2025-05-26 - Performance Lecture 2

> Date & Time: 2025-05-26 17:35:10
> Location: [Insert Location]
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> `Aircraft Performance` `Flight Principles` `Aerodynamics`

Theme

Takeaways

1. Cruise flight sequence: Reach altitude, accelerate, set power, maintain level flight, trim.
2. Fundamental aircraft performance principle: “Power plus attitude equals performance.”
3. Re-trimming is necessary after changes in power, airspeed, or flap settings.
4. Power Available (Thrust x Airspeed) curve shape: Memorize (mnemonic: looks like Spotify logo).
5. Power Required (Drag x Airspeed) curve shape: Memorize (mnemonic: looks like Nike logo).
6. Trim drag results from control surface deflection for trim, especially the elevator.
7. Forward CG increases trim drag; aft CG (within limits) decreases trim drag.
8. Aircraft must never be operated outside certified Center of Gravity (CG) limits.
9. Maneuvering flight: In turns, increase power and pitch up to maintain altitude.
10. Rate of turn increases with airspeed; turn radius also increases with airspeed.

Highlights

- `"Power plus attitude equals performance."-- [Speaker 1] 《Lecture on Group Performance》`
- `"The mass doesn't affect the gliding range."-- [Speaker 1]`
- `"Weight affects glide airspeed, but not lift to deck ratio and so glide range is unchanged."-- [Speaker 1]`
- `"VMP is less than VMD."-- [Speaker 1]`
- `"Power plus attitude equals performance."-- Speaker 1`

- `"Whenever you don't have any power, your attitude is now your performance."-- Speaker 1`
- `"Attitude for airspeed, power for height."-- Speaker 1`
- `"Attempting to stretch a glide by pitching the aircraft nose up and so reducing airspeed below the best glide range speed is a classic aerodynamic trap."-- Speaker 1`
- `"The key to successful landings on a short runway is practice and courtesy."-- Speaker 1`

Chapters & Topics

Principles of Cruising Flight

> The operational sequence and objectives for an aircraft transitioning to and maintaining cruise flight, emphasizing stability and efficiency.

- **Keypoints**
  - Primary goals: Accelerate to cruise speed and maintain cruise altitude.
  - Sequence: Reach altitude -> Accelerate to speed -> Adjust power -> Maintain level flight -> Trim.
  - Cruising speed example: ~90 knots for a “cruiser” type aircraft.
  - Trimming is essential for maintaining a constant attitude.
  - Related theory: “Power plus attitude equals performance.”
- **Explanation**
  Upon reaching the designated cruise altitude, the primary objectives are to accelerate to the planned cruising speed and then sustain both this speed and altitude. The typical sequence involves: 1. Attaining the cruise altitude. 2. Accelerating the aircraft to its cruising airspeed (e.g., approximately 90 knots for a cruiser aircraft type). 3. Adjusting the engine power to the appropriate setting for cruise. 4. Maintaining level flight, ensuring no unintended climb, descent, or turns. 5. Trimming the aircraft to achieve a stable attitude, which allows it to maintain its flight path with minimal control inputs. A core concept underpinning this is “Power plus attitude equals performance.”
- **Examples**
  > After climbing to the desired altitude, the pilot accelerates the aircraft to approximately 90 knots. Power is then adjusted to maintain this speed in level flight, and the aircraft is trimmed for hands-off stability.

  - Reach altitude
  - Accelerate to 90 knots
  - Adjust power setting

    - Maintain level flight
    - Trim the aircraft

Trim Drag and its Relation to Center of Gravity (CG)

> Trim drag is an aerodynamic penalty incurred from using trim surfaces to maintain aircraft attitude. Its magnitude is significantly influenced by the aircraft's center of gravity position.

- **Keypoints**
    - Trim drag is caused by deflecting trim surfaces to counteract inherent pitching moments.
    - A forward CG position leads to a larger pitch-down moment, requiring more trim input and thus increasing trim drag.
    - An aft CG position (within limits) reduces the required trim input and decreases trim drag.
    - Reducing trim drag can lead to slight performance gains (e.g., "a couple of knots to cruising speed or fuel miles to range").
    - Operating outside CG limits is prohibited and unsafe.
    - The effect of trim drag is most marked with a forward CG because the trim tab has to be deflected more, creating more drag.
    - Moving the CG rearwards (within limits) reduces trim drag and improves overall lift, potentially adding to cruising speed or range miles.
    - As CG moves forward, the amount of downward force required from the horizontal tailplane increases because the moment arm from the CG to the tail is larger, requiring more force to counteract the nose-down tendency.
    - As CG moves aft, the horizontal tail download decreases because the mass concentration is closer to the tail, requiring less corrective force from the tail surfaces as the CG itself contributes to stability or reduced instability depending on its exact position within limits relative to the neutral point and center of lift.
- **Explanation**
  Aircraft often exhibit a natural pitching tendency at cruise speed (commonly a pitch-down moment). This is counteracted by the horizontal stabilizer and elevator, often using a trim tab, which generates a "down load" on the tail. This corrective force, while necessary for stability, causes drag, termed "trim drag." The position of the CG is critical: A forward CG increases the aircraft's natural pitch-down tendency. This necessitates a larger downward force from the tail, meaning greater elevator/trim tab deflection, which in turn increases trim drag. Conversely, an aft CG (within limits) reduces the natural pitch-down tendency. This means the tail surfaces work less, requiring smaller trim deflections and thus reducing trim drag. This reduction in drag can slightly improve cruise speed or range. However, it is paramount that the aircraft is always operated within its certified CG limits.

- **Examples**
  > An aircraft loaded with its Center of Gravity near the forward limit will require more elevator trim (or a larger down load from the horizontal stabilizer) to maintain level flight. This results in a higher trim drag penalty compared to an aircraft loaded with a mid-CG position.

