The Vertical Flight Technical Society

What's all the buzz about eVTOL?

Uber graphic April 2017

Mike Hirschberg, Executive Director

AHS International

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www.vtol.org

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What is an eVTOL?

- Electric Vertical Take Off and Landing aircraft, aka
  - Transformative Vertical Flight (TVF) aircraft
  - Urban Air Mobility
  - On Demand Mobility
  - Urban Air Taxi
  - *Not* a “flying car”!

Uber graphic Nov. 2017

- Includes hybrid/electric aircraft with a combustion engine to generate electricity for long range/endurance
- Creates new design freedoms by allowing power distribution through electrical cables instead of driveshafts (“power by wire” like “fly by wire”)

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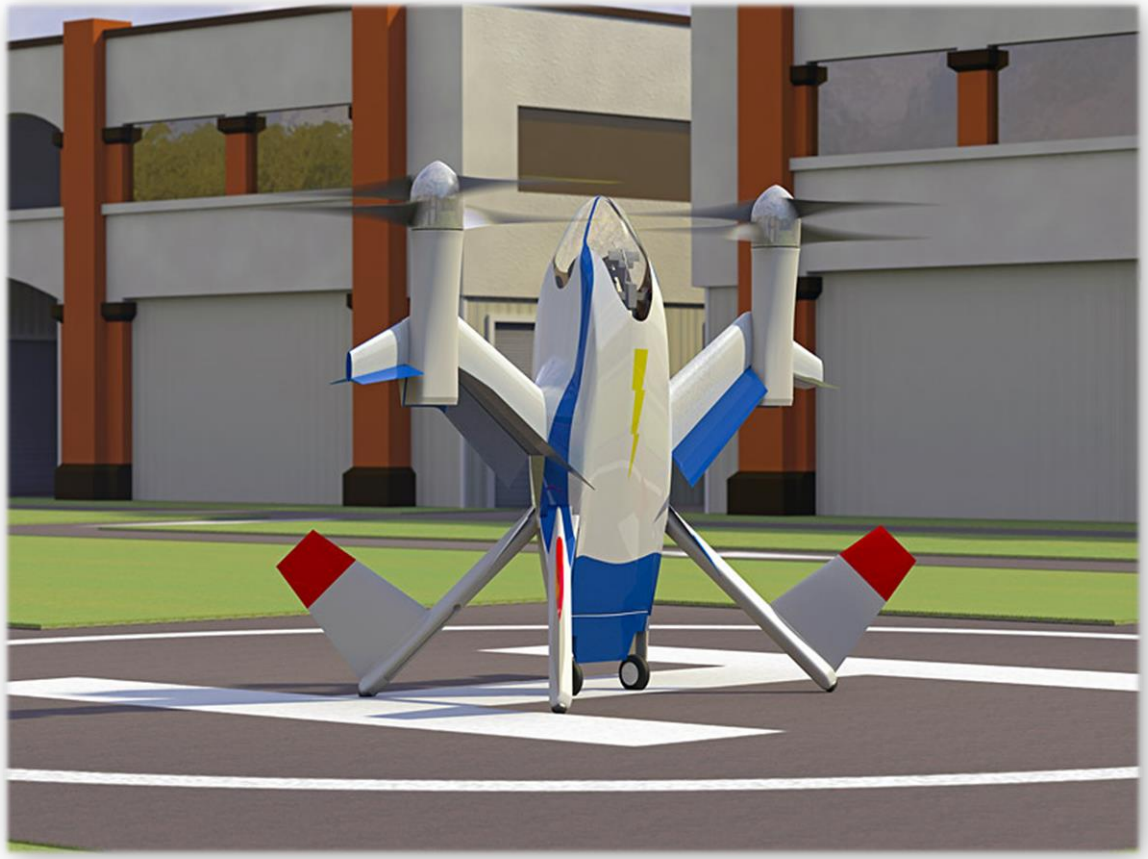
Pre-Historic eVTOL (winged vs. wingless)



NASA Puffin Single-Seat Electric VTOL Study (2010)

Photo courtesy of NASA

Volocopter VC1 Demonstrator (2010)

Photo courtesy of Volocopter GmbH

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Multi-“Rotor” Configurations

NASA GL-10 Greased Lightning
(2014 tethered, 2015 transition)

Photo courtesy of NASA

Volocopter VC200
(2013 tethered - 2016 manned)

Photo courtesy of Volocopter GmbH

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Volocopter 2x Multicopter
Now in flight test/pre-production

