the DESIGN MUSEUM

Future Observatory: Tomorrow's Wardrobe

14 September 2024 – 30 August 2025 at the Design Museum

Our clothes are woven into every aspect of our lives, protecting, warming, and defining us. But our clothes are also in crisis. Dominated by a cycle of overproduction and overconsumption, the fashion and textile industry has become one of the most unsustainable design fields in the world: a race to the bottom for the environment, global workers, and the quality of our wardrobes. But it doesn't have to stay this way.

Much of the material waste, air and water pollution, and worker exploitation associated with the fashion industry today is due to **'fast fashion'**, a relatively new phrase generally attributed to a 1989 article in The New York Times. It relies on rapid, cheap production of necessarily low-quality clothing to meet – and feed into – an ever-accelerating trend cycle.

This model dictates how most of us make, buy, use, and dispose of our clothes (in 2014 we bought 60% more garments than in 2000, but kept them half as long) and increasingly other product types. 'Tomorrow's Wardrobe' explores the urgent research and innovation taking place across the UK to imagine a better future for fashion.

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WHAT IS 'SUSTAINABLE'?

The UN's Sustainable Development Goals

Something is sustainable if it can be done the same way for a long time, *"without compromising the ability of future generations to meet their own needs"* (UN, 1987). It broadly covers **environmental** and **social sustainability**, further broken down in the UN's 17 Sustainable Development Goals (**SDGs**).

COURTESY OF THE UN WWW.UN.ORG/SUSTAINABLEDEVELOPMENT/SUSTAINABLE-DEVELOPMENT-GOALS/

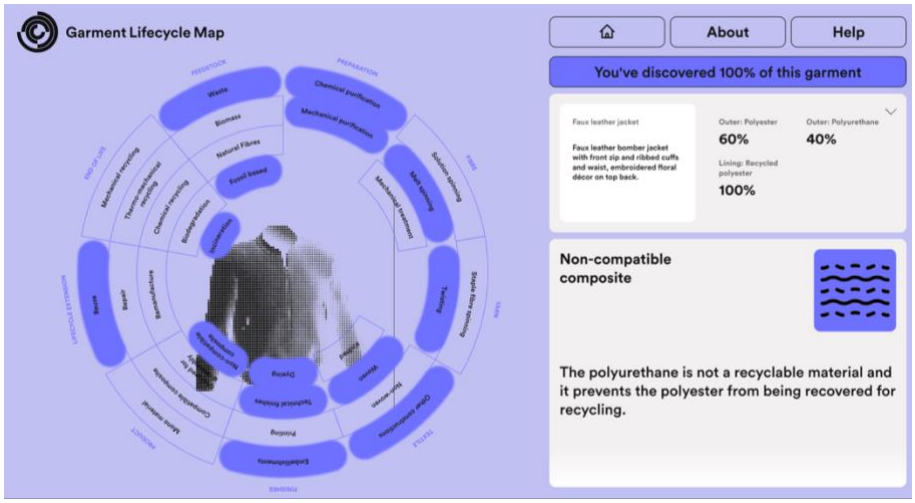
Sometimes brands try to appeal to sustainability-conscious customers without actually being very sustainable: this is called **'greenwashing'**, and an increasing area of activity in UK legislation.

The stages of a life-cycle assessment

One way consumers and designers can evaluate a garment's sustainability is to break down its journey from raw material, to retail context, to the end of its useful life. This is called a **product life-cycle assessment**.

raw materials	• may deplete resources (e.g. water, energy). • may displace or destroy natural habitats. • may be extracted through unethica/forced labour.
manufacture	• may produce harmful waste or pollution. • may occupy limited land. • potentially unsafe working conditions.
transportation	• uses energy. • usually releases pollutants into the atmosphere (particularly air freight).
use	• dependent on the product, but a common issue with garments/textiles is laundering: plastic microfibres may be washed into water systems, and dry-cleaning releases hazardous perchloroethylene (PERC).
end-of-life	• synthetic fibres may degrade into microplastics without biodegrading. • organic materials may emit methane gas due to lack of oxygen in landfill.

These basic stages can be added to or broken down much further, particularly in the fashion industry, which creates products from different materials and moving parts and operates within complex international systems of shipping, workplace legislation and tariffs.



