

# Ch 22

# Unconventional Designs

2016-04-26

# Beech Starship

- PT6 turboprops<sup>USA</sup>
- Variable sweep canards
- Quiet interior, but noisy exterior



# Strut-Braced Wing

- Folding wings needed to access gate space for conventional aircraft
- Part of NASA SUGAR program



# Strut-Braced Wing

- Trade lower seat mile cost with pax-miles/hr and scheduling
- Might work ok for regional jets flying at M 0.7- 0.75
- Must manage interference between strut and MLG attachment



# Strut-Braced Wing

- Hurel-Dubois HD-31
- First flight 1953
- 2 Wright Cyclone
- $V_{\text{cruise}} = 146$  kts
- 36 pax



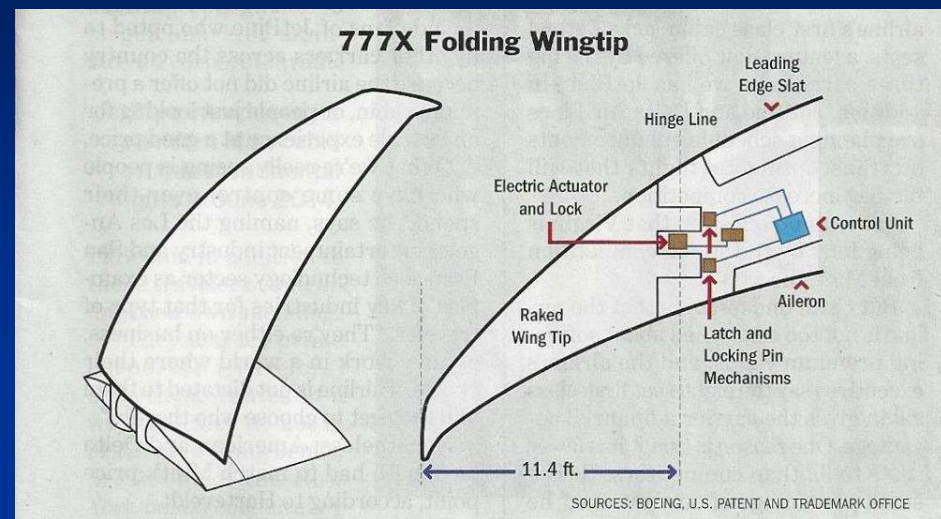
# Folding wing-tips on B777



- Rig-tested but never installed on aircraft
- Offered on B777 but no airlines bought it

