



The Vertical Flight Society



Mike Hirschberg, Executive Director
The Vertical Flight Society
www.vtol.org • director@vtol.org



75+ Years of Advancing Vertical Flight

www.vtol.org/history

- Founded as “The American Helicopter Society, Inc.”
76 years ago in Connecticut on Feb. 25, 1943
 - “For the purpose of collecting, compiling and disseminating information concerning the helicopter”
 - Sikorsky Aircraft received its order for the first American helicopters on January 5, 1943 (28 XR-4 helicopters)
- The first and longest-serving helicopter non-profit
 - Founding members Igor Sikorsky, Art Young, Frank Piasecki, etc.
 - Included engineers, pilots, operators and presidents from industry, academia and government in Allied countries
- First Annual Forum in Philadelphia in April 1945
- Now 6,000 individual and 105 corporate members

***Born with the American helicopter industry,
but advancing vertical flight worldwide***



Sikorsky XR-4 helicopter
Courtesy of Sikorsky Aircraft Corp.



First Annual AHS Awards Banquet
Oct. 7, 1944

AHS is the Vertical Flight Society



- Official name change last April
 - More accurate description of who we are
- We've been using the words for 50 years
 - “AHS International—The Vertical Flight Society” since 1997
- www.vtol.org since 1995

1943



1990s



1969

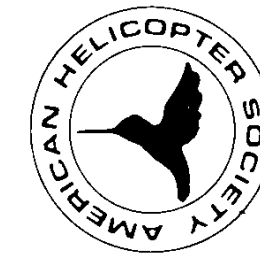


2000s



The Society for Vertical Flight

1979



2017



**The Vertical Flight
Technical Society**

Disruption in Vertical Flight

“The reasonable [hu]man adapts himself to the world: the unreasonable one persists in trying to adapt the world to himself. Therefore all progress depends on the unreasonable [hu]man.”

— George Bernard Shaw,
Man and Superman

“We’re living in a changing world.... We can’t get comfortable with our [high] barriers to entry, that we can move slowly, that we can create at a slower pace than other industries. **We’ve not yet had a Tesla come** and rev our engines and show us who we need to be.”

— Lynn Tilton, CEO, MD Helicopters
Heli-Expo 2016

Disruptive Technologies

- Drones: 1.2 millions drones in the US. DJI has 85% of the market due to FAA restrictions during 2000s
- EVs: Tesla S started in 2012, now all car companies have electric cars
- Space: SpaceX and Blue Origin commercial human space launches
- Airliners: P&W GTF and GE LEAP provide ~20% fuel reduction
- App economy: Smart phones, ride-sharing, Airbnb, etc
- Advances in helicopter tech
 - New products with modern tech
 - H160 suite of technologies
 - Electric tail rotors, fly by wire, etc.
- Tiltrotors & Compounds
 - Step-change in range and speed
- Electric VTOL
 - Potential for step-change in utilization through reduced costs, noise and speed
 - Vertical flight for consumers
 - “VTOL for All”

The Future of Vertical Flight

www.vtol.org/vertiflite



Military Developments



Distributed Electric VTOL



Advanced Civil Technologies



Urban Air Taxis

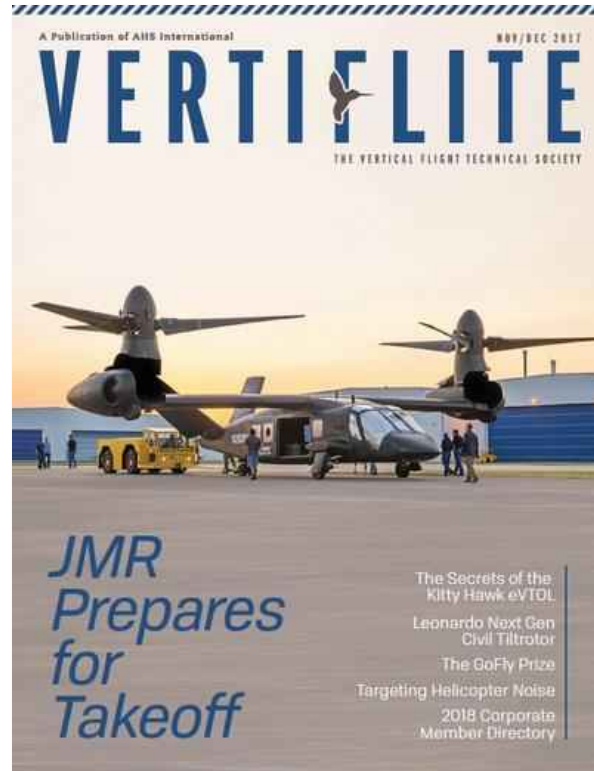
Disruptive technologies and approaches ...

