Transformative VTOL

John W. Piasecki, President & CEO
Piasecki Aircraft Corp.

5th Annual AHS Transformative Vertical Flight Workshop
18 January 2018
75 years of Innovation, Discipline, Agility, and Perseverance
Strategic Trends

- Need for Advanced VTOL Performance
- Software enabled systems allow novel concepts
- Exponential growth in UAV use and acceptance
- DoD Third Offset Strategy: More with Less
- Innovative engagement of non-traditional aerospace companies (Google, Amazon, Uber)
DoD Rotorcraft & UAS Challenges

Inadequate Operational Reach & Reaction

Lengthy Development Timelines

- V-22 Osprey 22 Years to IOC
- RAH-66 Comanche 25 Years to Cancellation

Vertical Maneuver To Operational Depths

6K/95F

Safety & Survivability

Rotorcraft: A Leading Loss of Life in OEF/OIF
Oct'01 – Dec'13:
625 Americans / 419 Rotorcraft / >$6Billion

Mishap Rate 4-10X’s Higher than SecDef Goal

Concurrent Modernization

- FY14
- FY17
- FY34+20yrs

Future Vertical Lift

JMR TD PoR

Tech Dev EMD

Production

Declining Funding

S&T Demos

Future VTOL UAS

Current Fleet

Existing Fleet Sustained Thru 2070
DoD Operating Environment

Expeditionary & Distributed Ops

Complex Terrain

Asymmetric Threats

Logistics Footprint & Operating Cost

Autonomous advanced VTOL can address many of these challenges
Emerging VTOL Opportunities

VTOL UAS

Autonomous Logistics

Urban Operations

On Demand Mobility
Aerial Reconfigurable Embedded System (ARES)
Modular Multi-Mission VTOL
Aerial Reconfigurable Embedded System (ARES)

Wingborne Flight Performance

VTOL & Shipboard Compatible

Ducts’ Small Footprint Increases Access and Safety

Autonomous or Optionally Piloted

Multi-Mission Modularity

Module Teaming

Address Peak Demands w/o Increasing Fleet Unit Cost

Right Sized for Small Unit Support

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ARES Demonstrator Development and Test

- **Structural Proof Load Test Complete, May ’15**
- **Propulsion Testing Complete, Oct ’16**
- **Subsystem Installs, Oct ’16**
- **Final Assembly, April ’17**
- **System Check-Outs**
- **Hardware-in-the-Loop (HITL) with GCS**
- **Ground Test & Low Speed Envelope Expansion**
- **Modal vibration & structural coupling**

**Graduation Flight Demo**
- Cruise fuel burn measurement
- Flight module Performance
- Vertical take-off
- Vertical landing
- JMIC delivery
- Handling qualities evaluation

**Artist’s concept**
ARES Objective Vehicle (OV-X) Design Studies

- Current ARES design is derived from the Original roadable TX demo vehicle
- ARES Objective Vehicle concept designs
  - Incorporate Demo Vehicle lessons learned
  - Relieve roadable requirements
  - Address emerging DoD multi-mission VTOL UAS requirements
- Update OV-X design based on demo results

Tailoring the ARES Objective Design to Address Emerging Requirements
ADAPT™ Flight Controls Research

OSD Rotorcraft Safety & Survivability Study (‘09)

RW Losses
- 19% Hostile Action
- 41% Combat Non-Hostile
- 40% Non-Combat
- Mishap Rate 4-10X’s Higher
- Sec Def / Congressional Goal

RW Fatalities
- 73% in Combat Theatre
- 68% Human Factor Cruise Flt
- 5x’s Higher Mechanical Mishap Fatalities in Combat Theatre vs Non-Combat

Targeted Benefits
- Safety & Survivability
- Reduced Pilot Workload
- Reduced Susceptibility & Vulnerability
- Automated response
- Performance
- Expanded Speed/GW Flight Envelope
- Increased Efficiency
- Improved Maneuverability
- Reduced Cost
- Increased Productivity
- Fuel Savings
- Reduced Maintenance

ADAPT Flight Control Features
- Damage Tolerant Control (DTC)
  - Reconfigurable Control Allocation
  - Autonomous Emergency Response
- Flight To Optimal (FTO)
  - Trim & Maneuver Optimization
  - Load Limiting Feedback Control
  - Redundancy Management

Advanced VTOL Aircraft with Redundant Effectors

Damage Tolerant Controls Identified as a Top Priority S&T Focus

Self-Healing Flight Control Systems

Self-Healing Flight Control Systems

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Casual Factors
- CFIT, DVE > Situational Awareness, Pilot Workload & Operating Environment
- MANPADS, RPGs > Situation Awareness, CM, Vulnerability, and Crashworthiness

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Self-Healing Flight Control Systems

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eVTOL Design Study

Design Mission:
High Value / Time Certain Distribution

Configuration Trade Studies
- 25 configurations down-selected to 5 then to 1
- Must close mission within given GW limit
- Safety & Certifiability
- Simplicity & Reliability
- Development Time, Cost & Risk
- Design flexibility, future growth
- Cost Effective

Key Risks
- Weight & L/D → Margin and Configuration
- Battery Power Density → Modular Hybrid
- Autonomous Ops in NAS → Optionally Piloted
- Safety → Inherent to Design & Redundancy
- Reliability → Simplicity & Design Criteria
- Certification → Baseline & Spiral Insertion

Safety & time to certification are significant discriminators
“There's a lot more to do... and you out there who are doing it... The future is bright... It's your future... Be there!!”

Frank Nicholas Piasecki (1919-2008)
March 9, 2005
Smithsonian National Air and Space Museum
Lifetime Achievement Award Ceremony