WETSUITS FOR PARATRIATHLETES

stem challenges

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CONTENTS

There is a lot of material in this pack. Teachers might find it useful to first read the Teacher notes introduction, and the student Challenge brief.

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CHALLENGE BRIEF

YOUR CHALLENGE

Triathlon is an event that requires competitors to complete a three-stage race of swimming, cycling and running. Triathletes wear special wetsuits for the swim which are then removed before the cycling and running stages. Whilst still providing warmth and buoyancy, these wetsuits are designed slightly differently to the ones surfers might wear. They can be thinner and smoother to make them go faster through the water and they are easier to take off (the race does not stop between stages so it is really important to be able to take the wetsuit off quickly). More information can be found on the Triathlon and Wetsuits Factsheets.

Triathlon wetsuits are, of course, expertly designed – but they are designed for able-bodied athletes. This poses a serious problem for paratriathletes.

Your challenge is to design a new wetsuit for a paratriathlete.

You should create a presentation with your proposals for a new wetsuit design. See the Fit for purpose, Things to consider and Presentation advice sections that follow, for some help and guidance.

FIT FOR PURPOSE

Your design must meet the specific needs of a paratriathlete. You will need to find out about the disability of the paratriathlete for whom you are designing the wetsuit. Some issues to address might include:

- The paratriathletes' legs may sink beneath them, causing drag (water resistance). This makes swimming more difficult, and slower.
- Legs that are not kept together also increase water resistance.
- Legs may have poor blood circulation, making it harder to keep warm.
- Getting in and, more importantly, out of an 'able-bodied' wetsuit can be extremely difficult for paratriathletes – this wastes valuable racing time.

You do not need to consider all design elements of a wetsuit, such as the type of material it is made from, comfort, wear and tear, and so on. Your design is expected to illustrate how an existing triathlon wetsuit could be adapted. Of course, you are free to create a whole new design, if you wish.

THINGS TO CONSIDER

- You will need to work in teams of four to six people
- Think carefully about the task ahead and manage your time and workload effectively
- The Factsheets provide information that could help you with the Challenge. You may choose to carry out further research to give you that leading edge. Suggestions for websites that you may find useful are provided on various Factsheets.
- You must gain a good understanding of Paratriathlon (but most importantly, the swimming stage and the transition) and the disability of the paratriathletes for whom the wetsuit is to be designed
- Although your design is for paratriathletes with a particular disability, there are still individual differences such as height and weight that should be taken into account.
- Use the knowledge gained from the Factsheets and your research to think both scientifically and creatively about your wetsuit design.
- You should be able to explain how your design will improve the performance of paratriathletes.

CHALLENGE BRIEF

- You must make sure that the safety of the paratriathletes is not jeopardised.
- Wherever possible, carry out tests to inform and justify your design choices. The *Buoyancy* and *Streamlining* Factsheets might give you some ideas of what you could test or investigate further.
- The ability to produce a prototype (no matter how unsophisticated) is not essential, but would help to illustrate your design.

PRESENTATION ADVICE

Teams must clearly show how they arrived at their final choices. All proposals and recommendations must be justified – these justifications should form the main part of the presentation.

Communicating and, where possible, modelling ideas in a range of ways, is important to achieve this.

SOME HINTS AND TIPS

- Think about how to present useful information – remember the process is just as important as the final proposal.
- Use a mixture of verbal, written and visual communication.
- Present scientific and technological information, rather than emotive arguments.
- Use scientific and technological language and terminology correctly.
- Be able to talk knowledgeably about every aspect of your challenge.

Consider

- Video recordings
- Photographs
- Other forms of ICT
- Diagrams and sketches – originals as well as 'worked up' final copies. Your designs must be clearly labelled and annotated.
- Charts and graphs – if you need to present findings from any testing you may have carried out.
- Posters, leaflets, handouts
- Making a prototype – You may wish to attempt to make a prototype of your wetsuit. It does not have to be ready for use, or even made from the correct materials – it can just be another way to illustrate your design.
- Rather than making a whole wetsuit, you may attempt to model specific aspects of your design.
- Live demonstrations – Rather than just using secondary research findings to justify your design choices, can you show the judges how certain features work and why they are useful?

Remember: It is important, wherever possible, to test your ideas during the design process. The results can then inform your final decisions.

These are just some things to think about – you may think of more!

{FACTSHEET} BUOYANCY

When describing how well an object floats in a liquid, such as water, you are describing its buoyancy. If an object is very buoyant, it will float. Objects with little buoyancy will sink.

When an object is placed in water, gravity pulls it downwards. At the same time, water pushes against the object in the opposite direction. This force of buoyancy is also known as water upthrust.

BALANCED FORCES

Have you ever wondered how big ships stay afloat? They have an extremely large surface area for the water upthrust to push against. Therefore, even though the ships may carry heavy cargo, the water upthrust is equal to the weight of the ship. The opposing forces are balanced causing the ship to float.

When the buoyant force (water upthrust) on an object is less than the weight of the object itself, and therefore not balanced, the object will sink.

SHAPE AND WEIGHT

The weight of an object in water is dependent on how much buoyant force there is.

The amount of water upthrust acting on an object will change according to the shape of the object. If the object presents a large surface area to the water (such as a ship), there is a greater area for the water to push against.

Imagine trying to submerge a tray in water. First, try holding the tray on its side, then place it flat on the surface and push down. Which way do you think would produce the most resistance?

DENSITY AND WEIGHT

Density = mass ÷ volume

A big marshmallow has a small mass, but a large volume; it has a low density. If you squeeze the marshmallow, so that it has the same mass but in a smaller volume, its density increases.

If the density of an object is less than the density of the liquid it is in, the object will float. Common materials that float in water include wood, foam and cork. Air is also much less dense than water which is why some buoyancy aids work by trapping pockets of air (see below).

You may have experienced how objects feel lighter when they are in water. The mass of an object does not change, but the effect of water upthrust makes it weigh less. The more buoyant an object, the lighter it feels and the easier it is to lift and move in liquid.

It is easy to believe that objects that sink have no buoyancy and weigh the same in liquid. All objects will displace some liquid and therefore have some buoyancy. As a result, they do weigh less in liquid.

Just as objects of different densities will vary in buoyancy in the same liquid, the same object can have different buoyancies in different liquids. For example, saltwater has a higher density than fresh water, so you would be more buoyant in the sea than in a swimming pool. The Dead Sea has a particularly high density, and people that visit it on holiday enjoy experiencing the ease with which they can float.

{FACTSHEET} BUOYANCY

BUOYANCY AIDS

Humans are equipped with natural buoyancy aids – the lungs. However, humans generally do not have enough buoyancy to keep afloat.

A number of buoyancy aids have been developed for various situations where humans need help to float.

ARM BANDS

Most people have used these at some point. Commonly used when learning to swim, they keep the arms above the water, providing an extra lift. They are usually made from plastic and are inflatable. The arm bands can displace a large volume of water, much heavier than themselves, and so provide excellent buoyancy.

