The Drapers' Company / Industrial Trust Technical Textiles Competition 2010

Teacher Support Information and Booklist

With many technical textiles out there, understanding them and how they can be applied to a product can be a challenge in its self. Looking at the following will help you
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www.d3olab.com	www.technitex.org	www.shape3.com	www.fibretronic.com	www.technical-textiles.net	www.geofabrics.com

The main types of Fibres used in Technical Textiles:

Inorganic fibres: synthetic polymers are the most common
Organic fibres: alginate – substance from brown seaweed; chitin – is a natural polymer in fungi & crab shells; chitosan – derived from shrimp shells

Conductive fibres:
Metallic fibres ………………….. www.sprintmetal.com; www.unitika.co.jp
Polymers + copper sulphide….. www.r-stat.com
Carbon………………………….. www.carbonelorraine.com; www.soficar-carbon.com
Carbon loaded polymers……… www.dupont.com; www.kanebo-international.com; www.kuraray.co.jp/en; www.basf.com; www.epitropicfibres.co.uk

The following properties of a fibre are important for technical textiles:

structure ● fibre density ● tensile/rigidity ● elastic recovery ● thermal ● chemical/biological/uv resistance ● friction ● moisture absorption + retention ● electrical resistance/static electricity ● optical

High Performance Fibres have properties beyond the performance of fibres used in everyday products

Examples of trade mark technical textile fibres (HPF):

Kevlar: www.dupont.com — Peek: www.zyex.com
Twaron: www.twaron.com — Vectran: www.goodfellow.com — PPS: www.rhodia.com

Thermal properties of fibres:

To check the thermal properties of a fibre tests are carried out for the following:

ignitability ● flame spread ● heat release ● smoke production ● toxic gas generation

An excellent example of an application of thermal protection is in a space shuttle: reinforced carbon-carbon (RCC) panels, low & high temperature insulation tiles (or heat shield tiles), felt reusable insulation blankets and fibrous insulation blankets are typical of the technical textile products used. www.nasa.gov/

Composite Materials: www.sigmatex.com/

A composite is a physical combination of two or more separate materials. Fibre-reinforced composites (FRC) are of main interest in the technical textile sector.

The advantages of a composite over other bulk materials are:

high tensile strength/rigidity ● low density ● improved oxidation & corrosion resistance ● controlled thermal expansion ● controlled electrical conductivity ● fabrication of very large components at a lower cost

Applications of fibre reinforced plastics (FRP) which are a significant part of the composite family are:

aerospace (30% of an aeroplane) ● electricity generation (blades on a wind turbine) automotive (interior & under bonnet parts)

The future design of cars need to meet with improved requirements on safety, comfort, styling and environmental efficiency. Thus increase our use of composite materials.

Bio composites: (this is an area which is currently limited but expanding)

With a rising focus on issues of recycling & environmental concern the use of biodegradable fibres is paramount. Natural fibres can be used as reinforcing materials once a biodegradable resin has been applied. The fibres used for this are: Flax ● hemp ● kenaf ● sisal

Personal Protection: armour ● fire/heat protection ● chemical & biological

www.panhorus.com ; www.mjscannell.ie ; www.army-technology.com

Armour – military, police + security (body armour – bullet/stab/cut proof vests; armoured vehicles – bullet/bomb blast protection); industrial + sports wear (protection against sharp + blunt objects, abrasion).

Fire/heat protection – examples include: fire suits; industrial – gloves / aprons / boiler suits.

Chemical & biological – military/security – CWS suits / face masks; industrial – gloves / aprons / boiler suits.

Medical: www.toray.com/ ; http://www.systagenix.com

Modern dressings are made from a new material called polysaccharides which include alginate, chitin & chitosan fibres. These fibres can be non-woven, woven, knitted and braided.

Other applications of technical textiles in this field are:

General hospital textiles – clothing & materials for patients & staff; protective clothing

Wound management – dressings; bandages; plasters etc

Prothesis & epidemiology – vascular implants; ligament grafts; sutures; tissue engineering

An excellent example of how far technical textiles are aiding advancements in tissue engineering: taking a sample of cells and growing them under the right condition to form tissue around a technical textile scaffold.

