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No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits to demonstrate NCEA qualification.

Credits: 4

Level 3

Introduction:

The embedded knowledge of this case study is linked to my interest in the Heattech product. My interest in this case study was first prompted when I was given 'The LifeWear Book' (Autumn/ Winter 2016 edition) to study as a potential report subject. As I read further into itself, I found that the product and its creator, Uniqlo, were both expressing and creating a newly defined product that would embrace the properties of natural and raw fibres to create a garment worthy of allowing their customers to own a piece of clothing that would give comfort, soft texture, good fit, heat retention, and anti-perspiration functions.

Heattech is a Japan manufactured product that specialises in the insulation and heat generation of clothing. It consists of four different raw materials that allow the product to retain heat and keep its customers warm with just a single layer of cloth-that represents its appearance. These raw materials are Rayon, Microacrylic, Polyurethane and Polyester.

- Heattech is owned by Uniqlo, who also collaborated with Toray Industries Inc. Uniqlo is a Japanese Casual wear designer, manufacturer, and retailer. The company was founded on September 2nd, 1974, by Tadashi Yanai, who is both founder and CEO of the company.

- Toray Industries Inc. is a multinational corporation headquartered in Japan that specializes in industrial products centred on technologies in organic synthetic chemistry, polymer chemistry and biochemistry. It was founded 90 years ago, in January 1926, with Chairman of the company being Sadayuki Sakakibara, and President (of the company) being Akihiro Nikkaku.

Heattech clothing is a product of collaboration between Uniqlo and Toray, who both contributed equally to its design and manufacturing. The product was launched in 2004 with its goal being to sell 1.5 million pieces of Heattech clothing. **Since then, sales have increased yearly, and in 2011 100 million pieces were sold- the total sum of sales has reached 299 million.**

<http://www.fastretailing.com/eng/group/strategy/tactics.html>

Although Heattech is a 'winter preferred' product, it is extremely popular, and is sold at a reasonable price- all items are around 1500 yen at the most (which is \$20.31 at New Zealand price) Heattech clothing is also popular due to its thinness, lightness, softness, and the comfort that is achieved by the elasticity of the fabric- these have been the hallmark qualities that are ensuring sales of the Heattech product.

Brand Endorsement:

Brand endorsement is the form of advertising that uses famous personalities or celebrities who command a high degree of recognition, trust, respect, or awareness amongst the people. It is because of this that Uniqlo has been using famous names such as actors Charlize Theron and Orlando Bloom, and athletes Adam Scott (Australian professional Golfer), Novak Djokovic (Serbian professional Tennis player), Shingo Kunieda (Japanese, handicapped, professional Tennis player- wheelchair) and Kei Nishikori (Japanese professional Tennis player)

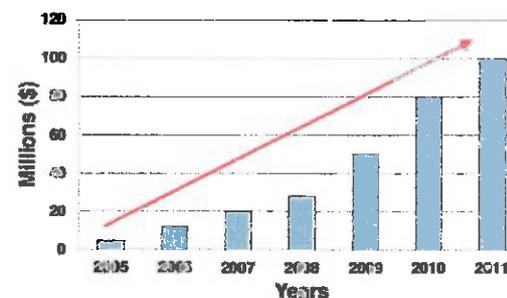
- Charlize Theron is the face of Uniqlo's technical fabric range, and was revealed to have signed up with the High Street Chain in 2010. The brand has also signed up British actor Orlando Bloom to front the Menswear campaign, while Charlize Theron is wearing the womenswear campaign.

- All four world class athletes are sponsored by Uniqlo, allowing them to act as Uniqlo's global brand ambassadors. Wearing Uniqlo clothing during their games and matches to help enhance their performance and excel in their respective fields. Defining LifeWear within the world of professional sports.

Mr. Djokovic is a professional tennis player and UNICEF Goodwill Ambassador in Serbia. He established the Novak Djokovic Foundation in 2007 and works to improve the lives of children and provide better educational opportunities for them- He and UNIQLO agreed to launch the **Clothes for Smiles Project.**

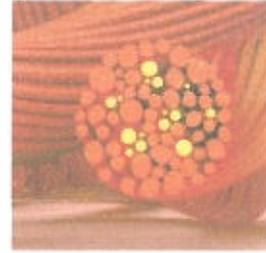


Global HEATTECH Sales Are Steadily Increasing



Description A: detailed description of product that has been made using the enhanced material:

Heattech is a Japanese owned clothing brand that ensures ultimate comfort and warmth for its customers. Designed to be thin, and worn alone without having to wear layer upon layer of heavy, woollen, clothes, the fabric is specially formulated and lightweight. It retains all the body's natural heat by possessing the following qualities:



- **Heat generating and retaining:** the fabric absorbs moisture generated by the body and converts it into heat. The heat is consumed using small pockets of air that are trapped between each fibre in the fabric- this makes it difficult for the generated heat to escape.
- **Moisture retaining:** Milk protein (containing natural amino acids) has been mixed in with the fibres to ensure the fabric is smooth and soft to the touch.
- **Antibacterial:** Antibacterial agents have been woven into the fabric to keep it fresh.
- **Absorption and fast drying:** the Heattech fabric quickly absorbs, and diffuses, moisture to keep you dry.
- **Stretchability:** the fabric stretches to a perfect fit for extra comfort, and also keeps its shape after repeated washing.

