Automatic Control

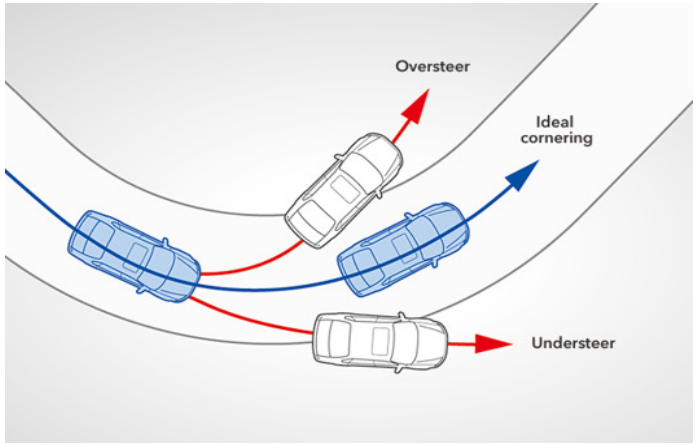
Basic Control System Concepts

by
Mohd Azri Hizami Rasid
Faculty of Mechanical Engineering
mahizami@ump.edu.my

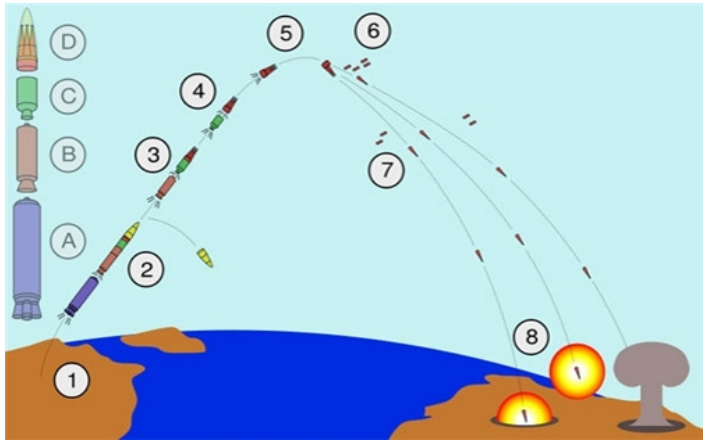
Chapter Description

- Aims
  - To make student understand the basic control system concepts and illustrate the required control system into block design process.
- Expected Outcomes
  - Student will be able to explain the control system definition and applications
  - Student will be able to explain the basic features and system configurations: open-loop system and closed-loop systems
  - Student will be able to explain control design process
- References
  - Norman S. Nise, 2008. Control Systems Engineering, sixth Edition, John Wiley & Sons, Inc.

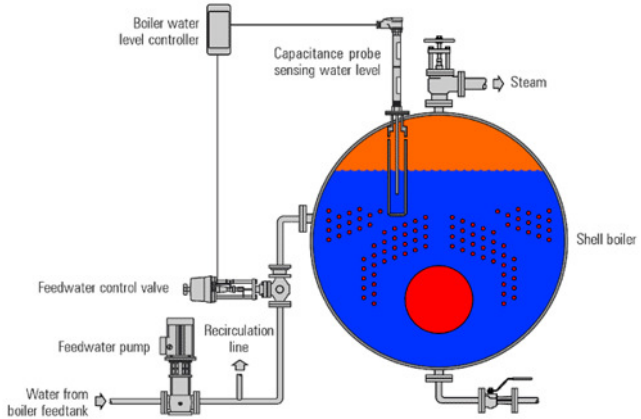
Why learn Automatic Control in Mechanical Engineering?



