

CIRCULAR TRANSITIONS

A Mistra Future Fashion
Conference on
Textile Design and
the Circular Economy

23 – 24 November 2016
Chelsea College of Arts
& Tate Britain,
London

ual: university
of the arts
london



Index

- 2 Schedule Day 1
- 3 Schedule Day 2

- 6 Welcome to our Circular World

- 11 A word from Mistra Future Fashion

- 12 The Future of:
Mistra Future Fashion Phase 2
Circular Design at UAL

- 14 Materials
- 17 Models
- 20 Mindsets

- 23 Evening Programme

- 26 Session 1 Design and User Engagement
- 30 Session 2 Finishing and 3D Technologies
- 33 Session 3 Repair and Models for ReUse

- 36 Session 4 Design Driven Material Innovation
Interdisciplinary Research

- 39 Session 5 Production Technologies
- 42 Session 6 Lifecycle Thinking for Design

- 46 Concluding Keynote

- 47 Acknowledgements
- 48 Conference Venues

Day 1 Tate Britain

8.45am	Registration	Dr Jen Ballie (Glasgow School of Art, UK) et al.
9.30am	Phil Hadridge, Nigel Carrington, Sigrid Barnekow Welcome	Re-Mantle and Make: the role of maker spaces in empowering a new wave of circular thinking for textile designers
10am	Dr Kate Goldsworthy, Prof Rebecca Earley Introduction	
10.20am	<u>Materials</u> — Keynote 15 Cyndi Rhoades Worn Again	3.20pm <u>Mindsets</u> — Keynote 21 Elin Larsson Filippa K
10.50am	Tea and coffee break	3.50pm Tea and coffee break
11.20am	<u>Materials</u> — Session 16 Eugenia Smirnova (Aalto Arts) Colours in a Circular Economy Dr Rosie Hornbuckle (University of the Arts London, UK) Exploring the Application of Design Knowledge and Skills for the Circular Economy Beyond Materials Selection and Design for Production	4.20pm <u>Mindsets</u> — Session 22 Dr Amy Twigger Holroyd (Nottingham Trent University, UK) Shifting Perceptions: the reknit revolution Prof Rebecca Earley (UAL, UK) Whole Circles
12.20pm	<u>Models</u> — Keynote 18 Sophie Thomas Thomas Matthews	5.20pm Phil Hadridge Day 1, Round-up
12.50pm	Lunch break	<hr/> Evening Chelsea College of Arts 23
1.50pm	<u>Models</u> — Session 19 Jennifer Whitty (Massey University, NZ) Operating in the Third Space; the Space Between	6pm Red Room Drinks reception and exhibition launch
		7pm Banqueting Hall Conference dinner

Day 2 Chelsea College of Arts

Banqueting Hall

Red Room

Green Room

9am	Phil Hadridge, Prof Rebecca Earley and Dr Kate Goldsworthy Introduction	
9.30am	<u>Session 1</u> — Design and User Engagement 26 Marium Durrani (Aalto University, Finland) et al. Shared Emotional Values in Sustainable Clothing Design Approaches Rachael Taylor (Southampton Solent University, UK) Designing Alternative Economies to Create Cultures of Sustainability Monica Buchan-Ng (UK) Weave Your Economy: speculative economic design Jade Whitson-Smith (University of Huddersfield, UK) A Dematerialised Approach to Sustainable Fashion Design Dr Emma Dulcie Rigby (University of the Arts London, UK) Mundane Matters: laundry, design and sustainability	<u>Session 2</u> — Finishing and 3D Technologies 30 Kirstie Burn (Edinburgh Napier University, UK) et al. An Exploration of the Sustainable and Aesthetic Possibilities of 3D Printing onto Textiles as an Alternative to Traditional Surface Decoration Dr Laura Morgan (Loughborough University, UK) et al. Laser Moulding for Textiles: supporting sustainability in design and manufacture Emma Grain (University of Huddersfield, UK) A Closed Loop Model for 3D Printing Fashion Dr Karen Shah (University of Huddersfield, UK) A Space of Waste

Day 2 (continued)