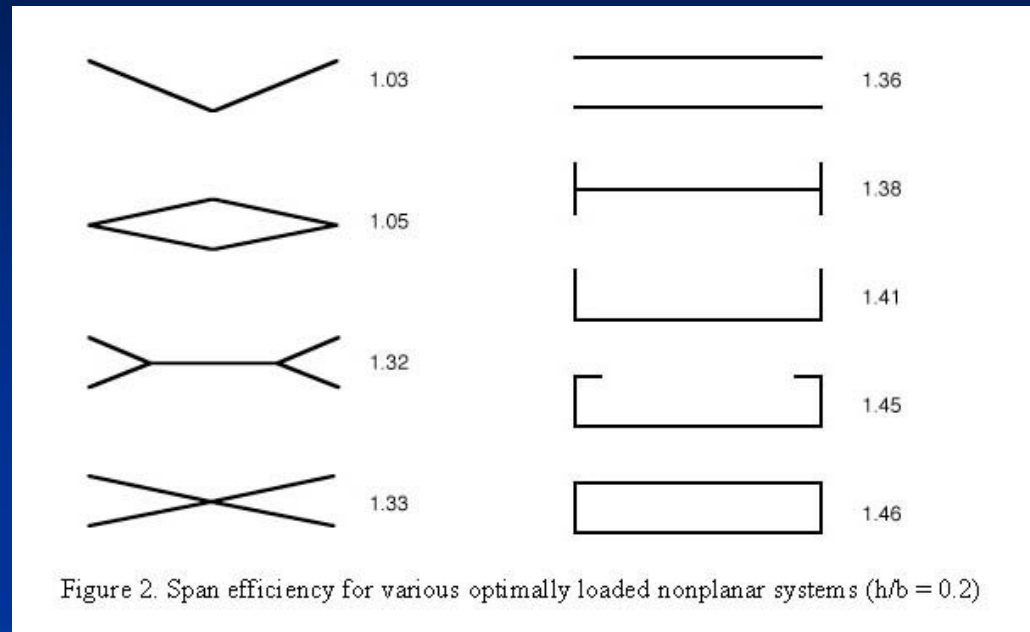
# Proposed folding wingtips on B777X

- Testing prototype of wingtip fold in Sept 2015



Source: AWST

# Box Wing



- Based on analysis by Prandtl



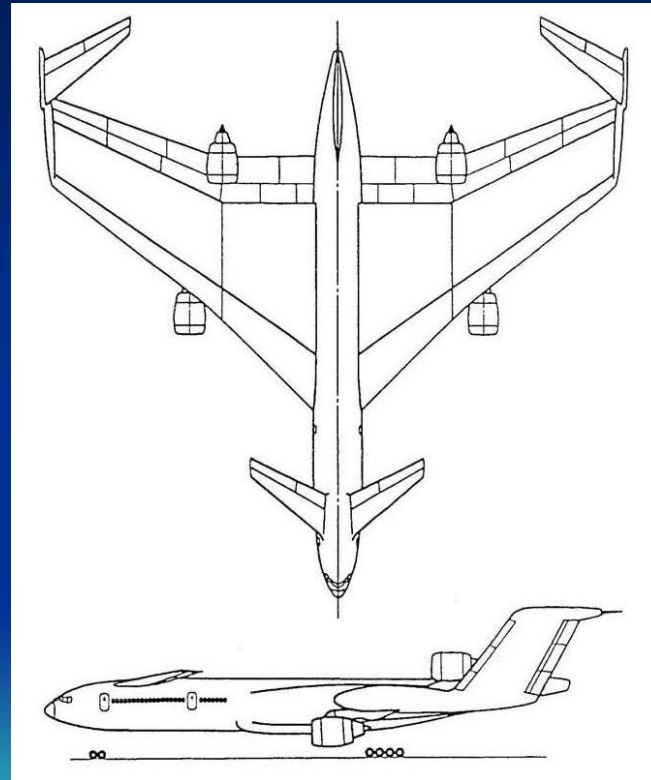
# Box Wing

- Oswald efficiency factor 1.46
- MLG attached to fuselage
- Need strong outboard corner joints
- Narrow chord wing has little structural depth
- Must also resist flexure from engine moments
- Where does fuel go?



# C-Wing

- McMasters/Kroo/Pavek concept
- Hybrid blended wing-body
- Negative lift on horizontal stabilizer for statically stable aircraft



Source: John McMasters

# Joined Wing

- Advantages
  - Lighter structure
  - Good locations for multiple antennae
- Disadvantages
  - Maybe works better for conventional wing-body-vertical tail configuration
  - Complex aerodynamics
  - Interference at wing join



A Boeing joined-wing, SensorCraft, undergoes testing at NASA Langley's 16 X 16-ft. wind tunnel in 2010.

Source: Aviation Week

# Combined Box Wing/Joined Wing

- Advantages
  - Reduced interference at join
  - Good locations for multiple antennae
- Disadvantages
  - Need strong joint at bend of rear wing
  - Complex aerodynamics



Source: Aviation Week

# MIT Double-Bubble Fuselage



Mark Drela

- Laminar flow wing
- Double-bubble fuselage
- UHBPR propulsion (not shown)
- 180 pax, 2500 nm range