Source: subaru-cyprus.com



Source: quora.com by Zachary E. Fishbein



Source: spiraxsarco.com

Source: zerotohundred.com

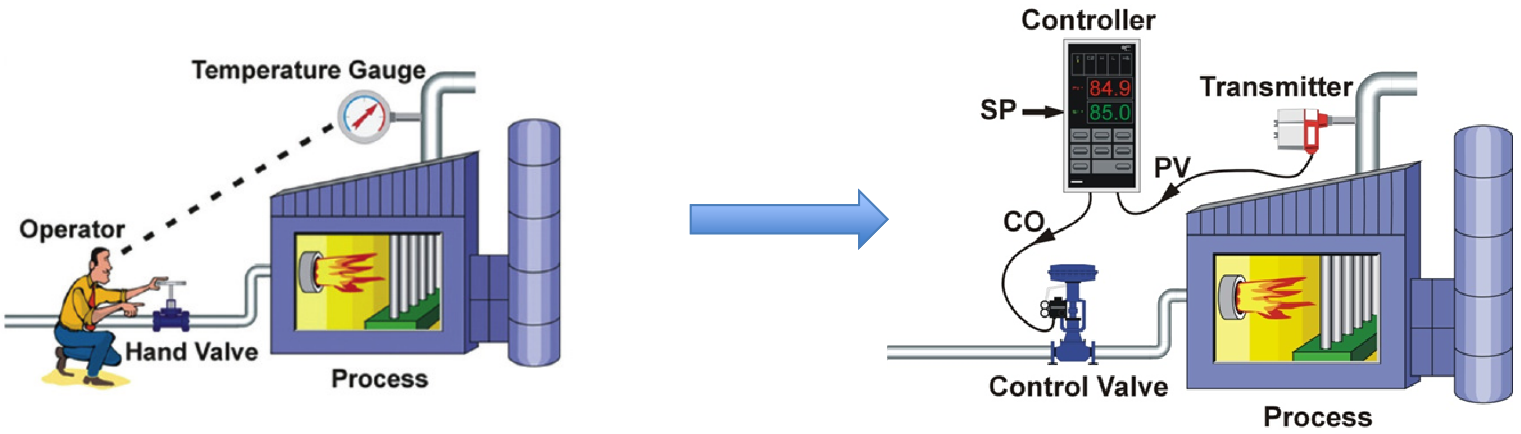
Why learn Automatic Control in Mechanical Engineering?

- Building models
- Simulating predictions
- Dynamic interactions
- Filtering & rejecting noise
- Selecting and building hardware
- Testing

→ It's understanding your system

What are common difficulties in automatic control?

- Don't like working with things that you can't see
- Too abstract to be mentally pictured
- Gap between theory and practice



Source: elprocus.com

Key to understand automatic control

- Ability to mental picture and imagine> Have a sense of physics.
- Understand principles of behavior: dynamics, fluid mechanics, heat transfer, electrical
  → They are governed by similar principles
- Solid foundation in mathematics!

Basic Control System Concepts

Definition :

A control system consists of subsystems and processes (or plants) assembled for the purpose of obtaining a desired output with desired performance,

Definition

Control:

Measuring the value of the controlled variable (output) of the system and applying accordingly the manipulated variable (input) to make the two as equal as necessary.

A system:

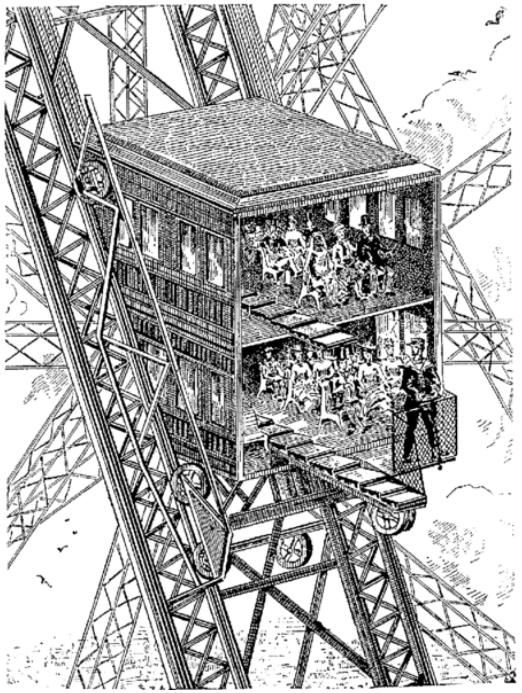
is a combination of components that act together and perform a certain objective.

