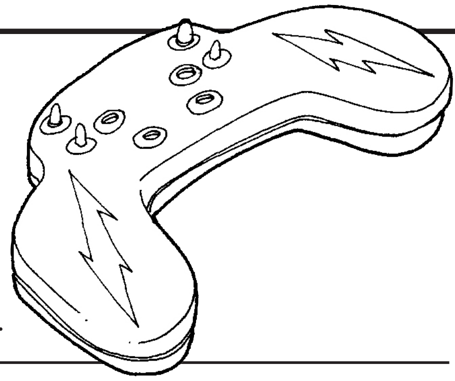
# Electronic education



## *The big picture*

### Task

To design and make an electronic educational toy to meet an identified need.

### The story so far

Electronic Education is a company that specialises in developing fun electronic toys that meet an educational need. Its products are usually built around microcontroller integrated circuits. The students' task is to identify a situation where an electronic toy could meet a learning need and then to develop a product that meets that learning need.

## Learning

### Designing

Using a learning need as a starting point for design ideas. Using a systems approach for designing electronic products.

### Making

Producing printed circuit boards, mounting components onto printed circuit boards, making product cases, fixing primed circuit boards and batteries into product cases.

### Technical matters

Understanding the functioning of a simple electronic product as a system and as a microcontroller plus associated components.

### Other matters

User interfaces for electronic products.

Product life-cycle of electronic products.

## Design decisions

**The sort of product**

This has been decided by the teacher – an electronic toy that meets a learning need.

**The point of sale**

The student can decide where the product might be sold – Dixons, a large department store, e.g. John Lewis, a toyshop such as Early Learning.

**The customer**

The student can decide whom the product is for.

**The performance of the product**

Although the overall nature of the product has been decided by the teacher – an electronic toy that meets a learning need – exactly what the learning need is and how the toy meets that learning need are decided by the student. The learning need could be to count, spell, match shapes or understand meanings through making connections.

**The appearance of the product**

The student can choose the appearance of the product so that it has appeal for the intended user, and is appropriate for the setting in which it will be used and the retail outlet where it will be sold.

**The way the product works**

The student can decide how the product works at 5 levels:

- as a whole product – free standing, hand held;
- at the systems/subsystems level – input, process, output with simple feedback;
- as a programmed system through the microcontroller;
- at the printed circuit-board level derived from a systems approach;
- in the choice of some components within some of the subsystems.

**The way the product fits together**

The student can decide:

- the way the product case fits together;
- the way the printed circuit board is fitted into the product case;
- the placing of the power source;
- the positioning of components within the user interface.

**The materials, components, adhesives, fixings and finishes**

For the product case the students can choose from:

- plastic tubing, card for nets, thin sheet plastic (for vacuum forming), mdf (for moulds), light materials for knobs etc, modelling materials for product development.

For decorating the product case the students can choose from:

- marker pens, spray paint, rub-down lettering, transfers.

For the electronics the students can choose from:

- PCB board and chemicals, solder, components needed for input and output devices and to support the microcontroller (typically a resonator).

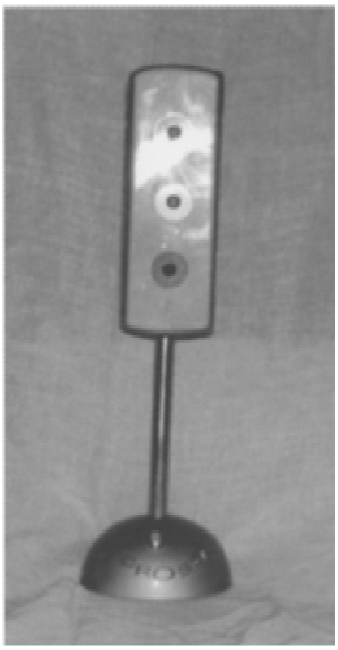
For assembly the students can choose from:

