

Introduction to Aeronautics

ARO 101 Sections 03 & 04

Sep 30, 2015 thru Dec 9, 2015

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Week #9 Lecture Material

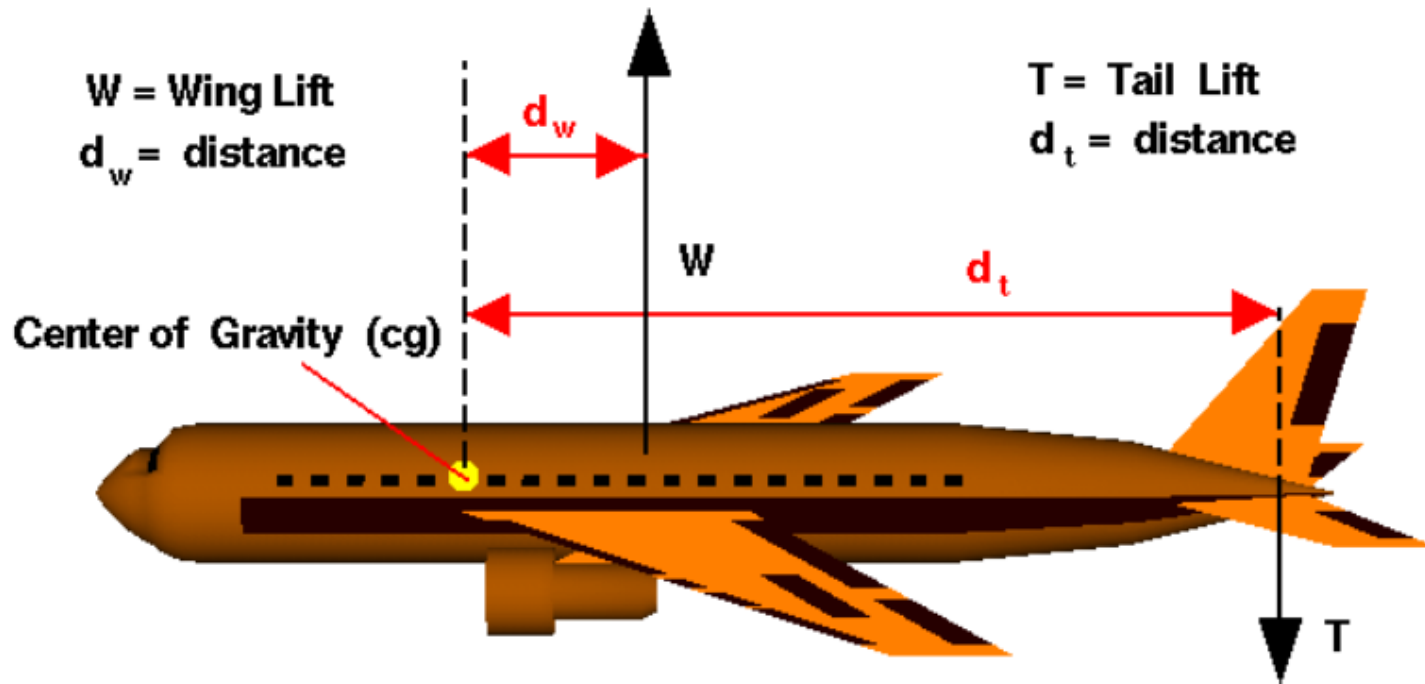
Topics For Week #9

- **Basic Aircraft Stability**– How do we describe the stability of an aircraft in flight with respect to Angle Of Attack (α) and Angle of Sideslip (β)?
 - ✓ **Static Longitudinal Stability**: *Relative location of center of gravity (cg) with respect to the aerodynamic center (ac). How does an aircraft respond to angle of attack upsets from a “trimmed” condition?*
 - ✓ **Static Directional Stability**: *Also known as “weather vane stability.” Nose points into a steady state crosswind due to the vertical tail.*
- **Flight Dynamics Angle Definitions**– Angles defined for vertical and lateral flight paths and how they relate to one another. Crosswind landing technique.
- **Primary Aircraft Structural Elements**– We identify the various structural members, and their proper names, used to form the structure of the wing and fuselage of a modern aircraft.
- **Flight Phases**– All fixed wing aircraft progress through the same flight phases. Let’s define them and examine what characterizes each phase of flight.
- **Air Transport Safety**– A plot that shows that as annual numbers of people flying continue to increase, total deaths associated with aircraft accidents decrease.