FLOATS

Originally made of wood, floats nowadays are made from expanded foam, a low density material. They have a large surface area and are usually held in both hands with arms outstretched. Floats are designed to provide support when swimming rather than simply for floating.

LIFE JACKETS

Life jackets are found on boats and ships, and are used by people in a number of water sports. They are buoyant enough to keep a persons head above water, even if they fall asleep. They can vary from inflatable to ones made from foam, as in floats.

LIFE RINGS

Life rings can be seen on boats and by the coast. They are thrown to people who have fallen into the water and need help, possibly to prevent them from drowning.

Other types of buoyancy and flotation aids are available, including fun products for children, such as inflatable rings, whales, sharks, and even dinosaurs and aeroplanes!

BUOYANCY TESTS

There is a number of buoyancy experiments you could try.

EUREKA, EUREKA

Archimedes' 'Eureka' moment came when he got into his bath tub and noticed the water overflow. He displaced the water.

Stand a container, full to the brim with water, in a larger container. Place different objects into the water. If the object floats, gently push it down until it is completely submerged. By measuring how much water each object displaces, you compare their buoyancy. (See Fig 1.)

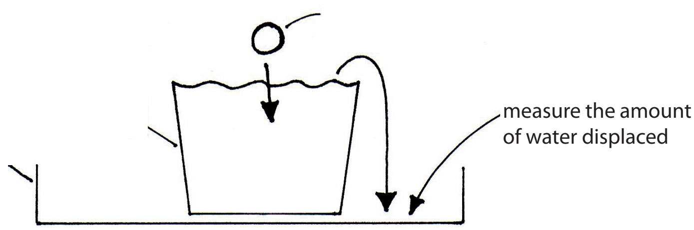

Fig 1

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{FACTSHEET} BUOYANCY

GOING UNDER

You could make a submarine using an empty plastic bottle, to investigate buoyancy. With a ruler, draw a line the length of the bottle. Carefully cut three small holes along the line [TAKE CARE USING SHARP SCISSORS]. At either end of this line of holes, use sticky tape to secure a 50 g mass. (See Fig 2.)

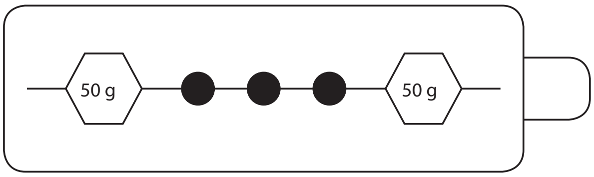

Fig 2

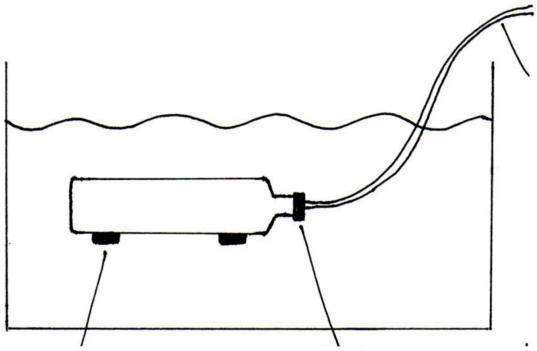

Fig 3

The 50 g masses ensure that the holes stay faced downwards once the bottle is in water.

Attach a piece of tubing to the open end of the bottle so that no water can enter, other than through the tube or the holes made. Make sure the tubing is long enough for the unattached end to remain always outside the water.

When you place the bottle in a large container of water, it will start to sink as the water rushes through the holes into the bottle. If you blow into the tubing, the water will get blown out, and the bottle will rise.

Does varying the masses have any effect? How could you measure how much air you have blown in and how hard you are blowing into the tube?

YOU'RE ONLY AS LIGHT AS YOU FEEL

Using an object, such as an egg, find out if buoyancy changes in different liquids. You could try using water, saltwater and cooking oil, for example. Maybe you could investigate what happens in salt solutions of different concentrations.

DESIGN YOUR OWN

The ideas above are just suggestions. You may think of other ways to investigate buoyancy.

Think about how you could investigate the buoyancy of different materials, and find out about the effect of different shapes on buoyancy. Could you design a fair test?

If you are fortunate enough to have access to a swimming pool, you might even consider how you could investigate the buoyancy of humans. You must only do this with your teacher's permission and in the presence of an adult and a qualified lifesaver.

A variety of containers, such as buckets, plasitic storage boxes, high-sided trays and large glass demonstration tanks are suitable for the tests and investigations.

USEFUL WEBSITES

The following websites provide further information and useful links.

http://www.relaxnswim.com/physics/buoyancy.htm

http://www.visionlearning.com/library/module_viewer.php?mid=37

http://www.ghm57.dial.pipex.com/NEw%20site/Prod1.htm

http://www.tri247.com/article_7394.html

{FACTSHEET} JOINING MATERIALS

When making clothes, different cuts of fabric and various materials need to be joined together. Some joins need to be permanent (e.g. the stitching at the shoulder of a shirt), whilst others are temporary, to allow the garment to be taken on and off (e.g. the zip of a coat). Sometimes, joins are made purely for decorative purposes (e.g. sequins and non-functional buttons).

Here are some examples of methods used to join and fasten (temporarily secure) materials.

JOINS

STITCHES

Shorter stitch lengths make the attachment of fabrics stronger. Stitches with higher tension are firmer, although too much and the fabric will pull. 100% polyester or nylon thread are strong and should be used for heavier fabric.

Whenever holes are made by needles, the waterproof properties of a garment can be compromised. As few holes as possible should be made, ensuring those that are made are not unnecessarily large. A microfibre needle should be used because they are not wider at the eye. All stitches and seams must be sealed (see below).

Useful stitches:

- Straight stitch (or Lockstitch) – Using a sewing machine, two threads are interlocked, one from the needle, the other from the bobbin.
- Blindhem stitch – Used for almost invisible hems.
- Zigzag stitch – Used on the edge of fabrics to prevent fraying.
- Flatlock stitch – Used to create a more comfortable flat seam.

(Further information can be found at www.sewing.org/html/guidelines.html)

GLUES AND SEALANTS

A glue that sticks to one thing will not necessarily stick to another. This is because the microscopic surfaces of materials are very different.

Fabric glues can be permanent (washable) or non-permanent (useful for holding fabric in place before sewing). Some glues can be used to join two pieces of fabric instead of sewing. There are also glues that can prevent fraying and glues that stretch with a stretchy fabric.

Bonding tape is an adhesive material placed between two fabrics. The fabrics are then heated (by ironing) to bind them together.

Sealing seams to make them waterproof can be done with glues or tape.

FASTENERS

POPPERS

A small bump on one disc (usually metal or plastic) is 'popped' into the hole of an opposing disc. The poppers should remain fastened until a small amount of force is used to pull them apart. They are very easy to use but are not the strongest form of fastening. Poppers are usually attached to fabrics by using a special 'punch and die' set, or by sewing.

