Composites-

Perspektiven in der Luft- und Raumfahrt

Jour Fixe 21. November 2022

Leibniz-Institut für Verbundwerkstoffe

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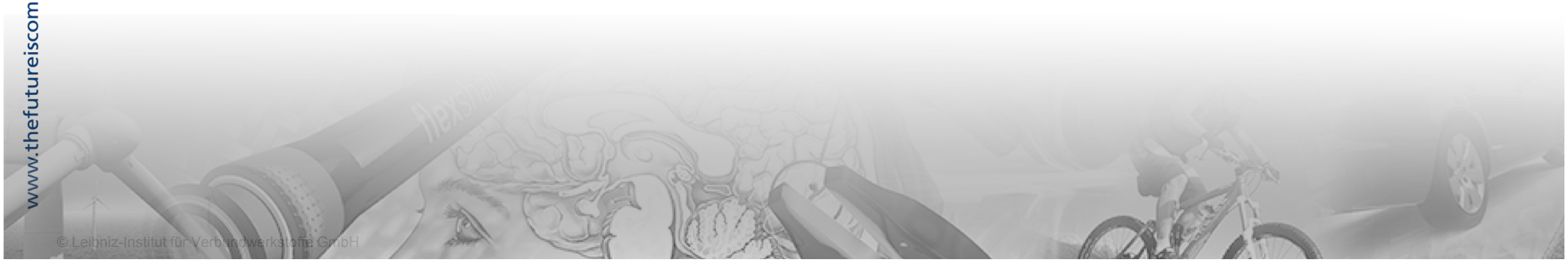

Aircraft Challenges

- Transport of people, luggage and freight
- Across large distances (400...16 000 km)
- Safe and fast (800..900 km/h)
- Cheap and ecological (European Green Deal 2050, “Zero Emission Aircraft” 2035)
- Worldwide traffic system

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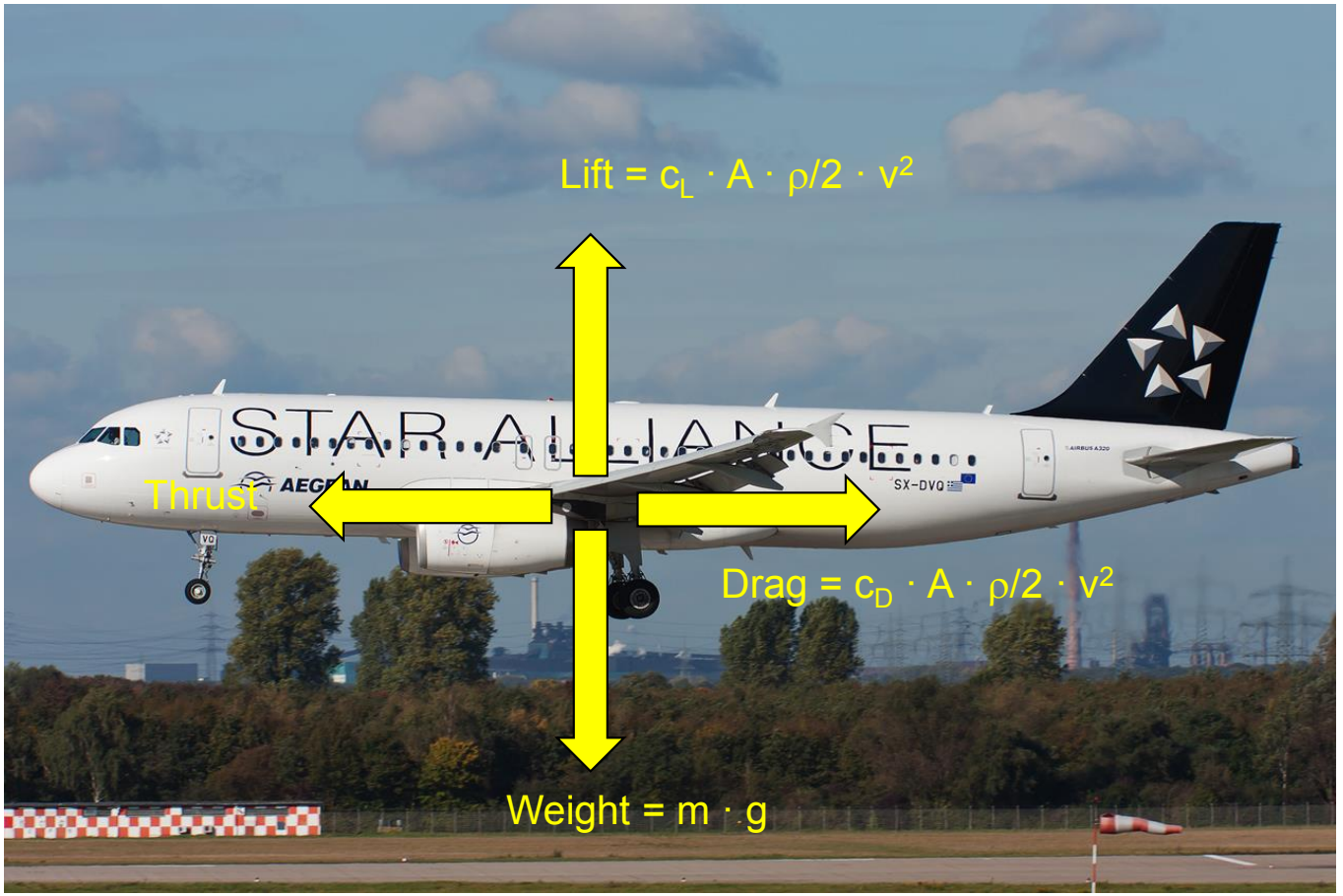
Lift, Drag, Weight and Cost



