Leather without skin

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Abstract:
For thousands of years, leather has been the obvious material to make shoes of. However, since mass-production of shoes started in the second half of the 19th century, the industry has been looking for materials that are much easier and cheaper to produce. Recently the motivation to replace leather by other materials, has changed into sustainability. Raising animals for food and leather requires huge amounts of food, pastureland, water, and fossil fuels. Turning skin into leather requires massive amounts of energy and dangerous chemicals, for instance mineral salts, formaldehyde, various oils, dyes and finishes. In search of innovative materials to replace animal skins for the purpose of shoe production, all kinds of materials are being developed. Strangely enough the names of these new materials often refer to 'leather', while there's no animal skin involved. This paper will discuss some of these new materials such as bio-fabricated collagens, fruit leathers, jellyfish leathers and Flyleather and how they compare to genuine leather.

Contents:

Introduction

For thousands of years, leather has been the obvious material to make shoes of. However, since mass-production of shoes started in the second half of the 19th century, the industry has been looking for materials that are much easier and cheaper to produce. Recently the motivation to replace leather by other materials, has changed into sustainability. In search of innovative materials to replace animal skins for the purpose of shoe production, all kinds of materials are being developed. Strangely enough the names of these new materials often refer to 'leather', while there's no animal skin involved. What kind of materials are these bio fabricated collagens, fruit leathers, jellyfish leathers and Fly leather and how do they compare to genuine leather?

1. Genuine leather

Genuine leather is made of animal skin that has been treated with a tannin derived from a plant or tree, a mineral or fat. The collagen fibres, which form the basic material of each skin, contain a lot of water. By tanning, all this water is replaced by the tannin molecules in order to prevent the skin from decay. As a result the skin transforms into a durable, water resistant, water repellent and flexible material which can be finished in every conceivable way and used in products we are dealing with every day.

A huge disadvantage of leather is the environmental impact of the leather industry. Raising animals for food and leather requires huge amounts of food, pastureland, water, and fossil fuels. Turning skin into leather requires massive amounts of energy and dangerous chemicals, for instance mineral salts, formaldehyde, various oils, dyes and finishes.

Because of the need to reduce the carbon footprint of products that are traditionally made of leather, all over the world scientists, artists and designers are exploring the possibilities of developing sustainable innovative materials that have the look and feel of genuine leather. A goal that, due to the incomparable characteristics of genuine leather, is not very easy to achieve.

2. Animal-based leather-like materials

Flyleather by Nike

Some of the new materials are just like leather based on animal products. For instance Nike's self-named super material Flyleather which is actually made of leather scraps. The leather is collected from the tannery floors and combined with synthetic fibres and fabrics. Thereafter the material goes through a finishing process before being put on a roll to be cut. This material is said to consist of at least 50% recycled leather fibres. Obviously, it's a bonded leather and it doesn't have the same abilities as leather because of the loss of the strong collagen binding that defines genuine leather.

Nevertheless Nike's vice president of footwear innovation, Tony Bignell, claims that this material 'completely mimics athletic pigmented full-grain leathers in everything from fit to touch'! Nike also claims that Flyleather has a much lower environmental impact although it's made of leather and textile waste, which still has to be produced even before Flyleather can be manufactured.

Zoa by Modern Meadow

A very interesting new material is called ZOA. Biotech company Modern Meadows has been working for a number of years to create a bio-fabricated synthetic material that may be an alternative to leather. Like leather the material consists of collagen, protein and other ingredients found in animal skins and is said to have traditional leather aspects like suppleness and breathability. The material is manufactured by using DNA editing tools to engineer specialised collagen producing yeast cells. The brilliant thing about Zoa, is that there's no need to grow and kill an animal for it. The material grows itself so all you need is a little bit of animal collagen and some time.

You can even influence the way it grows and connect it seamlessly to another material during the process. Unfortunately it still needs to be tanned afterwards, because like all animal materials, it tends to decay when not properly preserved.

Figure 1: T-shirt seamlessly connected to in-grown Zoa ©ModernMeadow

Medusa-Project by Dutch artist Charlotte van Alem

However strange it may sound, also jellyfish may provide a leather-replacing material. Dutch artist Charlotte van Alem has found a way to turn washed-up jellyfish into a material that is suitable to produce shoes of. Inspired by the growing number of dead Jellyfish in the Baltic Sea, Charlotte initiated this project to explore the possibility of creating a new environmental-friendly material.

The technique used to preserve the jellyfish is based on ancient techniques for making parchment. This involves washing, salting, tanning, layering, dying and finally pressing or sewing the different layers together. Only natural additives are being used.

In collaboration with Dutch shoe designer Liesel Swart, Charlotte developed a jellyfish based material suitable for manufacturing footwear. The material consists of multiple layers tempered, dyed and pressed jellyfish. The material is reasonably strong, quite flexible and has a leathery texture and a paper-like feel. And as may be expected from a jellyfish; the material is water-repellent! However, due to the current intensity of the production process, it may take quite a long time before the Jellyfish material will be available for the shoe industry.