Photos courtesy of Volocopter GmbH
Karlsruhe, Germany

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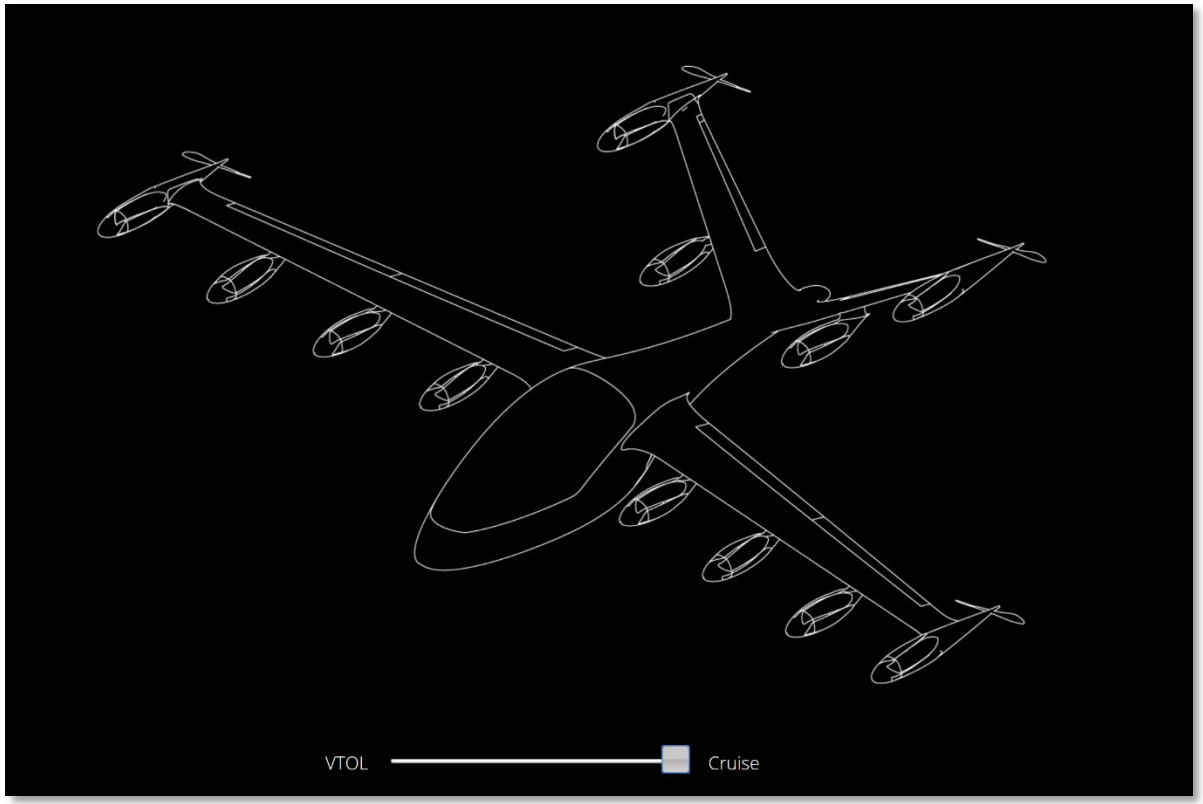
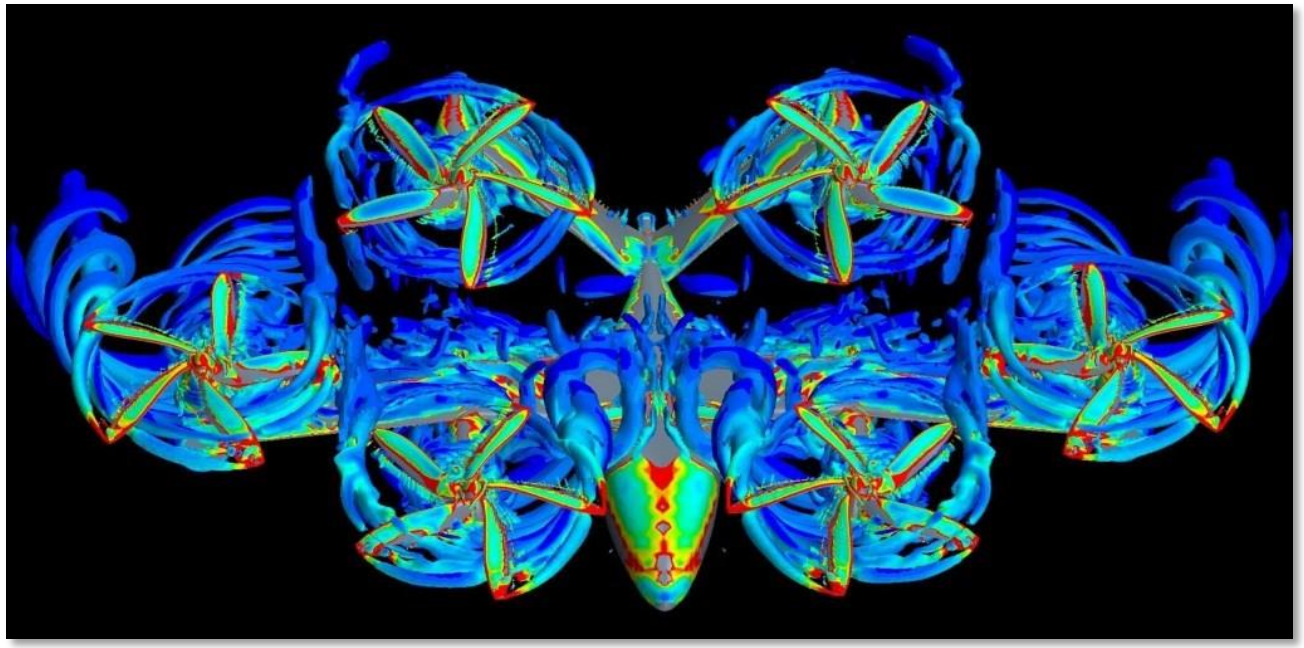
Joby Aviation