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{FACTSHEET} JOINING MATERIALS

BUTTONS

Buttons are usually made of plastic and circular in shape. They have small holes in the middle to allow them to be sewn to fabric. The button is then fed through a slit in another piece of fabric to fasten.

VELCRO®

Velcro® consists of two layers. One layer looks like a hairy piece of fabric. This is the 'hook' layer. The other has lots of smaller 'hairs'. This is the 'loop' layer. When pressed against one another, the 'hooks' catch in the 'loops', sticking the two pieces of fabric together.

HOOK AND EYE

The hook and the eye (a small loop) are each sewn onto pieces of fabric. The hook is then looped through the eye to secure the two pieces together.

ZIPS

A zip consists of two sets of 'teeth'. As the garment is 'zipped up', these teeth become locked together. There are many different types of zip (or zipper), including those that are open ended and those that are closed at one end. Zips can also be completely air and water tight.

TRIATHLON WETSUITS

Triathlon wetsuits need to be removed quickly, so the method used to fasten the suit is important. However, the wetsuit must also be waterproof. This influences the type of fasteners used. In addition, the type of stitching and sealing is affected. Wetsuits may be sealed in various ways including blind and flatlock stitching, glueing, and heat sealing (e.g. using bonding tape).

If you wish to investigate different joins and fasteners for your wetsuit, neoprene samples can be purchased from:

http://www.ewetsuits.com/acatalog/neoprene-sheets-5mm.html

http://www.homecrafts.co.uk/products-Neoprene-Sheets_E800A.htm

USEFUL WEBSITES

More information can be found on the following websites:

http://inventors.about.com/library/inventors/blfasteners.htm

http://science.howstuffworks.com/innovation/zipper.htm

http://www.essortment.com/hobbies/howzipperswork_saoi.htm

http://en.wikipedia.org/wiki/Snap_fastener

http://www.surfing-waves.com/wetsuit.htm

{FACTSHEET} STREAMLINING

Streamlining refers to the shape of an object and how effectively it moves through a liquid or gas.

Think about objects that move through water, such as boats and submarines. or objects that fly, such as aeroplanes. Consider the shape of these and how it makes them more streamlined. Speedboats are very pointed at the front which allows them to slice through the water quickly and efficiently. Streamlining in water is known as Hydrodynamics. Fighter jets and Formula One racing cars have thin noses and are generally smaller and flatter than slower aircraft and cars respectively. Streamlining in air is referred to as aerodynamics.

THE BEST SHAPE

Streamlined shapes have a front with a small surface area. The larger the surface area, the more a liquid or gas will work against the object as it moves forward. Consequently, the more energy the object must use to counteract this force. Reducing the surface area creates less for the liquid or gas to push against.

Interestingly, the most streamlined shapes not only have a small surface area at the front, but also at the back. A long teardrop, with the more pointed end at the back, is considered one of the most streamlined shapes. Think of the liquid or gas that the teardrop-shaped object is travelling through, as moving in lines (streamlines) over the teardrop and 'slipping' neatly off the end. Compare this with something square in shape. The liquid or gas struggles to get past the flat surface and then 'falls' off the end, making messy streamlines. This results in the object dragging pockets of liquid or gas behind itself. A streamlined shape is one that can cut cleanly through a liquid or gas, and reduce drag.

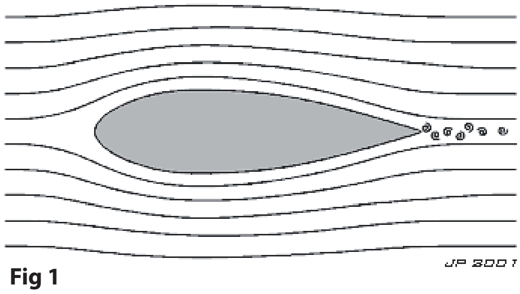

Fig 1

HUMANS AND STREAMLINING

Sprinters, cyclists, skiers – they all need to be as streamlined as possible to ensure they race at their fastest. Sprinters keep low and compact as they drive out of the starting blocks. Skiers crouch with their poles tucked tightly under each arm. Cyclists bend forward with their heads down, and wear special, aerodynamically designed helmets. But none of these have to contend with water.

Have you ever raced into the sea? If so, you will have experienced how difficult it is to keep running, especially as the water gets deeper. Maybe you have waded across a river. You will also have experienced how water can make it difficult to move fast.

Imagine racing a friend over one width of a swimming pool – your friend is allowed to swim, but you have to walk. Who would win and why?

Just as body position is important for sprinters, cyclists and skiers, so it is when swimming. A streamlined body shape makes moving through water easier and quicker.

If you watch a swimmer dive into the pool at the beginning of a race, they adopt a special streamlined position while underwater. They keep their feet and legs together with their toes pointed, their arms are outstretched with hands together, like an arrow, and their head is tucked in. They maintain a straight line from finger tips to toes, only moving to propel themselves through the water.

Once the swimmer reaches the surface, they kick their legs. This not only propels them forwards but also keeps their legs close to the surface so that their body stays as straight and streamlined as possible.

This is demonstrated perfectly by multi-Olympic Gold medal winner, **Michael Phelps**.

{FACTSHEET} STREAMLINING

HOW TO GO FASTER

Top swimmers are known to shave off their body hair in an attempt to reduce drag, making themselves more streamlined and able to swim faster.

In recent years, however, swimwear has been designed to improve the speed at which swimmers can move through water.

The special material used in swimsuits aims to reduce drag and help the swimmer to keep their body in a more streamlined position. It has been developed by studying, and attempting to mimic, shark skin. All suits cling tightly to the body, and a variety of designs are available, including full body suits (similar to wetsuits). They are tested using sophisticated computer software and wind tunnels.

TRIATHLON

Streamlining technology is extremely important in the design of triathlon wetsuits. However, the swimsuits worn by top swimmers, such as Rebecca Adlington, are unsuitable for the triathlon. For example, they would not meet the demands of swimming in cold, open waters. More information about triathlon wetsuits can be found on the *Wetsuits* Factsheet.

STREAMLINING TESTS

You could try to find out how quickly different shaped objects move through water. Think about how you could design a fair test.

If you have a large enough container, you could submerge a ramp or half-pipe in water. Make a base with wheels (such as a skateboard) from simple construction kit, small enough to fit down the ramp or half-pipe. Different shapes and designs could then be added to this base, each time recording how long it takes to travel the length of the ramp or half-pipe, under water. (See Fig 2, next page).

How could you test the effectiveness of different body positions when moving through water? Maybe you could use an action figure with limbs that can be manipulated to create different body shapes. Could you measure the amount of force that is needed to pull the figure through water? (See Fig 3, next page).

