

Unit 8D Using control for security

Focus: control

About the unit

The main aim of this unit is for pupils to learn how to apply and combine their understanding of mechanisms, pneumatics and computer control when designing and making.

In this unit, pupils tackle a design and make assignment (DMA) on the theme 'Safe and sound', in which they produce a computer-controlled security system that includes interlocking and alarms.

Pupils gain the knowledge, skills and understanding they need to carry out the DMA successfully through product evaluation activities and focused practical tasks. They:

- design computer-controlled systems that control a range of output devices and monitor a range of input signals
- implement designed computer-controlled systems so that they respond to real signals and control real devices
- model a range of locking and opening/closing mechanisms, and include these in their own designs
- use a modelling system to create strong and stable structures for testing security devices
- integrate the structural and mechanical elements of a modelling system to create complex working models

There are also opportunities for pupils to:

- use simple coding systems and to implement these in security and other systems

Where the unit fits in

This unit is expected to take 15–22 hours.

This is one of three units that focus on using control: one in year 7 on using electrical and mechanical control to control a display; this one in year 8 on programming a computer-based controller when using control for security; and one in year 9 on designing and making electronic circuits for control when using control for electronic monitoring. (There is an option to introduce microcontrollers in year 9.) These units ensure progression in understanding a range of control technologies and their use in designing and making.

It is expected that pupils in all years will go beyond simply ensuring that control technologies work, to designing, modelling and making products that incorporate the control aspects. In this unit, the focus is on modelling a working security system using kits, resistant materials, or a mixture of both. There are opportunities to develop pupils' skills in both mechanical control and structural design.

If you choose not to teach this unit, then plan to include the essential activities identified by the symbol ■ as part of another unit.

If this unit is used later in year 8, then pupils should be able to complete more of the optional activities. Teachers may find it helpful to use this unit as an end-of-year project, to bring together knowledge and develop group skills.

Expectations

At the end of this unit

most pupils will: work with a range of tools, equipment, materials, components and control elements, including electronic and mechanical components, showing understanding of their characteristics; draw on and use their understanding of computer control to produce a real working model; draw on and use their understanding of simple coding systems; draw on and use their understanding of structural and mechanical modelling; draw on and use their understanding of the operation of locking and opening/closing mechanisms; produce a finished security system that works as planned, combines components and control systems effectively, relates the modelling produced to final product ideas, and reflects group collaboration; evaluate their security system in use and identify ways of improving it

some pupils will not have made so much progress and will: work with structural and mechanical components; use some locking and opening/closing mechanisms; use some elements of computer control to produce a real working model; use some simple coding systems; produce a finished security system that is suited to its purpose; test and evaluate their security system to show they understand the situation in which it will function

some pupils will have progressed further and will: go beyond the use of modelling components in their solution to produce a prototype system that includes other materials, taking full account of their characteristics, *eg using resistant materials in structural elements*; apply a more sophisticated understanding of computer control to their designing and making, so that their end product contains a wider, fully realistic, functional range; produce a security system that works effectively; use appropriate techniques to evaluate the system, taking into account the needs of its intended users

Prior learning

It is helpful if pupils have:

- learnt how control systems are used in everyday life
- used appropriate vocabulary relating to control systems
- modelled their ideas for their own product using mechanisms, by using construction kits or making a model from a set of instructions
- included an electric motor in a simple circuit
- learnt how the direction of rotation and speed of an electric motor can be controlled
- learnt that there are different sorts of switches
- assembled components to make working models
- controlled the speed and direction of movement using pulleys and/or gears
- designed and carried out fair tests to compare the strength of frame and sheet structures
- used cams and linkages to create a particular kind of motion
- used levers to change the amount and force of a movement in a planned way

Pupils should have gained the above knowledge, skills and understanding in years 6 and 7, through unit 6C ‘Fairground’ and unit 6D ‘Controllable vehicles’ in the key stage 2 scheme of work and unit 7D ‘Using control to control a display’, or similar projects.

Language for learning

Through the activities in this unit, pupils will be able to understand, use and spell correctly words relating to:

- structures and structural elements, *eg force, load, compression, tension, strut, tie, reinforcement*
- mechanical and pneumatic components and their assembly, *eg worm gear, spur gear, bevel gear, slider, cam, follower, linkage, valve, cylinder*
- computer-controlled elements, including external devices and components, *eg interface, input, output, port, sensor, switch, high, low, motor, solenoid, continuous control, sequence, sequential control, feedback, code, set, reset, flow chart, system diagram, procedure, microcontroller, download*

Reading – through the activities pupils could:

- understand information which is not explicitly stated or that the reader is assumed to understand
- distinguish facts from hypotheses/theories/opinions and how far the information is complete and helpful

Resources

Resources include:

