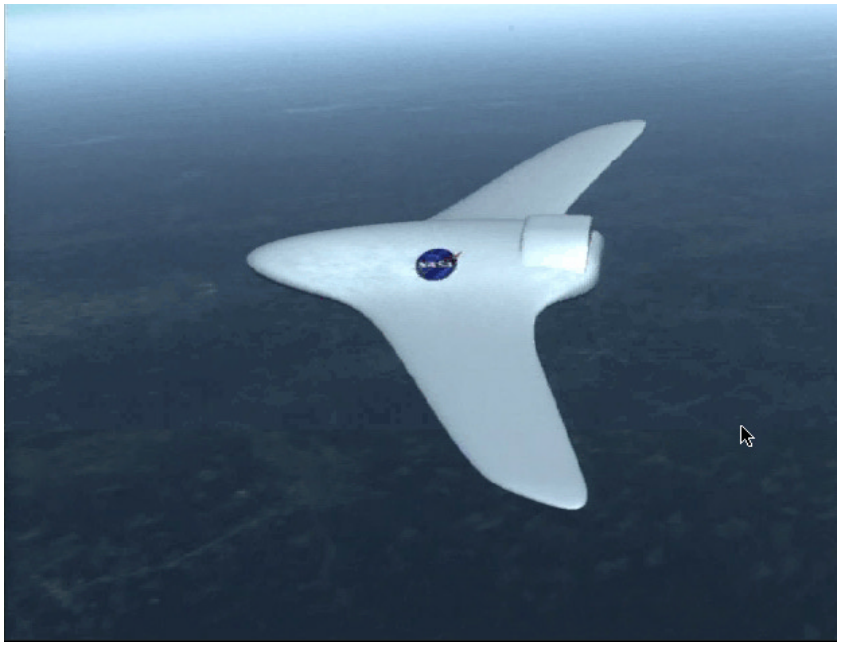
Aeropropulsion–NASA's Future Direction



Revolutionary Aircraft Enabled by Aeropropulsion and Power Revolutions

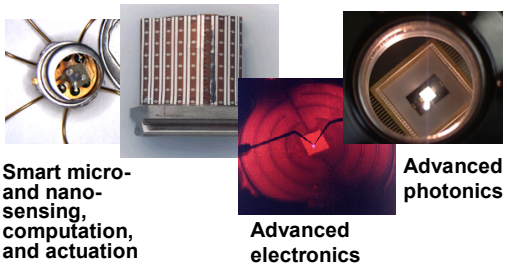


Gas Turbine Revolution

Ultraclean, Quiet, Intelligent Engine: Fundamental Technologies

Intelligent Engine System Asset Management

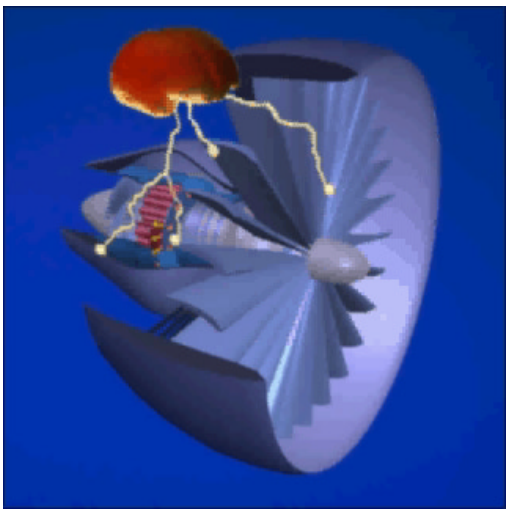
- Embedded micro- and nanosensors
- Coupled simulation and data-feedback health and performance management
- Autonomic engine control strategies



Smart micro- and nano-sensing, computation, and actuation

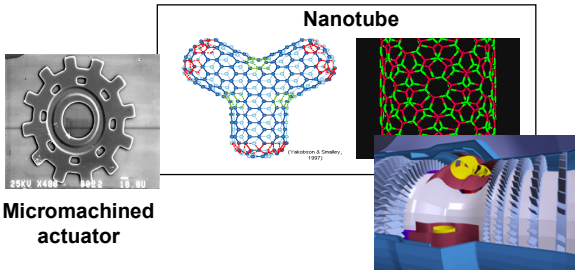
Advanced electronics

Advanced photonics



Ultraclean, Quiet, Intelligent Engine: Fundamental Technologies

- Microflow management
- Acoustic masking
- Innovative combustion strategy
- Morphing structures
- Adaptive/Self Healing structures
- Adaptive engine cycles