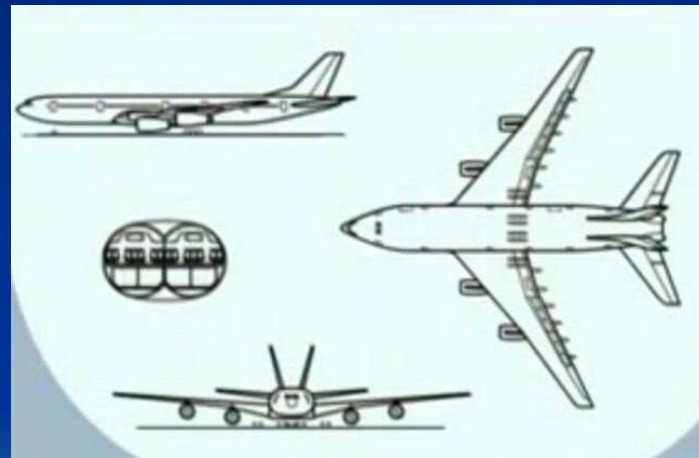
# MIT Double-Bubble Fuselage





# Double-Bubble Fuselage

- Airbus P550
- Presumably early A380 project studies



# 3-surface Configuration

- Airbus concept uses wing and horizontal stabilizer to shield noise from unducted fan





# 3-surface Configuration

- Canard surface provides trim, aft surface provides control
- Advantages
  - Theoretical optimum spanwise lift distribution
  - Can put wing spar through middle of fuselage
- Disadvantages
  - More control surfaces implies greater maintenance
  - More difficult to integrate landing gear
  - Non-uniform flow over wing



Piaggio Avanti



Airbus UDF concept

# Shielding Inlet and Nozzle

- Noise shielding method taken from A-10 (except that A-10 was for visual and IR shielding)



# Over-the-wing Engines

- Successfully proved on VFW-614
- Current development on HondaJet
- Difficult to work well for Mach .75+



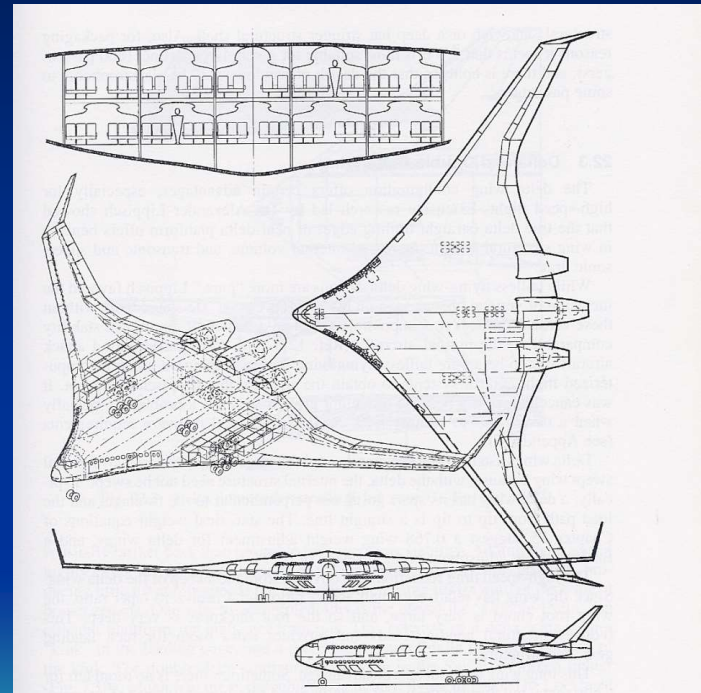
# Over-the-wing Engines

- Structurally challenging but workable
- Benefits of shorter landing gear and airstairs without weight and balance problems of fuselage-mounted engines



# Blended Wing-Body

- Advantages
  - Higher L/D
  - Noise shielding of jet engines
- Disadvantages
  - Increased weight of non-cylindrical passenger cabin
  - Difficult passenger access/egress