Transport Textiles: aerospace ● automotive

www.airbus.com

Aerospace interiors – upholstery; carpets; overhead lockers

Automotive products – covering materials; functional items; speciality high technology items (airbags, seat belts, reinforced rubber products – especially tyres); upholstery; headliners, carpets

Civil Engineering: geotextiles ● geosynthetic materials

Geotextiles - fluid transmission; filtration; separation (to form a barrier between fine and coarse soils)

Geosynthetic materials - a membrane comprising of: resin, plasticiser, filler, carbon black & additives

Applications of geotextiles and geosynthetic materials: www.geofabrics.com

road ● rail ● bridge & embankment construction ● reservoir ● dams & sea defence construction

Textiles for Agriculture & Horticulture:

Products: Ropes & twines ● Agricultural bags ● Non woven agro textiles ● Nets / netting products

Ropes & twines – originally made from hemp or sisal now made from polypropylene

Agricultural bags – originally made from jute or cotton now made from high-tenacity polypropylene

Non woven agro textiles – made from perforated / non perforated polymeric film, their function is for climatic protection against the elements.

Nets / netting products – mainly woven, Raschel knitted or extruded: Raschel knitted nets are used for packing hay bales; non woven nets are being used for crop protection against the elements and wildlife.

Building Construction & Architectural textiles: www.webdynamics.co.uk

This is an area predicted to grow over the next decade. We will see more uses of technical textiles being used within buildings and even complete structures manufactured entirely from textiles.

The main areas that technical textiles are currently being used:

reinforcement ● partitioning structures ● waterproofing & breathable materials

protective functions ● communications ● architectural textiles

Reinforcement – foundations use geomembranes & geotextiles.

Partitioning structures – double wall and spacer fabrics are using a warp knitted technical textile.

Waterproofing & breathable materials – PVC coated rip-stop fabric is now being used as it enables air circulation which prevents water vapour condensation which is harmful to timber frame roofs. Conductive textiles are being used in ceiling, wall and under floor heating.

Protective functions – woven and non woven fabrics incorporating copper conductors or conductive fibres are used to provide electromagnetic & electrostatic screening of interior areas which are essential in hospitals and other buildings housing special computers & sensitive electronic devices.

Communication - woven and warp knitted fabrics are incorporating optical fibres which illuminate panels, ideal for emergency exit signs. Textile structures can also be used for communication networks such as computer cables, telephone wires, electrical distribution wiring & transport vehicles.

Architectural textiles – technical textiles are replacing traditional building material. These textile structures are more weather resistant, lighter in weight and far more economical to install than traditional materials.

The Millennium Dome in London is a prime example of an architectural textile.

Smart Materials

Smart materials comprise of a range of materials that have been developed to respond to specific stimuli by producing responses which are, in some way, seen as special. 'Intelligent' is also often used to describe smart materials.

Here are the Main Types of Smart Materials:

Conductive fibres & yarns: www.r-stat.com
Conductive fibres and yarns can be used to provide connectivity with batteries or other electronic modules, enabling fabrics to handle electrical power or signals.
Synthetic fibres can be made conductive by coating with copper sulphide, or alternatively embedding carbon into polyester fibres (epitropic fibres).

Conductive polymers: www.panipol.com
Plastics are polymers: they are replacing metals in many applications due to their lightness, freedom from corrosion and ability to be formed into complex shapes by the moulding process. Plastics are good insulators of electricity. A plastic with electrical conductivity would offer many possibilities in product design. A conductive polymer which could be converted into a fibre would be of great benefit to smart textiles, but such a polymer is yet to be developed.

Shape memory alloys: **http://www.dynalloy.com**
Shape memory alloys exist in one of two physical states in response to external temperature or physical stimuli. Materials such as shape memory alloys and shape memory polymers have the potential to be combined into fabrics to provide responsiveness to heat.

Heat storage material: www.outlast.com
Heat storage materials are capable of providing some thermal regulation in response to changes in the external environment. Applications include outdoor clothing, underwear, ski wear, blankets & gloves.