Original 2-seat Joby S2
12 lift/cruise propellers + 4 cruise propellers
All electric



Current 4-seat Joby S4
6 lift/cruise propellers
All electric

Click icon for movie link

Graphics courtesy of Joby Aviation
Santa Cruz, California, USA

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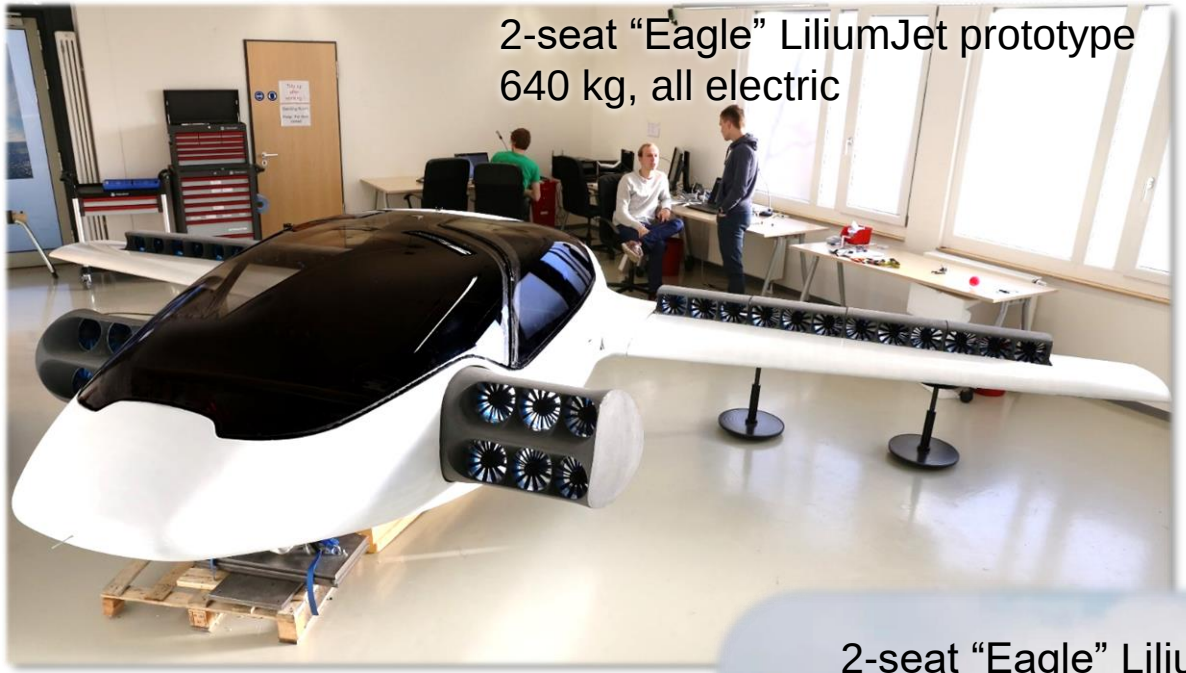
Lilium Aviation



2-seat “Eagle” LiliumJet prototype
640 kg, all electric

New 5-seat
LiliumJet concept

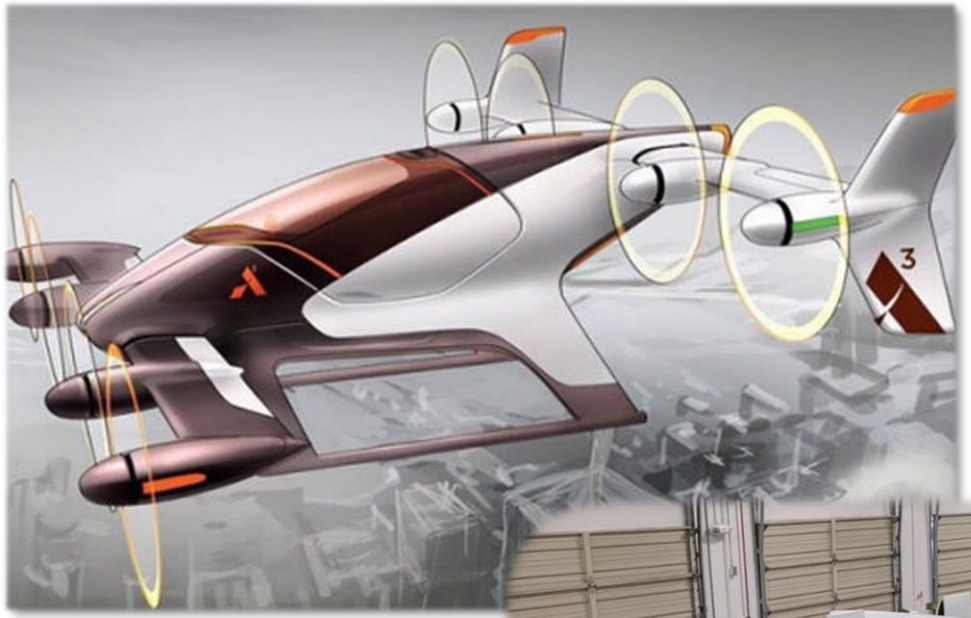
- 36 electric fans
  - 24 on wings
  - 12 on canards
- 160 kt (300 km/h)
- “Eagle” first flight April 2017