Figure 2: Water shoe made of Jellyfish bells by Charlotte van Alem ©David Meulenbeld

3. Bio-based leather-like materials

Mushroom 'leather'

Fungi are not only very nutritious but have turned out to be a very interesting material for manufacturing all kinds of products. Belgian designer Kristel Peters is working with fungus as a basic material for shoes. One of her projects is growing shoes from mycelium. Mycelium is the vegetative part of a fungus or fungus-like bacterial colony, consisting of a mass of branching, thread-like hyphae. These fungal threads are growing on organic materials containing a large amount of cellulose and on several nutrients like coffee grounds, malt or sugar. The hyphae form a three-dimensional network that is optimized to extract nutrients from the surrounding medium for further growth.

Figure 3: Alice, a 3D-modular shoe by Kristel Peters, ©Kristel Peters, www.shoedesigner.be

Under optimal conditions, mycelium can grow very fast. Within two months, a sheet with the surface of a mature bovine skin can be obtained. The material itself, also referred to as Myco-leather, is very strong, either flexible or solid, easy to dye and can be moulded into any desired shape while growing. It’s also non-toxic and when grown in the desired shape it doesn’t yield any production residues.

Figure 4: A shoe made of MuSkin, ©Kristel Peters, www.shoedesigner.be

Another material made from Fungi is called MuSkin, a contraction of the words Mushroom and skin. MuSkin is made of the fruit body of the Phellinus Ellipsoideus, a kind of parasitic fungus that grows in the wild and attacks trees in the subtropical forests. Once extracted, the material is treated in a similar way to animal leather but with completely natural techniques. These include using eco-friendly products such as eco-wax, which adds special characteristics to the material. It is breathable, water-repellent and non-toxic. It could be a suitable alternative to manufacture products that come into contact with the skin, because it's supposed not to trigger any allergic reactions. Unfortunately at this moment the material is not strong enough to be used in footwear. The shoes on this picture are only samples and cannot actually be worn.

Fruit ‘leathers’

Figure 5: Mango leather shoe © Dutch Leather and Shoe Museum

Mangos are the most popular fruit in the world. By 45 million tons of this tropical fruit are produced every year. Not all that fruit makes it to the consumer, leaving tons and tons of overripe fruit to be destroyed. Rotterdam based company Fruit Leather uses the left-over mango’s to produce a leather imitating material. At the beginning of the production process the pits are tasks out of the rotten mango's after which the latter are mashed several times to obtain a smooth puree with the right consistency. The puree then is being cooked together with a binding agent. Slow-cooking the mango prevents fermentation and kills any bacteria in the fruit. After much moisture is cooked out the mass needs to be dried. The mango paste is equally spread out on glass trays and treated in a dehydrator until the sheets only contain 20% of their original moisture. Finally, the sheets have to be finished to make them water-resistant. In this form the material can be used to make shoes of but the material has to be further developed because it tends to rip when it's being pulled around a last.

There are several other leather-imitating materials deriving from fruit or fruit-processing industries like Skinned Banana, Malai and Piñatex. Skinned Banana is a project by Dutch product designer and shoemaker Lotte de Boer. She used the skins of the also very popular banana to make her version of fruit leather. According to her research, about 11 million m^2 of skinned banana material could be made of all the peels that we throw away in the Netherlands every year!

Figure 6: Skinned Banana footwear by Lotte de Boer ©Lotte de Boer

Unfortunately also the Skinned banana material is not usable for everyday use yet: there's some work left to be done on the water-resistance of the material because it starts to 'melt' when in contact with water.

Figure 7: Gold bag made of Piñatex ©Taikka

Piñatex is made of pineapple leaves which are basically a by-product of the pineapple harvest. Technically it's a nonwoven textile but because of its characteristics and its appearance it's often referred to as pineapple leather. Pineapple fibres are extremely strong. The application possibilities range from clothing, shoes and upholstery to wigs and V-belts for, for example, conveyor belts. They can also serve as reinforcement for concrete.

The final material I'd like to mention, is Malai. Malai is a bio-composite material entirely made of organic and bacterial cellulose, grown on agricultural waste, sourced from the coconut industry in Southern India. Waste water produced by local farmers is used to feed the bacteria's cellulose production, instead of being dumped. 4000 litres equals the production of 320 m2 of Malai. The material is said to feel comparable to leather or paper, though these are quite different materials, it is water-resistant and it doesn't cause any allergies or intolerances. A range of colours is available, achieved by the use of natural dyes, free of dye fixatives. Just like Mycelium, Malai can grow into three-dimensional objects using a moulding technique.

Figure 8: Products made of Malai - Photo's by Marie Bartosova, courtesy of Malai Design & Materials

Conclusion

So what's the conclusion of all this? First of all, all leather-imitating materials mentioned in this paper, except for Fly leather, have nothing to do with genuine leather. The natural qualities of this unique material are very difficult to copy. Obviously that's why it has been used for thousands of years and still hasn't been replaced. Nevertheless, our demand for leather and leather goods is a great concern and all initiatives to come to a material that is less environmentally harmful as leather must be encouraged.

Secondly, an increasing number of materials is mistakenly indicated by the term leather. In museum collections this could lead to storage problems and unnecessary damage to objects or even to sub-collections. It is therefore important that we are aware of the fact that leather is not a protected term and that it also can be used to describe materials from a very different origin than animal skin.

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