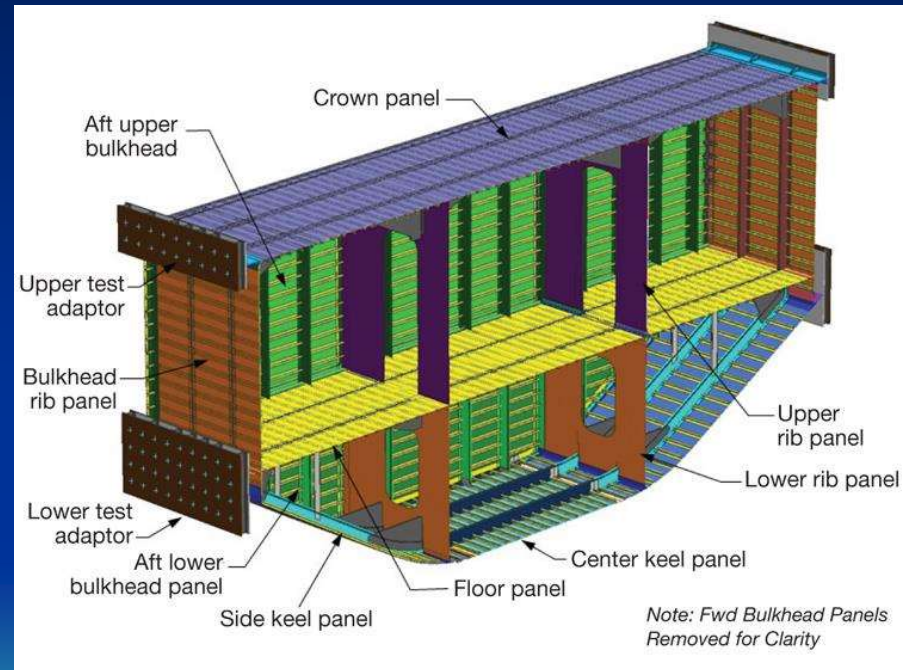
Source: Raymer

# Blended Wing-Body

- Disadvantages (cont'd)
  - More difficult cargo loading and aircraft servicing
  - More difficult engine access
  - Excessive cabin motion when maneuvering
  - Difficult longitudinal trim (especially when using high-lift devices)
  - Non-uniform flow into engine nacelles at high  $\alpha$

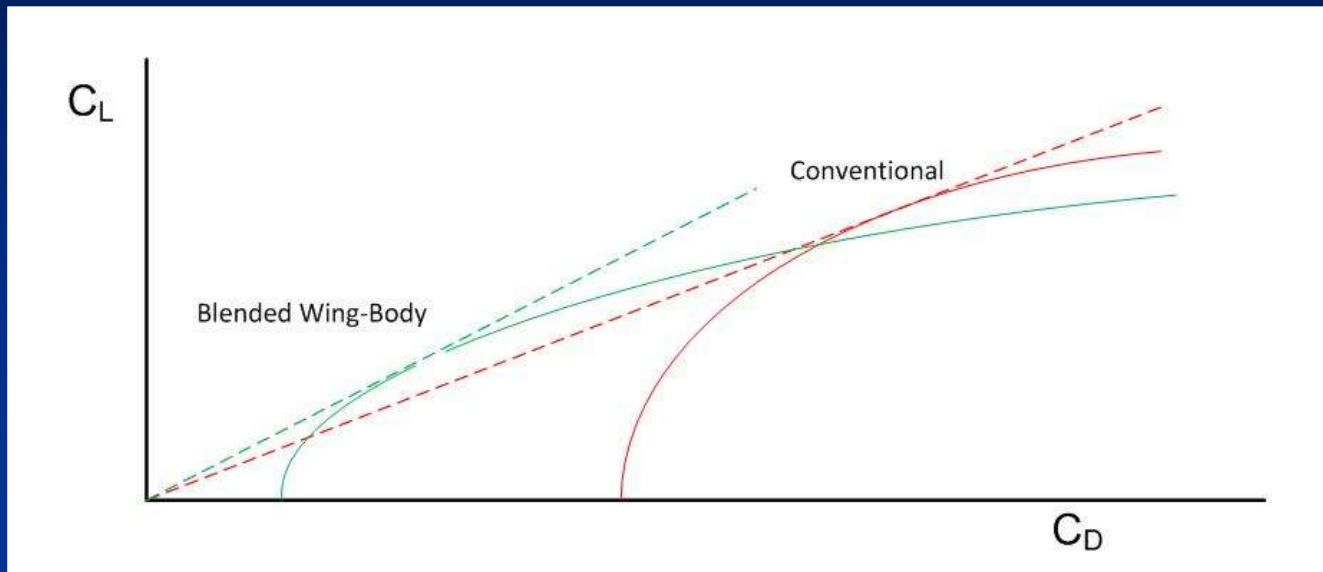
# Blended Wing-Body

- NASA contract to Boeing to evaluate non-circular pressurized structures



[www.compositeworld.com](http://www.compositeworld.com)

