Note for STEM Ambassadors – Schools may have some of the items you need, so check with the teacher before your session. Remember a risk assessment should be done before beginning this session. See the resources hazard sheet for further suggestions.

1 A Cross River Partnership by STEMNET in association with the Centre for STEM Enhancement (CSTEME) at London Metropolitan University.
Battery-powered buggy

The first step is to make a simple powered vehicle:

- Cut out a piece of corriflute (or cardboard), for example 15 cm by 10 cm to form the base. Using tape, stick a drinking straw at either end of your base.

- Cut your doweling to fit, pass through the straws and attach a wheel at each end. Students must be careful when doing this. Students should place the wheels flat on the table, rather than holding the wheels in their hands to avoid piercing themselves with the doweling.

- Attach the propeller onto the motor. The motor must be mounted so that the propeller does not hit the buggy. Students can be creative in their designs for this.

- The motor is powered by 2 AA batteries fitted into a battery holder. The circuit is completed by two lengths of wire, for safety you may wish to prepare and solder the wires and battery holder prior to the session.

The group should have been able to make a battery powered buggy, but they will soon find that they cannot guide its direction. To do this would require a complicated steering mechanism and a driver for each vehicle, which would be too expensive. Remember, a large amount of aid, some of it quite heavy (food, water, building materials etc.) needs to be brought in quickly and safely, without the vehicle getting stuck in the ground.

A good way to achieve this would be to use a simple guidance system where many vehicles can travel, joined together and hauled by a single locomotive, down the same well-engineered path from A to B.

Some Extras

Vehicles that run on tracks are easy to electrify as it is simple to provide one or two more rails to carry electricity to and from the motors.

You can do this by modifying the simple guidance system described above. Arrange two wooden guide rails on a length of Corriflute, and then put two strips of foil inside the guide rails. Make certain there is no contact between the two foil strips.

Now take the vehicle and remove the battery. Bend one of the wires running to the motor so that it touches one foil rail and the other wire so that it touches the other one. Connect the two foil rails to the battery. The vehicle should move along the track. When the battery is reversed, the vehicle should move in the opposite direction.

To ensure good contact between the wire and the foil you may need to use something metallic and heavy. Screws and washers make good contacts when attached to the wires from the vehicles. You could also try wire wool, which spreads to make a brush contact. Why might we want to electrify our track? What are the advantages and disadvantages of electrification?

What To Do

To fully engage your whole group provide a context for this activity.

Imagine there has been a natural disaster and the transport system has been damaged beyond repair. A small village has become isolated and is in need of food and aid for its inhabitants. The area on route to the village is muddy and broken after bad weather. The cars and lorries that have attempted to travel to the village have become stuck in the ground and have been abandoned.

The group must design a transport system to reconnect this village to its nearest neighbour so that the much needed aid can be provided in large quantities, quickly and safely.

Simple guidance system

Lay a double row of square-section wood along corriflute or cardboard, so that the wheels of the vehicle are outside the rows. If you don’t have wood you can use strips of card or corriflute.

Now if the vehicle moves to the left or right, the wheels bump into the wood and so are kept on track. The load is spread along the guidance system and thus less likely to sink into the ground. This should allow the village to be reconnected to its nearest neighbour. However a further isolated village has now been discovered.

Set the group the following Guided Vehicle Challenge, developed by the Derby Railway Engineering Society (www.dres.org.uk)

Your group have designed and built a small vehicle to carry aid, and have seen that without a guidance system the vehicle could travel in many directions.

Your group must now design a fixed guidance system which includes a movable section. This will allow the vehicle to be moved from a fixed position A to position B and from A to position C.

The vehicle must have no steering but be guided by the fixed ‘path’ system. The moveable section (points) must be operated from a position at least 150 mm away and without touching the points themselves.

This is a great opportunity to be creative – what ideas can the students think of?
David Horton from Bombardier

A Suspension & Dynamics Engineer for Bogies

David chose to do A-levels in Maths, Physics, Biology and Music, and read Mechanical Engineering at Imperial College.

In September 2007 David graduated and joined Bombardier on their two year graduate scheme. He gained experience in different areas of the company, spending time in various disciplines such as Structural Design, Project Engineering, Overhaul and Vehicle Dynamics. After his time on the scheme David slotted into the role he now holds as a Suspension & Dynamics Engineer for bogies, and has already had the chance to go to Siegen and Hennigsdorf in Germany with his job.

