Better weighing

The big picture

Task

To design and make a weighing machine to meet an identified need in school.

The story so far

Better Weighing is a company which produces mechanical weighing machines and scales for use in retail and industry. It has identified schools as a possible market for its products. The students' task is to investigate the school context to find situations where things need to be weighed and to develop a prototype weighing machine with a brief instruction manual.

Learning

Designing

Using a simple technology, in this case mechanisms, as a starting point for design ideas. Using a systems approach for designing a mechanical product.

Making

Assembling mechanical systems from components (given and specially constructed), integrating these into a product case, producing a product case.

Technical matters

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

Other matters

User interfaces for mechanical products. Product life-cycle of mechanical products.

Design decisions

The sort of product

This has been decided by the teacher – a mechanical weighing machine for use in school.

The point of sale

The student can decide where the product might be sold – a large department store, e.g. John Lewis, a retail chain like Habitat.

The customer

This has been decided by the teacher in broad terms (someone in school will use the weighing machine) but the student will be able to choose the individual user.

The performance of the product

Although the overall nature of the product has been decided by the teacher – a mechanical weighing machine for use in school – exactly what the weighing machine is used for is decided by the student.

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 three levels:

- as an overall mechanical system – beam, compression spring, tension spring;
- as a set of subsystems using input, process, output to provide a reading of weight;
- as a set of components combining to give the required subsystems.

The way the product fits together

The student can decide:

- the way the case fits together;
- the way the mechanical components fit together;
- the way the mechanical components fit into the case;
- the way the components produce a user interface that gives a reading of the weight.

The materials, adhesives, fixings and components

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, clear acrylic for scale-reading windows.

For decorating the product case the student can choose from:

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

For the mechanisms the student can choose from:

- mechanical components;
- springs, gear wheels, racks, pinions, paper fasteners, nuts and bolts, metal strip for linked levers;
- electrical components: light bulbs, switches, connection wire.

For test equipment the student can choose from:

- masses and force-meters for spring testing and calibration.

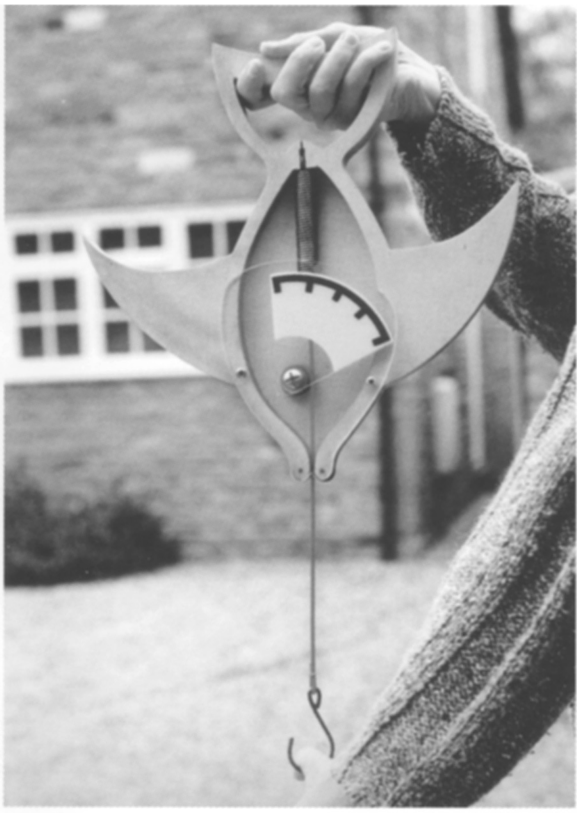
For assembly the student can choose from:

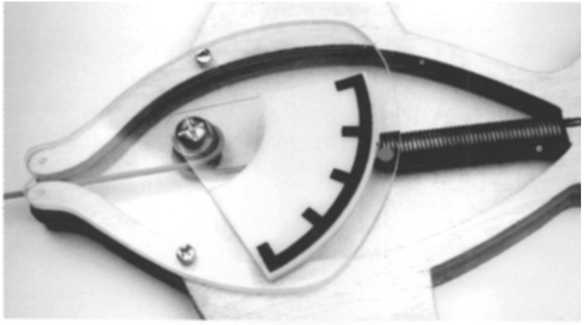
- double-sided adhesive tape, nuts and bolts, small self-tapping screws.