# Blended Wing-Body



- Will optimize at lower  $C_L$
- Higher cruise Mach number



# Blended Wing-Body

- Successful sub-scale flight test with X-48



# Hybrid Wing-Body

- AFRL Revolutionary Concepts for Energy Efficiency (2009- )
- $M_{\text{cruise}} = 0.81$
- More practical than commercial config.
- Burns 70% less fuel than C-17
- Over-wing nacelles permit very-high-BPR engines



Source: AW&ST

# Hybrid Wing Body

- Multi-role tanker/transport
- 15% more efficient than Boeing KC-46A



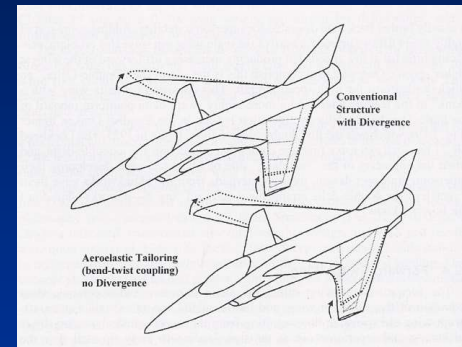
# Hybrid Wing Body

- 4%-scale model in National Transonic Facility at NASA Langley



# Forward-swept Wing

- Advantages
  - Fast roll response
  - Avoids tip stall
  - In bizjet, can put wing spar through middle of fuselage
- Disadvantages
  - Root stall may cause pitchup
  - Needs structural tailoring to avoid divergence
  - Reduced efficiency of swept flaps



Source: Raymer



HFB-320 Hansa Jet

# Supersonic Transport Brief History



- 2707 would carry pax overwater pax traffic
- 747 would be a freighter

# Supersonic Transport

- Technically feasible
- Questionable economics
- Expensive to buy, but operational efficiency (pax-miles/hr) can be doubled



Source: Aviation Week

Lockheed Martin 81 pax 4,000  
nmi range Mach1.6 low sonic  
boom SST



# Supersonic Bizjet

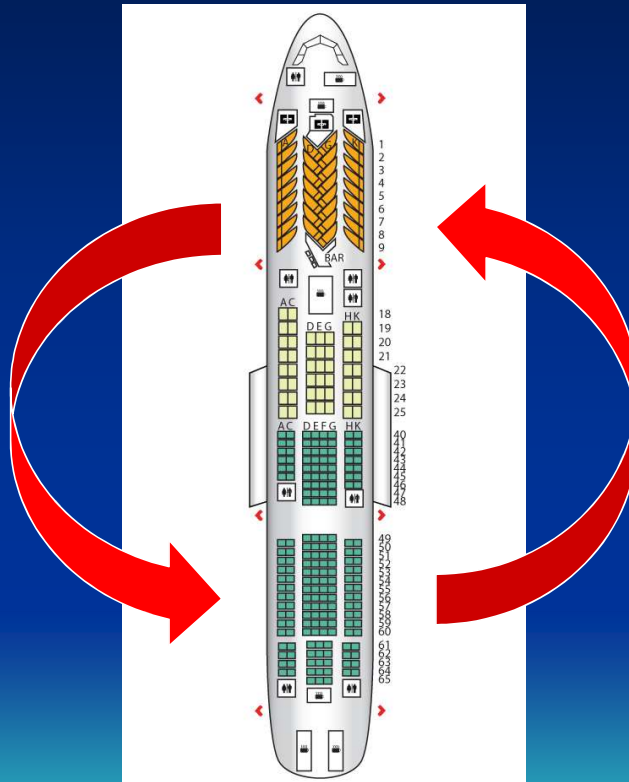


- Difficult to get required fineness ratio without very small x-section cabin



# Subsonic Synergism

Subsidize  
economy  
fares,  
enables  
more people  
to fly



Provide  
frequency of  
flights

# Disruptive Influence

- Current synergism is breaking down
- Airlines abandoning first class
- Looking for ways to bring back premium flyers