Flying In Trimmed Flight

Wing & Tail Forces Balanced to Achieve No Rotation About CG

“Hands-off flying” when aircraft is “in trim” should maintain altitude, heading, & speed.



For trimmed flight, no rotation about cg.

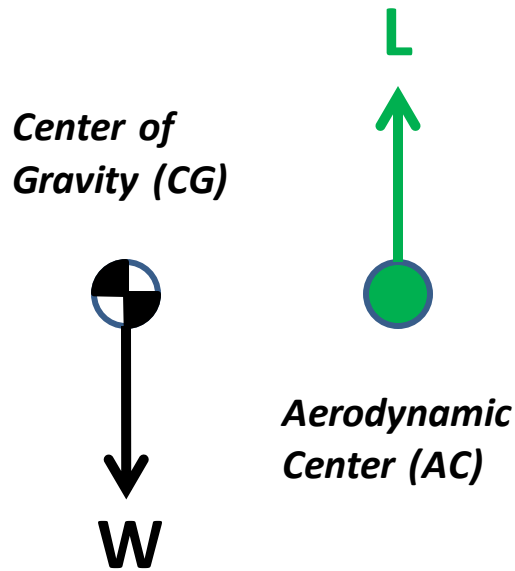
Equation: $(\overleftarrow{W} \times \overleftarrow{d_w}) + (\overleftarrow{T} \times \overleftarrow{d_t}) = 0$

(Lift of Wing x distance from cg) + (Lift of Tail x distance from cg) = 0

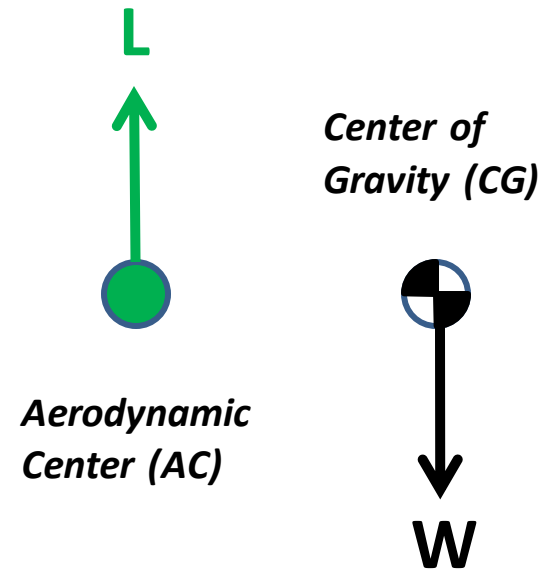
Static Longitudinal Stability

Tendency For Airplane To Return To Trimmed Flight When Disturbed

Why must an aircraft's CG be located in front of its AC?



