Federal Aviation Administration

Human Factors Issues of Unmanned Aerial Systems Operations

Congreso Internacional de Medicina Aeroespacial

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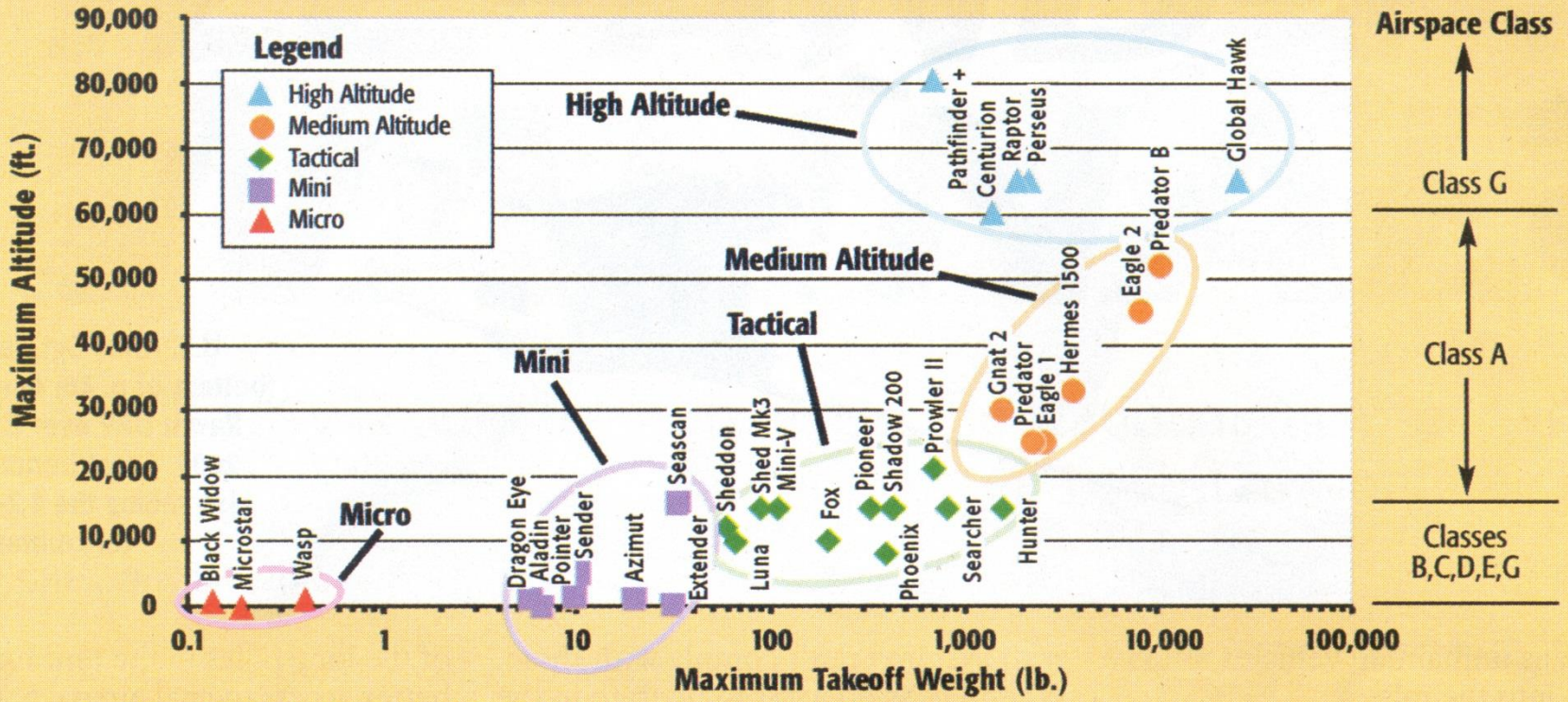
President, International Academy of Aviation & Space Medicine

April 2019


FLIGHT
zh
aw
TECHNORAMA

Unmanned Aerial Vehicles/Systems

MAXIMUM ALTITUDE OF UNMANNED AIRCRAFT SYSTEMS BY CATEGORY



Source: Roland E. Weibel, MIT Aero/Astro Ph.D. candidate, International Center for Air Transportation

UAS by the Numbers as of 09/26/2018

- 431,296 – Total downloads of the B4UFLY app
- 955,893 – Online hobby registrations under the FAA's Small UAS registration system
- 252,821 – Online commercial registrations
- 1,215,318 – Total UAS registrations

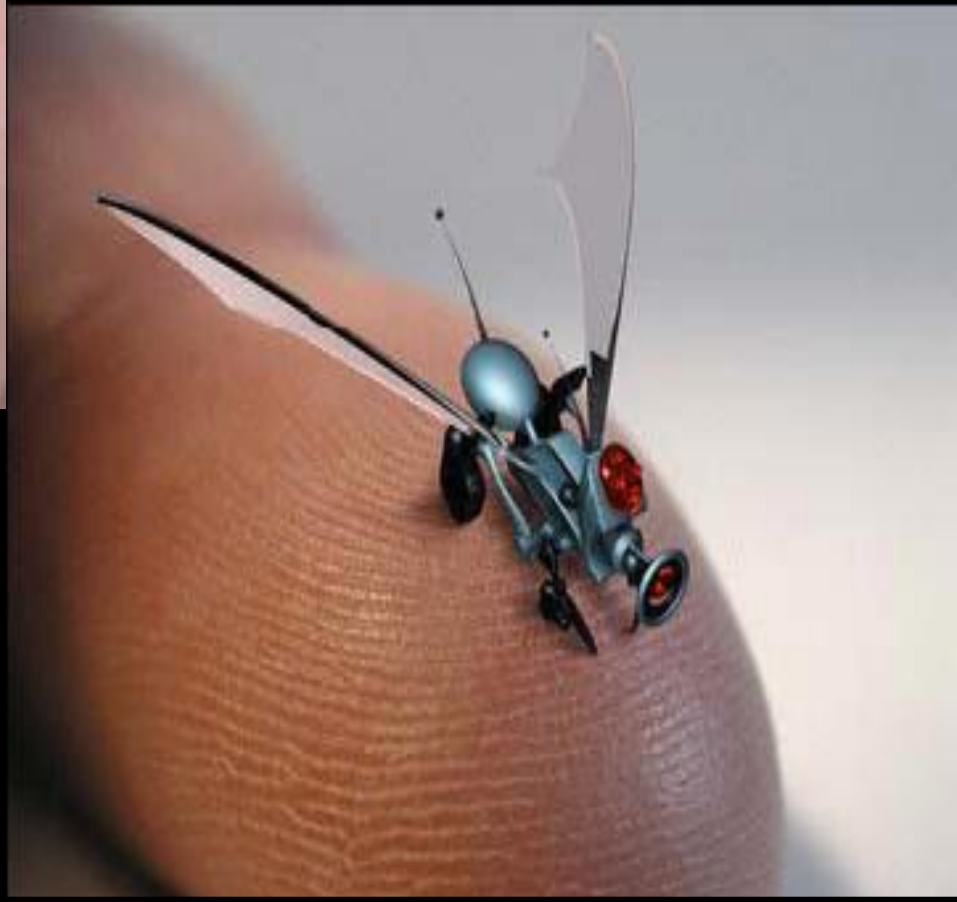
UAV/UAS vs Model Aircraft

FAA Advisory Circular 91-57 limits recreational use of airspace by model aircraft to below 400 feet AGL and away from airports and air traffic

AC 91-97 only applies to aircraft modelers, and excludes individuals or companies flying model aircraft for business purposes


USAF

Model Aircraft for Hobbyist Activities



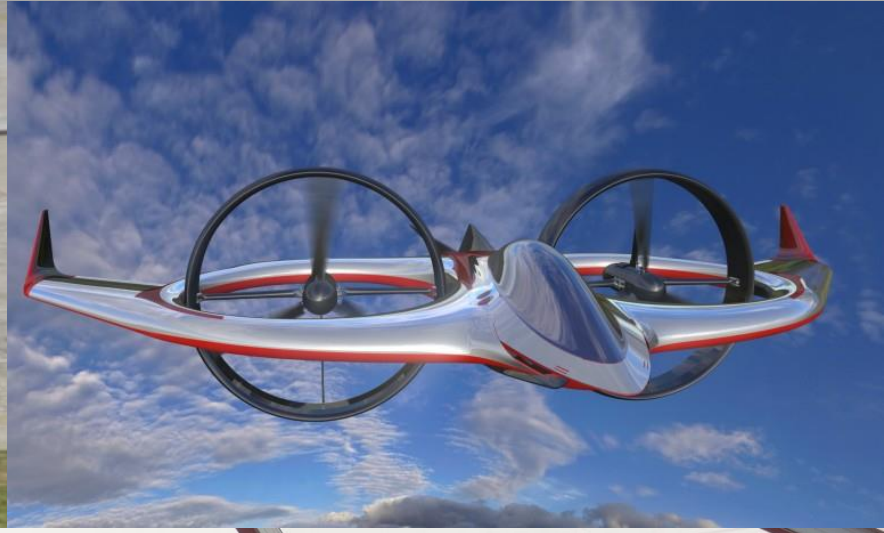

AP


WIFI
DRONE


WIFI
DRONE

FAA Aviation Safety Inspector Marcello Mirabelli with the Bell TR918. Vehicles like this are now called unmanned aircraft systems (UASs). The Bell TR918 was developed for commercial use and certified by FAA.