  - Forward CG creates a larger natural pitch-down moment.
  - The elevator/trim tab must be deflected more to create a sufficient down load on the tail to counteract this moment.
  - Increased deflection of the control surface into the airflow results in increased aerodynamic drag, specifically trim drag.
  - This increased drag means more engine power is required to maintain a given airspeed, or airspeed will be lower for a given power setting, potentially reducing range and endurance.

  > An aircraft loaded with its Center of Gravity towards the aft limit (but still within safe, prescribed limits) will generally require less elevator trim (or a smaller down load from the horizontal stabilizer) to maintain level flight. This results in lower trim drag.

  - An aft CG reduces the aircraft's natural pitch-down moment, or may even create a slight pitch-up tendency that requires less correction.
  - The elevator/trim tab requires less deflection to achieve the desired attitude.
  - Reduced deflection of the control surface into the airflow results in decreased trim drag.
  - This reduction in drag can lead to slightly improved cruise speed or fuel efficiency, thereby increasing range or endurance for a given amount of fuel.
- **Considerations**
- An aircraft must never be flown with the CG outside the prescribed limits.
- Understanding CG effect on trim drag is crucial for flight planning and aircraft loading to optimize performance and ensure stability.
- While an aft CG reduces trim drag, an excessively aft CG can lead to instability, making it equally dangerous as an excessively forward CG which can lead to issues with controllability, especially during landing flare or stall recovery.
- **Special Circumstances**
- If encountering a flight with a CG at the forward limit, how should it be addressed? The pilot should anticipate higher fuel consumption due to increased trim drag and potentially more physical effort to control pitch or heavier control forces, depending on the aircraft design. Ensure aircraft is within all performance limitations for take-off, climb, and landing with that CG.
- If encountering a flight with a CG at the aft limit (still within prescribed limits), how should it be addressed? The pilot might notice lighter control forces and potentially slightly better performance. However, they must be vigilant as the aircraft might be

less stable longitudinally. Ensure aircraft is within all performance limitations for take-off, climb, and landing with that CG.

Determining Maximum Range/Endurance Airspeeds & Understanding Power Curves

> Methods for identifying critical airspeeds for aircraft performance (maximum range and endurance) using the power required curve, and understanding the characteristics of power available and power required curves.

- **Keypoints**
  - Power Available Curve: Represents engine's max power output vs. airspeed (mnemonic: "Spotify logo"); calculated as Thrust × Airspeed.
  - Power Required Curve: Represents power needed for level flight vs. airspeed (mnemonic: "Nike logo"); calculated as Drag × Airspeed.
  - Maximum Range Airspeed: For greatest distance. Found by tangent from origin to power required curve. Occurs near best L/D ratio and is typically faster than Vmd. Also best glide speed.
  - Maximum Endurance Airspeed: For longest time airborne. Found at the minimum point of the power required curve. Corresponds to minimum power required and Vmd. Approximately 75% of best range airspeed.
  - Memorizing the shapes of these curves is important for theoretical understanding.
  - The best range airspeed is where a tangential line from the origin meets the power required curve.
  - The best endurance airspeed is at the minimum point of the power required curve, representing minimum drag (VMD).
- **Explanation**
  Understanding aircraft power curves is essential for optimizing flight performance. The **Power Available Curve**shows the maximum power an engine can produce at different airspeeds; its shape is often remembered by the mnemonic of a "Spotify logo." Mathematically, Power Available = Thrust × Airspeed. The **Power Required Curve**illustrates the power an aircraft needs to maintain level flight across various airspeeds; its shape is often likened to a "Nike logo." Mathematically, Power Required = Drag × Airspeed.

Two key performance airspeeds are derived from the power required curve:

1. **Maximum Range Airspeed**: This is the speed at which the aircraft can cover the greatest horizontal distance for a given amount of fuel. It occurs at an angle of attack very close to that which provides the best lift-to-drag ratio. Graphically, it is found by drawing a tangent line from the origin (0,0) of the power required graph to the curve. The airspeed at this point of tangency is the best range airspeed. This speed is

typically slightly faster than the minimum drag speed (Vmd) and is also the aircraft's best glide speed in an engine-out scenario.

2. **Maximum Endurance Airspeed**: This is the speed at which the aircraft can remain airborne for the longest possible duration on a given amount of fuel. It is found at the lowest point of the power required curve. This speed corresponds to the minimum power required to maintain level flight and also occurs at the minimum drag speed (Vmd). The lecture mentions that this speed is approximately 75% of the airspeed that gives the best lift-to-drag ratio (i.e., the best range speed).

- **Examples**

  > On a graph plotting power required (Y-axis) versus airspeed (X-axis), a straight line is drawn from the origin (0,0) such that it touches the power required curve at only one point (i.e., it is tangent to the curve). The airspeed value on the X-axis corresponding to this point of tangency is the best range airspeed.

  - Plot the power required curve (often resembling a "Nike logo").
  - Draw a straight line from the graph's origin (0 power, 0 airspeed).
  - Adjust the angle of this line until it just touches the power required curve at a single point.
  - Read the airspeed value directly below this tangent point on the X-axis. This is V_R (best range airspeed).

  > On a graph plotting power required (Y-axis) versus airspeed (X-axis), identify the lowest point of the power required curve. The airspeed value on the X-axis corresponding to this minimum point is the best endurance airspeed.

  - Plot the power required curve.
  - Visually locate the absolute lowest point (minimum value) on this curve.
  - Read the airspeed value directly below this minimum point on the X-axis. This is V_E (best endurance airspeed), which also corresponds to Vmd (minimum drag speed).

  > The lecture mentions that the best endurance airspeed for a specific type of aircraft referred to as a "cruiser" is 61 knots.

  - This is a practical example of a specific V_E value for a given aircraft type, which would typically be found in its Pilot Operating Handbook (POH).
- **Considerations**
- "For us, we just need to know how the maximum power available looks like, the curve. We don't need to know how and why does it look like. Just, we need to memorize the shape."
- "So we just need to remember how they [power required curves] look like."
- "Where the tangential line meets the power required curve, the airspeed for maximum range is found. And this is what we need to remember."

