AHS and the Future of Vertical Flight
January 19, 2012

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Executive Director
American Helicopter Society (AHS) International
The Vertical Flight Technical Society

www.vtol.org
Overview

1. About AHS
2. State of Vertical Flight Today
3. Possibilities for Tomorrow
$1.7M annual revenue in 2010
  – Down from $1.9M in 2007
6,100 current individual members
  – Down from 7,000 members in 2009
18% non-U.S. members
70+ corporate members
23 active chapters
21 technical committees

AHS is the premier vertical flight technical society, but these are tough economic times and tough times for societies in general. We need your help to remain a healthy organization!
Leadership – AHS leads technology, safety, advocacy and other initiatives. We bring together industry, academia and government to tackle the toughest challenges.

Advocacy – AHS works to affect change to benefit the industry and create recognition of the benefits of vertical flight.

Vertiflite – get in-depth insight into the latest developments with the world’s leading magazine on vertical flight technology. We’re now bi-monthly!

The Journal – the world’s only vertical flight technical journal, The Journal of the AHS has the latest scientific findings and engineering breakthroughs.

Networking – interact with some of the 1300 attendees at the Annual Forum or with small gatherings at your local Chapter meeting or Specialists Meetings.

Participation – get involved with your local chapter, join one of our 21 different technical committees or help in many other ways!

Recognition – be eligible to be recognized by your peers for outstanding contributions or nominate others through our awards program.

Education – student chapters, VFF Scholarships, Human Powered Helicopter Competition, and Student Design Competition.
About AHS

Mission

The American Helicopter Society (AHS) International is the world’s premier professional vertical flight technical society. Since its inception in 1943, AHS has provided an international forum through which to expand the body of knowledge of vertical flight. The Society is the global resource for information on vertical flight technology.

Vision

To provide global leadership for scientific, technical, educational and legislative initiatives that advance the state-of-the-art of vertical flight.
Strategic Imperatives

1. Expand the membership
   - Need your help!

2. Develop a robust online presence
   - New website, social media, online *Vertiflite*, online *Proceedings*

3. Return more value to the members
   - Bi-monthly *Vertiflite*, Members Only section

4. Be the leaders of advocacy for vertical flight technology
   - Working with the Congressional caucus, Vertical Lift Consortium to influence decision making
The American Helicopter Society (AHS) International is the world's premier vertical flight technical society.

Since its inception in 1943, AHS has been a major force in the advancement of the global rotorcraft industry.

Why be a member? We are the leaders of advocacy for vertical flight technology. Our highly acclaimed magazine, Vertiflite, brings our members in-depth insight into the latest developments. Our technical publication, The Journal of the American Helicopter Society, is the world's only vertical flight technical journal. Membership also provides networking opportunities, access to Members Only features on our website, discounts to our products and the opportunity to be recognized as part of our prestigious awards programs. Find out more!

Fall Membership Drive: Between now and November 15, 2011, new members who join AHS will be eligible to win prizes. In addition, current members who sponsor new members will also be rewarded. Learn more!
The AHS staff is working hard to expand our online presence with our new AHS website and expanded Web 2.0 offerings, such as Facebook, LinkedIn, Twitter, RSS feeds and a wiki. **Join us wherever you are online!**

**Facebook:** We’ve had a presence on Facebook since 2009. The [American Helicopter Society History Committee](https://www.facebook.com/AHSHistoryCommittee) fan page features daily posts of “This Day in HeliHistory,” while the [American Helicopter Society (AHS) International](https://www.facebook.com/AHSInternational) fan page highlights the latest news and announcements across the industry.

**LinkedIn:** Over 120 million professionals use LinkedIn to exchange information, ideas and opportunities. Are you LinkedIn? If so, join the [American Helicopter Society (AHS) International](https://www.linkedin.com/groups/165929-AHS-International) group to get updates on the latest Society news, connect with other AHS members, and network.

**Twitter:** Are you a Twitter Junkie? Don’t want to wait another second for the latest information? Both of our Facebook pages and LinkedIn are linked to Twitter feeds. Choose what kind of tweets you’d like to receive by following @HeloHistory, @HeloNews and/or @HeloSociety!