[Source of A320 image: aviation-pictures.net]

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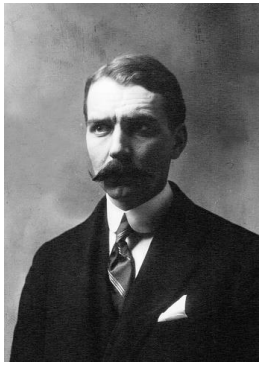
Aircraft Composite Technology
The Value of Low Weight



Louis Charles Breguet
1880-1955
[Image Source: Wikipedia]

$$R = \frac{v}{b_F \cdot g} \cdot \frac{c_L}{c_D} \cdot \ln \frac{m_0}{(m_0 - m_t)}$$

R	Range [m]
b_F	specific fuel burn [kg/N·s]
v	velocity (True Air Speed) [m/s]
c_L	coefficient of lift [1]
c_D	coefficient of drag [1]
m_0	mass of the aircraft at the beginning of the mission [kg]
m_t	mass of the fuel burnt during the mission [kg]
g	acceleration of earth [m/s^2]

$$m_t = m_0 \cdot \left(1 - e^{-\frac{R \cdot b_F \cdot c_D \cdot g}{v \cdot c_L}}\right)$$

$$m_t = m_0 \cdot 0.17$$

For Airbus A320:

R	= 5000 km = 5 ·10^6 m
b_F	= 1.6 10^-5 kg/N·s (Engine: CFM 56)
v	= 830 km/h = 230 m/s
c_L/c_D	= 18
g	= 9.81 m/s^2
DSG	*= design service goal, FH = flight hours*

→ - 1kg structural mass m_0 means – 0.17 kg (0.2 l) kerosene per 5000 km mission
→ 1 DSG = 60,000 FH → 10,000 missions (a 5000 km) → 2000 l kerosene saving

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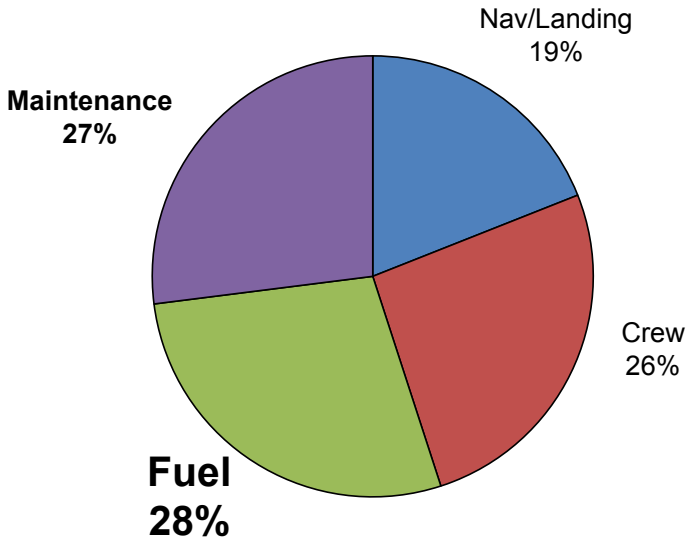
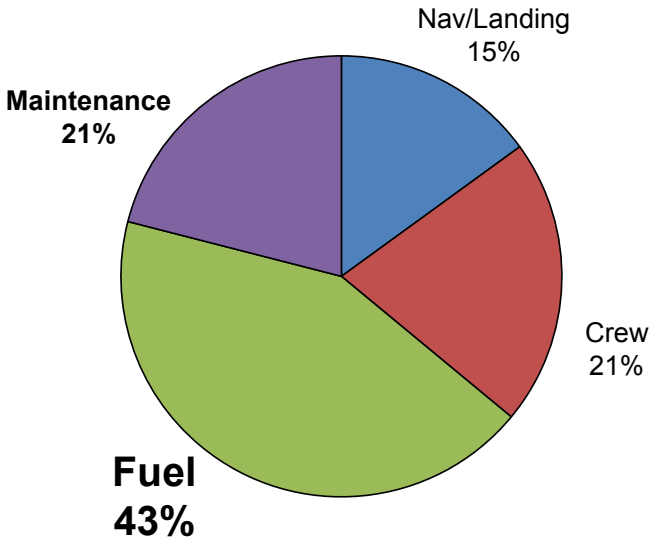
Aircraft Composite Technology
The Value of Composites