*"A control system consists of **subsystems** and **plant** assembled for the purpose of controlling the outputs of the plants."* -> Norman S. Nise

Example : elevator

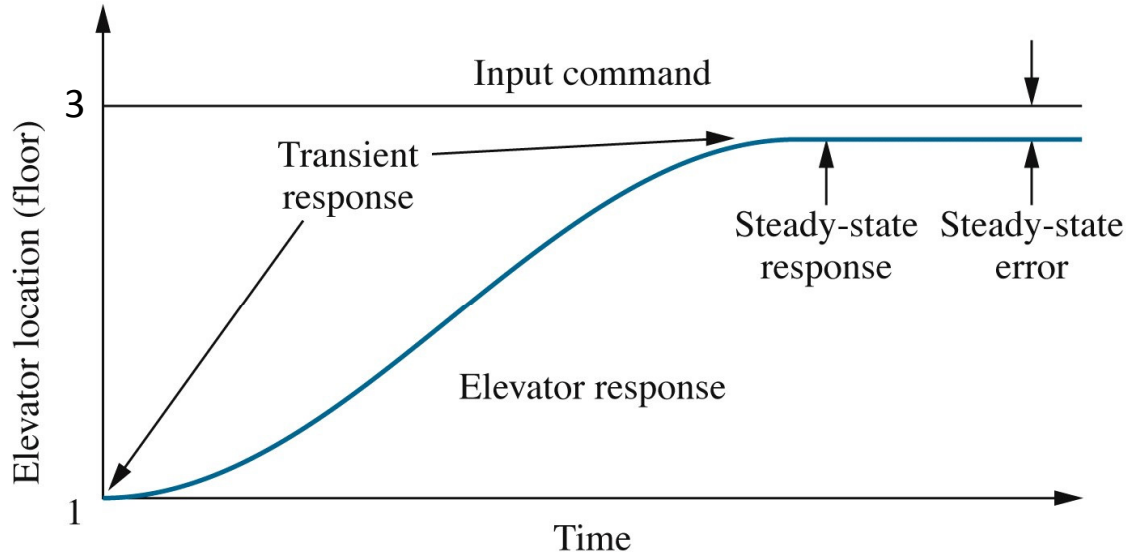
Example

- Consider an elevator, when the third-floor button is pressed on the ground floor, the elevator rises to the third floor with a speed and floor-leveling accuracy designed for passenger comfort.



Source: commons.wikimedia.org

Example : elevator



Elements of control system

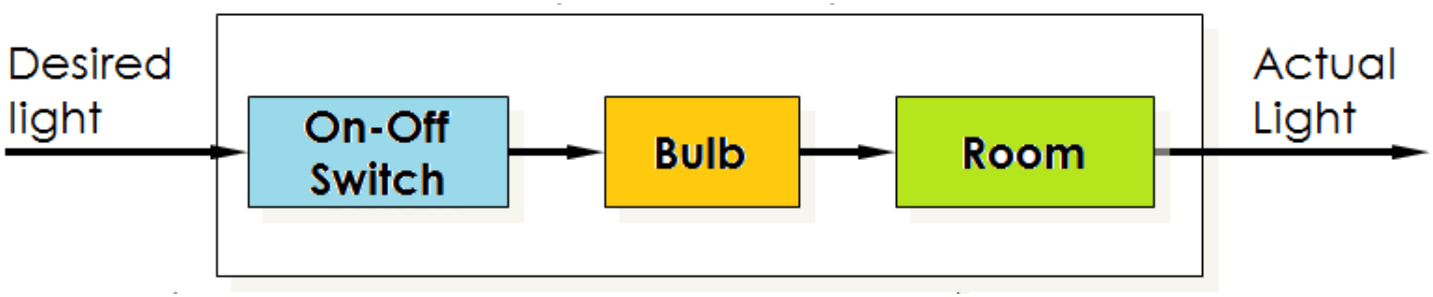
A control system consists of these elements:

1. **Input**: the desired response of a control system
2. **Output**: the actual response of a control system
3. **Subsystem:** any system that helps controlling the output of the control system
4. **Plant:** a system where the output is the variable to be controlled.

Elements of control system

A control system consists of these elements:

1. **Input**: the desired response of a control system
2. **Output**: the actual response of a control system
3. **Subsystem:** any system that helps controlling the output of the control system
4. **Plant/Process:** a system where the output is the variable to be controlled.



