The Future of Vertical Flight:

US and international military rotorcraft developments

Mike Hirschberg, Director of Strategy

Vertical Flight Society • www.vtol.org

These slides at www.vtol.org/FVL
What is The Vertical Flight Society?

- The international **professional society for those working to advance vertical flight**
  - Founded in 1943 as the **American Helicopter Society (AHS)**
  - Everything from VTOL MAVs/UAS to helicopters, eVTOL, etc.
  - 6,400 individuals, 170 companies, 30 universities, etc.

- **Expands knowledge** about vertical flight technology and promotes its application around the world

- Advances **safety and acceptability**

- Advocates for vertical flight **R&D funding**

- Helps **educate and support** today’s and tomorrow’s vertical flight engineers and leaders

- **Brings together the community** — industry, academia and government agencies — to tackle the toughest challenges

Join us today: www.vtol.org
VTOL Innovators – Then and Now

1st AHS Banquet
1944

1st eVTOL Workshop
2014
An 80+ Year Legacy

- VFS has a long history of advocacy and leadership
  - Helped establish NASA-Army Joint Office, Nat’l Rotorcraft Technology Center (NRTC), Centers of Excellence, RITA/VLC
  - Worked with NASA and DoD to save the NFAC wind tunnel

- Provided major support to transformative initiatives
  - Joint Strike Fighter / F-35B STOVL
  - V-22 Osprey tiltrotor / civil tiltrotor

- Providing major foundational support to new transformative initiatives
  - Battery-, hybrid- and hydrogen-electric VTOL (eVTOL)
  - Future Vertical Lift (FVL)

**VFS Works to Advance Vertical Flight!**

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US Military VTOL Capability Gaps

- Performance shortfalls
  - Speed, range, payload, endurance, altitude

- Unexploited autonomy/collaboration
  - Significantly increased mission effectiveness remains untapped

- Unacceptable survivability & situational awareness shortfalls
  - Safety and threat losses, no common picture

- Costly sustainment
  - Supportability, maintainability, reliability and availability

10 years of conflict and DoD studies reveal significant VTOL mission capability gaps
V-22 was only all-new U.S. military rotorcraft design fielded in past 30 years

All other deployed designs are 30-50 years old

- UH-1 Huey first flight 1956; Chinook 1961; Black Hawk 1975; Apache 1976
- OH-58 Kiowas in service from 1969 to 2017
- Some 1960s airframes are still flying!
- CH-53A Sea Stallion 1964; CH-53K operational April 2022
### Boeing 2009 Slide

**Comparison of Fighter & Rotorcraft Generations**

<table>
<thead>
<tr>
<th>Boeing BDS / Boeing Military Aircraft / Rotorcraft Systems</th>
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<tr>
<td>Biplane Era</td>
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#### 1st Gen Rotorcraft
- Piston engine
- Wood blades
- $V_C < 50$ kts

#### 2nd Gen Rotorcraft
- Turbine engine
- Metal blades
- $V_C \sim 130$ kts

#### 3rd Gen Rotorcraft
- Comp. blades
- Survivability
- Adv. weapons integration
- $V_C \sim 150$ kts
- High speed
- Fly-by-Wire
- Composites
- Signature reduction
- $V_C > 170$ kts

**Source:** Boeing Rotorcraft @ VFS Forum 65 (2009)
Rotorcraft Generations

Modified from slide presented on Rotorcraft Generations at AHS Forum 66 in Phoenix, AZ, 12 May 2010.

1st Gen 
1945-1960

R-5, H-21
Airspeed <100 kt
Reciprocating Engines
Wood Blades
Mechanical Controls
No Survivability

CH-47A, UH-1, CH-53
Airspeed <130 kt
Turboshaft Engines
Metal Blades
Automatic Flight
Control Systems
Metal Structure
Reduced Vulnerability
Passive Survivability
Countermeasures
Crashworthiness
Standards Defined

2nd Gen 
1960-1975

UH-60A, AH-64A
Airspeed >150 kt
Increased Engine Power
Composite Blades
Reduced IR Signatures
Improved Crash Safety
Active Survivability
Countermeasures

3rd Gen 
1975-1990

V-22, UH-60M, AH-64E
CH-47-II, A/UH-1Y/Z
Airspeed >150 kt
More Efficient and
Powerful Engines
Limited Composite
Structures
Adv Flight Controls
Adv Blade Design
Avionics Sensor Fusion
Reduced RF & Acoustic
Signatures

3rd+ Gen 
1990-2015

RAH-66, CH-53K
Airspeed >170 kt
More Efficient and
Powerful Engines
Extensive Composites
Digital Fly By Wire
Adv Blade Design
Avionics Sensor Fusion
Reduced RF and Acoustic
Signatures
Intelligent Survivability
Adv Countermeasures
Active Crash Safety Systems

4th Gen 
2015-2030

FVL, MUX, FUAS
Airspeed >200 kt
Long range/endurance
High efficiency & high
power/weight engines
Novel Configurations
Open System Architecture
Individual Blade Control?
Thrust Augmentation?
Adaptive Controls?
Signature Reductions
Optionally Piloted
Digital Interoperability

5th Gen 
2030-

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Rotorcraft Generations

Adapted from slide presented on Rotorcraft Generations at AHS Forum 66 in Phoenix, AZ, 12 May 2010.

