AVT-RSY-323 Research Symposium on Hybrid/Electric Aero-Propulsion Systems for Military Applications

NASA Electrified Aircraft Propulsion Efforts

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Introduction

- **NASA is investing in research to enable Electrified Aircraft Propulsion (EAP).**
  - NASA is working across a range of markets
  - The overarching strategy is to create enabling technology, demonstrate this technology in flight-test vehicles, and transfer the knowledge to industry for future products
  - Electrified aircraft propulsion has varying impact on air vehicle design depending on the key requirements of the market that the vehicle is intended to serve

Market: National/International	Market: On demand mobility	Market: Regional
Impact: Fuel Burn/Emission Reduction	Impact: New mobility capability	Impact: Revitalization of smaller routes

Figure 1-1: Benefits of Electrified Aircraft Propulsion by Market

Hybrid Gas Electric Subproject of Advanced Air Transport Technology Project

- **The Hybrid Gas Electric Propulsion subproject (HGEP) was created in 2014 to**
  - find a viable transport-class EAP aircraft concept
  - identify barrier technologies
  - advance the technology readiness level of those barrier technologies.
- **Approach**
  - study aircraft concepts and identify potential aerodynamic efficiency gains
  - investigate powertrain architectures
  - develop the fundamental components that will enable broad improvements in aircraft power systems

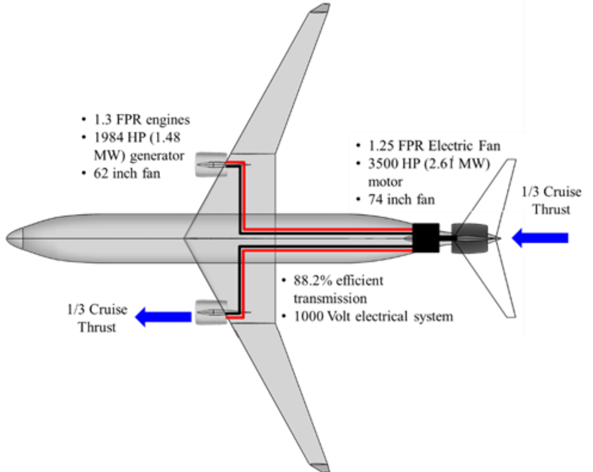

Figure 2.1-1: Single Aisle Vehicle Concept

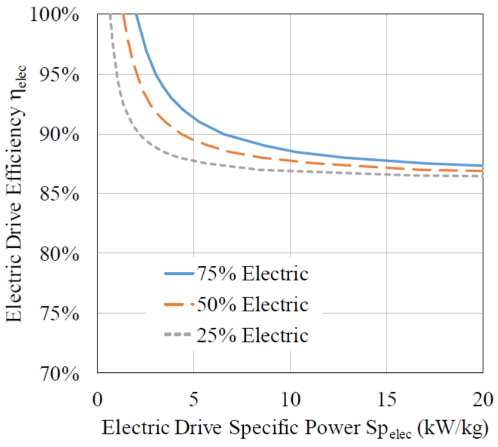

Figure 2.1-2: Breakeven Curves for turboelectric propulsion

X-57 Maxwell

- **X-57 “Maxwell” is a technology demonstrator aircraft**
  - Supported by the NASA Flight Demonstrations and Capabilities Project
  - uses a crew-rated electric propulsion system designed to augment the aircraft performance in the high speed cruise condition
  - will develop best-practices knowledge for passenger applications of electric propulsion technologies
  - will demonstrate the principles to achieve an 80% reduction in energy required per passenger-mile in the 150-knot speed class

Figure 2.2-2: - X-57 Maxwell with Mod II systems integrated including electrified powertrain.