Description B: explicit description and explanation of how the enhancement works:

The enhancement works by trapping heat that is generated by the body and using it to keep the wearer warm, while ensuring that no heat is lost in the process. The fabric is made up of four distinct fibres that all contribute to the final product, and they all work in unison to provide maximum warmth and wearability. The main components used that enhance the Heattech fabric are as follows:

- Rayon: (a cellulose fibre). Rayon absorbs moisture from the body (that the wearer produces), and retains the heat that is created from the movement of the H₂O molecules- also known as Kinetic Energy.
- Microacrylic: developed specifically by Toray, this fibre is smooth and silky, and are 1/10 the thickness of a human hair. When these fibres are bundled together they create small air pockets that maintain heat that has been reemitted from the rayon (see yellow in the picture to the right)

"It's the combination of Rayon and micro-acrylic fibres working in succession that is the essence of HEATTECH"
(The LifeWear Book- Autumn Winter 2016 UNIQLO)

- the Rayon and Microacrylic are spun together

- Polyurethane: a stretchable/ elastic fibre that allows Heattech clothing to move with the body with minimal discomfort.
- Polyester: allows the fabric to retain its shape and structure after multiple washes and wears.

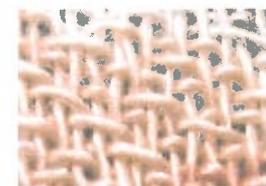
(Both Polyurethane and Polyester contribute more to the feel and wear of the fabric)

The main raw materials are:

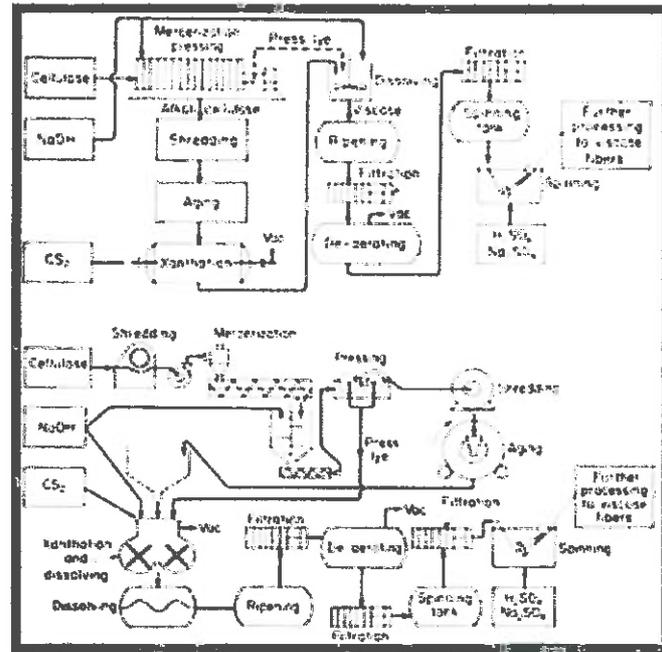
Rayon: a manufactured, regenerated, cellulose fibre.

Properties:

- **Absorbent:** the most absorbent of all cellulose fibres, rayon absorbs perspiration and permits it to evaporate from the skin. Absorbency also allows for dyes and deep colours.
- **Strength:** rayon loses a large amount of strength when wet, which means that it stretches and shrinks more than cotton (also a cellulose fibre)
- **Abrasion (scrape) resistance:** rayon's resistance to damage is poor, due to inelasticity of the fibres. This means that it is easily damaged by scraping, which will then create a small ball of fibres on the surface of the cloth.
- **Static:** rayon has no static build-up
- **Flammability:** Due to rayon's excessive flammability, it caused controversy over the dangers of burning from the result of rayon-caused fires. This led to the Flammable Fabrics Act, which was enacted by the U.S. Department of Commerce in 1953 to bring awareness to the dangers of fabric giving children 'flash burn'.
- **Reaction to chemicals:** because rayon is a cellulose fibre, it is easily damaged by chemical regardless of how weak or strong the chemicals are.



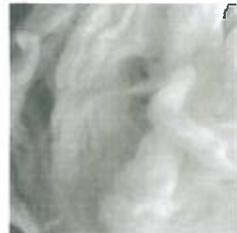
Detailed description + Diagram: Rayon is a manufactured regenerated cellulose fibre. It is made from purified cellulose, mainly from wood pulp, which is chemically transformed into a soluble compound. It is then dissolved and forced through a spinneret to produce threads which are chemically solidified, resulting in synthetic fibres of nearly pure cellulose. Because rayon is manufactured from naturally occurring polymers, it is considered a semi-synthetic fibre. Specific types of rayon include viscose, modal and lyocell, each of which differs in manufacturing process and properties of the finished product. Rayon was the first manufactured fibre, and unlike most man-made fibres it is not synthetic because it is made from natural cellulose fibres. Rayon is made from wood-pulp (a naturally occurring, cellulose based raw material). Because of this, Rayon's properties are likely to be similar to fibres that are natural cellulosic (such as cotton or linen). It will then be less similar to petroleum based synthetic fibres (such as nylon or polyester) because nylon/polyester fibres have been chemically interfered with.



Micro-acrylic: are synthetic fibres that are made from a polymer with an average molecular weight of ~100 000, about 1900 monomer units.