The Future of Vertical Flight

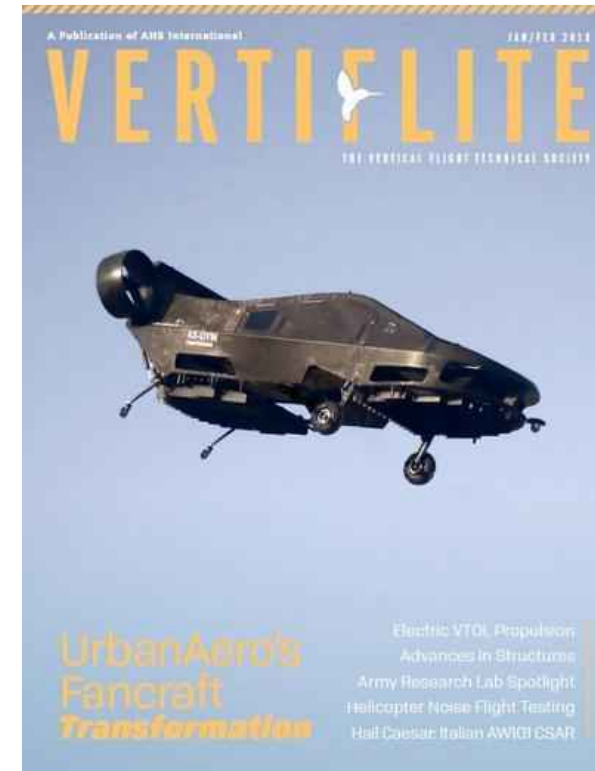
www.vtol.org/vertiflite



Civil and Military
Compound Helicopters



Civil and Military
Tiltrotors



Unconventional
Configurations



Winged eVTOL
Flight Testing

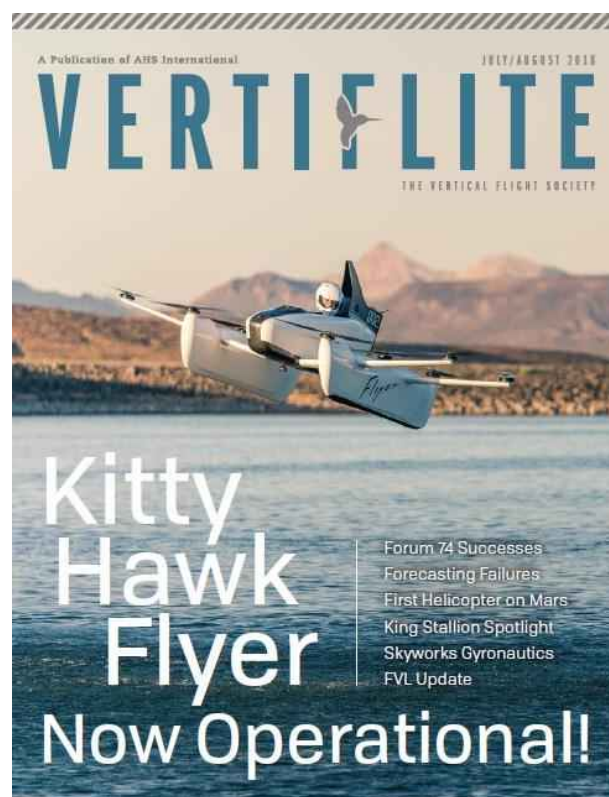
... enable a transformation in vertical flight

The Future of Vertical Flight

www.vtol.org/vertiflite



Electric Air Taxis



Electric Ultralights



New Commercial Helo Tech

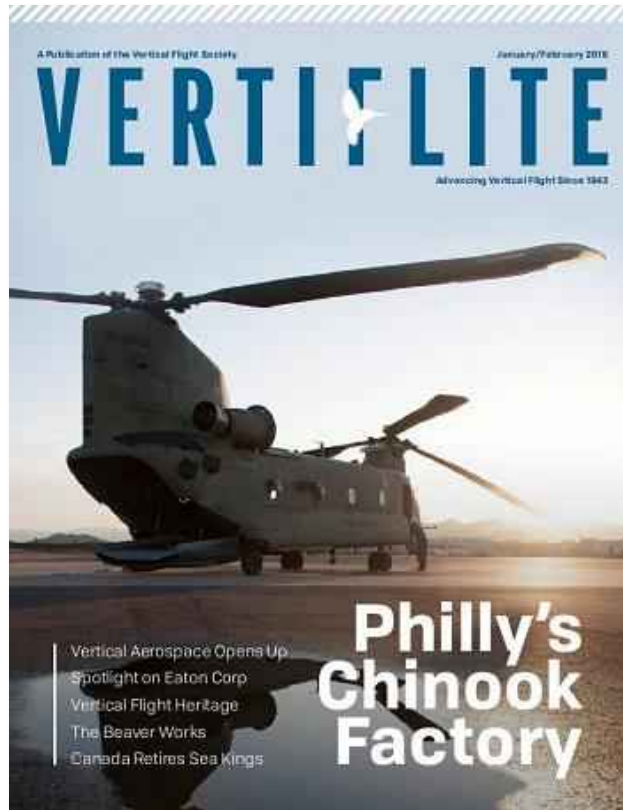


High-Speed Compounds

New players and new products promise new capabilities...

