Turning Goals Into Reality

Propulsion Systems
Contribution to the Future

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Williamsburg
**Rolls-Royce is…Building the Future Now**

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Preparing for the Future: Near-term

Platforms: Requirements: Challenges

**V-22:** convertible rotorcraft: SFC, systems integration

**ERJ-145:** low cost: supply chain, environment

**Global Hawk:** HALE: SFC, Re, HPX

**JSF:** stealth, STOVL, supercruise: SFC, lift system integration

**Propulsion Enablers**

- Innovative architectures
- Efficient engines
- Power transmissions
- US Government funded advanced technology programs:
  - DOD: IHPTET
  - NASA: AST & QAT
  - US/UK ASTOVL
- Commonality with commercial systems
JSF Lift System

- Variable Guide Vanes
- Fan Blisk
- Clutch
- 2 Stage Counter Rotating Fan
- 3 Bearing Swivel Module
- Roll Post

- ~19,000 lb
- ~18,000 lb
- ~3,700 lb
- ~39,000 HP

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Laying the Foundation for the Future: Medium-term (2010-2020)

Platforms: Requirements: Challenges

**UCAV:** range, stealth, endurance: SFC, cost

**Mobility:** high thrust, range: SFC, cost

**Supersonic:** speed, economics, environment: cycle, cost

**Strike:** speed, stealth, endurance: cycle, cost

**Propulsion Enablers**

- High OPR, temperature
- Variable cycles
  - Performance
  - Emissions
  - Noise
- More electric engines
  - High power extraction
  - Lubrication free
  - Magnetically suspended & controlled rotors
  - Prognostics & diagnostics
- Government funded advanced technology programs:
  - IHPTET, VAATE, QAT, UEET, NAI

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VAATE Focus Areas

**Versatile Core**
Military/Civil Multi-Use, Maintenance Friendly
- Wide Flow / High Efficiency Components
- Long Life for Safety & Design Margin
- High Excess Horsepower Technology

**Intelligent Engine**
High Performing, Adaptive
- Adaptive Component Performance
- Integrated Propulsion & Power
- Real Time Life Tracking
- Proactive Health Management

**Durability**
Turbine Engine Readiness
- Physics-Based Predictive Systems
- Integrated Inspection/Repair/Mfg & Materials Systems
- Robust, Damage Tolerance for Multi-Use Application
- Holistic Test Protocol & Accelerated Severity Testing

10X Improvement in Capability / Cost
**Electric Engine Concepts**

- **Air for pressurization/cabin conditioning supplied by dedicated electrical system**
- **All engine accessories electrically driven**
- **Active magnetic bearings**
- **Internal starter motor/generator replaces conventional gearboxes**
- **Generator on fan shaft provides power to airframe under both normal and emergency conditions**
- **Aircraft/engine interface simplified to fuel, electricity and thrust**
- **Intelligent sensors Advanced engine health monitoring**
- **Distributed controls**

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Anticipating the Future: Far-term

Platforms: Requirements: Challenges

Extended Endurance UAVs: continuous surveillance & communications: closed cycles, systems integration

Global Transport (trans-atmospheric): speed, cost: cycle, cost

Access to Space: speed, cost: cycle, materials

Propulsion Enablers

- Novel cycles
  - TBCC
  - Pulse detonation
  - Fuel cells

- New fuels
  - Endothermic, hydrogen, nuclear, solar

- High temperatures and thermal integration

- Government funded advanced technology programs:
  - VAATE, NAI
High Mach Turbine Engine Technology

- High Mach turbine enables SSCM and LRSA
- Turbine Based Combined Cycle (TBCC) systems enable hypersonic cruise and/or dash
- TBCC enables Two Stage to Orbit (TSTO)

Access to Space

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Constant Volume Combustor

Exploded View

CVC

Conventional

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Propulsion is Enabling the Future!

- Propulsion innovation and platform advances are inextricably linked.
- Technology enablers have typically been developed by government programs and are pulled by advanced military requirements.
- The time scale of propulsion technology is typically more than 20 years from early component demonstrations to first flight.
- New requirements drive certain technologies, but most step changes come from synergistic combination of several enabling technologies.
- Many propulsion technologies, novel cycles and new architectures are being developed today that will enable major steps in future systems.
Rolls-Royce Innovation: Delivering the Future