**RSS:** Aren’t allowed to check social media at work or just don’t belong to any of the above? Don’t worry! Just click on the RSS button under News to subscribe to our RSS feed.

**YouTube:** We’ve got some great historical and AHS-related videos on our YouTube channel, and plan to expand this area in the future. Our channel is [HeloSociety](https://www.youtube.com/channel/UCl9kT99tWz5v0n9yE8oU3Zg).

**Wiki:** The AHS History Committee has started the VTOL Bio Wiki as a “Who’s Who” of the rotorcraft industry, from vertical flight pioneers, to AHS award members and other prominent leaders. We’ve got over 100 biographies already started, but, as with any wiki, the content is provided by volunteers! If you’d like to contribute, go to [http://www.vtol-bios.org](http://www.vtol-bios.org) to sign up.

**Mobile site:** On the go and need fast access to the AHS website? Do you use your smartphone for access to social media? Scan this QR (Quick Response) code from your smartphone or go to [mvtol.org](http://mvtol.org) for the mobile version of the AHS website. We’ll be providing extra content through QR codes in the future. Look for them in forthcoming issues of [Vertiflite](https://www.vertebrate-flight.org).
Journal of the American Helicopter Society

ISSN 2161-6027
Visit publication homepage

The Journal of the American Helicopter Society is the world's only scientific journal dedicated to vertical flight technology. It is a peer-reviewed technical journal published quarterly by AHS International and presents innovative papers covering the state-of-the-art in all disciplines of rotorcraft design, research and development. (Please note that AHS members receive significant discounts on articles and subscriptions.)

Journal subscribers who are AHS members log in here if you are not already logged in.

Authors can find submission guidelines and related information on the AHS website.

224 issues are available electronically

Volume 56

Number 4, October 2011
## Body of Knowledge

![Image of publications](vtol.org)

**Bi-monthly Vertiflite in Jan 2012**

**Online Proceedings in Jan 2012**

**New Online Journal in Dec 2011**

<table>
<thead>
<tr>
<th>Publication</th>
<th>Papers</th>
<th>Pages</th>
<th>Initial Online</th>
<th>Completed</th>
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<tbody>
<tr>
<td><em>Vertiflite</em> magazine</td>
<td></td>
<td>25,000</td>
<td>Jan 2012</td>
<td>Late 2012</td>
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<td><em>Journal of the AHS</em></td>
<td>1,600</td>
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<td>AHS Forum <em>Proceedings</em></td>
<td>5,500</td>
<td>75,000</td>
<td>Jan 2012</td>
<td>Mid 2012</td>
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<tr>
<td>Specialists Meeting proceedings</td>
<td>50,000</td>
<td></td>
<td>Early 2012</td>
<td>Late 2012</td>
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<td><strong>Total:</strong></td>
<td></td>
<td>175,000</td>
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Advocacy

- Met with Senate staffers 8/2 on NASA Aeronautics budget
- Working with Vertical Lift Consortium
- Letter to SecDef 9/29 urging support of Future Vertical Lift (FVL) Strategic Plan
- Working with new Army Aviation Caucus in Congress  – Letter to SecDef supporting FVL
- Interactions with media
- Advocacy section on www.vtol.org
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>January 20-22, 2011</td>
<td>Unmanned Aerial Vehicles</td>
<td>Tempe, AZ</td>
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<tr>
<td>February 7-9, 2011</td>
<td>Airworthiness, CBM and HUMS</td>
<td>Huntsville, AL</td>
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<tr>
<td>February 23-25, 2011</td>
<td>Next Generation Vertical Lift</td>
<td>Ft Worth, Texas</td>
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<tr>
<td>May 3-5, 2011</td>
<td>Forum 67</td>
<td>Virginia Beach, VA</td>
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<td>August 31-Sept 1, 2011</td>
<td>Vertical Lift RDT&amp;E</td>
<td>Patuxent River, MD</td>
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<td>Sept. 21-22, 2011</td>
<td>Systems Engineering</td>
<td>Binghamton, NY</td>
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<tr>
<td>October 25-27, 2011</td>
<td>Propulsion</td>
<td>Williamsburg, VA</td>
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<tr>
<td>November 8-9, 2011</td>
<td>IHSS (Safety)</td>
<td>Ft Worth, TX</td>
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<tr>
<td>January 18-20, 2012</td>
<td>Future VL Aircraft Design</td>
<td>San Francisco, CA</td>
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<tr>
<td>May 1-3, 2012</td>
<td>Forum 68</td>
<td>Ft Worth, TX</td>
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AHS is the world’s premier vertical flight technical society