	Banqueting Hall	Red Room	Green Room
10.50am	Viewing: Posters	Exhibition & Roundtable Session: Materials	Tea and coffee break
11.30am	Session 3 — Design Driven Material Innovation Interdisciplinary Research 33 Marjaana Tanttú et al. (Aalto University, Finland) Can Design-Driven Material Innovation Approach also Drive Circularity? Kate Goldsworthy (UAL, UK) et al. Towards a Quantified Design Process: Bridging Design and Lifecycle Assessment Dr Dawn Ellams (UAL, UK) Designing Cycles: an interdisciplinary approach to coloured fashion & textiles Miriam Ribul (UAL, UK), Hanna de la Motte (SP Technical Research Institute, Sweden) The Material Affinity of Design and Science for a Circular Economy		Session 4 — Repair and Models for ReUse 36 Bridget Harvey (University of the Arts London, UK) RepairAbility Through Repair Thinking Emmeline Child (UAL & University of Northampton, UK) Developing Models for Successful Upscaled Upcycling of Fashion Andre West, Sanjaykumar Patil (North Carolina State University, USA) The Creation of Made to Measure Recycled Garments Alexandra Kiki Lo (UK) Visibly Mended by Design
12.50pm	Viewing: Posters	Exhibition & Roundtable Session: Models	Lunch break
1.50pm	Session 5 — Production Technologies 39 Dr Anne Prah (concept+design, UK) Design for Circularity: material innovation for wearable technology Prof Marie O'Mahony (OCAD University, Canada), Dr Alison Gwilt (Sheffield Hallam University, UK) Where Does Wearable Technology Fit in the Circular Economy? Dr Dawn Ellams (University of the Arts London, UK), Nick Morley (Faering, UK) Digital Denim by Design Dr Manju Sugathan (Nottingham Trent University, UK) The Design of a Speciality Hand Knitting Yarn using Appropriate Technology		Session 6 — Lifecycle Thinking for Design 42 Yuval Etzioni and Ziv Neeman (Shenkar College of Engineering, Design and Art, Israel) A Sustainability Textile Design Course as a Transformative Process Sara Li-Chou Han et al. (Manchester Metropolitan University, UK) Whole Systems Thinking for Circular Economy Design Practice Karen Marie Hasling (Design School Kolding, Denmark) Using a 'Five Perspectives of Sustainable Design' Model Dr Jen Ballie et al. (Glasgow School of Art, UK) Material Futures: Crafting Circular Conversations
3.10pm	Viewing: Posters	Exhibition & Roundtable Session: Mindsets	Tea and coffee break
3.40pm	Ed Van Hinte 46 Concluding Keynote and Panel Discussion		
4.40pm	Day 2, Round-up		

Welcome to our Circular World

The idea for Circular Transitions has emerged from research with roots as far back as 1996 here at the University of the Arts London. Since that time researchers with Textiles Environment Design (TED) have been working to address the role of the designer in closing the loop on textile materials. From projects like *Particle Fabrics* (2002–2003), the AHRC-funded *Ever & Again: Rethinking Recycled Textiles* (2005–2009) through to our current research with *Mistra Future Fashion* (2011–2019) and our EU project *Trash-2-Cash* (2015–2018), we are continuing to explore all things circular relating to the fashion and textiles industry from a myriad of perspectives.

The conference agenda proposes and critiques new perspectives, in this rapidly growing field, by dividing its structure between three broad themes. These three interconnected themes emerged from our *Mistra Future Fashion* research, which frames sustainable fashion textile design in a new way: material, product and process innovation; social, systemic and economic concepts; and the self and shifting mindsets and habits. We present these here as *Designing to Change Material Systems, Social Models and The Self and Mindsets*.

To get to this point in time we have been on an incredible journey and we would like to mark this moment by reflecting on some of the highlights along this path.

Mistra Future Fashion and Sustainable Design Practices

In 2010 a Swedish funding call by *Mistra* asked 'How can sustainable design processes be created and embedded within companies and gain the participation of consumers?' Our project proposal recognised the overwhelming opportunity for sustainability in the fashion industries situated in connected thinking at all stages of the 'cradle to cradle' environment.

At that time sustainable textile designers tended to deal with isolated problems in a piecemeal way. A designer would often choose to upcycle, use natural dyes, or source organic cotton, and this became their 'thing'. Around this their aesthetic developed, and the designer considered that this was their chosen path to more sustainable fashion and textile design. TED researchers wanted to support and accelerate a more holistic approach

to sustainable design – a multifaceted approach that could lead to greater innovation, environmental improvement and also market advantage.

