Aircraft Anatomy

Understanding the Power and Precision Behind Every Flight

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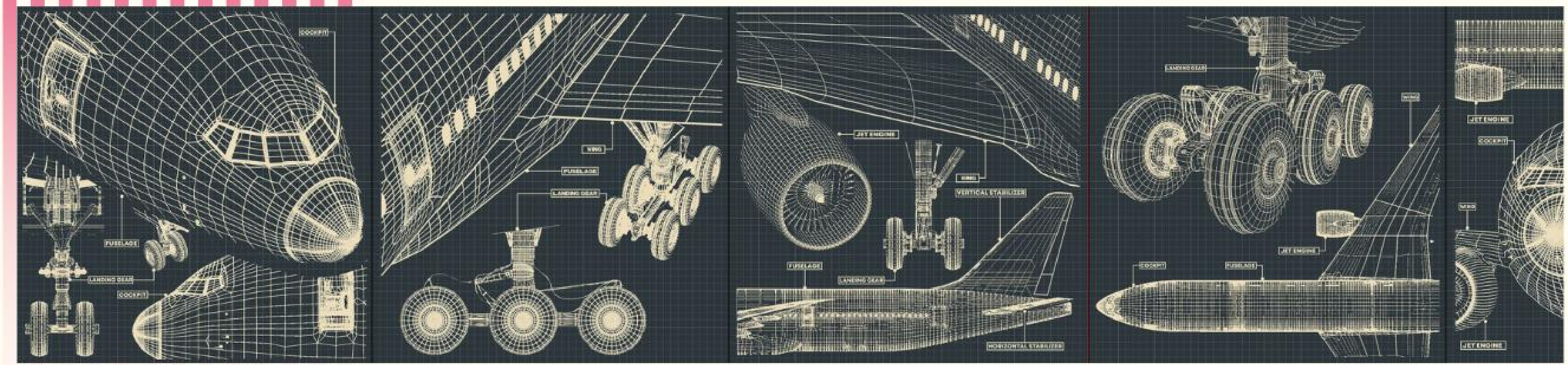


Flight Plan

Power Rating of an Aircraft's Engine

Understanding type of engines used in today's modern aircraft and their power ratings.

Types of Motors Used in Aircraft Engines

A look into the different motor technologies that drive are used in aircraft.

Controlling Procedure of Primary Flight Control Surfaces

Understanding what happens between cockpit and flight surfaces.

How Passenger Count Affects Engine Power

Exploring the link between onboard capacity and the power needed for efficient flight.

How Much Power Does It Take to Fly?

Exploring the Engine Power Ratings of Modern Aircraft

- Engine power is a key factor in determining an aircraft's performance.
- Power ratings are measured in units like:
  - **Thrust (pounds-force or kilonewtons)**
  - **Shaft Horsepower (shp)**
  - **Kilowatts (kW) or Brake Horsepower (BHP)**
- Modern aircraft use different types of engines based on size, speed, and purpose.
- We will discuss only 3 types of engines:
  - **Turbofan Engines** (used in large commercia airplanes)
  - **Turboprop Engines** (used in regional and utility aircraft)
  - **Piston Engines** (used in general aviation aircraft)

Let's take a closer look at each of them...

Turbofan Engines

Widely Used in Modern Commercial Aircraft

General Electric GE9X

Designed for the Boeing 777X, this is one of the most powerful commercial jet engines, producing approximately 105,000 pounds-force (lbf) of thrust.
Estimated power rating 489MW.

CFM LEAP-1A/1B

Powering aircraft like the Airbus A320neo and Boeing 737 MAX, these engines generate between 28,000 to 35,000 lbf of thrust.
Estimated power rating 46MW.

Rolls-Royce Trent XWB

Used in the Airbus A350, delivering around 84,000 lbf of thrust.
Estimated power rating 431MW.

Turboprop Engines

Powering Regional and Short-Haul Aircraft

Pratt & Whitney Canada PW100 Series

Common in regional turboprop aircraft, with power outputs ranging from 1,800 to 5,000 shaft horsepower (shp), equivalent to approximately 1,340 to 3,730 kilowatts (kW).

GE CT7-8

Employed in medium-lift helicopters and some fixed-wing aircraft, offering a maximum takeoff power of 2,634 shp, or about 1,964 kW.

Piston Engines

Perfect for Flight Schools and Private Planes

Lycoming TIO-540-AJ1A

A turbocharged engine rated at 310 brake horsepower (BHP), approximately 231 kW.

Continental TSIO-550-C

Used in various general aviation aircraft. Rated at 310 BHP or approximately 224kW.

Types of Motors in Aircraft Engines

Early Aircraft (Pre-1950s)

Electric Starter Motors
Early piston-engine aircraft utilized electric motors primarily as starters to initiate engine operation.