- Understanding these speeds is crucial for efficient flight planning and handling emergency situations like engine failure.
- The relationship (75%) between best endurance and best range speed is an approximation and can vary between aircraft types. Pilots should refer to the specific aircraft's POH/AFM for precise values.
- **Special Circumstances**
- If encountering an engine failure, how should the best range airspeed be utilized? The pilot should establish and maintain the best range airspeed (best glide speed) to maximize the horizontal distance the aircraft can travel without engine power, thereby increasing the chances of reaching a suitable landing area.
- If needing to hold over a specific point or remain airborne for the maximum possible time (e.g., waiting for weather to clear at destination, or in a search and rescue scenario), how should the best endurance airspeed be utilized? The pilot should fly at the best endurance airspeed to minimize fuel consumption per unit of time, thus extending the aircraft's airborne time.
- If the power required curve is not available, how can a pilot approximate these speeds? Pilots often have rule-of-thumb speeds or POH-specified speeds for best glide (approximating best range) and minimum power/drag conditions (approximating best endurance).

Aircraft Performance Calculation Using Tables

> The process of determining key aircraft performance parameters such as brake horsepower, true airspeed, and fuel flow by referencing performance charts or tables. These calculations are based on given conditions like pressure altitude, air temperature, and engine RPM.

- **Keypoints**
  - Identify the correct performance table based on current conditions (e.g., RPM, temperature relative to standard).
  - Understand how to read and apply values for pressure altitude and temperature, including standard temperature and deviations from standard (e.g., ISA+10°C, 20 degrees below standard).
  - Use interpolation techniques when exact conditions are not directly listed in the tables.
  - Key parameters typically found include Brake Horsepower (BHP), True Airspeed (TAS), and Fuel Flow (e.g., Gallons Per Hour - GPH).
- **Examples**
  > An aircraft is cruising at 3,000 feet pressure altitude, standard temperature, with 2,400 RPM set.

  - Locate the performance chart section for 3,000 feet and standard temperature conditions.

- Within that section, find the data corresponding to 2,400 RPM.
- Read off the values for Brake Horsepower (stated as 63% in the example, which was a key to the answer), True Airspeed, and Fuel Flow in gallons per hour.

> Given: Flight Level 75 (7,500 feet pressure altitude), outside air temperature (OAT) of +10°C, lean mixture, and 2300 RPM. Determine gallons per hour (GPH) and true airspeed (TAS).

- Calculate ISA temperature at FL75: Standard temperature at sea level is 15°C. Lapse rate is approx. 2°C per 1,000 feet. So, ISA at 7,500 ft = 15 - (7.5 * 2) = 0°C. The OAT is +10°C, meaning it's ISA+10°C.
- Select the performance table for 2300 RPM and lean mixture.
- Since 7,500 feet is not explicitly listed, interpolation between figures for 6,000 feet and 8,000 feet (at ISA+10°C or by applying temperature correction) is necessary.
- The lecture interpolated for 7,000 feet first (as an intermediate step, values mentioned: 11.95 GPH and 159.5 knots TAS by averaging 6,000ft and 8,000ft data for standard temp).
- The final closest answer for 7,500 feet at +10°C OAT was stated as 11.6 GPH and 160 knots TAS.

> An aircraft is at 4,000 feet, temperature is 20 degrees Celsius below standard, and RPM is 2,300.

- Use the performance chart for 2,300 RPM.
- Find the column or section that corresponds to '20 degrees below standard' temperature.
- Locate the row for 4,000 feet.
- Read the values: Brake Horsepower (59%), True Airspeed (106 knots / 122 mph), and Fuel Consumption (6.7 GPH).

Lift-to-Drag Ratio (L/D) and Gliding Performance

> The lift-to-drag ratio (L/D) is a fundamental measure of an aircraft's aerodynamic efficiency, representing the amount of lift generated relative to its drag. It is crucial for determining gliding performance.

- **Keypoints**
  - L/D Ratio is calculated as Coefficient of Lift (CL) divided by Coefficient of Drag (CD).
  - An aircraft's wing is most efficient when its L/D ratio is at its maximum.
  - Maximum L/D ratio corresponds to the best glide speed for range (VMD).
  - An L/D ratio of 'X' (e.g., 10) implies the aircraft generates X units of lift for each unit of drag, or can travel X units horizontally for each unit of altitude lost during

a glide (e.g., 10 feet forward for 1 foot down).
    - Flying at VMD (Minimum Drag Speed) provides the best L/D ratio, resulting in the shallowest glide angle and the maximum gliding range.
    - Flying at VMP (Minimum Power Speed) results in the slowest rate of descent, maximizing glide endurance (time in the air).
    - A key relationship is VMP < VMD (VMP is slower than VMD).
- **Explanation**
  The gliding efficiency of an aircraft is based on its aerodynamic efficiency, in particular, a figure known as lift to drag ratio. This is found by dividing the coefficient of lift by the coefficient of drag at each angle of attack. The wing is going to be most efficient when the lift to drag ratio is going to be at its maximum. When flying at the maximum range speed (which corresponds to the best lift-to-drag ratio), the aircraft will have the shallowest glide angle, and thus the maximum glide range.
- **Examples**
  > An aircraft has a lift-to-drag ratio of 10:1.

    - This means that at the specific angle of attack yielding this L/D ratio, the aircraft's wings produce 10 units of lift for every 1 unit of aerodynamic drag.
    - In a glide, this aircraft can travel 10 units of horizontal distance for every 1 unit of altitude lost. For example, if gliding from 1,000 feet above ground level (AGL) in still air, it could cover 10,000 feet of horizontal distance.

Effect of Wind on Gliding Performance

> Wind has a significant impact on an aircraft's glide path over the ground and its achievable gliding range, even though the aircraft's aerodynamic performance (airspeed and rate of descent for a given L/D ratio) through the air mass remains constant.