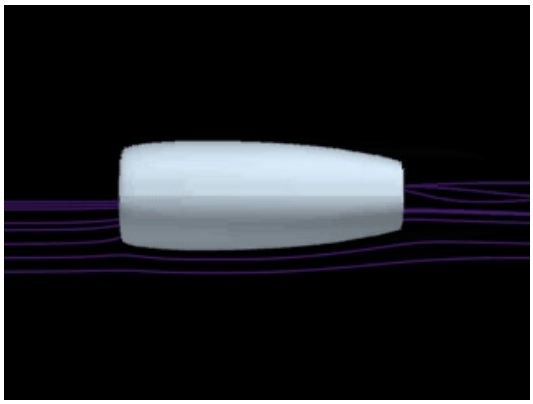


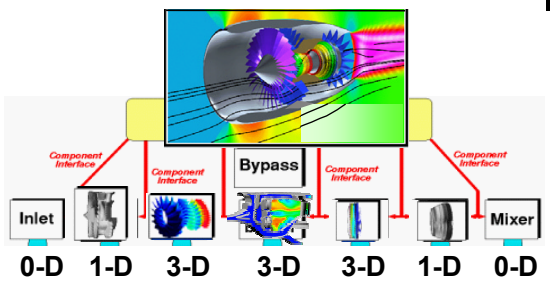
Micromachined actuator

Ultraclean, Quiet, Intelligent Engine: Fundamental Technologies

Intelligent Computing

- 0-D modeling zooming to 3-D fidelity
- Probabilistic design and analysis
- Coupling of multiple disciplines: fluids, structures, thermal
- Virtual numerical test cell

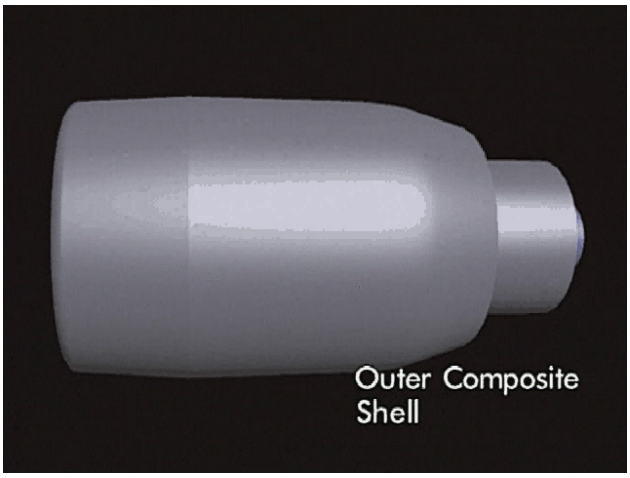


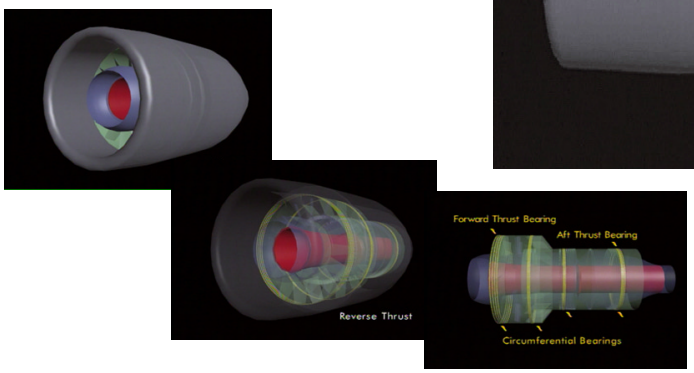


Variable Capability, Ultra High Bypass Ratio Intelligent Engines: Fundamental Technologies

