Nuffield Design & Technology
working in the curriculum

How fast should your buggy be?
ten hours work

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Most children enjoy playing with toy vehicles of one sort or another from simple push-along toys when they are young to radio-controlled racers when they are older. In this unit the children in your class are able to design and make a battery-powered toy vehicle for themselves or for slightly younger children. While not as sophisticated as a radio-controlled toy, it represents a realistic technical challenge to which they are likely to respond enthusiastically. The toy can be based on an actual vehicle, on a vehicle from a book or film, or it can be a fantasy vehicle developed from the children’s imagination. The appearance of the vehicle should appeal to the group or individual who will use it, but whatever the final form of the toy it must have the basic elements of control – an on/off switch with which to control forward movement. The context can be extended to develop other control features – backward movement as well as forward, fast and slow travelling speeds, lighting and sound effects.

In this unit children will learn:

- to develop their ideas through sketching and working with technical components, wooden strip, paper, card and found materials;  
  (Sessions 1, 2 and 4)
- to develop their designs by thinking about the purpose of the toy and the needs of possible users;  
  (Session 1)
- to mark, measure, cut and join materials with increasing accuracy;  
  (Sessions 2–5)
- to use a variety of tools with precision and care;  
  (Sessions 2, 3, 6 and 7)
- to use simple mechanisms to provide a transmission system;  
  (Sessions 4, 6 and 7)
- to use simple electrical circuits to operate motors, lights and buzzers.  
  (Sessions 4, 6 and 7)
the small tasks
the focused practical tasks

1. Exploring moving toys  
   30 minutes
2. Making a simple picture frame  
   60 minutes
3. Making spinning tops  
   60 minutes
4. Exploring technical systems  
   90 minutes
5. Exploring networks and surface decoration  
   60 minutes

the big task
the design and make task

The big task is for children to design and make a controllable, battery-powered toy vehicle using card, wood, found materials and a variety of mechanical and electrical components.

4 hours in 30-minute or 60-minute lessons

The evaluation 30 minutes
Unit review 30 minutes

The crisp body shell is made from textured card giving a futuristic effect. The cut outs allow the internal workings to be seen as well as imitating places for head lights and the driver. The wide strip of card can easily support the pp3 battery, electric motor and reversing switch. The drive mechanism is a simple elastic band pulley system. This needs to be arranged so that the pulley on the motor shaft and that on the axles are carefully aligned to maximise the transmission.
The children can decide on the following:

- who the toy is for
  - required learning in Sessions 1 and 6,
  - design decision made in Session 6;

- how the toy will be constructed:
  - although the basic frame structure is given, there is ample opportunity for children to develop variations involving different arrangements of axles, wheels, motors, batteries, mechanical and electrical fittings
  - required learning in Sessions 2 and 3,
  - design decision made in Sessions 6 and 7;

- the functions:
  - this involves deciding on the number of control features – stop/go as a minimum, plus forwards/backwards, fast/slow, left/right, with additional features to be controlled such as lights and buzzers
  - required learning in Session 4,
  - design decision made in Sessions 6 and 7;
design decisions

- the appearance:
  - deciding on the appearance of the battery-powered vehicle involves thinking about their own preferences and perhaps those of other children who might play with the battery-powered vehicle;
    - required learning in Session 5,
    - design decision made in Sessions 6 and 7;

- deciding on the overall proportion involves choosing the type and size of wheels, and choosing the overall dimensions of the vehicle;
  - required learning in Session 1,
  - design decision made in Sessions 6 and 7.
exploring moving toys

Teacher input
Tell the class that they are each going to make a battery-powered toy vehicle. It can be for themselves, a friend or a younger child. Explain that to start off you are going to show them a whole range of different toy vehicles that work in different ways including battery power. This will help them understand what their toys could look like and how they might work.

Now show the class a collection of toy vehicles. There should be enough toys for each table to have a small collection to use for the Pupil activity. Demonstrate that there are different ways of working, such as push along/pull along, rip cord flywheel, wind-up clockwork motors, battery-powered electrical motors. Point out the important features – wheels, axles, a chassis to support the wheels and axles, some way to make the toy move. Point out that although the vehicles look different they all have these common features.

Pupil activity
Tell the children to draw a simple sketch of each toy on their table, to label the important parts and add notes to explain what moves it along. You can use the drawings and the collection of toy vehicles as a reference display during the rest of the activity.
exploring moving toys (continued)

Teacher input

Tell the children that they will have to decide on the following:

- who the toy vehicle is for;
- what it should look like;
- what it should do.