The Future of Vertical Flight

www.vtol.org/vertiflite



New Military Helo Tech



Urban Air Mobility



... for military and civil applications

Aging U.S. Military Fleet

- V-22 only 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
 - Many 1960s airframes are still flying!
 - CH-53K only new design in acquisition process



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



18 years of conflict and DoD studies reveal significant VTOL mission capability gaps

Future Vertical Lift (FVL)

- **5 Capability Sets from Light to Ultra Heavy**
 - Plus advanced unmanned programs Army Future UAS and Navy/Marine MUX
- **Currently 3 Capability Sets in planning**
 - **CS1 (Light):** Army's Future Attack Reconnaissance Aircraft (FARA) to replace Kiowa Warriors
 - **CS2 (Medium):** Navy to replace Seahawks and Fire Scouts
 - **CS3 (Medium heavy):** Army's Future Long-Range Assault Aircraft (FLRAA) to replace Black Hawks
- **Joint Multi-Role (JMR) Technology Demonstrations – 30,000 lb-class (13.6 t)**
 - Bell V-280 Valor and Sikorsky-Boeing SB>1 Defiant
 - *US industry has invested \$1B in JMR at 4:1 government spending*



US Army

Future Attack Reconnaissance Aircraft (FARA)

- Solicitation released Oct. 3;
proposals submitted Dec. 18
- 6 contract awards June 2019
- 2 prototypes – flights in late 2022
- \$750M in government funding +
\$375M contractor funding = \$1.1B
- Smaller in size than Capability Set 3
assault aircraft
 - approx. 14,000 lb (6.5 t) and 12.2 m
(40 ft) rotor diameter
- Operational by 2028
- Likely 6 companies competing:
 - Airbus Helicopter
 - AVX Aircraft/L3
 - Bell
 - Boeing
 - Karem Aircraft
 - Sikorsky Aircraft
- 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

Sikorsky S-97 Raider for FARA



Future Vertical Lift (FVL) Concepts for Capability Set 3



Sikorsky Boeing SB>1 Defiant JMR Demonstrator



Bell V-280 Valor JMR Demonstrator



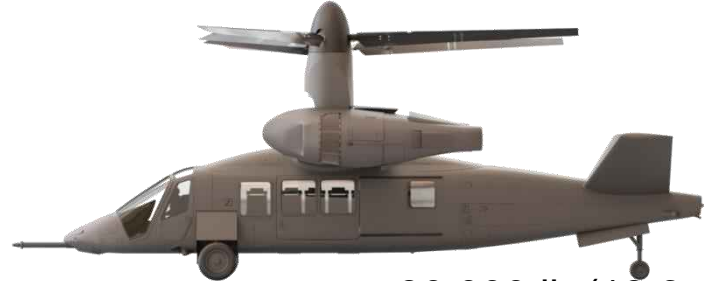
Compounds & Tiltrotors

Sikorsky-Boeing SB>1 Defiant™ (2019)



30,000 lb (13.6 t) class

Bell Helicopter V-280 Valor (2017)



30,000 lb (13.6 t) class

Sikorsky S-97 Raider™ (2015)



11,000 lb (5 t)

Leonardo (with Bell) AW609 (2003)



16,800 lb (7.6 t)

**Sikorsky X2 Technology™
Demonstrator (2008)**



5,500 lb (2.5 t)

Bell Boeing V-22 Osprey (1989)



52,600 lb (23.8 t)

AW609 Civil Tiltrotor



Next Gen Civil Tiltrotor (NGCTR)



Clean Sky 2: Airbus RACER



eVTOL @ Heli-Expo

CityAirbus D-HCIA © Alexander Lutz

- CityAirbus spotted in Donauwörth
- Sikorsky officially announces in UAM
- Workhorse SureFly exhibit (10x20)
- Terrafugia exhibit (40x40)
- Bell Nexus on display
- Airbus UAM models



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Terrafugia TF-2



SureFly™



1st Annual Panel (2018)

The Electric VTOL Revolution

Wednesday, Feb. 28, 2018 @ 11:00-11:45 am

- **Mike Hirschberg**, Executive Director, AHS International (moderator)
- **Michael Thacker**, EVP Technology & Innovation, Bell Helicopter
- **Mark Moore**, Director of Aviation Engineering, Uber Technologies
- **Greg Bowles**, VP for Global Innovation & Policy, General Aviation Manufacturers Association (GAMA)
- **Dr. Mike Romanowski**, FAA Aircraft Certification Service's (AIR) Director of the Policy & Innovation Division (AIR-600)

2nd Annual Panel (2019)

The Electric VTOL Revolution

Wednesday, March 6 @ 9:00-11:00 am Room B310

Moderated by Elan Head, Vertical Magazine

- **Mike Hirschberg**, Executive Director, Vertical Flight Society
- **Scott Drennan**, VP Innovation, Bell
- **Zach Lovering**, VP of Urban Air Mobility Systems, Airbus UAM
- **Thierry Grison**, VP Business Development Hybrid New Market, Safran
- **Danny Sitnam**, President/CEO, Helijet International
- **Rex Alexander**, President, 5 Alpha
- **Michael Dymant**, Managing Partner, NEXA Capital Partners

Electric Helicopters?