AgustaWestland




AgustaWestland
Eurofighter Typhoon

Greased Lightning or GL-10

A team at NASA's Langley Research Center is developing a concept of a battery-powered plane that has 10 engines and can take off like a helicopter and fly efficiently like an aircraft

Phantom Eye

Global Hawk

Heron 1

The Eitan is 79 feet long, has a wingspan of 86 feet — about the size of a Boeing 737 airliner

There are hundreds of different UAS from over 440 manufacturers

UAS industries exist currently in 86 countries

7 countries have used armed UAS in combat and 19 countries have or are acquiring armed UAS

It is estimated that approximately 1.5 million UAS have been sold over the last 3 years

Real estate photography
Volcano monitoring
TV and news
Gas burn-off stack inspection
Fire scene inspection
Coastal zone studies
Meteorological research
Anti-piracy operations
Industrial terrain mapping
Climate monitoring
Algae proliferation detection
Coastal mapping
Forestry research
Wildlife census
Security and surveillance
Geophysical survey
Police applications
Archaeological site mapping
Forest fire detection and support
Perimeter surveillance

Perimeter surveillance
Agricultural surveillance
Border surveillance
Railway track bed inspection
Salt water infiltration detection
Marine mammal monitoring
Nuclear accident surveillance
Movies/Advertising/Events
Aerial terrain mapping
Photography/Video
Power line/Cable inspection
Agricultural operations support
Glacier and ice cap mapping
Tidal zone mapping
Traffic accident analysis
Monument Inspection
Disaster site monitoring
Disaster site operations
Tsunami, tidal surge mapping
Invasive species identification

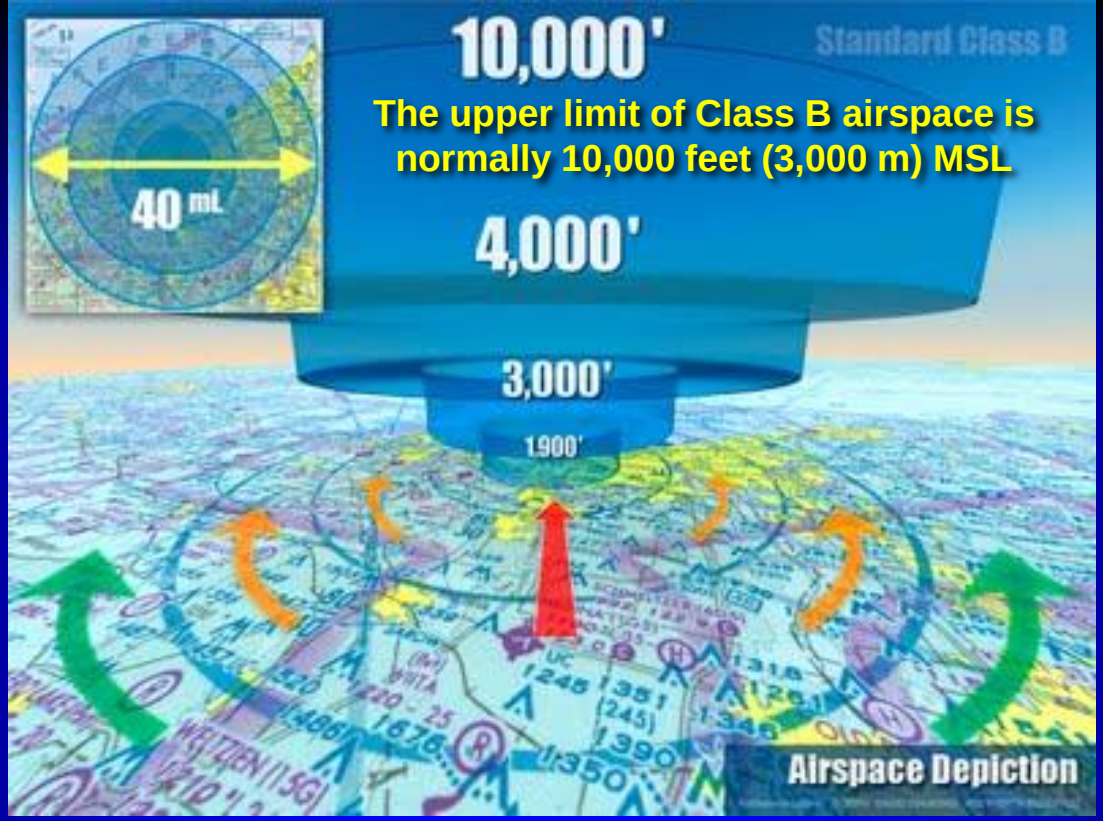

madison

Civil UAS vs Public Use UAS

CIVIL UAS: The FAA issues an *Experimental Airworthiness Certificate* (EAC) for private sector (Civil) UAS to do research and development, training and flight demonstrations

PUBLIC USE UAS: The FAA issues *Certificate of a Waiver or Authorization* (COA) for public aircraft used for law enforcement, firefighting, border patrol, disaster relief, search and rescue, military training, and other government operational missions

Routine operation of UAS over densely-populated areas is prohibited



UAS operations are currently not authorized in Class B airspace, which exists over major urban areas and contains the highest density of manned aircraft in the National Airspace System

FAA Experimental Airworthiness Certificates for Civil UAS Operations


POLICE


HIGHWAY PATROL
HIGHWAY PATROL


SWAT
KEEP BACK 100FT.
SHERIFF


SHERIFF
Honor, Service, Compassion
9265

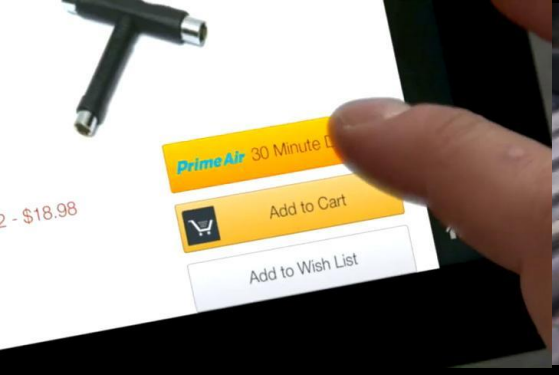
Today, UAS perform border and port surveillance by the DHS, help with scientific research and environmental monitoring by NASA and NOAA, support public safety by law enforcement agencies, help state universities conduct research, and support various other missions for public (government) entities

UAS Research & Testing Sites

After a comprehensive 10-month selection process involving 25 proposals from 24 states, on December 30, 2013, the FAA selected the following six UAS research and test site operators across the country:

- *University of Alaska*
- *State of Nevada*
- *New York's Griffiss International Airport*
- *North Dakota Department of Commerce*
- *Texas A&M University in Corpus Christi*
- *Virginia Polytechnic Institute and State University*


BIOHAZ
BAG


Prime Air 30 Minute D
Add to Cart
Add to Wish List
- $18.98


amazon PrimeAir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FROSTY WINTER LAGER
Lakemaid
BEER

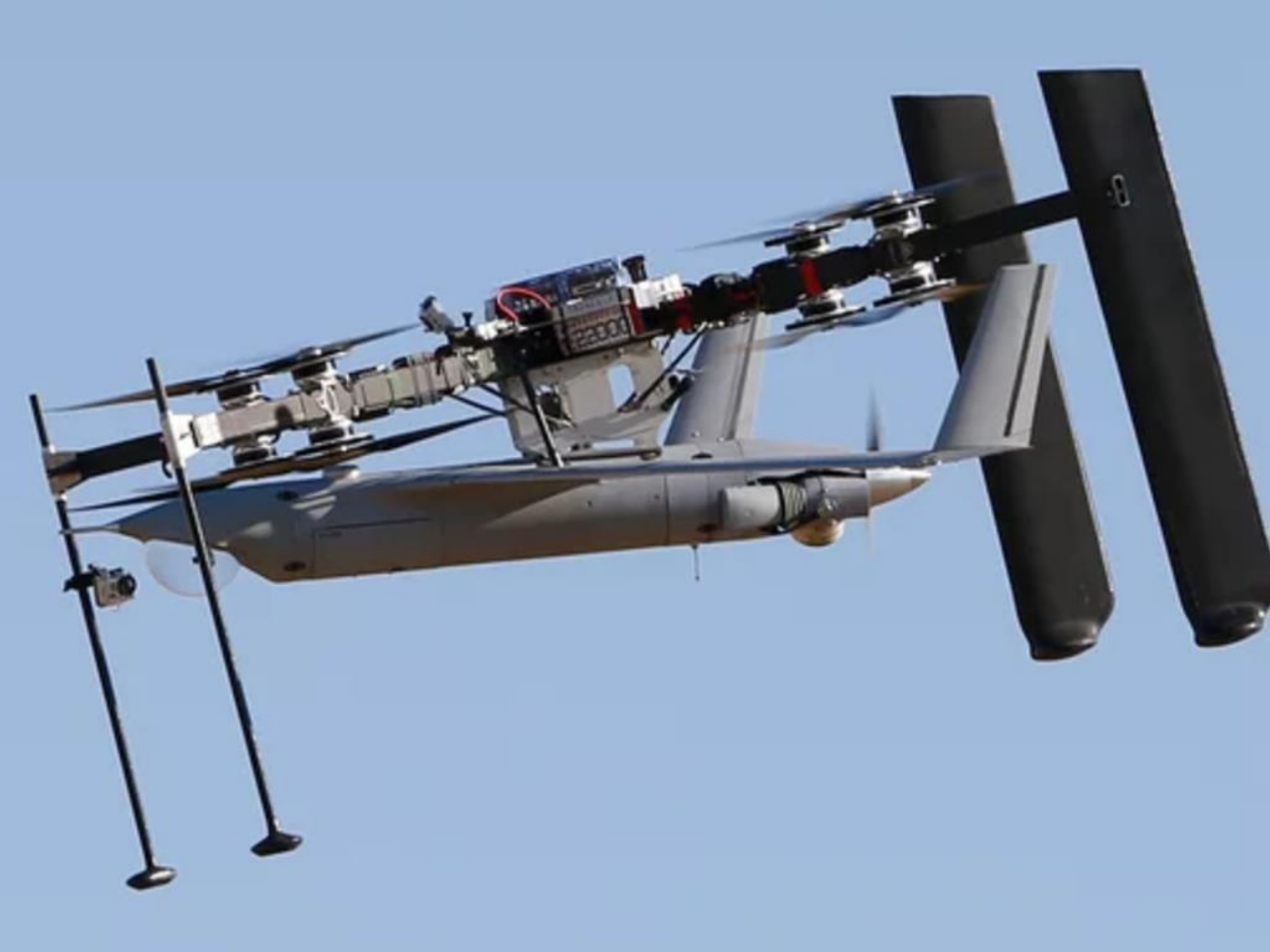

Lakemaid
BEER


Domino's

Chinese e-commerce giant Alibaba Group Holding Ltd began actual deliveries-by-UAV