Click icon for movie link

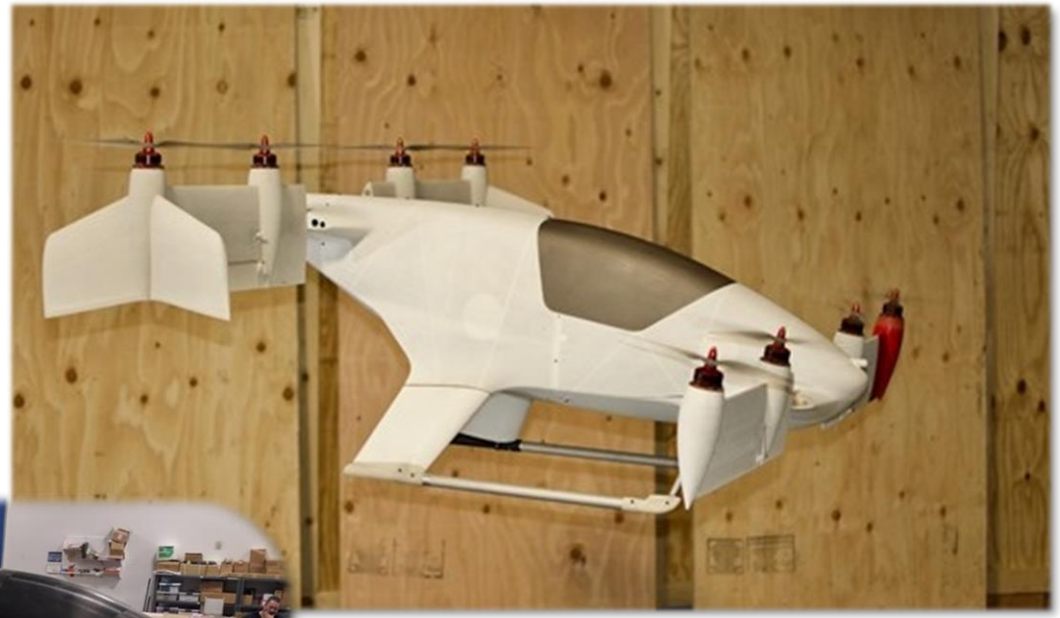
Graphics courtesy of Lilium Aviation
Garching, Germany

www.eVTOL.news

A³ by Airbus: Vahana



Single-seat 8-propeller tandem tiltwing



23%-scale flight tests completed this summer

Two full-scale single-seat aircraft under construction

www.eVTOL.news

Graphics courtesy of A³

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EHang 184

Single-seat full-scale “octo-copter” conducting extensive manned and unmanned flight testing

www.eVTOL.news

Graphics courtesy of EHang

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XTI Aircraft: TriFan 600

Regional hybrid-electric “bizjet”

2/3-scale technology demonstrator under construction to fly in 2019
Planned top speed is 340 kt and a range of 1,000 nm