EXPLORE VARIOUS GARMENT LIFE-CYCLES IN VISUAL FORM USING THE GARMENT LIFE-CYCLE MAP, COMMISSIONED BY FUTURE OBSERVATORY TO COINCIDE WITH THE TOMORROW'S WARDROBE DISPLAY: GARMENTLIFECYCLEMAP.COM. RESEARCH & CONCEPT: LAETITIA FORST. DESIGN: ACRE. 2024.

Transparency and activism

Supply and production chains are complicated and can be perhaps deliberately opaque. The EU has mandated that within 5 years all textiles sold within its borders must possess a **'Digital Product Passport' (DPP)** tracing their origins and manufacture. The UK has no such legislation, but some companies provide DPPs voluntarily.

100% ORGANIC COTTON BARREL LEG JEANS FROM NOBODY'S CHILD. QR CODE ON TAG LEADS TO THE JEANS' DPP WHEN SCANNED. OBJECT COURTESY OF: NOBODY'S CHILD. PHOTO: AARON PARSONS. 2024.

There are also grassroots activist movements pushing companies and governments to show more accountability and transparency, from Fashion Revolution's global 'Who Made My Fabric?' campaign in 2020 to community-group 'sew-in'/'street-stitching' protests.

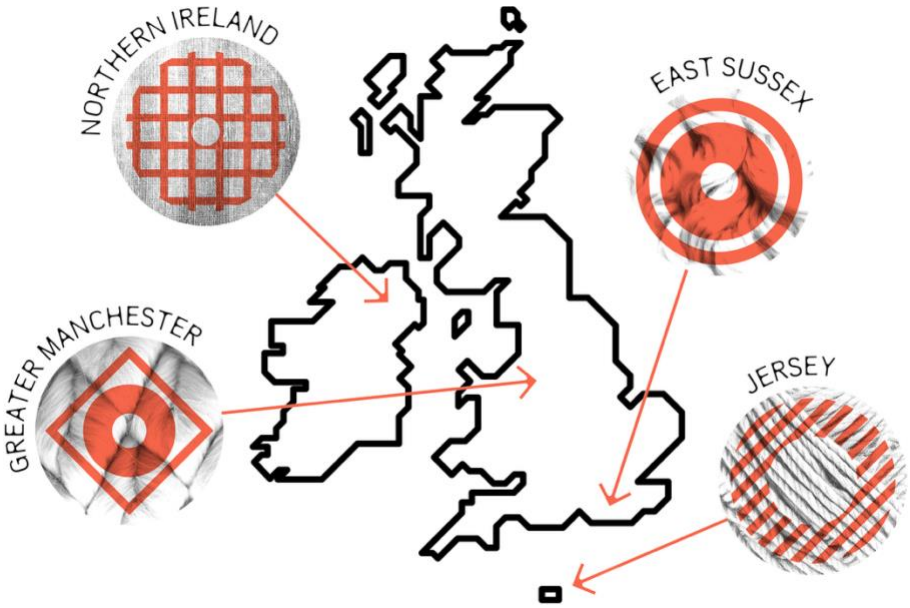
SPREAD FROM FASHION REVOLUTION'S 'WHO MADE MY FABRIC?' CAMPAIGN REPORT, 2021. PART OF THE CAMPAIGN INCLUDED DOWNLOADABLE POSTERS, STILL AVAILABLE ON THEIR WEBSITE: FASHIONREVOLUTION.ORG/WHOMADEMYFABRIC/.

REIMAGINING LOCAL MATERIALS

The UK used to be a global textile hub. The **offshoring** of fabric production since the 1950s created access to huge volumes of cheap clothing, but came with costs including carbon emissions from international freight, toxic manufacturing processes, massively increased waste production, and human exploitation.

Consequently there is an increasing interest in **'onshoring'** or 'reshoring' fabric manufacturing, often turning back to or reimagining traditional methods of production in ways that both **shorten supply chains** and **regenerate landscapes**.

The following pages introduce textile revolutions taking place across the UK, each based on a different local and sustainable material: flax (used to make linen) in Northern Ireland, bulrushes in Greater Manchester, wool 'Fibresheds' in East Sussex (and beyond), and agricultural waste generated by Jersey potato farmers.



2D DESIGN: SPIN.

Home-grown wool

The ‘Fibershed’ (or, in the UK, **‘Fibreshed’**) movement centres **local** labour, dyes and fibres – largely wool. Emphasis is on working with the seasons and land for the good of all its inhabitants, through **regenerative** practices such as recycling waste fleeces into fertiliser.

The name comes from the idea of a ‘watershed’ or drainage basin: a geographical area where all rainfall, surface run-off, groundwater, etc. flow into one body of water.

