

Designing and assembling a model car: Lesson idea

Project overview

Introduction

In this unit, pupils are asked to build a model car. The model can be split into five main sections:

1. The chassis: Pupils either make a chassis based on a design given to them or design and make their own chassis design.
2. The body: Pupils either make a body based on a design given to them or design and make their own body design.
3. Transmission: Pupils use a battery powered circuit to drive a motor that makes the model move.
4. Pupils incorporate other circuits (lighting).
5. Graphics: Pupils use manual graphics or computer aided graphics to enhance the aesthetics of their model car.

Stimulus

- Exemplar model cars
- Circuit examples
- Car chassis examples
- Graphics Examples
- Car body example

Task

Pupils are asked to design and make a model rally car. This is broken down into mini-projects to aid understanding and allow flexibility in teaching approaches.

The chassis part of the project allows pupils to design and make a model that will hold/support a battery, a motor, axles, wheels, and some way of driving one axle from the motor.

The body part of the project allows pupils to design and make a car body that will fit onto the chassis they have made. The body will be formed using a simple surface development which can be drawn using manual graphics or C.A.G.

Pupils can render the surface development prior to bending and sticking to shape or can use a desktop publishing program to design the graphics.

The transmission part of the project allows pupils to design with given components. Pupils should design a way of using the rotating output from an electric motor to drive the front or rear axle of the model. There is scope here for pupils to design and integrate some kind of lighting system onto the model. This could model, headlights, tail-lights, indicators or aesthetic lighting.

Reflection

Pupils should evaluate each step of the project, discussing and deciding what went well and what could be improved with each part (chassis, body, drive system, electrics, lights, graphics)
Review understanding against learning outcome

eRally: Model Making Activity

1. Tasks for pupils to assemble a model car.
2. Tasks to let pupils explore different types of transmissions (looking at how chemical energy is changed to electric energy and then to mechanical energy).
3. Tasks to allow pupils to incorporate circuits into a model (probably the chassis they have built in the first task).

My buggy exploring technical systems:

This sheet shows simple representations of switching circuits that can be used with the model cars. For each, it would be possible for pupils to explore using simulation software such as Yenka (Crocodile Clips).

Once they have investigated the best type of switch they can then plan to incorporate it into their model.

Battery	Cross-brace
Pulley Wheels	End
Holes for axles	Side
Rubber bands	End
Axles	Side
Motor	Gussets
Wires	

1. Mark and cut wood to length using a tenon saw or scroll saw. You will need two “*sides*”, two “*ends*” and a “*cross brace*”. The *cross brace* should be the same length as the *ends*. Lightly sand the *ends* of the wood to remove burr. Dimensions: Sides = 125mm in length, Ends to make width of chassis 55mm.
2. Mark the position of the holes in the *sides* and carefully , drill two holes in each piece. The holes should be slightly bigger than the dowel used for the *axles* (by about 0.2mm). There may be a jig available to help you do this accurately.
3. a. Align *End* pieces with the end of the *sides* and place the *cross brace* half way along the

length of the chassis.

- b. Check that it goes together 'square' then glue it up using PVA or a hot glue gun. You may have access to a jig to make this easier. Make sure you put *rubber bands* around the *cross brace* before you glue it up (this will be used to hold on the *motor* and *battery*).
4. Once the glue on the wood has dried, use *gussets* (cut triangular pieces of card) to strengthen the structure.
5. Mount the *motor* and *battery* on the *cross brace* using rubber band/tape. Attach a *pulley wheel* to the *motor*.
6. Glue one *wheel* to one end of each *axle*. Slide into the *chassis* from one side. Before sliding them right through attach a *pulley wheel* to one *axle*. This will be the driven *axle*. Also loop a rubber band over the *pulley*. Finish by sliding the *axle* all the way through to the other side and glue on another *wheel*.
7. Loop the *rubber band* from the *pulley* at the *driven axle* to the pulley at the *motor*. Hook up your *battery* and enjoy.

Chassis assembly— Wooden Model

Pupil Help Sheet

This is a basic design. Changes can be made by adding switches, lighting circuits, larger/smaller pulley wheels, larger/smaller wheels, etc

Introduction

The task of teaching the design and manufacture of the chassis can be as managed or free as a teacher chooses. The design shown on the right is a suggestion, is easy to resource and should be easy for the majority of pupils to manufacture. The most important outcome is for all pupils to have a working chassis that allows the model to move under its own power.

Stimulus

- Exemplar chassis.
- Examples of chassis from real applications (videos or photographs).

Task

The task could include pupils learning parts of the design process, applying and learning terminology from the design process (such as primary and secondary functions, safety, ergonomics...). It could also be used to teach pupils how to use basic hand/machine tools and assembly techniques.

The chassis should be sturdy enough to support the axles whilst they are being driven by the motor. The motor and battery must also be supported.

The chassis could also be a design task in itself. It could be made from materials other than wood, such as card, aluminium, plastic sheet, etc...

Reflection

Pupils should reflect on problems they have come across in building the chassis. They should reflect and report on the affect of these problems on next steps (designing and building the body and lighting).

Discussion points: Length of elastic band and tension on elastic band, size of pulley wheels, diameter of axle, diameter of axle holes, securing the motor, shape of pulley wheel, how wheels are joined to axles.

Next Steps

Pupils now design and build a lighting circuit to attach to the model.

Pupils design and make a body for the model (investigating a variety of graphic communication techniques).

Reflection

Pupils should display the surface development in the classroom, school or on Glow.

Pupils should discuss/demonstrate their understanding of; drawing simple surface developments, using graphics (font, line, colour, shape) to enhance a product.