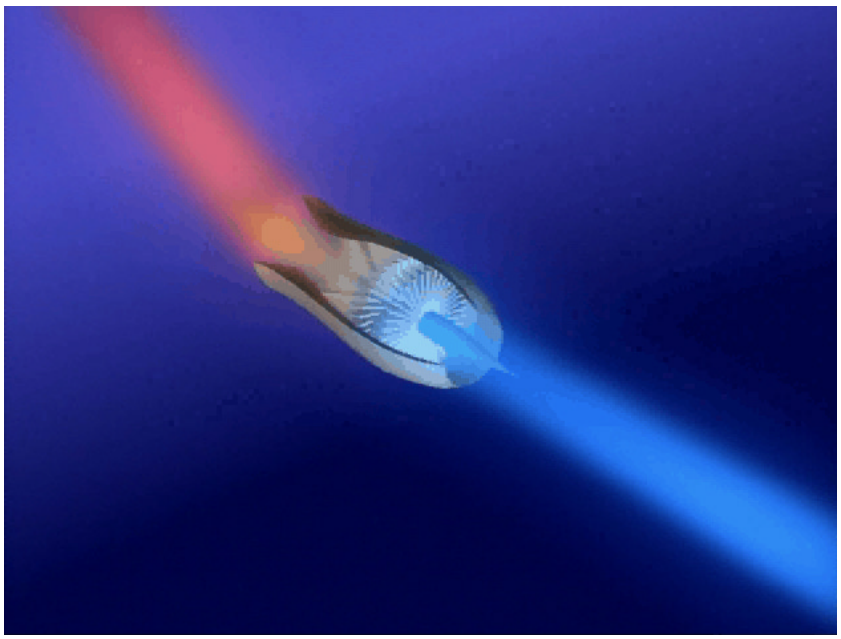
Exoskeletal Engine

- Outer shell rotating
- All composite engine
- Magnetic bearings





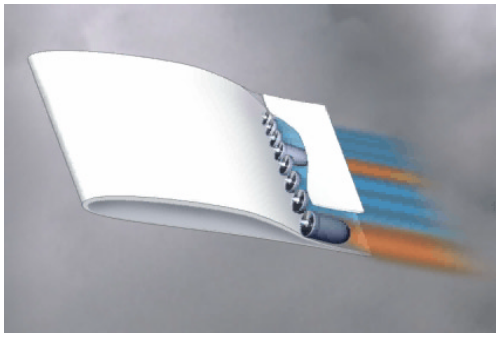
Engine Architecture Revolution (Distributed Vectored Propulsion)



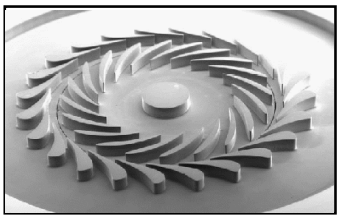
Distributed Vectored Propulsion

Distributed Engines

- Multiple low-cost, low-power engines deployed along wing
- Distributed thrust and thrust vectoring
- Aircraft boundary layer ingestion
- Microturbine engines distributed over aircraft wings



Mini-engines:
High-efficiency cores powering multiple fans

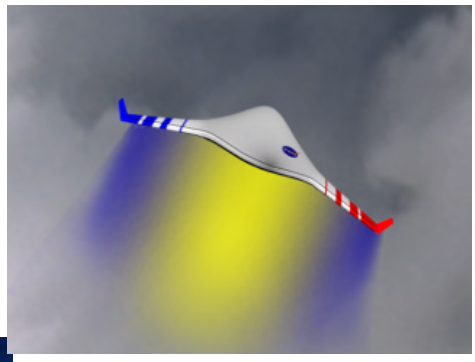


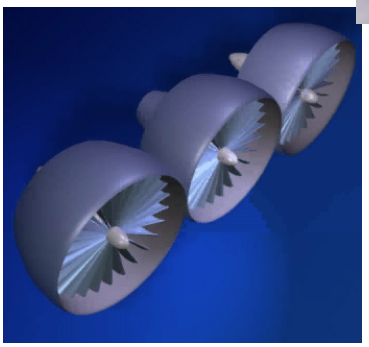
Silicon carbide microturbine

Distributed Vectored Propulsion

Multifan Core

- High-efficiency cores powering multiple fans (propulsors)
- Advanced mechanical power transmission

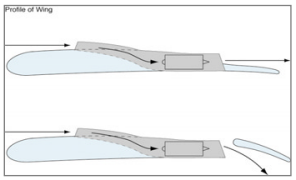


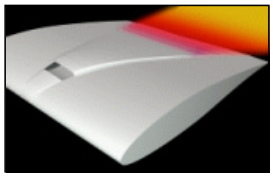


Distributed Vectored Propulsion

Distributed Exhaust

- High-aspect-ratio nozzles embedded in the wing trailing edge
- Ducted polymer matrix composite (PMC) nozzles
- Embedded inlets and nozzles employing flow control