Optical fibres: www.gtwm.gatech.edu/
Optical fibres convey light by a process of total internal reflection. They are made from either glass or plastic of high optical clarity and purity. Light can travel in an optical fibre over long distances with very little reduction of brightness. An optical fibre cable has an assembly of a large number of individual fibres, with a central steel wire core providing strength, all of which is encased in protective armour cladding. Optical fibres can be used for passing signals in serial digita; or analogue form, between places in a machine or from one machine to another.

Piezoelectric materials:
A piezoelectric element acts as a sensor of pressure or force as it produces an electrical voltage output in response to compression. Great simplicity, compactness, reliability and durability are major advantages of piezoelectric sensors.

Quantum tunnelling composites (QTC): **http://www.eleksen.com/**
Peratech makes Quantum Tunnelling Composites (QTCs), substances that are extremely sensitive to pressure, heat, radiation and volatile compounds (smells). When QTC is put into textiles, the textiles become sensitive to these inputs. Peratech's brand for textile sensors is SoftSwitch ™ which has produced textile switches and sensors for such diverse uses as finger sensors for NASA robots and fabric control switches on astronaut's suits as well as military and civilian clothing.

Nano materials: www.engadget.com/2006/09/21/nanonunos-water-repelling-umbrella/

NanoNuno umbrella:

The idea came from the "natural phenomenon" witnessed on the Lotus leaf, having a similar, sleek surface the water, simply rolls off.

Nanotechnology is an emerging branch of technology. Nano is a term that denotes 1 billionth. Therefore Nano materials refer to materials whose size is 1 billionth of a metre. It has been found that the properties of materials, when reduced to the nanometre dimension may well differ from their properties observed when they exist in their 'normal' larger dimensions. Because of this Nanotechnology has the promise of creating new materials by direct manipulation of individual molecules or atoms. However Nano materials may pose a health & environmental hazard, as with any new technology a period of time is necessary to understand and evaluate such implications.

Smart colouration materials: www.chromazone.co.uk
Thermochromism – materials that change colour in response to temperature change

Photochromism – is a reversible process, usually triggered by light (commonly used in sunglasses that react to light.) Other applications: fashion clothing for night clubs where UV light is used; military camouflage where colour change takes place to respond to the environment.

Retro reflection: 3M™ Scotchlite™ Reflective Materials use a technology known as retro reflection.
Retro reflection occurs when light rays are returned in the direction from which they came.

Other Smart materials: www.azom.com ; www.mide.com
Other materials that may be considered to be 'smart' and that are used for engineering applications but have yet to find significant applications in textiles are:

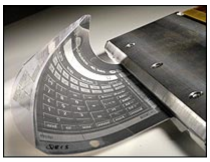
auxetic materials ● magnetostrictive materials ● electrostrictive materials ● electrorheological fluids

Wearable Electronics: www.fibretronic.com ;
Wearable electronics refers to clothing that ranges from fabrics and garments that contain micro-electronic sensors to monitor gather and transmit information on the wearer's health / physical state to garments that enable portable communication and entertainment systems to be incorporated and activated within the garment system.

e-fabrics: contain conductors or connectors; silver is a suitable conductor for e-fabrics. These may be intended for wearable items, furnishings or similar.

e-garments: items that have been enhanced by electronic devices that have been adapted to be incorporated within garment products. The garments incorporate interconnections and controls such as buttons to be able to support the electronic circuitry.

Check out the following:



Washable computer? http://web.media.mit.edu/~rehmi/fabric/index.html

Flexible displays? http://news.bbc.co.uk/1/hi/technology/3506289.stm

Military, medical and industrial sectors are primary application areas for smart materials. Smart materials are being used to enhance the functionality of a product. Consumer products are rapidly increasing in their use of smart materials.

Sports and performance Clothing – Fact Sheet

In the last 20yrs sports clothing has moved into the fashion sector, increasing the size of the market.

The fundamental issues associated with the performance of clothing:

' To ensure that the wearers enjoy a comfortable physiological environment whilst performing outdoor leisure activities for pleasure, competing in team games or at the limits of their sporting ability or challenging themselves and nature in potentially life-threatening, adventurous, pursuits in extremely hostile climate environments.'

Clothing comfort: In order to keep our body comfortable with clothing we need to create Heat Balance.

There are four mechanisms for heat transfer: radiation ● convection ● conduction ● evaporation

Thermal radiation – is the invisible energy that is exchanged between two bodies that are not in contact and have a difference in absolute temperature.