- **Keypoints**
    - Tailwind: A tailwind decreases the glide angle relative to the ground (makes it shallower) and increases the gliding distance over the ground. The aircraft covers more ground for the same amount of altitude lost.
    - Headwind: A headwind increases the glide angle relative to the ground (makes it steeper) and decreases the gliding distance over the ground. The aircraft covers less ground for the same amount of altitude lost.
    - The aircraft's rate of descent (e.g., in feet per minute) and true airspeed through the air mass are not directly changed by horizontal wind.
    - If two identical aircraft start gliding from the same altitude at their best glide airspeed, one into a headwind and one with a tailwind, they will theoretically reach the ground at the same time, but at different points on the ground.

    - While slight speed adjustments (faster into a headwind, slower with a tailwind) can theoretically optimize ground range, Standard Operating Procedures (SOPs) often recommend maintaining a single best glide speed.
- **Explanation**
  A tailwind makes the gliding angle more shallow, increasing gliding range. A headwind makes the glide angle steeper, reducing gliding range. Even though in both of these cases the aircraft will have the same rate of descent, and the aircraft is still going to achieve the ground at the same time (assuming they maintain the same airspeed and L/D through the air). But the only thing is going to change is the distance covered over the ground.
- **Examples**
  > A general aviation aircraft has a still-air glide range of 3 nautical miles from an altitude of 2,000 feet.

    - When gliding into a 20-knot headwind, its glide range over the ground is reduced to approximately 2.25 nautical miles.
    - When gliding with a 20-knot tailwind, its glide range over the ground is increased to approximately 3.75 nautical miles.

Effect of Aircraft Mass on Gliding Performance

> Aircraft mass does not affect the maximum gliding range or the best lift-to-drag (L/D) ratio an aircraft can achieve. However, mass does influence the airspeed at which this optimal L/D ratio and consequent maximum glide range are attained.

- **Keypoints**
    - Maximum gliding range is determined by the aircraft’s best L/D ratio, which is a function of its aerodynamic design and angle of attack, not its mass.
    - A heavier aircraft must fly at a higher indicated airspeed to achieve the same angle of attack (and thus the same L/D ratio) as a lighter aircraft of the same design.
    - Since both a lighter and a heavier version of the same aircraft can achieve the same maximum L/D ratio, their maximum potential gliding range from a given altitude will be the same.
    - The heavier aircraft will achieve this range at a higher true airspeed.
    - Pilot’s Operating Handbooks (POHs) typically quote glide airspeeds for the aircraft at its maximum certified mass.
- **Explanation**
  The aircraft mass, surprisingly, does not affect gliding range. The lift-to-drag ratio is achieved at a specific angle of attack. Provided that the pilot flies at that angle of attack, the aircraft will fly just as far whether it weighs 1,000 kilograms or 10,000 kilograms. The mass doesn’t affect the gliding range. What does change is the glide airspeed. The heavier aircraft will have a higher airspeed at a given angle of attack

than the lighter one. Weight affects glide airspeed, but not the lift-to-drag ratio, and so the glide range is unchanged. However, the heavier aircraft must fly faster to attain the same lift-to-drag ratio.

- **Considerations**
- Pilots must fly at the correct (higher) airspeed in a heavier aircraft to achieve the best L/D ratio and maximum glide range.
- **Special Circumstances**
- If a modern airliner (hundreds of tons) can glide further than an average glider from the same altitude, how is this reconciled with mass not affecting range? This is because the airliner possesses greater aerodynamic efficiency, meaning it has a higher maximum L/D ratio by design, compared to the glider. It achieves this superior L/D ratio and longer range while flying at a much higher airspeed.

Effect of Flaps on Gliding Performance

> Flaps generally decrease gliding performance. While they increase lift, they disproportionately increase drag, which worsens the lift-drag ratio critical for gliding.

- **Keypoints**
    - Most aircraft achieve the best gliding performance with a clean wing (no flaps).
    - Flaps worsen the lift-drag ratio.
    - Flaps reduce the maximum glide range.
    - Flaps steepen the glide angle.
    - Lowering flaps increases lift but at the expense of a greater increase in drag.
- **Explanation**
  Lowering flaps increases both lift and drag. However, for gliding, the increase in drag is typically more detrimental than the benefit from increased lift, leading to a reduced glide range and a steeper glide angle. The best glide performance is usually achieved with a 'clean wing' (no flaps). Flaps are useful in specific landing scenarios to steepen the approach without increasing airspeed.
- **Considerations**
- Unless the aircraft's Pilot Operating Handbook (POH) specifically states otherwise, assume that the maximum glide range is obtained without using any flap.
- **Special Circumstances**
- If needing to land on a short runway or clear obstacles on approach, how can flaps be used? Flaps can be lowered to steepen the glide angle, allowing for a descent at a steeper angle without an increase in airspeed, which helps in such situations by effectively worsening the lift-drag ratio.

Descent Planning Rules of Thumb

> Two primary rules of thumb assist pilots in planning descents: one for calculating the top of descent (TOD) in nautical miles, and another for determining the required rate of descent in feet per minute (FPM).

- **Keypoints**
  - Rule for TOD: (Altitude to lose in feet / 1000) * 3 = TOD in Nautical Miles.
  - Rule for Rate of Descent: Ground Speed (knots) * 5 = Rate of Descent (FPM).
  - These rules are practical for both VFR and IFR flight operations.
  - Wind conditions affect descent planning: a tailwind necessitates starting the descent earlier, while a headwind allows for a later start.
- **Explanation**
  To calculate the Top of Descent (TOD), divide the altitude to lose (in feet) by 1000, and then multiply the result by 3. This gives the distance in nautical miles from the destination or target point at which the descent should commence. For example, to lose 5,000 feet, the calculation is (5000/1000) * 3 = 15 NM. To determine the target rate of descent, multiply the aircraft's ground speed (in knots) by 5. This gives the required vertical speed in feet per minute (FPM). For example, at a ground speed of 100 knots, the descent rate would be 100 * 5 = 500 FPM.
- **Examples**
  > A pilot needs to descend from 6,000 feet to 1,000 feet, meaning a total altitude loss of 5,000 feet.

