1. Year Groups

Years 5/6

2. Aspect of D&T

Electrical systems

Focus

Monitoring and control

3. Key learning in design and technology

Prior learning

- Initial experience of using computer control software and an interface box, a standalone box or microcontroller, e.g. Crumble.
- Some experience of writing and modifying a program to make a light turn on or flash on and off.
- Understanding of the essential characteristics of a series circuit and experience of creating a battery-powered, functional, electrical product.

Designing

- Develop a design specification for a functional product that responds automatically to changes in the environment.
- Generate, develop and communicate ideas through discussion, annotated sketches and pictorial representations of electrical circuits or circuit diagrams.

Making

- Formulate a step-by-step plan to guide making, listing tools, equipment, materials and components.
- Competently select and accurately assemble materials, and securely connect electrical components to produce a reliable, functional product.
- Create and modify a computer control program to enable their electrical product to respond to changes in the environment.

Evaluating

- Continually evaluate and modify the working features of the product to match the initial design specification.
- Test the system to demonstrate its effectiveness for the intended user and purpose.

Technical knowledge and understanding

- Understand and use electrical systems in their products.
- Understand the use of computer control systems in products.
- Apply their understanding of computing to program, monitor and control their products.
- Know and use technical vocabulary relevant to the project.

4. What could children design, make and evaluate?

cycle or vehicle alarm security lighting system
alarm for valuable artefact garden light
automatic nightlight electronic moneybox
alarm for school shed other – specify

5. Intended users

vehicle or cycle owner school community
school administrator themselves siblings
parents security staff other – specify

6. Purpose of products

safety protection security detection
warning comfort illumination entertainment
other – specify

7. Links to topics/themes

Our School Toys and Games
Keep Safe Ourselves
Culture and Leisure Travel Homes
Buildings other – specify

8. Possible contexts

home school community culture
leisure enterprise business
other – specify

9. Project title

Design, make and evaluate a _____ (product) for _____ (user) for _____ (purpose).

To be completed by the teacher. Use the project title to set the scene for children's learning prior to activities in 10, 12 and 14.

10. Investigative and Evaluative Activities (IEAs)

- Discuss a range of relevant products (such as nightlights, garden lights, alarm systems, security lighting, electronic moneyboxes) that respond to changes in the environment using a computer control program e.g. *Why is a computer control program used to operate the products? What are the advantages of using computer control? What input devices, e.g. switches, and output devices, e.g. bulbs and buzzers, have been used? Who have the products been designed for and for what purpose?*
- Investigate sensors such as light dependent resistors (LDRs) and a range of switches such as push-to-make, push-to-break, toggle, micro and reed switches. To gain an understanding of how they are operated by the user and how they work, ask the children to use each component to control a bulb in a simple circuit. Remind children about the dangers of mains electricity.
- Children could research famous inventors related to the project e.g. Thomas Edison – light bulb.

11. Related learning in other subjects

- **Spoken Language** – ask relevant questions, give well-structured descriptions and explanations. Build technical vocabulary.
- **Computing** – use technologies for research purposes and be discerning when evaluating digital content.
- **Science** – apply knowledge and understanding of circuits, switches, conductors and insulators.

12. Focused Tasks (FTs)

- Through teacher demonstration and explanation, recap measuring, marking out, cutting and joining skills with construction materials that children will need to create their electrical products.
- Using a model circuit, demonstrate and enable children to practise using different input and output devices. Allow them to practise methods for making secure electrical connections e.g. using wire strippers, twist and tape connections, screw connections, crocodile clips and connecting blocks.
- Remind children how to avoid making short circuits.
- Drawing on science understanding, ask the children to explore a range of electrical systems that could be used to control their products, including a simple series circuit where a single output device is controlled, a series circuit where two output devices are controlled by one switch and, where appropriate, parallel circuits where two output devices are controlled independently by two separate switches.
- Drawing on related computing activities, ensure that children can write and modify computer control programs that include inputs, outputs and decision making. Test out the programs using electrical components connected to microcontrollers, interface boxes or standalone boxes.