From prior experience of working with other companies the team at TED believed that textile and fashion designers needed to be trained to think and create within a full framework of sustainable design concepts. They should be able to combine complex technical techniques together with new materials, processes and product design ideas to improve the use and disposal potential of the product. To embed these design strategies into companies, sophisticated professional training programmes were needed: ones which are both highly creative, encouraging new connected thinking that leads to sustainable design innovations, and which enable the company to evaluate their design thinking, finding ways to make use of the innovative ideas quickly and economically. The result was *The TEN*, a set of design strategies in the form of cards, designed as a framework for thinking through and mapping sustainability issues. We use these ten strategies to inform and inspire our work.

Moving towards a Circular Approach

The researchers developed an informative, accessible and inspiring course, which used lifecycle understanding and design thinking approaches. Participants of the course were asked to evolve innovative concepts for the design, and disposal, of fashion and textiles. Case study research, informed by discussions at stakeholder companies like H&M, enabled the team to design and build a toolbox for delivering professional training programmes and educational experiences to designers and teams in companies of all scales.

Workshops asked participants to reflect on and evaluate existing fashion products, and to propose ideas to improve them. At H&M the development and testing of new hands-on tools led to an improvement in daily decision-making around sustainable design of up to 7%. Product redesign outcomes, created using a pre and post Higg Index score, varied from 1% to an impressive 41% improvement; with the most significant changes being made in creating recyclable garments using recycled fabrics.

TED researchers also explored new design concepts – through internal team workshops and practical experimentation – creating more future-focused briefs. The online and touring exhibition demonstrated how designing fashion and textile prototypes could enable us to better understand the industry and cultural potential for systemic change. The resulting ten prototypes demonstrated new roles for fashion textile designers in industry contexts and understanding the importance of individual values and the self. The more socially focused research produced new insights for design practice around strategy, models and tools; specifically seeking transformation through workshop facilitation approaches and hands-on making.

→ www.textiletoolbox.com

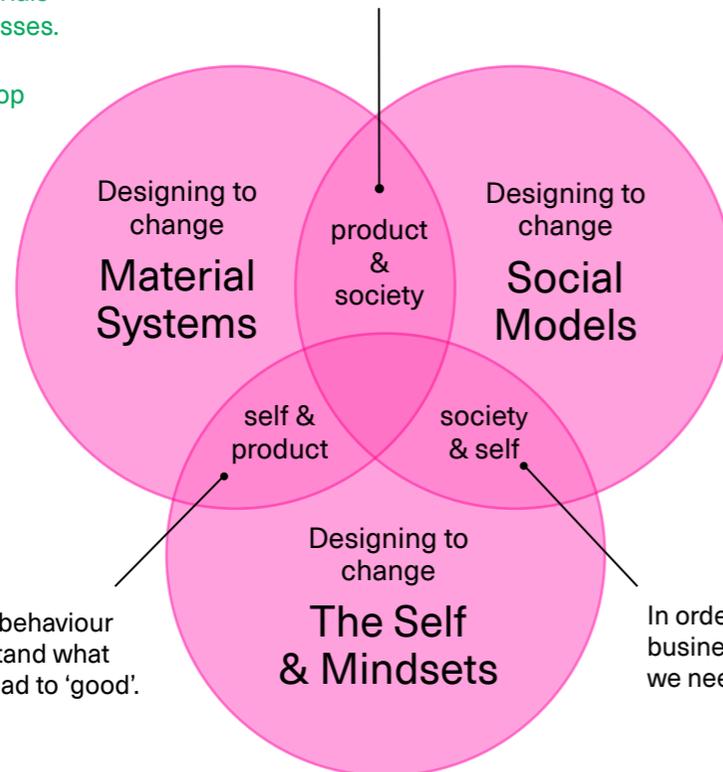
Transforming Industry

Designing within current industrial and economic systems. The circular economy. Improving and intervening with materials and production processes. Recycling, upcycling, low toxicity, closed loop

New Business Models

Designing for new business models and social systems (fashion libraries, collaborative consumption, ethical production, local communities)

In order to transform industry we need to develop business and material systems in tandem.



In order to change behaviour we need to understand what material systems lead to 'good'.

In order to apply new business models we need behaviour change.

Changing Behaviour

Designing to change mindsets and culture, activist approaches and mindful 'user behaviour'. Institutional change and 'embeddedness'. Encouraging inner knowledge, reflexivity, altruism, empathy

Materials, Models and Mindsets

These three themes emerged from our reflection on the textile toolbox concepts. They demonstrate a varied and layered approach to designing for circularity which can act at all levels of industry and society and with different driving forces. They encompass all aspects of design as we see it and celebrate the material, relational and personal challenges which need to be solved in order to achieve our circular goals.