Next Steps

Pupils join body to chassis using tape, Blutak, or glue. Pupils should bear in mind that they may have to remove the body to fix any problems with the chassis.

Body design and assembly

Introduction

The body part of the project allows pupils to design and make a car body that will fit onto the chassis they have made. The body will be formed using a simple surface development which can be drawn using manual graphics or C.A.G. A surface development is the 2D shape that is folded to make the 3D body from paper, card or some similar material.

Once the surface development has been drawn pupils can be given the opportunity to render the surface using manual graphics or C.A.G. Pupils can use this to learn skills relevant to Graphic Communication.

Stimulus

- Exemplar surface developments with graphics
- Exemplar surface developments without graphics
- Templates for surface developments (see appendix)
- Templates on C.A.G. package (i.e. Xara, Freehand, InDesign)

Task

Pupils create a body for to cover the chassis they have made. This can be easily differentiated through use of templates for body shapes and graphics through to allowing pupils to design shapes and graphics on their own.

Pupils can also provide space on their designs for headlights, indicators, etc...

Body design and assembly— Graphics

Task

The main task is for pupils to discover how to make their models move forward using a battery, a motor, some wires and rubber bands. They should gain knowledge of electric circuits. There is scope to include soldering, adding different switching circuits perhaps for forward/backward motion), steering wheels, etc...

Pupils should gain some understanding of energy conversion, specifically converting chemical energy to electrical energy and then to mechanical energy. There is also scope for pupils to apply knowledge of kinetic and potential energy.

A good way to approach this task is for all pupils to build a common simple transmission based on a pulley system. Attach the motor to the chassis, loop a rubber band around the pulley wheel on the motor and the other end around the pulley wheel on the axle. Once this is complete, teachers and pupils can discuss/explore different ways to transfer energy from the motor to the axle.

Reflection

Pupils should reflect on the application of known technology. Encourage report writing, poster presentations or video presentations of their models.

Next Steps

Pupils use their model to explore circuits (specifically lighting), using the existing battery or an auxiliary battery.

Introduction

The transmission in a vehicle is the drive train.

In this unit, pupils should be allowed to explore different methods of driving the wheels on the ground. The power source is most likely a battery driving a motor. So, at a basic level, pupils should work out the best way to use energy from the motor. Other energy sources can be explored (e.g. twisted elastic bands).

This unit allows exploration of scientific principles of energy conversion and of different mechanical systems. Pupils should be able to critically explain why certain types of transmission are suitable whilst others aren't.

Stimulus

- Models of different types of transmission (like gear train, pulleys systems, worm gears, bevel gears)
- Fischer Technik mechanics kits
- Switching work sheets
- Completed models
- Videos explaining real transmissions
- Pupil help card; Chassis Assembly
- Simulation software: such as Yenka

Body design and assembly— Transmission

Help Sheet

Switching Circuits

Introduction

This part of the project allows pupils to explore electric lighting circuits as part of their model car. Lighting circuits can be planned or retro-fitted to models. Pupils can be exposed to a wide range of experiences depending on available resources. For example a pupil may build a fixed circuit, while another may be able to plan what they want having gained an understanding in the basics. The body of the car will have to be adapted to house lights. An auxiliary battery may have to be used to provide energy for the lights, though they may be powered by the battery used for the transmission.

Stimulus

- Model lighting circuits
- Multimeter, or individual meters
- Automotive lighting videos
- Simulation software
- Electric circuit information cards
- Night rally videos

Task

Pupils should make or design and make a lighting circuit for their models. They should be encouraged to experiment, but to base their experimentation on sound theory. For example, why use a parallel circuit for two headlights instead of a circuit in series, or how could front and rear lights be turned on simultaneously. As with the transmission unit of the project pupils should gain an understanding of the types of switch that are suitable. Again, simulation is invaluable. Pupils should learn why.

Reflection

Pupils should report on the reasons for building the circuit they used and on their success or difficulties.

Next Steps

Pupils race their models in a lighted environment and where the lights have been turned off.
Pupils upload a video or presentation of the completed model to Glow.

Headlights and tail-lights

Body design and assembly— Lighting Circuits

Task

A good way to approach this task is for all pupils to build a common simple transmission based on a pulley system. Attach the motor to the chassis (using tape, a rubber band, glue, battery box), loop a rubber band around the pulley wheel on the motor and the other end around the pulley wheel on the axle. Once this is complete, teachers and pupils can discuss/explore different ways to transfer energy from the motor to the axle.

Body design and assembly— Transmission

Help Sheet

- Why is this type of mechanism suitable for use in this application?
- What would happen if the pulley wheel on the motor was made bigger?
- What would happen if the pulley wheel on the axle was made smaller?
- What would happen if the pulley wheel on the axle was made bigger?
- What would happen if the battery was changed for one with more or less potential?
- This is a compound gear train. Why wouldn't you use it to drive the axle?
- This is a worm gear. Why wouldn't you use it to drive the axle?
- What mechanism in a car could this be used for?

Worth exploring:

For each type of switch, discuss and record why the switch may be used in different situations. For example, a toggle on/off switch can be used to switch lights on and off because...

Worth exploring:

You are using a battery to provide energy to the motor to drive the wheels. Find out and discuss what types of energy are being used (mechanical, chemical, electrical) and how energy transfer takes place in each case.

Some models will move faster than others. Discuss why this is the case when all are using the same type of battery.

Worth exploring:

Discuss and record information regarding colour theory. Look at Primary, Secondary and Tertiary colours, harmony, contrast, tone and tint. Use this knowledge to explain why certain colours have been chosen.