Scorpio Technology NEWSLETTER

INSIDE THIS ISSUE

TEACHER CONFERENCES, WORKSHOPS & EVENTS

Scorpio is attending or supports these teacher activities:

DATTA QLD State Conference 2023 online and onsite, Brisbane Convention & Exhibition Centre from **15 – 16-06-2023**

Design and Technologies Week October

Victorian Model Solar Vehicle Challenge **14-15-10-2023**

iTE Technology Education Conference 2023 TechExpo, Sydney Masonic Centre, **30-11-2023 – 01-11-2023**

WELCOME

Gears are an integral component of today's machines, from space shuttles to smartwatches. Without them technology would not be where it is today. In this newsletter we investigate gears in their various forms and applications.

Remember, we're here to support you, however we can. Contact us at (03) 9802 9913 or email us at sales@scorpiotechnology.com.au

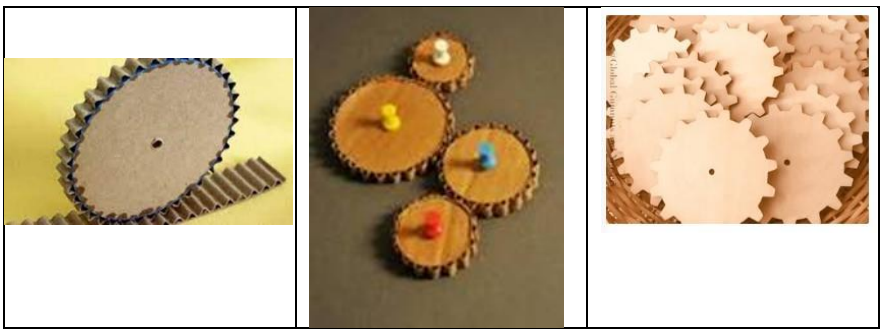
PRIMARY STEM: GEAR UP

Gears are everywhere so we don't need to look far to find examples – watches, bicycles and mechanical type toys.

Investigating how do gears work

OPTION 1. A great STEM activity is to make your own **cardboard gears**. Adapt to suit your student ability level.

- There are a number of ways to do this but an easy way is to draw circles of various diameters (Mathematics) onto cardboard. Cut them out.
- Cut a strip of corrugated cardboard.
- Glue thin strips of the corrugated cardboard around your cutout cardboard circles. You may find it easier to pin in place during drying. Leave to dry.
- Find the centre of each "gear" you have just constructed. You have now made a basic gear called a **SPUR GEAR**.
- Place gears to form a GEAR TRAIN. That means place them in a pattern where they interlock (see picture for an example). When the gears interlock they work together moving in different directions.



OPTION 2. Laser cut wooden cogs / gears could also be used. Some craft suppliers have a variety that could be used. https://www.education.com/science-fair/article/toothy/

LEARN TO MAKE, MAKE TO LEARN

"Once you break a habit into its components, you can fiddle with the gears.

Charles Duhigg
American Journalist (1974-)

SOLAR

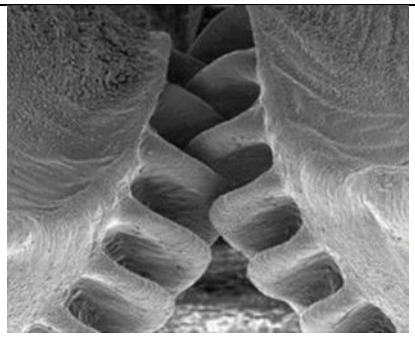
CHALLENGERSM403

This kit is the same as the **CHALLENGERV2**, except that this kit has the SM403 Motor mounting kit, to allow the competitors to use the SM403 motor. This provides a more economical way to enter the designed cars section, and can later be upgraded to the higher performing Faulhaber motor, by swapping the motor mounting kit.
Code: **CHALLENGERSM403**

DID YOU KNOW?

In 2013 biologists discovered the first working gear system in nature in the small hopping insect ***Issus coleoptratus.*** The working gear system is in the juvenile's hind legs. The gears in the rear legs mesh together at the same time when the insect jumps forward - this ensures the insect jumps straight. "Each gear tooth has a rounded corner at the point it connects to the gear strip; a feature identical to man-made gears such as bike gears – essentially a shock-absorbing mechanism to stop teeth from shearing off."

