Tishk International University
Engineering Faculty
PMechatronics Department

Avionics

TOPIC: Fight control system

Week3_Lecture1

1st Grade- Fall Semester 2020-2021

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Objectives

- Aircraft Flight Control Systems
- Primary Flight Controls
- Secondary Flight Controls
- Auxiliary Flight Controls
- Autopilot

Aircraft Control Systems

Aircraft flight control systems consist of flight control surfaces, the respective cockpit controls, connecting linkages, and the necessary operating mechanisms to control an aircraft's direction in flight. Aircraft engine controls are also considered as flight controls as they change speed. They can be divided into three main groups:

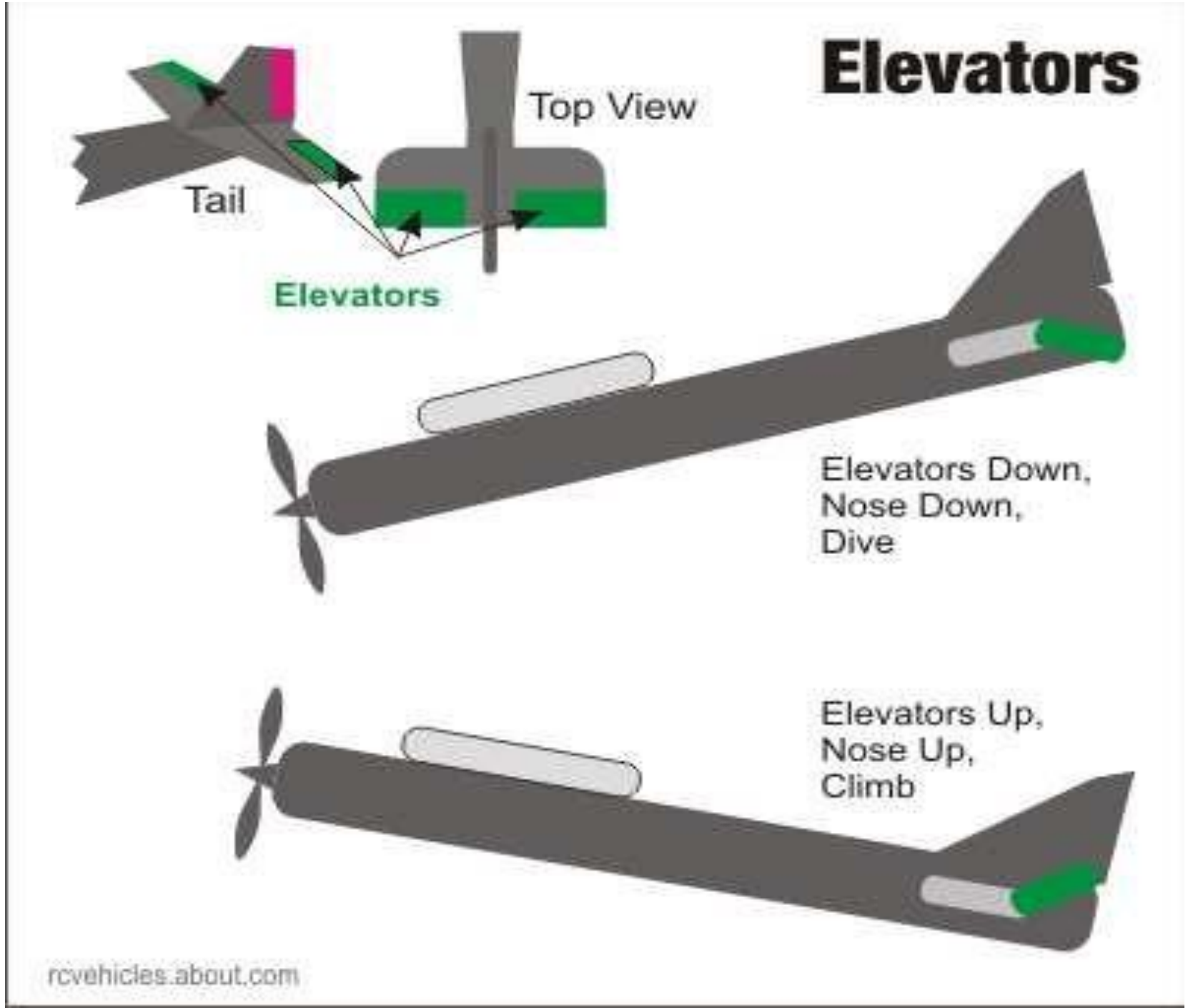
- Primary flight control
- Secondary flight control
- Auxilliary flight control