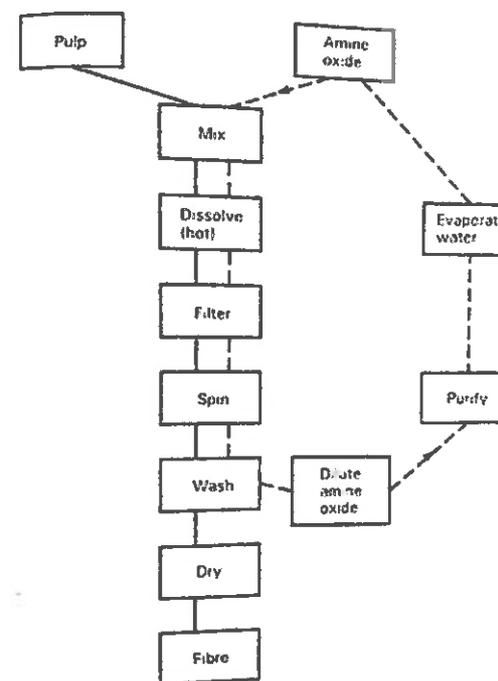
Properties:

- **Length:** The length of acrylic is able to be controlled (filament or staple form)
- **Fineness:** The incredible fineness of the fibres changes the properties of the regular sized fibres and makes them have a wonderful hand and drape. In spinning, the multiple minute size threads/ fibres have more motion and allow the fibres to shift lightly in the spun yarns for a more drape and a very soft feel and prevent loss of the yarn structure. The resulting knits do not droop. They also absorb and draw away moisture better and seem to breathe. Microfiber knits feel more like natural fibres and feel less "damp" in warm weather than regular synthetic yarns.



To compare with familiar fibres: microfibers are 1/2 the diameter of a fine silk fibre, 1/3 the diameter of cotton, 1/4 the diameter of fine wool, and 100X finer than human hair.

- **Strength and extension:** Micro-acrylic is a very strong fibre. Its obstinacy is 5gm per denier (a unit of weight) in dry state, and 4.8gm per denier in a wet state. Extension at break is 15%. It recovers well from deformation
- **Elasticity:** It has an elastic retrieval of 85% after 4% extension when the load is extremely released.
- **Appearance:** It is about 30% bulkier than wool. Regarding insulating warmth, it has about 20% greater insulating power than wool.
- **Reactions to chemicals:**
- **Acid:** It has good resistance to mineral acid.
- **Alkali:** The resistance to weak alkali is fairly good, but strong alkali damages this fibre.
- **Solvent:** It has excellent resistance to common solvents, oils, greases, and natural salts.
- **Water:** moisture regain of this fibre varies from 1.5% to 3%. Easy to wash and quick drying.



- **Reaction to heat/ light:** due to the fineness of acrylic fibres, heat is able to pierce the fibres more quickly. This proves to be a disadvantage of such fine fibres that give so many beneficial properties to Heattech products.

- **Reaction to biological agents:** unaffected by mildew, larves, mould or insects

Detailed description + Diagram: Micro-acrylic fibres are synthetic fibres. These fibres are made from a polymer with an average molecular weight of ~100 000, about 1900 monomer units. To be 'acrylic' in the USA, the fibre polymer must contain 85% (or more) of acrylonitrile monomer- which is an organic compound polymer with the formula CH_2CHCN . Micro-acrylic fibres were first created in 1941 by DuPont (conglomerate: combination of two or more corporations that are engaged in completely different businesses) who then trademarked them under the name *Orlon*. Acrylic was first developed in the mid-1940s but was not produced in large quantities until the 1950s. Due to its strength and warmth, acrylic fibre is often used for sweaters and tracksuits, and is also used as linings for boots and gloves, as well as in furnishing fabrics and carpets. It is manufactured as a filament, then cut into short staple lengths similar to wool hairs, and spun into yarn.

The polymer is formed by free-radical polymerization in aqueous (water) suspension. The fibre is produced by dissolving the polymer in a solvent such as N,N-dimethylformamide (DMF) (organic compound that is a common solvent for chemical reactions) or aqueous sodium thiocyanate, metering it (measuring it per meter) through a multi-hole spinnerette and clotting the subsequent filaments in an aqueous (water) solution of the same solvent (wet spinning) or evaporating the solvent in a stream of heated, inactive gas (dry spinning). Washing, stretching, drying and crimping complete the processing.

SEE DIAGRAM: (http://www.lyocell-development.com/2012_07_01_archive.html) Previous Page at bottom right

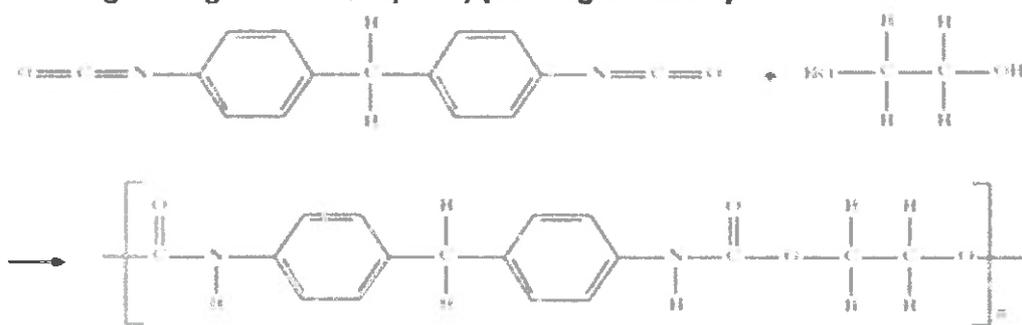
Polyurethane: Polyurethane is a polymer composed of organic units joined by carbamate links.