It is no accident that all three of our Day 1 keynotes are from industry. The circular economy will not function without collaboration across disciplinary divides. Science, industry, design, policy making and consumers must work together to solve this 'wicked problem', a value that runs right through the core of our programme.

Materials

In this theme we explore design to create change through new industrial and economically viable systems which respond to *material, technology, and scientific developments*. Papers and exhibits in this theme will look at challenges and benefits of new modes of production, opportunities for cleaner processes in the textile materials value chain and the potential for digital processes to enable a circular economy.

Ten years ago it was often cited that 'innovation in the textile recycling industry has been halted for the last 200 years'. This is certainly not the case today. There are numerous exciting technologies emerging in the 'space race' to a viable and superior chemical recycling process. It will soon be possible not only to recapture valuable synthetic materials which get lost after an all too short useful life, but to also regenerate natural cellulosic fibres from cotton waste and multiply the benefits across the entire fibre spectrum. Our keynote speaker in this section, Cyndi Rhoades (Worn Again) is at the forefront of this emerging technology and will lead us on a journey into the future of fibre regeneration.

Models

In Models we explore design to evolve new *Systemic Models* through manufacturing, services, networks and communities. New business models and tools, cradle-to-cradle thinking, and projects which explore speeds and appropriate design are all vital to this approach. Collaboration is essential to drive the circular model and this in itself can be a challenge. What are the tensions between our traditional modes of competition and collaboration? Can we create more social equity within the circular supply chain? What opportunities are there for designers to bridge understanding of scientific tools such as environmental assessment?

Our keynote speaker here is Sophie Thomas (Thomas Matthews). Her revolutionary project the Great Recovery (RSA) paved the way for designers to engage with the challenges of waste and opportunities of a circular economy through their 'teardown' workshops and observations. In brokering new dialogues between designers, suppliers and the waste industries there is potential to instigate new collaborations for innovation around end-of-life.

The Great Recovery project recommended that 'designers be bolder and broader' and become 'systems thinkers'. They should reset their definition of beauty to encompass the whole circular life of the materials and processes within their product and design out waste.

Mindsets

In Mindsets we explore design to change *behaviour* to shape new habits, attitudes, beliefs, frameworks and experiences. We present ideas for facilitating collaboration across disciplines, pioneering and enabling the changing role of the designer in a circular economy. How can design contribute towards well-being that develops circular cultures? We consider how both designers and end users need to be conscious of their decision-making and how design can support this.

We are thrilled to welcome our third keynote speaker Elin Larsson (Filippa K) here as a pioneer in the sustainable fashion world. The Filippa K vision is 'fashion where sustainability is the guide to growth'. They take ecosystems and planetary boundaries as inspiration. Their vision for a circular fashion future is inspirational, to adopt circular business models and become part of the circular economy. They also encourage users to curate a 'smaller but smarter wardrobe', one that lasts over time, is well taken care of and updated in new ways through second-hand, swapping, lending and rental services which ultimately link in to fibre recycling at end-of-use.

On behalf of the whole UAL and Mistra Future Fashion teams behind this conference, we welcome you to this event, and wish you a great circular design future.

Dr Kate Goldsworthy (Chair of Academic Committee)

Kate is Reader in Circular Textile Design at University of the Arts London, where she is a lead researcher in TED, at the Textile Futures Research Centre (TFRC). She leads the multidisciplinary Design Theme of the research consortium Mistra Future Fashion (2015–2019) and is also a researcher on the EU Horizon 2020 project, Trash-2-Cash. Kate's approach is practice-based, always placing making at its core; she works to bridge materials sciences and design through the production of design artefacts and models. Her new Laser Finishing process, developed during her doctorate, enables fully closed-loop recycling of polyester fibres at end of life, and has been exhibited internationally. Her most recent commission for the Museum of Modern Art Boston was acquisitioned for their permanent collection. She is currently a member of the EPSRC Forum in Manufacturing Research, and was named by *The Guardian* as one of their top ten circular economy experts in 2015.

