Unit 1: Medical imaging

A future in STEM?

At Siemens we understand that it can be challenging for parents and carers to find ways of supporting the education of young people at home. We believe that all young people should be given the opportunity to explore their interests and discover their talents. This resource has been designed to support you in guiding your child through a range of STEM topics, to engage them and spark an interest in STEM subjects.

There are three of these in the set:

Medical Imaging

Showing how ideas about waves from Physics are used to produce stunning and exciting images of the inside of the human body.

Smart Cities

Exploring ways in which our cities are being redesigned to make them suitable for a low energy and sustainable future.

Climate Change

Showing how technologies are used to counter the causes of disastrous variations in conditions around the world.

Many people who work for Siemens are experts in STEM subjects.

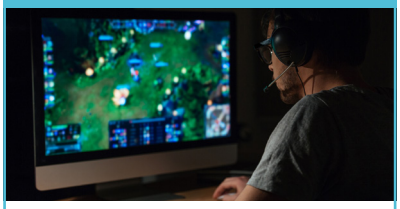
Science ↔ Technology ↔ Engineering ↔ Maths

There is a strong relationship between these subjects. Studying them enables students to follow a pathway that leads to a wide range of training and employment in STEM careers. These are often well paid, prestigious and secure.

One of the key skills for many STEM professionals is being able to draw upon a wide range of ideas. For example, large bridges are designed by civil engineers; these professionals are not scientists or mathematicians, but they use ideas and processes from those subjects and can only become qualified having studied those subjects extensively.

Young people often struggle to relate the topics they learn about in school to the real world and careers. Sometimes young people can formulate ideas in school but can't see their immediate relevance. Students in school spend a lot of time studying maths and science. In fact, many people who go on to use those subjects don't work as mathematicians or scientists but as engineers. Engineers are problem solvers; they use ideas and skills to come up with solutions. For example:

Programmer

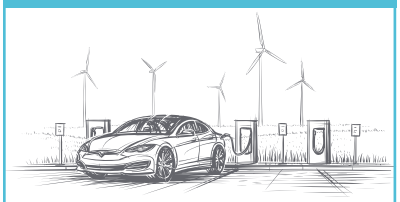


How can I use code to make a more exciting game?

Food Technologist

How can I design a cake with healthier ingredients?

Designer



How can I design an electric car with a greater range?

Medical imaging

In this topic we are looking at how MRI scanning works. We'll be finding out:

Why engineers have developed the process → How the scanner works → What it's like being scanned → How the images are used → How the images compare with those from other techniques → How to find out more

Finding out what is going on inside the body is both fascinating and crucially important. Medical diagnosis is complex and we have become more skillful in gathering useful information. Getting a picture of the inner workings of the body means that better decisions can be made by doctors and nurses on how to care for patients, improving their recovery and quality of life.

This patient in **Figure 1**, for example, has a slipped disc. Looking at the image, we can be see how one of the vertebrae has become displaced. The image is really important to assist doctors in designing treatment. It isn't only doctors that are involved though; the picture was produced by an MRI scanner, which had to be designed, tested and built. This was done by a team of engineers.

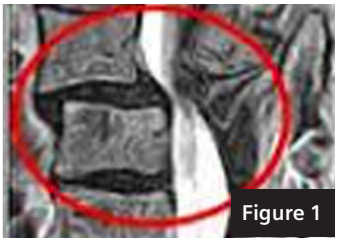


Figure 1

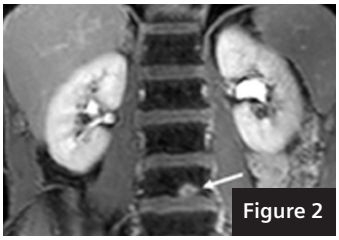


Figure 2

The machine also has to be operated, and this needs radiographers. **Figure 2** shows a cancerous growth; it took skill and experience to use the scanner to get a picture that shows the size and location clearly. This image aids treatment and increases the patient's chance of recovery.