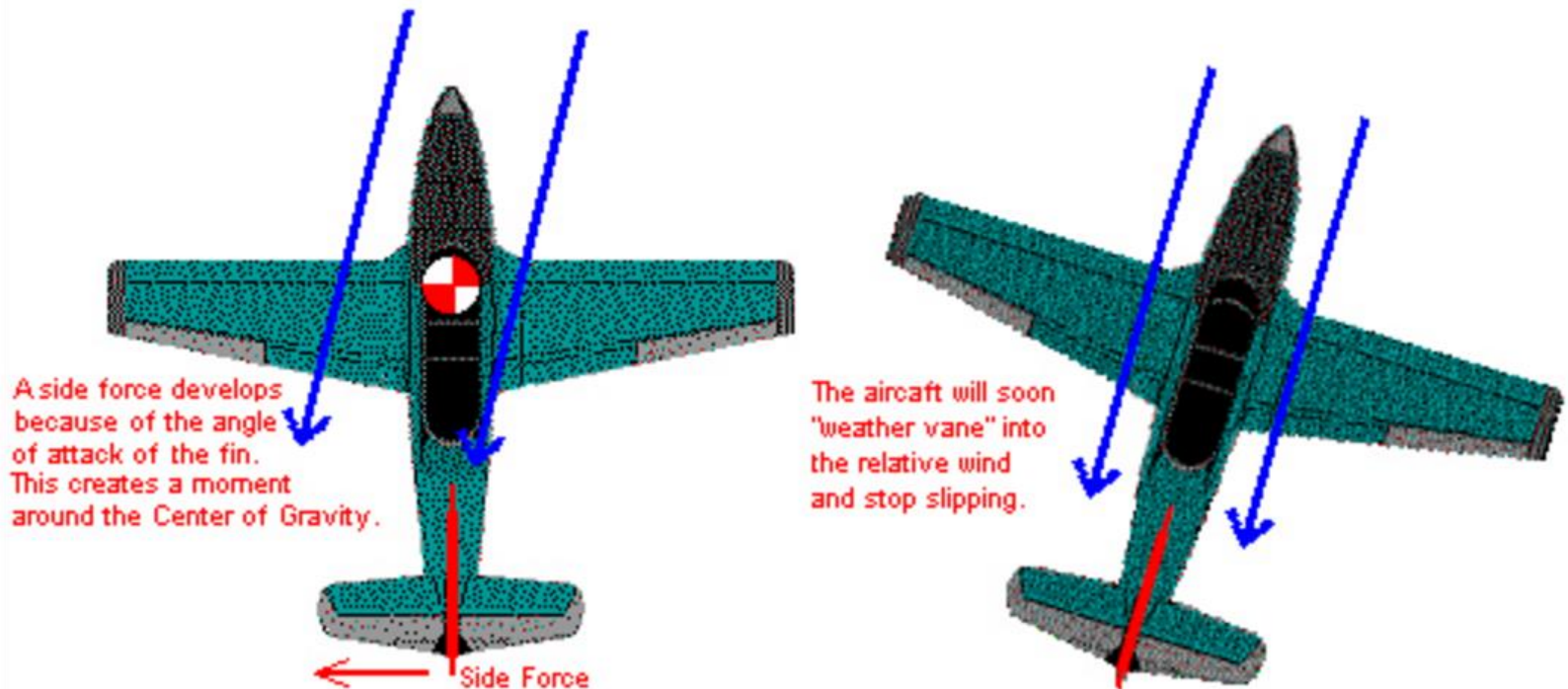
As angle of attack increases...
Lift will increase, but...
Weight vector pulls nose back down!
Airplane returns to trimmed flight!



As angle of attack increases...
Lift will increase, but...
Weight vector continues to pull tail down!
Airplane eventually flips over!

Static Directional Stability

Tendency For Airplane To Return To Zero Sideslip When Disturbed



Also Known As: “Weathervane Stability” because the same force/action occurs on a weathervane which is what causes it to point INTO the relative wind.