Significant progress in modernization has been made in the past 7 months but significant work remains ahead of us

Membership and revenue trends are both negative

The economic and government funding forecasts are gloomy

Get involved – we need your help!

We can be successful if we increase our membership and effectiveness to fulfill our Vision:

Provide global leadership for scientific, technical, educational and legislative initiatives that advance the state-of-the-art of vertical flight.
State of Vertical Flight
Today
V-22 only new military rotorcraft design fielded since Apache (1984)

- All other deployed designs are 30-50 years old; first flights 1956-1975!
- Many Vietnam-era airframes are still flying!
- No new designs are in the acquisition process

CH-47A 60-03449
Prototype #8

CH-47B 66-03449
(Vietnam 1969)

CH-47C 78-03449

CH-47D 92-03449

CH-47 #03449: 75 Year Life Cycle ??
Block Modifications and Sustainment of Vietnam Era Design

Estimated End of Useful Life
Chinook Analogy

1960 Chevy Truck

1966 Engine Overhaul

1978 Engine Overhaul

1992 New engine, wheels, Radio, seatbelts, etc

2002 ABS, GPS, XM, Airbags Bluetooth, etc.

2020? Low rider body kit and accessories plus new engine
JMR Analogy
State of VTOL Aviation

- No new Army rotorcraft fielded in over a generation
  - Chinook, Kiowa, Black Hawk and Apache designed during Vietnam War
  - RAH-66 Comanche cancelled after 21 years
  - UH-72/EC145 based on BK117 (first flight 1979)
  - Current designs based predominantly on conventional warfare

- No new start VTOL programs of record
  - Wartime usage 4-5 times greater than planned
  - Services’ focus: block modifications and sustainment of current platforms
  - COTS/GOTS acquisition fails to exploit new capabilities

- VTOL fleet approaching technical and tactical stagnation
  - VTOL R&D/S&T pipeline has been critically underfunded
  - Near term O&M focus over long term S&T investment
  - Foreign VTOL technical expertise is arguably outpacing U.S.
  - Current VTOL fleet reaches end of service life 2020 - 2035

VTOL operations – a significant capability in today’s war... uncertain future
Capability Gaps Are Widening

**Vietnam**: Gaps closed by force in numbers and new generation of rotorcraft (UH-1, AH-1, CH-47)

**Cold War**: Gaps closed using new technologies developed during Vietnam + new airframe fieldings (UH-60, AH-64)

**Hybrid Warfare**: Gaps growing due to increasing requirements, coupled with an aging fleet and no new designs

OSD Future Vertical Lift (FVL) Capabilities Based Assessment (CBA) identified 55 significant gaps
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 air or cockpit picture

- **Costly sustainment**
  - Supportability, maintainability, reliability and availability

10 years of conflict and DoD studies reveal significant VTOL mission capability gaps
Technologies for the Future

- Fly-by-wire
- Variable rotor speed
- Active/adaptive rotors
- Advanced configurations
- Swashplateless
- etc.