- technical modelling components, *eg Fischertechnik, Lego, Polymek, Meccano Airways*, including mechanical elements, *eg cams, pulleys, gears, wheels, axles, valves, cylinders*
- a computer-based control system, *eg*
 - a computer with a suitable interface (sometimes known as a buffer box) and control software
 - a computer with a controller that can be used independently of the computer once it is programmed, and control software
 - a computer used to program an embedded control system, such as a microcontroller or smart card
 - a programmable controller that can be programmed without a computer, such as
 - SEQ programmable controller from Commotion
 - Lego™ control centre or programmable brick
 - Bit-by-bit controller from the Technology Enhancement Programme
 - SmartCard controller from the Technology Enhancement Programme
- input and output devices, *eg light, temperature, pressure and magnetic sensors, switches, buzzers, lamps, LEDs, solenoids, motors, piezoelectric sounders*, and a means of mounting these on the structural and mechanical components
- useful websites, *eg*
 - www.sdsystems.com
 - www.amsys.co.uk
 - www.jpssystem.com
 - www.stratasys.com
 - www.howstuffworks.com/inside-lock.htm
 - www.howstuffworks.com/electromagnet.htm
 - www.howstuffworks.com/question238.htm
 - www.howstuffworks.com/microcontroller.htm
 - www.howstuffworks.com/house2.htm
 - www.dtonline.org/apps/infopage/app.exe?3&6&1&0&1&0

Future learning

Pupils could go on to a further systems and control unit, *eg unit 9D ‘Using control for electronic monitoring’*.

Out-of-school activities and homework

Pupils could:

- survey security systems in local or city shops, and at home
- collect examples or pictures/ photographs of different approaches to domestic security for a class discussion

Links with other subjects

- Science: unit 9L ‘Pressure and moments’ gives pupils experience of structural and mechanical modelling with components, how levers work and how things balance.
- ICT: year 9 unit 13 ‘Control systems’ builds on learning from this unit, teaching pupils more about inputs, outputs, procedures and constraints of systems and testing.
- Mathematics: coding systems.
- English: reporting on research findings, debating values issues relating to security.

Learning objectives

Pupils should learn:

Possible teaching activities**Learning outcomes**

Pupils:

Points to note**DESIGN AND MAKE ASSIGNMENT (DMA)**

- to design a product that brings together their knowledge and understanding of a range of technologies, including computer control, to meet a specific purpose, by applying the knowledge, skills and understanding they developed during the product evaluation activities and focused practical tasks

Set the pupils a DMA that requires them to bring together their knowledge, skills and understanding of computer control and mechanical components to meet a specific and appropriate purpose. This assignment could be used to develop group skills and team work.

Example

This example DMA has been written so it can be copied and given directly to pupils. Further details or contexts can be added, as appropriate.

Safe and sound

Security systems that improve commercial, domestic and personal security are becoming increasingly widespread and sophisticated, depending more and more on electronic and computer control. The use of such systems also raises questions about social issues, *eg personal privacy*.

Design an effective computer-controlled system to improve security in a domestic, personal or commercial setting, *eg to prevent theft, to detect tampering or to control access*. Think carefully about how the system could distinguish between legitimate and unauthorised users.

- research the background to the setting, survey existing security solutions and use the information they collect to inform their own designing
- put together a design specification
- discuss, as a group, how they can use output devices and sensors in their design ideas
- make preliminary models to explore and test their thinking
- experiment with alternative designs and model mechanisms to establish correct working before they decide on their final proposal
- propose appropriate control systems and sub-systems
- prepare an ordered sequence for managing the task
- evaluate their product by comparing it with design criteria at chosen stages in its development

PRODUCT EVALUATION

Organise a range of activities that give pupils an opportunity to:

- examine, describe and evaluate the various ways in which different types of property are kept secure (including electronic, physical and social)
- investigate a range of approaches to allow authorised access and to warn of security violations
- explore and evaluate the working of a range of electronically controlled devices, including those that incorporate embedded computer control
- examine some of the values issues that are raised by introducing security systems



Health and safety – care should be taken to ensure that pupils can assess immediate risks when carrying out product evaluation activities, *eg teachers should give clear information and supervise activities if pupils are dismantling locking mechanisms*

■ essential activities

○ optional activities

Learning objectives

Pupils should learn:

- to identify the need for, and constraints on, the development of security systems in a wide range of contexts, *eg commercial, domestic, personal*
- to recognise and understand the operation of simple electrical, mechanical and pneumatic locking elements, *eg to operate a bolt, move a shutter*
- to consider the advantages and disadvantages of different approaches used in security systems, *eg deterrence, physical barriers, computer-based sensing, surveillance*
- to identify important values issues that are raised by introducing security systems
- to consider the constraints on security system design as a result of the setting, *eg the need for public access, ease of use*