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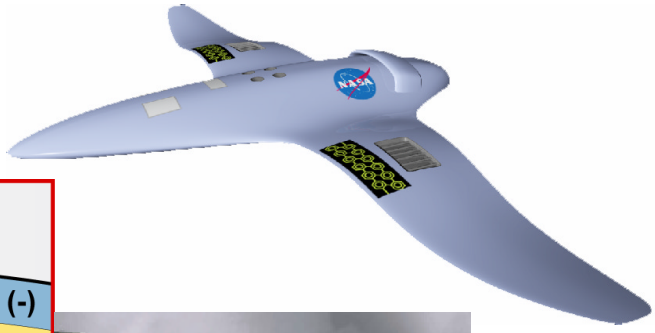
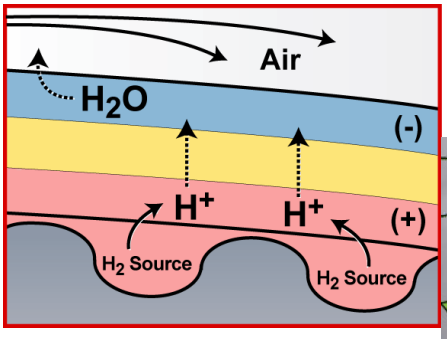
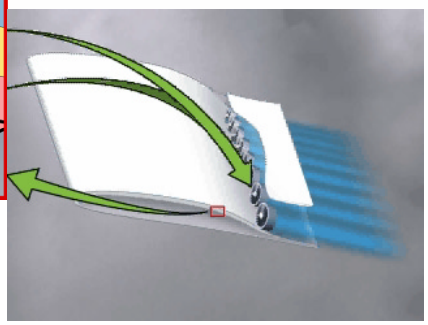
Fuel Infrastructure and Alternative Energy and Power Revolutions (Hybrid Combustion and Electric Propulsion)





Fuel Cell Wing



Distributed Propulsors

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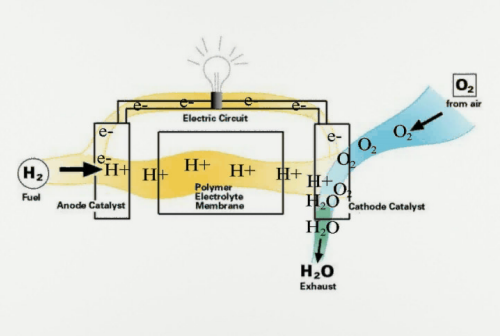
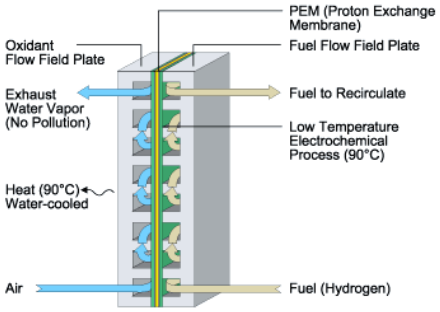
Alternative Energy Propulsion

Fuel Cell-Powered Electric Propulsion System

- Proton exchange membrane (PEM) fuel cell
- Zero NO_x and HC emissions
- Water emission or use of chemical reformer

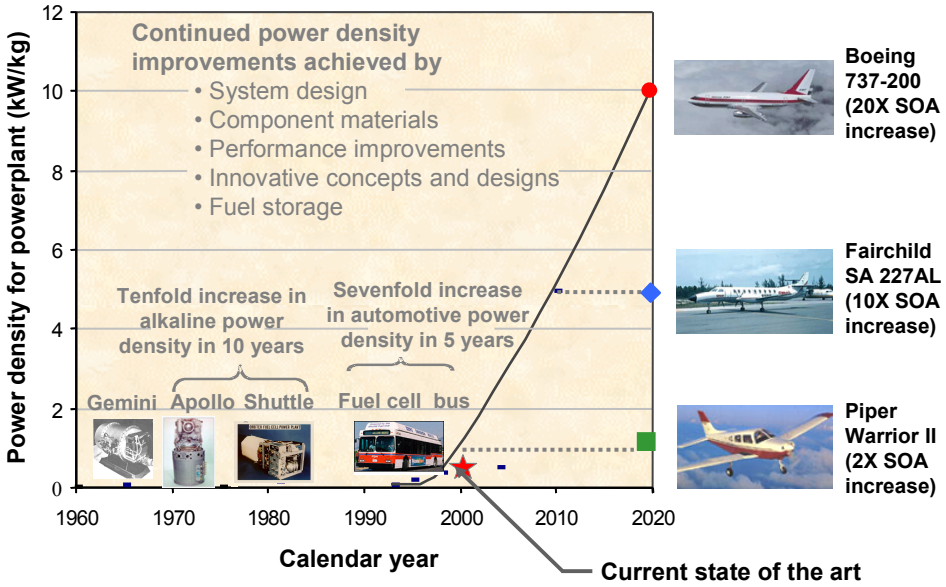


Basic hydrogen PEM fuel cell operation and hardware



Alternative Energy Propulsion

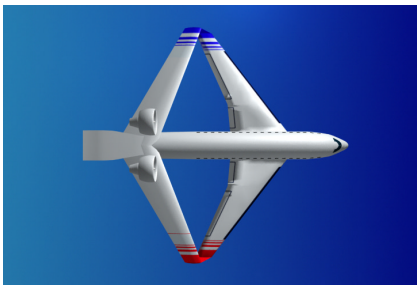
Potential Fuel Cell-Enabled Electric Propulsion

