Torque

Mechanisms can change the direction and speed of movement. They can change one type of movement into another. They can change force and “torque”.

Torque is the name given to a turning force, or Moment. The amount of force is measured in Newton meters, and is calculated by the force (in Newtons) x the distance (in meters) from the centre of rotation to the place where the force is applied.

In this rotary system the torque (turning force produced) by the driver shaft of the pillar drill is transferred to the driven shaft using a pulley. Any speed change in the system also causes changes in torque to the driven shaft. If the driven pulleys speeds up because of the VR (velocity ratio) of the system, the torque at the output shaft is reduced. For example the pillar drill shown here uses an electric motor which produces 100Nm (Newton meters) when running. The torque produced at the driven shaft is given by:

Output torque = Input torque x VR
= 100 x $^{1}/_{2}$
= 50Nm
Note: VR is calculated by using the formula:
Diameter of driven pulley ÷ Diameter of the driver pulley

If the system slows things down, the torque at the output shaft is increased. The slower the output shaft is going compared to the input shaft the greater the torque produced. Cranes only lift things slowly, but their slow running lifting winches produce very large forces.

In rotary systems the turning force produced by a driver shaft is transferred to the driven shaft. Any speed changes also causes changes to the turning forces produced by the system.

If the system increases the output speed, the torque at the output is reduced.

If the system decreases the output speed, the torque at the output shaft is increased.

In this example a hand wound boat winch has a handle 0.5 meters long and a gear ration of 4:1.

The radius of the driven gear is 4 times the radius of the driver.

If a force of 150N (Newtons) is applied to the end of the handle how much torque does the output shaft have?

Torque = Force x Radius

Handle torque at driver gear is:

150 x 0.5 = 75Nm

Because the gear system reduces the speed of the output shaft the Torque increases by the same amount as the ratio of the radius between the two gears, or the same as the VR of the system. (Ignoring friction) Therefore:

Output torque = 75 x 4

= 300 NM