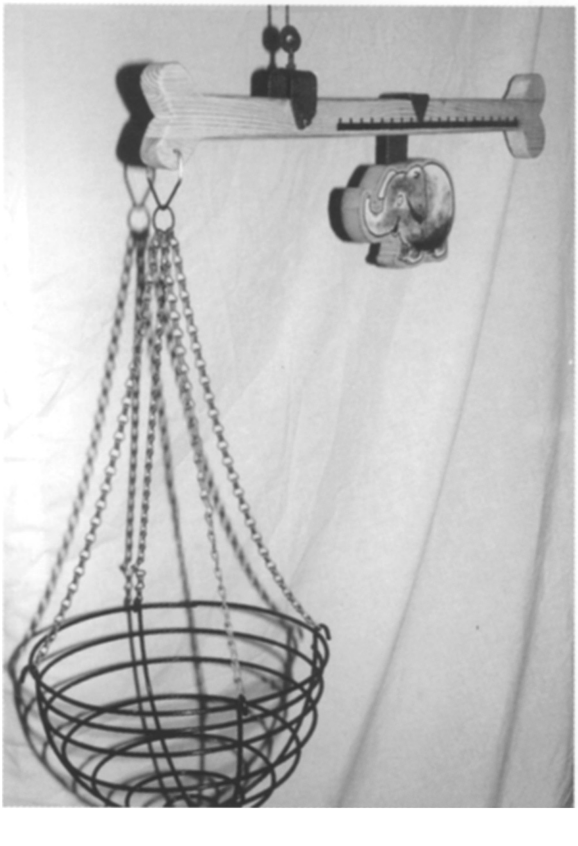
Products

The teacher began by revising turning moments and the behaviour of springs. The students were then able to choose from two different modes of operation for their weighing machine.

Here the student has produced a spring balance for weighing fish during fishing competitions. A simple friction drive causes the dial to turn when a load is applied to the hook and stretches the spring. The shape of the device is elegant







Here the student has used a beam balance for weighing a small pet. The 'basket' and chain are shop-bought but the remainder has been made by the student. There is evidence of considerable visual flair with the main beam being in the form of a bone and the counter balance slider picturing an elephant. The student also considered how the beam balance might be used within a door frame.

Values

Technical

Students should discuss the need for accuracy and reliability in the way it works, its manufacturability and ease of maintenance.

Economic

Students should consider the place of weighing in the market place and the need to produce a design that can be manufactured.

Environmental

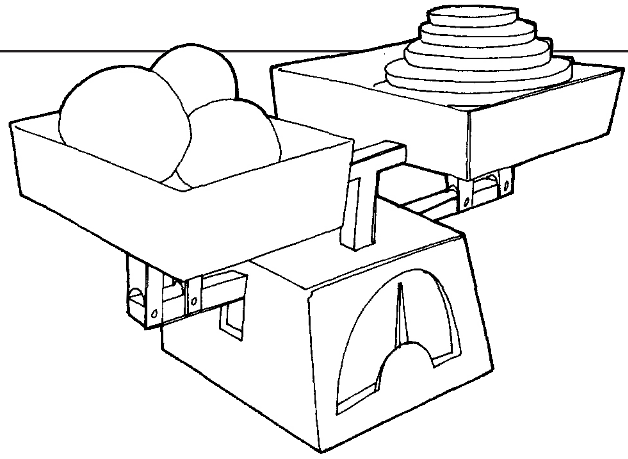
Students should consider the source of the materials used, their disposal after the device has completed its useful life and the effect of the manufacturing processes.