Figure 2.2-3: X-57 cockpit includes new instrument panel configured to manage the electric powertrain

X-57 Spiral Development Approach

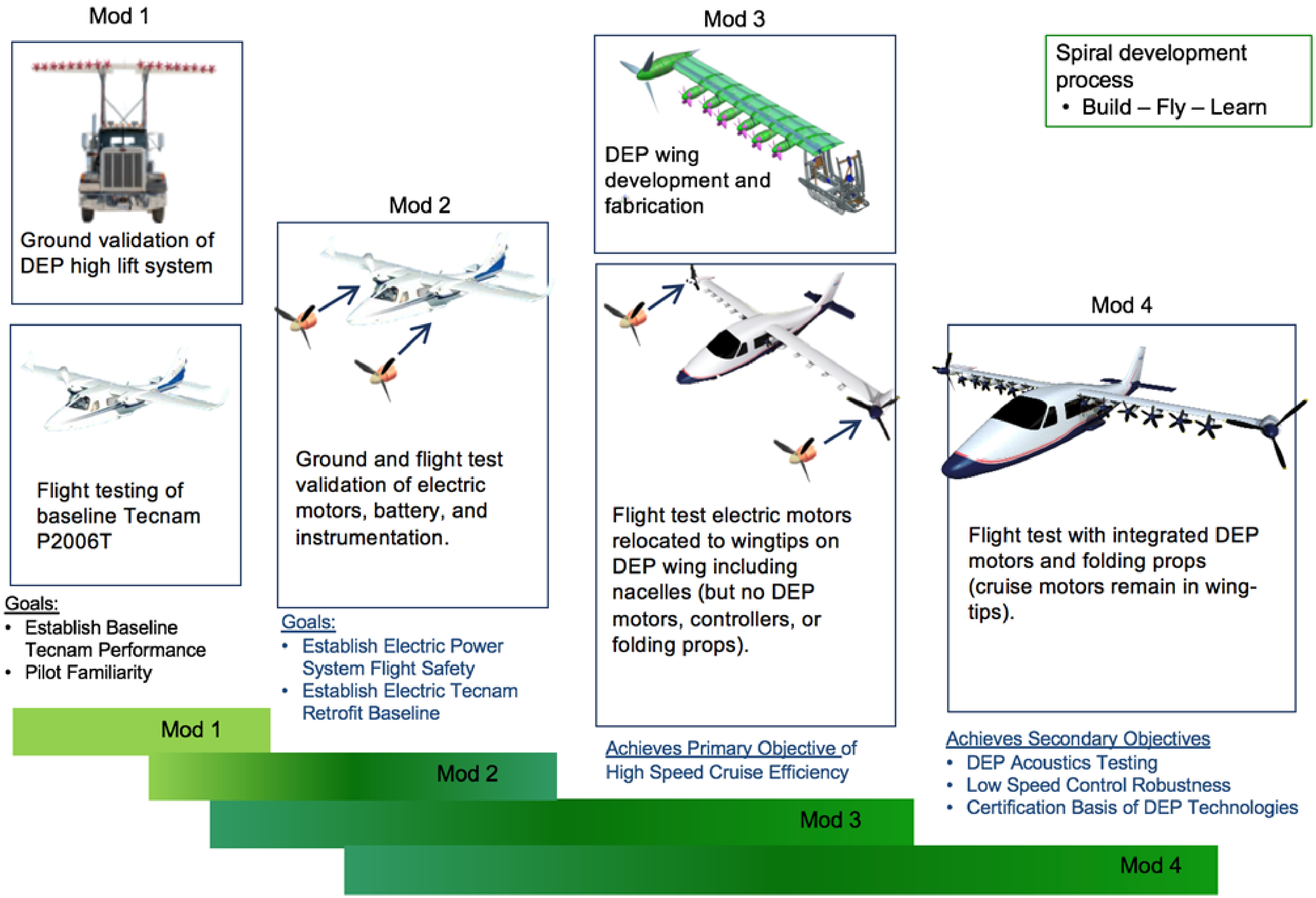

Figure 2.2-1: X-57 Spiral Development Approach

Revolutionary Vertical Lift Technology (RVLT) Project

- **Overarching project goal**
  - to develop and validate tools, technologies, and concepts to overcome key barriers for vertical lift vehicles

Figure 2.3-1: RVLT Concept Vehicles

Revolutionary Vertical Lift Technology (RVLT) Project

- **Activities**
  - Part of the RVLT Project focus is to perform research that informs standards for electric and hybrid-electric propulsion systems of eVTOL
  - NASA designed four UAM concept vehicles of varying payloads, range, type and propulsion systems to identify crucial technologies, define research requirements, and explore a range of propulsion systems
  - Developing electrical ports in Numerical Propulsion System Simulation (NPSS)
  - Development of magnetic gearing for use in the propulsion architectures of eVTOL