13. Related learning in other subjects

- **Science** – apply knowledge and understanding of circuits, switches, conductors and insulators.
- **Computing** – design, write and debug programs that accomplish specific goals, including controlling physical systems. Use sequence, selection, and repetition in programs. Work with variables and various forms of input and output.
- **Mathematics** – apply understanding and skill to carry out accurate measuring using standard units i.e. cm/mm.
- **Spoken language** – asking questions to check understanding, develop technical vocabulary and build knowledge.

14. Design, Make and Evaluate Assignment (DMEA)

- Develop an authentic and meaningful design brief with the children.
- Ask the children to generate innovative ideas by drawing on research and develop a design specification for their product, carefully considering the purpose and needs of the intended user.
- Communicate ideas through annotated sketches, pictorial representations of electrical circuits or circuit diagrams, including the microcontroller, interface box or standalone box to be used. Drawings should indicate the design decisions made, including the location of the electrical components and how they work as a system with an input, process and output. Reference should be made to the control program used and how it will operate to control the inputs and outputs.
- Produce detailed step-by-step plans and lists of tools, equipment and materials needed. If appropriate, allocate tasks within a team.
- Make high quality products, applying knowledge, understanding and skills from IEAs and FTs. Create and modify a computer control program to enable the product to work automatically in response to changes in the environment.
- Critically evaluate throughout and the final product, comparing it to the original design specification. Test the system to demonstrate its effectiveness for the intended user and purpose.

15. Related learning in other subjects

- **Mathematics** – apply understanding and skill to carry out accurate measuring using standard units i.e. cm/mm.
- **Science** – apply knowledge and understanding of circuits, switches, conductors and insulators.
- **Computing** – design, write and debug programs that accomplish specific goals, including controlling physical systems. Use sequence, selection, and repetition in programs. Work with variables and various forms of input and output.
- **Spoken language** – maintain attention and participate actively in collaborative conversations, staying on topic and initiating and responding to comments. Develop understanding through speculating, hypothesising, imagining and exploring ideas.

16. Possible resources

microcontroller or standalone control box or interface box

collection of battery-powered, manually-controlled and programmable products

batteries, battery holders, crocodile leads

different output devices including bulbs with bulb holders, buzzers, light emitting diodes (LEDs), motors

different input devices including micro switches, reed switches and magnets, light dependent resistors (LDRs)

wire, automatic wire strippers, masking tape, construction materials and tools as required

17. Key vocabulary

reed switch, toggle switch, push-to-make switch, push-to-break switch, light dependent resistor (LDR), tilt switch

light emitting diode (LED), bulb, bulb holder, battery, battery holder, USB cable, wire, insulator, conductor, crocodile clip

control, program, system, input device, output device, series circuit, parallel circuit

function, innovative, design specification, design brief, user, purpose

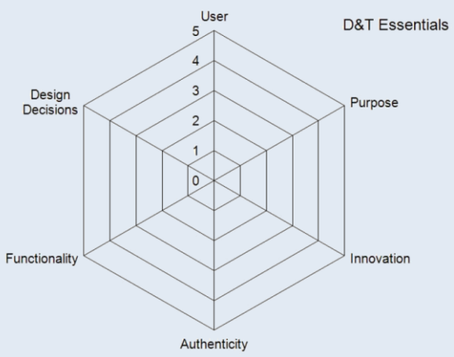
18. Key competencies

problem–solving teamwork negotiation
consumer awareness organisation motivation
persuasion leadership perseverance
other – specify

19. Health and safety

Pupils should be taught to work safely, using tools, equipment, materials, components and techniques appropriate to the task. Risk assessments should be carried out prior to undertaking this project.