Example: air-conditioning

Plant: The room

Input: Desired luminosity

Output: Actual luminosity

Subsystems: Switch & bulb

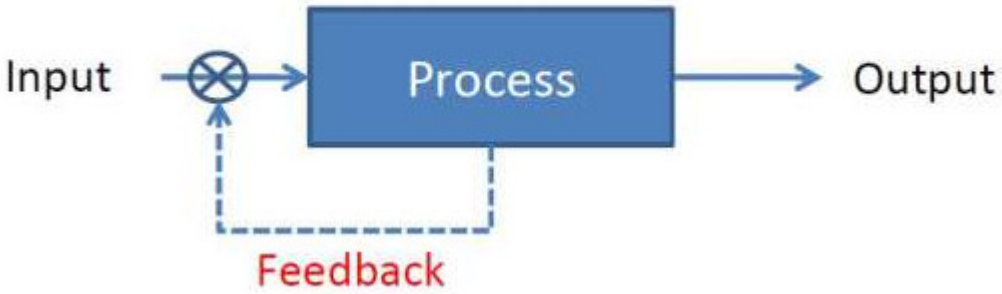
Actuator: bulb

Types of control systems

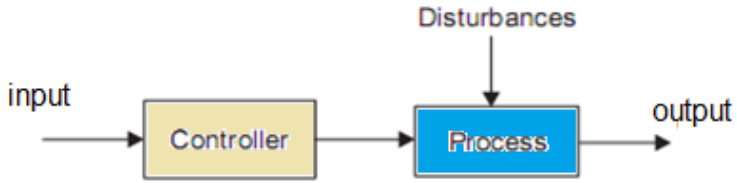
Types of control system :

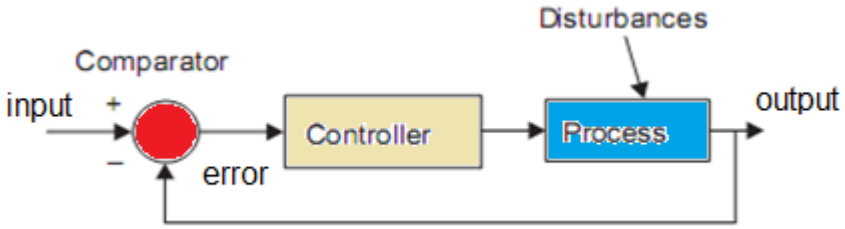
- OPEN LOOP SYSTEM

- CLOSED-LOOP FEEDBACK SYSTEM



Open loop vs. Closed loop



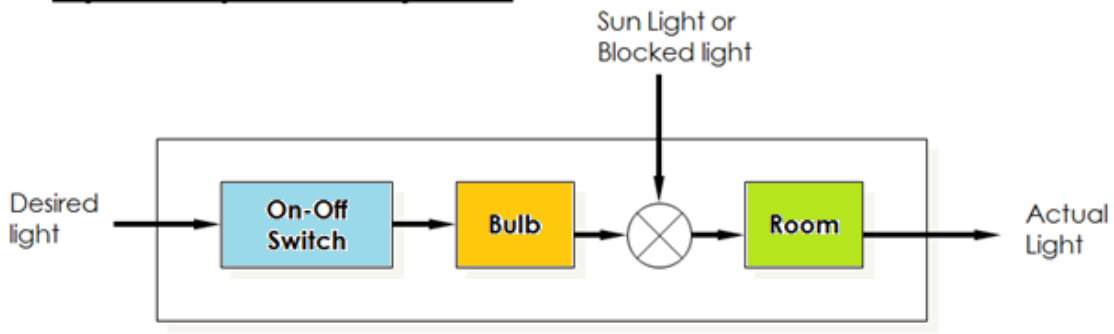


Open loop	Closed loop
No continuous control over the output	Continuous control over the output
The input has predict / to take into account eventual disturbance	Eventual disturbance will be auto-corrected
No feedback loop	Additional sensor and comparator need to be integrated into the feedback loop
The input into the controller is constant	The input into the controller is the error signal (which varies in function of disturbance)