Natural (free) Convection – heat loss occurs whenever fluid (air / water) that is cooler than the body comes into contact with the skin and then moves away. **Forced Convection** – is when the fluid is moving past the skin (wind in air or currents in water) or the body moves through the fluid.

Conduction – is the heat exchanged between the body and surrounding surfaces it is in contact with.

Evaporation – is responsible for up to 30% of heat loss usually by the evaporation of sweat.

Heat Balance – Humans have the ability to maintain 'thermal balance' within certain environmental limits.

Outside of these limits clothing plays a major role in helping the body achieve thermal balance. Its primary function is to insulate the body. Thinsulate™ is an early example of an insulation material whilst PrimaLoft® produced by Albany International is a more recent insulating material.

http://solutions.3m.com/wps/portal/3M/en_US/ThinsulateInsulation/Insulation/ ; www.primaloft.com

Fabrics insulate because of their ability to trap air:
Fibres used for thermal insulation are: wool ● down ● synthetic

Wool – is used in garment construction due to its warmth and resilience.

Down – from the eider duck has excellent thermal insulation properties because of its fineness and large surface area to trap air.

Synthetic – for many years synthetic insulation manufacturers have tried to create materials that duplicate the properties of 'down'. These include:

synthetic wadding's ● textured yarns ● hallow fibres ● micro fibres ● fibre pile ● Polarfleece™

www.buffalosystems.co.uk/ ; www.tog24.com

Thermal insulation is normally specified in units of clo or tog. An instrument used to measure the thermal insulation in a fabric (the thickness and amount of air trapped) is a togmeter.

Wind & Water Resistance:
Wind destroys the insulation by causing the still air trapped to be displaced.
Moisture reduces the insulation of fabrics by invading the space of trapped air and filling them with moisture.
Moisture can enter from the outside (external elements) or from the inside (sweat).

It is important that fabrics are both windproof and waterproof. To do this the fabric needs to be tightly woven or coated and laminated.

Two types of tightly woven waterproof fabrics are: Ventile™ and synthetic low decitex multifilament fabrics.

The different ways of coating or laminating are: wax ● thermoplastic ● impermeable polymer
(Neoprene, silicone, polyurethane and polyester are amongst the most popular of the polymers used.)

The following different types of tests can then be carried out to measure wind and water resistance:
air permeability ● the Bundesmann shower test ● the hydrostatic head test ● the spray rating test

Water Vapour Transmission: www.ploucquet.com
This is for clothing which has to protect against foul weather such as rain and snow whilst allowing perspiration to escape in the form of water vapour. These are known as waterproof breathable fabrics.

The basic requirement is that they allow very small molecules of water moisture vapour to pass through whilst preventing larger size water droplets, for example rain, from penetrating them.

Wicking:
Wicking is the ability of fabrics to transport moisture. Wicking can occur whether a fabric is in a horizontal or vertical plane. As a result of wicking there has been controversy about whether natural fibres or synthetic fibres are most suitable for the clothes next to the skin. Natural fibres have the advantage of higher moisture absorbency than synthetics however their disadvantage is that if the rate of perspiration production greatly exceeds its skin-surface evaporation rate then sweat can accumulate causing discomfort to the wearer. Since synthetic fibres can wick moisture without absorbing it from the skin they are now favoured for functional sportswear.

To further enhance the wicking performance of fabrics double sided fabrics have been developed: the inside is made from a man-made fibre material such as polyamide, polyester or polypropylene, whilst the outside is made from an absorbent staple material such as cotton or modal.

Other techniques use micro fibre yarns or hollow fibres to enable the sweat to evaporate.

Clothing Systems: www.paramo.co.uk ; www.equipuk.com/

Clothing systems are engineered garments comprising of different fabrics to perform specific functions within the garments, or combinations of garments worn together, to try to maintain a comfortable environment for the wearer.

A three layer system is very popular at the moment, which utilises a base layer, an insulating layer and a layer impermeable to wind and rain.

Another type of clothing system has been developed to combat the accumulation of condensation from moisture vapour: by utilising two waterproof breathable fabric layers with an air gap maintained between them (ideally by using a spacer).

