## 1.0 – Machines are tools that help humans do work

### 1.1 – Simple Machines - Meeting Human Needs

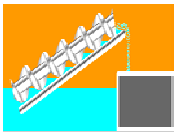
Machines help people use energy more efficiently. A machine helps us do work.

The earliest machines were simple devices to make work easier; like moving a large rock or moving a load up an incline, splitting wood or lifting materials up to a working area above the ground. These simple machines depended on people or animals as their source of energy.

**Meeting the Same Need In Different Ways**
Machines were built to satisfy basic human needs, such as getting water. Three devices used to get water in earlier times included:


Sakia (or, Persian wheel)


Roman aquaduct

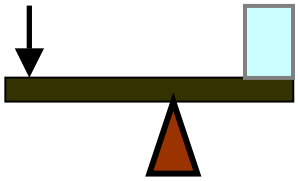

Achimedes screw

**Simple Machines**
A simple machine is a tool or device made up of one basic machine. There are six types of basic machines. http://www.fi.edu/qa97/spotlight3/spotlight3.html
http://www.usoe.k12.ut.us/curr/science/sciber00/8th/machines/sciber/intro.htm

**Lever** – is a rigid bar or plank that can rotate around a fixed point called a pivot, or fulcrum. Levers are used to reduce the force need to do a particular task. You can move a very large load, but you must move a greater distance than the load moves.
http://207.10.97.102/elscizone/lessons/land/simplmachines/3classes.htm

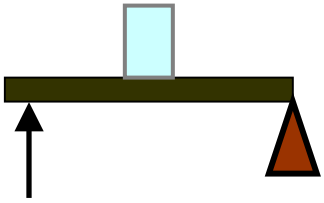
There are 3 classes of levers.  (a prybar can be all three classes of lever, depending on how it is used.)

**Moving heavy loads**



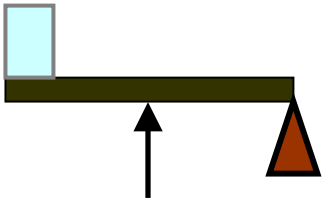
**First Class Lever**
*crowbars and pliers*

**Lifting heavy loads**



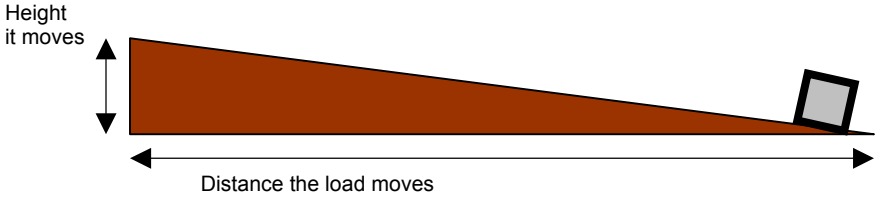
**Second Class Lever**
*wheelbarrow*

**Gaining speed**

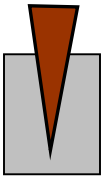


**Third Class Lever**
*Hammer, your arm*

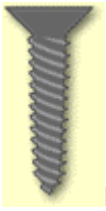
**Inclined plane** or ramp makes it easier to move a load higher than it is, but it has to be moved over a much longer distance. An inclined plane makes it possible to lift heavy objects using a smaller force (examples: loading ramp, wheelchair access ramp)



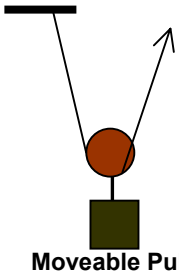
**Wedge** is similar in shape to an inclined plane, but is used in a different way (and can only be used in one direction). It is forced into an object to split it apart. The wedge increases the force applied to the object, but it moves a greater distance into the object than it splits apart.

Examples:
axe blade  or, a knife

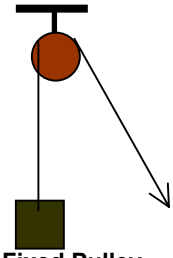
A **Screw** is a cylinder with a groove cut in a spiral on the outside. (It is actually an inclined plane that winds around itself) It helps you increase the force you use. It can be used to convert rotational (turning) motion to linear motion (movement in a straight line). It moves objects in a straight line very slowly.

 Examples include: jar lids, light bulbs, and spiral staircases

A **Pulley** consists of a wire, rope, or cable moving on a grooved wheel. One or more combinations of wheels and ropes can be fixed in place or moveable. Pulleys help you lift larger loads.



**Moveable Pulley**



**Fixed Pulley**

The **Wheel and Axle** is a combination of to wheels of different diameters that turn together - a lever that rotates in a circle around a center point or fulcrum. A longer motion on the wheel produces a more powerful motion on the axle. They can be used to increase the size of the force (steering wheel in a car) or the speed (bicycle wheels).

