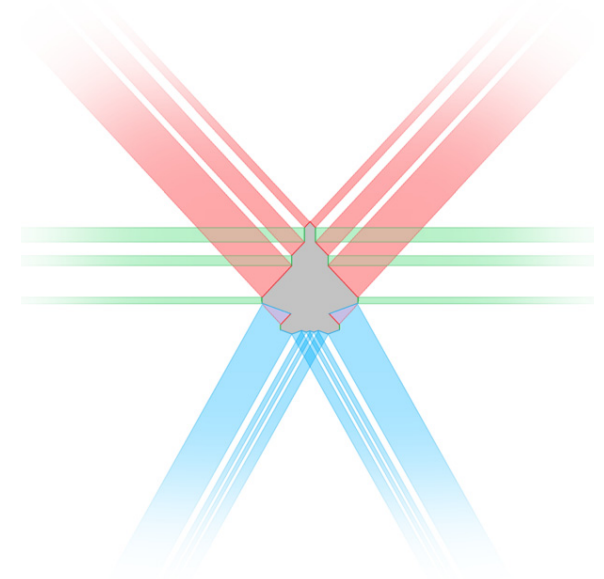
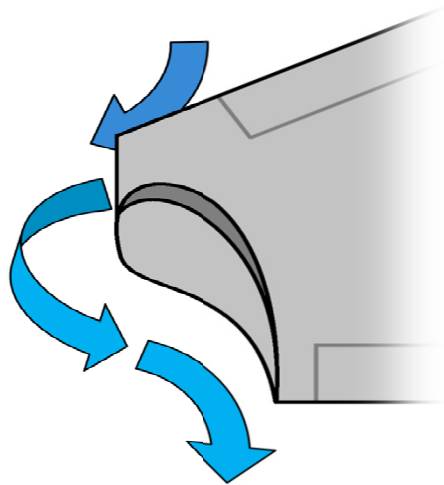
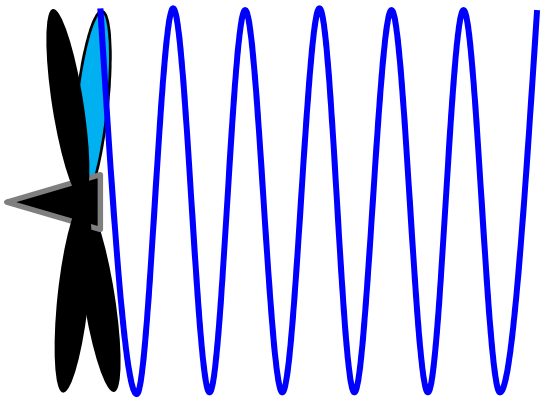


Airplane Design for Non-Engineers / Airplane Design “FAQ”



Bernardo Malfitano – UnderstandingAirplanes.com

EAA AirVenture Oshkosh 2018

Bernardo Malfitano

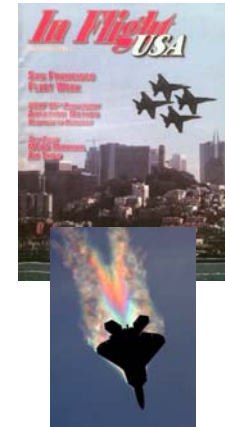
Academic

- B.S. Mechanical Engr., Stanford University
- M.S. Mechanical Engr., Columbia University
Elective courses, lab work, and research topics included airplane design, aerodynamics, control systems, and propulsion



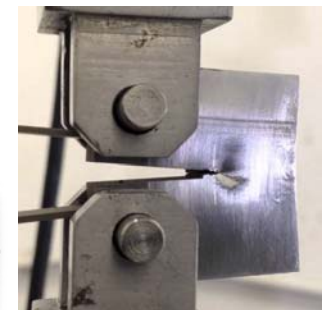
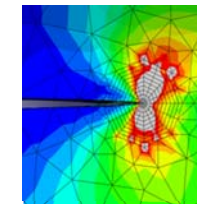
Hobbies