The three-day, three-city test of the system began in Beijing, with deliveries being made from a single merchant operating through Alibaba's Amazon-like Taobao Marketplace website

UAV used by EasyJet for fuselage inspections



[Music]

Safety Issues

Hazards Posed by UAS to Aviation Safety

- *Physical contact between UAS (fixed wing and rotary wing) and piloted aircraft*
- *Physical contact between UAS and humans*

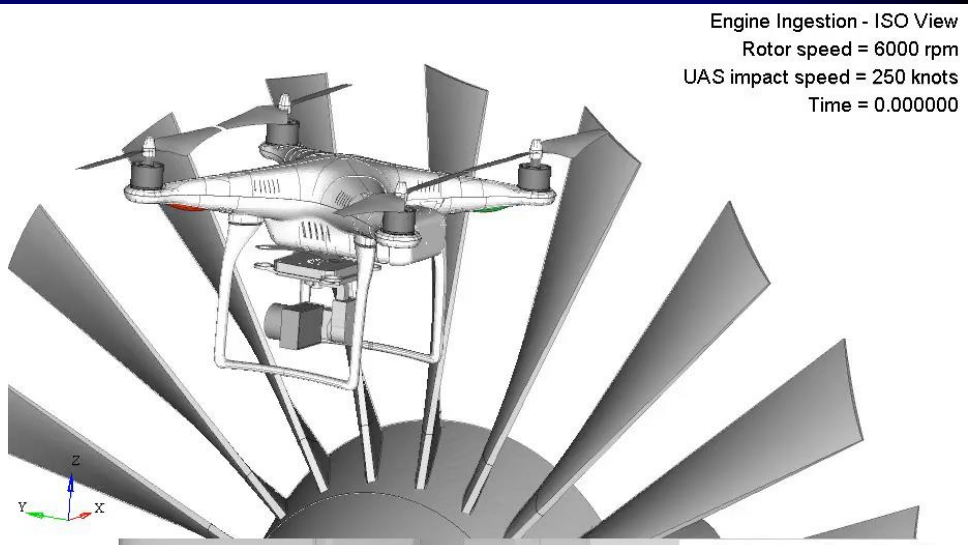
Alliance for System Safety of UAS through Research Excellence (ASSURE)

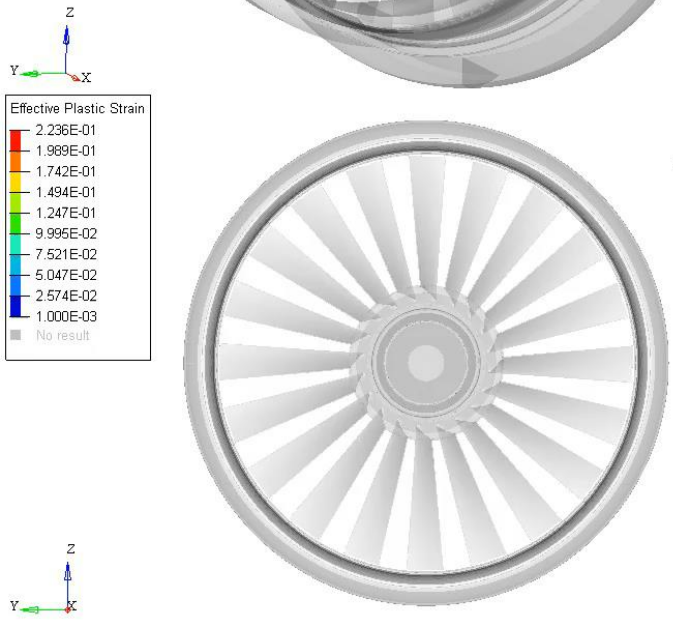
- *Mississippi State University*
- *Montana State University*
- *Ohio State University*
- *Wichita State University*

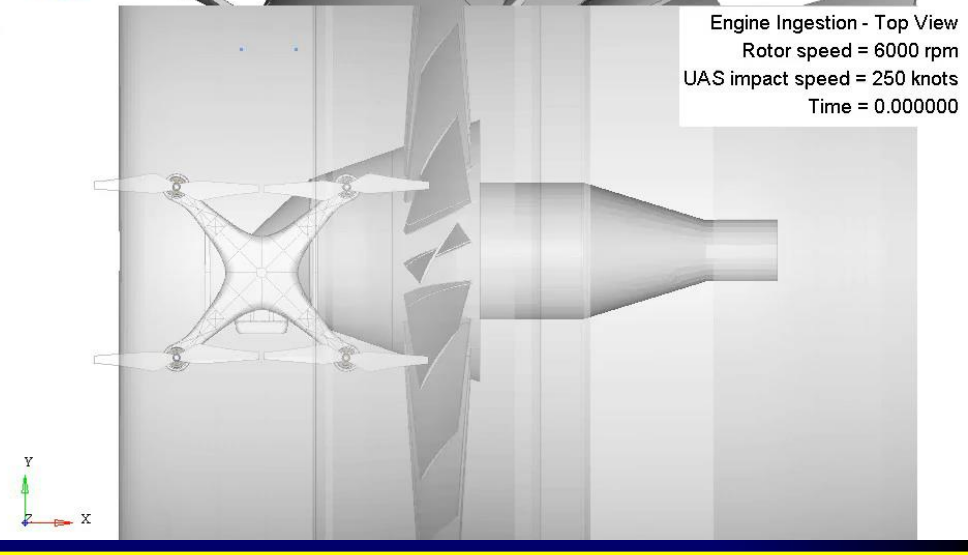
UAS Air-to-Air Collision Severity Evaluation Final Report

- *They evaluated the potential impacts of a 2.7-lb. quadcopter and 4 lb. quadcopter; and a 4-lb. and 8-lb. fixed wing drone on a single-aisle commercial transport jet and a business jet*
- *They examined impacts to the wing leading edge, the windshield, and the vertical and horizontal stabilizers*
- *The windshields generally sustained the least damage and the horizontal stabilizers suffered the most serious damage*