Fibresheds are inherently small, but there are currently more than 70 across the world including every corner of the UK, from Scotland to South West England.

THERE ARE OVER 60 BRITISH SHEEP BREEDS. CENTURIES-OLD ‘HERITAGE BREEDS’ SUCH AS THE HEBRIDEAN OR WELSH BADGER FACE HAVE ADAPTED OR BEEN SELECTIVELY BRED TO SPECIFIC CONDITIONS OR HABITATS, ALLOWING WOOL TO BE ‘CULTIVATED’ IN HOSTILE LANDSCAPES WHERE FEW LIVESTOCK OR CROPS COULD THRIVE. IMAGES: MALDEN, 1915. BRITISH SHEEP AND SHEPHERDING. FROM THE BIODIVERSITY HERITAGE LIBRARY.

Bringing linen back to Ireland

Linen is a **natural fibre** made from the hardy **flax** plant, which holds up to intensive washing and softens over time. It's one of the oldest textiles in the world and was a core industry in 20th century Ireland. The fabric is often still woven there from fibres cultivated and spun further afield, so it can be sold as higher-value 'Irish linen'.

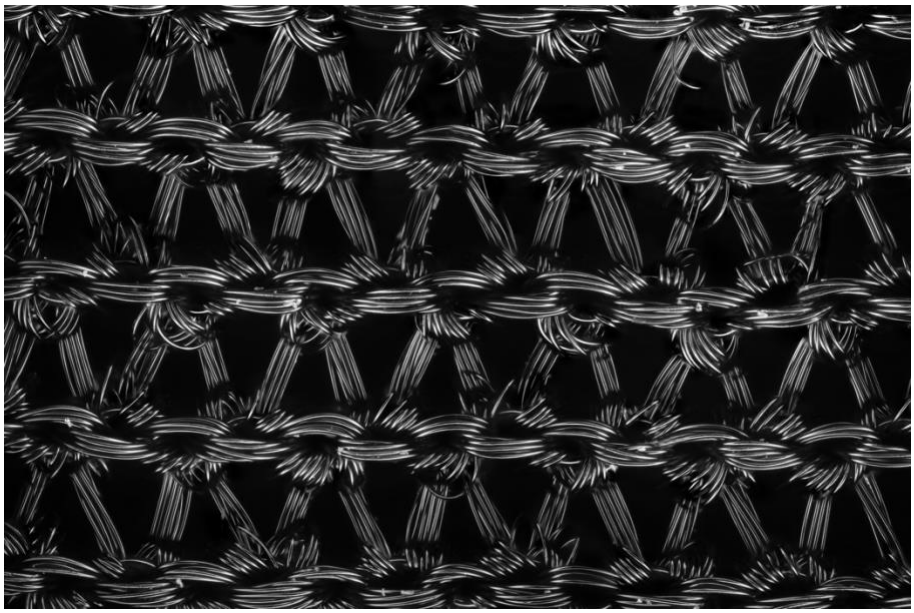
Textile manufacturer Mourne Textiles discovered a collection of industrial spinning machines in a derelict mill back in 2023. They've since been working with researchers at Ulster University to bring flax spinning back to Northern Ireland – using existing equipment to make the whole process even more sustainable!

FLAX PLANT AND LINEN PRODUCTION PROCESS SAMPLES COURTESY OF MOURNE TEXTILES AND MALLEN LINEN (TOP); **VINTAGE IRISH LINEN (**BOTTOM).

Fibres: from natural to manufactured

Linen is a **natural, plant fibre**. Natural fibres (including linen, cotton, wool, and silk) are **biodegradable**, and usually require less energy to produce – although their cultivation can undoubtedly still have negative impacts through massive water consumption, soil degradation, and landfill waste (if not disposed of responsibly).

Most people are also familiar with **synthetic fibres** such as polyester, nylon, and acrylic. These are created from a manufactured or 'synthetic' raw material, generally plastic-based. This raw material is processed into long thin fibres, usually through a process of **extrusion** into thin filament 'threads'. These threads can then be spun, woven, or knitted in the same way people have manipulated natural fibres for millennia.



40-DENIER NYLON STOCKING UNDER A MICROSCOPE, DEMONSTRATING THE SMOOTH UNIFORMITY MANUFACTURED SYNTHETIC FIBRES ARE CAPABLE OF. PHOTO: ALEXANDER KLEPNEV. 2021.