Properties:

- **Reaction to heat/ sunlight:** polyurethane is resistant to heat, but is subject to cracking and UV damage.
- **Lightweight:** due to its fineness, polyurethane fibres are very lightweight.
- **Durable:** polyurethane fibres block moisture, meaning that stains can often be removed with warm water and soap.
- **Reaction to chemicals:** it has good resistance to weak and cold alkalis, as well as being resistant to cosmetic oils and lotions. However, harsh chemicals such as acetone or vinegar, will attack the fibre and affect the surface (of the fabric). Abrasion resistant.
- **Reaction to biological chemicals:** resistant to mildew, insect, and microorganisms.
- **Strength:** very strong, and can be strengthened when manufactured into different thicknesses (depending on intended use). Can withstand heat and moisture.
- **Quality of fibre:** very strong, useful for products that require abrasion resistance, strength, flexibility, and absorbing qualities.
- **Elasticity:** polyurethane has formed rubber like properties, and is able to be stretched several times its original length, and on releasing the stretching loads it will snap back to its original length.
- **Absorbency:** contains absorbency qualities.
- **Flexibility:** flexible, and easy to work with.



Detailed description + Diagram: Polyurethanes are linear polymers that have a molecular support containing carbamate groups (-NHCO₂). These groups, called urethane, are produced through a chemical reaction between a diisocyanate and a polyol. First developed in late 1930s, polyurethanes are some of the most versatile polymers. They are used in building insulation, surface coatings, adhesives, solid plastics, and athletic apparel. The fibres are usually referred to as 'spandex', and are highly flexible and elastic. The polyurethane thus formed has rubber like properties. It gives an elastomeric fibre, which displays elasticity associated with natural rubber and hence can be stretched several times its original length and on releasing the stretching loads it will snap back quickly to recover its original length almost completely (See diagram below)



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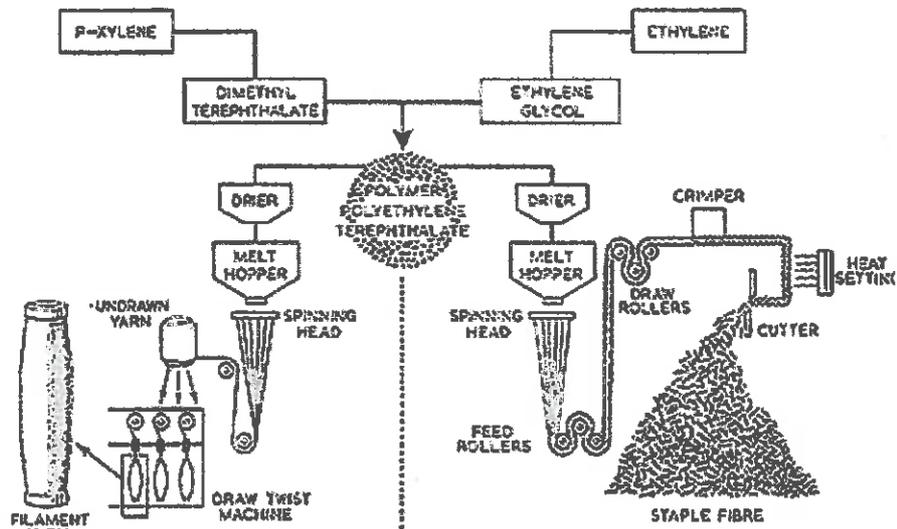
Polyester: Polyester is a category of polymers that contain the ester functional group in their main chain. It is a manufactured fibre. (See image above to left: image of appearance of polyester fibre)



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Properties:

- **Reaction to chemicals:** Polyester fibres have a high resistance to organic and mineral acids.
- **Weak acids:** do not harm at a boil
- **Strong acids:** do not attack the fibres significantly in the cold
- **Other:** Alcohols, Ketones, soaps, detergents and dry-cleaning solvents have no chemical action on polyester fibres.
- **Quality of fibre:** The polyester filaments are very strong, and remain strong even when wet due to the fibre resisting the entrance of water molecules (to an extreme extent)
- **Shrinkage:** Because polyester can be pre-shrunk in the finishing process, of its manufacturing, it resists shrinkage and can also not stretch out of shape.
- **Reaction to staining:** Due to low absorbency, polyester is naturally resistant to stains.
- **Reaction to heat/ light:** Polyester fibres undergo degradation when exposed to sunlight, and is also a poor heat conductor (as it has low resistance to heat) - it melts on heating. Polyester textile materials can be permanently heat-set: it is a thermoplastic fibre (meaning that it is capable of being shaped or turned when heated) Thermoplastic fibres heated under strictly controlled temperatures soften and can then be made to similar to a flat, creased or pleated configuration. When cooled thermoplastic fibres retain the new formation.
- **Reaction to biological chemicals:** unaffected by mildew, larves, and mould or insects
- **Static:** due to low moisture regain, it develops a static charge.
- **Colour fastness:** It is not easy for dye molecules to penetrate the fibre when dyed. However, it retains its colour after a regular wash.



Detailed description + Diagram: Polyester is a synthetic fibre derived from coal, air, water, and petroleum. Developed in a 20th-century laboratory, polyester fibres are formed from a chemical reaction between an acid and alcohol. In this reaction, two or more molecules combine to make a large molecule whose structure repeats throughout its length. Polyester is used in the manufacturing of many products, including clothing, home furnishings, industrial fabrics, computer and recording tapes, and electrical insulation. Textured polyester fibres are an effective, non-allergenic insulator, so the material is used for filling pillows, quilting, outerwear, and sleeping bags. In 1926, United States-based E.I. Du Pont de Nemours and Co. began research into very large molecules and synthetic fibres. This early research, headed by W.H. Carothers, focused on what became nylon (the first synthetic fibre) Soon after, the research resulted in the creation of the polyester fibre.