As explained earlier in this Factsheet, shape is not the only factor that affects streamlining. You might like to use the same object, and find out how covering it in different types of material affects its movement through water.

These are just suggestions, and you might be able to think of better ways to illustrate streamlining.

An investigation into streamlined design at http://www.pbs.org/saf/1208/teaching/teaching2.htm might give you some more ideas.

Of course, if you are lucky enough to have access to a swimming pool, you could think of further ways to investigate streamlining. Any such investigation should only be carried out with your teacher's permission, and in the presence of an adult and a qualified lifesaver.

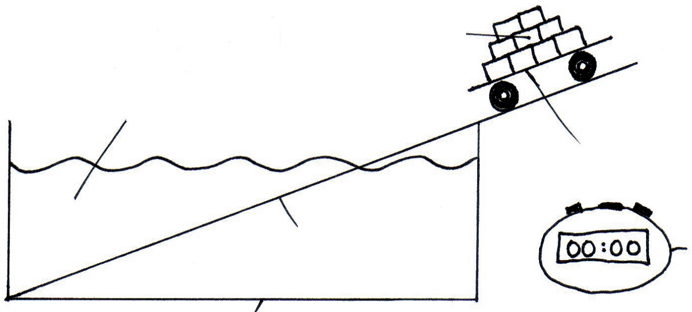

Fig 2

large container

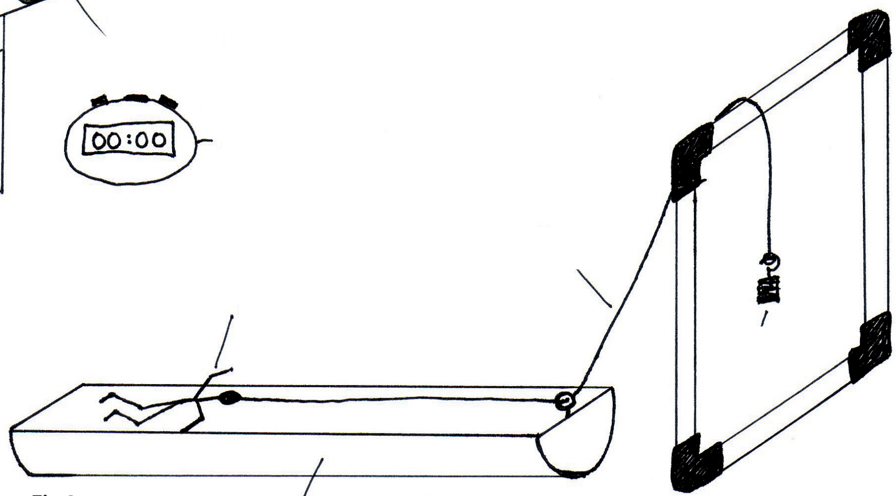

Fig 3

half-pipe (gutter) filled with water

USEFUL WEBSITES

Much of the information in this Factsheet has been taken from the following websites, where further information and useful links can be found ...

http://www.independent.co.uk/news/science/sharkskin-swimsuits-lead-hitech-bid-for-olympic-gold-724371.html

http://www.speedo.com/aqualab_technologies/aqualab/index.html

http://en.wikipedia.org/wiki/High-technology_swimwear_fabric

http://www.gcsescience.com/pfm34.htm

http://swimming.about.com/cs/startandturntec/a/streamlinetips_2.htm

http://swimright23.webs.com/streamline.htm

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{FACTSHEET} THE HUMAN BODY

When considering how people swim, thinking of ways to improve technique, drawing up training regimes, and developing new technologies to help performance, it is important to have a very good knowledge of the human body.

In science, the words physiology and anatomy are used when studying the human body. Physiology looks at how the body functions. Anatomy is the study of the body parts – their position and structure.

MUSCLES

Muscles are extremely important. They perform three main functions:

- Allow body position to be maintained, e.g. sitting and standing
- Produce heat to help keep body temperature normal
- Allow movement, e.g. walking and running

There are many muscles in the human body. The major muscle groups include:

- **Upper body** – Trapezius, Biceps, Triceps, Forearms, Shoulders (Deltoids) and Chest (Pectorals)
- **Core muscles** – Abdominals and Lower back
- **Lower body** - Hamstrings, Quadriceps and Calves

The location of these muscles on a human body, and more information about them, can be found at:

http://www.wanderworks.com/simply_muscle/muscle_groups.htm

The BBC Science: Human Body & Mind website

http://www.bbc.co.uk/science/humanbody/body/factfiles/muscle_anatomy.shtml

also provides excellent information on muscles, and allows you to move the muscles on an interactive body.

SWIMMING

Although swimming is a full body workout, the main muscles used in freestyle (front crawl) are the shoulders, triceps, abdominals, and upper leg muscles.

The following link shows which muscles are used during different swimming strokes:

www.ehow.com/how-does_5448601_muscle-structure-swimmer.html (click on *AnyBody: Swimming – Backstroke, Breast, Butterfly, FreeStyle* video under Resources). This has been taken from the Starter Activity so you may have already seen it.

If you look closely at the freestyle (front crawl) stroke, you will notice how the arms pull down and back through the water, calling the shoulder muscles (deltoids) and triceps in particular, into action. The kicking legs rely on lots of power from the hips and muscles such as the hamstrings and quadriceps. However, while you may not be surprised by this, it can be easy to overlook the importance of the abdominals and lower back. These core muscles provide power and stability, and help to maintain a good swimming position.

A BUOYANT BODY

Buoyancy helps a lot when swimming. Someone who is not very buoyant will float lower in the water. This causes more drag and makes swimming more difficult. Someone who is able to float higher in the water, reducing drag, is able to generate greater speed through the water.

Body density affects how buoyant a person is. This varies from one person to the next, and is dependent on factors such as bone structure, body fat, muscle size, and lung capacity.

{FACTSHEET} THE HUMAN BODY

The most widely used method for measuring body density is hydrostatic weighing. This involves being weighed underwater. More information can be found at:

http://sportsmedicine.about.com/od/fitnessevalandassessment/g/UnderwaterWeigh.htm

MAINTAINING BODY POSITION

While the size, shape and weight of a person can affect how buoyant they are in water, the distribution of buoyancy can affect how easy it is to swim.

The most buoyant part of the human body is the lungs because they are full of air. The density, and therefore buoyancy, of other body parts is affected by muscle size. Larger muscles are heavier. However, swimmers and other athletes that swim, such as triathletes, need strong legs.

No legs are completely buoyant. Therefore, kicking is necessary to maintain a good swimming position. Less muscular legs may be more buoyant in water but less able to kick effectively. Muscular legs may be heavier but have the strength for a more effective kick.

Imagine if you were unable to kick your legs at all. How would that affect your swimming?