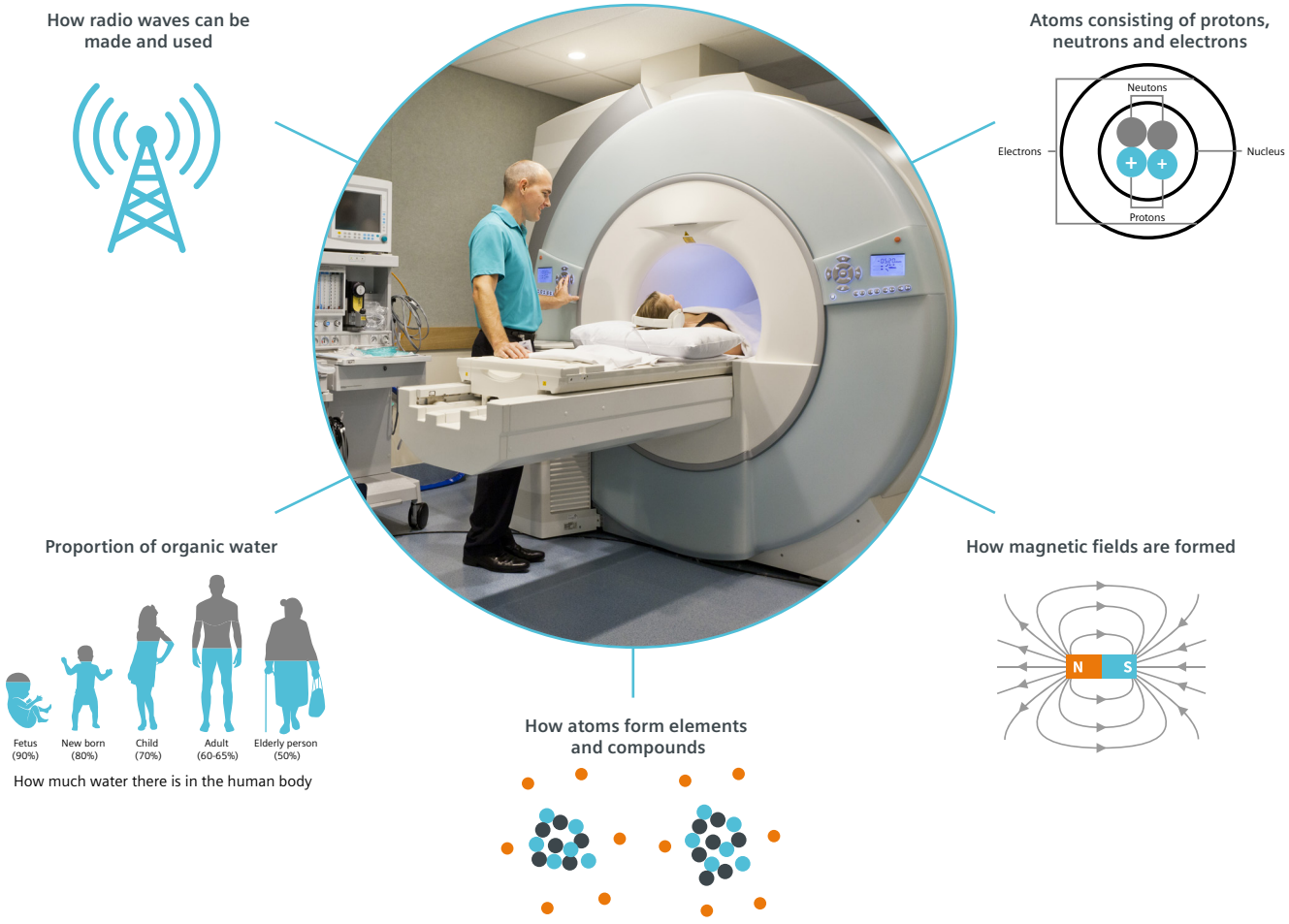
Children and young people often ask their parents and teachers why STEM skills are important. As the examples above can demonstrate to your child, STEM skills lead to discoveries and engineering solutions that help to save lives, and increase people's quality of treatment, care, recovery and life. What could be more important than that?

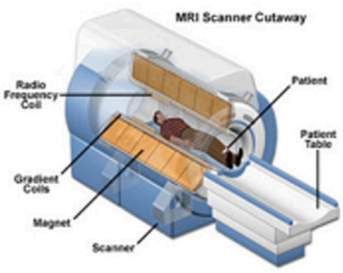
More examples of images are shown in the Siemens MRI gallery at https://health.siemens.com/mr/image-gallery

How an MRI scanner works

Students in KS3 learn about a number of topics which are useful in understanding how MRI scanning works. MRI scanners combine ideas from Biology, Chemistry and Physics. All of these come up in secondary school science, either in KS3 or whilst studying for GCSE science qualifications. Young people find science engaging when it works with concrete experiences (such as using magnets or exploring solubility), but less relevant when the ideas are without context. An MRI scanner is a good example of how there often needs to be a move to a more abstract way of thinking.

Many different ideas from school science are used in MRI scanning





When your body is scanned you lie on a horizontal platform, which carries you inside the machine into a set of coils. These coils produce a magnetic field, which affects the protons in the hydrogen atoms in the water molecules in your body. These are then agitated by the radio signals and the responding radio signals from the protons are detected by the scanner, and processed into an image. This image is then used by doctors to help with diagnosis.