History of the product:

Thermals were first introduced in the 17th Century, in England, as 'long underwear' (long johns, thermal underwear), and consisted of two pieces: top and bottom. They were typically worn underneath peoples clothing in the winter.

Long johns were first manufactured at John Smedley's Lea Mills, although there is speculation that the name for Long johns came from boxer John Sullivan (who is said to have worn an outfit similar to Long johns when fighting in the ring- however there is no substantial or conclusive evidence to support this)

Fibres: in England, the European manufacturers used wool blends, or even 100% wool, which were typically merino. The wool was used because it provides high insulation, and will keep its insulation properties even when wet (as opposed to cotton) It appears that some long underwear products also included a layer of polyester to absorb moisture away from the skin. Merino has also been widely recognised for retaining heat without causing the wearer of the product to overheat.

Fibres: in the USA, long underwear are usually made from cotton or polyester fibres, even a polyester-cotton blend fabric. However, some products are made with flannel.



Long johns have been developed over the years from 100% wool, to wool and synthetic polyester, which was incorporated into the European manufacturing. However, the use of polyester was questioned when it was realised that polypropylene garments can retain body odour, which is then difficult to remove. This has caused complication to production of the garment, but also demonstrates how companies and manufacturers are dealing with the problem, and developing their products to prevent it from causing a loss in purchasing numbers (regarding a loss in customers and money)

Due to polypropylene clothing being made with a small amount of advanced fibres, it appears that several factors (in relation to fibres) caused certain components of the polypropylene fabric to work well, and other factors to not work well. For example, the degradation in polypropylene products often results in the products developing small cracks that enlarge with time. A UV-absorbing additive was introduced during manufacturing that prevented the plastic from absorbing the UV rays directly. Carbon black was then added to the polypropylene mix to also help protect against UV rays. To protect against oxidation, anti-oxidants were added to stop the oxygen molecules from bleeding off, making the material brittle. Additives tend to raise the price of polypropylene, and while they can slow degradation, they cannot prevent it entirely. Another primary disadvantage of polypropylene is that it has a high thermal expansion factor, making it hard to work with at high temperatures. When exposed to high temperatures, the material tends to deform easily, thus limiting manufacturing methods primarily to injection moulding, which can limit the sizes of objects created with the plastic. There are several other more minor disadvantages, such as the material's high flammability when used in its natural state, along with its inability to bond well with paint. Additives have managed to lower flammability to safe levels, and techniques have been developed to allow painting of polypropylene surfaces. These modifications make the plastic a common choice as a manufacturing material for anything from containers to furnishings

Product Development: Long johns have been successfully developed and changed with fabrics that ensure that the product carries all the necessary properties for warmth and comfort. Heattech has created a completely new 'long john' fabric that has been made with fibres that have never been combined before in the production of thermals (the fibres have been used separately, but have never been combined to create a new fabric)

* **Diagram shows development of product, fabric, and fibre over four different forms of the product: Long Johns, Thermal underwear, Polyprops, and Heattech. SEE LAST PAGE OF REPORT.**

The raw materials are being enhanced with or by:

Polyester (enhances the other materials). As it is the main component used in the production development, it makes sense to say that polyester is the key enhancement to the HEATTECH product. Polyester is a synthetic fibre derived from coal, air, water, and petroleum. Developed in a 20th-century laboratory, polyester fibres are formed from a chemical reaction between an acid and alcohol. In this reaction, two or more molecules combine to make a large molecule whose structure repeats throughout its length. Polyester is used in the manufacturing of many products, including clothing, home furnishings, industrial fabrics, computer and recording tapes, and electrical insulation. Being a top man-made fibre, polyester acts as an enhancement to HEATTECH fabric due to it being so flexible to work with. New manufacturing techniques are now developed to the point where they are able to produce fibres adapted to suit the widest possible applications: they can have round, oval, or angular profiles, different colours, widths etc.



The components/ fibres/ layers are combined by:

Yarn is a long continuous length of interlocked fibres, suitable for use in the production of textiles (sewing, knitting, weaving etc.)

Yarn is created by the spinning of the fibres. The spinning is done by a spinning wheel, which draws the fibres across the wheel, and as it spins, the fibres are collected on a cylindrical object called a bobbin. The bobbin holds the spun fibres, which are now connected into a long strand of thread, or yarn.

Electric spinning wheels or e-spinners are powered by an electric motor rather than via a treadle. Some require mains power while others may be powered by a low-voltage source, such as a rechargeable battery. Most e-spinners are small and portable. One of the attractions of an e-spinner is that it is not necessary to coordinate treading with handling the fibre (drafting) (so it is generally easier to learn to spin on an e-spinner than a traditional treadle-style spinning wheel) E-spinners are also suitable for spinners who have trouble treading for various reasons. E-spinners represent an evolution of the tools used in the craft of hand-spinning, similar to what has occurred in sewing, quilting, woodworking, and other crafts

The cloth is formed from the fibres/ fabric/ material by:

“Four key fibres and 3 distinct yarns make up HEATTECH fabric: Rayon and micro-acrylic, polyurethane and polyester. Knit together they work in unison to provide optimum warmth and wearability” (The LifeWear Book-Autumn Winter 2016 UNIQLO)