USEFUL WEBSITES

An interesting study into how buoyancy influences front crawl performance, can be found at

http://onlinelibrary.wiley.com/doi/10.1002/jst.23/pdf

Other websites that will allow you to find out more about muscles, buoyancy and swimming, and have sourced some of the information on this Factsheet, are:

http://www.teachpe.com/gcse_anatomy/muscles.php

http://www.brianmac.co.uk/muscle.htm

http://www.getbodysmart.com/ap/muscularsystem/menu/menu.html

http://spot.pcc.edu/~lkidoguc/Aquatics/AqEx/Water_Buoyancy.htm

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{FACTSHEET} TRIATHLON AND PARATRIATHLON

Triathlon and paratriathlon are exciting sports, involving three disciplines: swimming, cycling and running.

Competitors are required to race over various distances in each of these disciplines, according to the type of triathlon event. These events include the super sprint, sprint distance, middle distance, ironman distance and, more commonly, the standard distance. This standard distance triathlon requires athletes to complete a 1500 m swim, followed by a 40 km bike ride, finishing with a 10 km run.

The race also involves the change from one discipline to the next. These points are known as transitions. They occur between the swimming and cycling stages, and then again from the cycling stage to the running stage. Being part of the race, it is important that these transitions are as quick as possible. Therefore, triathletes practise their transitions as well as train for each discipline.

Watch clips of triathletes racing at:

www.britishtriathlonmedia.org and www.triathlon.org/multimedia/videos

THE HISTORY OF TRIATHLON

In 1974, a group of friends consisting of swimmers, cyclists and runners, began training together. It was their idea to start organising competitions that combined the three sports.

This led to the first recorded triathlon in September of the same year. 46 athletes finished the race involving a 5.3 mile run, followed by a 5 mile bike ride, and finishing with a 600 yard swim.

The sport of triathlon grew very quickly and in 1988 discussions began regarding the inclusion of triathlon in the Olympic Games. Eventually triathlon was added to the Olympic Programme and made its debut at the Sydney 2000 Games.

THE AUTHORITIES

The International Triathlon Union (ITU) was founded in 1989. Based in Vancouver, Canada, it has grown to include over 120 affiliated National Federations around the world.

British Triathlon is one of these Federations, consisting of Triathlon England, Triathlon Scotland, and Welsh Triathlon. The three Home Nation Associations are responsible for their own memberships, national teams, and the development of triathlon within their country. British Triathlon has particular responsibilities for the Great Britain teams, and British and International events.

The purpose of British Triathlon is:

"To promote excellence in our sport, and create opportunities for everyone to achieve their personal triathlon challenges."

PARATRIATHLON

British Triathlon has strived to create a sport that is accessible to as many different people as possible, including those with disabilities. This has led to the National Paratriathlon Programme. The programme supports Britain's best Paratriathletes through selection to the British Paratriathlon Performance Squad. These paratriathletes aim to compete at the top level and be successful at European and World Championships.

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{FACTSHEET} TRIATHLON AND PARATRIATHLON

To ensure fair competition, paratriathletes compete in different categories, or classifications. There are currently six paratriathlon categories:

TRI 1 Handcycle: Paraplegic, Quadriplegic, Polio, Double Leg Amputee. Must use handcycle on bike course and racing wheelchair on run.

TRI 2 Severe leg impairment including above knee amputees. Athlete must ride bicycle and run with above knee prosthesis (or similar prosthesis) or run using crutches.

TRI 3 Les Autres: This category includes athletes with Multiple Sclerosis, Muscular Dystrophy, Cerebral Palsy, double leg amputee runners or paralysis in multiple limbs. Athlete will ride a bicycle and run. Athlete may use braces or prosthesis if required.

TRI 4 Arm impairment including paralysis, above-elbow amputees and below-elbow amputees, or impairment in both upper limbs. Athlete may use prosthesis, brace or sling on the bike and/or run.

TRI 5 Moderate leg impairment including below-knee amputees. Athlete rides bicycle and runs with prosthesis.

TRI 6 Visual Impairment, legally Blind (20/200 vision with best corrective vision). A handler of the same sex is mandatory throughout the race. Athlete is tethered during the swim and run. Athlete uses a tandem bicycle.

Watch video footage about the paratriathlon, including clips of paratriathletes competing, at:
www.triathlon.org/paratriathlon
www.triathlon.org/multimedia/videos/category/paratriathlon
http://www.britishtriathlon.org/great-britain-teams/elite-teams/paratriathlon

USEFUL RESOURCES

This information on this Factsheet has been taken from the following websites, where further information can be found:
http://www.britishtriathlon.org/
http://www.triathlonengland.org/
http://www.welshtriathlon.org/
http://www.triathlonscotland.org/
http://www.triathlon.org/
http://www.triathlon.org/paratriathlon/

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{FACTSHEET} WETSUITS

Wetsuits are used in a number of water sports and activities, such as windsurfing, waterskiing, diving and surfing. They are designed to provide warmth (insulation), buoyancy and protection. Wetsuits are made from a material called neoprene, which is stretchy. The neoprene contains lots of small bubbles. It is these bubbles that give the wetsuit its insulation properties, and also creates additional buoyancy.

The amount of warmth and buoyancy a wetsuit provides depends on the thickness of material used. Wetsuits tend to be made with neoprene of a thickness somewhere between 1.5 mm and 6 mm. The thickness also affects how stretchy the neoprene is. Neoprene samples can be bought from:

http://www.ewetsuits.com/acatalog/neoprene-sheets-5mm.html

http://www.homecrafts.co.uk/products-Neoprene-Sheets_E800A.htm

TRIATHLON

Triathletes wear a wetsuit for the swimming stage. However, the normal type of wetsuit worn by people participating in water sports is not ideal for the triathlon. Important considerations for the triathlon are that the swimming stage occurs in open water (rivers and lakes). Triathletes need to be able to swim as fast as possible, and they must be able to take their wetsuit off quickly during transition.

'Normal' wetsuits are designed to protect against contact with other equipment, a surf board for example. Not only do triathlon wetsuits not need to withstand abrasion, but thick neoprene can restrict the range of movement needed to swim quickly. Although triathlon wetsuits can have sleeves, sleeveless versions are available that reduce restriction and provide more freedom of movement in the arms.

Buoyancy is also an important property of triathlon wetsuits. Legs are the least buoyant part of the human body – if they do not move in water, they would sink. When swimming, the water passing beneath causes the legs to move upwards. Kicking the legs makes them rise even closer to the water's surface. If legs were more buoyant, achieving this streamlined swimming position would take less effort – effort that can then be used to swim faster.

This is a particular issue for triathletes as the large leg muscles they develop through cycling and running make their legs even heavier. Combine this with a far more buoyant upper body (due to the position of the lungs) and the role of the wetsuit is paramount. The wetsuit must help triathletes to maintain a good, streamlined body position, reducing any drag caused by the legs. Therefore, triathlon wetsuit manufacturers tend to use thicker, more buoyant material in the hips, thighs and lower leg.