- Articles and photos on various aviation magazines, websites, & books, since 2003
- Pilot, RV-6 owner. 1st solo: 2009
1st aerobatic solo: 2012
1st flight to Oshkosh: 2014



Professional

- Boeing Commercial Aviation Services (Fleet support, structural analysis of repairs, maintenance planning); **Long Beach: 2007-2008**
- BCA Structural Damage Technology (Fatigue & Fracture Mechanics allowables testing and analysis methods development); **Everett: 2009-2018**
- BCA Airplane Configuration & Integration (Product Development); **Harbour Pointe: 2018-Present**



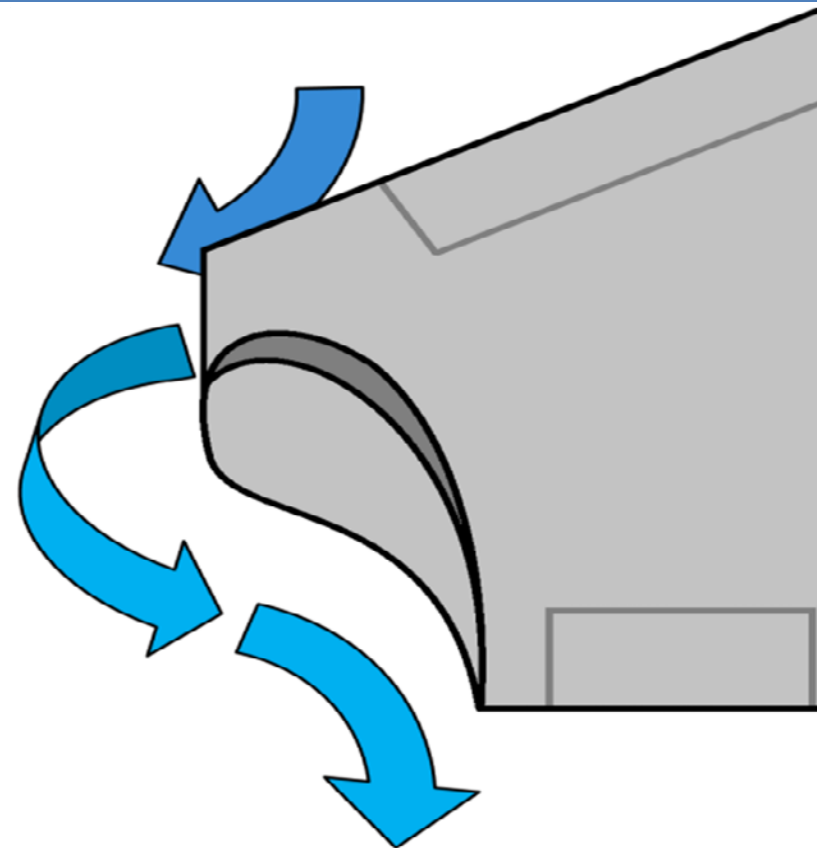
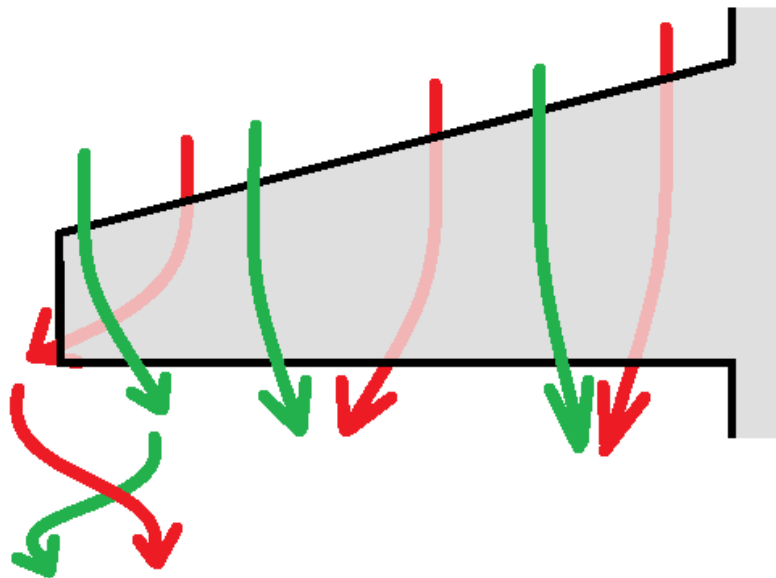
Notes