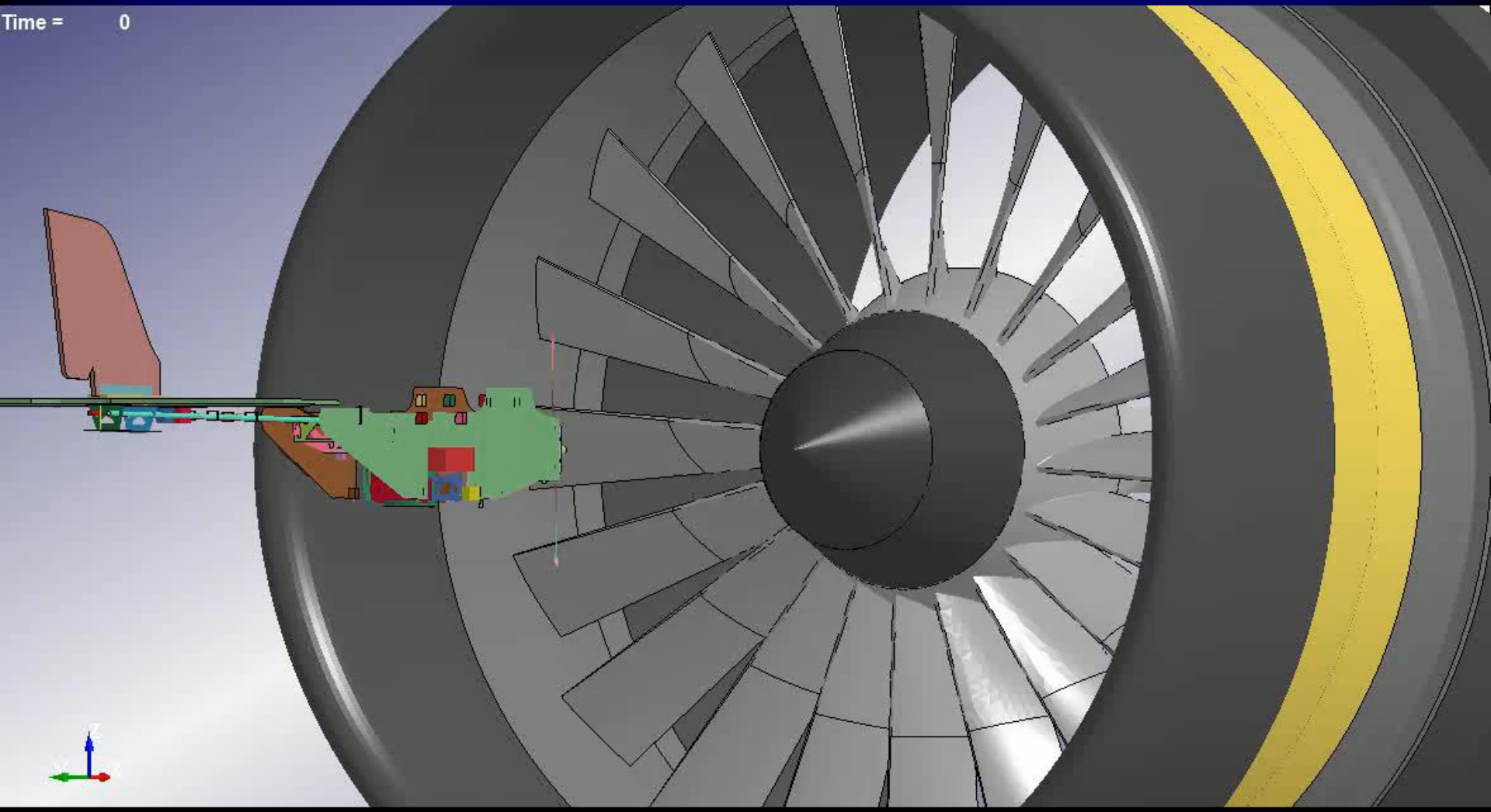
Quadcopter Engine Ingestion Damage





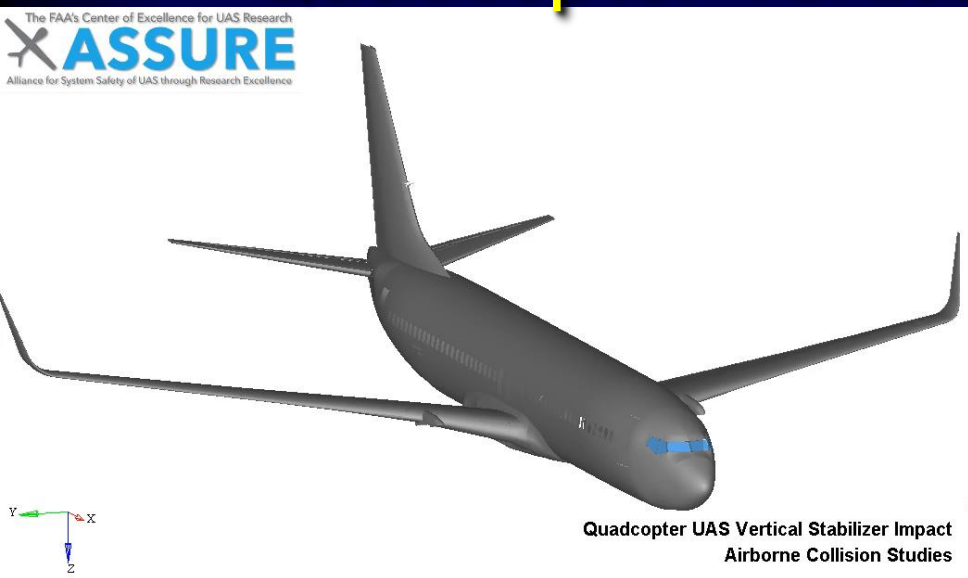


Fixed Wing Takeoff



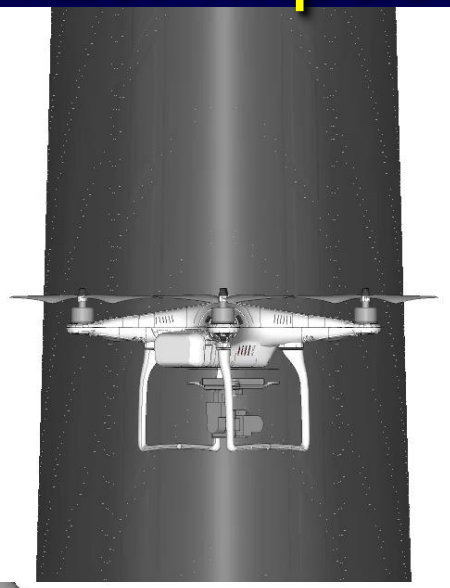
Quadcopter Vertical Stabilizer Impact

The FAA's Center of Excellence for UAS Research
ASSURE
Alliance for System Safety of UAS through Research Excellence