Photos taken by an electron microscope show how the gears mesh.
https://www.apexdyna.nl/en/gear-history
https://www.smithsonianmag.com/science-nature/this-insect-has-the-only-mechanical-gears-ever-found-in-nature-6480908/



GEAR UP

I don't like gears on a car, and I hate using them.
They've just always looked shifty to me.

Did you hear about the wooden car with wooden tyres, wooden gears and a wooden steering wheel?

It wood'en go!

Four Engineers get into a car. The car won't start.
The **mechanical engineer** says: "There must be a problem with the gear box."
The **electrical engineer** says: "It must have a broken starter."
The **chemical engineer** says: "There must be something wrong with the fuel"
The **IT engineer** says: "Hey, let's all get out of the car and get back in."

GEARS

Gears have been used worldwide since ancient times in many applications. There are many types of gears such as spur gears, helical gears, bevel gears, worm gears, gear rack, etc. Each is used in a different way and for different purposes. Gears are used to transmit rotations and forces from the driving shaft to the driven shaft.

Spur Gear

Pinion Gear

Worm Gears

Gear Rack

SPUR GEAR is the most commonly used gear. The larger of the meshing pair is called the gear and smaller is called the pinion. For clarity all spur gears have the number of teeth listed for both larger and smaller gears.
GEAR RACK is flat. It is used to convert rotational motion into linear motion.
WORM GEAR Worms and worm gears sets are used to transmit motion between nonparallel shafts.
PINION GEAR is a smaller gear in a pair of meshing gears, or is the cylindrical gear used in a rack and pinion mechanism its function is often to decrease speed while increasing torque.

Q. What does "Module" mean when talking about gears?

A. "Module" is the Metric unit of size that indicates how big or small a gear is. As the gear teeth get larger, the module value goes up. Thus:

$$m = d/z$$

$$\text{Module} = \frac{\text{Reference diameter}}{\text{Number of teeth}}$$

For example:

- a 1.0 Module 50 Tooth gear will have a diameter of 50mm
- a 0.5 Module 50 Tooth gear will have a diameter of 25mm

Q. Gears have different hole sizes. Where are they used? The hole size depends on the usage:

Hole size	Useage
1.9mm	Press fit onto a 2.0mm motor shaft
2.4mm	Press fit onto a 2.5mm shaft. 12T / 2.4 mm hole Pinion gears can be used as retainers on a 2.5mm rod.
2.6mm	Free spinning on a 2.5mm shaft (Yellow gears)
2.9mm	Press fit onto a 3.0mm shaft

GEARS IN SCORPIO KITS

Many of Scorpio's kits have gears or gearboxes. They use a variety of gears, gear drives and gearboxes. Many kits require students to calculate gear ratios - another great way to add STEM into their work. Information with "how to" is included in the relevant teaching units.

Is it better to have a higher or lower gear ratio? A higher gear ratio is good when you need more acceleration to cruise your vehicle, whereas a lower gear ratio provides more torque to get the vehicle moving from a resting position.

ANTIKYTHERA MECHANISM - The 2,200 Year Old Computer "Tablet"

Alex Kapoyanis

Most of us are under the impression that ancient civilisations used rudimentary scientific devices. This couldn't be further from the truth.

In 1900 sponge divers discovered a Roman-era shipwreck from about 65 BCE, likely originating from the island of Rhodes, near the coast of the Greek island of Antikythera, in the Aegean Sea. The following year the remains of the "Antikythera Mechanism" were recovered. They were the size of a large dictionary. The pieces broke into 82 fragments and revealed corroded coin-size precision gears.

"The mechanism is remarkable for the level of miniaturisation and the complexity of its parts, which is comparable to that of fourteenth-century astronomical clocks."

Michael Wright

Mechanism Expert

Researchers could not agree upon how the device functioned or whether it was a nautical or astronomical instrument. They did agree that it was a sophisticated device. For over a century, many people worldwide have tried to piece together this machine. They were puzzled to know how it works, where and who constructed it.