The cloth is formed from 3 basic steps, which are required for fabric production:

1. **Yarn Production:** Here, the raw materials that have been harvested and processed are transformed from raw fibres into yarn and threads. This is done by spinning the fibres. Spinning can be done by hand, but this process is quite monotonous and time consuming. Usually, the vast majority of spinning is done by a spinning wheel. The fibres are drawn across the wheel, and as it spins, the fibres are collected on a cylindrical object called a bobbin. The bobbin holds the spun fibres, which are now connected into a long strand of thread or yarn.
2. **Weaving:** Weaving is done on a machine known as a loom and requires two sets of yarn. The first set, called the warp set, is strung tautly across a metal frame. The second, called the weft, is connected to metal rods, with one thread per rod. The loom is controlled by a computer, which lets the weft know how the fabric should be woven. After the fabric has been woven, it's removed from the loom and is ready for the final step
3. **Processing:** Fabric that's fresh off the loom is called greige. It's discoloured and full of impurities, seed particles and debris. Before it can be transformed into useful textiles, it must be cleaned. First, it's treated with bleach to purify the base colour. Next, it's treated with a variety of chemicals and cleaners to remove oils, wax and other elements that are naturally occurring in most fibres. Finally, it's ready to be shipped out to clothing and textile manufacturers.
4. **Dyeing: (Additional Step)** The first step in dyeing the fabric is to run it through a machine called a Mercerizer. The Mercerizer contains a chemical solution, including caustic soda (also called lye), which is kept at moderately low temperatures. The mercerization process increases the size of the pores on the fabric threads, making it easier for them to accept colour during the dyeing process (without mercerization, bright, bold fabrics would not be possible) Next, the fabric is washed, and while it's still wet, it's stretched across a metal frame and pulled tightly. This aligns the weave patterns and also opens up the fabric to accept even more colour.

(Clothes dyed with simple, nonreactive dyes tend to fade overtime. This is simply a result of bits of the dye washing away from the material. One way to protect the dye on your garments is through the use of colour-safe bleach. While this substance actually contains no bleach, it does contain hydrogen peroxide, which helps breakdown stains without lifting colour. The real benefit of colour-safe bleach is in the chemical additives it contains. These additives act as a clear shield for your textiles, holding in colour while also providing an optical brightening by reflecting light, making colours appear brighter)

The combination or enhancement improves the product by:

When combined, the fibres are tasked with providing warmth and comfort that improve the products 'original' job: keeping the wearer warm (thermals etc.)

Uniqlo has ensured that the fabric carries 8 distinct functions that improve the products performance, compared to when Heattech was first created:

- **Heat Generation:** as Heattech absorbs body moisture, the movement of small droplets (in the fabric) generate heat to keep the wearer warm.
- **Heat Retention:** air pockets between the fibres maintain both body warmth, and the warmth generated by Heattech's moisture absorption.
- **Moisturizing:** milk protein is mixed with the fibre for a soft but supple feel on the skin.
- **Quick Dry:** Heattech fabric draws off liquid and quickly dries moisture. Perspiration dries up instantly, so the fabric remains dry and refreshing.
- **Odour Control:** a specialized antibacterial agent in Heattech helps to minimize odours.
- **Stretchable Comfort:** Heattech stretches to give perfect fit and ultimate comfort.
- **Anti Static (added to the product in 2009):** in relation to its moisture retention properties, the fibre responsible also reduces discomfort from static electricity.
- **Non-Deforming (added to the product in 2009):** Heattech maintains its shape even after several repeated washings.

The enhanced material impacts on the design of the products by:

When choosing the materials for a product the designer/ manufacturer must consider a number of factors:

- **Use of product:** The choice of material has to take into account how the product/component will be used and what environment(s) it will be used in. Take for example a Heattech top. The fabric chosen will have to withstand wear and tear from constant wear if worn in cold climates (if a person is skiing etc.) washing with detergents, exposure to sun (i.e. fading of fabric colour) tolerate temperatures from below 100° C.

- **Quantity to be manufactured:** Some products could be manufactured in more than one way. Often the decision depends on the quantity to be manufactured. Heattech clothing for example could potentially be manufactured in more than one way:

a) **Machine Manufacture:** Because UNIQLO is such a large company that is in collaboration with TORAY, for Heattech clothing, it is possible for Heattech clothing to be manufactured by machine, seeing as the fabric needs to first be made before it can be cut and sewn.

b) **Factory:** It is possible that Heattech clothing is constructed and sewn manually by workers. However, it makes more sense to say that it is made via machine manufacturing.

- **Market cost (niche):** Another factor in choice of materials can be the end cost of the product. If the product being designed is at the bottom end of the market where cost is very important then the material has to be as cheap as possible. As long as the material is able to carry out its function for a reasonable period (of time) then it will be deemed satisfactory. However with an up-market product cost becomes less of an issue. Materials chosen should perform well, should be long lasting and reflect the quality image of the product.

This enhanced material could also be used for:

- **Bedding:** although winter bedding is already effective with cotton, wool and polyester as its main fabric choice, Heattech fabric could successfully replace the regular fabrics with a new and improved insulating fabric. Heattech fabric could provide more insulation, with less negative feedback regarding odour problems, and wear of fabric.
- **Sleeping bag interior fabric:** although sleeping bags are already successful with insulating quilts, Heattech fabric could improve the function of the interior fabric. Because Heattech fabrics absorbs and maintains heat, it generally serves the same purpose as the already used quilt in the sleeping bag- however it could enhance the products performance. It is unknown if sleeping bags do carry odour problems, but Heattech could ensure that this would not happen.