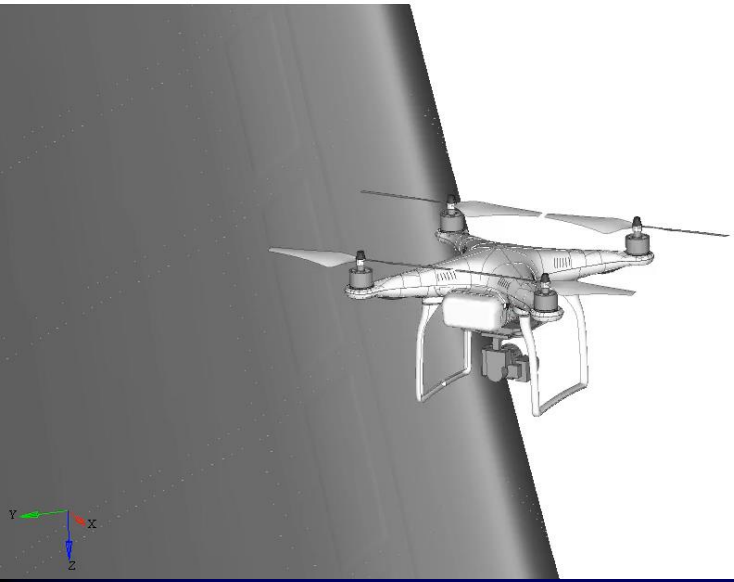


Quadcopter UAS Vertical Stabilizer Impact
Airborne Collision Studies

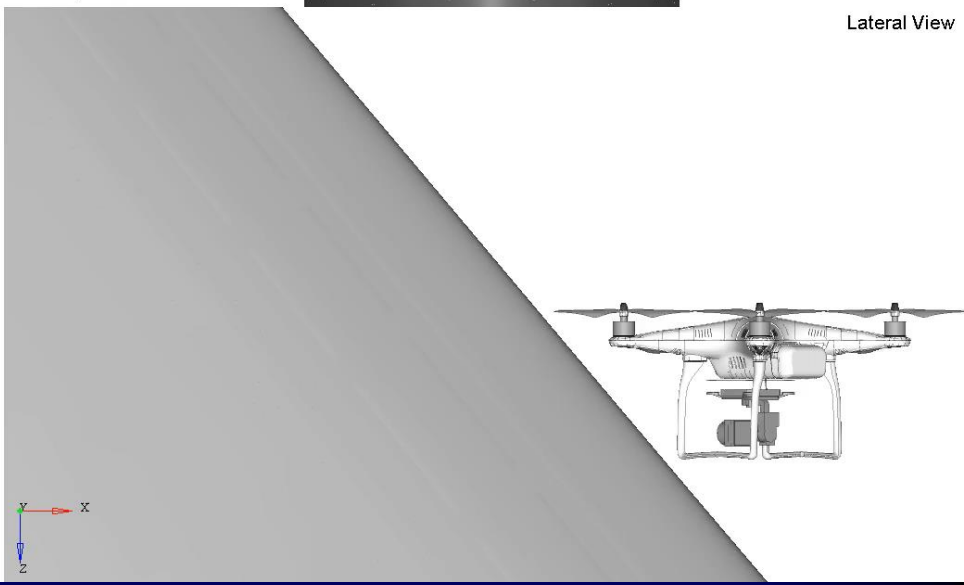
Front View



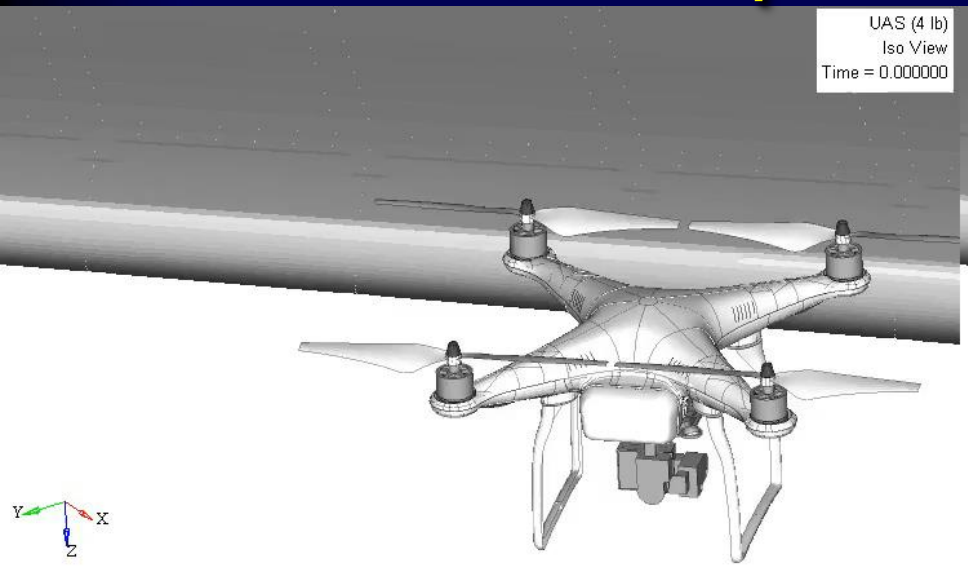
Zoom View

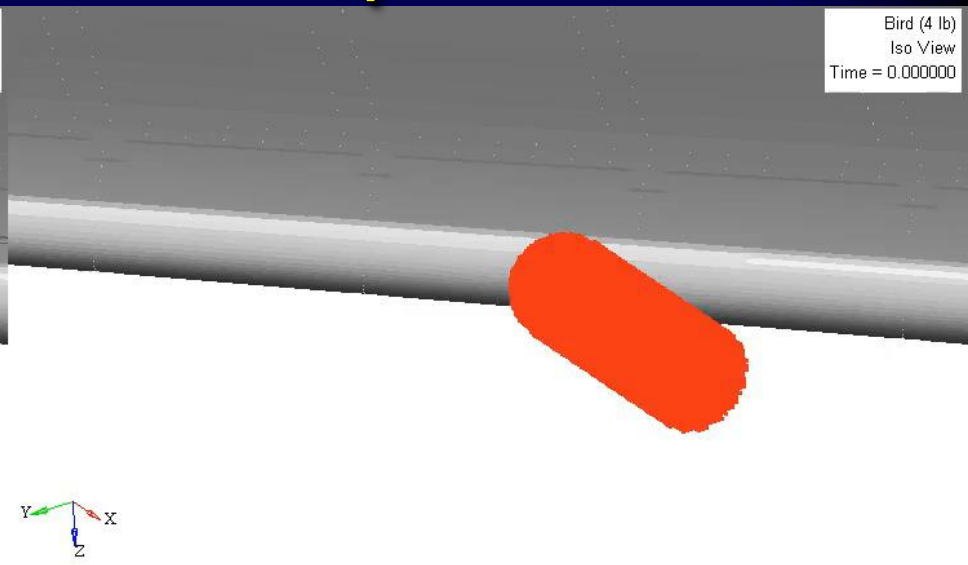


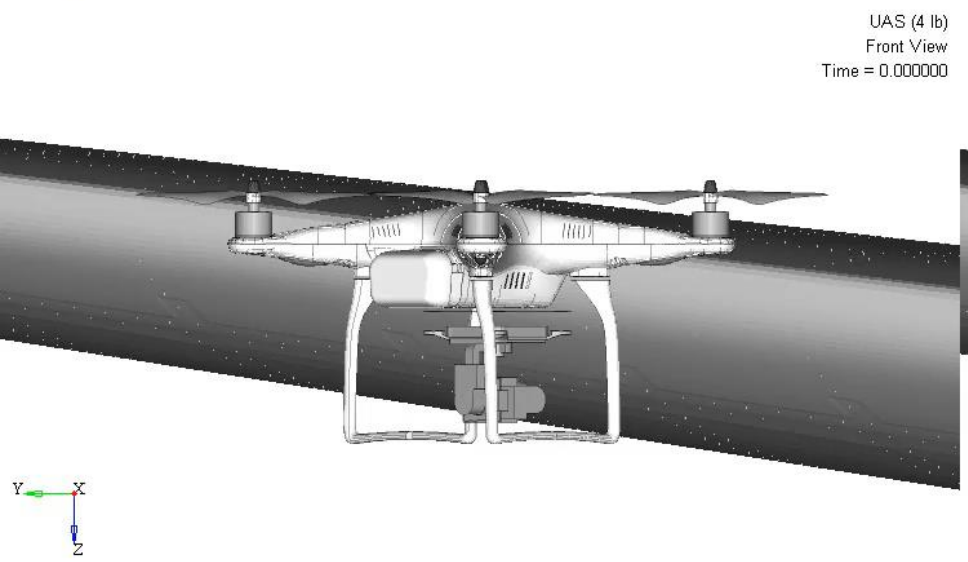
Lateral View

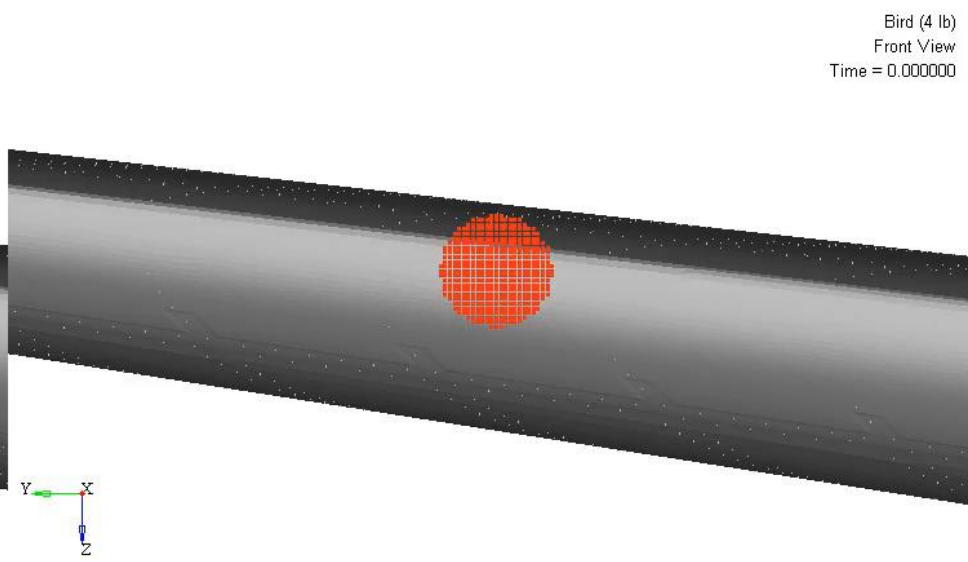


Quadcopter vs Bird Impact

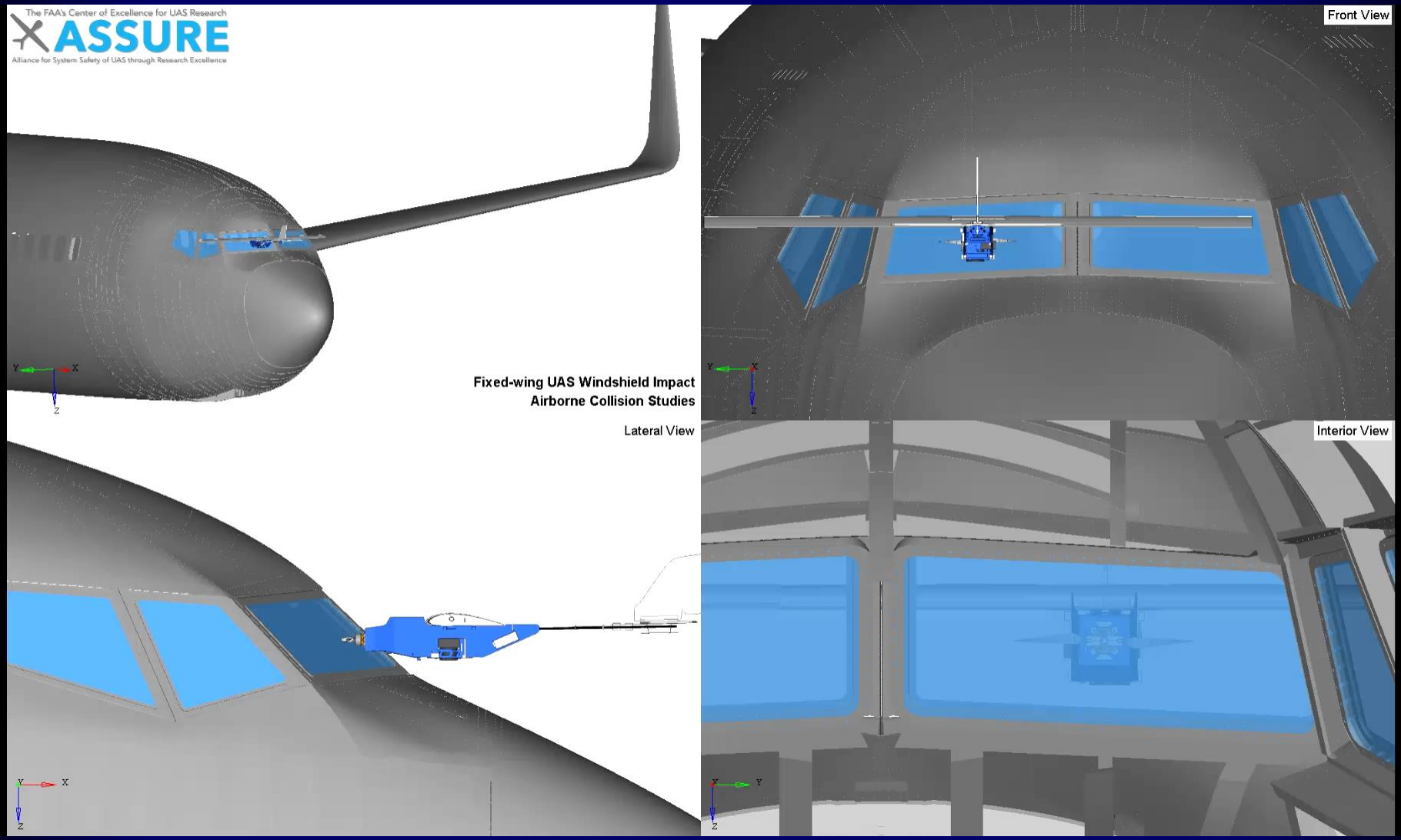








Fixed-Wing Windshield Impact



Quadcopters with exposed propellers can hurt people and they also regularly get damaged in crashes

Polyhelo created the Nano Tornado that instead of open props it utilizes four ducted fans

https://www.faa.gov/uas/media/Part_107_Summary.pdf

Part 107.9 - Accident Reporting Requirements

No later than 10 days after an operation that meets the criteria of either paragraph (a) or (b) of this section, a remote pilot in command must report to the Federal Aviation Administration in a manner acceptable to the Administrator, any operation of the small unmanned aircraft involving **at least:**

a. Serious injury to any person or any loss of consciousness; or

b. Damage to any property, other than the small unmanned aircraft, unless one of the following conditions is satisfied:

1. The cost of repair (including materials and labor) does not exceed $500; or

2. The fair market value of the property does not exceed $500 in the event of total loss

If a UAS Crashes who is Responsible for Damages?