Primary flight control

- Elevator Control System
- Aileron Control System
- Rudder Control System

Elevator Control System

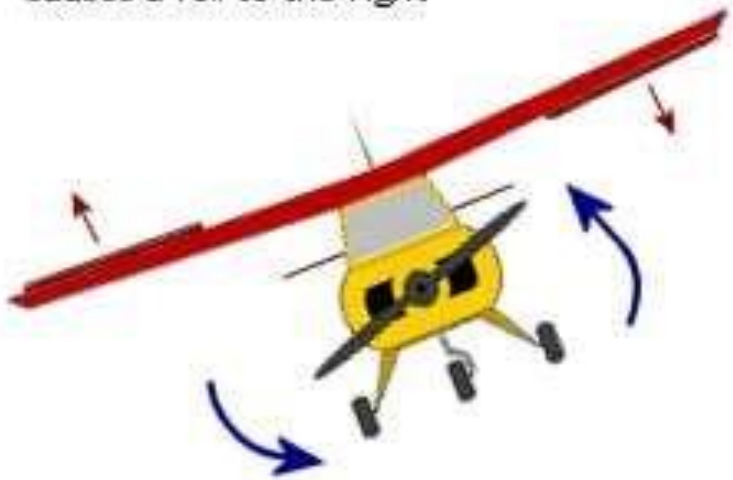
- An elevator is mounted on the back edge of the horizontal stabilizer.
- They move up and down together.
- When the pilot pulls the stick backward, the elevators go up. And vice versa.
- This makes the wings fly at a higher angle of attack which generates more lift and more drag.
- Pitch movement


Elevators
Top View
Tail
Elevators
Elevators Down,
Nose Down,
Dive
Elevators Up,
Nose Up,
Climb
rcvehicles.about.com

Aileron Control System

- Ailerons are mounted on the trailing edge of each wing.
- They move in opposite directions.
- When the pilot moves the stick left, the left aileron goes up and the right aileron goes down.
- A raised aileron reduces lift on the upward aileron and a lowered one increases lift
- Centering the stick returns the ailerons to neutral maintaining the bank angle.
- The plane will continue to turn until opposite aileron motion returns the bank angle to zero to fly straight.
- Longitudinal axis

Left aileron down, right one up
causes a roll to the right



Left aileron up, right one down
causes a roll to the left

Rudder Control System

- Mounted on the back edge of the fin in empennage.
- When the pilot pushes the left pedal, the rudder deflects left.
- Pushing the right pedal causes the rudder to deflect right.
- Deflecting the rudder right pushes the tail left and causes the nose to yaw right.
- Centering the rudder pedals returns the rudder to neutral and stops the yaw.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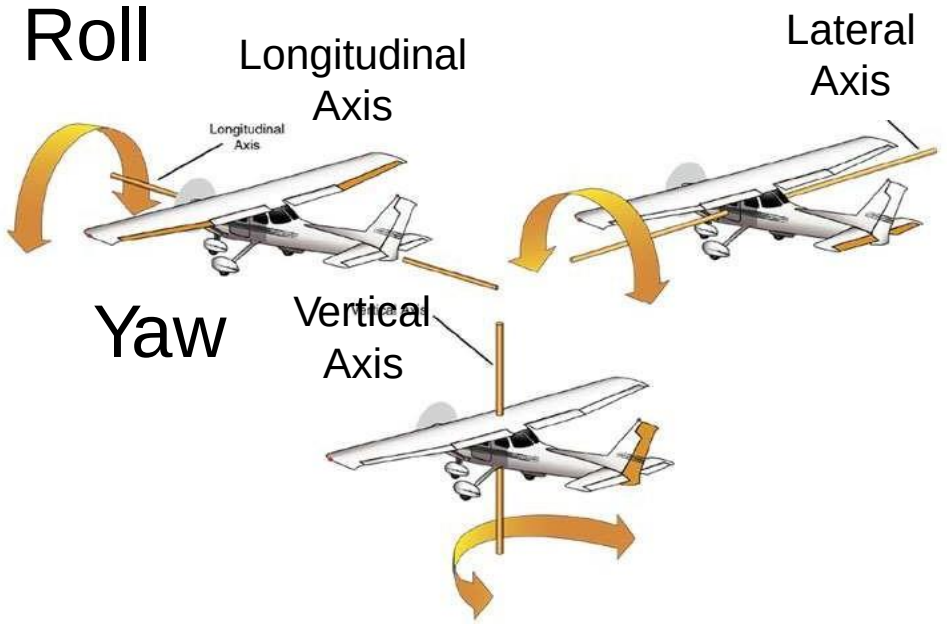
Aircraft Motion and Control