Moral and social

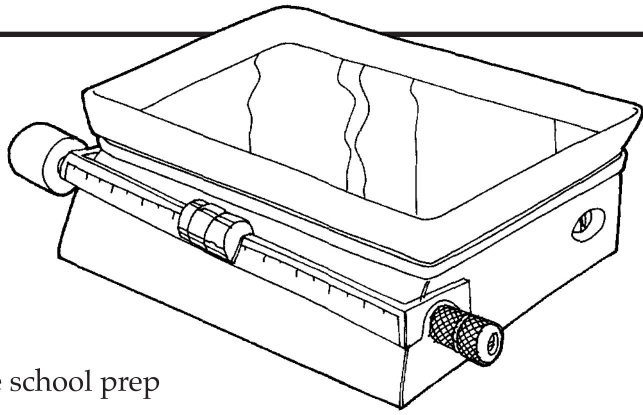
Students should consider the importance of the general public having confidence in the trustworthiness of weighing machines.

Aesthetic

Students should discuss the relationship between the appearance of the weighing machine and the items that it will weigh and its appeal to those who use it.



Better weighing



The detail

Sample brief

Design and make a weighing machine that can be used in the school prep room to weigh small animals.

Sample specification

What the product has to do:

- measure and display the weight of small animals;
- operate in the mass range 0-500 g;
- be accurate to within 10 g.

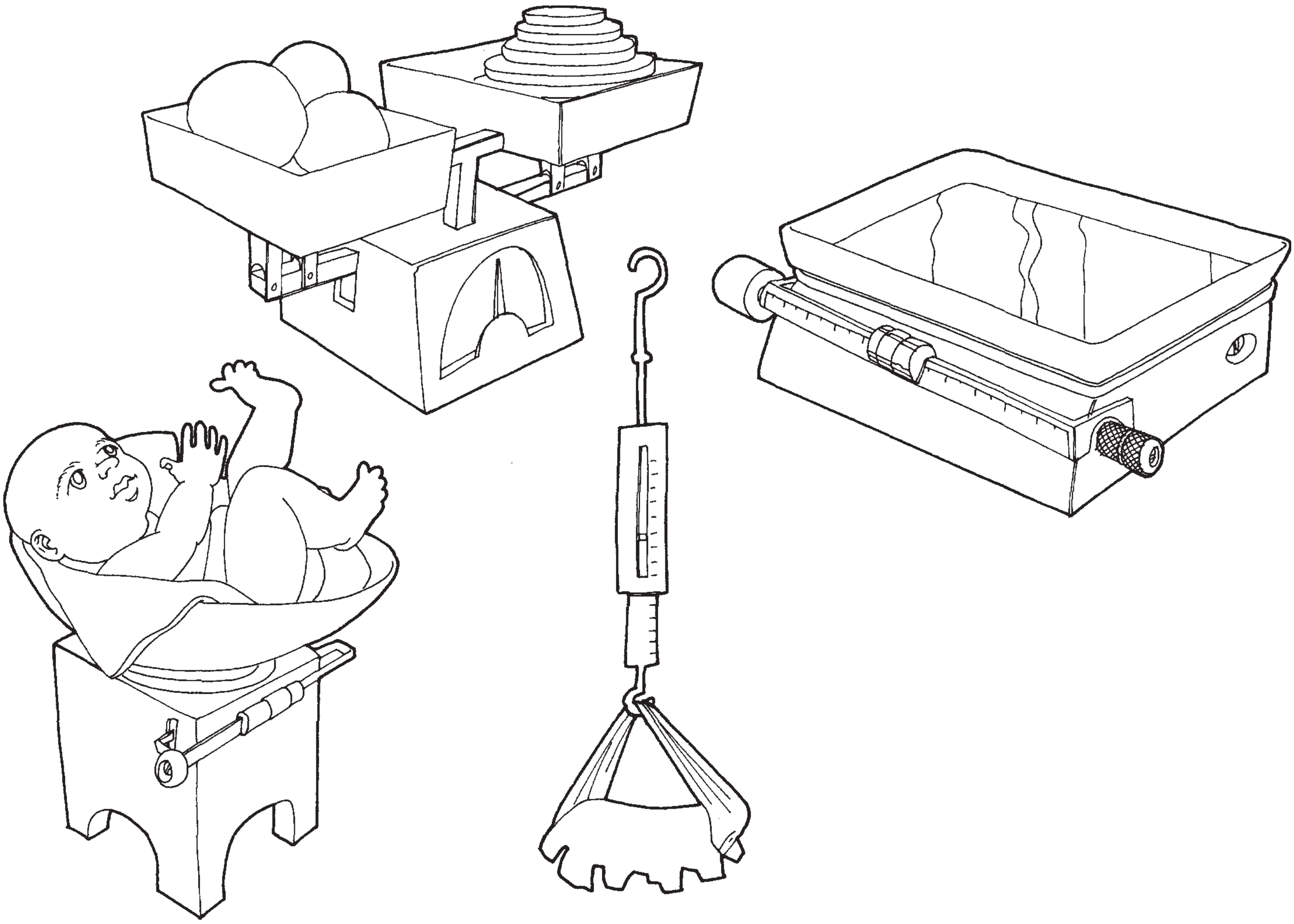
What the product should look like:

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

Other features:

- ensure that the animals suffer minimal distress;
- be easy to read.

Starter sketches



Nuffield teacher talk

'OK, you want the weighing machine for the babies and small children in the nursery. What range will it need to weigh over? What do I mean by range? Well, what's the heaviest child likely to weigh compared with the smallest child? That'll be the range that your machine will have to be able to measure. You don't know. OK. How could you find out? Use the old bathroom scales that we've got. Then you'll have to find a spring that changes well across that range.'

'So you want to use a spring that gets squashed by the weight. What'll happen if the spring is very stiff and difficult to squash? It'll be good for measuring heavy weights but not light weights. Can you explain why? That's right, a small weight won't squash it enough to give a reading.'

'I can see that the spring will be stretched when you put the letters on but I'm not sure how you'll know what a particular stretch means. And you've found a spring that stretches OK over the likely weights of letters and small parcels. This is good. But you need to know the exact weight of a letter or packet to know how much the postage is. Can you remember what calibrate means? That's it – to use known weights to find out how much the spring stretches for a particular weight. So now you can calibrate your spring.'

'I know your science teacher says weight is a force and that you measure force in newtons. And she's right, but I don't think anyone will understand your weighing machine if it measures in newtons. Can you work out how to convert newtons into kilograms?'

'The tricky bit is making sure that you can attach the spring. If you look in the sample box, you'll see that most of the tension springs have a loop or hook at each end. You can use that to attach your spring. Is the place where you attach each end important? You're not sure. Well, think like this. The bit that moves is a lever pulling against the spring. If the spring is attached here, near the fulcrum, will it be harder or easier to stretch it than if it's attached here, far from the fulcrum? Try it and see.'

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/low 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*

Making

RMRT 9 *Designing containers to be made by vacuum forming* (unless tackled in Year 8)
RMRT 10 *Mass producing a simple product* (unless tackled in Year 8)

Technical

MCRT 1 *Changing types of movement* (unless tackled in Year 7 or 8)
MCRT 2 *Changing axis and direction of rotation* (unless tackled in Year 7 or 8)
MCRT 3 *Changing force, speed and distance* (unless tackled in Year 8)
MCRT 5 *Understanding levers* (unless tackled in Year 8)
MCRT 6 *Springs in the office*
MCRT 7 *Understanding screw threads*
MCRT 8 *Assembling mechanisms*
MCRT 9 *Introducing mechanisms design*
MCRT 10 *Making your own mechanisms*