A few months ago a UAV crashed into spectators at a Virginia bull run - There were three to four minor injuries caused by the falling UAV - The operator claimed his UAV's battery died in midair

During a regional triathlon in Australia a local UAV operator was hired to take aerial photographs of their event - One of the event's triathletes received head injuries from a collision with the UAV - The athlete, organizers, and the cinematographer are arguing over who is responsible for the injuries

This is uncharted legal territory, but experts' consensus is, at the very least, the pilot will have a lot of explaining to do. Recreational UAV manufacturers usually urge buyers to purchase separate UAV insurance

Researchers at the University of Minnesota are developing a mind-controlled quad-copter using a skullcap fitted with a Brain Computer Interface (BCI)

Researchers from Portugal's Brainflight project successfully demonstrated a drone flight piloted by human thought

Current CAMI Research Objective:

Collect data to support the regulatory and guidance materials that set the minimum requirements for approving:

1) *Ground control stations*
2) *Training and certification of UAS pilots/operators and other crew members*
3) *Ground observers*

Security Issues

Shoulder-mounted SkyWall launcher takes aim at illegal drones

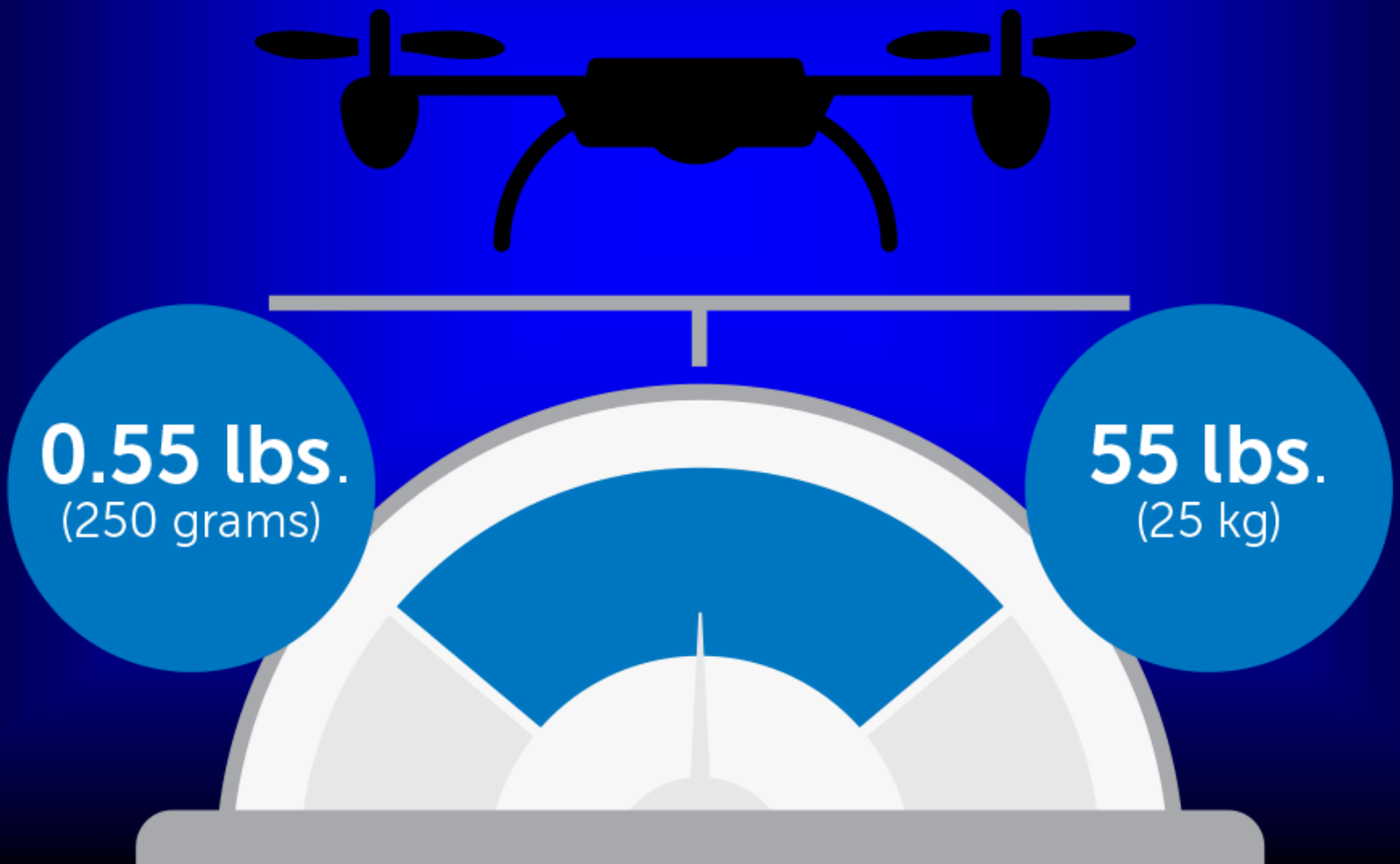

DRONESHIELD
NESHIELD


ВоенТВ

B4UFLY Smartphone App

Do I need to Register My Drone?

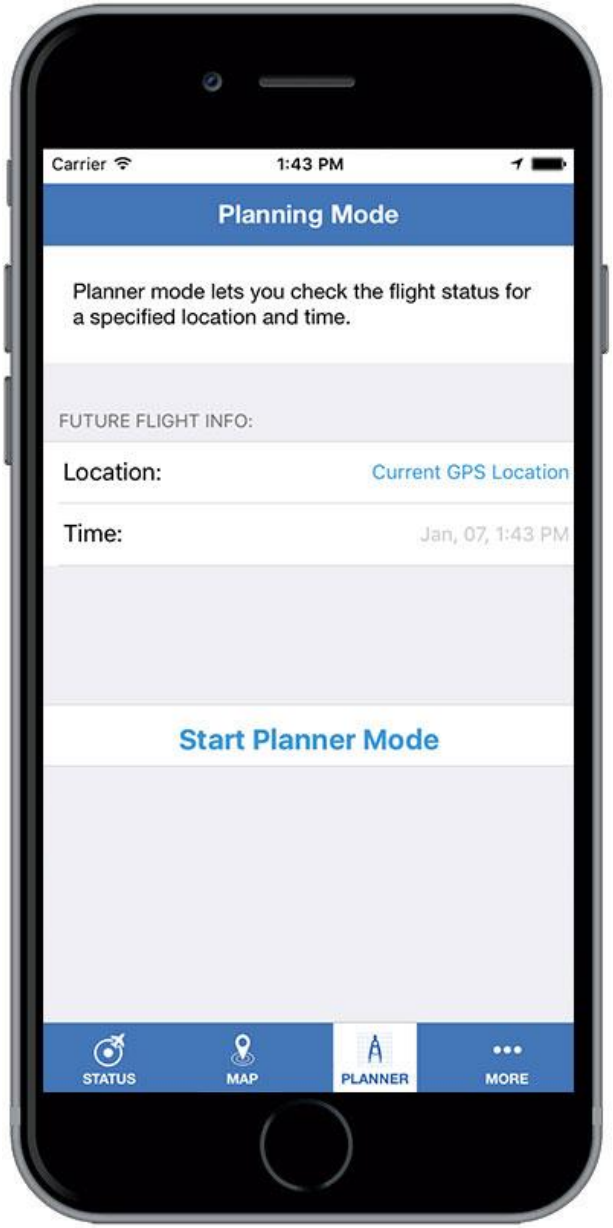
Yes if it weighs between **0.55 lbs** (250 grams) and up to **55 lbs** (25 kg) including payload such as on-board cameras



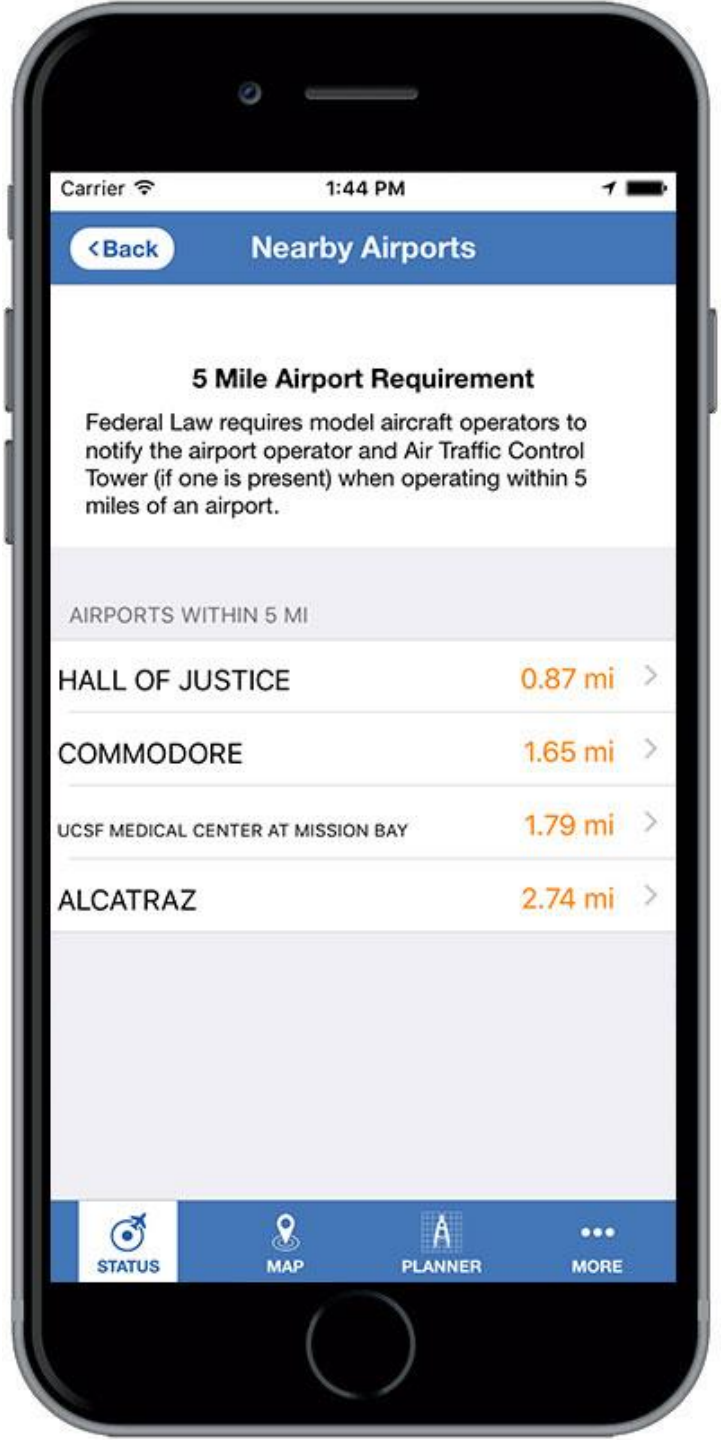
B4UFLY is an easy-to-use smartphone app that helps unmanned aircraft operators determine whether there are any restrictions or requirements in effect at the location where they want to fly