Axis	Motion	Stabilized by	Control	Pilot Control
Longitudinal	Roll	Wings	Aileron	Yoke twist left or right
Lateral	Pitch	Horizontal stabilizer	Elevator	Yoke forward or aft
Vertical	Yaw	Vertical stabilizer	Rudder	Rudder pedals

Roll

Pitch



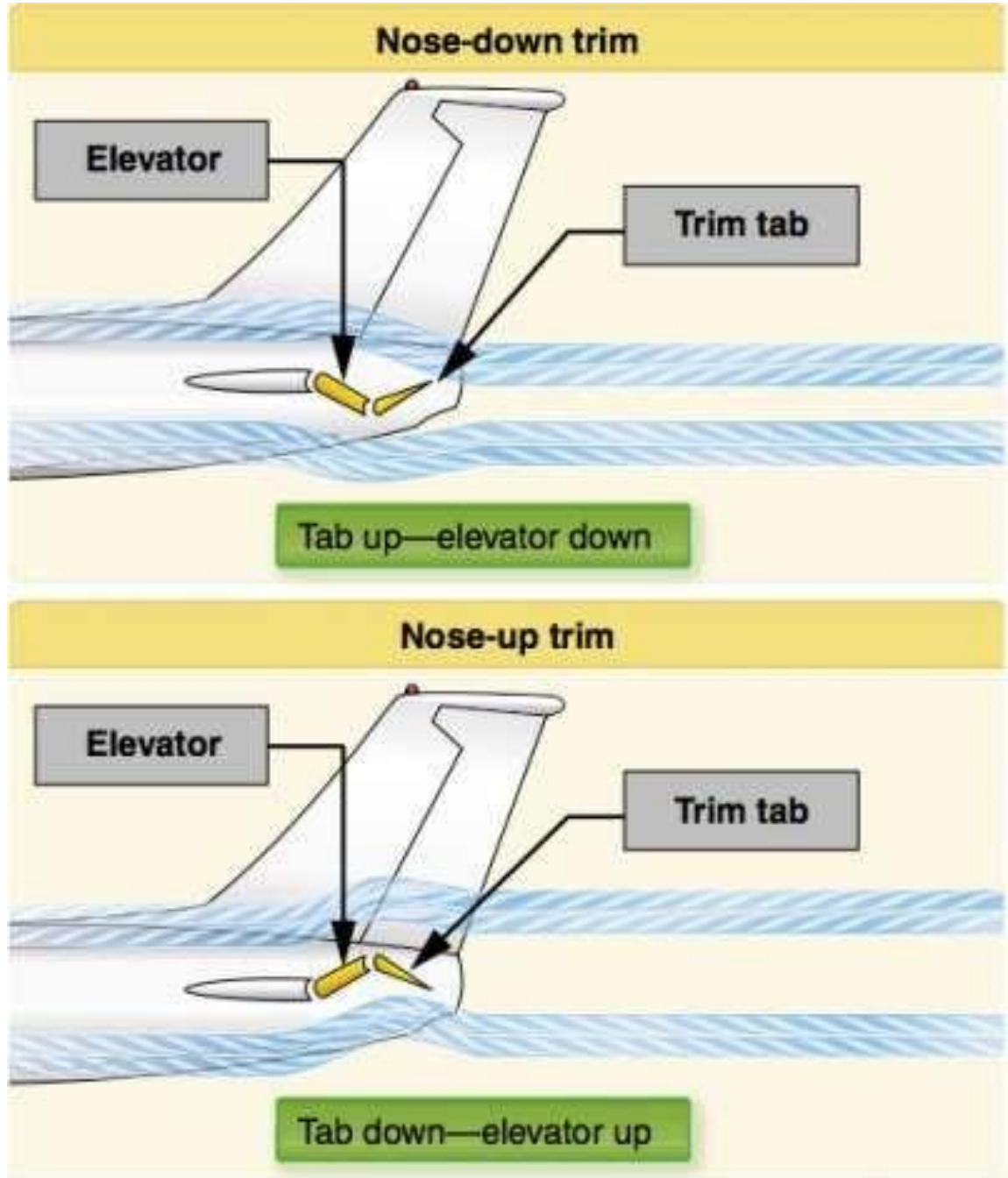
Secondary Flight Control

- Elevator Trim Tab System

- Rudder Trim Tab System

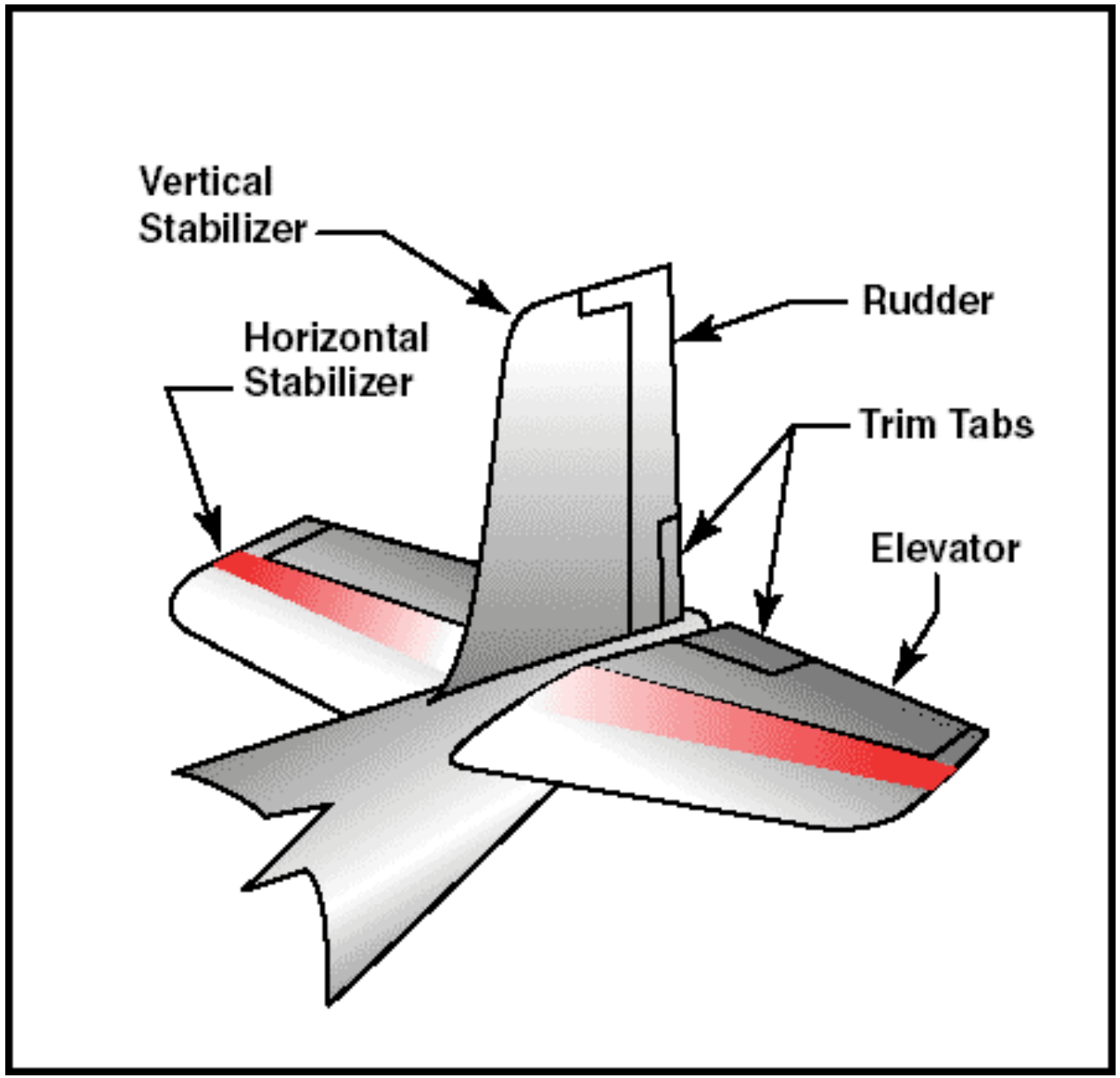
Elevator Trim Tab System

- Elevator trim balances the control force necessary to maintain the aerodynamic down force on the tail.
- When aircraft is flying, a lot of trim could be required to maintain the desired angle of attack.
- This mainly applies to slow flight, where maintaining a nose-up attitude requires a lot of trim.
- An important design parameter for aircraft is the stability of the aircraft when trimmed for level flight.
- Any disturbances such as gusts or turbulence will be damped over a short period of time and the aircraft will return to its level flight trimmed airspeed.


Nose-down trim
Elevator
Trim tab
Tab up—elevator down
Nose-up trim
Elevator
Trim tab
Tab down—elevator up

Rudder Trim Tab System