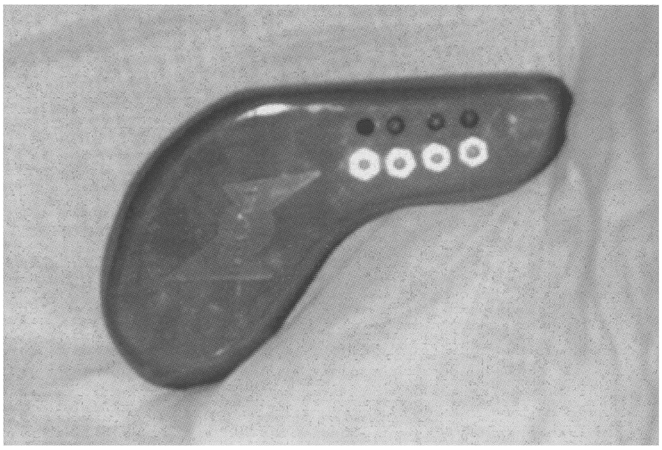
- double-sided adhesive tape, nuts and bolts, grommets, small self-tapping screws.

## Products

The teacher taught the class how to program PIC microcontrollers using the TEP Chip Factory

Here a student has produced 'Safe Cross', a single traffic light, designed as an aid for teaching young children how to cross the road. When the button is pressed the lights go through the standard sequence and a buzzer beeps when crossing is safe.





Here a student has produced 'Blinking Bester' designed to help children coordinate and develop their reactions. An LED comes on for a short time, the child presses the button next that LED. If the correct button is pressed then this repeats with the time that the light is on diminishing. The game stops when the child presses the wrong button or the time delay has diminished to half a second.



Here a student has produced Time Bomb' designed to help children count. A buzzer beeps between one and four times. The child counts and presses the appropriate button ('1'–'4'). A green LED signals a correct answer, a red LED signals a wrong answer.

Here a student has produced 'John Says', designed to help the development of pattern recognition and counting. The LEDs blink in a particular order and the child presses the buttons next to the LEDs in the same order. If the child is correct, another sequence is presented, if wrong then the game stops.

## Values

### Technical

Students should consider the need for reliability in an educational product.

### Economic

Students should consider the feasibility of short production runs to meet small markets.

### Environmental

Students should consider the environmental impact of materials used in battery-driven electrical goods.

### Social

Students should consider the effects of educational toys on those who use them and their relationships with others.

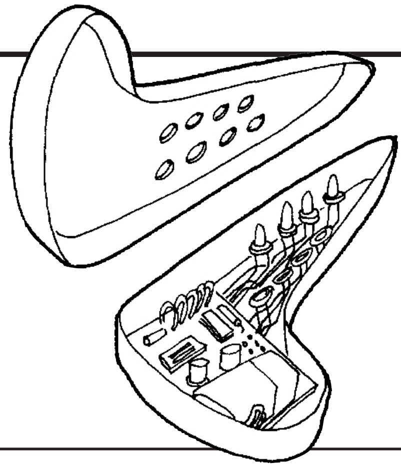
### Moral

Students should consider whether teaching is a worthwhile activity.

### Aesthetic

Students should consider the importance of appearance in educational products.

# Electronic education



## *The detail*

### Sample brief

Design and make an electronic toy that will help a young child (three to four years old) to learn the numbers 1-10.

### Sample specification

**What the product has to do:**

- indicate a number between one and ten;
- allow a child to indicate that it knows the number;
- provide suitable feedback for both right and wrong answers;
- ensure that the feedback for wrong answers isn't positive.

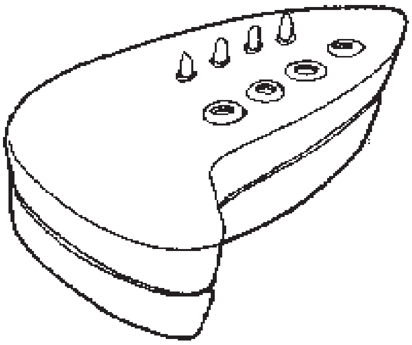
**What the product should look like:**

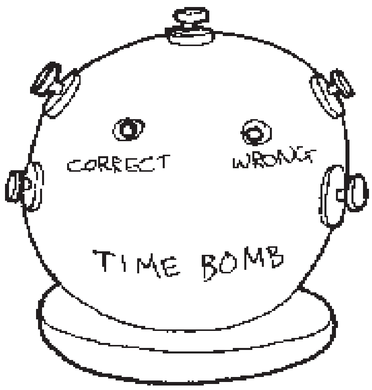
- be attractive to a child of three to four;
- suit the location where it will be used;
- be attractive to the user.