# Terrafugia Transition

- Performance
  - $V_{\text{cruise}} = 87 \text{ kt}$
  - Range = 356 nm with 30 min reserve
  - Takeoff = 1700 ft over 50 ft obstacle
  - Useful load = 500 lb
  - Cruise fuel burn = 5 gph
  - Useable fuel = 23 gal
  - Mileage on road = 35 mpg



# Terrafugia TF-X



- Hybrid electric
- Fly-by-wire
- VTOL capabilities
- Automated flight management system
- Backup parachute

# Moller Skycar



- Moller International founded in 1983

# Moller Skycar 400

- Projected performance:
  - Speed: 300 kt
  - Range: 700 nm

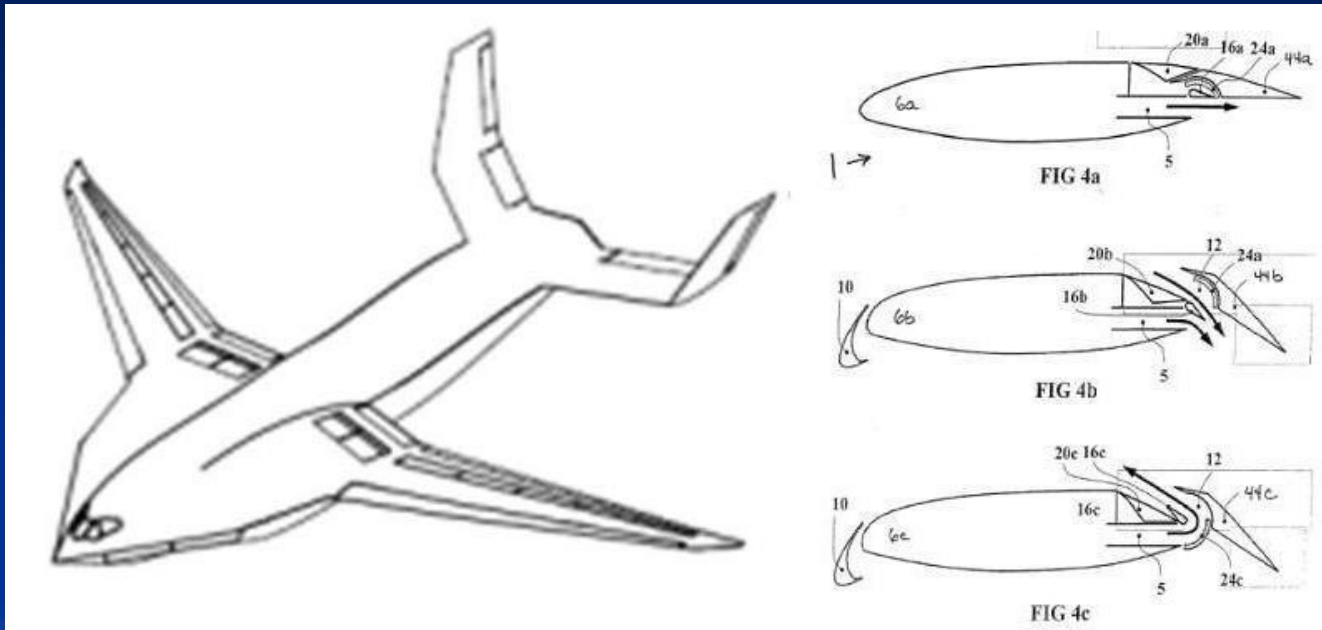


# AFRL Speed Agile Program



- LO replacement for C-130
- Tactical radius 500 nm
- TOFL 2000 ft with full load

# LM's novel thrust reverser



- Uses circulation control/internally blown flaps outboard
- Ejector lift/thrust reverser inboard