- Not this!
- Cars were not buggies with mechanical horses

- Eliminate complex rotors!
 - Cyclic, collective, swashplate
 - Transmissions, gearboxes, shafting, hydraulics, etc.
- Distributed Electric Propulsion
 - Replace single complex system with multiple simple thrusters
- Get on a wing for efficiency
 - Higher speed, longer range
- Environment
 - Noise, noise, noise!
 - “Tailpipe” emissions

The Electric VTOL Revolution

- Electric & hybrid electric propulsion enable new possibilities for:
 - Regional Air Mobility (RAM)
 - Urban Air Mobility (UAM)/Air Taxis
 - Urban Cargo Delivery
 - Personal Air Vehicles
 - Ultralights
 - Personal Flying Devices
 - Urban Package Delivery

↑
Heavier, Hybrid



150+ Electric VTOL Designs?!?

“To invent an aircraft is nothing.
To build one is something. To
fly is *everything*.”

Otto Lilienthal



“It’s easy to design an aircraft
if you don’t know how.”

Mike Hirschberg



“If you want to end up
with a *small fortune* in
aerospace, you need to
start out with a *large one!*”

Anonymous

Why Now?

- Advancements in electric motors
- + Advancements in batteries
- + Advancements in computer modeling and simulation
- + Advancements in composites
- + Change in FAR Part 23
- + Tech innovations
- + Tech investments > \$1B
- = All enable new configurations and new innovations



Airbus Vahana in 2017

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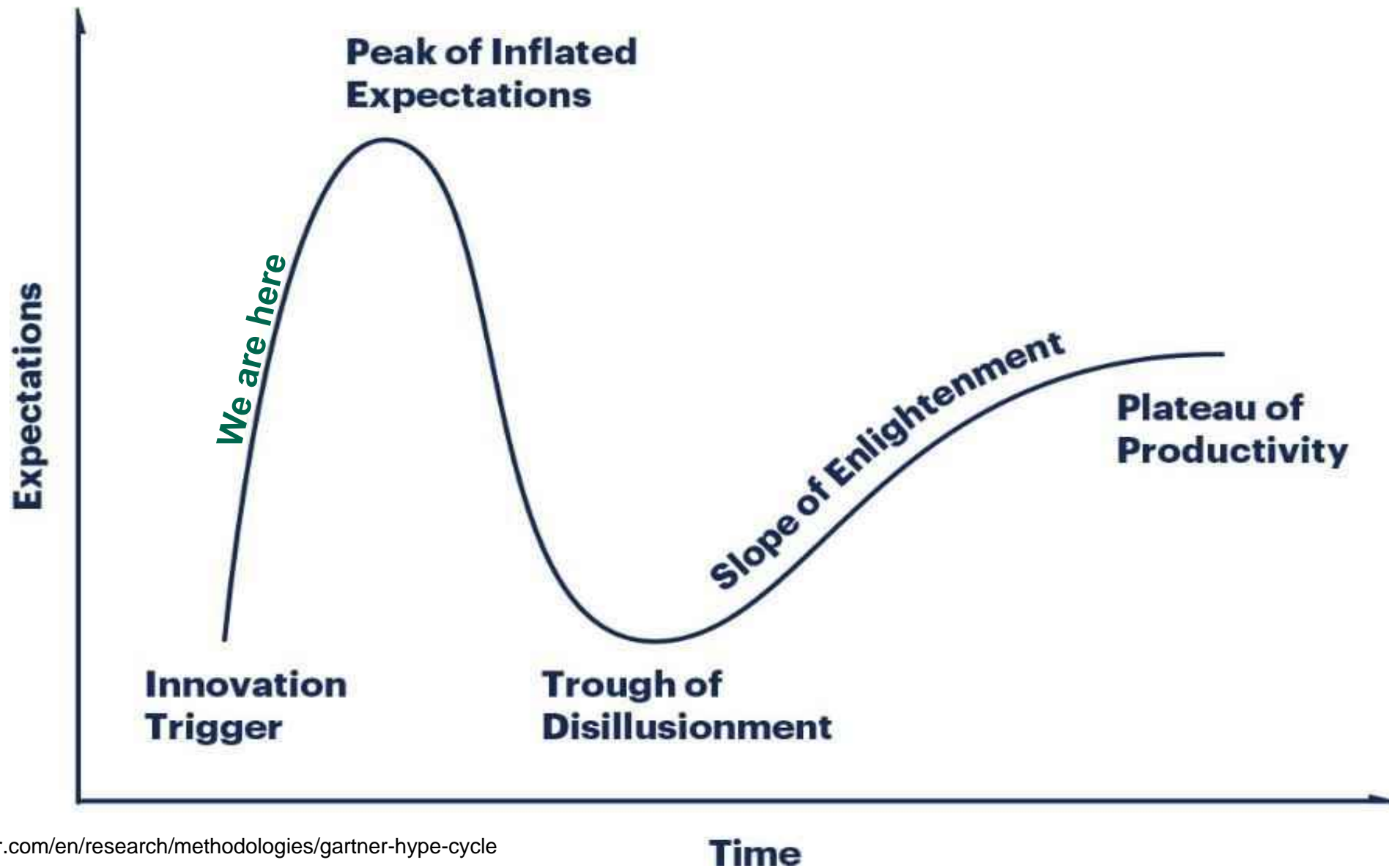
Joby Motors 10 kW (2010)