- Trim doesn't only apply to the elevator, as there is also trim for the rudder and ailerons.
- The use of this is to counter the effects of slip stream, or to counter the effects of the center of gravity being to one side.
- This can be caused by a larger weight on one side of the aircraft compared to the other, such as when one fuel tank has a lot more fuel in it than the other, or when there are heavier people on one side of the aircraft than the other.

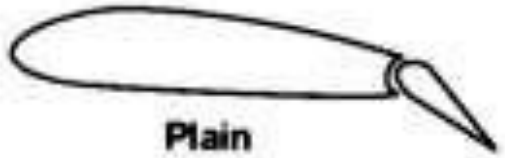

Vertical
Stabilizer
Horizontal
Stabilizer
Rudder
Trim Tabs
Elevator

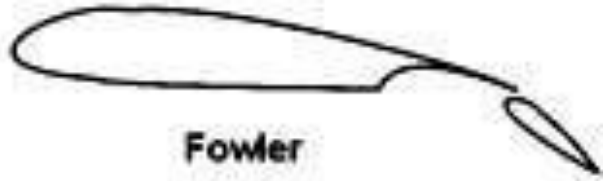
Auxilliary flight control

- Flap Control System
- High Lift Devices

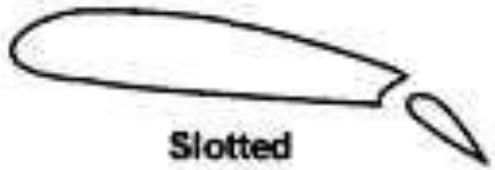
Flap Control System

- **Flaps** are hinged surfaces on the trailing edge of the wings of a fixed-wing aircraft.
- As flaps are extended, the stalling speed of the aircraft is reduced.
- Flaps are also used on the leading edge of the wings of some high-speed jet aircraft, where they may be called Krueger flaps.
- Flaps increase the camber of the wing airfoil, thus raising the lift coefficient. This increase in lift coefficient allows the aircraft to generate a given amount of lift with a slower speed.
- Extending the flaps will reduce the stalling speed of an aircraft.
- They also increase drag which helps to slow the aircraft.


Plain


Fowler


Split


Slotted


Krueger Flap
retracted
Krueger Flap
extended


AILERON
FLAP
MAIN UNDERCARRIAGE

High Lift Devices

Spoilers

- On low drag aircraft like sailplanes, spoilers are used to disrupt airflow over the wing and greatly increase the amount of drag.
- This allows a glider pilot to lose altitude without gaining excessive airspeed.
- Spoilers are sometimes called "lift dumpers". Spoilers that can be used asymmetrically are called spoilerons and are able to affect an aircraft's roll.

Slats

- Also known as Leading Edge Devices.
- Are extensions to the front of a wing for lift augmentation, and are intended to reduce the stalling speed by altering the airflow over the wing.
- May be fixed or retractable .
- Fixed slats give excellent slow speed and STOL (short take off and landing) capabilities, but compromise higher speed performance.
- Retractable slats provide reduced stalling speed for take-off and landing, but are retracted for cruising.