- All images are © their respective owners.
- All opinions expressed here are my own. I do not represent my employer, the FAA, or the EAA.
- A video of me delivering this talk can be found at <https://www.youtube.com/channel/UCh7C3C5hKAVZR0SCPhECrMQ>
- This is a one-hour summary of my 10-hour course on airplane design for non-engineers. Details about my course, including all the slides, are at UnderstandingAirplanes.com

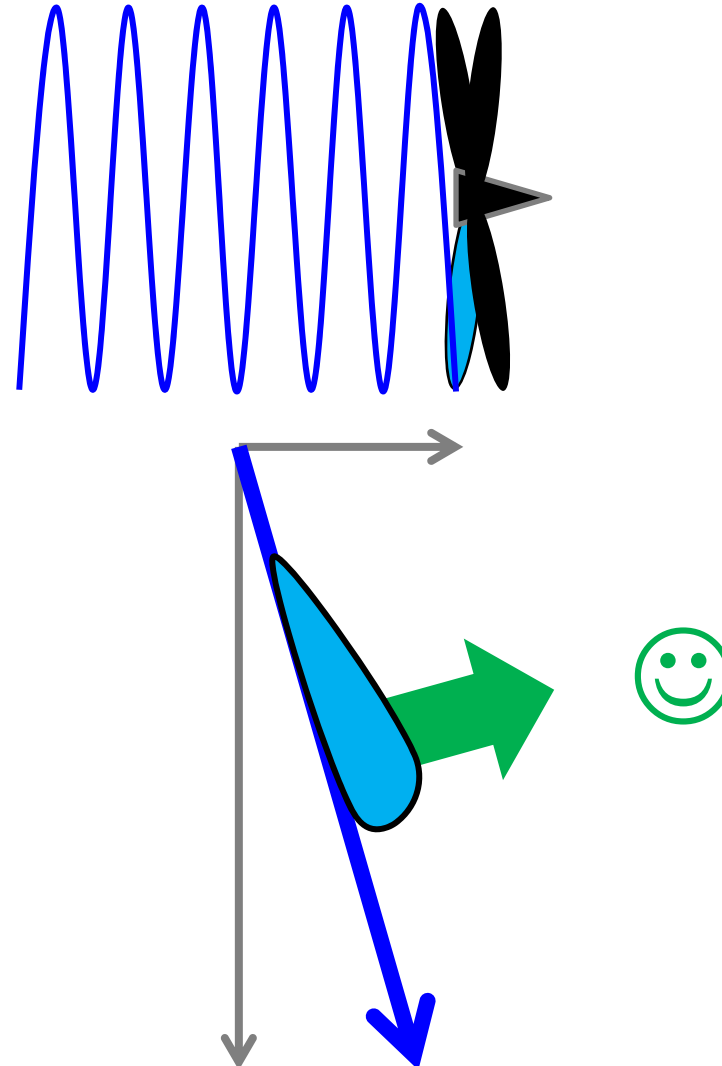
Frequently Asked Questions:

- 1) How do winglets work?
- 2) Why do most small airplanes have propellers while most big airplanes have jet engines?
- 3) Why do stealth airplanes have parallel straight edges, flattened fuselages, and no tail?
- 4) Why don't we have supersonic airliners anymore?
- 5) Why are there so few electric or solar airplanes?
- 6) What are the pros and cons of composites?
- 7) Why do engines keep getting wider?
- 8) Why do most airliners not have T-tails, high wings, or engines mounted on the tail?
- 9) When must an airplane be retired?
- 10) Why do we still not have flying cars?