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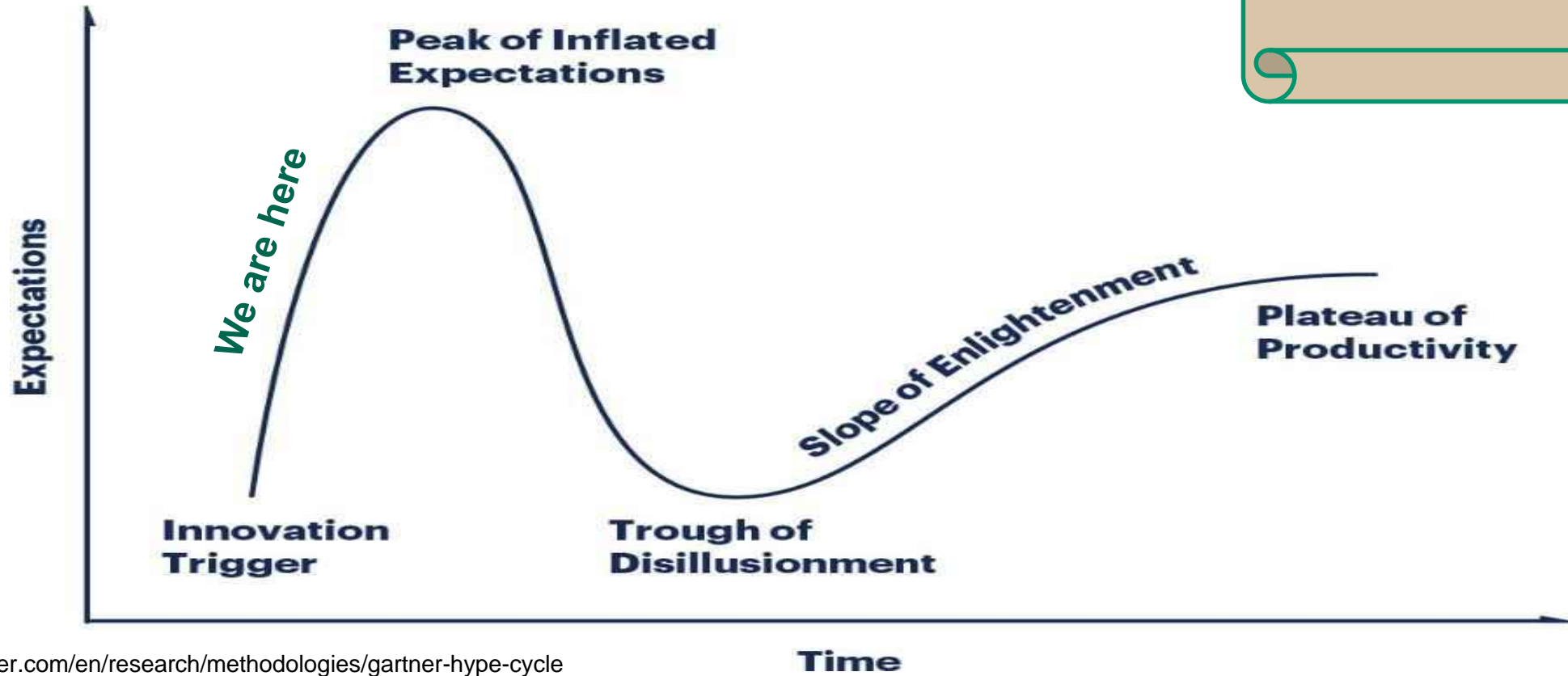


“The Hype Cycle”



“The Hype Cycle”

The eVTOL Revolution Needs YOU!



Uber Elevate

- **Uber Elevate**
 - Unveiled at eVTOL Workshop in Sep 2016
 - White Paper in Oct 2016
 - Summits April 2017, May 2018, June 2019
- **Developing an “Ecosystem”**
 - Partnerships with cities, real estate companies, aircraft manufacturers, EV charger manufacturers and cities
 - Connecting innovators, investors, regulators, technical experts, media
- **Small aircraft, but high barriers**
 - Technical, regulatory, environmental, economic, infrastructural and cultural



- **VFS www.eVTOL.news website**
 - 150+ aircraft concepts detailed
 - Many missions beyond Uber’s Elevate

Uber Elevate: 5 Aircraft Partners



Aurora Flight Sciences



Bell



Pipistrel



Embraer



Karem Aircraft

Uber Elevate: 5 Key Challenges

1. Flight demos in 2020; operational in 2023
2. Technology: all-electric (not hybrid) for 5 seats (pilot + 4 pax)
3. Infrastructure (physical and ATM/UTM)
4. Pilot shortage vs. autonomy
5. Regulations



Joby Aviation S4

Bloomberg Businessweek

February 1, 2016, 5:00 AM EST

Air-Taxi Startup Has a Working Prototype and a Fresh \$100 Million

● Joby Aviation hides its craft at a secretive private airfield.

