Discovery Learning Centre

Department of Mechanical Engineering

www.mech.canterbury.ac.nz

A hands-on investigation of technology
For children ages 8-14

A machine is anything that helps you do something. People use machines to do things faster, or to do things that people don't want to do. With a bulldozer, one man can have the strength of 600 men using just their hands. Doctors use machines to perform difficult surgery, because the machine hand can be steadier than the human hand.

How do machines work, and how do they help people?

In the *Discovery Learning Centre* you will be able to see, operate, and understand a lot of different machines. You can turn cranks and operate levers to see how a machine works and what it does. All around you are the components of machines that engineers have invented to perform some useful task.

Think of the machines you have at home, or at school. How would you get the same thing done if you didn't have those machines? Can you think of something important that people need, or that would help the environment? Maybe you will invent a machine for that someday.

Class visits to the Discovery Learning Centre can be arranged by your teacher by going to the department website.

Each letter is associated with a place in the Discover Learning Centre. Do the activities listed for as many as you like. Also, try to figure out what each picture is and write your answer in the box.

A – The Power to Make Things Go: Engines

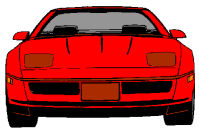
An engine turns the energy from a fuel into motion. The amount of power that an engine has depends on how big it is. Can you find three different size engines?

A petrol, or Internal Combustion Engine, works by squirting a small amount of fuel and air into the combustion cylinder. When the spark plug creates a spark with electricity, it causes a fiery explosion, which supplies a lot of energy to push the piston up. The piston is connected to a shaft that turns. That turning shaft is connected to the gear box and then through some more gears to make the wheels turn. The exhaust is pushed out of the cylinder and a new charge of fuel and air is injected as the piston moves down.

Find the Engine that came out of a car motorcycle lawn mower

Would you want to touch a running engine? _____ Why? _____

Find the mechanism that makes the up-and-down motion from the engine into the turning motion of the shaft.



Find the spark plug

We use the term Horse Power (HP) to describe how powerful an engine is. Can you think of why that is? _____

B – One Engine, Many Speeds: Gears & Pulleys

Your bike has gears. What do you use them for?

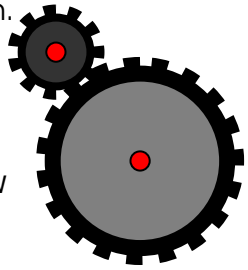
_____

_____

With gears, you can turn fast motion into slow motion, or the other way round. We use **r**evolutions **p**er **m**inute, **rpm**, as the measure of how fast a shaft is turning. The **gear ratio** means how many more times one gear goes around compared to its mate.

○ If a shaft is turning at 40 rpm, how many times does it go around in three minutes?_____

FAST



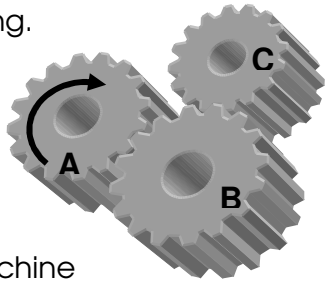
SLOW

○ Find the gear set on the table that would change fast into slow motion.

○ Pick a gear set and find the **gear ratio**:

1 revolution on slow gear = _____on fast gear

⊕ Put arrows on gears B and C to show which way they are turning.



Gears That Change Motion

Motors, engines, windmills, and most other **prime movers** deliver energy in the form of a continuously turning shaft. What if your machine needs up and down motion? What if you need something to turn for two seconds, stop, then go backwards for two seconds? Gears can be used to make one kind of motion into another kind.

⊕ Can you find a gear assembly that produces a back and forth motion?

⊕ Describe the motion of your favourite gear set to a friend, and see if they can guess which one it is.

Pulleys: Gears with no teeth

⊕ Find the pulley assembly. How does it work like a gear?

_____

_____

C – Rolling Right Along: Shaft and Bearings

Friction is not our friend unless we want to stop. Press your hand on the table top or carpet, and try to push it forward. You have to push against friction. Friction is where two surfaces are dragging or rubbing against each other. Now, put the round rod or a metal ball under your palm, and try to push your hand across the table. You have eliminated the friction!

Roller bearings were invented to get rid of the friction in a turning shaft. When you are roller-blading, do you want the wheels to turn smooth and easy? There are ball bearings in there.

- Try taking apart and putting back together the bearings in the black box, so you can see how they work.
- What things do you have at your house that would have ball bearings in them?

_____

_____

D – On and Off: Valves, Flow and Heat

Can you think of any machines that use liquid to make them work?_____

_____

What would happen if the liquid flow didn't turn off? What if the flow was too fast or too slow?_____

What would happen if the liquid water in your car's engine got too hot?_____

Machines need valves to control when water runs into a dishwasher, or how gas flows to the car engine. Machines also need ways to keep cool when they are working hard. Look at the valves that are cut open on the table. You can see inside where the water would flow. Can you see how the water gets shut-off?

- Draw on the valve to show how the mechanism works to make the water flow or stop.

- Find the **Heat Exchanger** on the table that would cool down a water flow with blowing air. How do you cool down your hot soup?