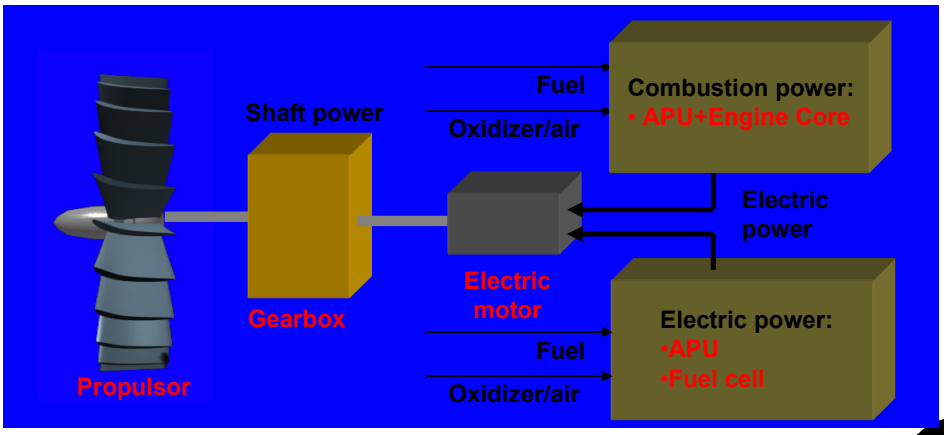


Alternative Energy Propulsion

Hybrid Combustion and Electric

- Takeoff thrust-augmenting auxiliary power unit (APU)
- Onboard electric power for zero emissions fan thrust

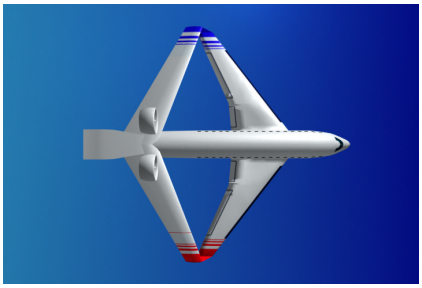


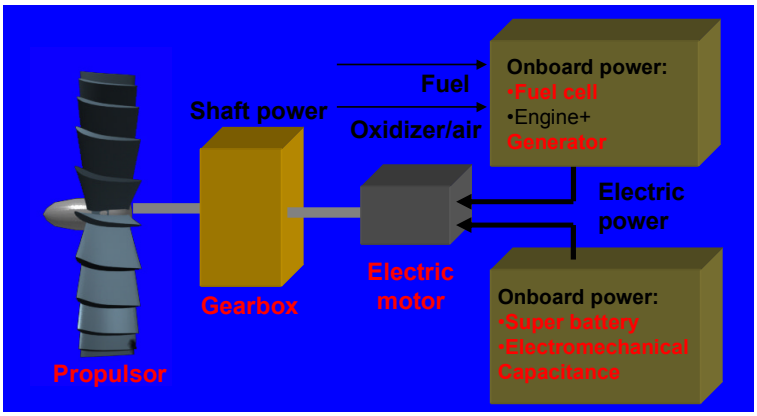


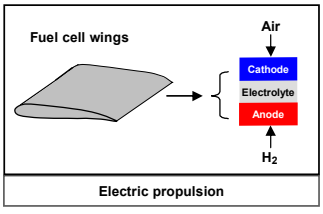
Alternative Energy Propulsion

Fuel Cell Onboard Electric Power

- Multiple fuel options including conventional hydrocarbon, hydrogen, and solid oxide
- Shared structural components with aircraft



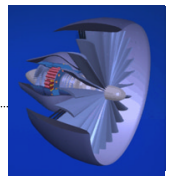




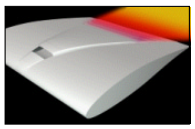
Summary

Twenty-first-century aeropropulsion and power research will enable new transport engine and aircraft systems.

- Emerging ultralow noise and emissions with the use of intelligent turbofans

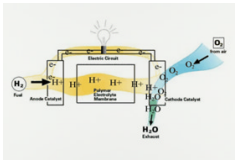


- Future distributed vectored propulsion with 24-hour operations and greater community mobility



- Research in hybrid combustion and electric propulsion systems leading to silent aircraft with near-zero emissions

- The culmination of these revolutions will deliver an all-electric-powered propulsion system with zero-impact emissions and noise and high-capacity, on-demand operation



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