They should write down suggestions for this although this is not a final decision as there are things they need to find out and learn before they can decide for sure.

Homework

Each child should try to find out what the possible user of the toy vehicle might like. This could involve posing the questions to themselves or the person who will be using the toy. Ask every child to bring in a favourite postcard or small picture that they will be able to frame next session.

Resources

Stimulus: a variety of different types of moving, wheeled and battery-powered vehicles;
Consumables: paper;
Tools: pencils and rubbers.

Health and safety check

Discuss the hazards and risks involved in working as a group and handling other people’s property and how the risks can be controlled by the way the children behave and treat the items on display.
SECTION 4

teaching the unit

making a simple picture frame

Teacher input
Tell the class that they will need to make a chassis for the toy vehicle and that one way to do this is to make a simple wooden frame and that in this lesson they will learn how to do this by making one that they can use as a picture frame for their favourite postcard or picture.

Pupil activity
Once the children have constructed their frames they should be left to dry overnight. The postcards and pictures can be stuck in place again using a tiny amount of PVA glue. The resulting picture gallery can be put on display and used to show the importance of accurate marking, careful cutting, precise assembly and minimal use of glue.

Resources
Stimulus: postcards from home;
Consumables: quantity of 10 mm X 10 mm wood, strip, abrasive paper, card, PVA glue;
Tools: pencils, rulers, sawing boards, junior hacksaws.

Health and safety check
Discuss the hazards and risks involved in using cutting tools and glue and how the risks can be controlled by taking care and using the correct procedures.
Making Spinning Tops

**Teacher input**
Tell the class that they will need to know about fitting wheels onto axles and axles through frames and this involves drilling holes the right size and careful assembly. A good way to practise this is to make hexagon spinning tops.

**Pupil activity**
Show the class how to carry out the following activities.

- To use the ready-to-copy ‘My buggy hexagon template’ to mark out a hexagon on a square of thin plywood.
- To hold this securely with a G-clamp to a sawing board and cut off the corners to form a hexagon.
- To mark out the centre point using crossing diagonals.
- To drill a 6 mm hole at the centre point and fix a short piece of dowel into this hole.
The children can experiment with the following variables:

- the length of the dowel;
- the shape of the point;
- loading the hexagon in various ways:
  - adding mass near the centre by adding Plasticine;
  - adding mass near the periphery by adding Plasticine;
  - removing mass near the centre (by drilling holes);
  - removing mass near the periphery (by drilling holes);
  - changing the surface on which the top is spinning.

When children have made and experimented with the tops, they should write a short piece describing what it is that causes a top to spin longer.

**Resources**

**Consumables:** quantity of thin plywood, 6 mm dowel, Plasticine, ‘My buggy hexagon template’;

**Tools:** hand drills, 6 mm bits, pencils.

**Health and safety check**

Revisit the discussion about controlling risks when using cutting tools. Discuss the hazards and risks involved in using a hand drill and how the risks can be controlled by taking care and using the correct procedures.
exploring technical systems

Teacher input
Tell the class that there are three different stations in the room with examples of technical systems that will be useful in getting their toy vehicles to work. At each station there are things to look at with worksheets explaining what to do. There are three ready-to-copy ‘My buggy exploring technical systems’ sheets in the Resources section. If you wish to reduce the technical opportunities available to the children you can reduce the number of stations available and the contents of each station.

Pupil activity
At Station 1 there are examples of five transmission systems:
- a simple belt drive;
- a compound belt drive;
- a wheel and worm system;
- a simple gear train;
- a compound gear train.
Tell the children that they will need to think about which one is likely to be the easiest for them to build into their toy.

At Station 2 there are three examples of different switches in simple circuits to control electric motors:
- a circuit using a push-to-make switch;
- a circuit using an on/off switch;
- a circuit using a reversing switch.
Tell the children they will need to think about how they might use each sort of switch to control their toy.
At Station 3 there are five examples of circuits to control lights and buzzers:
- a circuit using a push-to-make switch to control a buzzer;
- a circuit using a push to break switch to control a light bulb;
- a circuit using an on/off switch to control a flashing LED;
- a circuit with two light bulbs in series controlled by an on/off switch;
- a circuit with two light bulbs in parallel controlled by an on/off switch.

