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Designing for the Circular Economy

TRASH-2-CASH (T2C)
EU-funded research project (2015–2018) utilising zero-value waste textiles and fibres with design-driven technologies to create high-quality products. Pioneering a whole new way of developing materials.

WWW.TRASH2CASHPROJECT.EU

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Dyed cotton recycled with the Ioncell-F process and transformed into new fibres by Eugenia Smirnova and Aalto CHEM Ioncell team.

Design is moving towards a new more systemic understanding and knowledge in the circular economy is emerging. A circular economy approach aims to close material loops and therefore all products should be designed to have multiple life cycles. After the first use phase, the product will continue in technical or biological cycles, meaning redesigning and remanufacturing or composting. While garments and textiles include many harmful chemicals, and further composting causes methane, which contributes to greater greenhouse gas emissions and global warming[1], priority in closing the loop should be in a technical cycle with textile and fashion products.

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In a circular economy all materials flow in the system and even waste is seen as a valuable material source, but for this to happen this needs new knowledge in material recovering processes. We have to challenge current design principles and use new natural or recycled elements as a basis for product design in the future. This text presents some new ideas on how to design in a circular economy context. The presented design examples come from research projects Trash-2-Cash (T2C) and DWoC. The T2C project's (2015–2018) aim is to transform waste materials (cotton, cellulose, polyester and blends) into high quality textile fibres. Paper waste or cardboard waste can also be used to produce high quality textile material. This can be done with the novel Ioncell-F method. Using cardboard and paper is a smart choice, not only because we are utilising waste, but also because in their production fewer chemicals and less energy are used than in making pure, virgin birch cellulose[2].

The following design examples show that we need new understanding and design strategies on how to design in a circular economy context and how to use all materials and even use colours in a new way in the recycling and material recovering processes.

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In a circular economy all materials flow in the system and even waste is seen as a valuable material source.

Natural Lignin as a design element

Cellulose has been used in making fibres for over a hundred years, but other compounds of wood may also enter the field of fashion in future. The recently developed Ioncell-F process enables the production of textile fibres from a mix of cellulose and Lignin, and this seems to be a promising method for the chemical recycling of textiles. Using lignin for fibres not only increases the value of this abundant natural resource, but also opens interesting opportunities for design in a circular economy context. Lignin enables the bringing of colour to textiles without any additional dyes. Due to the brown colour of lignin, using varying amounts on fibres creates a range of natural brown hues[3]. By combining these hues, e.g. through knitting or weaving, it is possible to make patterned garments that originate entirely from wood. This could be a benefit in recycling, since fibre recyclers will know exactly what is in the material, instead of having to guess from amongst the estimated 27,000 commercial dyes currently on the market[4]. Using lignin instead of petrochemical dyes would also be one way towards having completely biodegradable textile materials.

Textile waste is a valuable raw material. Illustration by Eugenia Smirnova.

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Lignin can find its way into textiles via several routes. Either it is added prior to fibre spinning, or it comes as part of the raw material, such as in recycled cardboard. From the design point of view lignin gives the possibility of communicating the origin of man-made cellulose fibres in a visual and intuitive way [3]. Brown from the birch, or khaki from cardboard could be used as aesthetical eco-statements in design.

Recycled colour as a design element

Knitted trials showing the potential of lignin in textiles. The dark brown knit has 15% lignin; the light brown is made of recycled cardboard. The patterned knit has no added dyes, just cellulose and lignin.

The increase in the amount of textile waste makes it worthwhile to use this waste stream as a source for new fibre production. But what happens with the chemicals inside the textile material as part of the recycling process? In a circular economy system these other compounds should also be suitable for recycling and this suitability also concerns colours. Normally, in the textile industry, the start point is always with bleached and white fibre or yarn, which is then dyed according to certain recipes to end up with a precise colour.

In the Ioncell-F process it is possible to recycle the textile materials and the textile colours. We have tested this with different textile dyes and the first results show that some colours are more reliable and stable in this process than others [5]. Both post-consumer textiles and pre-consumer textile waste could be used in this process. If pre-consumer waste is used (waste material collected from textile factories) the dye type is known while if the post-consumer waste (old, used textiles) is used, the dye type can vary and the end result is uncertain.

Different design paths could be developed if colours are to be recycled in the future. Firstly we could limit the used colour types in the original textile material. We would only use those colours, which are stable in colour and shade within the recycling process. A global system would be constructed where all dyed material could be easily tracked and managed and the where the colour result after remanufacturing could be predicted. The other approach accepts a change in colour in the remanufacturing process. Here all textile waste could be used without knowing the original dye type in the material. Textile waste could be mixed to end up with an approximate shade and further processed as a fibre. The design process could start e.g. after

Textile source materials (rectangle pieces), optic pulp sheets of average colour (round pieces), remanufactured fibres in the upper part of the picture.

old textile material has been manufactured as a new fibre, which then has a certain colour. Fibres with a colour could be further mixed with each other while making a yarn, which ends up with a melange effect. They could also be dyed later so as to end up with new shades. In this kind of system, end colours might not be so accurate and therefore more tolerance for different colour shades would be needed from both industrial manufacturers and consumers[5].

New approaches are needed on many levels

These examples show that in the future technical and system level innovation will not be enough to create the circular economy. New design approaches and design strategies need to be created which will use all waste materials, chemicals and colours in a more appreciative and creative way. Design within an industrial system will need to be more flexible to be able to use all waste sources in the manufacturing process even if the design outcome has more variation than it would today. Currently, even small changes in the colour shade are understood as poor quality and this kind of product is easily discarded in quality control, while in the future, the circular economy context may demand new norms for colour shade variability in industrial design and production.

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IONCELL-F
is a new spinning technology developed in Finland based on research performed at Aalto University and University of Helsinki. The process belongs to the so called Lyocell-type spinning category and allows for the production of cellulosic fibers with excellent mechanical properties. The heart of the process is a novel solvent that allows to spin cellulose and other biopolymers into filaments to be used for textile and mechanical applications (e.g. composite materials). It is a closed-loop process which avoids the use of toxic chemicals and generates no waste and is thus fully in line with an envisioned concept of circular and sustainable economy.

WWW.IONCELL.FI

Woven Ioncell-F fabric produced from birch and printed by Marimekko 2016.