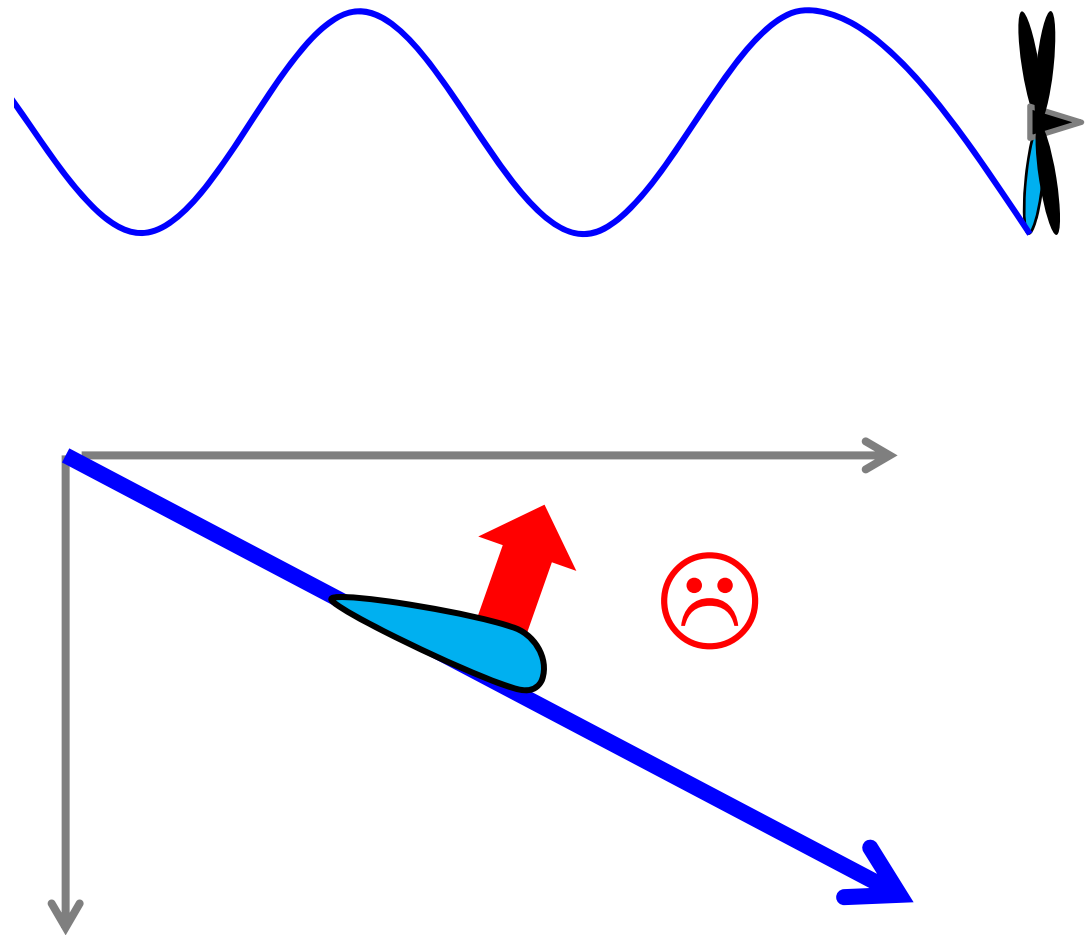
Winglets



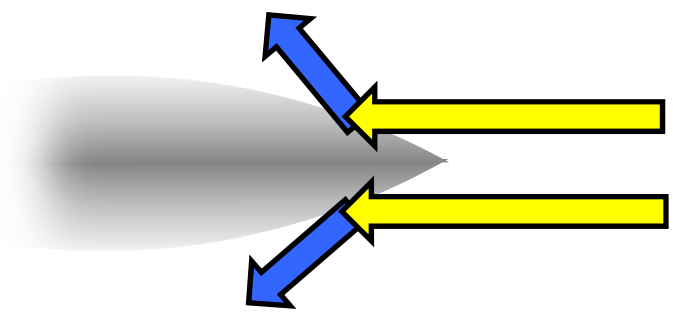
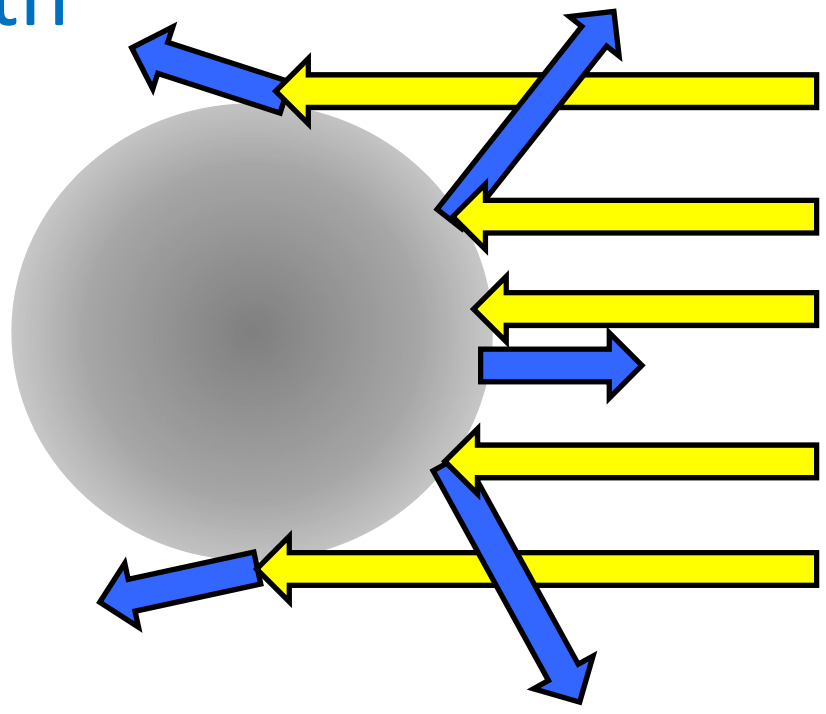