  - Altitude to lose = 5,000 feet.
  - Divide by 1000: 5,000 / 1000 = 5.
  - Multiply by the rule of thumb (3): 5 * 3 = 15.
  - The descent should be initiated 15 nautical miles from the point where the pilot aims to be at 1,000 feet.

  > A pilot is cruising at 7,000 feet and needs to descend to 4,000 feet to cross a reporting point for Logroño. This is an altitude change of 3,000 feet.

  - Altitude to lose = 3,000 feet.
  - Divide by 1000: 3,000 / 1000 = 3.
  - Multiply by the rule of thumb (3): 3 * 3 = 9.
  - The descent should begin 9 nautical miles before the reporting point.

  > An aircraft has a ground speed of 100 knots.

  - Ground Speed = 100 knots.
  - Multiply by the rule of thumb (5): 100 * 5 = 500.
  - The target rate of descent is 500 feet per minute.
- **Considerations**
- The number '3' is a constant rule of thumb for TOD calculation in nautical miles.

- The number ‘5’ is a constant rule of thumb for calculating the descent rate in FPM from ground speed.
- A typical target descent rate is around 500 FPM, but the GS*5 rule provides a more precise figure for current conditions.
- **Special Circumstances**
- If encountering a tailwind during descent planning, how should the TOD be adjusted? Start the descent earlier because the tailwind will result in a shallower descent path over the ground.
- If encountering a headwind during descent planning, how should the TOD be adjusted? The descent can be started later because the headwind will result in a steeper descent path over the ground.

The Danger of “Stretching the Glide”

> Attempting to extend the gliding distance by pitching the aircraft’s nose up to reduce airspeed below the best glide range speed is a counterproductive and dangerous maneuver known as a ‘classic aerodynamic trap’.

- **Keypoints**
  - It is crucial to maintain the aircraft’s published best glide speed during an engine failure or any unpowered glide.
  - Pitching the nose up excessively increases the angle of attack, which worsens the lift-to-drag ratio primarily due to increased induced drag.
  - This action results in a steeper actual glide path and a shorter glide distance.
  - Stretching the glide can lead to dangerously low airspeeds, potentially resulting in an aerodynamic stall and subsequent loss of control.
  - In an engine-out scenario (no power), the aircraft’s attitude is the primary determinant of its performance.
- **Explanation**
  When a pilot tries to ‘stretch’ a glide by pitching the nose up, the angle of attack increases. While this might intuitively seem to prolong flight, increasing the angle of attack beyond that for the best lift-to-drag ratio leads to a significant increase in induced drag. This degrades the lift-to-drag ratio, causing the aircraft to descend more steeply and lose airspeed more rapidly, ultimately reducing the actual distance glided and increasing the risk of a stall or spin.
- **Examples**
  > An aircraft gliding at its best glide speed (e.g., 70 knots) maintains an optimal angle of attack (e.g., 5 degrees) and achieves a certain maximum glide distance. Another aircraft, under the same initial conditions, attempts to stretch the glide by pitching its nose up.

    - The aircraft attempting to stretch the glide will experience a reduced airspeed and an increased angle of attack.
    - This increased angle of attack (beyond optimal) leads to a poorer lift-to-drag ratio.
    - Consequently, its rate of descent will increase, and its glide path will become steeper, causing it to cover less horizontal distance before reaching the ground compared to the aircraft maintaining the best glide speed.
- **Considerations**
- Regardless of the perceived urgency during an engine failure, the first priority is to establish and maintain the best glide speed.
- Pilots should avoid the illusion that pitching up will extend the glide; it is a trap that worsens the situation.
- **Special Circumstances**
- If an engine fails and the pilot is tempted to pitch up to try and reach a distant landing spot, how should this instinct be managed? The pilot must consciously resist the urge to pitch up (stretch the glide) and instead strictly adhere to maintaining the aircraft's best glide speed to maximize the actual glide distance and maintain control.

Control Mantra: "Attitude for Airspeed, Power for Height"

> This is a fundamental control principle for light aircraft, particularly emphasized during the approach phase. It dictates that pitch attitude is the primary control for airspeed, while engine power is the primary control for altitude or rate of descent/climb.

- **Keypoints**
    - Precise airspeed control is more critical during slow-speed phases like approach and landing than in cruise.
    - If airspeed becomes critically slow, pitching the nose down is a safe recovery action as it reduces wing loading, decreases the angle of attack, and helps increase airspeed.
    - Sudden or large increases in power in a light aircraft at slow airspeeds can cause destabilizing yaw moments due to propeller effects (P-factor, slipstream).
    - An aircraft stalls based on exceeding its critical angle of attack, regardless of the power setting.
    - In the event of an engine failure, the control column (pitch attitude) becomes the sole means of controlling airspeed.
    - Relying on power to recover from a critically slow airspeed situation may be ineffective in relatively low-powered aircraft, as acceleration can be slow.
    - The action of pitching the nose down to recover from a slow airspeed situation is consistent with standard stall recovery techniques.

- **Explanation**
  When an airspeed correction is needed (e.g., if airspeed is low on approach), the correct initial pilot input is to adjust the aircraft's pitch attitude (e.g., lower the nose to increase airspeed). Power is then adjusted to correct the flight path (e.g., to regain the desired glideslope or arrest an increased rate of descent). This technique is vital for precise speed control and stability, especially at lower speeds.
- **Examples**
  > A pilot is on final approach and notices the airspeed has decreased below the target approach speed.