The enhanced material product needs to be maintained by:

Heattech requires a gentle (machine) wash, implying that the fabric needs to be handled with care and precision, along with friendly-chemicals that will not jeopardise the product in any way. If this is not carried out, then the garment has a high risk of being stretched, pulled, and potentially damaged (which can cause tears and cuts in the fabric)

Polypropylene care: *"Polypropylene is an extremely durable material and will last you indefinitely if cared for properly on a regular basis. Ideally, it should be hand washed in cold water or machine washed in cold water on the delicate cycle with the polypropylene item turned inside out. Because of the melting factor, it's recommended to air dry polypropylene. This won't take too long because of polypropylene resistance to water. If you must use a dryer, ensure the dryer is set to its lowest heat setting and not for more than a few minutes. Polypropylene is colour fast so if you get it in some colour other than black, it won't fade. Most manufactures treat their polypropylene with an anti-microbial agent which helps the material resist mildew, stains, and soils"*

(<http://www.nomoredependence.com/2011/03/polypropylene-clothing/>)

When the life of the product made with the enhanced material has ended it could be disposed of by:

RAYON: Due to rayon being more biodegradable than cotton, and that more than acetate, it can be disposed of naturally, where it will decay over time.

POLYURETHANE: With the wide application of polyurethane foam materials, a large number of polyurethane foam wastes need to be disposed. There are mainly three types of disposal technology, landfill, incineration and recycling. Physical recycling method, due to the simple operation and relatively active application, in the short term is an effective means. Chemical recycling method, due to its higher technical difficulty, is difficult to realize large-scale industrialized production in the short term. And in the future, recovery application is the ultimate method

MICRO-ACRYLIC: acrylic is not easily recycled, and remains in landfill- acrylic fibres are highly flammable, and are a risk to the environment.

POLYESTER: Polyester is made from petroleum, a non-renewable resource that creates damaging environmental impacts during the extraction process. However, when considering the whole lifecycle of the fibre, from the raw materials, through the use phase to the end of the lifecycle, polyester is not as environmentally damaging as believed. It has lower energy impacts during the washing and cleaning phase and is also completely recyclable at the end of its life. Polyester textile recycling has been developed using the clear plastic water bottles, or PET as the raw material, a source of plastic that would otherwise go into landfill.

Conclusion:

In conclusion, it is sensible to assume that HEATTECH clothing is a successful brand that has been able to fully satisfy the customer's needs. HEATTECH has developed from recent chemical production in the sense that it has in fact been made from a complete new fabric (that has been made from 4 different fibres), and is mainly manufactured through the process of dry spinning, with dyes being added etc.

The product itself represents the material and product development of polypropylene clothing, and it is because of this that there is such a growing demand in HEATTECH clothing. Uniqlo is smart in its design, as it is creating a product that contains comfort, smart technology outcomes, and also developed factors. This has caused the product to be a clear example of material and product enhancement as it contains not only new fabrics and fibres, but has also been made with new technology and product development factors. Due to the manufacturing process, the HEATTECH product has the possibility to go above and beyond in terms of its product availability around the world- the UNIQLO Company has the potential to advance the design of the HEATTECH garment in terms of fibre materials, and qualities. HEATTECH was created combining fashion and special advanced Japanese technology to create a complete new, and diverse, product that is the result of modern technology and manufacturing in Japan.

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(Diagram)

*** Product Development:**

Long Johns were first introduced in England in 17th C. BC. They were originally in the style of two-piece underwear with long legs and long sleeves that were worn during cold weather. Usually worn underneath clothing.

Thermal underwear is still common today, and is usually in the style of long sleeved and short sleeved tops, and leggings. Usually worn in winter, outside for sports etc. tramping.

Polyprops are common, and are usually in the appearance of tops (long/ short sleeved), or leggings. They are usually worn for tramping, or outdoor activities.

Heattech is 'the new and improved' thermal that is sold globally, with products being sold in different forms: tops, leggings, coats, pants etc.

Fabric Development:

Long Johns were originally made from cotton, or a cotton-polyester blend. Some were made from flannel (in the USA)

Thermal underwear (in Europe) are made from wool blends, or even 100% wool, usually merino or high quality wool.

Polyprops are usually made from cotton blends, or polyester. Some can also be made from wool blends, or flannel.

Heattech is made from a fabric that combines rayon, polyurethane, polyester, and micro-acrylic fabric. The name for this fabric is unknown (or is possibly known as just Heattech)

Fibre Development:

Long John fibres:
- Cotton
- Flannel: cotton, wool, synthetic fibre
- Polyester

Thermal underwear fibres:
- Wool: merino, high quality wool, 100%
- Cotton
- Polyester
- Synthetic fibre