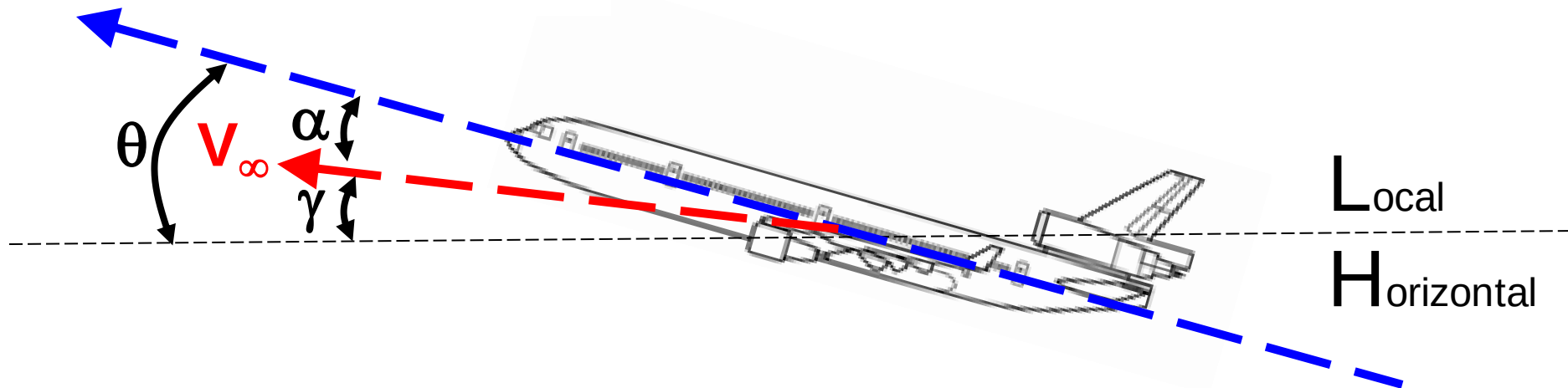
Vertical Flight Dynamics Angles

Pitch Angle, Flight Path Angle, & Angle Of Attack

α - Angle of Attack

θ - Pitch Angle

γ - Flight Path Angle

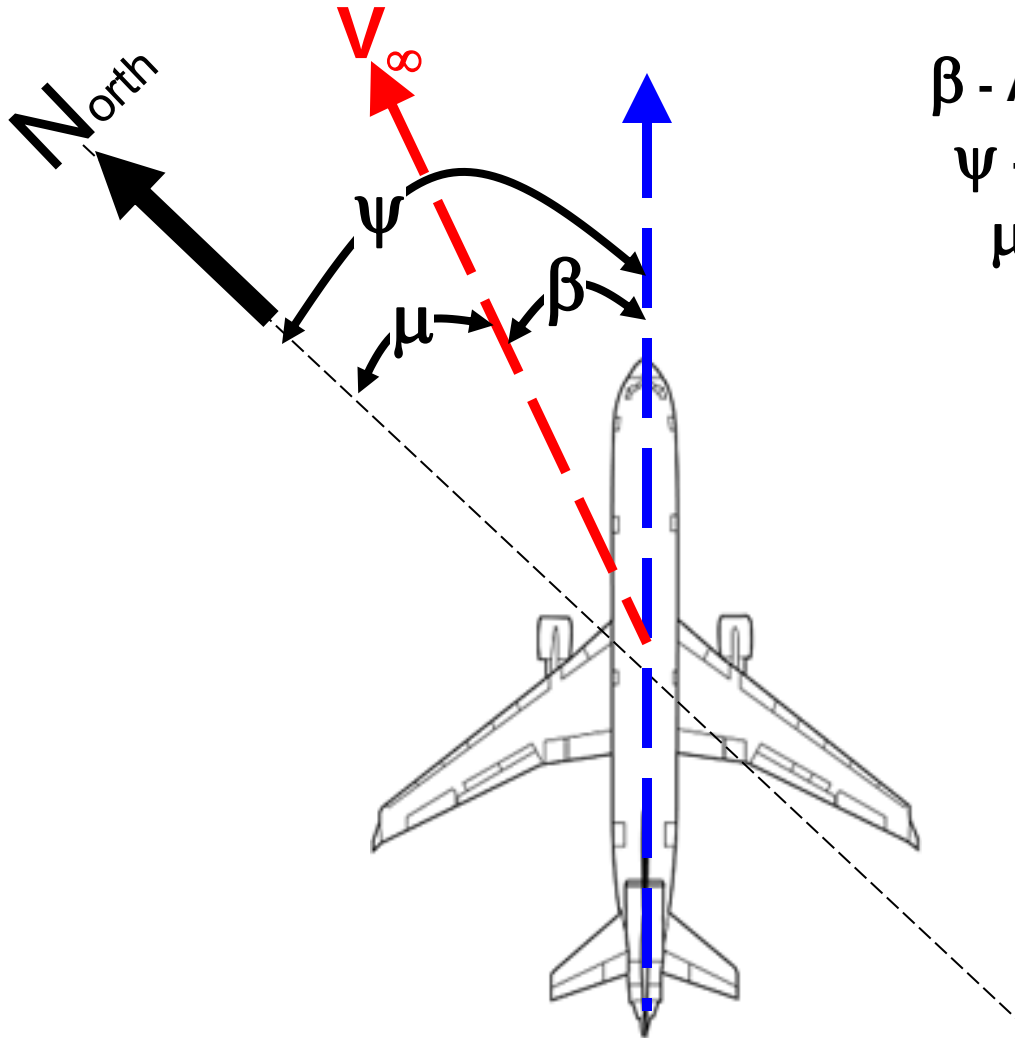


Therefore, we have another equation for determining AOA:

$$\alpha = \theta - \gamma$$

Lateral Flight Dynamics Angles

Heading Angle, Track Angle, & Angle Of Sideslip



β - Angle of Sideslip

ψ - Heading Angle

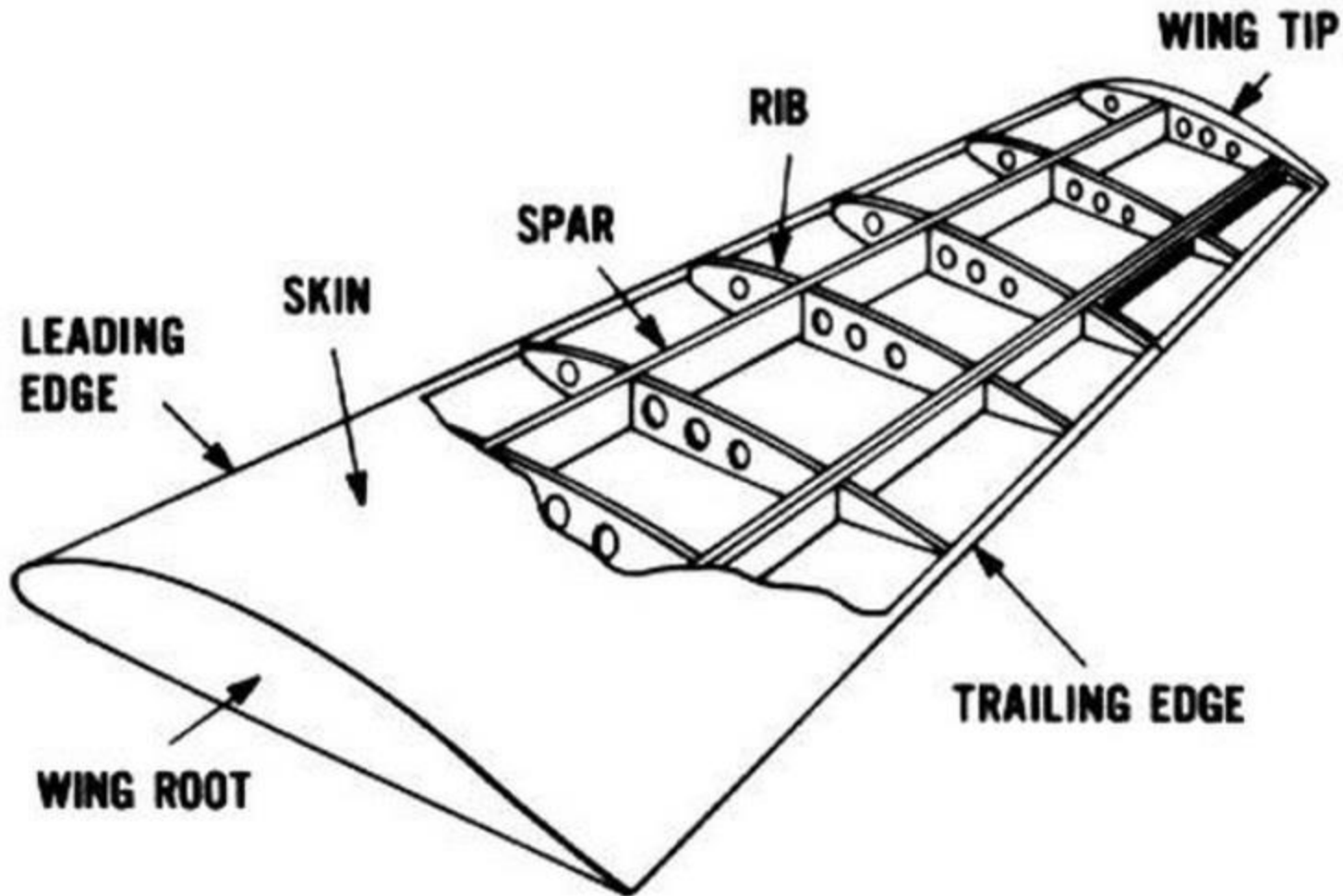
μ - Track Angle

Similar to Vertical Angles:

$$\beta = \psi - \mu$$

Primary Aircraft Structural Components

Elements Of The Wing Structure



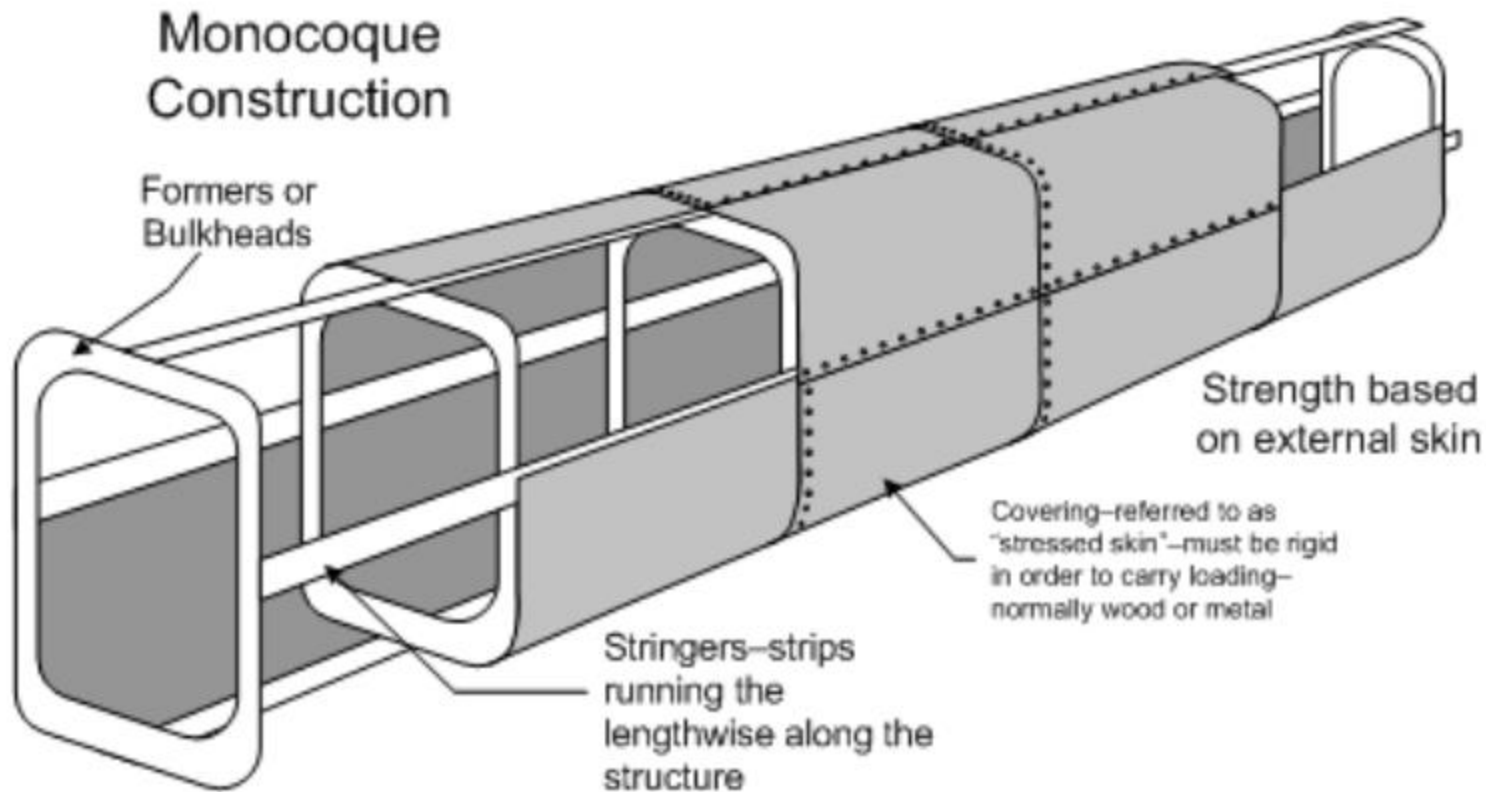
Primary Aircraft Structural Components

Elements Of The Fuselage Structure



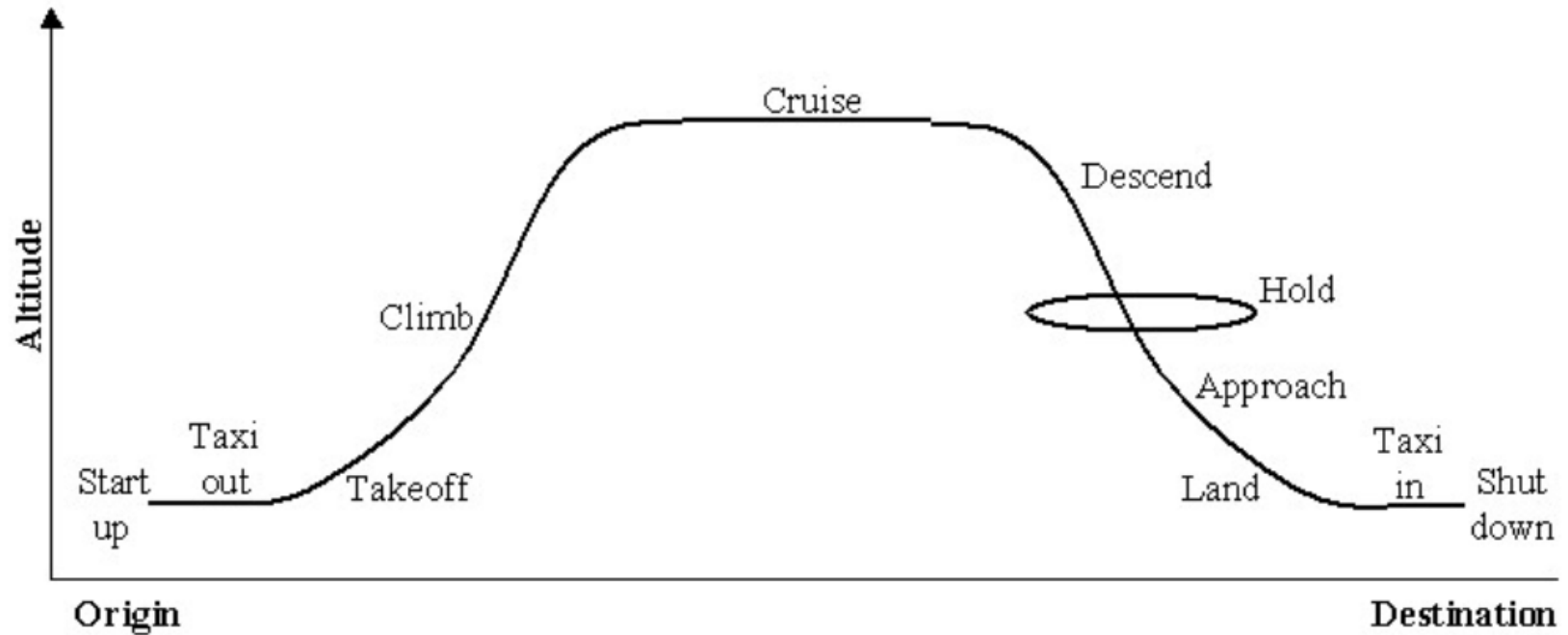