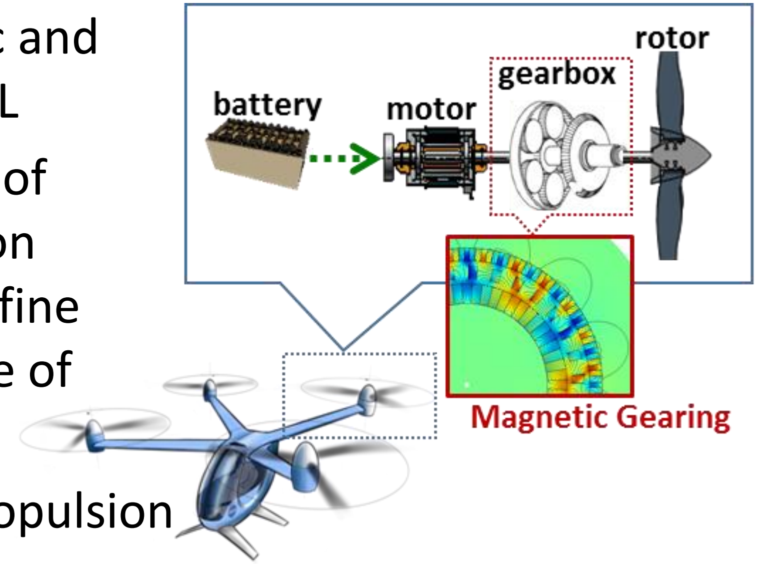

Figure 2.3-1: Magnetic Gearing

Potential EAP Benefits for Commercial and Military Applications

- **Potential Commercial Benefits**
  - hybrid/electric propulsion is considered to be a promising technology for fuel, emissions, and noise reduction in support of the challenging goals established by 2050 EU Flightpath/SRIA, NASA ARMD Strategic Implementation Plan, and the US Air Force ATTAM programs

- **Potential Military Benefits**
  - Potential benefits are expected in the areas of vehicle signature reduction (lower noise, lower exhaust signature),
  - usage in enhanced flight environments
  - minimized human-in-the-loop workload by offering a platform compatible with future goals of autonomous operations facilitation
  - maintenance cost reductions, and performance burst/dash energy.
  - Additional synergies are likely when used in conjunction with energy weapons.

SUAS Power / Propulsion Goals

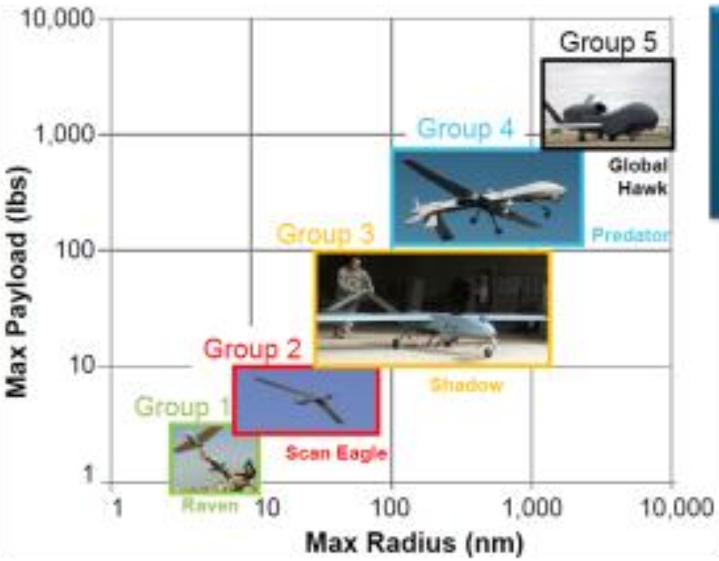

Figure 2.4-1: Unmanned Aerial System Sizes

Figure 2.4-2: SUAS Power/Propulsion Goals

Conclusion

- NASA is broadly investing in Electrified Aircraft Propulsion (EAP)
- NASA investments are guided by a combination of potential market impacts and technical key performance parameters.
- The impact of EAP varies by market and NASA is considering three markets: national/international, on-demand mobility, and short haul regional air transport.
- Technical advances in key areas have been made that indicate EAP is a viable technology.
- Flight research is underway to demonstrate integrated solutions and inform standards and certification processes.
- Significant progress has been made to reduce EAP adoption barriers and further work is needed to transition the technology to a commercial product and improve the technology so it is applicable to large transonic aircraft.

Acknowledgments

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