RAH-66, CH-53K

- Airspeed >170 kt
- More Efficient and Powerful Engines
- Extensive Composites
- Digital Fly By Wire
- Adv Blade Design
- Avionics Sensor Fusion
- Reduced RF and Acoustic Signatures
- Intelligent Survivability
- Adv Countermeasures
- Active Crash Safety Systems

4th Gen

2015-2030

FVL

- Airspeed >200 kt
- Long range/endurance
- High efficiency & high power/weight engines
- Novel Configurations
- Open System Architecture
- Individual Blade Control?
- Thrust Augmentation?
- Adaptive Controls?
- Signature Reductions
- Optionally Piloted
- Digital Interoperability

5th Gen

2030-20??

circa 2010
# FVL Family of Systems

<table>
<thead>
<tr>
<th>Light</th>
<th>Medium</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cockpit</td>
<td>- Requirements</td>
<td>- Sustaining</td>
</tr>
<tr>
<td>- FACE/JCA</td>
<td>- Reduced overhead</td>
<td>- Maintaining</td>
</tr>
<tr>
<td>- Training</td>
<td>- Mission flexibility</td>
<td>- Repair parts and components</td>
</tr>
</tbody>
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**Capability Set 1**
- Missions:
  - Reconnaissance
  - Attack
  - Security
  - CCA/CAS
  - Surface Warfare
  - Direct Action
  - Maritime Interdiction Operations

**Capability Set 2**
- Missions:
  - Reconnaissance/Attack
  - Security
  - CCA/CAS
  - MEDEVAC
  - Air Assault
  - Logistics
  - HA/DR
  - Amphibious Assault
  - NEO

**Capability Set 3**
- Missions:
  - Mine/Counter Mine
  - MEDEVAC
  - Air Assault
  - Logistics
  - HA/DR
  - Amphibious Assault
  - NEO

**Capability Set 4**
- Missions:
  - MEDEVAC
  - Air Assault
  - Logistics
  - HA/DR
  - Amphibious Assault
  - NEO

**Capability Set 5**
- Missions:
  - MEDEVAC
  - Air Assault
  - Logistics
  - HA/DR
  - Amphibious Assault
  - NEO

- Army
- Marines
- US Special Operations
- Navy
- Coast Guard
- (DHS)

- Army
- Marines
- US Special Operations
- Navy
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- Army
- Marines
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- Navy
- (DHS)

- Army
- Marines
- US Special Operations
- Navy
- (DHS)
Future Vertical Lift (FVL)

- 5 Capability Sets from Light to Ultra Heavy
  - Plus advanced unmanned programs
- Joint Multi-Role (JMR) Technology Demonstrations – 30,000 lb-class (13.6 t)
  - Bell V-280 Valor vs. Sikorsky-Boeing SB>1 Defiant
  - US industry invested ~$1B in JMR at 4:1 gov’t spending
- Other Capability Sets
  - CS1 (Light): Army’s Future Attack Reconnaissance Aircraft (FARA) to replace Kiowa Warriors
  - CS2 (Medium Light): Navy to replace Seahawks and Fire Scouts with FVL Maritime Strike
  - CS3 (Medium heavy): Army’s Future Long-Range Assault Aircraft (FLRAA) to replace Black Hawks; Attack/Utility Replacement Aircraft (AURA) Future Vertical Lift Family of Systems (FVL FoS)

Sikorsky-Boeing SB>1 FVL CS3 Concepts
Sikorsky-Boeing SB>1 JMR Demonstrator

circa 2022
Bell V-280 Valor JMR Demonstrator

- www.vtol.org/cft and www.vtol.org/fara
US Army original vision:
Future Attack Reconnaissance Aircraft (FARA)

- Announced March 2018
- Solicitation released Oct. 3; proposals submitted Dec. 18
- 8 proposals submitted:
  - Airbus Helicopter
  - AVX Aircraft/L3Harris
  - Bell
  - Boeing
  - Hi-Lite Aircraft
  - Karem Aircraft/Northrop/Raytheon
  - MD Helicopters
  - Sikorsky Aircraft
- 5 contract awards April 2019
- 2 prototypes – flights in FY22Q1

