FACTFILE:
GCE TECHNOLOGY & DESIGN

1.18 MECHANICAL AND PNEUMATIC SYSTEMS AND CONTROL: PART 1

Rewarding Learning

Mechanical and Pneumatic Systems and Control: Part 1

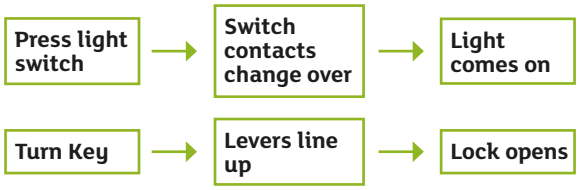
Learning outcomes

Students should be able to:
- analyse Mechanical and Pneumatic control systems in terms of input, control, output, on / off continuous control, and open and closed loop systems using feedback;

Control systems are defined as a device that controls the outcome of other devices using a set of commands or functions. All complex control systems can be described by the systems approach. There are three sub systems that are integral to the operation of the overall system, they include; **Input, Control, Output.**

The use of a control system is made up of these three sub systems which perform individual operations by following set programmes or functions. They can be found in different forms depending on each systems requirement. The basic building blocks of the system's approach can be seen below.

The systems approach can be used to explain how a system operates without having to go through the detail. Below is an example of how a systems approach can be used to break down the key components, making it easier to identify a specific area which can be categorised under one of the three sub systems.



Inputs

For the purposes of mechanical and pneumatic control systems, an input can be a **movement** or a **change in the environment.** An example of this can be a user pressing a button to activate a system or alternatively **a single acting cylinder activating a 3PV.** For the purposes of a mechanical system an input can take the form of the energy being used to operate the mechanism. An example of this could be a **simple handle using the turning force created by the user** or a **motor driving a shaft** attached to a pulley system.

Mechanical Inputs are the result of a change in **movement / motion,** they are:
- Linear
- Rotary
- Reciprocating
- Oscillating

Controls

The control element of a mechanical and pneumatic system focuses on the operation of the device or system. The control of a mechanical system is the **conversion of one type of motion into another,** an example of this would be the

reciprocating motion of a crank and slider which results in an output of rotary motion. The control aspect of a pneumatic system focuses on the **directional change in air using components such as a 3/2 valve or a 5/2 valve.** It is important to remember that when considering mechanical and pneumatic systems it is often found that the component is usually the control and that the change in movement or motion is the varying factor.

Outputs

An output can be viewed as a **movement** caused by the input to achieve a desired outcome, for example move a box along a conveyor belt, clamp a piece of material securely during drilling or even lift a heavy object to a certain height. A mechanical output can be viewed as the final outcome, such as the **rotation of a chuck** on a pillar drill or the **rotation of a bicycle wheel.** A pneumatic output is the **movement of a SAC or DAC piston arm.**

Mechanical Outputs result in a change in **movement / motion,** they are:

- Linear
- Rotary
- Reciprocating
- Oscillating

On / Off Continuous Control

On/off control is where a system can only exist in one of two states, on or off. E.g. a light switch. Continuous control is when a system can exist anywhere between two extremes. E.g. a light switch with a dimmer can be on, off or anywhere in between.

Open Loop Systems

Open loop systems are simply a control system where a typical input controls an output with no feedback present. Examples of this are a light switch or cruise control on a car engine. Open loop systems are made up of blocks that are connected together in a linear way. Each sub system leads into the next as a result of the previous completing its task. An example of an open loop system would be a user activating a 3PV using a push switch, this in turn activates the 3PV and sends a SAC positive.

Open loop block diagram

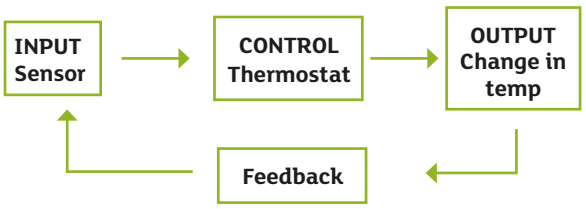
In the above system the push button activates the system which allows air to flow through the 3PV and into the SAC which in turn goes positive, extending the piston rod. The limitations of the open loop system are evident as the input in the system is not influenced by the output that occurs. The system cannot be corrected if there is an incorrect output.

Closed Loop Systems

A closed loop system is more complex and is generally used when there is a need to measure something or provide feedback to adjust the system's input in some manner. An example of this would be a fridge whereby the temperature is controlled and adjusted when necessary. The closed loop system not only carries out the desired task but it also provides a way of checking that the task was completed correctly. This system which allows for 'checking' is known as **feedback**.

Feedback can come in two different forms; positive and negative feedback. Positive feedback is where the output of a system is moved away from its original state. Negative feedback directs the output towards its original position.

Closed loop block diagram with feedback



The feedback can involve the person having to manually adjust the input. An example of this could be adjusting a flow control valve to restrict the amount of air entering a SAC. There are more sophisticated systems that check themselves therefore eradicating the need for user interaction.

Revision Questions

1 Briefly distinguish between open and closed loop systems.

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2 What is meant by the term feedback?

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3 A system is required to manually operate a machine clamp in a manufacturing plant. The operator will be required to manually activate the clamp during operation. Design a block diagram that will provide a solution.