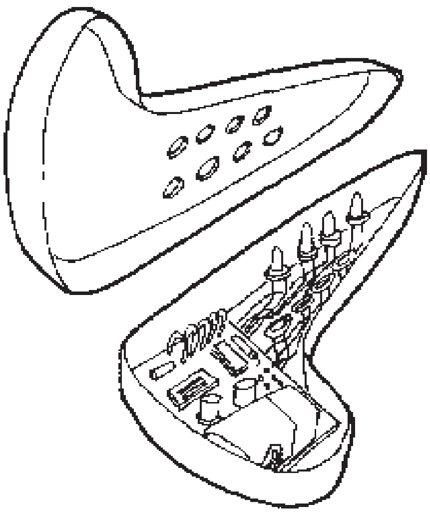
**Other features:**

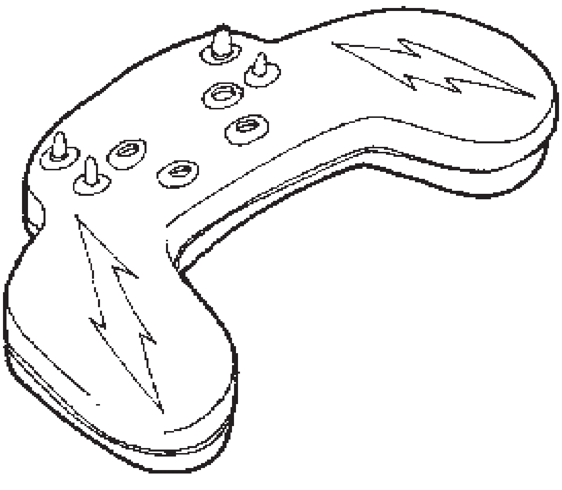
- be battery powered;
- have an on/off switch;
- provide easy access to change the battery;
- be safe for a young child;
- be sturdy to withstand use by a young child;
- be easy to mount/fix in its target location, or be light enough and easy to hold in use;
- have a target price of less than £9-99.

### Starter sketches







## Nuffield teacher talk

'You've got six animal cards and there's a pattern of aluminium foil on the back of each one that will make up a circuit when the card is put in the right place – next to the name of the animal. The cards are shaped so that there is only one way to fit in any of the spaces. When the right card is put next to the animal name, a flashing light comes on. This is all fine so far. What happens when the wrong card is put next to the animal name? Nothing – that's a pity. Couldn't you get the buzzer to blow a raspberry when its wrong? It's tricky but what happens if you have a buzzer connection on all the cards that always plays unless the right answer-connection is made and then the light comes on? Try programming something like that.'

'I get it – each shape will only fit into one of the holes. When a shape is put into the right hole the LED near the shape comes on and stays on and the buzzer buzzes for two seconds. When all the shapes are in the right holes the games over. Don't you need a big reward for getting them all right? Like all the LEDs coming on one after another and a tune playing. No, it's not that hard. You can write a simple program to get the LEDs to 'chase' one another. It's just a matter of turning them on and off in sequence. And we've got a tune-playing chip. You just have to turn that on and off at the right time. To start with, do a flow chart describing what has to happen.'

'OK, it's a catching game. The ping pong balls travel down the ramp in a line and the solenoid shoots each one up into the air, one at a time. The aim is to catch as many balls as possible out of the ten that are put on the ramp. And this is the prototype – your ramp is made from corriflute and you're controlling the solenoid with a push switch. Have you tried it with a small child? Your brother and he's four. How many could he catch? He managed six out of ten. How often did you shoot a ball into the air? Just after he'd caught or dropped the last one. How long do you reckon that took? About two seconds? So you have to program the controller to pulse the solenoid every two seconds for how many seconds? You can work it out: ten balls, two seconds per ball gives you 20 seconds.'

'OK, you've got these cards with pictures of different sorts of foods on them – grass, fruit, insects, small mammals. And you've got pictures of different animals and the idea is matching the animal to what it eats. You've talked to Sarah about her matching card game and you've got the technology sorted out but you're stuck on getting it to look right. Well, you could try thinking about where humans eat and make a joke of it. How do I mean? Well, we eat in restaurants. How do you chose your food in a restaurant? Yes, from a menu. Could your game look like a menu for an animal restaurant?'

