Primary Aerodynamic Controls

What About this plane?

What do you call this control element?

ELEVON
Elevator and aileron

What about V tail?

Types of Controls

- Cable and Pulley
- Push-Rod
- Hydraulic
- Fly-By-Wire
Control System Terminology

- **System** - Group of elements put together to form a function. System is defined by differential equations that govern the relation between input and output (Transfer function).
- **Input** - Excitation applied to a control system from an external source.
- **Output** - The response obtained from a system.
- **Feedback** - The output of a system that is returned to modify the input.
- **Error** - The difference between the input and the output.

Elements of a Feedback Control Loop

- **R(s)** - reference input.
- **C(s) or Y(s)** - output signal (variable to be controlled).
- **E(s)** - error signal.
- **G(s)** - Y(s)/E(s) or forward path or open-loop transfer function.
- **H(s)** - feedback transfer function.
- **G(s)H(s)** - open-loop transfer function.

**Angle of attack**

\[ V_p = \text{projection of } V \text{ onto } x_b, z_b \text{ plane where} \]
\[ V = \left( u^2 + v^2 + w^2 \right)^{1/2}. \]

Angle of attack,
\[ \alpha = \tan^{-1} \frac{w}{u}. \]
For \( \alpha < 15^\circ \),
\[ \alpha \approx \frac{w}{u}. \]

**Sideslip**

\[ \beta = \sin^{-1} \frac{v}{V} \approx \frac{v}{u}. \]
Types of Control Systems

�� Open-Loop
- Simple control system which performs its function without concerns for initial conditions or external inputs.
- Must be closely monitored.

�� Closed-Loop (feedback)
- Uses the output of the process to modify the process to produce the desired result.
- Continually adjusts the process.

Control Modes in Feedback Loops

- Regulation
  - Constant set point.
  - Set point normally changed by human
  - Example
    - Level Control in a Tank.

- Servo (Tracking).
  - Dynamically Variable set point
  - Setpoint normally manipulated by another controller
  - Example
    - radar trackers.

Example 1

- Open or closed loop?
- regulation or tracking?
- Identify the control loop elements?

Simple Feedback Systems

- desired temperature
- room temperature
- heat loss
- furnace
- house
- thermostat
- Gas valve

Liquid level & flow control
Simple Feedback Systems

**OPEN LOOP**

- Desired temperature
- Gas valve
- Furnace
- Heat loss
- Room temperature
- House

**CLOSED LOOP**

- Desired temperature
- Thermostat
- Gas valve
- Furnace
- Heat loss
- Room temperature
- House