# LM's large scale W/T testing



- Tested in NASA Ames 80' X 120' tunnel

# Amazon Prime Air



- 86% of packages < 5 lb
- Delivery time < ½ hour
- Radius = 10 miles

# Amazon Prime Air

- Won't work for apartments or any other high population density environment
- High risk of damage or injury due to collision

# Inspection UAV



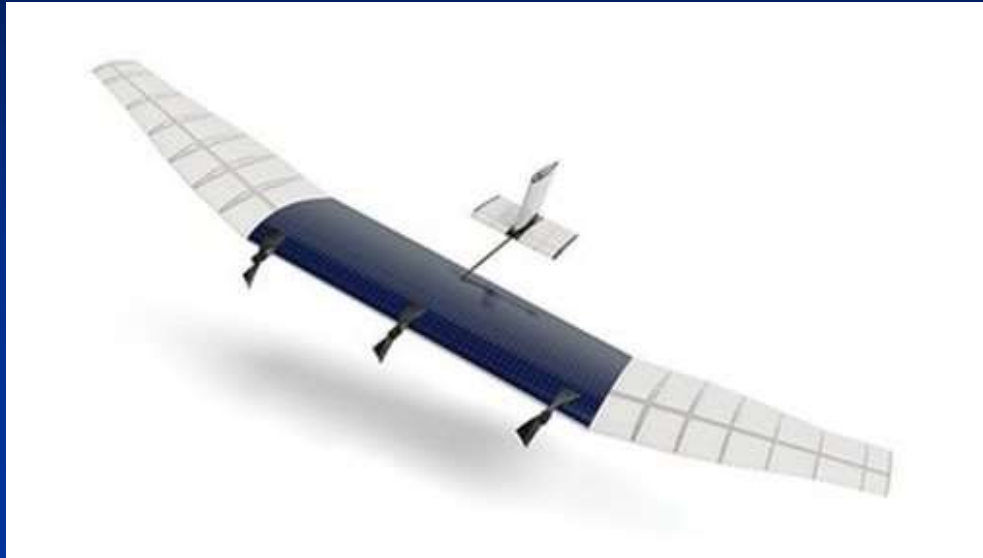
- MD4-3000

# Crop Inspection



- MD4-200

# Facebook Aerial Internet Transceiver



- Wi-fi in the sky
- For more information, go ask Mark

# Only in America



# Military UAVs – Reconnaissance



- MQ9 Reaper
- Stand-off weapons platform



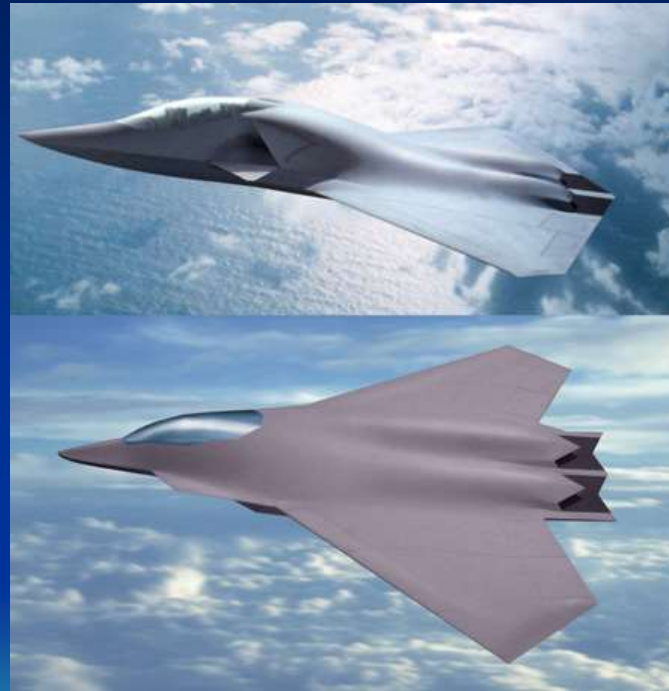
# Military UAVs - Combat



- X-47B Technology Demonstrator
- First carrier landing 2013/07/10

# Next Generation Air Dominance

- Boeing optionally-piloted NGAD



# Unconventional Designs

## The End

2016-04-26