  - Incorrect response: Immediately adding significant power without changing attitude. This might lead to a pitch-up, further speed decay initially, or flight path destabilization.
  - Correct response (following the mantra): Lower the aircraft's nose slightly (adjust attitude) to allow airspeed to increase. Simultaneously or subsequently, adjust power as needed to maintain or regain the correct glideslope (control height/descent rate).
- **Considerations**
- This mantra is particularly emphasized for light, propeller-driven aircraft; large jet aircraft with significant inertia may employ slightly different control philosophies.
- Pilots trained to use power for airspeed may instinctively push the throttle forward even if an engine has failed, which is an ineffective and potentially ingrained incorrect reaction.
- **Special Circumstances**
- If airspeed becomes critically low during an approach in a light aircraft, how should the pilot primarily correct it? The pilot should pitch the nose down to reduce the angle of attack and allow the airspeed to increase, then use power to adjust the flight path and rate of descent.
- If an engine fails while on final approach, how should the pilot manage airspeed to reach the runway? The pilot must use pitch attitude (control column) to maintain the best glide speed, as power is no longer available to influence airspeed or height significantly.

Approach Speed Calculation and Landing Configuration

> The aircraft's mass is a determinant of its stall speed. Approach speeds are established by reference to the stall speed in the landing configuration (VS0). As a general rule, the approach speed is approximately 1.3 times VS0.

- **Keypoints**
  - Aircraft mass directly influences stall speed.
  - Approach speed is calculated based on VS0.

    - The common multiplier used is 1.3.
    - VREF and VF are synonymous terms for approach speed under certain contexts.
- **Explanation**
  For instance, if an aircraft's VS0 (stall speed in landing configuration) is 50 knots, its calculated approach speed would be around 65 knots (50 knots * 1.3). This approach speed is maintained in the landing configuration. Alternative terms for approach speed include VREF and VF, with VF typically used for larger jet aircraft, often in Phase 2 of training.
- **Examples**
  > Consider a cruiser aircraft with a stall speed in landing configuration (VS0) of 50 knots.

    - a. The standard formula to determine approach speed is 1.3 multiplied by VS0.
    - b. Therefore, Approach Speed = 1.3 * 50 knots = 65 knots.

Braking Techniques After Landing

> Employing the correct braking technique after landing is essential for maintaining aircraft control and ensuring safety. This involves specific actions regarding timing, throttle management, and brake application to prevent issues such as component overheating or loss of directional control.

- **Keypoints**
    - Initiate braking only after the nose wheel has touched down.
    - Ensure the throttle is completely closed.
    - Apply brake pressure evenly and gradually.
    - Avoid locking the wheels during braking.
    - Utilize a tap-braking technique for metal brakes to manage heat.
    - Brake pressure can be increased as the aircraft decelerates.
    - Manage nosewheel pressure with the control column for protection and steering.
- **Explanation**
    i. Delay braking until the nose wheel is firmly on the ground. Premature braking, especially with the nose wheel airborne, can lead to a hard impact of the nose gear or loss of control.

2. Confirm the throttle is fully closed to cut off any residual engine power.
3. Apply brakes smoothly and progressively, increasing pressure evenly to the maximum effective level without causing the wheels to lock. A locked wheel results in less effective deceleration than a wheel under proper braking.

4. For aircraft equipped with metal brakes (not carbon), a tapping technique (intermittent pushing and releasing of the brake pedals) is recommended. This allows the brakes to cool, preventing overheating and potential brake fade.
5. As the aircraft's speed decreases, braking pressure can generally be increased.
6. It is usually safe to allow the nosewheel to contact the runway relatively early during the landing roll to aid in steering. However, the control column should still be used to maintain light pressure on the nosewheel, protecting it from damage on uneven surfaces and ensuring maximum weight on the main wheels for optimal braking effectiveness.

- **Considerations**
- Ensure that the throttle is fully closed, because this is important.
- Apply the brakes evenly to the maximum extent possible without locking the wheels.
- A locked wheel gives less deceleration than one under full proper braking.
- It is usually safe to allow the nosewheel to contact the runway quite early… although the control column should still be used to keep pressure of the nosewheel.
- **Special Circumstances**
- If braking is applied hard while the nose wheel is still in the air, the aircraft might impact the runway hard with the nose gear, potentially causing a crash.
- Continuous hard application on metal brakes can lead to rapid overheating, reducing braking effectiveness.

Key Runway Distances for Take-off and Landing

> A thorough understanding of various declared runway distances is fundamental for conducting safe flight operations. These distances, critical for performance calculations, are officially published in the Aeronautical Information Publication (AIP). They include TORA, Stopway, Clearway, TODA, ASDA (also referred to as EDA by some sources like Bristol), and LDA.

- **Keypoints**
  - TORA is for the take-off ground roll.
  - Stopway is an emergency overrun area for rejected take-offs.
  - Clearway is an area for initial climb to clear obstacles up to screen height (50 ft).
  - TODA is the sum of TORA and Clearway.
  - ASDA (or EDA) is the sum of TORA and Stopway.
  - LDA is the usable length for landing, measured from 50 ft over the threshold.
  - Displaced thresholds are implemented due to obstacles and reduce LDA.
  - All declared distances are found in the AIP.
- **Explanation**

    - **TORA (Take-Off Run Available):**This is the physical length of the runway declared available and suitable for the ground run of an aircraft during take-off. It often corresponds to the actual paved length of the runway.

- **Stopway:**An area defined beyond the TORA, which is clear of obstructions and capable of supporting an aircraft, designed for deceleration and stopping in the event of a rejected take-off.
- **Clearway:**A defined rectangular area beyond the TORA, over which an aircraft can make a portion of its initial climb to a specified screen height (typically 50 feet above ground level). The length of the clearway is limited, often to not more than 50% of the TORA.
- **TODA (Take-Off Distance Available):**This is the total distance available for an aircraft to take off, calculated as the length of the TORA plus the length of any available clearway (TODA = TORA + Clearway). The aircraft's calculated take-off distance required must not exceed the TODA.
- **ASDA (Accelerate-Stop Distance Available) / EDA (Emergency Distance Available):**This is the total length of the TORA plus any available stopway (ASDA = TORA + Stopway). It represents the distance required to accelerate to decision speed (V1), experience an engine failure, and then bring the aircraft to a complete stop.
- **LDA (Landing Distance Available):**This is the length of the runway declared available and suitable for the ground run of an aircraft landing. The LDA is typically measured from a point where the aircraft is expected to be 50 feet above the runway threshold. The presence of obstacles in the approach path may lead to a displaced threshold, which in turn reduces the LDA.