Many fertile areas for development – Needs more investment
Future of VTOL Aviation

- **Joint Heavy Lift (JHL)/Joint Future Theater Lift (JFTL)**
  - Studies since 2005 have proven merit
  - Continued funding needed

- **Joint Multi-Role (JMR) Rotorcraft Technology Demonstrators**
  - Critical to the future of VTOL aviation

- **Future Vertical Lift (FVL) Strategic Plan**
  - Needed to give direction to industry and leverage industry IRAD over next 10 years

- **Vertical Lift Consortium (VLC)**
  - Industry group formed at behest of OSD to improve and accelerate next generation capabilities for the warfighter

**Sustained government leadership is needed to resolve critical capability gaps!**
What impact will Defense cuts have on vertical flight?

Extremely challenging performance and affordability goals
  – Shipboard compatibility adds another dimension of difficulty

Contracts awarded this summer by AATD

Tech Demo + Acquisition program lasts 20 years
  – 2030 is 55 years after Black Hawk and Apache first flights
  – What lessons learned can be gained from the latest helicopter demonstrators?

Are there sufficient funds for 2-3 demonstrators?

What role does the Vertical Lift Consortium (VLC) play?

What role should AHS play?

Significant dialogue needed between industry, technology and requirements communities!
Scout Replacement

- OH-58 Kiowa first flight 1966
  - Based on Bell 206 first flight 1962
- RAH-66 Comanche program canceled 2004
- ARH program canceled in 2008
- Armed Aerial Scout (AAS)
  - Analysis of Alternatives complete
  - Army decision between upgrade, COTS or new start
  - RFP coming soon for a flight demonstration to inform the decision
  - Army sounds like they are looking for an 80% solution
Possibilities for Tomorrow

www.vtol.org
### Bell-Boeing
- Signed TIA on 30 June
- 18-month effort
- Focus on tilt-rotor technology
- Conducting trades to improve performance and reduce cost

### Boeing
- Signed TIA on 30 June
- 18-month effort
- Evaluating technologies for four initial configurations
- Will down-select to one best configuration

### Sikorsky
- Signed TIA on 30 June
- 18-month effort
- Single edge-wise rotor, X2-based compound, tilt-rotor
- Will carry all three designs through to conceptual design for objective and demo

### AVX
- Signed FFP contract on 20 Sep
- 15-month effort
- Evaluating technologies for a coaxial rotor, ducted fan compound helicopter
## Compound Summary

<table>
<thead>
<tr>
<th>Technology Demonstrator</th>
<th>Piasecki X-49</th>
<th>Sikorsky X2</th>
<th>Eurocopter X³</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Flight:</td>
<td>Jun 2007</td>
<td>Aug 2008</td>
<td>Sep 2010</td>
</tr>
<tr>
<td>Max Speed:</td>
<td>~215 kt*</td>
<td>253 kt</td>
<td>232 kt</td>
</tr>
<tr>
<td>Date:</td>
<td>2012?</td>
<td>Sep 2010</td>
<td>May 2011</td>
</tr>
<tr>
<td>Time to Max:</td>
<td>TBD</td>
<td>67 months</td>
<td>40 months</td>
</tr>
<tr>
<td>Aircraft Basis:</td>
<td>Retrofit</td>
<td>New</td>
<td>Combination</td>
</tr>
<tr>
<td>Funding:</td>
<td>Congressional</td>
<td>Private</td>
<td>Private</td>
</tr>
</tbody>
</table>

*180 kt demonstrated to date


Compound Summary

Technology Demonstrator

Top Speed:

Piasecki X-49 ~215 kt*
Sikorsky X2 253 kt
Eurocopter X³ 232 kt

Operational Concept

Top Speed:

Piasecki PA-61B 275 kt
Sikorsky S-97 230 kt
Eurocopter ?

*180 kt demonstrated to date
A hybrid helicopter (1) includes firstly an airplane provided with a fuselage (2) and a lift-producing surface (3), together with lift/turbine surfaces (30, 34, 40), and a two-speed drive system consisting of:

- A mechanical interconnection system (35) between firstly a rotor (10) of radius (22) with collective pitch and cyclic pitch control of the blades (11) of the rotor (10), and
- Secondly at least one propeller (4) with collective pitch control of the blades of the propeller (14), and
- At least one turbine engine (15) driving the mechanical interconnection system (35).