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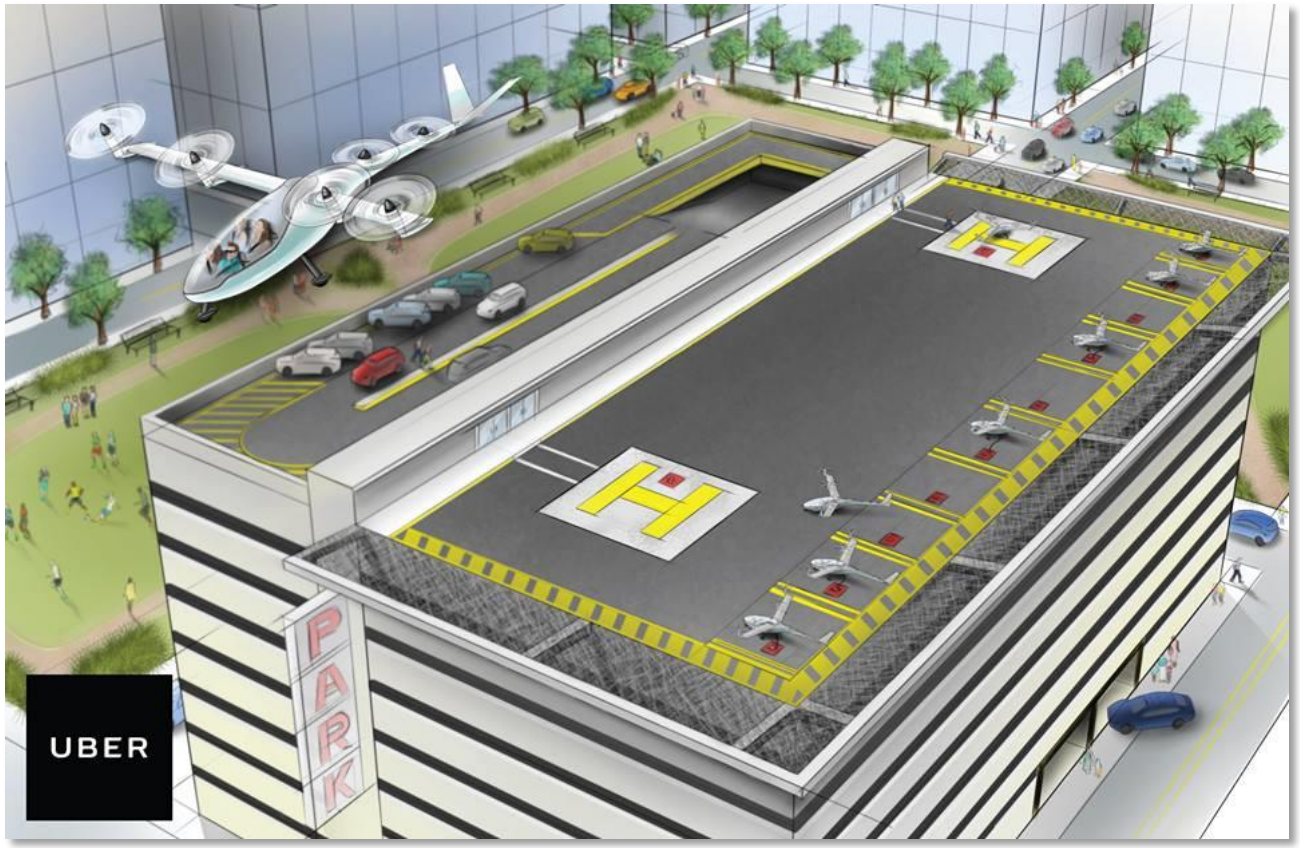
Uber Elevate

- Uber Elevate
  - Unveiled at AHS Workshop in Sep 2016
  - White Paper in Oct 2016
  - Summit in April 2017
- Developing an “Ecosystem”
  - Partnerships with cities, real estate companies, aircraft manufacturers, EV charger manufacturers and cities
  - Connecting innovators, investors, regulators, technical experts, media
- Smaller aircraft, but higher barriers
  - Technical, regulatory, environmental, economic, infrastructural and cultural



Uber graphic April 2017

- 10-12 concepts looking at the Uber mission
- Another 2 dozen looking at other missions

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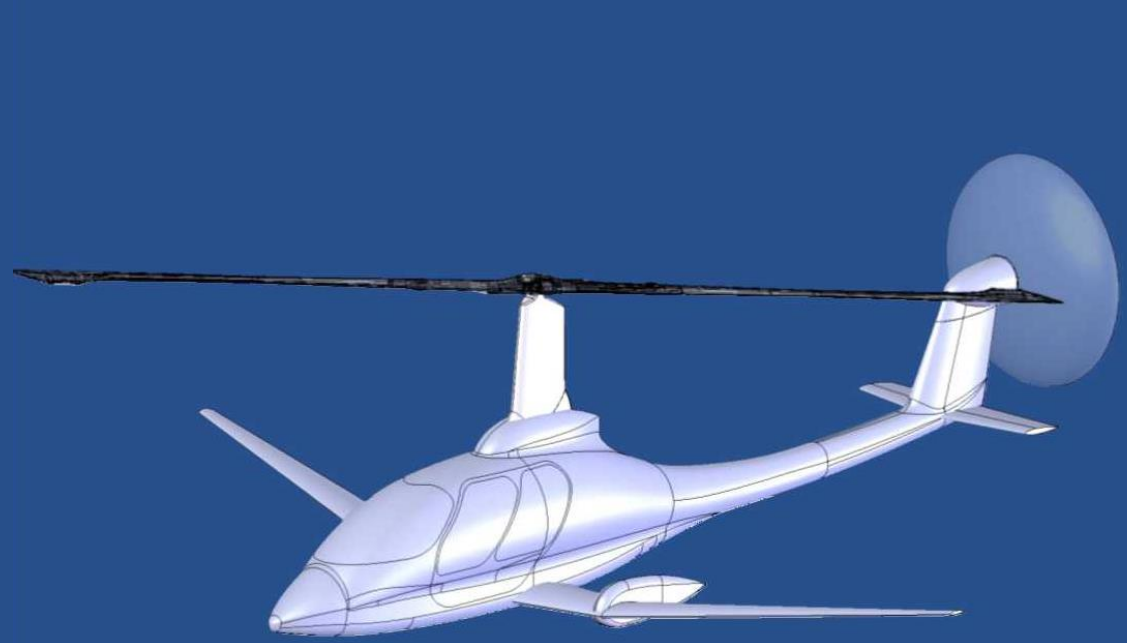
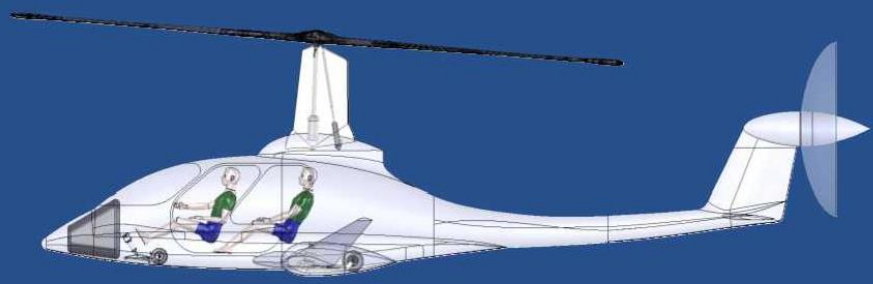
Carter Aviation Technologies
Electric Air Taxi SR/C Concept