Propellers vs Jet Engines



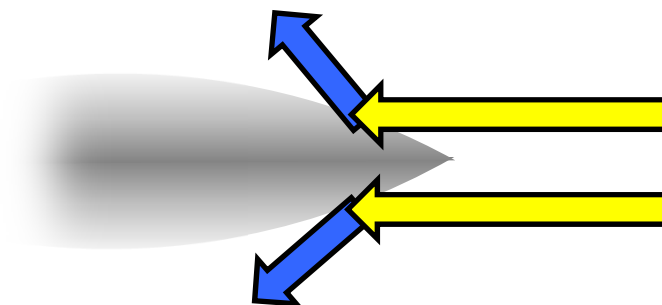
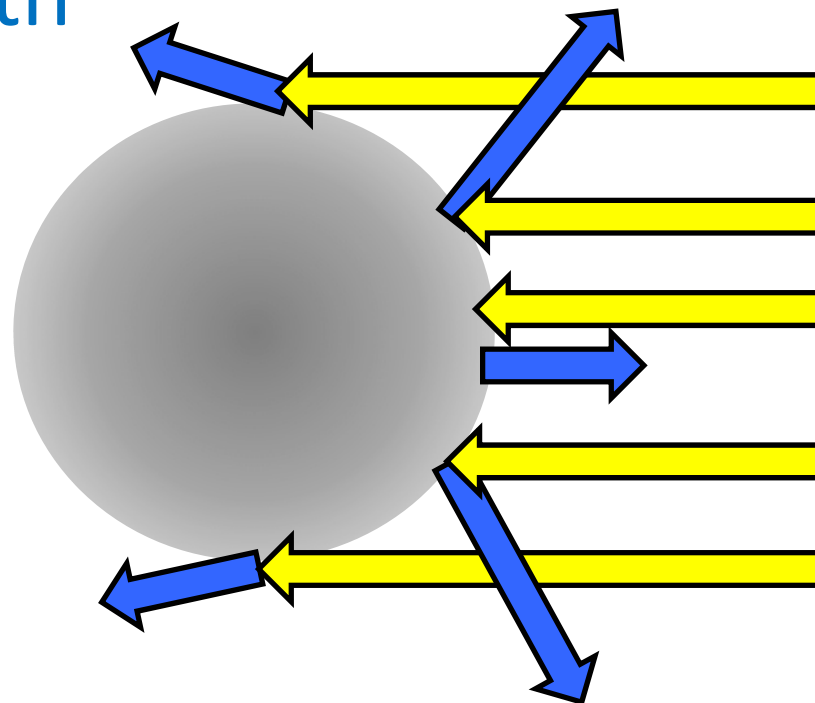
Propellers vs Jet Engines