David’s advice for those who want to become successful Engineers would be to take the view that work experience is as important as academic study. During his degree, David found work experience with several companies in the summer months. ‘Companies won’t necessarily advertise so show some initiative and write to them. Moreover any opportunity you get to go out on the shop floor, take it. Once you put theory into practice you learn a lot more.’

Amy Barley from Bombardier

Amy was interested in how things work from an early age. She enjoyed Maths, Physics and Chemistry throughout school and studied these as her higher subjects on the International Baccalaureate at sixth form. She then studied for a BEng(Hons) in Engineering with Business Management at Birmingham University.

In 2009 Amy was appointed as a Materials Engineer within the Passengers Division, and enjoys the experience of whole vehicle engineering (i.e. working with all systems throughout the vehicle life, from concept design to end of service).

‘There is no such thing as a typical day when you’re working in the railway industry. For example I had a day recently in which I went from working with the voltage equipment on the roof of a train to testing the fire performance of seat materials, to assessing paint performance on a vehicle body.

‘There are railway networks all over the world which need railway engineers. This offers a great opportunity to travel.

Handy Hints

Adding a societal context to this activity is very important. An example has been given in the method, but do adapt depending on location, current news etc.

It is also useful to discuss the engineering and cost trade-offs. Why not add a procurement element to the activity; give each group a budget and apply a cost to all the materials used. This is particularly useful when materials are limited.

The group are being asked to design and make railway points’ or ‘switches’ which can be operated at a distance (this does not need to be electronic in nature, a simple push or pull mechanism will work well).

The following link shows an easy to understand animation http://en.wikipedia.org/wiki/File:Railroad_switch_animation.gif

For more complex ideas show your group some examples from the following site www.hitachi-rail.com/products/monorail_system/track/type/index.html

Explanation

Points (or switches) will allow a train to be guided from one track to another. This is achieved by a pair of linked rails which narrow (or taper) inside the outer rails.

These rails are moved to direct the train onto a specific track. There will generally be a straight “through” track (such as the main-line) and a diverging route.

Who uses these ideas?

STEM Ambassador Profiles
This Is Engineering

Engineering is a very wide and creative field and there are many different routes you can take to become an Engineer. Engineers use science to turn ideas into reality, solve problems, make things happen more quickly, safely and efficiently, and keep the modern world functioning.

There are a large variety of Engineering degrees which can be studied at university. For more information visit www.ucas.com

You will generally need STEM A levels (Advanced Highers in Scotland) including mathematics and preferably physics too. Alternatives include STEM-related Advanced Diplomas (or BTEC National Extended Diplomas) plus appropriate qualifications in mathematics and possibly physics too.

Many big companies have Engineering Graduate Schemes, the entry requirements for which will typically be a degree such as Mechanical, Electrical or Civil Engineering.

In the specific field of Railway Engineering you can seek an apprenticeship with Network Rail, where you can get involved with all kinds of things such as helping to maintain the track, fix signals, build bridges, design new stations and operate test trains. Visit http://careers.networkrail.co.uk/apprentices for more information.

There are many other companies in the railway industry, such as Bombardier Transportation, who can design and build trains, trams, signalling and even an entire railway system. Visit www.bombardier.com for more information.


Curriculum Links

You may find this resource useful when studying some topics in Key Stage Three:

**England**

**Science:** Forces and their effects

**Scotland**

**Science, Forces:** 2-07a, 3-07a – applications of friction,

**Technological developments in society:** 2-01a – using knowledge to help design and improve products

Next Steps

Remember there are more resources at networking.stemnet.org.uk, search for Engineering.

For more information on STEM Clubs visit: www.stemclubs.net

For more information about the Engineering Engagement Project visit: www.raeng.org.uk/eenp

For more information on the Young Railway Professionals visit: www.youngrailwayprofessionals.org

CREST Awards are easy-to-run, encourage students to continue with STEM subjects, and add real value to UCAS applications. To link this activity to CREST Bronze Awards, contact your CREST Local Coordinator: www.britishscienceassociation.org/crestcontacts

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