Graphics courtesy of Carter Aviation Technologies

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Aurora eVTOL

- 8 VTOL electric props
- 1 pusher electric prop
- 97 kt (180 km/h)
- First Flight 2018

Graphics courtesy of Aurora
Manassas, Virginia, USA

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Factors Affecting Helicopter Noise Generation

- **The number of rotor blades (blade loading)**
- **Gross weight**
- Rotor blade shaping (tips)
- Tip speed
- **Engine**
- **Tail rotor**
- **Aircraft attitude**
- Aircraft speed/dynamic maneuvers
- Altitude/temperature

Airbus H160 with Blue Edge Blades and improved Fenestron

MD Helicopters MD520N with NOTAR

Bold = Factors expected to be ameliorated by eVTOL designs

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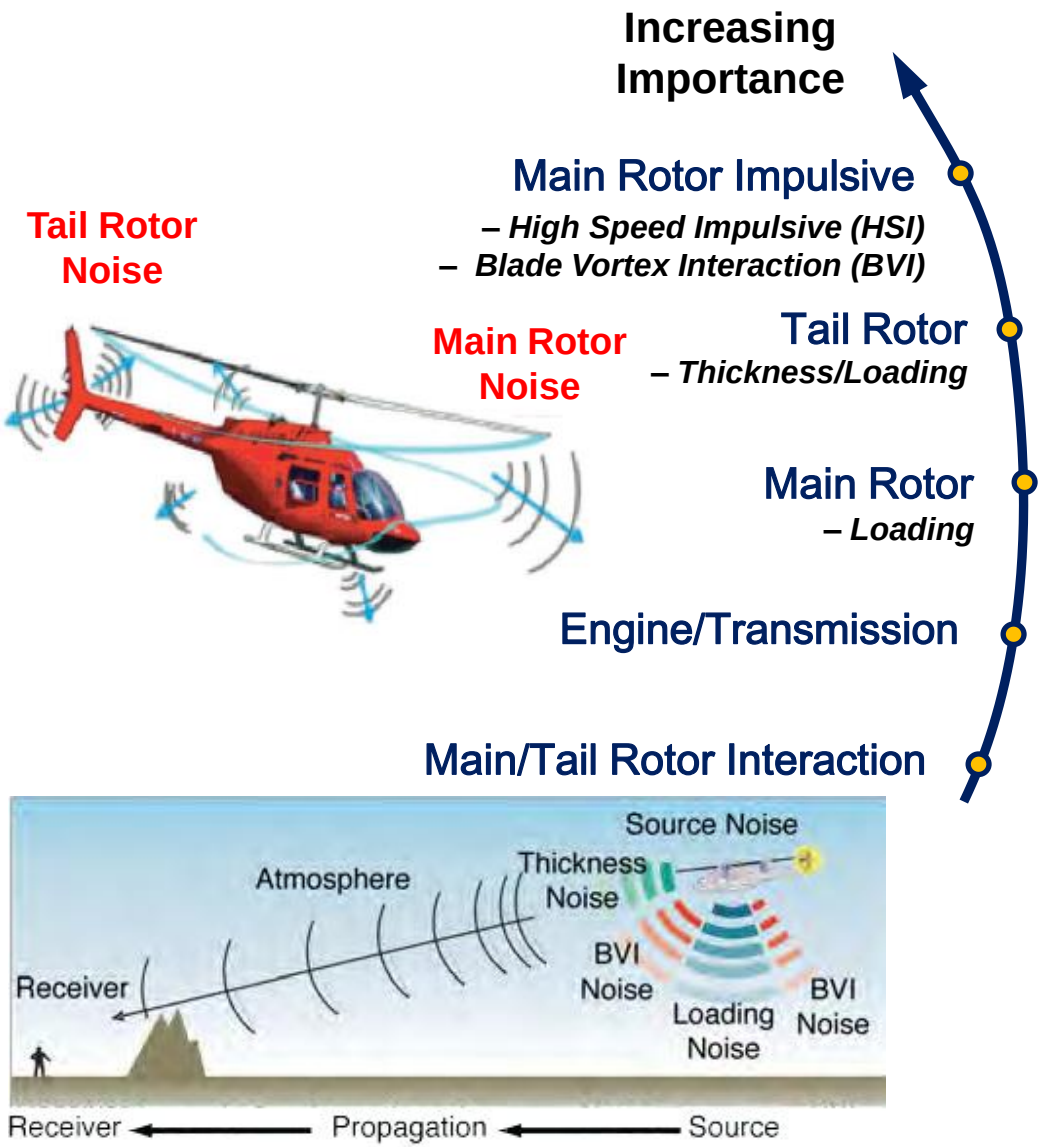
Helicopter Noise Sources