In the 1970s and 1990s X-ray imaging led to theories that the device must have replicated the motions of the heavens and that some of device's astronomical predictions were based on those of the ancient Babylonian (modern day Iraq).

The Antikythera Mechanism displays several lunisolar calendars. It was designed to track the lunar calendar; show predicted lunar and solar eclipses; track the seasons; chart the position and phase of the moon; track the motion of the sun and the five known planets that are visible to the naked eye.

"The engraved plates depict at least two calendars, a Greek calendar (based on the metonic cycle, which equals about 19 years) and an Egyptian calendar, which was the common "scientific" calendar of the Hellenistic period."[1]

Even more astonishingly, it showed when important events such as the Olympics (the 4 year period of the Olympiad) and other festivals would take place. All this from a very complex and precise series of 30 moving gears, fitting in a space of only 25mm deep, that "rotate a series of dials and rings"[1] forward or backward.

The gears were set in motion by the user turning a hand-crank or dial (not found in the wreckage) on the side of the now lost case, "connected by a crown gear to the main gear wheel, which drove the further gear trains", discs and plates, "with each revolution of the main gear wheel corresponding to one solar year"[1]. These ring and dials, the first known set of scientific dials or scales, contain inscriptions and annotations of the Greek zodiac signs. The

[1] https://www.britannica.com/topic/Antikythera-mechanism

National Archaeological Museum of Greece in Athens features the Anthikythera Mechanism.

pointers on the front face of the device have not survived (or are still missing at the bottom of the sea).

Newer imaging techniques have revealed inscriptions that had been unseen previously. They included a list of planetary cycles on the front cover. On the back cover the X-ray CT scans revealed what can best be described as a "user's manual".

University College London's Antikythera Mechanism Research Project (AMRP) led by mathematician and filmmaker Tony Freeth studied the mechanism for over 4 years. They used new data and images and researched older findings. A discovery in the inscription on the front cover in the Venus and Saturn sections displaying highly accurate period relations of these planets (462 and 442, respectively) showed that these were factorizable. The result was that these planetary periods could be mechanised with moderate sized meshing gears of between 15 and 223 triangular teeth, with tooth counts incorporating the shared prime factors of the planetary period relations.[2] Otherwise, the gears would have been too large to fit into the small space available to the manufacturer of this device. What an amazing feat by the ancients!

Computer re-creation of the gearing inside the Antikythera Mechanism

Freeth's team was finally able to create a model which they believe very likely explains how the 30 gear mechanism with the 223-tooth driver gear, employed differential and epicyclic gears, as well as pin-and-slot couplings, to display the various planetary cycles and other celestial bodies visible to the naked eye.

According to Freeth, in the team's findings published in 2021, the Antikythera Mechanism *combines cycles from Babylonian astronomy, mathematics from Plato's Academy and ancient Greek*

astronomical theories. As a computational instrument for mathematical astronomy, this intricate, portable device is the world's first known analog computer and certainly the first "tablet".

Who designed this amazingly complex device? There are several thoughts on this. It is believed it is not a one of device. It is theorised that the great ancient Greek mathematician, Archimedes, or Greek astronomer and the father of trigonometry, Hipparchus, who taught in Rhodes, may have been involved with the design. The Roman orator, Cicero (106-43 BC) is quoted as saying he'd seen something similar on his travels. He refers to one or more of these devices in his writings.

As for it who had the skills and technology to build a device with such precisely cut gears. Inscriptions found on the device may point to a workshop of Corinthian origin or from a Corinthian settlement in Syracuse (present day Sicily), which happens to be the birthplace of Archimedes. Nothing is known for certain, no machinery or tools from this time have yet been found by archaeologists anywhere in the world.

The secrets of the Antikythera Mechanism may not be entirely unlocked. Nevertheless, if you ever find yourself in Athens, drop by the National Archaeological Museum to see the corroded remains of the original bronze device, as well as some models built over the years, on display there.

[1] Antikythera Mechanism: The world's oldest computer | Nation (ethnos.gr)
[1] https://www.mentalfloss.com/article/81445/15-intriguing-facts-about-antikythera-mechanism
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