FACTFILE:
GCE TECHNOLOGY & DESIGN

1.43 SYSTEMS AND CONTROL

Rewarding Learning

Systems and Control

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

Course content

Students should have a knowledge an understanding of both mechanical and pneumatic control systems in terms of input, control, output, on/off continuous control and open and closed loop systems using feedback and be able to demonstrate how these systems might be used in industry.

Mechanical Control Systems

A mechanical system is a device made up of various mechanical parts. Its input is provided by an effort. Once the effort and is applied, it can set off a motion to move a load. The force applied to the load is the output of the mechanical system. Examples of mechanical systems include levers, gears and shafts. Fig. 1 shows some examples of mechanical systems.

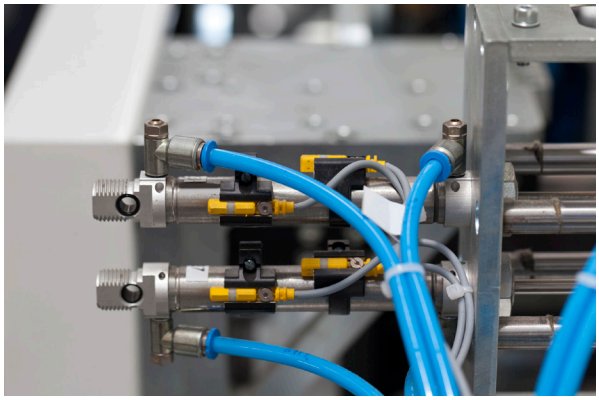
(a) Can opener

(b) Corkscrew

Fig. 1 Examples of mechanical systems

Pneumatic control systems

A pneumatic system is a system that uses compressed air to transmit and control energy. Air is first pressurised to give energy in the cylinder. Then signals are input into the system through the use of switches. Next, air is transferred through sealed pipes to the pneumatic parts/ cylinders for processing. Finally, the force produced by the pneumatic parts is utilised to finish the designated task. The use of pneumatic systems is very extensive, for example, in controlling the movement of train doors, the operation of automatic production lines and mechanical clamps, etc.



(a) Production line of CD-ROM (b) Mechanical clamp
Fig. 2 Examples of pneumatic systems

Input, Control, Output, On/off continuous control

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.

Control

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 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 and Closed Loop Systems

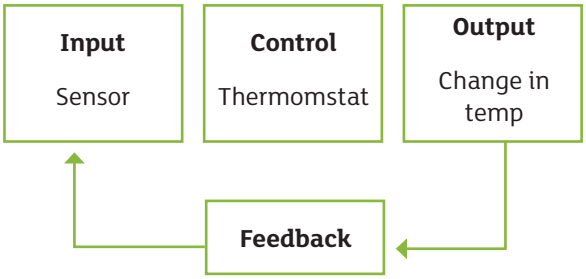
Open Loop Systems

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.

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 Explain closed loop systems and give examples of where closed loop systems might be used in industry.

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2 Describe the various types of mechanical output

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3 Describe the characteristics of an open loop system when applied to mechanical and pneumatic control systems

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