

Straight and Level

Aims

- to fly the aircraft directionally straight, laterally level, in balance, at a constant attitude and speed.
 - To understand the design/stability of our particular aircraft.
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Objectives

- Normal cruise, slow cruise (with and without flap) and fast cruise.
- The forces and stability in S&L flight.
- Describe how the aerofoil produces lift.
- State all the factors in the production of lift and drag.
- What happens to induced drag with increasing AoA.

Revision of Effects of Controls

- What are the three primary flight controls and their primary effects?
 - How do you counteract propellor slipstream when you increase power?
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Straight & Level Flight

The Four Forces

- Lift, Weight, Thrust, Drag
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Forces During Straight & Level

- During straight and level flight, the aircraft is said to be in “equilibrium.”
 - Therefore, lift equals weight and thrust equals drag.
 - If any of these weren’t true, we wouldn’t be in straight and level flight. (We’d either be climbing/descending or accelerating/decelerating).
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The Lift Formula

- $Lift = C_l * \frac{1}{2} * \rho * v^2 * s$
 - C_l ~ wing shape and angle of attack
 - $\frac{1}{2} * \rho$ ~ air density
 - v ~ speed
 - s ~ wing surface area
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Practical Application of the Lift Formula

- As pilots, we generally only control Angle of Attack and Airspeed.
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Aircraft Stability

- Aircraft stability is classified as static and dynamic.
 - Positive static stability;
 - Neutral static stability;
 - Negative static stability;
 - Positive dynamic stability;
 - Neutral dynamic stability;
 - Negative dynamic stability
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Longitudinal Stability

- Distance from CP to tailplane is greater than from CP to mainplane – hence, greater reaction.
- As the mainplane and tailplane are attached to the fuselage at different angles of incidence i.e. due to a vertical wind gust, that increases AoA on the mainplane by 2 degrees, the AoA on the tailplane will increase by 50% and the tailplane by 100%.

Directional Stability

Lateral Stability

Upper keel surfaces tend to roll the aircraft level, as well as lower CG i.e. pendulum

Dihedral (low AoB) tends to roll wings level

Drag

- Drag is the rearward force, parallel and in the same direction as the relative airflow.
 - Total drag
 - induced
 - parasitic
 - * skin friction
 - * form
 - * interference
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Induced Drag

- Induced drag is a function of angle of attack.
 - As the AoA decreases and airspeed increases, induced drag decreases.
 - As airspeed decreases and AoA increases, induced drag increases.
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Parasite Drag

- Parasite drag comprises of
 - Form drag
 - Skin friction
 - Interference drag
 - It increases with the square of velocity i.e. 50 knots equals 100kg of drag, while 100 knots equals 400kg of drag!
 - Perhaps why the biplanes of yesteryear only cruised at 50 knots.
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Total Drag

- Combination of:
 - Induced drag;
 - Parasite drag;
 - Total drag (combination of Induced & Parasite).
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Establishing Straight & Level

- Power + Attitude = Performance!
 - Power: As required for flight phase.
 - Attitude: To maintain altitude.
 - Speed: Allow the aircraft to stabilise.
 - Trim: Trim the aircraft to relieve control pressure.
 - P.A.S.T is the Method to attain $P + A = P$.
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Maintaining Straight & Level

- Lookout
 - Lookout for any aircraft
 - Attitude
 - Ensure the selected attitude is maintained with reference to the horizon.
 - Instruments
 - Adjust the nose attitude by external reference. Do not set the attitude by the instruments.
 - Instrument scan: heading/landmark, balance indicator, altimeter, VSI.
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Airmanship/TEM/HF

- Threat: Traffic
 - Error: Failure to identify and take effective action to avoid conflicts
 - Management: Effective situational awareness, lookout, communication and evasive actions
 - Mitigation: SA! Scanning outside for traffic
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IMSAFE

- Pilot Fitness Checklist
 - Illness
 - Medication
 - Stress
 - Alcohol
 - Fatigue
 - Emotion
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Quiz to Objectives

- The forces in S&L flight
- Slow cruise, normal cruise, and fast cruise
- Types of stability

- Power + Attitude = Performance
- What happens to induced drag with increasing AoA