Tests which use manikins have been designed to measure and evaluate the performance of clothing systems; however these are limited to external factors. An alternative next stage is to introduce the human variability factor by employing human volunteers to wear garments whilst keeping the climatic conditions controlled. This is done by using temperature and humidity sensors on the body connected to laboratory monitoring equipment.

Sports and Swimwear:

Important issues for athletics wear are: thermal space, degree of contact, moisture + liquid sweat removal by wicking, air permeability, clothing weight, aerodynamics and solar protection.

Because of these factors synthetic fibres particularly polyester, acrylic and polypropylene are now the most widely used for fabrics in athletics clothing.

A ‘multipurpose’ garment for the athlete may be unattainable as sports vary so widely so do the different fabric attributes required for each sport.

Swimwear: Speedo’s Fast Skin swim suit utilizes two types of fabric which manufacturers claim reduces the amount of drag on a swimmers body: Flexskin + Fastskin www.speedofastskin.com/

There is some disagreement between researchers regarding the effectiveness of the designs of swimsuits in improving swimming performance.

Divers’ wetsuits are constructed from neoprene, a closed cell foam made from polychloroprene, since it is hard to compress it is an excellent insulator even when sat on. www.thescubaguide.com/

Protective Head Wear: www.thebmc.co.uk/

Protective helmets are worn in many sports where head injury is considered a risk such as climbing, cycle racing, skiing and ice-sports: the technology used is similar in all cases.

Helmet design criteria can be broken down into two categories: functional and non-functional
Functional characteristics make the helmet ‘work’ and the non-functional ensures that the helmet is used.
The challenge to the designer is to satisfy both criteria

‘it is possible to construct a helmet that will protect from almost any injury but it would be so large, bulky and uncomfortable that nobody would wear it’

All protective helmets consist of a shell and a means of absorbing energy within the shell.
There are two types: the traditional cradle or the modern lightweight which has polystyrene foam.

The high technology fabrics of today are just a glimmer of things to come in the textile industry. This type of forward thinking coupled with visions, ideas and projects for the future are what make Schoeller Switzerland the leader in innovative textiles. www.schoeller-textiles.com/

Drapers / Industrial Trust Booklist compiled by Rose Sinclair- Aug 2009 Suggested KS4, A level , Graduate / Postgraduate	
1. Fabric Science and Fabric Science Swatch book– ninth Edition – by Allen C. Cohen, Ingrid Johnson, Joseph J. Pizzuto	A level/undergrad/post grad
2. Techno Textiles by Braddock and O’Mahoney	KS4/Alevel/graduate
3. Techno Textiles 2 by Braddock and 0’Mahoney	KS4/Alevel/graduate
4. Fashioning Technology-Syuzi Pakhchyan	KS4/Alevel

5. Fashionable Technology by Sabine Seymour	A level /undergrad/post grad
6. Sportstech by Braddock and O'Mahoney	KS4/Alevel/undergrad/postgrad
7. Ultra Materials by George Beylerian and Andrew Dent	Alevel/undergrad/post grad
8 Process- 50 Product Designs from concept to manufacture by Jennifer Hudson	A level/undergrad/post grad
9. Textiles Now by Drusilla Cole	KS4/Alevel /undergrad/postgrad
10. Switch Craft by Alison Lewis	KS4
11. Fashioning the future by Suzanne Lee	A level/undergrad/post grad
12. Manufactured the conspicuous transformation of everyday products	A level/undergrad/post grad
13. Textile Futures Fashion, Design and Technology by Bradley Quinn	Under grad/post grad
14. Extreme Textiles by Mathilda Quaid	KS4/Alevel/undergrad/post grad
15. Switch Craft by Alison Lewis	KS4
16. Fashion Geek by Diana Eng	KS4
17. Memory on Cloth: Shibori Now: Contemporary Shibori Innovations by Yoshiko Wada	A level/undergrad/post grad
18. Nano Materials for architecture by Suzy Lydecker	A level/undergrad/post grad
19. Manufacturing processes for design professionals by Rob Thompson (Thames and Hudson)	Alevel/undergrad/post grad
20. The Plastics Handbook by Chris Lefeteri	KS4/ Alevel

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to download the entry form