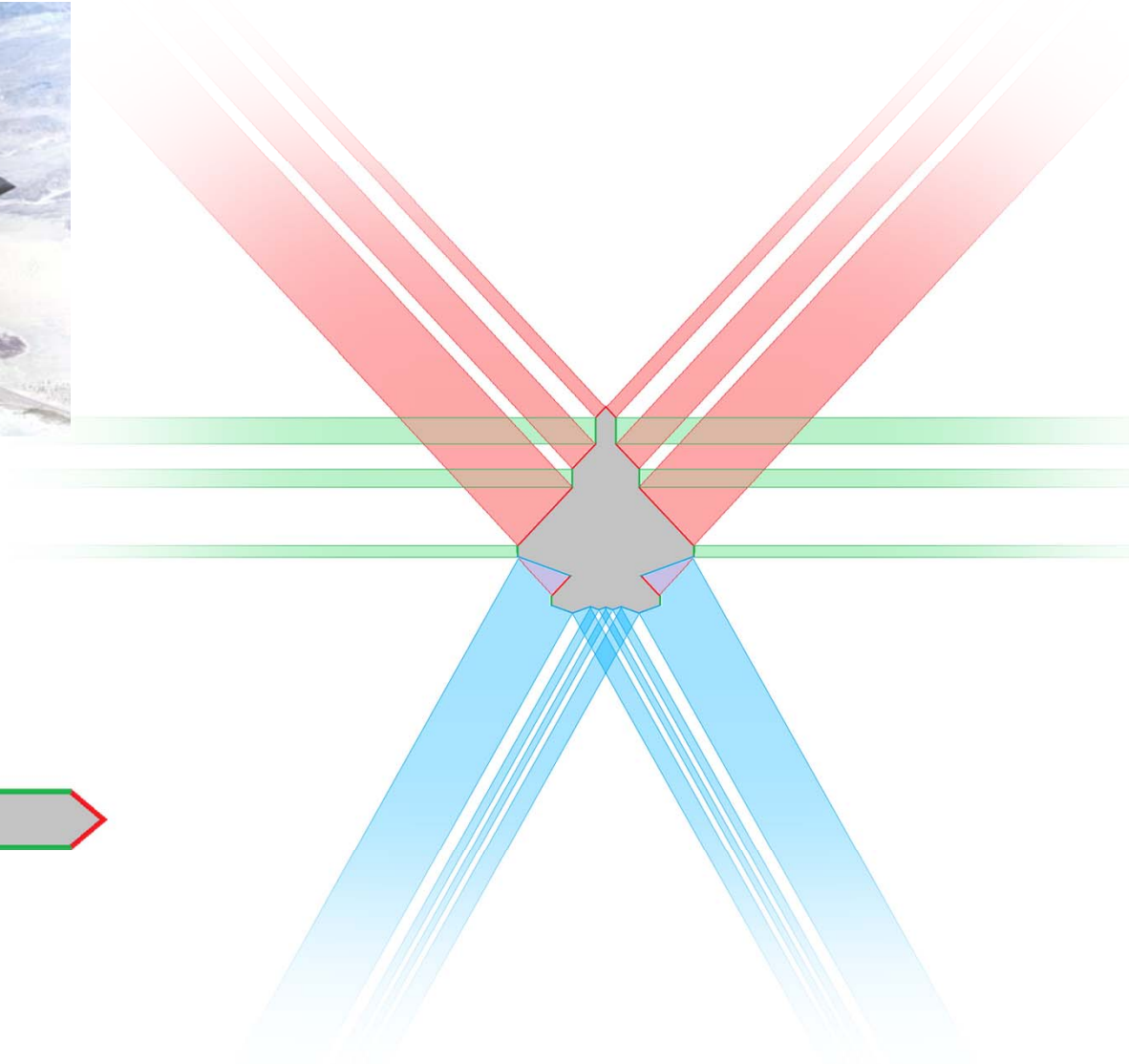
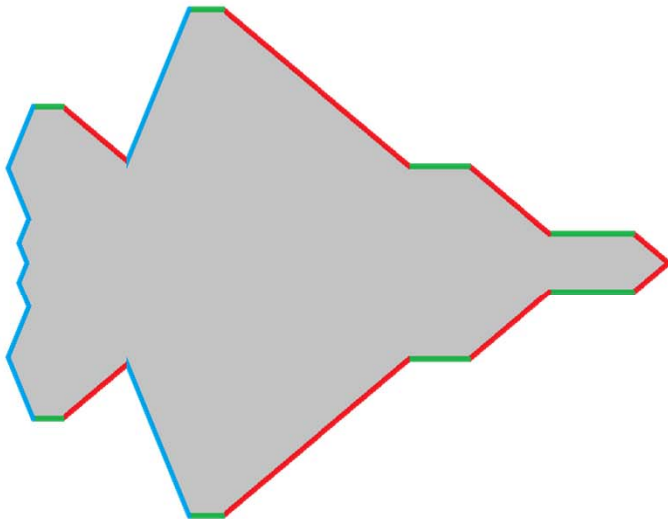
Stealth