## Resource Tasks

### General design

For the first Capability Task in Year 9:

SRT 6 *Writing a fuller specification*
SRT 31 *Graphs*
SRT 39 *Evaluating outcomes – Is it appropriate?*

For the second Capability Task in Year 9:

SRT 7 *Research*
SRT 20 *Harmony and scale*
SRT 27 *Modelling with CAD*

### Focus area design

SRT 33 *Using system diagrams* (if not already tackled in Year 8)
SRT 34 *Understanding system interfaces* (if not already tackled in Year 8)
SRT 35 *Understanding feedback* (if not already tackled in Year 8)
SRT 36 *Using flow charts* (if not already tackled in Year 8)

### Communication

CRT 5 *Drawing orthographic views 1*
CRT 6 *Drawing orthographic views 2*
CRT 7 *Assembly and exploded views* (unless tackled in Y8)

### Making

RMRT 9 *Designing containers to be made by vacuum forming*

### Technical

CCRT 1 *Railway-crossing gates*
CCRT 2 *Home security system*
CCRT 3 *Child's toy*

## Case Studies

Furby® (photocopiable).

## ICT opportunities

Use the Internet to find out about electronic toys. Try putting 'electronic +toys +educational' in the search engine. Look directly at this site http://www.vtechinc.com/html2/products.html.

Use control software for program development and downloading into a microcontroller. Use PCB design software to develop a PCB for a microcontroller. Use CAD/CAM to develop both graphics and nets for the casing.

# Electronic opportunities

## *The big picture*

### Task

To design and construct an electronic sensing system to meet an identified need.

### The story so far

Electronics Incorporated is a company that specialises in developing prototype products which use simple sensing technology to meet people's needs. It has access to sensors that can detect changes in temperature, light level and moisture level as well as a wide range of switches. The students' task is to identify situations in which a particular sensing system provides useful information and then to develop a product that meets the needs of that situation.

### Learning

#### Designing

Using a simple technology, in this case sensing, as a starting point for design ideas. Using a systems approach for designing electronic products.

#### Making

Producing printed circuit boards, mounting components onto primed circuit boards, producing product cases, fixing printed circuit boards and batteries into product cases.

#### Technical matters

Understanding the functioning of a simple electronic product as a system and as a collection of components.

#### Other matters

User interfaces for electronic products.

Product life-cycle of electronic products.

### Design decisions

**The sort of product**

This has been decided by the teacher – an electronic product that utilises sensing.

**The point of sale**

The student can decide where the product might be sold – Halfords, Dixons, a large department store, e.g. John Lewis, a specialist electronics supplier.

**The customer**

The student can decide whom the product is for.

**The performance of the product**

Although the overall nature of the product has been decided by the teacher – an electronic device that utilises sensing – exactly what the system senses and the use to which this information is put is decided by the student. It could be used to sense changes in the weather, changes in water level to avoid overflows, water being too hot for baths, a too high light level to avoid wasting electricity.

**The appearance of the product**

The student can choose the appearance of the product so that it has appeal for the intended user, is appropriate for the setting in which it will be used and the retail outlet where it will be sold,

**The way the product works**

The student can decide how the product works at 4 levels:

- as a whole product: free standing, hand held, wall mounted;
- at the systems/subsystems level – input, process, output with simple feedback;
- at the printed circuit-board level derived from a systems approach;
- in the choice of some components within some of the subsystems,

**The way the product fits together**

The student can decide:

- the way the case fits together;
- the way the printed circuit board is fitted into the product case;
- the placing of the power source;
- the positioning of components within the user interface.

**The materials, components, adhesives, fixings and finishes**

For the product case the students can choose from:

- plastic tubing, card for nets, thin sheet plastic (for vacuum forming), mdf(for moulds), light materials for knobs etc.

For decorating the product case the students can choose from:

- marker pens, spray paint, rub-down lettering, transfers.

For the electronics the students can choose from:

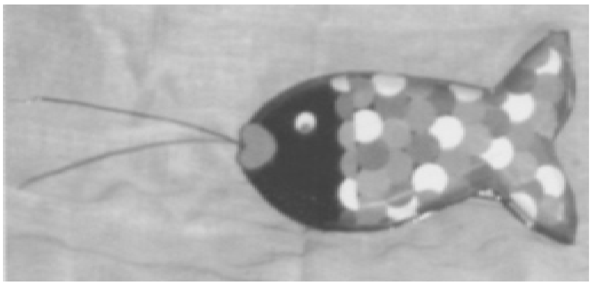
- PCB board and chemicals, components based on QuickTrack®/PCB Wizard® systems boards typically; transistors, resistors, diodes, LDRs, thermistors, switches, bulbs, LEDs, motors, buzzers, solder, plus programmable ICs if you wish to use this technology.