Commercial

RMRT 4 *Taking care of products*

Case Studies

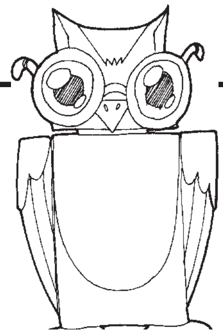
Weighing, downloadable from the website www.secondarydandt.org

ICT opportunities

Use the Internet to find out about the law as applied to weights and measures. Try putting 'trading standards +UK +weights +measures' in the search engine. Look directly at www.hants.org.uk/regulatory/tradesta/.

Use DTP software to produce an instruction manual. Use CAD software to produce diagrams for an instruction manual. Use CAD software to design the layout of visual display systems. Use CAD/CAM for the manufacture of standard parts.

Petshop parade



The big picture

Task

To design and make a mechanical toy that will amuse and intrigue, and will be sold in a large pet shop.

The story so far

A chain of large pet shops sells a wide range of animals, cages and animal feed. Within each shop is a gift shop where novelties are sold. It is keen to develop a range of simple mechanical novelties that will imitate animal movement in a way that will be appealing. The students' task is to develop a mechanical toy that could be sold at the gift shop.

Learning

Designing

Using the movement of animals as a basis for design. Using a systems approach for designing a mechanical product.

Making

Assembling mechanical systems from components (given and specially constructed) and integrating these into a mechanical toy.

Technical matters

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

Other matters

Product life-cycle of mechanical products.

Design decisions

The sort of product

This has been decided by the teacher – a simple mechanical toy.

The point of sale

This has been decided by the teacher – a large pet shop such as Pet City.

The customer

The student can decide whom the product is for.

The performance of the product

The student can decide whether the toy is amusing, intriguing, decorative or even slightly offensive.

The appearance of the product

The student can choose the appearance of the product when deciding on which animal the toy will be based.

The way the product works

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

- as an overall mechanical system that turns one sort of movement into another;
- as a set of components combining to give the required mechanical system.

The way the product fits together

The student can decide:

- the way fixed parts fit together to give the desired animal shape;
- the way the mechanical components fit together;
- the way the mechanical components fit to the moving parts;
- the way the moving parts fit to the fixed parts.

The materials, adhesives, fixings and components

For the parts of the animal the students can choose from:

- mdf sheet, mdf block, mdf discs, dowel.

For the mechanisms students can choose from a range of components:

- gears, worms, wheels, cranks, racks, pinions.

For decorating the animal students can choose from:

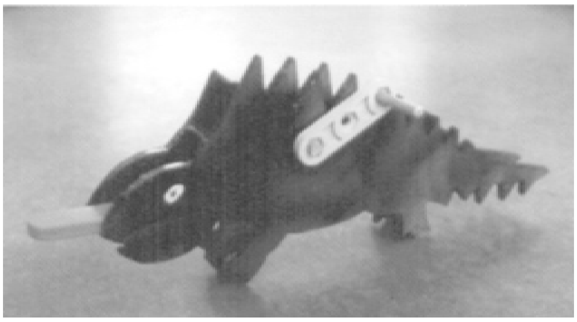
- acrylic paint, spray paint, polyurethane toy paint.

For assembly students can choose from:

- PVA adhesive, double-sided adhesive tape, small screws.

Products

The teacher began by showing the class a set of useful mechanisms made from Fischer Technic. Their task, working in pairs, was to explore them all to find out what they do and how they work. Then each had to choose one and using a mdf, dowel and appropriate mechanical components make a working copy. This taught all sorts of 'tacit' understanding about mechanisms – alignment, tolerances, clearances. The teacher added two interesting constraints – the toy had to look like an animal, and should use just one mechanism, this prevents over complication.



Here the students have produced a dinosaur with a tongue that pokes in and out driven by a rack and pinion.