20. Overall potential of project



Years 5/6

Electrical Systems

Monitoring and control

Instant CPD

Tips for teachers

- ✓ Please also refer to the Instant CPD guidance in 'Year 5/6 Electrical systems – more complex switches and circuits' and 'Year 3/4 Electrical Systems – simple programming and control' when carrying out this project.
- ✓ To ensure progression from Y3/4, children need to develop an understanding of 'monitoring' as well as control and the idea of 'input' as well as 'output'.
- ✓ Ask children to save different versions of their programs as evidence of using an iterative process.
- ✓ Check the condition of the batteries prior to activities.
- ✓ Set up a 'working' circuit so that children can test suspect components.
- ✓ Make sure electrical components and batteries match e.g. 1.5v bulb with a 1.5v battery.
- ✓ Some components (e.g. buzzers and LEDs) need to be connected the right way round in a circuit, ensuring positive and negative match the outputs of the interface box or microcontroller.
- ✓ If you are using the Crumble microcontroller, look online for example projects that others have completed.
- ✓ Teach children how to avoid making short circuits.
- ✓ If children are designing and making an electronic moneybox, to lessen the risk of a short-circuit use plastic coins or wooden wheels as 'money'.
- ✓ Use 1.5v AA zinc carbon or zinc chloride batteries.
- ✓ Do not use rechargeable, lithium or alkaline batteries.
- ✓ Switch off the Crumble's battery box when not in use.
- ✓ Use Crumble-friendly battery boxes with a built-in resettable fuse to protect against short circuits.
- ✓ Use light emitting diodes (LEDs) with internal resistors.
- ✓ Use non-mercury tilt switches.

Useful resources from www.data.org.uk

- **Primary-specific Crumble kit suitable for KS2 and related guidance**
- **Primary Subject Leaders' File Sections 5.8 and 5.10**
- **Applying Computing in D&T at KS2 and KS3**
- **Alarming vehicles**
- **Designing and making alarm circuits using inputs with computer control**
- **Developing handmade switches**

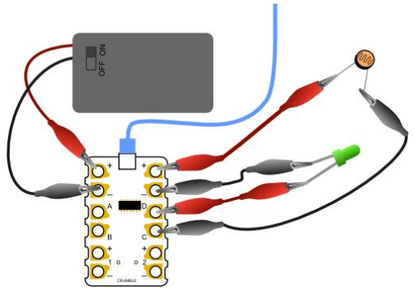
D&T Association publications:

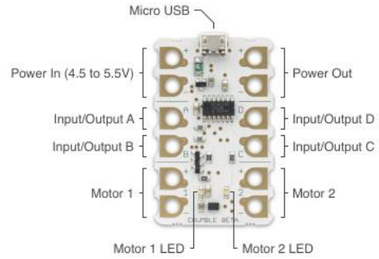
- **Primary Helpsheets - Units 4C, 4D, 4E, 6C, 6D**
- **Primary Lesson Plans - Units 4C, 4D, 4E, 6C, 6D**

Please note that these publications are based on previous National Curricula.

Connecting up a Crumble

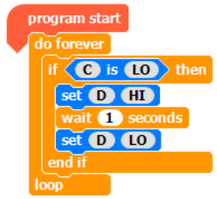
This arrangement is for an automatic nightlight, using a light dependent resistor (LDR) as the monitoring or input device and a light emitting diode (LED) as the output device.

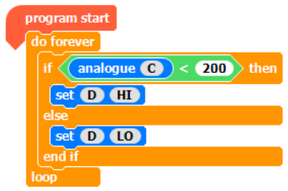




Example programs for an automatic nightlight

The LED connected to output D switches on when it goes dark. Change the value of the LDR connected to terminal C so that the system is activated at different light levels.