The device is remarkable in that for certain speeds of rotation of the at least one turbine engine (35), of the at least one propeller (4), of the rotor (10), and of the mechanical interconnection system (35) are mutually proportioned, the proportionality ratio being constant.
Mil Compounds

Mil Mi-X1

Mil MRVK
Kamov Compounds
Adaptive Rotor Technology

Active Twist Actuation
Active Blades Flaps
Variable Leading Edge Camber
Active Pitch Links
Variable Speed Transmission

Bell Boeing

Variable rotor speed
Active blade twist
Active leading edge
Active trailing edge
Swashplateless rotor system
Active tip sails

Sikorsky

Boeing
Bell Boeing Folding Advanced Stopped Tilt Rotor (FASTR)
• **Dragonfly Ship 1**
  - Two successful flights Nov/Dec 03
  - Crash on 23 Mar 04
  - Accident Investigation, main causes of crash:
    - Lack of controllability due to cross-coupled moments
    - Pitch /roll moment sensitivity to wind (aft wind)

• **Dragonfly Ship 2**
  - Flights Nov/Dec 05 & Mar 06, hover and low speed maneuver
  - Crash on 12 Apr 06 after 18 minutes flight
Boeing Unloaded Lift Offset Rotor (ULOR)

Performance, Low Vibration, Low Noise Enabling Technologies

- Pursuing technologies to significantly increase cruise speed, reduce vibrations, reduce acoustic signature, and increase maximum blade loading without hover performance penalties.
Rapid Development & Flight Test of a VTOL Air Vehicle with Greater than 2x Improvement in Forward Flight Characteristics over a Conventional CSAR Helicopter

- High Lift/Drag Ratio (>10)
- Low Disc Loading (<<Tilt Rotor)
- Reaction Drives (No Anti-Torque Required)

400 mph Cruise Speed, 1000 nmi Unrefueled Range with 1000 lb Payload

Auxiliary Propulsion: More Efficient than Rotor in High Speed Cruise

High Aspect Ratio Wing: Most Effective Lifting Surface at 400 mph

Rotor: Essential for Hover, Inefficient at High Speed.
Slow Rotor in Cruise & Transfer Lift to Wing.
Carter Slowed Rotor Compounds
DARPA Transformer (TX)

- Fuel in Self-Sealing Wing Tanks Outside of Crew Compartment
- Gimbaled Rotor Hub Provides Rotor Tilt for Low-Speed Control and Tilting Mast to Enable Efficient Cruise
- High-Inertia SR/C™ Rotor System for Powerful VTOL Performance, Including Safe Landing after Engine Failure
- Lightweight Composite Armor and Ballistically Tolerant Windscreens
- Crumple Zone for NHTSA Crash Protection
- JP-8 Fueled Turboshaft Engine for Airborne Cruise
- Electric In-Wheel 4-Wheel Drive for Ground Operations, Including Run Silent Capability
- Long-Stroke, High-Energy Suspension System for Off-Road Operations
- Robust Ground Vehicle for all-Terrain Mobility
- Fully Autonomous Integrated FCS to Support Control by Non-rated Ground Personnel
- Pitch and Yaw Thrust Deflectors for Control at High and Low Speeds
- All-movable Stabilizers for Stability and Control in Cruise
- Ducted Propulsion for Cruise Flight
- Alleron for Roll Control in Cruise
DARPA-Boeing DiscRotor

Rotor Blades Extended

Helicopter Mode

Blades Retracted

Fixed-Wing Mode
12 ft Wind Tunnel Model

- Hub and retraction system
- Telescoping blades
- 8-piece disc fairing
- Fairing frame
- Balance and upper controls
- BART test rig
AHS is the world’s premier vertical flight technical society
  – We are dedicated to the advancement of vertical flight
  – Get involved – *we need your help!*

**Future Vertical Lift/Joint Multi-Role is the future**
  – We absolutely need it, and we need to work it now!
  – Need leadership from senior decision makers

**The rotorcraft industry has fertile grounds for innovative ideas**

**Need to reach next generation capabilities within declining budgets**