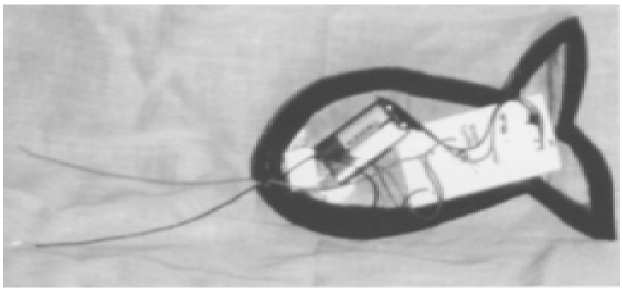
For assembly the students can choose from:

- double-sided adhesive tape, nuts and bolts, grommets, small self-tapping screws.

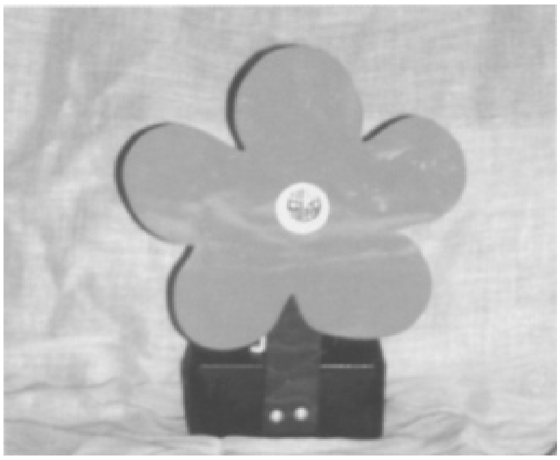
## Products

The teacher introduced the class to a range of sensing components and how they could be used with transistors to produce simple detecting systems.

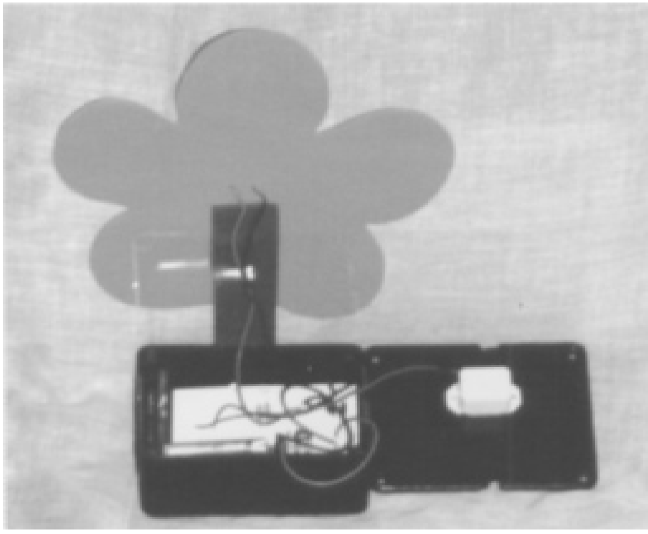


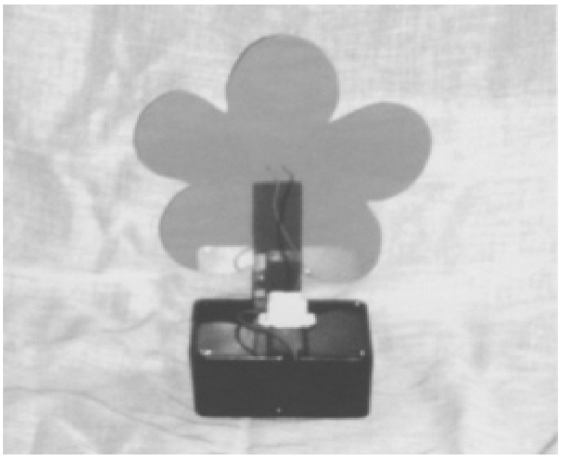


Here a students has produced a vacuum formed fish that sits on the side of the bath and buzzes when the water level is high enough. The scale effect on the fish through using self-adhesive coloured paper discs is attractive but may not last well in a bathroom environment. The two wires emerging from the mouth are the water sensor probes and this is not very elegant.