Operational Cost Breakdown (A320)

US$ 0.85/US Gallon



US$ 1.96/US Gallon



Structure is one of the most important contributors to operational aircraft cost

1 US Gallon = 3.785 l;
16 Oct 2015: US$ 1.45/gal (0.35 €/l);, Oct 2022 3,43 USD/gal
[Source: Flight Operations Support & Service, Airbus, Issue 2, 2008]

*2008: **100% = 3900 €/FH***
*[*US DOT Form 41 Airline Operational Cost Analysis Report *March 2010]*

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“Zero Emission”

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Thank you for your attention!

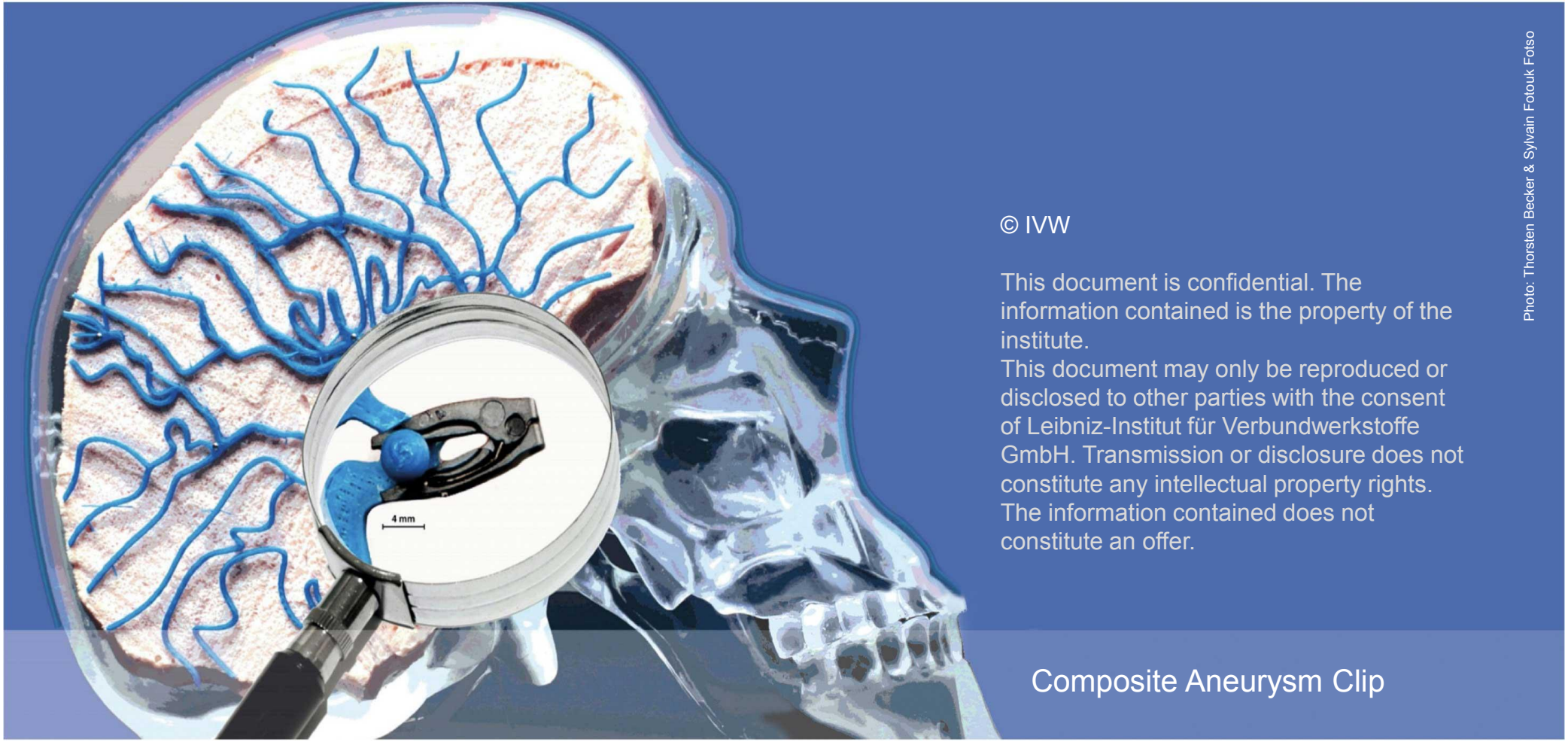

Photo: Thorsten Becker & Sylvain Fotouk Fotso

Composite Aneurysm Clip

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