There are a number of video clips available which show how MRI scanning works: https://www.youtube.com/watch?v=kmfmGhI8l9E

The experience of an MRI scan

Although an MRI scanner is very useful, some people find the experience of a scan to be a little disconcerting. It's not particularly quick; it's noisy and rather claustrophobic too.

In order to counter people's fears, Siemens have produced resources that are designed to explain to children and young people what is happening during a scan, and why there is nothing to fear. You can download the free MRI Scan App from the App Store (for Apple devices) and the Google Play Store (for Android devices). It explains the technology and imaging process as well as exploring what the experience is like.

The MRI Scan App video is at: https://www.siemens-healthineers.com/en-uk/magnetic-resonance-imaging/mri-scan-experience and features specially commissioned research and an interview with play specialist Sarah Browne.

Using the images

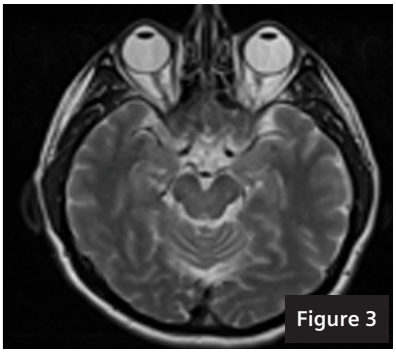


Figure 3

The images gained from MRI scanning are often stunning in relation to their clarity and detail.

Figure 3, for example, is a cross section through the skull. The scanner operator selects both the position and the plane of the view; in this case it is in the horizontal plane and around half-way down the skull. The eyeballs (and lenses) are clearly visible, as are the brain, skull and nasal cavities.

The process is safer than X-rays and can be used in a wider range of applications. **Figure 4** shows unborn twins.

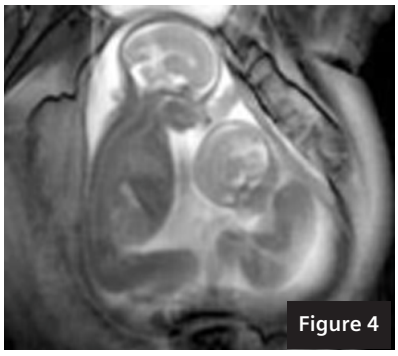


Figure 4

Medical imaging can be used in many different ways, even producing video. The following clip shows how an opera singer forms various tones when singing.
https://www.youtube.com/watch?v=aoUJCKdGd58

This has been achieved by taking many images rapidly over time, enabling us to study how the body works inside without invasive surgery. We can even see how the brain works, with this video showing how caffeine affects blood flow around it:
https://www.youtube.com/watch?v=uUHCCAq8oWA

All of these examples show that your child's development of STEM skills can have far greater impact beyond their chosen field; an engineer can show us how the brain works, or help us to understand how music is made.

Comparing MRI scanning with other diagnostic imaging tools

There is a range of technologies that can be used to produce images of what is going on inside the body. Each of these applies ideas from Physics to the challenge of finding out what is going on inside the body and all are in use in the health service today.

X-ray

X-rays are capable of passing through soft tissue but are stopped by denser material such as bone.

Ultrasound

Ultrasound uses high frquency sound waves which are reflected by different tissues in the body.

CT Scanning

CT scanning uses X-rays from a range of angles, processed by a computer to produce detailed images.

Students studying science at secondary school are expected to be able to compare and contrast ideas as well as describe and explain them. The details of this vary slightly from one exam board to another but all courses expect that students should know and understand the properties, applications and risks of various types of waves. Medical imaging is a good way of understanding how different types of waves are useful.

Other applications

It is also worthwhile to consider that these technologies can be applied to a range of other applications as well. Ultrasound scanning is used to examine welded joints for example; this could save hundreds of lives if a faulty joint is discovered in an aeroplane, bridge or skyscraper. MRI scanning has also been used beyond medical application, including the examination of archaeological remains. Mummified bodies which would otherwise be damaged by physical exploration can be examined in minute detail, enabling us to understand more about ancient Egyptian history. In this **Figure 5**, breast cancer was diagnosed in remains that are thousands of years old.

Figure 5

These technologies are opening our eyes to see the world in new ways, making for a safer and more interesting world for all of us.

Apprenticeships

STEM careers can be approached at a range of different levels. Siemens offer a range of high quality apprenticeships; these can be a great way into a rewarding career. They have an established apprenticeship scheme helping to support the industry of tomorrow. In the UK, Siemens Healthineers manufactures superconducting magnets for MRI scanners, as well as designing, maintaining and operating solutions in laboratory diagnostics and point of care. Apprentices can make an impact in healthcare and shape their future career whilst earning.

Details about the programme and the application procedure are at:
https://www.siemens-healthineers.com/en-uk/careers/apprenticeships#Shaping_your_future.
Your daughter or son can even meet some of the apprentices and start the application procedure there.