Autopilot

- An **autopilot** is a mechanical, electrical, and hydraulic system used to guide an aero plane without assistance from the pilot.
- The pilot is relieved of most of the physical & mental fatigue of controlling an aircraft and is free to devote his attention to the management and direction of progress of the flight.
- On newer aircrafts today, the Autopilot has evolved into a complex feature encompassing microprocessors and decision making systems which take over the complete control of an aircraft from take-off to landing.

Principle of Operation

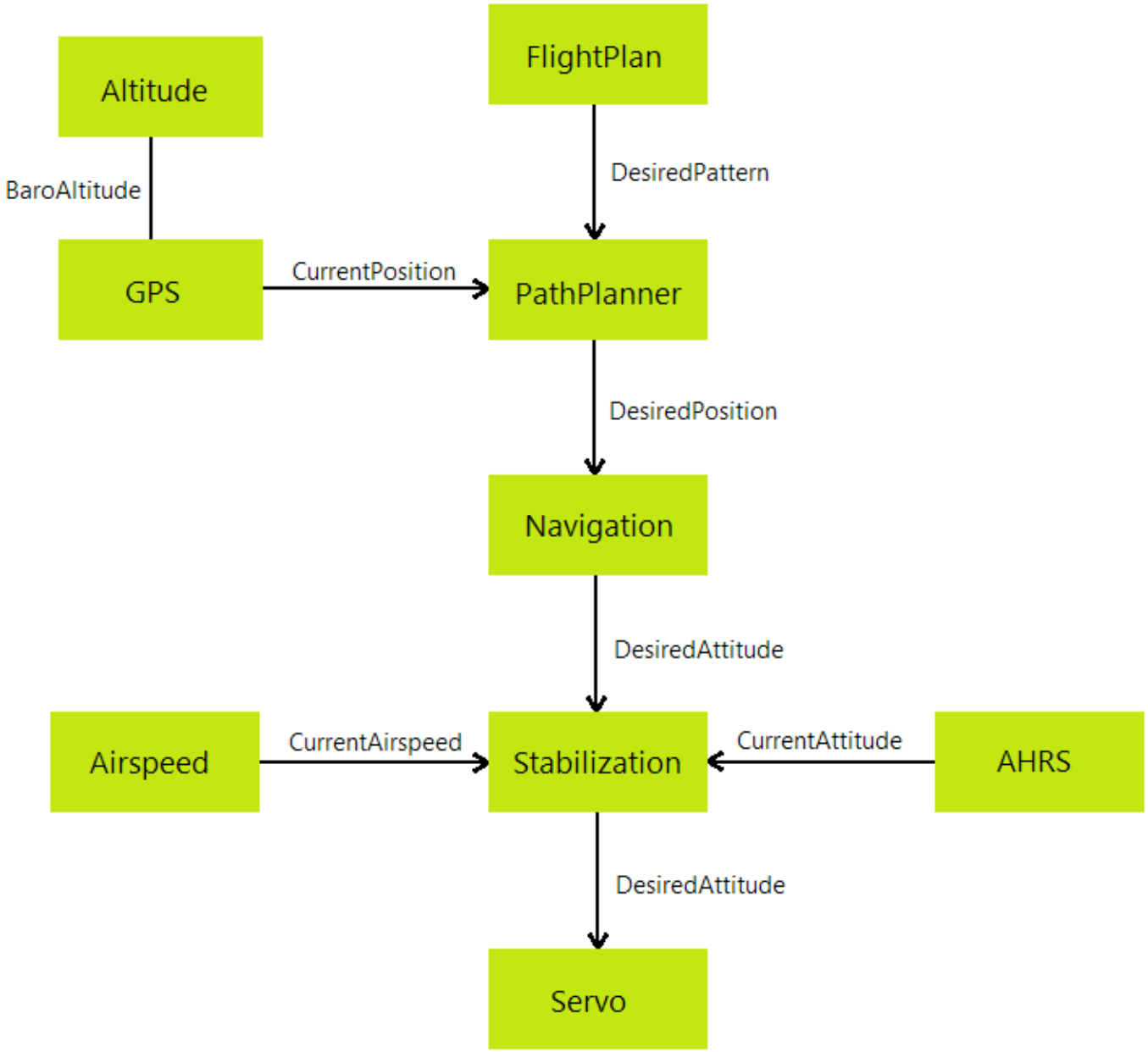
Input to system

1. Pilot commands
2. Sensors on exterior
3. Gyroscope
4. Accelerometer
5. Altimeter
6. GPS
7. ILS

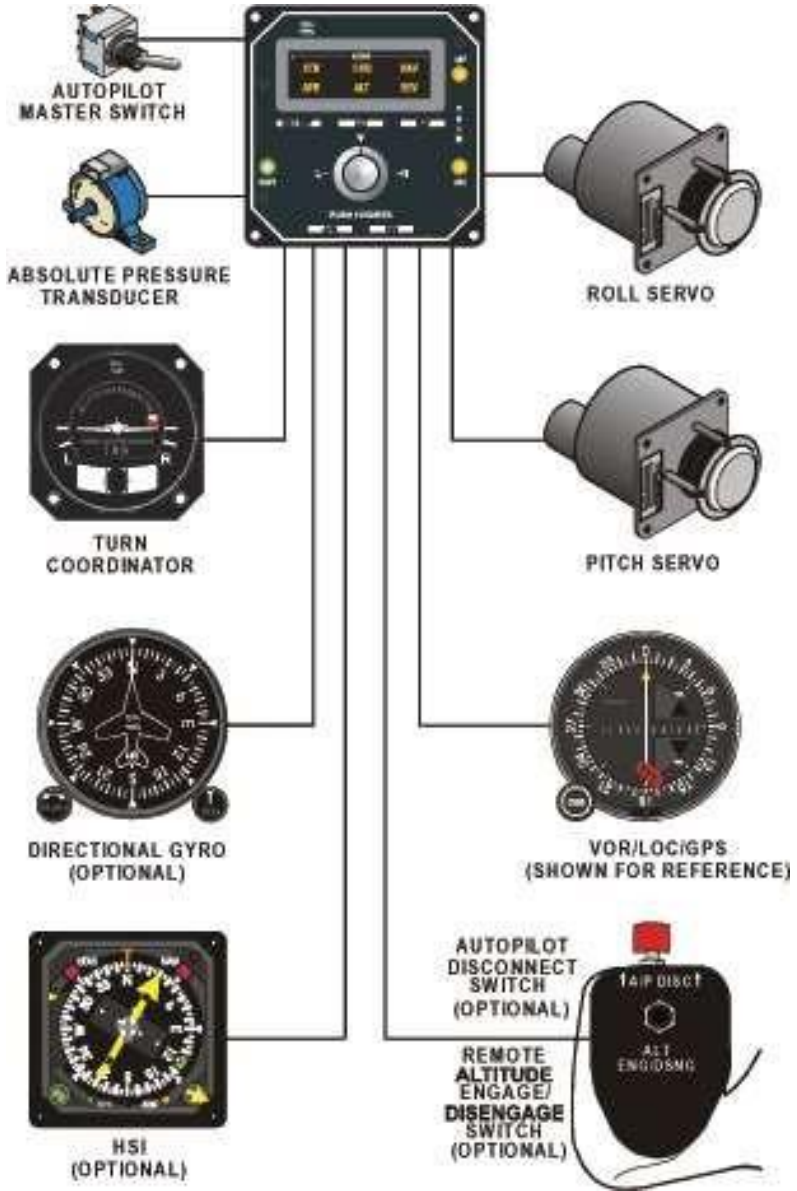
Output from system

1. Servo motors
2. Actuators on exterior
3. Spoilers
4. Rudder
5. Elevator
6. Ailerons
7. Engines

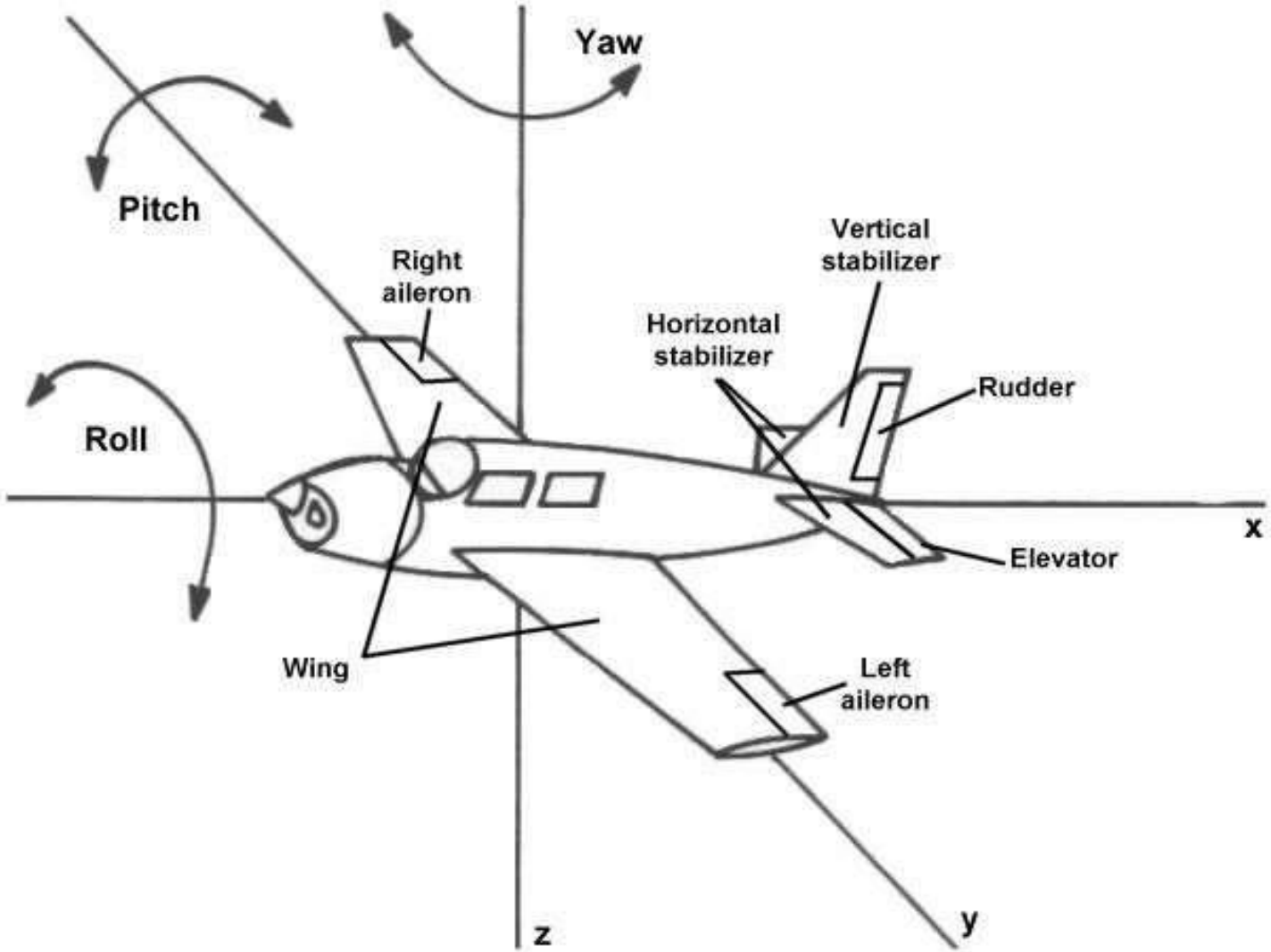
Principle of Operation



Principle of Operation



Movement of an Aircraft



Autopilot system manufacturers

- Garmin
- Thales
- Rockwell collins
- Honeywell


MASTER ARM
OFF
SIMULATE
MODE
ROLL
HDG SEL
PITCH
HOLD
ATT
HOLD
A/P
OFF
STRG SEL
ATT HOLD
STORES
JETTISON
WHEELS
UP
DN
GND JETT
ENABLE
BRAKES
CHAN 1
CHAN 2
PARKING
BRAKE
ANTI-SKID
STORES CONFIG
CAT I
CAT III
HORN
SILENCER
LIGHTS
LANDING
TAXI
OFF
DN LOCK
RWR
ON
065
SWAP
FCR
DTE
TEST
DCLT


Thank You!