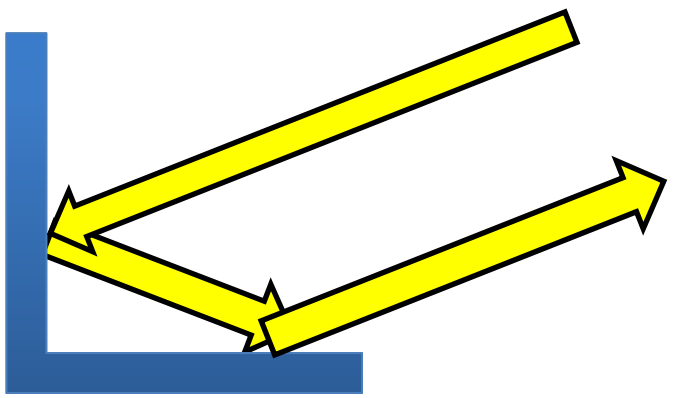
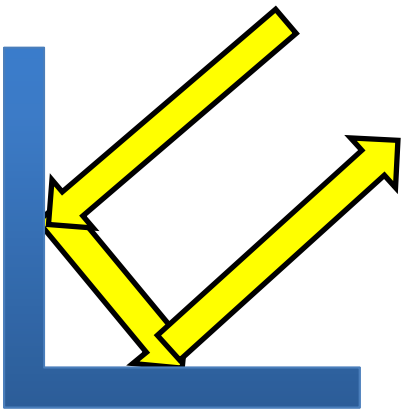
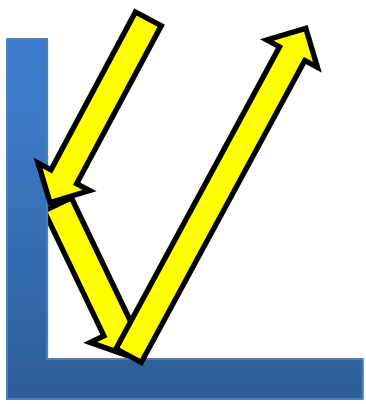
Stealth