Finally, the wetsuit must be quick and easy to remove. The transition from the swimming stage to the bike ride is still part of the race, so triathletes must be able to make a quick exit from their wetsuit! Sleeveless wetsuits are quicker to remove. Longer zips, including at the ankle and/or wrist (of a full suit), are also incorporated to aid swift removal.

IN SUMMARY:

- Full suit (with sleeves) or Sleeveless (quicker to take off and allows better movement of arms)
- High quality neoprene for extra comfort
- Thinner, more flexible material around shoulders and arms to improve movement (in full suits)
- Thicker, more buoyant material in the legs
- Smooth surface to reduce friction in water (not suitable for abrasive use, such as surfing)
- Provide warmth for cold, open water swimming
- Extra, and longer, zips for quick removal during transition

USEFUL RESOURCES

There is much information about wetsuits on the Internet. Typing 'triathlon wetsuits' into your search engine will throw up a huge number of useful websites. Here are a few:

http://www.tri247.com/article_7394.html

http://www.surfing-waves.com/wetsuit.htm

http://en.wikipedia.org/wiki/Triathlon_equipment

http://en.wikipedia.org/wiki/Open_water_swimming

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{TEACHER NOTES} INTRODUCTION

Paratriathletes need specialised equipment to allow them to compete. Whilst the development in technology of prosthetic limbs, racing wheelchairs and handcycles has been substantial, no such developments have been made with wetsuits for paratriathletes.

At the moment, paratriathletes have to adapt their wetsuits themselves. They splint their legs by inserting poles inside the wetsuit. They strap their legs to keep them together. Some even stitch the legs of the wetsuit together.

The students may think about designing a kind of 'mermaid' suit, with both legs fitting into one 'leg' (like a sleeping bag). They might include additional zips, allowing the wetsuit to be removed like a banana skin. Further considerations may be given to the legs of the wetsuit, incorporating extra buoyancy and built-in splints (or pouches, a bit like putting up a camping tent).

Current regulations prohibit the use of buoyancy aids, and no part of the wetsuit should exceed a thickness of 5mm. However, students need not be guided by these restrictions. They should be free to be as creative as possible. This Challenge is an opportunity for students to **explore**, **experiment** and **innovate**.

The students must produce a presentation, making proposals for their new wetsuit design.

The Challenge presents an interesting way to explore the relationship between mass, weight, force and pressure, as well as the concept of density.

Students should work in teams of four to six people. Teams will need to manage their time effectively, sharing out different tasks. They must make sure they meet the Challenge Brief, but not take on more than can be realistically completed in the time available. Careful planning is required.

STARTER ACTIVITY

The *Starter Activity* could be used to introduce the students to the Challenge. It is designed to grab their attention and engage them in the sport of swimming and how we use our bodies to swim. This is achieved by watching and discussing various video clips of people swimming.

THE FACTSHEETS

The Factsheets provide information that the students may find helpful when planning what to do and developing their design ideas. The information may help the students to decide what the most important properties are to include in the design of their wetsuit. They also provide some suggestions for tests and activities (*Buoyancy* and *Streamlining* Facsheets). The students do not have to do these, but they may prompt additional ideas. The students should be encouraged to explore their own thoughts, decide on further research to carry out, and design their own experiments.

Although the tests and activities suggested in the *Buoyancy* and *Streamlining* Factsheets do not pose any significant hazards, teachers must always complete a risk assessment when carrying out any practical work. Care is needed where water is being used, with appropriate precautions to minimise the risks of slippery floors.

Particular caution should be taken if any work is carried out in a swimming pool – ensure appropriately qualified adults are present. Remember, even shallow waters can be potentially dangerous.

The Factsheets should not always need to be printed out. They are there as a reference for students. Where possible, encourage students to look at the resources online.

PRESENTATION

The *Challenge Brief* provides some guidance for the students on what they need to do and how to present their work. There is no set way of presenting the design proposals.

When developing presentations, students should be reminded about features of good communication:

- using a mixture of verbal, written and visual communication
- presenting mathematical and scientific information, rather than emotive arguments
- using mathematic and scientific language and terminology correctly
- being able to talk knowledgeably about every aspect of the Challenge

{TEACHER NOTES} CURRICULUM LINKS (ENGLAND)

PROGRAMME OF STUDY FOR KEY STAGE 3

DESIGN AND TECHNOLOGY

KEY CONCEPTS

Designing and making

d. Exploring how products have been designed and made in the past, how they are currently designed and made, and how they may develop in the future.

Creativity

a. Making links between principles of good design, existing solutions and technological knowledge to develop innovative products and processes.

c. Exploring and experimenting with ideas, materials, technologies and techniques

Critical evaluation

a. Analysing existing products and solutions to inform designing and making.

b. Evaluating the needs of users and the context in which products are used to inform designing and making

KEY PROCESSES

a. generate, develop, model and communicate ideas in a range of ways, using appropriate strategies

b. respond creatively to briefs, developing their own proposals and producing specifications for products

c. apply their knowledge and understanding of a range of materials, ingredients and technologies to design and make their products

h. reflect critically when evaluating and modifying their ideas and proposals to improve products throughout their development and manufacture.

RANGE AND CONTENT

b. understanding of users' needs and the problems arising from them

m. how to prepare and assemble components to achieve functional results

SCIENCE

KEY CONCEPTS

Scientific thinking

b. Critically analysing and evaluating evidence from observations and experiments

Applications and implications of science

a. Exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave

KEY PROCESSES

Practical and enquiry skills

c. Plan and carry out practical and investigative activities, both individually and in groups

Critical understanding of evidence

a. Obtain, record and analyse data from a wide range of primary and secondary sources including ICT courses, and use their findings to provide evidence for scientific explanations

Communication

a. Use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues

RANGE AND CONTENT

Energy, electricity and forces

b. Forces are interactions between objects and can affect their shape and motion

PROGRAMME OF STUDY AT KEY STAGE 3

TECHNOLOGY AND DESIGN

TEACHING AND LEARNING OUTCOMES

This Challenge provides opportunities for pupils to develop a range of skills, knowledge and understanding within Technology and Design.

CONTENT AND APPROACH

Designing

Pupils have the opportunity to investigate, generate and evaluate design proposals, using information gathered from a variety of sources. They can use a design brief to guide their thinking, considering the form, function and safety of their design.

Communicating

Pupils should use a variety of communication skills and techniques, including oral, written and graphic communication. They have the opportunity to work in groups, presenting their ideas and findings both orally and in written reports. Pupils should use freehand sketches and detailed drawings with annotations.

Manufacturing

Manufacturing opportunities will be dependent on whether the pupils attempt to make their whole wetsuit, parts of it, or not manufacture it at all. They could select, and use correctly and safely, appropriate tools, carrying out manufacturing processes such as cutting and joining.

SCIENCE

EXPERIMENTAL AND INVESTIGATIVE SCIENCE

This Challenge provides opportunities for pupils to plan and carry out investigations, presenting and interpreting their results.