E – Moving Every Which Way: Mechanisms & Joints

You have joints in your body. We describe joints by the **degree of freedom** which means how many directions they can move. Special mechanisms let engineers make machines with all sorts of motions.

Put your elbow on the table and look at your hand. The last knuckle on your finger has one degree of freedom, it can only move one way. Hold your upper arm still near your wrist.

- How many degrees of freedom does your wrist have? _____

Now let go of your wrist, keeping your elbow on the table.

- How many degrees of freedom does your elbow have? _____
- Play with the mechanisms on this table. Try to describe the motion of your favourite mechanism and give it a creative name.

NAME	*Function: What does it do?*

F – Machines in Your Home: Fisher&Paykel Washing Machine

This is a real washing machine that has been cut open so you can see all the parts and how it works. The motor and tub have been locked in place, but in a working machine the middle shaft, called the agitator, rotates back and forth, and the metal tub spins very fast.

Your clothes will get clean if the following procedure is followed. How would you do the same job as the washing machine?

1. Clothes are soaked in water mixed with laundry soap.
2. Lots of motion. Clothes should be rubbed, swished, sloshed, scrubbed, so the dirt can be lifted off the fabric.
3. Soapy water is removed from the clothes.
4. Clothes are mixed with clean rinse water.
5. More motion. Swish, slosh, scrub, to rinse out the soap and dirt.
6. Rinse water is removed from the clothes.
7. Tick if you have ever run the washing machine at your house.

G – Forces of Nature: Wind Tunnel, Bubble Machine, Fluid Flow

Engineers need to design airplanes, cars, boats, bike helmets, and many other things to move smoothly through the air with low noise and low drag or resistance. When you stick your hand out of the window of a moving car, you can feel the drag force of the air. When you get into the wind tunnel you will feel the force. You can see the air flow motion by using the helium bubble machine.
This wind tunnel has been used to help design wind electricity generating machines.

- ***Remember***, you must have ***safety glasses*** on in the wind tunnel area.

H – Surround Sound: Reverberation Room

Yes, Engineers even control sound. Some places, like a theatre, the sound needs to travel to every one in the room. Other places, like a library, we want the sound to disappear. In our homes and offices, we don't want to hear the noise from cars going by, or from rooms next door. In our car, we don't want to hear the sound of the engine, or the wind whooshing by. The right amount of sound can be controlled by using special materials and shapes, and by controlling vibrations.

Have some fun in the reverberation room, where the sound isn't absorbed by the walls, it echoes around and around. This chamber is used to test out acoustic designs and materials which are used to control noise.

- What is a sound you don't want to hear if you are trying to sleep? _____

I – A Helping Hand: Robots

Mechanical engineers have lots of fun making robots. Robots can do boring work in factories so people don't have to. They can do work in places where it's dangerous for people to go. They can provide entertainment. In the DLC, you can see the first robot ever built in New Zealand to do the boring job of picking up y-front underwear from a stack and placing them in a box.

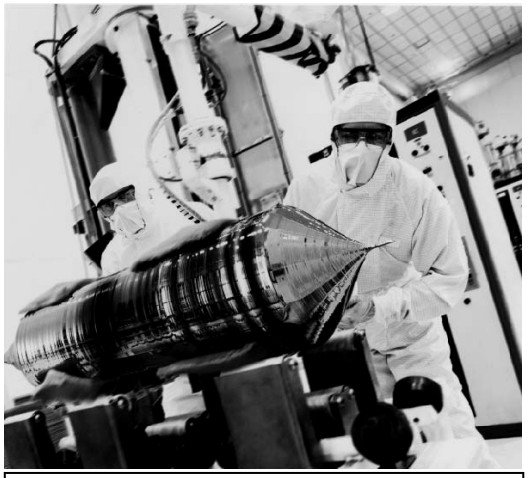
- What is the most boring thing you have to do? Would it be nice to have a robot do it for you?

J – Mechatronics and Micro Machines

Most of the fun toys and devices we use every day like cameras, VCR's, computers, and CD players, we could consider to be electronic devices. However, while these devices are controlled by electronics, they actually use tiny micro machines to perform the job of recording the happy events of our lives, providing us with our favourite music, or letting us play a game. In these tiny machines, the job is not to do a lot of hard work for us, like the car or washing machine, it is to move laser beams and magnetic heads into very precise positions very quickly. Where big machines are made for power, micro machines are made for precision.

- Can you see how the CD laser disk reader head is moved across the surface of the disk?

K – Manufacturing and Materials



All of the machines and devices you use have been made by someone in a factory. All of the metal was once in the form of a mineral deposit in the ground. Huge amounts of earth (about 1 ton of rock = 1 kg of metal) are mined out of the ground, and huge amounts of energy are used to make the materials which we use. Plastics are all made from petroleum oil and glass is made from melted sand. Once the materials are extracted and processed into stock materials, then manufacturing processes are used to make useful products out of them. Engineers also work on ways to re-use and recycle the materials after the product is discarded.

- Where do you suppose all the waste material from mining goes?
- Can you find the machine that makes holes?
- Which of the materials on the table is the hardest?
- Which material is the strongest and the lightest at the same time?
- Which material would be good for making airplanes?