However, there is a third category of 'semi-synthetic' fibre, which is also manufactured through a process of extrusion – but from plant-based raw material. These are called **regenerated cellulosic fibres**, and their main design advantage is that, like wholly synthetic manufactured fibres, they can be manipulated to possess certain **material properties** such as softness, drape, and shine.

As the name suggests, these regenerated fibres are made of plant **cellulose**, usually from trees. The **pulping**, **bleaching**, and extrusion processes necessary to transform solid plant matter into soft fibres can require huge amounts of energy and toxic chemicals.

Nevertheless, regenerated cellulose is generally more sustainable than **first-use** plastic textiles. Its impact can be further lessened through practices such as sourcing cellulose responsibly through responsible, local forestry (like Austrian manufacturer LENZING™); or more radically, by

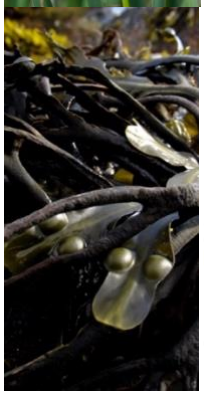
turning to agricultural waste or restorative cultivation/stewardship of existing ecosystems.

COURTESY OF FIBE.

Fibe (fibe.uk) use cellulose sourced from Jersey potato farming by-products which would otherwise be thrown away.

COURTESY OF PONDA.

Manchester-based **Ponda** (ponda.bio) manufacture BioPuff® insulation from *Typha latifolia* (the common bulrush), a fast-growing wetlands reed. By working with local farmers and conservation groups, Ponda are also helping 'rewet' the UK's endangered, carbon-sequestering wetlands.



COURTESY OF SKIN SERIES.

Keel Labs (keellabs.com) and **SKIN SERIES™** make textiles from alginate, a biopolymer found in certain seaweeds. Seaweeds grow rapidly, and underwater cultivation removes issues associated with large-scale land agriculture such as soil erosion, or fertiliser run-off leading to eutrophication.

INNOVATIONS IN THE STUDIO

Many modern-day manufacturing processes are automated, allowing for mass or even **continuous production**, yet garments are still made almost entirely by human beings.

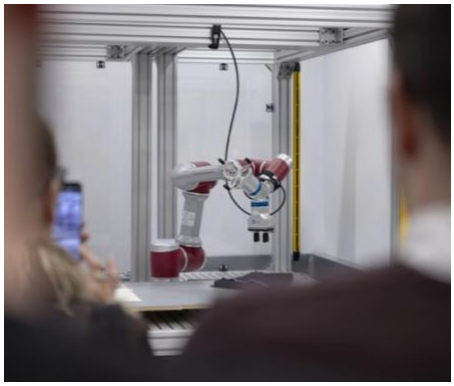
This is partly because **offshoring** to countries with minimal labour rights has kept human factory workers cheaper than any automated alternative, which has in turn resulted in ~90% of the UK's clothing now being imported. As well as the human cost, this drives **carbon emissions** up massively due to the sprawling global supply chain.

Offshoring has also resulted in the decimation of skills and knowledge necessary for garment-making in the UK, which makes any alternative difficult to imagine even if cost-cutting were not most companies' main concern.

Robotics

The Robotics Living Lab (RoLL), based at the Manchester Fashion Institute, is developing a suite of **robotic** garment-making tools, **"end effectors"** – devices that attach to the wrist of a robotic arm – which will perform actions such as cutting, stitching and pressing.

RoLL's hope is that these, in collaboration with new generations of upskilled fashion designers and makers (hence their nickname of **'cobots'** or collaborative robots), may help to revolutionise and revitalise local, ethical, sustainable British fashion design and production.



THE ROBOTICS LIVING LAB'S 'COBOTS' IN ACTION. IMAGES COURTESY OF MANCHESTER METROPOLITAN UNIVERSITY.

Digital tools (and digital toiles)

A **toile** is essentially a fabric **prototype**, generally made from cheaper material and/or without hardware or finishing.

Although integral to the **iterative design process**, toiles are ultimately made to be disposable – and while a physical sample is always advisable before launching full-scale production, **computer-assisted design (CAD)** may offer a way to reduce the number of toiles needed for earlier stages of the design process.

Digitoile is a design and research practice which has created a range of digital tools to aid in this, including:

- Polycam, a 3D scanner app
- ZBrush, a digital sculpting tool
- CLO, a 3D fashion design programme

These allow you to create and share a high-definition digital **model** of a work-in-progress garment without producing physical waste.