Primary Aircraft Structural Components

Elements Of The Fuselage Structure



Typical Aircraft Flight Phases

Heading Angle, Track Angle, & Angle Of Sideslip



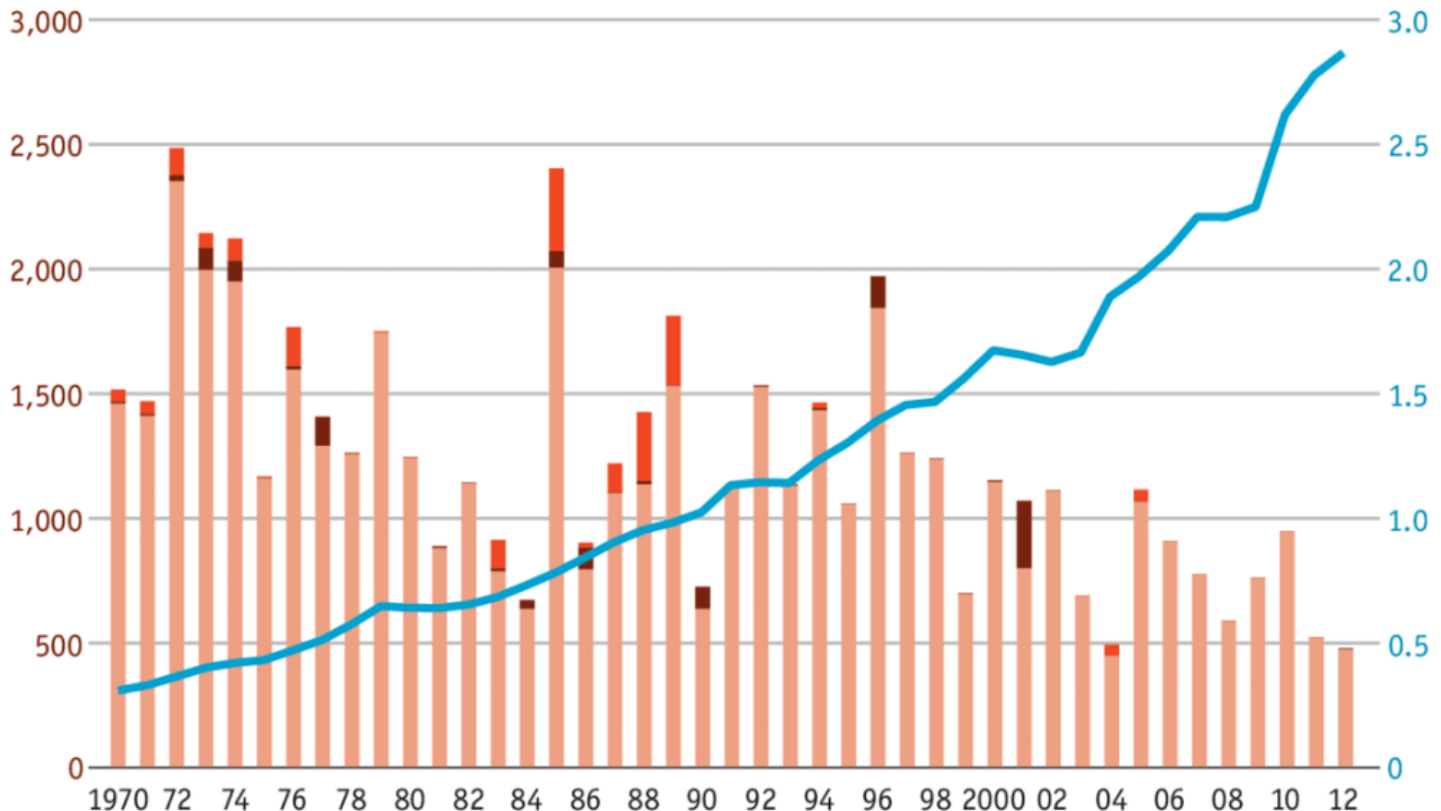
Flight Safety Statistics

Yes, It ***IS*** Safer To Fly Across Country Than To Drive Across Town!

Aircraft safety

Worldwide

Casualties* due to: ■ accident ■ hijacking ■ bombing — Aircraft passengers carried, bn



Sources: World Bank; Aviation Safety Network

*Excluding ground casualties