Tell the children they will need to think about how they might build light and sound effects into their toys.

Pupils should work in pairs and co-operate in learning about these technical systems.

**Resources**

**Stimulus:**
examples of simple belt drives, compound belt drives, wheel and worm systems, simple and compound gear trains; circuits using a push-to-make switch, an on/off switch, a reversing switch to control a motor, a push-to-make switch to control a buzzer, an on/off switch to control a flashing LED; circuits with 2 light bulbs in series controlled by an on/off switch, two light bulbs in parallel controlled by an on/off switch;

**Consumables**
‘My buggy exploring technical systems’ sheets 1–3.

**Health and safety check**

Revisit the discussion about controlling risks when working in groups in the context of investigating a range of delicate technical systems.

You can purchase components to construct these technical systems from Technology Teaching Systems.
exploring networks and surface decoration

Teacher input

Explain to the class that in this session they have two tasks. The first is to make a simple net to give them practice at producing a card body shell they could use to give the toy its overall appearance. There are three different nets available as ready-to-copy masters – ‘Wedge net’, ‘Double wedge net’ and ‘Bus net’. When enlarged to A3 size they can be used as template for actual body shells. Note that for their toys they can adapt existing boxes if this is more appropriate. Whatever they use they will need to decorate it so that it does not look like card or packaging; therefore, the second task is to decorate the net to give a variety of effects that might be useful.

Pupil activity

Show the class how to cut out a net and to crease it carefully so that it can be assembled into the form of a small body shell but do not fix into its final form as surface decoration is much more easily applied whilst the net is flat.

cut out net.
carefully crease the folds.
add aluminium foil to show radiator grill.
add sand to glue patches on bonnet.
stick dark paper into cut outs to show dark windows.
add stick on go faster stripes.
exploring networks and surface decoration (continued)

Explain to the class that they should try to create the following decorative effects:

- shiny like metal by carefully sticking on aluminium foil;
- rough like some rocks by putting on small amounts of glue and shaking on sand;
- dark glass windows by cutting out appropriate shapes;
- striped by sticking on coloured strips.

It is useful if children work in pairs and co-operate in learning about these decoration techniques.

You can put the resulting decorated body shells on display to show the care and attention needed to get effective surface decoration.

Resources

**Consumables:**  ‘Wedge net’, ‘Double wedge net’ and ‘Bus net’, paper, card, aluminium foil, PVA glue, sand, coloured gummed paper;

**Tools:**  pencils, rulers, rubbers, scissors.

**Health and safety check**

Revisit the discussion about controlling risks when using scissors and glue.
the big task: designing and making the buggy

**Teacher input**

Explain to the class that now each one of them is going to use all that they have learned to design and make a toy vehicle, either for themselves, a friend of about the same age or a younger child. Remind them that they thought about this at the beginning in terms of:

- who the toy vehicle is for;
- what it should look like;
- what it should do.

Now they have to make firm decisions.

**Pupil activity**

Each pupil should write a complete specification using the following starter sentences.

- The toy vehicle is for …
- The toy vehicle will be like a …
- The toy vehicle will …
- The toy vehicle will look like this …

With some children you may wish to use “My buggy specification” available as a ready-to-copy sheet.

Encourage the children to make a quick sketch to show what their toy will look like.

**Teacher input**

Remind the class that they have to make design decisions in ways that will meet the specification about the following.

- a) Develop a chassis complete with axles and wheels so that the toy rolls along.
- b) Add an electric motor, battery, switch and transmission system so that the electric motor can make the vehicle move forward in a straight line;
- c) Develop a card body shell that will give the desired appearance.
You may wish to use the ready-to-copy ‘Simple buggy – exploded view’ sheet with some children.

Note also that the A4 nets ‘Wedge net’, ‘Double wedge net’ and ‘Bus net’, can be enlarged to A3 and used as starting templates for body shells. Children who use these can design the chassis using a best-fit approach to measurement.