Modern Aircraft (1950s–Present)

Electric Starter Motors
Still essential in modern aircraft, used to spin jet engine's compressors to necessary speed for ignition.
Electromechanical Actuators (EMAs)
Electric motors are used in EMAs to move control surfaces replacing traditional hydraulic systems.
Hybrid-Electric Systems Combine electric motors with traditional engines, to lower emissions and boost efficiency.

Future Aircraft (Next 10–20 Years)

Axial-Flux Motors
Compact, high-efficiency motors with strong potential for aviation use.
High-Power Electric Motors
1-MW electric motors to facilitate the electrification of larger aircraft
Distributed Electric Propulsion
Multiple wing-mounted motors (e.g., NASA's X-57) enhance efficiency and cut emissions.

Passenger vs Power

Relationship between number of passengers in flight and Engine's power

The power required by an aircraft engine depends on several factors including the aircraft's weight, flight phase, altitude, speed, aerodynamic design, weather conditions, engine type, runway characteristics, and overall engine health.

Here we will only talk about the relationship of number of passengers and engine's power.

The relationship between the number of passengers on an aircraft and the power required from its engines is primarily influenced by the aircraft's total weight.

More passengers mean more weight, which demands more engine power to fly efficiently.

The mathematical relationship between weight and thrust can be expressed as: **T=Wx(CD/CL)**

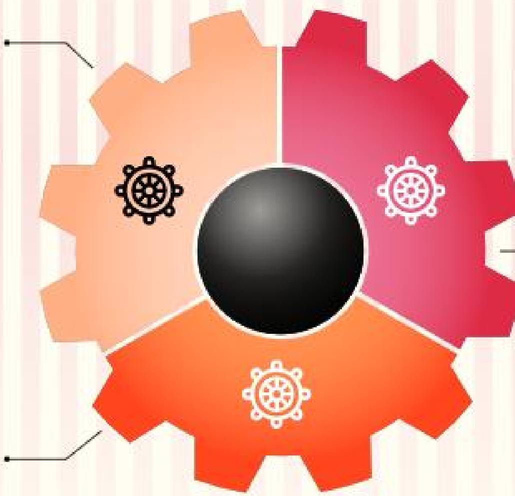
Where, T is thrust required, W is airplane's total weight, CD is coefficient of drag, CL is coefficient of lift.

On assuming CD/CL remains constant, this equation indicates that as aircraft's weight increases, the thrust increases proportionally and consequently, the engine power.

40 Passengers

Engine Output Needed for a 40-Passenger Flight

The engine power required for an aircraft carrying 40 passengers depends on various factors, including the aircraft's design, aerodynamics, and intended flight profile.



Considering aircraft Boeing 737-800, with 40 passengers only, average passenger weight to be 90kg and engine model is CFM56-7B, in take-off phase. Considering all other conditions to be ideal

The thrust required will be approximately 13,000-19,000 lbf and power will be around 5MW.

How does it fly?

Control Procedure of Primary Control Surfaces

01 Aircraft rely on primary flight control surfaces—ailerons, elevators, and rudders—to manage pitch, roll, and yaw.

02 These surfaces are manipulated through a combination of pilot inputs, mechanical linkages, hydraulic systems, and electronic controls.

03 In the next slides, we'll explore how each surface—aileron, elevator, and rudder—is individually controlled.

Control Procedure of Ailerons

01

Pilot Input

The pilot manipulates the control yoke or sidestick laterally (left or right) to command the aircraft to roll.

02

Input Detection

Sensors detect the movement of the yoke or sidestick, converting these physical inputs into electronic signals.

03

Flight Control Computers (FCCs)

The electronic signals are transmitted to the FCCs, which process the inputs, apply control laws, and determine the appropriate aileron deflections needed to achieve the desired roll.

04

Signal Transmission

The FCCs send electronic commands to the actuator control electronics (ACEs) located near the ailerons.

05

Actuator Activation

The ACEs command hydraulic or electric actuators to move the ailerons.

06

Aileron Movement

The actuators adjust the ailerons' positions: one aileron moves upward while the opposite one moves downward, creating differential lift that causes the aircraft to roll in the desired direction.

Control Procedure of Elevators

01

Pilot Input

The pilot pushes or pulls the control yoke or moves the sidestick forward or backward to command nose-down or nose-up pitch movements.

02

Input Detection

Sensors capture these movements and convert them into electronic signals.

03

Flight Control Computers (FCCs)

The FCCs receive the signals, process them, and calculate the necessary elevator deflections to achieve the commanded pitch attitude.

04

Signal Transmission

The FCCs send commands to the ACEs associated with the elevators.