Digital tools such as Digitoile (digitoile.co.uk/) could also open up or streamline other creative possibilities, such as options for modelling designs that are **upcycled** (i.e. made from end-of-life or unwanted fabrics and garments), or **modular** to allow for individual **customisation** or end-of-life **disassembly** and recirculation. All of these are potential strategies for a more sustainable fashion industry.

DIGITAL MODEL, PHYSICAL SAMPLE, AND PROCESS VIDEO OF 3D POLY ZIPPED JACKET SAMPLE 1, MADE FROM NYLON AND DESIGNED USING DIGITOILE. 2024. COURTESY OF DIGITOILE.

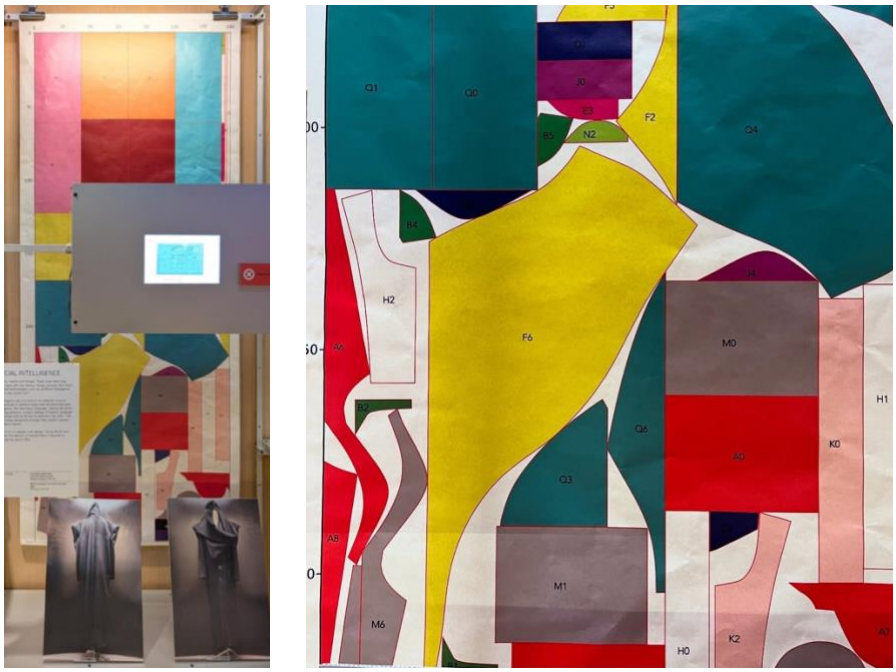
DIGITOILE MAY ALLOW DIGITAL MODELLING OF COMPLEX TEXTILE MANIPULATION SUCH AS DRAPING, WHICH ORDINARILY NEEDS TO BE DONE DIRECTLY ONTO A 3D MANNEQUIN OR HUMAN BEING.

AI

Artificial intelligence involves training machines to perform tasks associated with inductive reasoning and human intelligence: learning languages, making decisions, recognising patterns.

While there are concerns around AI's place in creative industries, its ability to 'think' faster than any human being makes it very useful for certain things.

College of Fashion graduate Eva Yin used an AI tool to develop a **lay-plan** – the way pattern pieces are arranged to be cut out of a rectangle of fabric – with minimal fabric waste, reducing the **offcuts** produced in cutting out a complex coat by nearly 70%.



EVA YIN'S COAT LAY-PLAN, DISPLAYED TO SCALE ON A STANDARD COMMERCIAL WIDTH OF FABRIC, AND IMAGES OF RESULTING COAT (LEFT). LAY-PLAN DETAIL WITH PATTERN-PIECE LABELS VISIBLE (RIGHT). 2024. COURTESY OF EVA YIN.

AND MORE…

We have only covered some of the innovations taking place in the fashion and textile industry right now. There are more options than ever to build a more sustainable wardrobe, whether that's through one of the innovations listed above or by opting to buy fewer or secondhand products in the first place; evaluating available options from larger international brands to pick the most sustainable and 'vote with your wallet'; turning to entirely sustainability-driven brands such as 'eco-uniform' retailer David Luke; **mending** our own clothes with the help of emerging skill-sharing repair cafes, repair services or apps like Save Your Wardrobe; or pushing for legislation such as **extended producer responsibility** laws.