Possible teaching activities

- Discuss with the pupils and ask them to list:
 - how individuals keep their possessions secure
 - how companies keep their possessions secure
 - why we need security systems
 - the alternatives to security devices
 - the disadvantages of security systems
 - the rules or laws that regulate the use of security systems
- Ask the pupils to examine and, where possible, disassemble a range of locking mechanisms, *eg door locks, window locks, case locks, bicycle locks*, in order to establish how the locking mechanism works and how it is controlled.
- Ask the pupils to survey security systems in local or city shops. Ask them to make a list of the various systems, *eg security tags, security guards, in-store video surveillance, street video surveillance, staff bag searches*. Ask the pupils to establish why each is used, and who the winners and losers might be.
Note: prior agreement and support for the survey should be secured from shop managers so that its purpose and context are clear.
- Discuss with the pupils examples of domestic or personal security systems, *eg for a bicycle, the home, a car*. Some, *eg bicycle security systems*, can be examined in school, while others can be shown as photographs. Encourage the pupils to note the use of computer control.
- Discuss with the pupils the principles of security. Ask them to list the things that make people notice security systems, *eg the different types of security alarms that alert people to a problem*.

Learning outcomes

Pupils:

- describe the possibilities for improving security in a given situation, listing the advantages and disadvantages of each approach
- describe the electrical, mechanical and pneumatic systems used in a locking system and explain their purpose, *eg the use of a solenoid valve to provide a signal to a pneumatic locking mechanism, the physical catch in a bike lock*
- suggest approaches to improving security in a given situation, listing the advantages and disadvantages of each
- identify and describe some social benefits and costs of a particular approach to security
- identify why particular security approaches have been used for practical and social reasons

Points to note

Health and safety – teachers must give a full explanation of safe working practice when disassembling electronically controlled devices

Language for learning during product evaluation

- Ask pupils to work in small groups for discussion and individually for writing, to survey promotional material for a range of security systems. Pupils should identify the use of factual and other information, evaluating the issues of security needs. Pupils should be able to distinguish facts from persuasive commentary.

■ essential activities

○ optional activities

Pupils should learn:

Pupils:

FOCUSED PRACTICAL TASKS (FPTs)

These practical tasks should focus on the knowledge, skills and understanding outlined in 'About the unit'. They should give pupils an opportunity to practise any new skills they will need during the DMA.

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| <ul style="list-style-type: none"> ■ how to use a modelling system to create strong and stable structures ■ how to integrate the structural and mechanical elements of a modelling system to create working models | <ul style="list-style-type: none"> ■ Set up an activity that gives the pupils experience of structural modelling with mechanical and/or pneumatic components. This could include integrating mechanical systems into a well-designed structure with the strength to support them, <i>eg using a modelling kit to build a range of relevant systems, following instruction sheets</i>. Set the pupils simple closed design briefs to build systems with particular structural, mechanical and/or pneumatic features. | <ul style="list-style-type: none"> ■ construct structural, mechanical and/or pneumatic models according to given instructions ■ design and construct effective structural and mechanical and/or pneumatic models for a purpose, <i>eg a lift-door mechanism, a walking automaton</i> |
| <ul style="list-style-type: none"> ■ to design computer-controlled systems that control a range of real output devices and monitor a range of real input signals | <ul style="list-style-type: none"> ■ Give the pupils an opportunity to explore and learn how to use a computer-controlled environment to implement a controlled system, <i>eg</i> <ul style="list-style-type: none"> – to control outputs – how to monitor the state of inputs – how to produce a sequence of steps – how to 'run' a developed program – how to connect input and output devices to the controller | <ul style="list-style-type: none"> ■ design and model computer-controlled systems for a purpose and implement them to control real systems, <i>eg barrier-controlled access to a model car park</i> |
| <ul style="list-style-type: none"> ○ about a range of locking and opening/closing mechanisms ○ how to model locking and opening/closing systems and include them in their own models | <ul style="list-style-type: none"> ○ Ask the pupils to model examples of manually, electrically and pneumatically operated locking and opening mechanisms, <i>eg using a modelling kit with motors, solenoids, pneumatic cylinders, or using a pneumatic control system</i>. The mechanisms should be based on real examples.
Note: this activity could be a follow-up to a disassembly task. | <ul style="list-style-type: none"> ○ describe qualitatively the operation of locking and opening/closing mechanisms, <i>eg a screw mechanism to move a bolt, a rotating mechanism to move a catch, a pneumatic cylinder controlled by a 3-port valve</i> ○ design and construct effective models of locking and opening/closing mechanisms |

■ essential activities

○ optional activities

Learning objectives

Pupils should learn:

- about computer-controlled systems and how they can be used in security and other systems
- how coding systems can be implemented simply

Possible teaching activities

- Provide activities that allow the pupils to learn about computer-controlled systems, *eg using the computer-controlled system they are familiar with, learning how to arm and disarm a system by pressing switches in a set order or pattern.*

Learning outcomes

Pupils:

- explain the working of a simple coding system and its purpose in a security system, *eg the use of a PIN to arm and disarm a burglar alarm*
- implement simple coding within a computer-controlled system that they are designing

Points to note

■ essential activities

○ optional activities