- eVTOL are expected to be quieter than helicopters
  - Lots of small rotors a high frequency (may independently vary frequency)
  - Buzz vs. “wop-wop”
  - May mask sound in ambient noise
- Some anecdotal testing seems to support this
- Being nearly inaudible is a requirement for Uber: need to fly in communities
- Still largely unproven
  - “Proof of the pudding” is in the *operations*

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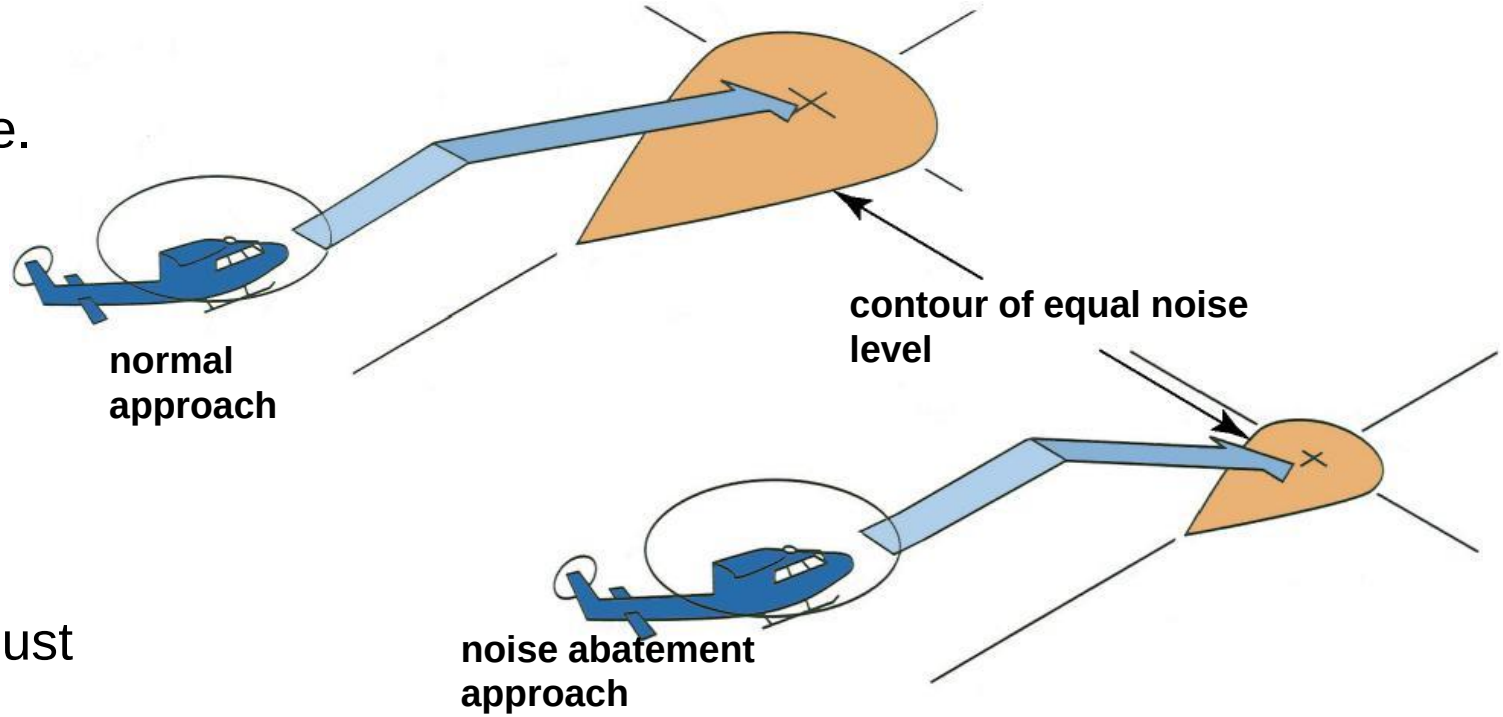
Many Fly Neighborly Principles Still Apply to eVTOL

Key Points to Fly Neighborly

- Fly at an altitude that is as high as practical.
- Avoid residential areas when possible.
- Fly over industrial areas and major roadways to mask the sound of helicopters.
- Avoid late night/early morning flights.
- Fly at an altitude that is as high as possible over scenic and recreational areas such as parks and beaches.
- Identify noise-sensitive areas and adjust routes to avoid them to the extent possible.
- Adhere to published noise abatement approach/departure procedures when flying in and out of airports and heliports.



