Perspective on DARPA Vertical Flight Initiatives

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21 October, 2015
A Timeline of (US) VTOL X-Planes

Number of Research Efforts

Focus on high-speed VTOL

Year


Electric Propulsion

Photo References/Sources:
1. American Helicopter Society, 2. A. Bagai,
3. DARPA, 4. U.S. Army, 5. Sikorsky Aircraft,

Distribution Statement “A” (Approved for Public Release, Distribution Unlimited)
“Taxonomy” of Vertical Flight Aircraft

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VTOL Hover and Cruise Efficiency

Hovering flight: T/W > 1.0

Free-Rotor Ideal Efficiency
PL = κ (2ρ/ DL)^1/2

SOA Trend Line
60% Efficiency

Ducted Rotor Ideal
Contraction Recovery

Helicopters
Compounds
Tilt-Wings/
Ducts/Prop

Fan-in-Wing

Vectored Thrust

Large Rotors

80% Efficiency

Primary Refs.: OEM Specifications, JAWA Online, Operators Manuals
Winchester, J., "Concept aircraft: Prototypes, X-planes, and Experimental Aircraft," Thunder Bay Press, 2005

Power Loading
Thrust / Power (lb/hp)

Disk Loading
Thrust / Disk Area (lb/ft^2)

Aircraft Speed (kt)

Helicopters
Compounds
Tilt-Wings/
Ducts/Prop

Fan-in-Wing

Vectored Thrust

Large Rotors

80% Efficiency

Primary Refs.: OEM Specifications, JAWA Online, Operators Manuals
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VTOL Trends in Cruise Efficiency

Aircraft Speed (kt)

Aerodynamic Efficiency (L/De)

- Typical Jet Transports
- Typical Turboprop Transports
- Examples: Helicopters, Compounds, Fan-in-Wing, Vectored Thrust

Primary Refs.:
- Flight Manuals, OEM Specification Data
- Various Conference Proceedings (AHS), AFDD

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VTOL Empty Weight, Useful Load

Manned Aircraft
(Lower We is better)

Max. Gross Weight, (lb)

Empty Weight, (lb)

Fixed-wing VTOL Concepts

Civil Helicopters

Military Helicopters

Compound Configurations

Payload

Main fuel

Crew and equipment

Aircraft empty weight

Empty Weight = GW

Empty Weight = 60% GW

Empty Weight = 40% GW

Primary Ref.: OEM Specifications, JAWA Online, Operators Manuals
Winchester, J., "Concept Aircraft Prototypes, X-planes, and Experimental Aircraft," Thunder Bay Press, 2005

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