Here a student has produced a flower to sit on the patio that will warn if it is raining so that you remember to bring in your books and toys. The acrylic flower and stalk are mounted on a bought box. The sensor is a circular piece of strip board mounted in the centre of the flower.





## Values

### Technical

Students should consider the need for reliability in technical products.

### Economic

Students should consider the feasibility of short production runs to meet small markets.

### Environmental

Students should consider the environmental impact of materials used in battery-driven electrical goods.

### Social

Students should consider the effects that ‘functional’ products might have on peoples lives.

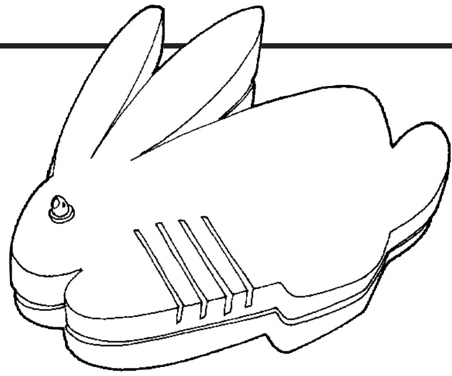
### Moral

Students should consider the responsibility of designing a product that could have a large influence on people’s lives.

### Aesthetic

Students should consider the importance of appearance in ‘functional’ products.

# Electronic opportunities



## *The detail*

### Sample brief

Design and make a sensing device that will activate an alarm when the temperature in an animal's hutch drops below a set level.

### Sample specification

**What the product has to do:**

- sense when the temperature falls below 7°C;
- be accurate to within 2°C;
- provide a suitable warning to the pet owner.

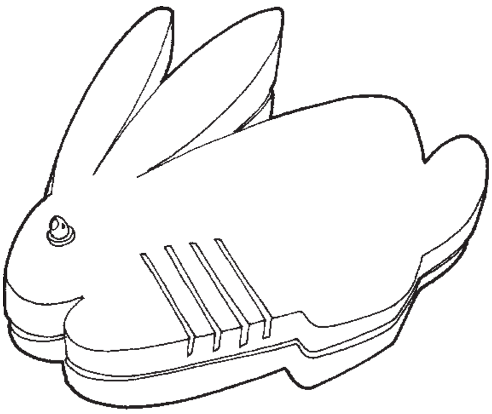
**What the product should look like:**

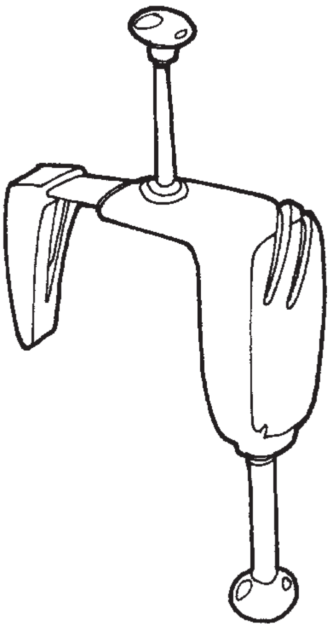
- be appropriate to the purpose;
- suit the location where it will be used;
- be attractive to the user.

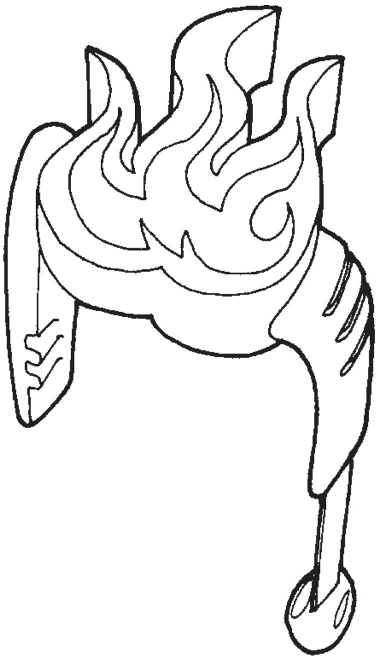
**Other features:**

- be battery powered;
- have an on/off switch;
- provide easy access to change the battery;
- be easy to mount/fix in its target location;
- have a target price of less than £9-99.