Polyprop fibres:
- Cotton
- Polyester
- Wool
- Synthetic fibre

Heattech fibres:
- Rayon
- Micro-acrylic
- Polyurethane
- Polyester

Grade M
Context garments

Material HEATTECH
Enhancement warmth heat generation
Product Long John

Assessment Schedule. AS91613		
VERSION 3 annotated 2016		
Demonstrate understanding of material development		
<p>Commentary</p> <p>The candidate has used a variety of sources which have been referenced in the report and a bibliography. The material is identified as HEATTECH a composite fibre creating a fabric that is able to generate heat from body warmth and insulate against the cold in garments such as the long john.</p> <p>The development of HEATTECH is described and explained drawing information and conclusions drawn from properties of the four fibres used to create HEATECH and used this information to explain the overall enhancements the material brings to the garments, development processes and the formulation of the material. The candidate covers the end of life of the garment and the maintenance explaining the impacts of design development, implementation and maintenance such as wash and care instructions and ultimate disposal. The report could be enhanced by a more clearly structured format to guide the candidate in their writing.</p>		
<p>Issues from the Specifications</p> <ul style="list-style-type: none"> • Where a candidate has provided a brief answer, the answer should not be penalised because of length. • Candidate work in excess of 10 pages must not be marked. • Where a candidate has used a small font markers should make a judgement about where to stop marking. This judgement should be made relative to 10 pages at Arial font • Where work is illegible, it cannot be marked. • Digital submissions that cannot be read cannot be marked. • Material must be referenced to acknowledge original sources, texts, URLs and websites 		
Achievement	Achievement with Merit	Achievement with Excellence
Demonstrating understanding of material development involves.	Demonstrating in-depth understanding of material development involves.	Demonstrating comprehensive understanding of material development involves.
<p>describing the development of a material designed to enhance a product's performance</p> <p>describing the implications of the material on the design, development, implementation, maintenance, and disposal of products.</p> <p>MEP A Material must be specified and its development must be evident-considering such things as historical and or technical aspects and properties; manipulation, transformation, formulation of the material(s)</p> <p>The enhancement must be identified in relation to a specified product (product specified) for example washability, durability, strength, speed enhancement, viscosity</p> <p>The Material must be described in its relationship to and impact on the design, development, production , on-going maintenance and disposal of the product</p>	<p>explaining how the material enhanced the performance of a product</p> <p>explaining how the material impacts on the design, development, implementation, maintenance, and disposal of products.</p> <p>As for achievement plus</p> <p>Explain (give detail , example and reason) how Material interacts with the product to enhance the performance of the product</p> <p>Explain how the material impacts on (influences the choices relating to) design production maintenance and disposal of product(s)</p>	<p>explaining the concepts and processes employed in the development of a material.</p> <p>As for achieved and merit plus</p> <p>Explaining (detail of description with example and reasoning) the concepts and processes used in the development of the material</p> <p>Development, processes such as raw material to refined material and its development and enhancements</p>

Technology AS91613 Schedule Appendix 1

<p>Markers must exercise professional judgement to decide if a report demonstrates understanding. The following appendix provides guidance for markers making this judgement.</p> <p>A report must use information to demonstrate understanding.</p> <p>Reports described wholly or substantially by one or more of the statements in the left column demonstrate understanding.</p> <p>Reports described wholly, or substantially, by one or more of the statements in the right column do not demonstrate understanding.</p>	
<p>Where the report is made up of both used and reproduced information the marker must decide if the report is successful against the standard when the reproduced information is ignored.</p>	
<p>Evidence of use of information(understanding)</p>	<p>Evidence of reproduction of information (copy and paste/plagiarism)</p>
<p>Candidate's report describes and explains the Material development related to their context practice, or information relating to the standard</p> <p>Information from the candidate's practice, research, the practice of others, and teaching is related to the development of a material and then in relation to products..</p> <p>The report describes understandings you would expect to come from a course of instruction derived from the Technology Learning area of the NZC at Level 8.</p> <p>These could include but are not limited to</p> <ul style="list-style-type: none"> • The context of the products' development links to the material development and the implications of the material on the design, development, implementation, maintenance, and disposal of products. • Describe/ explain the material, the product and the enhancement • Candidates begin with the development and processing of a material and then moved to link to the product development and implications of the material on the design, development, implementation, maintenance, and disposal of products • Explanations should have detailed description plus how and/or why statements to give reasons • Information is presented in alignment to context of study and is referenced appropriately and is relevant to the context at level 8 of the New Zealand curriculum • the design, development, implementation, maintenance, and disposal of products the product in relation to the ,material under review must be part of the candidate description/explanation (some products may not have all parts of this due to the nature of the product but this should be addressed in the report) • Products may include existing or feasible future products. In the case of feasible future products, the candidate must have covered the range of implications of the material within the context of the future focused product. 	<p>Information is unrelated to the context, unreferenced and is not relative to the understandings expected at NZC Level 8</p> <p>Downloaded material that is not mediated, interpreted or synthesised is not acceptable as this does not show understanding of the concepts related to the development of a material or the material's relationship with product design, development, implementation, maintenance, and disposal</p> <ul style="list-style-type: none"> • Comparing various materials for their use in a product or comparison of various products is not part of this standard
<p>Information from research, the practice of others, visiting experts or teaching is reported in the candidate's own voice to enhance their understandings. Information synthesised from a range of credible evidence and sources is synthesised in a coherent report</p>	<p>Information is not in the candidate's voice. The word choice, sentence structure, sentence length, punctuation and so on are not what a candidate could be expected to produce.</p> <p>However, care must be taken where students have synthesised material to a high degree and presented an articulate report</p>
<p>Referenced, complex research information unchanged by paraphrase (ie use of quotations) is related to other information in a manner that constructs meaning within the context.</p> <p>Use of credible evidence (not reliant on Wikipedia or wise geek as a sole reference)</p>	<p>Unreferenced, complex, research information is presented as though it is the candidate's own work. Plagiarism evident</p>
<p>Where the marker suspects a report is a deliberate attempt to deceive the report should be referred to the panel leader using the Irregular Booklet process.</p>	