PHYSICAL PROCESSES: FORCES

Linear

Learn that the movement of an object depends on the size and directions of the forces exerted on it.

Investigate the effect of friction on moving objects.

Pressure

Understand how the effect of a force over different areas results in different pressures.

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{TEACHER NOTES} CURRICULUM LINKS (SCOTLAND)

CURRICULUM FOR EXCELLENCE

TECHNOLOGIES

TECHNOLOGICAL DEVELOPMENTS IN SOCIETY

When exploring technologies in the world around me, I can use what I learn to help to design or improve my ideas or products. **TCH 2-01a**

From my studies of technologies in the world around me, I can begin to understand the relationship between key scientific principles and technological developments. **TCH 3-01a**

FOOD AND TEXTILES CONTEXTS FOR DEVELOPING TECHNOLOGICAL SKILLS AND KNOWLEDGE

I can use textile skills in practical and creative situations in my place of learning, at home or in the world of work. **TCH 3-10c**

By using problem-solving strategies and showing creativity in a design challenge, I can plan, develop, make and evaluate food or textile items which meet needs at home or in the world of work. **TCH 3-11a**

CRAFT, DESIGN, ENGINEERING AND GRAPHICS CONTEXTS FOR DEVELOPING TECHNOLOGICAL SKILLS AND KNOWLEDGE

By using problem-solving strategies and showing creativity in a design challenge, I can plan, develop, organise and evaluate the production of items which meet needs at home or in the world of work. **TCH 3-14a**

Having explored graphical techniques and their application, I can select, organise and represent information and ideas graphically. **TCH 3-15a**

SCIENCES

FORCES, ELECTRICITY AND WAVES

By contributing to investigations of energy loss due to friction, I can suggest ways of improving the efficiency of moving systems. **SCN 3-07a**

By investigating floating and sinking of objects in water, I can apply my understanding of buoyancy to solve a practical challenge. **SCN 2-08b**

Through experimentation, I can explain floating and sinking in terms of the relative densities of different materials. **SCN 4-08b**

KEY STAGE 3 PROGRAMME OF STUDY

DESIGN AND TECHNOLOGY

SKILLS

Designing

1. use given design briefs…
2. identify and use appropriate sources of information to help generate and develop their ideas and products
3. be creative and innovative in their thinking when generating ideas for their products
4. develop a specification for their product
5. explore, develop and communicate design ideas in a range of ways, including annotation, drawings and CAD
6. evaluate, refine and modify their design ideas as they develop…
7. evaluate their final design ideas…

Making

Opportunities will be dependent on whether the pupils attempt to make their whole wetsuit, parts of it, or not make it at all. Pupils could…

1. develop the skills to select and work with a range of materials
2. use a range of equipment and processes to shape and join materials
3. be creative in finding alternative ways of making if the first attempt is not achievable

RANGE

Pupils are given the opportunity to develop their design and technology skills through activities in which they investigate, design, make and evaluate products in a real life context..

SCIENCE

SKILLS

This Challenge provides opportunities for pupils to carry out different types of **enquiry** (developing the skills of planning, developing and reflecting), and to **communicate** their findings scientifically (using a range of methods).

RANGE

How things work

2. forces of different kinds
3. the ways in which forces can affect movement

(From the Key Stage 2 Programme of Study, but can be extended to densities and pressure)

{TEACHER NOTES} STARTER ACTIVITY

This activity could be used to introduce the Challenge.

As it involves watching some online videos, access to the internet and a media projector are required to deliver the session as a whole class activity.

1. Begin by watching the Men's 100 m Freestyle swimming final at the 2008 Beijing Olympic Games:

   » **www.youtube.com/watch?v=cFG32B-SymM**

   Although Alain Bernard is seen winning this race, one of the most successful swimmers in recent times, is Australian Ian Thorpe. He has won an impressive five Olympic Gold medals, three at Sydney in 2000 and two more at the 2004 Athens Games.

2. Explain to the students that you are going to show them a slow motion clip of Ian Thorpe swimming:

   » **www.youtube.com/watch?v=-8qUpeDb8kI&feature=related**

   Ask them to watch closely and consider the way he swims – how he moves his body, and what body parts and muscles he uses the most.

   Alternatively, or additionally, you could show the students the longer clip of Michael Phelps:

   » **www.youtube.com/watch?v=ax77_hHq9Dc**

   This astonishing American swimmer has 22 Olympic medals, including 18 Gold!

   Discuss the students' observations.

   Students might be surprised to know that swimming uses every major muscle group in the body, uncluding:

   - Upper body – Trapezius, Biceps, Triceps, Forearms, Shoulders (Deltoids) and Chest (Pectorals)
   - Core muscles – Abdominals and Lower back
   - Lower body – Hamstrings, Quadriceps and Calves

3. For an illustration of muscle use when swimming, go to

   » **http://www.youtube.com/watch?v=1rQ8iEGd2jk**

   This short animated clip highlights the muscles as they are used during the different swimming strokes.

   The diagrams at the end of this document could also be used to identify and label the different muscles.

4. Now ask the students to imagine that they are disabled in some way – missing a limb, for example, or even paralysed from the chest down.

   - Do they think it would still be possible to swim?
   - What do they think would be the main difficulties and how do they think these might be overcome?

   Establish the difficulty in appreciating just how hard it must be. Able-bodied people can easily take for granted the ability to swim, and yet many still find it difficult.

   - Can they even begin to imagine the problems of swimming without the use of many of their muscles?

{TEACHER NOTES} STARTER ACTIVITY

{TEACHER NOTES} STARTER ACTIVITY

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{TEACHER NOTES} STARTER ACTIVITY

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{ROLE MODELS} JENNY TILLOTSON

NAME: JENNY TILLOTSON

ORGANISATION: CENTRAL SAINT MARTINS COLLEGE OF ART & DESIGN

JOB TITLE: READER IN SENSORY FASHION

1. WHAT DO YOU DO?

I am a Reader in Sensory Fashion – I research and design wearable technologies, and look at using the sense of smell in fashion, wellbeing and healthcare.

2. DESCRIBE YOUR TYPICAL WORK DAY

If I am not travelling or speaking at conferences, I spend my time attending meetings, answering emails and reading trend reports about the latest developments in design, technology and science. I also write funding proposals, teach students, direct 'design and scent' teams and work in the laboratory.

3. WHICH SUBJECTS DID YOU ENJOY MOST AT SCHOOL?

I enjoyed Art, Drama, History and writing stories. Although my school was renowned for its STEM subjects they didn't interest me at the time; I preferred craft, and I learnt to sew and made many of my own clothes.

4. WHAT QUALIFICATIONS DO YOU HAVE?

A BA (Hons) in Fashion from Central Saint Martin's and a PhD in Printed Textiles from the Royal College of Art.