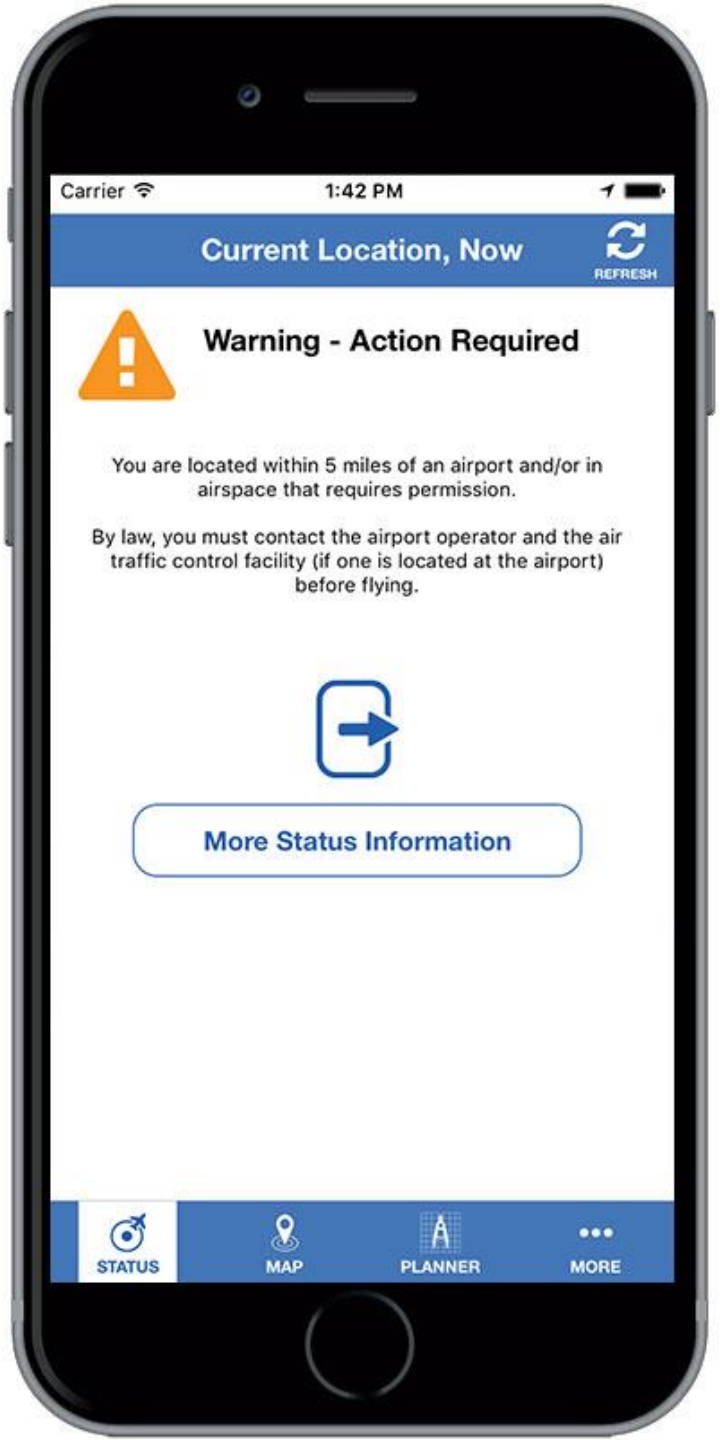
- *A clear "status" indicator that immediately informs the operator about the current or planned location. For example, it shows flying in the Special Flight Rules Area around Washington, D.C. is prohibited*
- *Information on the parameters that drive the status indicator*
- *A "Planner Mode" for future flights in different locations*
- *Informative, interactive maps with filtering options*
- *Links to other FAA UAS resources and regulatory information*


Carrier
1:43 PM
STATUS
Planning Mode
10.5 mi
Planning Mode Location
Novato
San Pablo Bay
Woodacre
Pinole
Stinson Beach
Mill Valley
Sausalito
Daly City
Pacifica
Google
37.787359,-122.408227
STATUS
MAP
PLANNER
MORE


Carrier
1:43 PM
Planning Mode
Planner mode lets you check the flight status for a specified location and time.
FUTURE FLIGHT INFO:
Location:
Current GPS Location
Time:
Jan, 07, 1:43 PM
Start Planner Mode
STATUS
MAP
PLANNER
MORE


Carrier
1:43 PM
STATUS
Map
10.5 mi
Mill Valley
Sausalito
Berkeley
Oakland
Alameda
SAN FRANCISCO INTL
Pacifica
San Mateo
Bair Island
Granada
Half Moon Bay
Google
37.787359,-122.408227
STATUS
MAP
PLANNER
MORE


Carrier
1:44 PM
Back
Nearby Airports
5 Mile Airport Requirement
Federal Law requires model aircraft operators to notify the airport operator and Air Traffic Control Tower (if one is present) when operating within 5 miles of an airport.
AIRPORTS WITHIN 5 MI
HALL OF JUSTICE 0.87 mi
COMMODORE 1.65 mi
UCSF MEDICAL CENTER AT MISSION BAY 1.79 mi
ALCATRAZ 2.74 mi
STATUS
MAP
PLANNER
MORE


Carrier
1:42 PM
Current Location, Now
REFRESH
Warning - Action Required
You are located within 5 miles of an airport and/or in airspace that requires permission.
By law, you must contact the airport operator and the air traffic control facility (if one is located at the airport) before flying.
More Status Information
STATUS
MAP
PLANNER
MORE

Know Before You Fly

DO:
FLY YOUR UNMANNED AIRCRAFT **BELOW** 400 FEET

DO:
FLY WITH **LOCAL CLUBS**

DO:
INSPECT YOUR AIRCRAFT **BEFORE** YOU FLY

DO:
TAKE A LESSON BEFORE YOU FLY

DON'T:
FLY YOUR UNMANNED AIRCRAFT **BEYOND LINE OF SIGHT**

DON'T:
FLY NEAR AIRPORTS **OR ANY MANNED** AIRCRAFT

DON'T:
FLY NEAR **PEOPLE** *or* STADIUMS

DON'T:
BE CARELESS *or* RECKLESS. YOU COULD **BE FINED IF YOU** ENDANGER **PEOPLE** OR OTHER AIRCRAFT

DON'T:
FLY ANYTHING THAT WEIGHS MORE THAN **55** LBS.

DON'T:
FLY FOR PAYMENT *or* COMMERCIAL PURPOSES **UNLESS** SPECIFICALLY AUTHORIZED BY THE FAA

www.faa.gov/uas • www.knowbeforeyoufly.org

SMALL UAV COALITION
A Partnership for Safety & Innovation

AMA
ACADEMY OF MODEL AERONAUTICS

AUVSI
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

Federal Aviation Administration

I **UNITED STATES OF AMERICA** XI

DEPARTMENT OF TRANSPORTATION • FEDERAL AVIATION ADMINISTRATION

IV NAME

ERICH JOHN FREYMANN

V ADDRESS [redacted]

GAINESVILLE FL 32606-8059

VI NATIONALITY USA

IVa D.O.B. [redacted]

SEX	HEIGHT	WEIGHT	HAIR	EYES
M	69	220	BLOND	BLUE

IX HAS BEEN FOUND TO BE PROPERLY QUALIFIED TO EXERCISE THE PRIVILEGES OF

II **REMOTE PILOT**

III CERTIFICATE NUMBER [redacted]