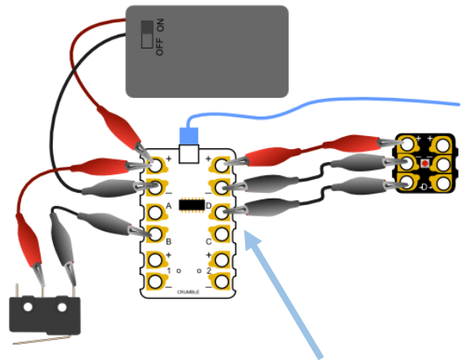




LED – connect +ve to D and -ve to Power Out
LDR – connect -ve to C and +ve to Power Out

An example program for an electronic toy moneybox

A sparkle LED is connected to the Crumble and switches from green to yellow to red every time a plastic coin is placed through the slot of the moneybox and depresses a micro switch connected to terminal B.



Connect the crocodile clips to 'common' and 'normally open' on the micro switch. Connect the +ve lead to Power In and -ve lead to B.

Use the 'D' output for sparkles.

How could children adapt the program so that it would detect a burglar stealing the moneybox?

What type of output device could they use?

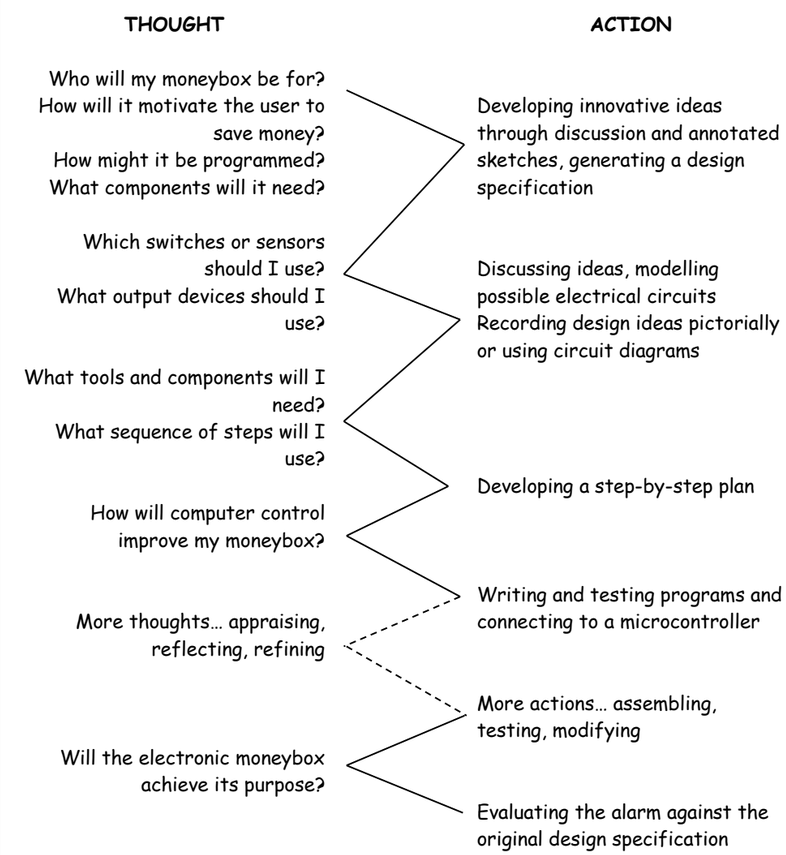
What type of switch could detect the movement of the moneybox?

How could the program be adapted to remind the user to save money on a regular basis?

Once the Crumble has been programmed, it will remember the program and run it automatically when the USB cable is disconnected.

Designing, making and evaluating an electronic toy moneybox for a child

An iterative process is the relationship between a pupil's ideas and how they are communicated and clarified through activity. This is an example of how the iterative design and make process *might* be experienced by an individual pupil during this project:



Glossary

Program – a sequence of instructions that can be used to control electrical components.

Microcontroller – a device that can be programmed to control how an electrical product operates.

Light emitting diode (LED) – an output device that glows when electricity is passed through it.

System - a set of related parts or components that together achieve a desired outcome.

Output devices - components that produce an outcome e.g. bulbs, motors and buzzers.

Input devices - components that are used to control an electrical circuit e.g. switches.

Process – how a computer program controls one or more output devices.