05

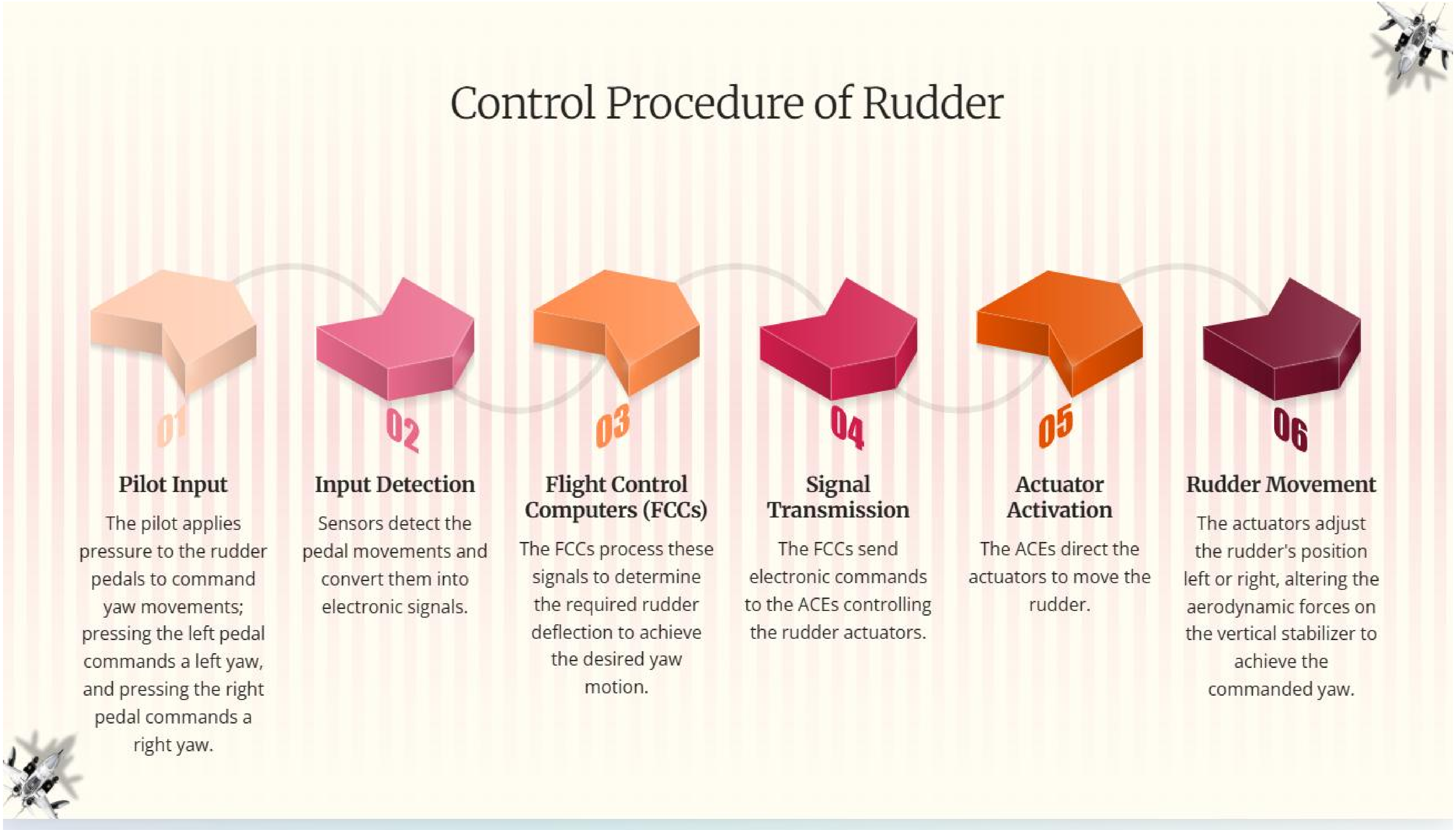
Actuator Activation

The ACEs control the actuators, directing them to adjust the elevators accordingly.

06

Elevator Movement

The actuators move the elevators up or down, altering the aircraft's pitch by changing the aerodynamic forces on the tail.


Control Procedure of Rudder
01
Pilot Input
The pilot applies pressure to the rudder pedals to command yaw movements; pressing the left pedal commands a left yaw, and pressing the right pedal commands a right yaw.
02
Input Detection
Sensors detect the pedal movements and convert them into electronic signals.
03
Flight Control Computers (FCCs)
The FCCs process these signals to determine the required rudder deflection to achieve the desired yaw motion.
04
Signal Transmission
The FCCs send electronic commands to the ACEs controlling the rudder actuators.
05
Actuator Activation
The ACEs direct the actuators to move the rudder.
06
Rudder Movement
The actuators adjust the rudder's position left or right, altering the aerodynamic forces on the vertical stabilizer to achieve the commanded yaw.


THANK!
YOU