MADE FOR DISASSEMBLY: A SKOR SNEAKER, PRODUCT OF A COLLABORATION BETWEEN LONDON-BASED STUDIO RANRA AND SPORTSWEAR COMPANY SALOMON. HELD TOGETHER WITH TIES AND STITCHES (RATHER THAN GLUES) SO INDIVIDUAL PARTS CAN BE REUSED OR RECYCLED. LEATHER GAITER, CORK SOLE, RECYCLABLE TPU BODY. 2024. COURTESY OF RANRA.

CUSTOMISATION AND MANUFACTURING TO ORDER: MONO MOCC SHOES BY VIVOBAREFOOT, MADE OF 3D PRINTED TPU. ONE OPTION FOR MITIGATING WASTE GENERATED BY OVERPRODUCTION IS TO MANUFACTURE IT ONLY ONCE IT HAS BEEN ORDERED. VIVOBAREFOOT'S 'VIVOBIOME' PROJECT USES 3D SCANNING AND PRINTING TO MAKE SHOES WITH A PERFECT, UNIQUE-TO-EACH-CUSTOMER FIT. 2024. COURTESY OF VIVOBAREFOOT.

UPCYCLING: LONDON-BASED STUDIO AHLUWALIA IS TURNING USED OR UNWANTED FABRICS AND GARMENTS INTO NEW PIECES LIKE THIS POLO SHIRT MADE FROM VINTAGE SPORTS TOPS. AS WELL AS KEEPING FABRICS IN USE AND OUT OF THE LANDFILL FOR LONGER, THIS MAKES A VISIBLE STATEMENT ABOUT THE NEED FOR CHANGING DESIGN AESTHETICS AT THIS TIME OF CLIMATE CRISIS. OBJECT: SAHARA SHORT SLEEVE POLO. 2024. AHLUWALIA. UPCYCLED VINTAGE SPORTS TOPS. COURTESY OF THE DESIGN MUSEUM COLLECTION.

REPAIR: WHETHER IT'S INVISIBLE, SUBTLE SWISS DARNS ON A MOTH-EATEN JUMPER OR 'VISIBLE MENDING' SUCH AS JAPANESE SASHIKO AND BORO-STYLE PATCHWORK, EXTENDING A GARMENT'S LIFE-CYCLE REDUCES THE NEED TO PRODUCE AND PURCHASE MORE, AND KEEPS CLOTHES OUT OF LANDFILL. CLOTHING BRAND TOAST'S 'CIRCLE' SUSTAINABILITY SCHEME INCLUDES A FREE REPAIR SERVICE FOR TOAST PRODUCTS. IMAGE: DETAIL OF 'TOAST RENEWED' NEAT WOOL KNIT TANK WITH VISIBLE MENDING. 2024. WOOL. COURTESY OF TOAST.

PROVOCATIONS

- Pick a favourite garment from your own wardrobe and try some or all of the following tasks with it.
    - **Analyse the garment.** Consider: how does it need to be laundered? How many pieces of fabric and/or other components (buttons, zips, elastic, etc.) is it made up of? Does it contain different fibres? If so can they be separated for recycling (blended fibres e.g. 'polycotton' are virtually impossible to recycle)? Does it have any obvious areas of wear and tear? Consider why specific choices were made by the original designer (e.g. functionality, sustainability, cost, aesthetic) and what you might change.
    - **Find the garment in the Garment Life-Cycle Map or try researching and plotting out your own.** How does it score on a sustainability scale, and which areas does it do better/worse in?
    - **Try designing a more sustainable alternative to the garment,** which you would still like and wear as much as this one. Sketch and annotate it.
- Can you think of a fashion marketing campaign (maybe a bus billboard, magazine ad, or sponsored post on Instagram) based on sustainability? **Find the brand on ethicalconsumer.org/directory.goodonyou.eco, and consider how the information you find aligns with – or is glossed over by – their marketing** (e.g. have they deliberately emphasised one thing while ignoring another, or used specific words which sound more promising/concrete than they really are?).
- *[Conduct under adult supervision in a well-ventilated area if using heat].* **Source waste fabric scraps from home, with which you can plan and conduct a series of experiments** (if fibre content or original fabric use is known, you can start with hypothesising about which scraps will have certain properties). For example…

  wash and dry under different conditions | apply heat with an iron | conduct a 'burn test' on a tiny piece | measure stretch per cm²

  Can you spot patterns amongst certain fibre types, or between knit vs. woven fabrics? What properties do you think make a fabric best for certain use cases? What trade-offs might be made and why?

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