**Resources**

**Consumables:** ‘My buggy specification’ or paper, ‘Simple buggy – exploded view’, quantity of 10 mm X 10 mm wood strip, abrasive paper, card, PVA glue, 6 mm dowel, wooden wheels, pulley wheels, gear wheels, worm gears, rubber bands, card, aluminium foil, sand, coloured gummed paper, insulated wire, crocodile clips, electrical switches, 6v bulbs, bulb holders, buzzers, low voltage dc electric motors, garden ties, paper fasteners, drawing pins, paperclips, lollipop sticks;

**Tools:** pencils, rulers, scissors, sawing boards, junior hacksaws, hand drills and 6 mm bits.

**Health and safety check**

Revisit the discussion about controlling risks when using the tools, materials and components available for making their buggy.

**Extension work**

Children who finish early or who require an extra challenge might be asked to do the following.

Extend the specification of the toy to meet additional movement features such as:
- move forwards and backwards in a straight line;
- move at one speed;
- move at different speeds.

Extend the specification of the toy to meet additional light and sound effects.
SECTION 4
teaching the unit

evaluating the final product

Teacher input
Positive aspects of the children’s designs must be valued but the children must also learn to be critical – working in groups during their evaluation should make this easier.

Pupil activity
Tell the pupils to work in groups of four. They should look at the specification for each toy, take turns looking at it and using it and then answer the following questions about each toy.

♦ How well did it do what it was designed to do?
♦ How much did it look like it was designed to look?
♦ How much did it appeal to those it was designed for?

Tell the pupils that they may find it useful to record these findings in table form. Once every child has the comments of everyone in the group about their toy, they can each write a few sentences answering the following questions.

♦ Can it be made safer?
♦ Can it be made to work more reliably?
♦ Can it be made to look better?
♦ Can it be made to work better?
♦ Can it be made to last longer?

With some children you may wish to use the ready-to-copy ‘My buggy evaluation’ sheet.

Resources
Consumables: ‘My buggy evaluation’ sheet or paper;
Tools: pencils.

Health and safety check
Discuss the hazards and risks involved in playing with toy buggies and how the risks can be controlled.
Teacher input
Explain to the class that it is important to think about how to get better at design & technology and that they can do this by discussing the following questions.

- What did you enjoy most?
- What did you find easy?
- What did you find difficult?
- What did you get better at?
- Did you help each other?
- What could have been done better?
- How could these be done better?

Pupil activity
The children should discuss the questions in groups and when they have finished you should ask each group to make a short report to the class. The class should agree a statement based on these reports for improvement for their next design & technology unit.

Resources
None needed.

Health and safety check
Discuss whether the class used hazard recognition, risk identification and risk control to design and make safely.
### Sessions 1, Sessions 2 and 3, Sessions 4 and 5

<table>
<thead>
<tr>
<th>Sessions 1</th>
<th>Sessions 2 and 3</th>
<th>Sessions 4 and 5</th>
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<tbody>
<tr>
<td>vehicle, battery, motor, chassis, axle</td>
<td>abrasive, hexagon, periphery</td>
<td>mechanism, belt drive, simple, compound, gear, worm and wheel, push to make switch, push to break switch, on-off switch, pulley wheel, forwards, backwards, reverse, flashing LED (light emitting diode), series circuit, parallel circuit, bulb holder, buzzer, network</td>
</tr>
</tbody>
</table>

### Vocabulary
- mechanism, belt drive, simple, compound, gear, worm and wheel, push to make switch, push to break switch, on-off switch, pulley wheel, forwards, backwards, reverse, flashing LED (light emitting diode), series circuit, parallel circuit, bulb holder, buzzer, network

### Resources Summary

<table>
<thead>
<tr>
<th>Session</th>
<th>Stimulus materials</th>
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<th>Tools</th>
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<td></td>
<td>quantity of thin plywood, 6 mm dowel Plasticine, My buggy hexagon template</td>
<td>hand drills, 6 mm bits, pencils</td>
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<tr>
<td>4</td>
<td>examples of: simple belt drives, compound belt drives, wheel and worm systems, simple and compound gear trains; circuits using a push-to-make switch, an on/off switch, a reversing switch, a push-to-brake switch</td>
<td>‘My buggy exploring technical systems’ sheets 1–3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>‘My buggy body nets’, paper, card, aluminium foil, PVA glue, sand, coloured gummed paper</td>
<td>pencils, rulers, rubbers, scissors</td>
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<td>6-7</td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td></td>
<td>‘My buggy evaluation’ sheet or paper</td>
<td>pencils</td>
</tr>
</tbody>
</table>

*(You can purchase components to construct these technical systems from Technology Teaching Systems, Unit 7, Month Road, Alfreton, Derbyshire, DE85 7RL.)*
Literacy

This module offers links to explanatory writing as in term 2. The explanation could be about how a simple or compound gear train works or how a wheel and worm system works. At the end of the module an explanation of how my buggy works could be written and displayed alongside the model. This would give an appropriate audience and purpose for this relatively difficult genre.