Graphics from the HAI Fly Neighborly Guide

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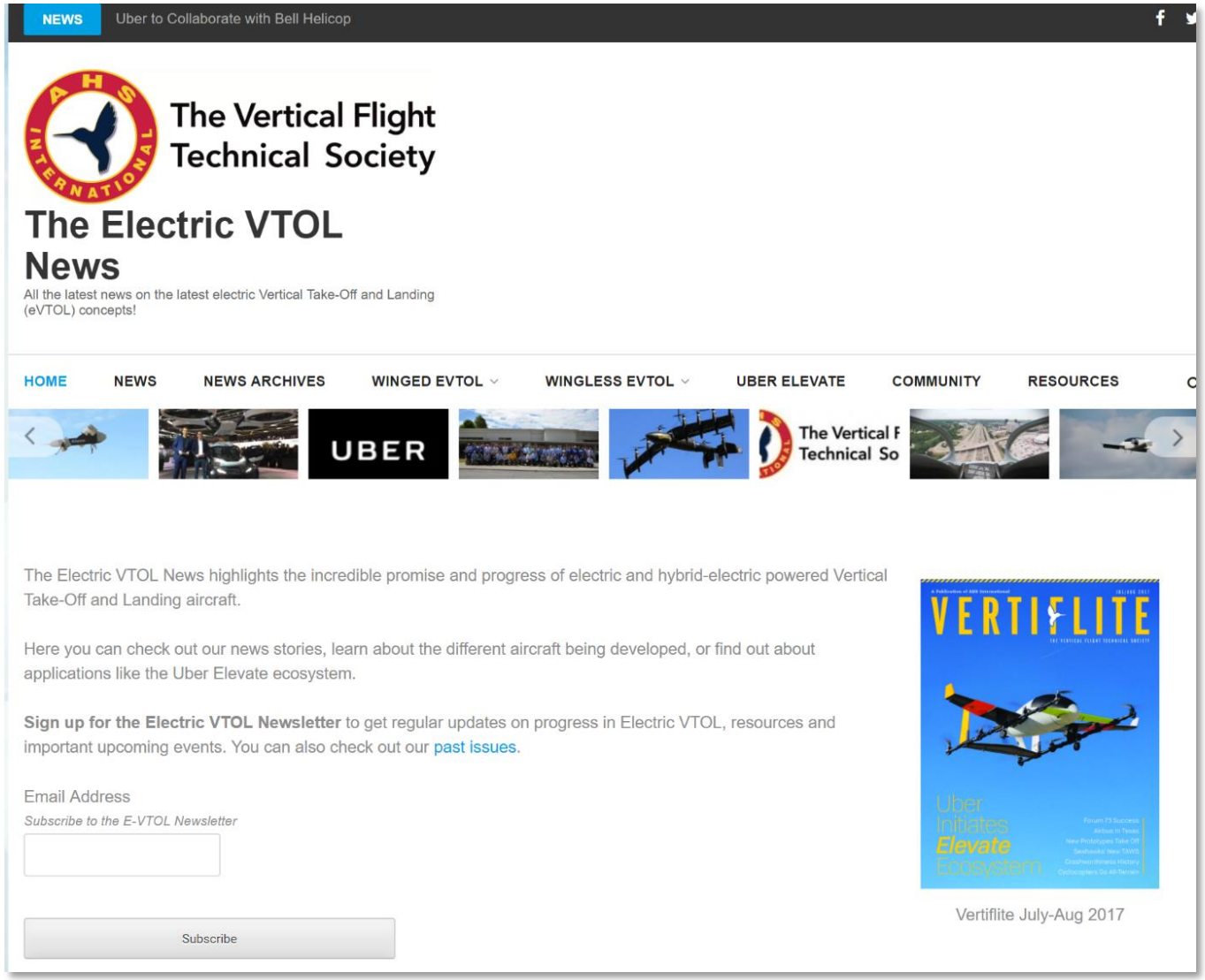
eVTOL Online Resources

- Electric VTOL News
  - www.eVTOL.news
  - www.facebook.com/electricVTOL
  - www.twitter.com/electricVTOL
  - Email newsletter
  - eVTOL News videos
  - Comprehensive analytical report (coming Dec 2017)
- Many missions beyond Uber Elevate
- No one really predicted the drone revolution. History may repeat.



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