### Starter sketches







## Nuffield teacher talk

'So your dad says that he wants to know when the temperature in his greenhouse goes below 4°C. What can you use to sense temperature? That's right, a thermistor. But you have to choose one that operates in the correct range. You'll need to check in the RS catalogue. Next thing: how will you get the processor to trigger at 4°C? That's right, adjust the variable resistor in your potential divider. OK, so now you've got two parts of your system: the sensing bit which you can adjust – the input, and the process bit that takes the signal from the sensor and gives an output when the temperatures drops below 4 °C. What do you want the output signal to drive? You think your dad would notice a flashing LED. That's good because it doesn't take much current to drive one of those. One point though – the LED will flash when the temperature drops to below 4°C but will stop flashing when the temperature rises again, so your dad might not see it. What can you do about that?'

'So this is for your gran who's getting very short sighted and is forever filling the tea cups so they overflow. You think you could do a full cup alarm. Have you talked to your gran? Yes – and she likes the idea. You think something that clips onto the side of the cup would be good. What could be the problem with that? That's right – if its too heavy it could topple the cup. What else? It might be fiddly for your gran. But it's a possibility. What's an alternative? What actually has to be in the cup? That's it – just the sensor. So it might be a better bet to have just the sensor's clip on the side of the cup. How can you find out which is best for your gran?'

'OK, you've got the PCB with all the components working and it senses from dark to light. You want it to wake you up at first light so that you can get up and go running. You want to fit it into a really small case that can clip onto the end of your bed near your head. That sounds OK. Let's think what has to go in the case. You tell me – the battery right, the PCB – right, the buzzer – right. And what has go on the case – the LDR and an on/off switch. If you put all those things in a neat arrangement – battery on the bottom, PCB on top with the LDR sticking up and next to that the switch – you can see how much room you'll need. Just make three measurements – length, width and depth. You have two options: buy one that's the right size and customise it, or make a net from stiff card which you can spray up. Which do you fancy?'

'So, it's to let you know when it's getting too cold for your guinea pig outside. It works fine – you've tested it by making the probes cold with an ice/water mixture, checked against a thermometer, so what's the problem? You want it to look cool. Not sure what you mean by 'cool' – you'll have to help me. Give me an example. Will Smith in *Men in Black* is cool. Is your guinea pig cool? Not at the moment but he could get cool if he wore the right sort of sun glasses. Can you make a plastic model of your guinea pig's head and face wearing sun glasses? Because if you can, we can vacuum form over it. You just need to make sure that the sides slope like on a jelly mould.'

## Resource Tasks

### General design

For the first Capability Task in Year 9:

SRT 6 *Writing a fuller specification*

SRT 31 *Graphs*

SRT 39 *Evaluating outcomes – Is it appropriated?*

For the second Capability Task in Year 9:

SRT 7 *Research*

SRT 20 *Harmony and scale*

SRT 27 *Modelling with CAD*

### Focus area design

SRT 33 *Using system diagrams* (if not already tackled in Year 8)

SRT 34 *Understanding system interfaces* (if not already tackled in Year 8)

SRT 35 *Understanding feedback* (if not already tackled in Year 8)

SRT 36 *Using flow charts* (if not already tackled in Yr 8)

### Communication

CRT 5 *Drawing orthographic views 1*

CRT 6 *Drawing orthographic views 2*

CRT 7 *Assembly and exploded views* (unless tackled in Year 8)

### Making

RMRT 9 *Designing containers to be made by vacuum forming*

### Technical

For traditional electronics use:

ECRT 9 *Designing a simple alarm circuit*

ECRT 10 *Improving a simple alarm circuit by using two transistors*

ECRT 11 *Improving a simple alarm circuit by using a latch*

For programmable integrated circuits use:

CCRT 1 *Railway-crossing gates*

CCRT 2 *Home security system*

CCRT 3 *Child's toy*

## Case Studies

Furby® (photocopiable).

## ICT opportunities

Use the Internet to find out about sensing systems for sale on the internet. Try putting 'sensors +technology' in the search engine. Look directly at this site http://www.networketi.com/.

Use PCB design software to support the jump from modelling with system boards to a PCB design. Use CAD/CAM to develop both graphics and nets for the casing.