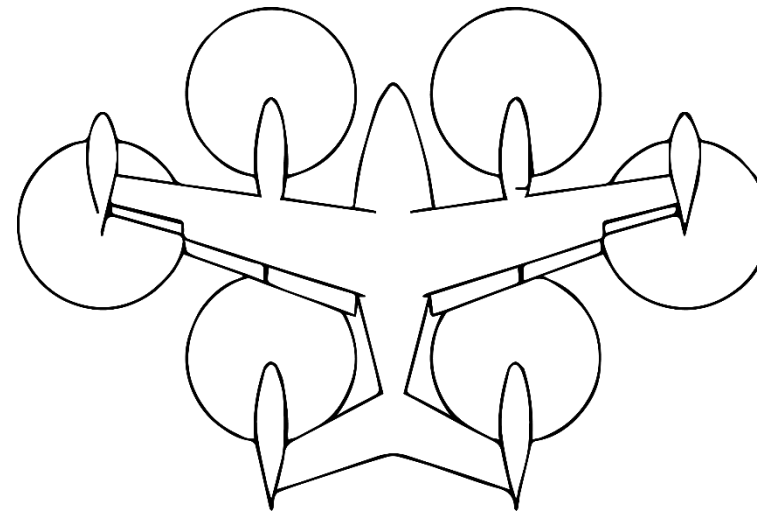
By Ashlee Vance and Brad Stone

Hyperdrive

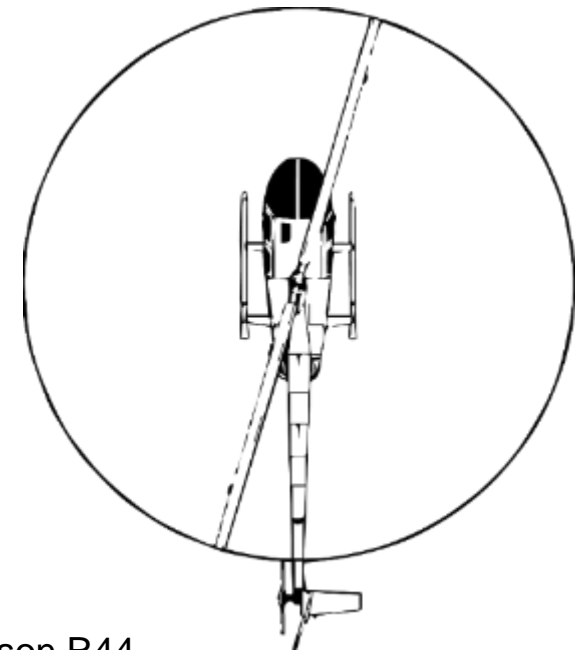


ILLUSTRATION: INKEE WANG FOR BLOOMBERG BUSINESSWEEK

“The pilot managed a vertical takeoff, 15 minutes of flight in a 15-mile loop, and a safe landing. Powered by electric motors and sophisticated control software, the taxi performs like a cross between a drone and a small plane, able to zip straight up on takeoff and then **fly at twice the speed of a helicopter while making about as much noise as a swarm of superbees.**”



Joby S4
4-Seat all-electric
6-propeller tiltrotor
Ultra-quiet
200 mph



Robinson R44
4-Seat piston
Single-main rotor
135 mph

eVTOL Ultralights

- Flight experience offerings
- Ultralights under FAR Part 103 do not require certification
- Less than 254 lb (115 kg) plus 30 lb *per float* plus parachutes, etc.
- Restricted in speed, overflights, etc.



Kitty Hawk Flyer (<254 lb)



Hoversurf Scorpion (<254 lb)



Opener BlackFly (310 lb)



LIFT Aircraft Hexa (432 lb)

eVTOL Gyroplanes

- Gyroplanes have taken off in Europe
 - AutoGyro GmbH sells 300+/year – 2,500 sold to date
 - Magni Gyro sold more than 1,100 gyroplanes
- AutoGyro flew hybrid-electric eCavalon in 2015, but not pursued
- No good US regulations – restricted to Experimental home-build kits
 - Now some movement with “Primary Category” basis
- Jaunt Air Mobility bought Carter Slowed Rotor/Compound (SR/C) IP
 - Hopes to be 6th Uber Elevate partner
- Skyworks Global bought Groen Brothers Aviation IP
 - Tip-jet VertiJet and electric eGyro developments

eCavalon



Jaunt



Verti-Jet™

GO FLY

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GoFly Prize

The GoFly Prize is a two-year, \$2,000,000 USD
competition to develop

**safe, quiet, ultra-compact, near-VTOL
personal flying devices**

capable of flying twenty miles (32 km)
while carrying a single person

Max dimension: 8.5 ft (2.6 m)

Max noise: 85 dBA @ 50 ft (15 m)