Here the students have produced a delightful owl constructed of discs whose head revolves through 360°.
It is driven by a worm and wheel, and lots of fast winding produces a serene, and anatomically impossible owl, looking around the room with disdain.

Here the students have produced a chameleon. Winding the tail slowly causes the body to revolve showing a range of different colours. This is achieved using paint software and a colour printer through a direct drive, which also causes the eyes to rotate by the use of bevel gears.

Values

Technical

Students should discuss the need for accuracy and reliability in the way it works, how easy it is to manufacture and ease of maintenance.

Economic

Students should consider how increasing the complexity of the toy (to provide more appeal) will be reflected in the price.

Environmental

Students should consider the source of the materials used, their disposal after the toy has completed its useful life and the effect of the manufacturing processes.

Social

Students should consider the role of toys that amuse and intrigue in improving people's disposition and relationships.

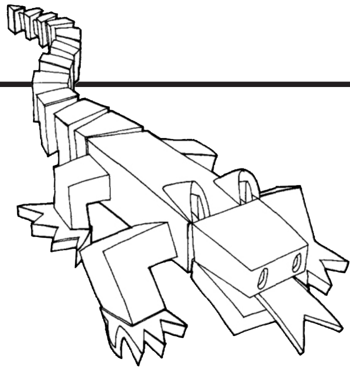
Moral

Students should consider the responsibilities involved in owning and caring for a pet.

Aesthetic

Students should have the opportunity to appreciate the beauty of both animal and mechanical movement.

Petshop parade



The detail

Sample brief

Design and make a mechanical toy in the form of an animal for sale as a novelty item at a large pet store.

Sample specification

What the product has to do:

- provide movement that is characteristic of the animal;
- move in a way that is appealing.

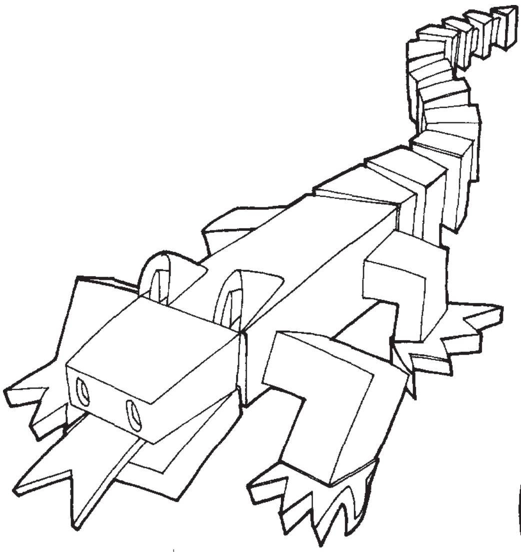
What the product should look like:

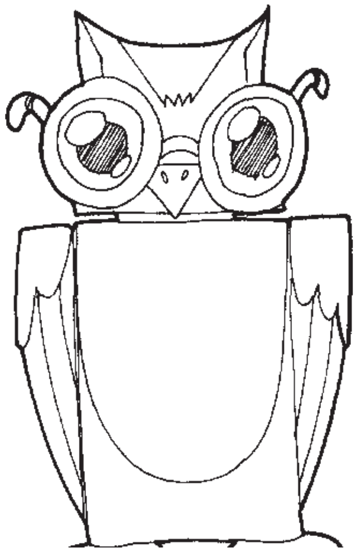
- be appealing to customers at the pet shop;
- capture the essence of the appearance of the animal it is based on.