**The Effects of Simple Machines**

*Change the direction of a force (a pulley on a flagpole)*

*Multiply force (a screwdriver)*

*Increasing or decreasing speed (scissors)*

*Transferring force (removing staples)*

See also the review notes here: http://www.connect.ab.ca/~lburns/students_eightunit2notes.html

## 1.2 The Complex Machine – A Mechanical Team

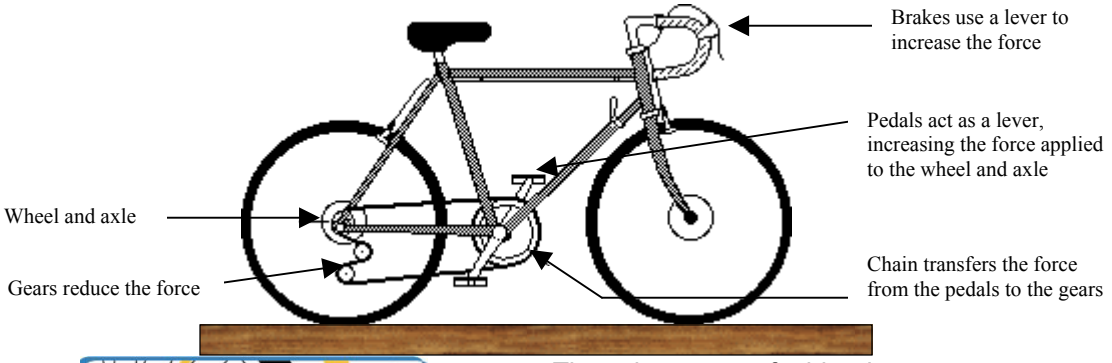
As time passed, people expected more and more difficult tasks to be completed by machines. Machines became more complex. Power sources had to be developed to run these complicated machines. Over the last two centuries - coal, oil and electricity powered complicated machines were developed to do work in large factories. The industrial revolution used these large complicated machines to mass-produce goods for use by consumers.

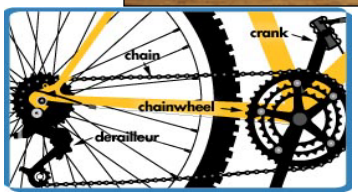
The **steam engine** moved these good across countries in a very short time, giving people more and better access to food, clothing, tools and raw materials than previously. The standard of living had improved. The continual development of new technologies has lead to our virtual dependence on machines.

### Complex Machines

Several simple machines all working together in a system are called **complex machines**. A **system** is a group of parts that work together to perform a function.

The **bicycle** is a good example of a complex machine because it is a system for moving a person from one place to another. Within the bicycle are groups of parts that perform specific functions, such as braking or steering. These groups of parts are called **subsystems**. Each subsystem in a complex machine contains a simple machine and usually has just one function.




The subsystems of a bicycle are:

- Wheel and axle
- Drivers & Gears
- Frames & Materials
- Brakes & Steering
- Aerodynamic design

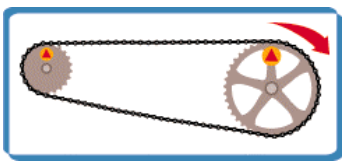
Explore the Science of Cycling at this website: http://www.exploratorium.edu/cycling/index.html
Build your Dream Bicycle: http://www.thetech.org/exhibits/online/topics/54j.html

### Subsystems That Transfer Forces

The subsystems in a mechanical device that produce motion, such as in a bicycle, play a role in how energy is transferred within the system. The subsystems are called **linkages** and **transmissions**.

### Linkages

The linkage is the part of the subsystem that transfers your energy from the pedals to the back wheel. In the bicycle, the chain is the linkage. In a car, the fan belt is the linkage from the engine to the cooling fan – to prevent the engine from overheating. Chains or belts form a direct link between two wheels – one that drives the motion and the other will follow in the same direction.



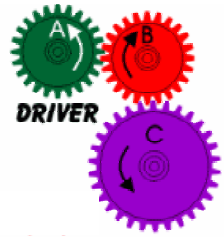
## Transmissions

Machines that are more complex than a bicycle move much larger loads. A special type of linkage is needed. It is called a **transmission**. It transfers energy from the engine to the wheels. A transmission contains a number of different gears. This enables the operator to move the object slowly with a large force, or quickly with a smaller force.

## Gears

Gears are essential components of most mechanical systems. They consist of a pair of wheels that have teeth that interlink. When they rotate together, one gearwheel transfers turning motion and force to the other.
There are many different types of gears. This website has just a few:
http://www.fi.edu/time/Journey/Time/Escapements/geartypes.html

. Gears can also be used to change the direction of motion in a mechanical device, such as in an ***eggbeater.***

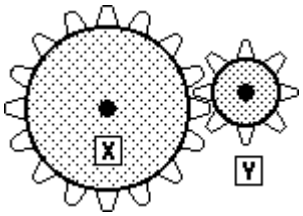



Gears can be used to increase or decrease force or speed

## How Gears Work

Gears transfer energy in a mechanical system. Gear wheels – which are wheels with precisely manufactured, identical teeth around its edge - work together in gear trains of two or more wheels transferring rotary motion and force from one part of a complex machine to another part.

A smaller gear (Y) is called a **pinion**. The gear that supplies the energy is called the **driving gear** (X). The gear to which the force is directed is called the **driven gear** (Y).




## How Gears Affect Speed

A ***large gear (X) driving a smaller gear (Y)*** decreases torque and **increases speed** in the driven gear. Gears such as these are called **multiplying gears**.

A ***small gear (Y) driving a larger gear (X)*** increases torque and **reduces speed** in the driven gear. Gears like these are called **reducing gears**. When the driving gear has fewer teeth than the driven gear, the driven gear then rotates more slowly than the driving gear. A car or bicycle in low gear uses reducing gears.

When the driving and the driven gears are the same size they are known as **parallel gears**.