- **Considerations**
- The calculated take-off distance required should never be more than TODA if a safe take-off is to be made.
- The stopway must be clear of any obstructions that could cause damage to the aircraft.
- The clearway's accounted length is typically limited (e.g., not more than 50% of TORA).
- **Special Circumstances**
- If an obstacle penetrates the approach surface, the runway threshold may be displaced inwards, reducing the LDA to ensure safe clearance.

Descent Planning Rule of Thumb

> Pilots often use a rule of thumb to estimate the top of descent (TOD) point and the required rate of descent (ROD) to efficiently reach a target altitude at a predetermined geographical point.

- **Keypoints**
    - TOD (NM before point) = (Altitude to lose in feet / 1000) * 3.
    - ROD (feet per minute) = Ground Speed (knots) * 5.
- **Explanation**
    - **Calculating Top of Descent (TOD) Point:**This determines how many nautical miles before the target waypoint the descent should commence.
        a. Identify the total altitude to be lost in feet (e.g., descending from Flight Level 80 (8,000 ft) to 4,000 ft means an altitude change of 4,000 ft).
        b. Divide the altitude to lose by 1,000 (or remove the last three zeros). For 4,000 ft, this gives 4.
        c. Multiply this result by 3. This product is the approximate distance in nautical miles from the waypoint at which to start the descent (e.g., 4 * 3 = 12 nautical miles).

- **Calculating Rate of Descent (ROD):**This determines the vertical speed in feet per minute (fpm) required for the descent.
    i. Note the aircraft's current ground speed in knots.
    ii. Multiply the ground speed by 5. This product is the approximate rate of descent needed in feet per minute (e.g., if ground speed is 100 knots, ROD = 100 * 5 = 500 fpm).

- **Examples**
  > An aircraft is currently at 8,000 feet and needs to descend to arrive at 'Echo' point at 4,000 feet. The aircraft's ground speed is 120 knots.

    - a. **Altitude to lose:**8,000 ft - 4,000 ft = 4,000 ft.
    - b. **TOD Calculation:**(4000 / 1000) * 3 = 4 * 3 = 12 nautical miles. The descent should begin 12 NM before reaching Echo point.
    - c. **ROD Calculation:**Ground speed (120 knots) * 5 = 600 feet per minute. The target rate of descent is 600 fpm.
- **Considerations**
- This is a rule of thumb; actual descent performance can be affected by factors like wind conditions, aircraft type, and specific ATC instructions.
- Always cross-check with aircraft performance manuals and operational procedures.
- **Special Circumstances**
- Strong headwinds may require starting the descent later or using a lower rate of descent, while strong tailwinds may necessitate an earlier descent or a higher rate.
- ATC may issue specific descent clearances that override these calculations.

VFR Procedures and Exam Relevance

> Students must study VFR (Visual Flight Rules) procedures, specifically for Mac, as they will be tested on this material. This topic is important even if not explicitly emphasized in the course curriculum.

- **Keypoints**
  - Questions on VFR procedures will appear in the exam.
  - Mandatory documents for any flight include: a valid NIE (Número de Identificación de Extranjero), and an iPad that is always fully charged.
  - Understanding and being able to perform the creation of a flight plan is a required skill.
- **Examples**
  > An example exam question was: 'Mandatory documents for the flight.'

  - Students were expected to list all required items, including but not limited to: a Valid NIE, an iPad always full of battery, and other relevant operational documents as specified in procedures.
- **Considerations**
- VFR topics will be on the exam even if not explicitly highlighted in the main course materials, so self-study of provided files (e.g., in Moodle) is necessary.
- Ensure all mandatory documents are current and equipment like the iPad is fully functional before any flight related activities or checks.

Mass and Balance Calculation for PS-28 Cruiser

> The procedure for calculating mass and balance for the PS-28 Cruiser aircraft is detailed in the aircraft's Standard Operating Procedures (SOP).

- **Keypoints**
  - The SOP document (page 74) for the PS-28 Cruiser contains an error in the graphical illustration demonstrating how to fill out the mass and balance form.
  - The error involves a line being depicted as straight, whereas it should be plotted by first going to a specific black line on the chart and then proceeding across from that point.
- **Explanation**
  To find the mass and balance procedure: Navigate to Ops, then to Aircraft, select PS-28 Cruiser, and open the SOP document. The relevant information is on page 74 of this 74-page document.
- **Examples**
  > The SOP for the PS-28 Cruiser aircraft, specifically on page 74, incorrectly illustrates how to fill the mass and balance chart. The diagram shows a straight line for plotting, but it should be an angled line sequence: first to 'this black line', and then across.

    - [Speaker 1] highlighted this mistake: ‘Even though here’s a mistake, they did a mistake here. There’s a lot of lines. Because they put a straight line. It should be like this, yeah. It’s a mistake… So, here they did a mistake. This is not correct for them. They should have went to this black line, and then gone like this.’
- **Considerations**
- The official SOP document for the PS-28 Cruiser contains a significant error in the mass and balance calculation guide which could lead to incorrect calculations if not identified.
- Always double-check calculations and understand the principles behind them, rather than solely relying on potentially flawed diagrams.
- **Special Circumstances**
- If using the PS-28 Cruiser SOP (page 74) for mass and balance, how should the graphical error be addressed? Students should disregard the straight line shown in the diagram and instead plot the values by first extending a line to the indicated ‘black line’, and then moving horizontally or vertically as appropriate from that intersection, as explained by [Speaker 1].