Max speed: >30 kt (56 km/h)

2886 registered “innovators”

716 teams

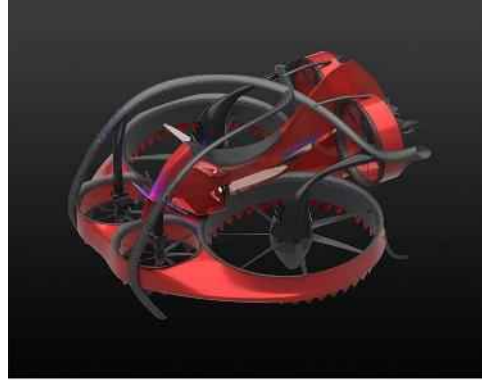
164 Phase 1 proposals

GoFly Prize Phase 1 Winners

10 winners announced 14 June @ \$20k each



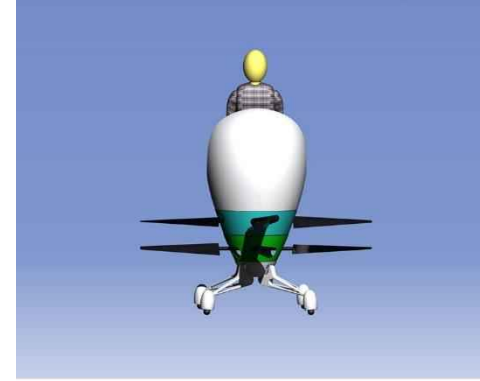
TEAM: AEROXO LV
DEVICE: ERA AVIABIKE



TEAM: MAMBA
DEVICE: MAMBA



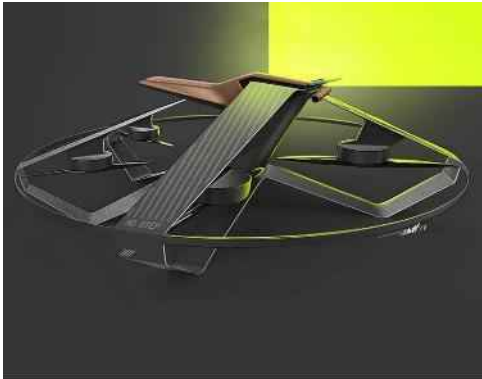
TEAM: TETRA
DEVICE: TETRA 3



TEAM: TEXAS A&M UNIVERSITY
DEVICE: HARMONY



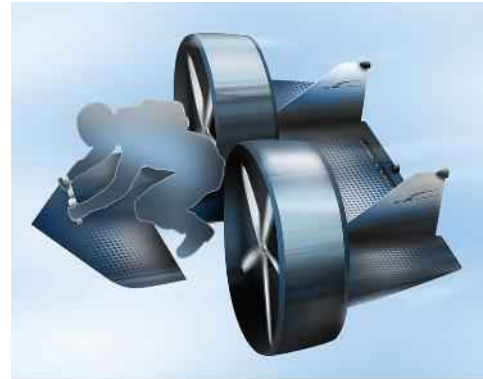
TEAM: GEORGIA TECH
DEVICE: HUMMINGBUZZ



TEAM: LEAP
DEVICE: VANTAGE



TEAM: SCOOP
DEVICE: PEGASUS 1



TEAM: SILVERWING
DEVICE: S1



TEAM: BLUE SPARROW
DEVICE: BLUE SPARROW

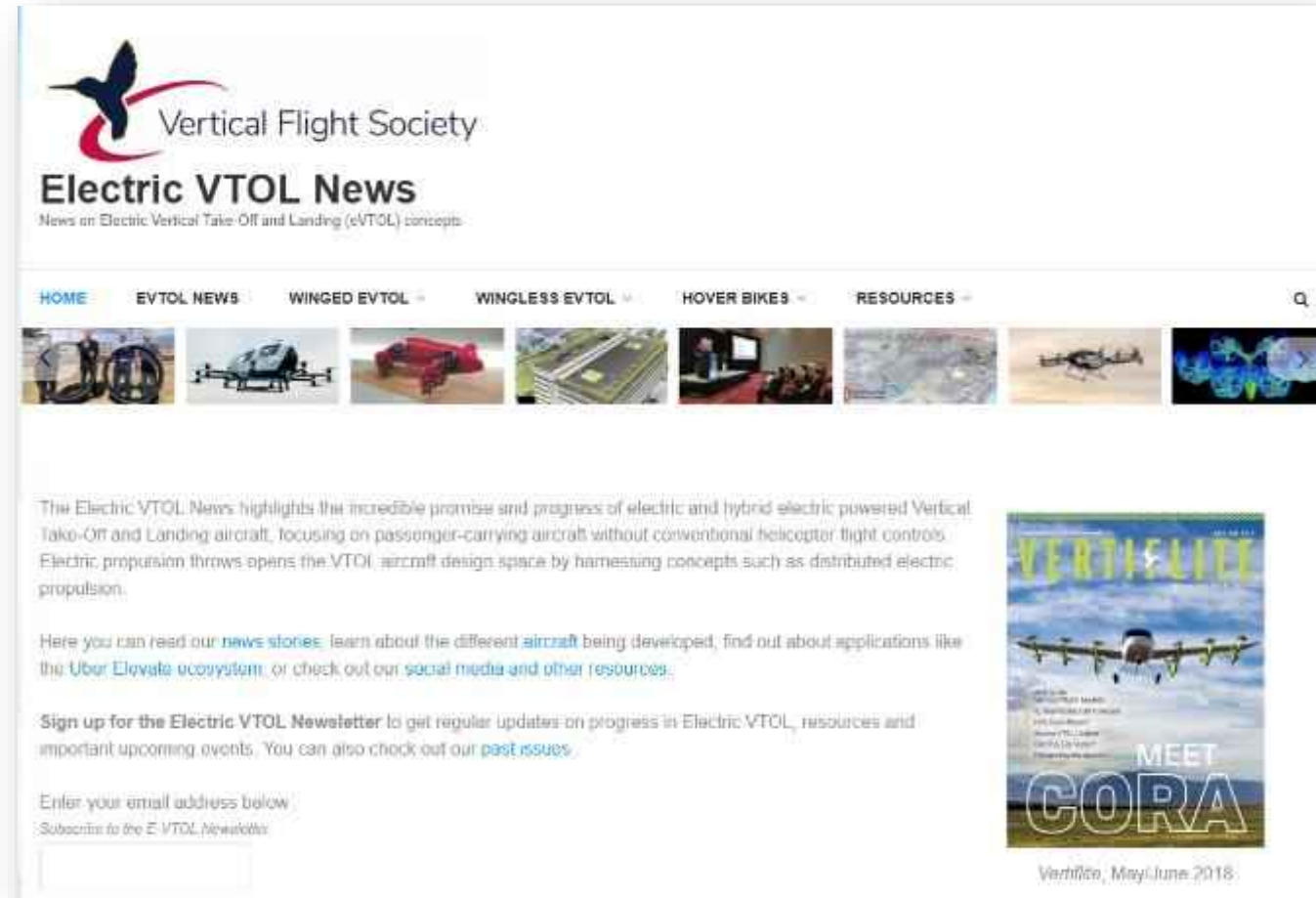


TEAM: TREK AEROSPACE
DEVICE: FLYKART 2

www.goflyprize.com

eVTOL Online Resources

- Electric VTOL News
 - www.eVTOL.news
 - www.facebook.com/electricVTOL
 - www.twitter.com/electricVTOL
 - www.youtube.com/VTOLsociety
 - www.vimeo.com/VTOLsociety
- Also
 - Email newsletter
 - eVTOL News videos
 - eVTOL video proceedings



The screenshot shows the homepage of the Vertical Flight Society's Electric VTOL News website. At the top left is the Vertical Flight Society logo. The main heading is "Electric VTOL News" with a subtitle "News on Electric Vertical Take-Off and Landing (eVTOL) concepts". Below this is a navigation menu with links for HOME, EVTOL NEWS, WINGED EVTOL, WINGLESS EVTOL, HOVER BIKES, and RESOURCES. A row of small images illustrates various eVTOL aircraft designs. The main content area features a paragraph about the promise and progress of electric and hybrid electric powered VTOL aircraft, followed by a link to news stories. Below that is a sign-up section for the Electric VTOL Newsletter, including a text input field and a "Subscribe" button. On the right side, there is a featured article titled "MEET CORA" with a cover image of a large eVTOL aircraft.