- $750M in government funding + $375M contractor funding = $1.1B each
- Smaller, slower than Capability Set 3 assault aircraft
  - ~14,000 lb (6.5 t) and 40 ft (12.2 m) rotor diameter and width
  - >180 kt cruise
- Operational by 2028
- Improved Turbine Engine (ITE)
  - GE T901 @ 3,000 shp selected over ATEC (Honeywell/PW) T900
  - Most advanced turboshaft ever
  - 25% sfc reduction, 20% longer life
  - 10,000 engines for Black Hawk, Apache
Future Attack Reconnaissance Aircraft (FARA)
5 Capability Sets from Light to Ultra Heavy
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Additional Capability Sets underway
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    *Future Vertical Lift Family of Systems (**FVL FoS**)*

Sikorsky-Boeing SB>1 FVL CS3 Concepts
Sikorsky-Boeing SB>1 JMR Demonstrator
circa 2022
Compounds & Tiltrotors

Sikorsky-Boeing S-100 SB>1 Defiant™ (2019)
30,000 lb (13.6 t) class

Sikorsky S-102 Raider X™ (2024)
14,000 lb (6.35 t)

Sikorsky S-97 Raider™ (2015)
11,000 lb (5 t)

Sikorsky S-94 X2 Technology™ Demonstrator (2008)
5,500 lb (2.5 t)

Bell Helicopter V-280 Valor (2017)
30,000 lb (13.6 t) class

Leonardo (with Bell) AW609 (2003)
16,800 lb (7.6 t)

Bell Boeing V-22 Osprey (1989)
52,600 lb (23.8 t)
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Increasing:
- Performance (Range, Endurance)
- Useful Load
- Resident Autonomy
- Achievable Effects (Lethal, MFEW)
- Cost / Complexity
NATO NGRC Project
Next-Generation Rotorcraft Capabilities

- 900+ NATO medium helicopters reaching end of life cycle in 2035–40
- Initial talks in 2012. Now 10+ years of studies and agreements completed.
- On June 16, 2022, France, Germany, Greece, Italy, the Netherlands and the UK pledged €26.7M to initiate concept development
  - Canada now joined; Spain and other countries interested
  - US participating as observers
- Industry Day May 2021 “Required Attributes”
  - MTOW 22,000–37,500 lb (10–17 metric tons)
  - 220 kt+ top speed (not less than 180 kt)
  - 900 nm unrefueled range
  - Endurance of 5+ hours (8 hours with extra tanks)
  - Deploy for 6-9 months on a Frigate (FF) or Destroyer (DD)
NATO & NIAG Studies on NGRC

via Dan Newman, Honeywell

ACT = Advanced Concept Transformation
GBAD = Ground Based Air Defense
NAAG = NATO Army Armaments Group
NAFAG = NATO Air Force Armaments Group
STO = Science & Technology Organization

SG-219 NGR Capability
SG-227: R/C MUM/T
SG-239 Integrated Sustainability
SG-241: Metrics, Data &Tools in Sys Life Cycle
SG-258: Above Water Warfare
SG-263: Multi Domain C2
SG-266 Joint- Domain R/C Interop & SV vs Peer
SG-193 Airworthy Cert of DVE Sys & Fit Trials
SG-167 Helos at Low Alt in DVE
AVT-329 Military Applications of NGR
SG-170 Counter UAS
SG-188 Sensor Mix Optimiz
SG-200 Low, Slow & Small Threat Effector
SG-220: GBAD Ops in 21st Century
SG-238 GBAD Ops vs Peer CM & UAS
SG-265 GBAD SV & Eff in Joint Ops v Peer
SG-241: Metrics, Data &Tools in Sys Life Cycle
SG-246 Innovative Military Aviation Acquisition
SG-266 Joint- Domain R/C Interop & SV vs Peer
SG-184 SpecOps Aviation Battlespace Awareness
SG-185 & SG-211 Def Aids Sys Exploitation
SG-242: Modular Mission Equip for SOA
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SG-184 SpecOps Aviation Battlespace Awareness
SG-185 & SG-211 Def Aids Sys Exploitation
SG-242: Modular Mission Equip for SOA
International Developments
Italy: Leonardo AW249
International Developments:
Turkish Aerospace

11,200 lb (5.1-t) T129 ATAK (based on AW129)

25,300-lb (11.5-t) T929 ATAK 2
First flight April 28, 2023

“10-Ton” T925 transport mockup
At the Paris Air Show (AvWeek)
Future Vertical Lift
- US Army’s FLRAA is transformative
  - Modular Open Systems Approach (MOSA) is important
  - Potential UAS development
- USN and USMC planning development programs
- Other allied nations planning military developments
- VFS is the global Vertical Flight Society
  - We are helping to shape the future of vertical flight!
  - $Billions going into new rotorcraft
  - Find out more at www.vtol.org and join us!