X DATE OF ISSUE 1 SEP 2016

XIV

VIII ADMINISTRATOR

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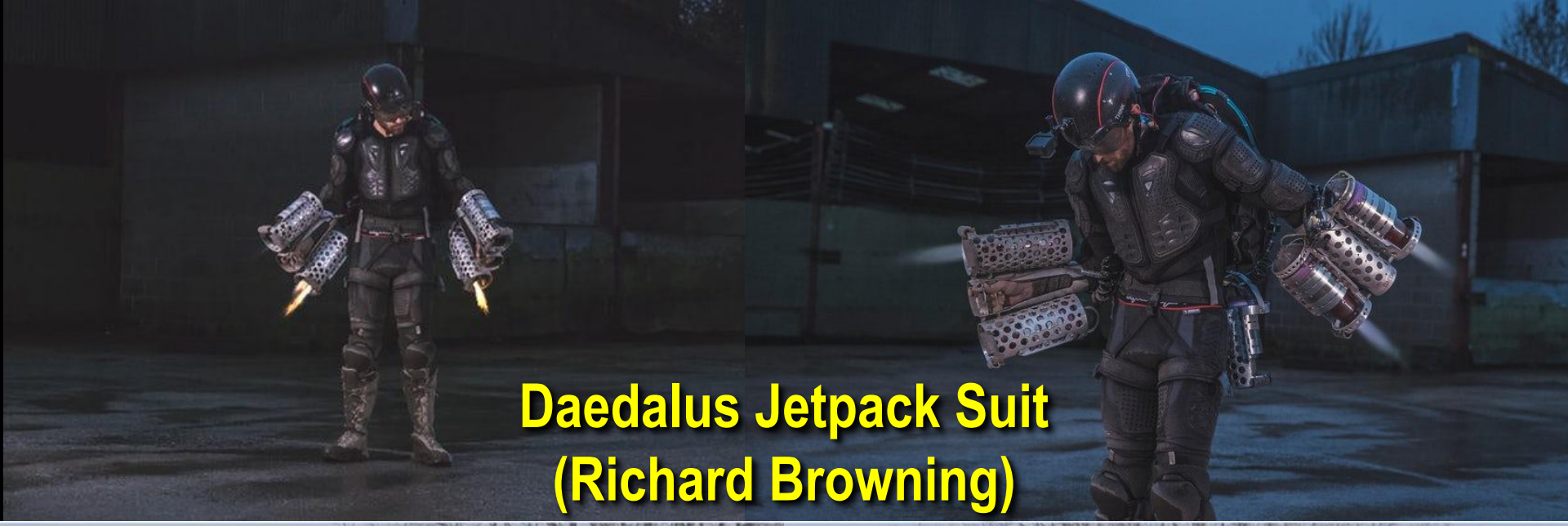
Personal Flying Machines

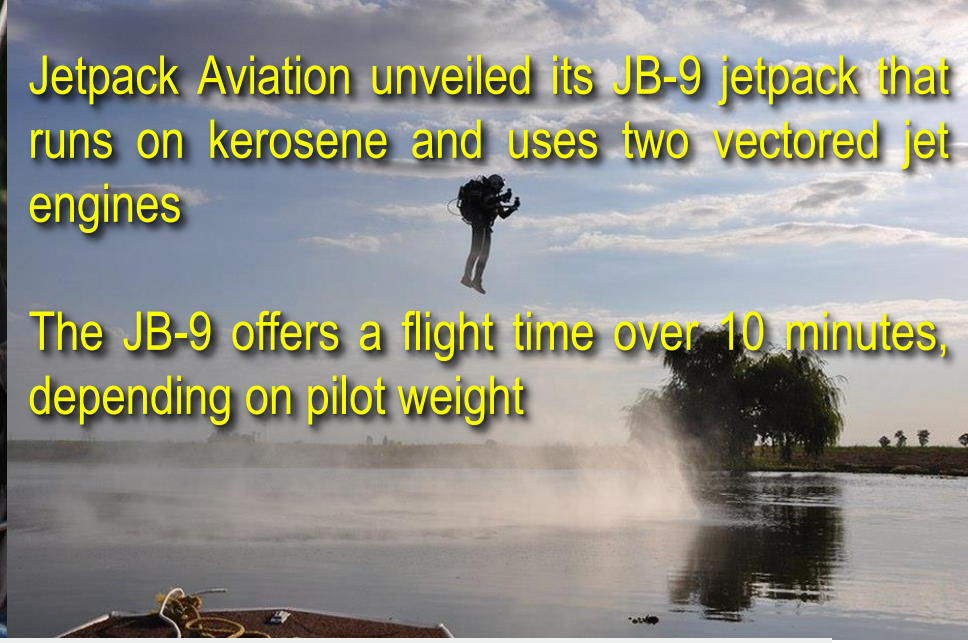
Zapata Flying Board

Zapata Ezfly is a small platform with a series of jet thrusters, with two handgrips that come up from the base and steering is done with bodyweight



Daedalus Jetpack Suit (Richard Browning)


GRAVITY
GRAVITY



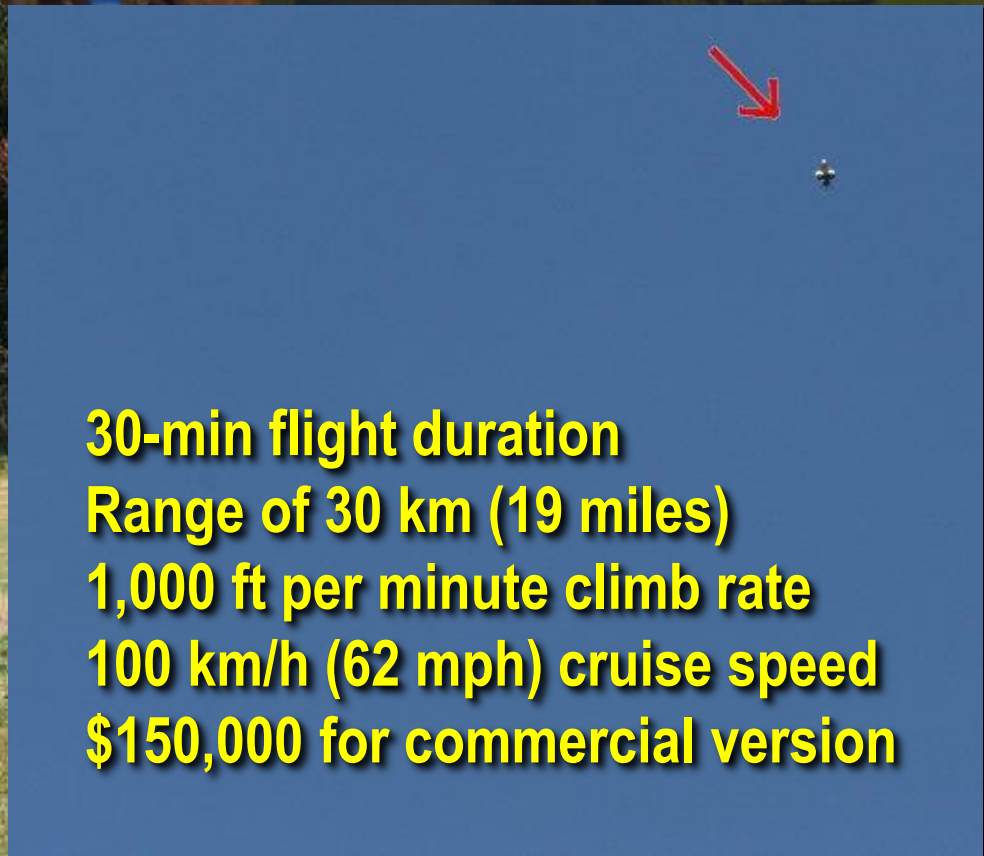
Jetpack Aviation unveiled its JB-9 jetpack that runs on kerosene and uses two vectored jet engines

The JB-9 offers a flight time over 10 minutes, depending on pilot weight

The JB-10 is some 7 percent more powerful than the JB-9

The JB-11 takes safety to the next level, as well as speed and power. Using three smaller turbojet engines per side instead of just one, JB-11 can hit speeds over 150 mph (240 km/h)

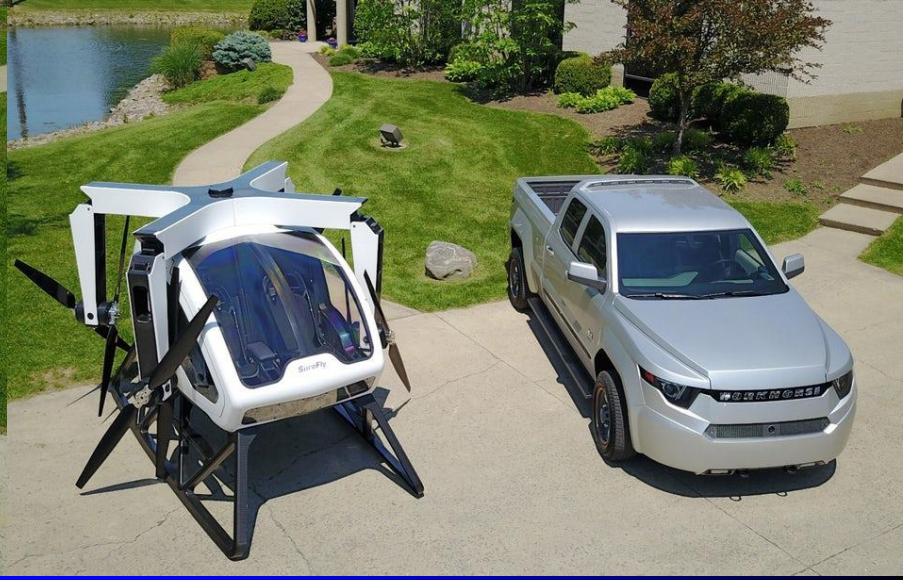
Martin Jet Pack



30-min flight duration
Range of 30 km (19 miles)
1,000 ft per minute climb rate
100 km/h (62 mph) cruise speed
$150,000 for commercial version

Hoversurf Scorpion Hoverbike (Russia)


POLICE



Workhorse first unveiled its Surefly flying car at the Paris Air Show in June 2017, and has now sent it into the air with a person inside for the first time

Airbus Vahana is a full-scale version of the electric, autonomous VTOL aircraft that completed its first ever test flight earlier in February

Lilium Aviation completed its first unmanned test flights of a two-seater version of its electric VTOL jet in early 2017 and is working on a five-seat production version and is targeting 2019 for its first manned flights

Ehang 184 for the first time carrying out test flights with people onboard


EHANG 184
EHANG

Volocopter VC200