5. TO WHAT DEGREE WERE STEM SUBJECTS IMPORTANT IN GETTING YOUR JOB?

I didn't need STEM subjects to get my current job, but I think Chemistry and Biology would have been useful when I was building my understanding of neuroscience and how the sense of smell works. Science fiction, however, has always been an inspiration and that definitely was important!

6. WHAT WERE THE MAIN FACTORS THAT ATTRACTED YOU TO YOUR CURRENT JOB ROLE AND HOW DID YOU GO ABOUT ENTERING INTO THIS CAREER?

In my early career I worked as a fashion stylist, which was glamorous but not stimulating enough. Then, 20 years ago, I was diagnosed with bipolar disorder which led to me deciding to switch careers. Inspired by science fiction and encouraged by my husband (who was then working as a designer for the sci-fi designer Thierry Mugler), I developed novel ways of projecting emotion and 'the senses', through new channels and using techniques beyond traditional textiles. I then did a PhD on mood-enhancing 'smart textiles' that I thought could benefit everyone.

7. DO YOU HAVE ANY ADVICE FOR SOMEBODY LOOKING INTO THE SAME CAREER?

Don't be scared to 'think big', however extreme it may seem, and remember failure is part of the journey - I have failed many times. If you have a dream, follow it - there is never a better time to be ambitious. I've had to wait a long time for my 'dream' to happen, and it is only just beginning.

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{ROLE MODELS} JENNY TILLOTSON

8. WHAT ARE THE BEST/ WORST THINGS ABOUT YOUR JOB? WHAT DO YOU FIND MOST REWARDING ABOUT IT?

The best part is getting to meet all kinds of people working in areas including bioscience, policy making and science fiction to name just a few! Also being able to develop my ideas to change the future and receive recognition from people including high-profile scientists, teachers and the fragrance industry. The worst thing is the disappointment when funding proposals fall through.

9. WHAT ARE THE CHALLENGES OF YOUR JOB?

Raising funds for research can be very difficult. As I am not scientifically trained, convincing scientists to believe in my work can sometimes be challenging. My research and design work is underpinned by science and technology though, and the story-telling I loved at school has helped me to communicate the science in a creative way.

10. WHAT HAS BEEN THE HIGHLIGHT OF YOUR CAREER SO FAR? WHAT HAS BEEN THE MOST EXCITING/ INTERESTING PROJECT YOU HAVE WORKED ON?

It was fantastic being recognised internationally as a pioneer of Scentsory Design® research, and being told how important my work will be in the future. Working in the lab at the University of Cambridge has been exciting and I was delighted to be made a Reader this year.

11. HOW DO YOU HOPE TO PROGRESS IN YOUR FIELD OVER THE COMING YEARS?

I want to miniaturise and perfect the technologies we have developed so they can have wider uses and greater impacts in the future. I see this technology being used in vehicles, space research, e books and as a sensory learning tool for schools teaching STEM subjects.

12. WHAT PASSIONS AND INTERESTS DO YOU PURSUE IN YOUR PERSONAL TIME?

I like to keep up to date with new trends in areas such as technology and fashion. My husband is an avid surfer so we enjoy spending time at the beach with our three children.

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{ROLE MODELS} SIMON McMASTER

NAME: SIMON MCMASTER

ORGANISATION: FOOTFALLS AND HEARTBEATS UK LIMITED

JOB TITLE: CHIEF OPERATING OFFICER

1. WHAT DO YOU DO?

Everything! As scientific founder of the company (that develops sensors for monitoring sportsmen and women), I look after the scientific side of development of applications and deal directly with clients.

2. DESCRIBE YOUR TYPICAL WORK DAY

I work from home so normally start the day checking through emails. I then split my day between product development and liaising with clients, and research and testing of products using equipment I have at home.

3. WHAT HOURS DO YOU WORK?

Normally I start the day around 8:30am and talk to the parent company office in New Zealand about 9pm although I won't necessarily be working all that time.

4. WHICH SUBJECTS DID YOU ENJOY MOST AT SCHOOL?

Chemistry, chemistry, chemistry! I loved chemistry, particularly as I had a fantastic teacher.

5. WHAT QUALIFICATIONS DO YOU HAVE?

I have a BSc in Chemistry from The Open University and a Graduate Certificate in Research Commercialisation. I went to school in New Zealand so completed the equivalent of Chemistry, Physics and English A-levels.

6. TO WHAT DEGREE WERE STEM SUBJECTS IMPORTANT IN GETTING YOUR JOB?

It is definitely important to have an interest. I'm possibly the world's most curious person and really enjoy finding out how things work. Science subjects allow you to further that curiosity.

7. WHAT WERE THE MAIN FACTORS THAT ATTRACTED YOU TO YOUR CURRENT JOB ROLE AND HOW DID YOU GO ABOUT ENTERING INTO THIS CAREER?

I sort of fell into it really. Whilst studying for my degree with The Open University I had the idea for Footfalls and Heartbeats Limited. We were studying nanotechnology and I thought 'I wonder if you could do that with clothing' and it went from there. Eventually I managed to get some funding to do some further research and subsequently started the company.

8. DO YOU HAVE ANY ADVICE FOR SOMEBODY LOOKING INTO THE SAME CAREER?

Always enjoy what you do. That way you will get the best results career wise. Perseverance is also important. Everyone has days where you don't want to do it anymore but if you persevere it will be worthwhile. Be open to new ideas.

{ROLE MODELS} SIMON McMASTER

9. WHAT ARE THE BEST/WORST THINGS ABOUT YOUR JOB? WHAT DO YOU FIND MOST REWARDING ABOUT IT?

Being able to meet and engage with very smart people working in a lot of different fields, getting their input on my work and learning more about the commercial side of what I do. Disadvantages are it can be quite lonely sometimes so it's important to have other interests going on outside of work.

10. WHAT ARE THE CHALLENGES OF YOUR JOB?

Learning to communicate and listen effectively with companies and understanding that even if something is the answer to a problem it may not be the right thing for the customer. As scientists we need to acknowledge why design is important and understand how people will use our product.

11. WHAT HAS BEEN THE HIGHLIGHT OF YOUR CAREER SO FAR?

Receiving around $300k of funding for the parent company in New Zealand confirmed there was real commercial interest in the idea. I also took part in a ChemNet course recently - helping young people learn what they could do with science and teaching them about textiles was fantastic fun.

12. HOW DO YOU HOPE TO PROGRESS IN YOUR FIELD OVER THE COMING YEARS?

I hope to develop both the UK and New Zealand businesses so they are both in a position to provide an excellent research and production facility. This would provide good careers for young people interested in science or design.

13. WHAT PASSIONS AND INTERESTS DO YOU PURSUE IN YOUR PERSONAL TIME?

Watching the All Blacks thrash everyone in rugby! I also enjoy sailing, cooking, keeping fit and travelling. Being a STEM Ambassador is also fantastic fun; I may even consider doing some teaching in the future as I want to inspire more young people about Chemistry.

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