Numeracy

There are several opportunities to practise skills and apply mathematical knowledge in this module. The children will be able to experience for a real purpose measuring accurately to the nearest millimetre. Opportunities will be given to make shapes and to demonstrate an increasing accuracy in doing so. There are also opportunities for visualising 3D shapes from 2D drawings and identifying different nets. A display could be set up with pictures of buggies, their 3D shapes and the nets, and children could try to match all three together.

Science

The work on finding how to make a spinner spin for the longest amount of time offers many scientific opportunities.

The PoS for science state that it is important to test ideas using evidence from observation and measurement, which is what this activity offers.

The children will be able to apply their skills of planning, obtaining and presenting evidence and considering the evidence and evaluating when they investigate how to make a spinner spin for the longest length of time.

This activity also offers the opportunity of revising circuits from the QCA SoW 4F ‘Circuits and conductors’.
My buggy exploring technical systems 1

Some mechanisms

**Simple belt drive**
- pulley belt
- drive
- handle to drive

**Compound belt drive**
- driven
- drive

Turn here and see what happens.
Can you explain the difference?

**Simple gear train**
- driven
- drive

**Compound gear train**
- driven
- drive

Turn here and see what happens.
Can you explain the difference?

**Wheel and worm system**

Turn here and see what happens.
How is this mechanism different to the others?
**My buggy exploring technical systems 2**

**Switches controlling motors**

**Push-to-make switch**

Press here.
What happens when you stop pressing?

**Toggle on/off switch**

Push here.
What happens when you stop pushing?
What do you have to do to stop the motor?

**Reversing switch**

Slide to the right.
What happens to the motor?

Slide to the left.
What happens to the motor?
**My buggy exploring technical systems 3**

**Controlling lights and buzzers**

**Push-to-make switch**

What happens to the buzzer when you press here?
What happens when you stop pressing?

**Push-to-break switch**

What happens to the bulb when you press here?
What happens when you stop pressing?

**Toggle on-off switch**

Push here.
What happens when you stop pushing?
What do you have to do to stop the LED from flashing?

**Parallel circuit**

Push here
What happens to the light bulbs?
Can you explain the difference?
What do you have to do to turn the light bulbs off?

**Series circuit**
My buggy wedge net

cut along solid lines
fold along dotted lines
My buggy double wedge net

cut along solid lines
fold along dotted lines
My buggy bus net

cut along solid lines
fold along dotted lines
My buggy specification

Name ___________________________

The toy vehicle is for …
Me [ ]
Someone else [ ]
Who? ___________________________

The toy vehicle will be like …
• an actual vehicle [ ]
• a vehicle from a book or film [ ]
• a fantasy vehicle [ ]

The toy vehicle will look like this:

Class ___________________________

The toy vehicle will …
• use an electric motor and battery to work [ ]
• go forwards [ ]
• go forwards and backwards [ ]
• travel at different speeds [ ]
• have lighting effects [ ]
• have sound effects [ ]
My buggy evaluation

Name ____________________________ Class ____________________________

The toy vehicle was for ____________________________

Did they like or dislike the toy? ☐ Yes/No ☐ Explain why.

The toy vehicle was intended to be like …
☐ an actual vehicle ☐ a vehicle from a book or film ☐ a fantasy vehicle
Was it? ☐ Yes/No ☐ If not, try to explain why. ____________________________

The toy vehicle was intended to …
☐ use an electric motor and battery. Did it? ☐ Yes/No ☐ If not, try to explain why.

☐ go forwards. Did it? ☐ Yes/No ☐ If not, try to explain why. ____________________________

☐ go forwards and backwards. Did it? ☐ Yes/No ☐ If not, try to explain why.

☐ travel at different speeds. Did it? ☐ Yes/No ☐ If not, try to explain why.

☐ have lighting effects. Did it? ☐ Yes/No ☐ If not, try to explain why.

☐ have sound effects. Did it? ☐ Yes/No ☐ If not, try to explain why.

☐ Did the toy vehicle look like your sketch? ☐ Yes/No ☐ If no, try to explain why.
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