VTOL Innovators – Then and Now

1st AHS Banquet
1944



1st eVTOL Workshop
2014





Vertical Flight Society

FORUM⁷⁵

VERTICAL FLIGHT SOCIETY
MAY 13-16, 2019 PHILADELPHIA, PENNSYLVANIA

Plan now to attend Forum 75!

**... Returning to Philadelphia,
where the Forum began in 1945.**



- Annual Forum attracts 1,250 engineers, scientists and leaders from industry, academia and governments
- VTOL aircraft CEOs/VPs/engineers, military leaders, researchers, etc
- ~300 technical papers
- ~50 panelists
- ~65 exhibitors
- Grand Awards Banquet
- eVTOL short course & industry tours



CEO Panel at Annual Forum, May 2018



Jay Carter at CarterCopter Exhibit Forum 74, May 2018

Forum 75 is May 13-16, 2019 @ Philadelphia

Summary



- We are the global Vertical Flight Society
 - 75th Annual Forum is May 13-16 in Philadelphia
- Significant civil and military advanced rotorcraft developments underway
 - State-of-the-art conventional helicopter developments and AW609 tiltrotor
 - FVL/JMR: advanced compound and tiltrotor — see www.vtol.org/FVL
 - Clean Sky 2: advanced compound and tiltrotor
- Significant funds being invested in electric VTOL (>\$1B)
 - 150+ companies investing in electric and hybrid/electric VTOL aircraft
 - The explosive expansion in drones may be repeated with manned eVTOL
 - For more info, see www.eVTOL.news

We exist to advance vertical flight!



Questions?



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