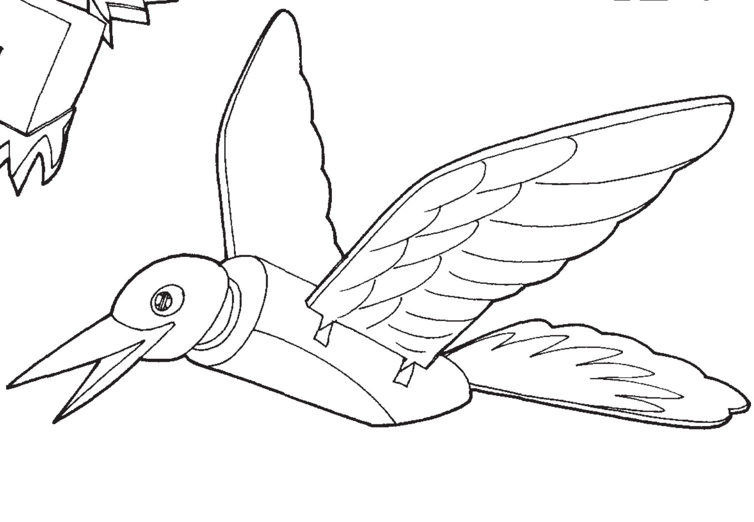
Other features:

- be operated by the turning of a single handle.

Starter sketches







Nuffield teacher talk

'OK, so you want to do a lizard with its tongue going in and out. You want to use a rack and pinion. How will that work? When you turn the handle one way, the tongue moves out. When you turn the handle the other way, the tongue moves back. So you don't turn the handle round and round, just to and fro. Can you think of a way of getting the in and out with the handle being turned round and round?'

'You want to do a dog whose head turns from side to side. You reckon this'll look better than turning through a complete circle. You can do it with your fingers. Just twiddling, really. OK, what are your fingers doing when you twiddle? That's right, moving backwards and forwards. So what mechanism moves things backwards and forwards? That's it – a crank and slider. Now, how can you get the slider to move the rod that holds the head? Just friction? Well, that might work, but what if you put a gear on the rod? What could mesh with the gear? Another gear on the slider – yes, but what do we call a long line of gear teeth? That's it – a rack!

'So what's the problem – you can't draw a good cat. Have you got any pictures to look at? Well, start by getting just four pictures of cats all from the same view; say sitting up and looking straight at you. Look at each one carefully and try to work out what they all have in common. Try tracing the head of each one. Put the tracings on top of each other. Do the same for their bodies. This'll give you a feel for what cats are like and in no time you'll be able to draw one you like.'

'You want to do an owl . The head will go round through 360 degrees and you know how to do that but you're not sure about how to make the body. You don't want to use a big solid block because that'd be too difficult to shape. Can you build the shape up from other shapes? Well, look – if you take a slice through the body you get a circle. That's it, like a disc. Well, couldn't you build up the body starting with small discs at the tail end, getting bigger towards the middle and then small again at the neck? And the good news is that you can use mdf wheels, all with holes in the middle. That's right, you can just thread them onto a rod that will support the head!'

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

Focus area design

SRT 33 *Using system diagrams* (if not already tackled inYear 8)
SRT 34 *Understanding system inter faces* (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*

Making

RMRT 10 *Mass producing a simple product*
MCRT 10 *Making your own mechanisms*

Technical

MCRT 1 *Changing types of movement* (unless tackled in Year 7 or 8)
MCRT 2 *Changing axis and direction of rotation* (unless tackled in Year 7 or 8)
MCRT 3 *Changing force, speed and distance* (unless tackled in Year 8)
MCRT 5 *Understanding levers* (unless tackled in Year 8)
MCRT 6 *Springs in the office*
MCRT 7 *Understanding screw threads*
MCRT 8 *Assembling mechanisms*
MCRT 9 *Introducing mechanisms design*

Commercial

RMRT 4 *Taking care of products.*

Case Studies

Lara Sparey, *Student's Book* pages 113—16

ICT opportunities

Use the Internet to get images of different animals and to find out about their characteristic movements. Try putting '+animals+pets' in the search engine. Look directly at http://netvet.wustl.edu/ssi.htm

Use CAD plus a coloured printer to produce realistic 'stick on' fur, scales or feathers. Use CAD/CAM for manufacture of standard parts.