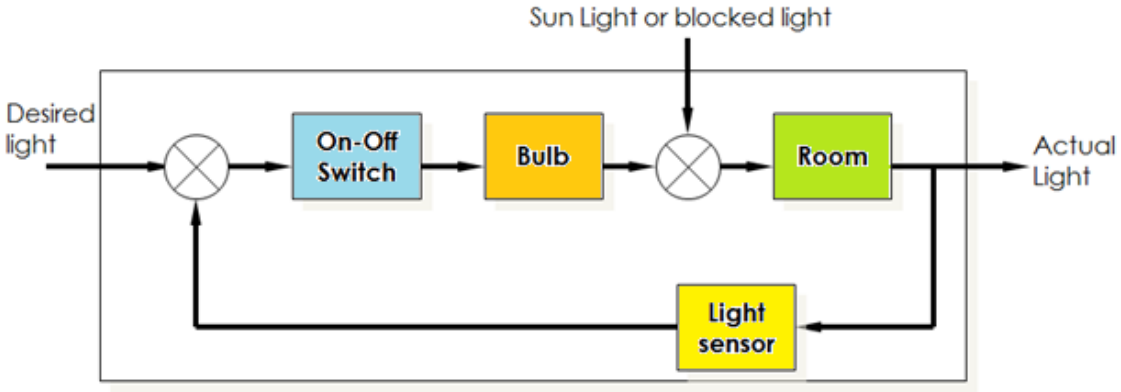
Closed loop system: Example

Taking the previous example of having a certain desired luminosity in a room, the open loop system can be transformed to closed loop as shown below

Open-loop control system:

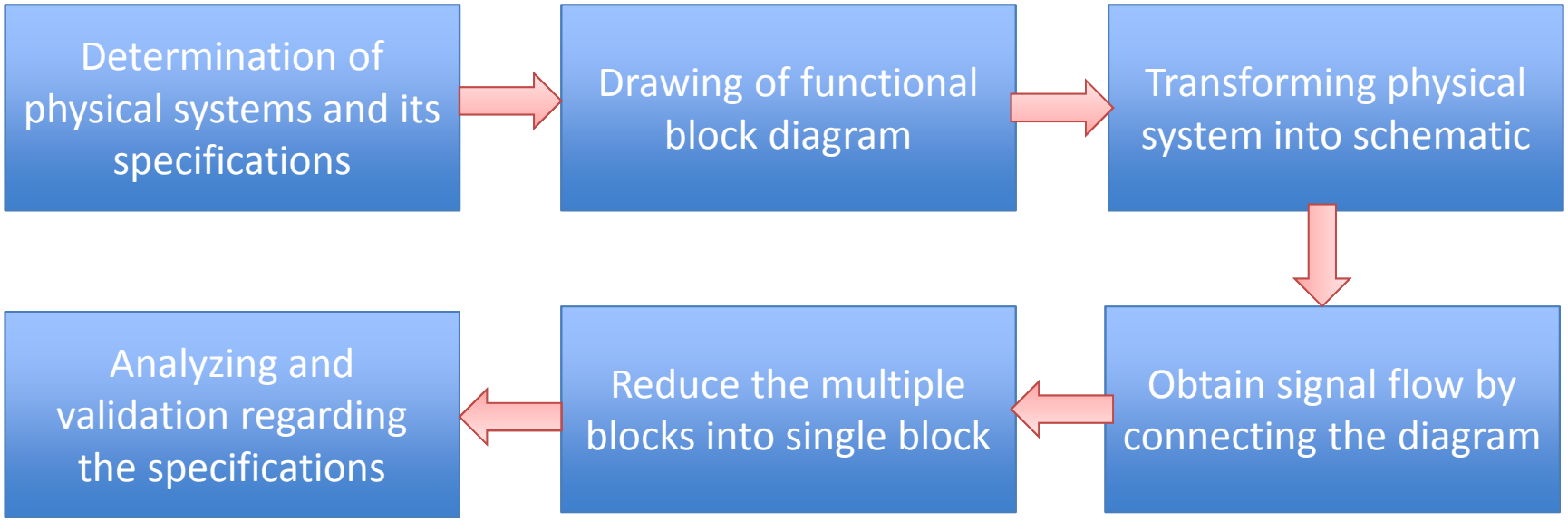


Closed-loop control system:



Control systems design process

From a physical systems to control diagram, several steps are involved including the Steps below. Throughout the course, we will see those elements



Conclusion of The Chapter

In this chapter, the following concepts have been explored

- The importance of Automatic Control in Mechanical Engineering and related issues
- Definition of control systems
- Elements of a control systems
- Open loop vs. Closed loop
- Brief on control system design

Thank you

Should there be any question, please contact the author at
mahizami@ump.edu.my