Stealth



Stealth



Supersonic Transports



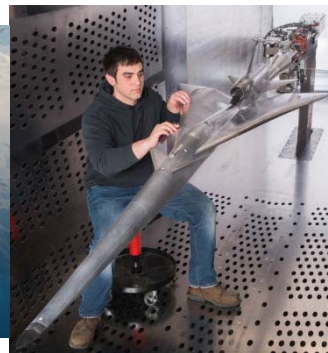
NASA/GULFSTREAM F-15 QUIET SPIKE



F-5 SHAPED BOOM DEMONSTRATOR



LOCKHEED
QueSST



AERION SBJ



BOOM / XB-1 "BABY BOOM"



Electric and Solar-Powered Airplanes

Elektrisch fliegen – mit Batterien von VARTA

Technische Daten MB-E1

- Spannung: 1200V
- Fluggewicht: 2020g
- Leistung: 120W
- Lebensdauer: 100h

Als Antriebssystem: **Roboterflugsteuerung, Steuerung mit RC-Modell**

Hersteller: **VARTA**, Motor: **Champion 17 28, 28 Ah mit Batterien**

Elektrisch fliegen – mit Batterien von VARTA

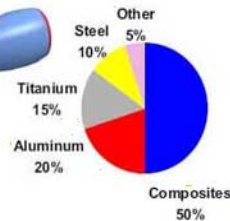
MB-E1 das 1. Flugzeug mit Elektroantrieb

Batterien – natürlich von VARTA



Composites

- Carbon laminate
- Carbon sandwich
- Fiberglass
- Aluminum
- Aluminum/steel/titanium pylons



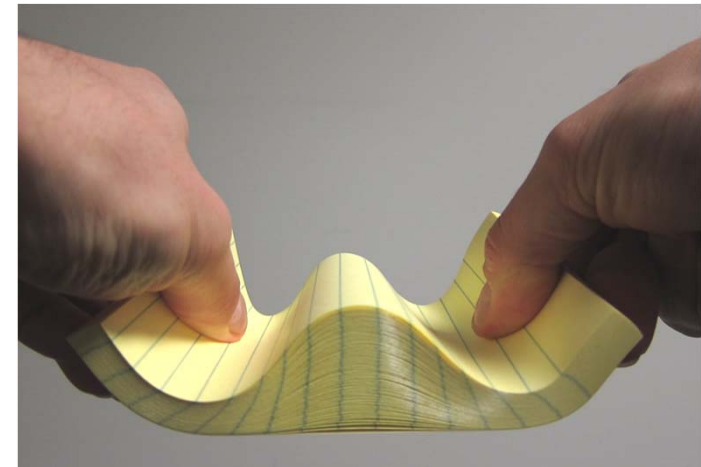
Pros:

- Lightweight
- Tailorable
- Less maintenance (probably)

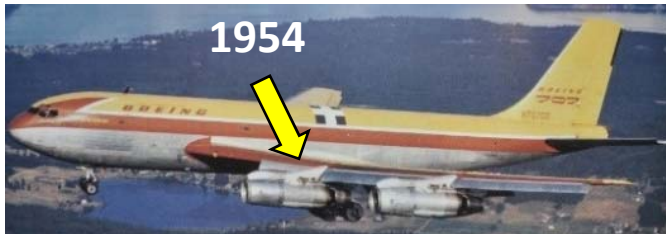
Disadvantages:

- Very **weak in through-thickness** dimension, gotta watch out for secondary loads!
- Poor performance at **high temperatures**
- **Cost**. Impractical until 2000s except in military.
- Impact-resistance and damage-visibility requirements, "**sacrificial outer layer**", hurts weight of thin skins (e.g. narrowbody fuselages)

Type of Failure	Loading
① Interlaminar Shear in a Skin	
② Fastener Pull-Through (Skin Laminate Failure)	
③ Interlaminar Tension in a Corner Radius	
④ Disbonding of Cocured/Bonded Spars, Ribs and Stiffeners	



Wider Engines



- Thrust Force = mV per second
- Power (energy) = $\frac{1}{2} mV^2$ per second
- So: More $m \rightarrow$ less V and less fuel

T-tails, High Wings, Tail-Mounted Engines



When to retire?



Flying cars



Airphibian



PlaneDriven



Aerocar



Terrafugia



Maverick



SkyRunner

Flying cars