Performance Exam Details (BBL Flight Performance and Planning)

> This section outlines key details for the BBL Flight Performance and Planning exam.

- **Keypoints**
    - The Performance exam consists of 44 questions.
    - The allotted time for completing the exam is one and a half hours.
    - Key topics covered include: fuel calculation, take-off performance calculation, landing performance calculation, general flight procedures, safety cockpit checks, before start procedures, taxi procedures, take-off procedures, and landing procedures.
    - The question bank specifically for the ‘performance’ section under ‘BBL flight performance and planning’ contains 119 questions. Students are expected to review all of these.
- **Explanation**
  To prepare for the performance topics, students should access the exam preparation materials by navigating to ‘Exams’, then ‘BBL flight performance and planning’, then selecting the ‘topic’ section, and focusing on ‘performance’. It is advised to ‘do the bank and read the slides. Do everything.’
- **Considerations**
- A thorough review of all 119 questions in the performance question bank is critical for exam success.
- Understanding all listed topics, from fuel calculation to landing procedures, is mandatory as per [Speaker 1].

Human Performance and Limitations (HPL) Exam Preparation

> This outlines the recommended study strategy for the Human Performance and Limitations (HPL) exam.

- **Keypoints**
  - The HPL question bank contains a large number of questions, specifically 326 or 327 questions.
  - The primary study method recommended by [Speaker 1] is to ‘just do the bank. Bank it all the way and get them all done.’
- **Considerations**
- Given the volume of questions (326/327), dedicating sufficient time to go through the entire HPL question bank is essential.
- Relying on the question bank is presented as a sufficient strategy for this particular exam.

Exam Question Bank Idiosyncrasies

> Students should be aware of potential issues and peculiarities within the exam question banks.

- **Keypoints**
  - Some questions in the bank may have ‘correct’ answers that are specific to the bank’s internal logic and might not perfectly align with real-world applications or broader theoretical knowledge.
  - Instances have been reported where a question might feature two identical answer options, with only one of them being designated as the correct one.
  - Students should aim to select the answer that the question bank deems correct, even if it seems counterintuitive or partially incorrect based on external knowledge.
- **Examples**
  > A specific exam question concerned the sources of carbon monoxide. In a real-world scenario, both exhaust air and cigarette smoke are valid sources. However, a student reported choosing only ‘exhaust air’ because smoking is theoretically prohibited in the context of the exam/flight.

  - [Speaker 5] explained: ‘There is a question that the correct answer is smoke of cigarette too, but I don’t put that because in theory. There is a question about the carbon monoxide. The correct answer in real story is the exhaust air and the cigarette smoke. I put the exhaust because in theory I cannot smoke.’
  - [Speaker 1] confirmed the bank’s authority: ‘Because again, some of the questions are not the correct answers. In this one, they are correct (referring to the bank’s designated answers).’

> It was reported that some questions in the bank might present two identical textual answers, but only one is marked as the correct option.

  - [Speaker 4] confirmed this: ‘The questioner has two identical answers, and one of them is right. One of them is not. It happens, yes.’

- **Considerations**
- The exam assesses knowledge based on the provided question bank, so bank answers take precedence over external information in case of discrepancies.
- Familiarity with the types of questions and known issues in the bank can be advantageous.
- **Special Circumstances**
- If encountering a question with two identical answer options during the exam, how should it be addressed? The transcript indicates this happens (‘The questioner has two identical answers, and one of them is right. One of them is not. It happens, yes.’). Students might need to recall if a specific instance was previously clarified or make their best judgment.
- If a question’s ‘correct’ answer in the bank (e.g., the carbon monoxide sources question) seems incomplete or not fully accurate based on broader knowledge, how should it be addressed? Select the answer designated as correct by the question bank, as [Speaker 1] noted, ‘some of the questions are not the correct answers (in a real-world sense). In this one (the bank), they are correct.’

Supplemental Oxygen Requirements

> This details the rules regarding the use of supplemental oxygen based on flight altitude, as discussed for exam purposes.

- **Keypoints**
  - According to [Speaker 1], supplemental oxygen is not needed for flights operating up to 10,000 feet.
  - There was some discussion around a potentially confusing exam question regarding oxygen use at different altitudes, but the reiterated guideline was no oxygen needed up to 10,000 feet.
- **Considerations**
- Understand the specific altitude thresholds for supplemental oxygen use as defined by the regulations and exam materials.
- Be aware that exam questions might test nuanced interpretations or specific scenarios related to these rules.

Assignments & Suggestions

- Remember all the necessary speeds that you will use, and as well the best glide speed.
- Practice using the CRP-5 for conversions (e.g., nautical miles to feet, kilometers to meters), referring to the tutorial in the book.
- Students are to read through performance-related material again to ensure understanding.
- Students should study hard for the upcoming HPL exam and the subsequent exam.
- Students are advised to review the notes taken during the lecture.
- For ‘New DKI’ studies, students should focus on:
    - Logonio (LRJ) airport information via Moodle: Student -> SOP2025 -> New DKI -> Airport -> LRJ.
    - BFR (Biennial Flight Review) material for Phase 1, Phase 2, and Phase 3.
    - Aircraft specific information for PS28 and GLAM2002.
    - For the 2008 aircraft, initially study the velocities, with more detailed study to follow.
- You should study the VFR procedures for Mac, as there will be exam questions on this topic.
- Write down what files you have to look for regarding VFR procedures.
- Learn the creation of the flight plan.
- For the Performance exam, you have to read all through the topics: fuel calculation, take-off, landing calculation, procedure, safety cockpit, before start, taxi, take-off, and landing.
- For Performance exam preparation: do the question bank, read the slides, and do everything.
- For HPL (Human Performance and Limitations) exam preparation: do the entire question bank (326 or 327 questions).