Prof Rebecca Earley (Chair of Organising Committee)

Rebecca is Chair of Sustainable Textile Design at University of the Arts London. She divides her working life between Chelsea College of Arts where she is a researcher in TED, Central Saint Martins where she is Director of the Textile Futures Research Centre (TFRC), and SP in Sweden, where she is part of the research consortium Mistra Future Fashion and the EU Horizon 2020 project, Trash-2-Cash. Rebecca's approach is research-informed practice which encompasses making materials and prototypes, writing, and exhibition curation. She is also a skilled workshop facilitator and communicator, focused on the translation of cross disciplinary design-led research into commercial and cultural contexts. She is currently a judge for the Global Change Award for the H&M Foundation, and was previously nominated as a Great Briton in 2006 for her contribution to the field of sustainable fashion textiles.

A Word from...

Sigrid Barnekow

Director, Mistra Future Fashion

Mistra Future Fashion is a research programme that, uniquely, holds a systems perspective. The vision is to close the loop in fashion and clothing – enabling systemic change, and leading to a sustainable development of the industry and society. The programme aims to deliver insights and solutions that will be used by stakeholders to significantly improve environmental performance and strengthen global competitiveness.

The research focus is on the circular economy, and how to enable today's linear industry to transform into a circular one. To achieve this the cross-disciplinary programme is organised into four themes:

1 How can we design for a circular economy?

By understanding the environmental potential of short-life vs long-life garments, and finding the most suitable choices for the transformation into a textile circular economy for different types of fashion speeds.

2 How to stimulate a more circular supply chain?

Identifying necessary actions in textile and garment supply chains that will enable a circular economy, and gaining better knowledge about what fibres and processes are most sustainable.

3 How can users contribute to a more sustainable fashion?

Recommending policies that encourage sustainable consumer behaviour, and achieving an increased degree of services for extended life of garments, reuse, and second-hand consumption.

4 How to increase textile recycling?

Developing knowledge on recycling methods and impacts of post-consumer textiles to provide guidance on necessary steps to enable sustainable textile recycling.

To ensure a dynamic and robust relationship between the research community and practitioners working in or with the fashion industry, the programme consists of an extensive consortium of relevant parties. Over 40 research and industry partners have jointly engaged since 2011 with a total budget of SEK 110 million. Mistra Future Fashion is initiated and funded by Mistra, The Foundation for Strategic Environmental Research, and coordinated by SP Technical Research Institute of Sweden.

Mistra Future Fashion Phase 2

So what next?

As we move into the final phase of our research we are exploring circularity in new ways based on the insights we have gained so far.

Insight 1: Circular can be fast or slow

When we examined the results of the first phase of the project – where we explored ten approaches to designing for circularity – we noticed something intriguing. As expected, most of the approaches were looking at ways to extend the use phase of the product (in both physical and emotional durability strategies) whilst three of the prototypes had little or no reference to product longevity and were rather concerned with easing the flow of materials back around the lifecycle, creating garments which were designed for a particular material-recovery technique or even intervened with the material at the actual point of recovery itself.

Insight 2: Context is everything

Another important factor is the ‘context’ of the garment and appropriate choices based on specific ‘archetypes’. Not all garments are the same and what makes sense for a basic white t-shirt may not be equally beneficial in the design of a coat, a piece of underwear or a hospital gown. In closer examination of the scientific (LCA) results we could see that impacts across all stages of the lifecycle are very different for these different product archetypes and there simply isn’t a solution which would suit all equally.

Insight 3: Circular Speeds inter-relate to ALL areas of a product’s lifecycle

When we look more closely at time and speeds across the whole lifecycle of a product we can see that it can apply to all of its lifecycle stages, not just production and use as is usually the case. The seemingly opposing ideas of extending the

lifecycle against reducing it are more connected through the nature of the cycle. Often it might simply push the impacts from one part of the cycle to another ... for instance if the materials needed to create a durable product are more impactful in production or if the laundry requirements of a longer-lasting product are more impactful ... and if the materials are ultimately not closed-loop (or recoverable at a high level) then the difference between a long-life product and a short-life one may not be that dramatic in real terms. For example, if you keep something for a long time and never wear it, you are likely to be buying more items to plug that gap in your wardrobe anyway.

Insight 4: There are trade-offs between durability and recyclability

There are often trade-offs between designing for durability and recyclability which make it difficult to choose one over the other ... some items require functionality which automatically increases impacts in other parts of the lifecycle, be it energy in material production to produce a hardwearing fabric or fibre mixes to achieve a low-laundry solution or even use of chemicals for ultimate advantage.

During 2017 we will be again exploring these ideas through a series of design concepts and prototypes. We are working closely with material and environmental scientists within the Mistra Future Fashion programme as well as embedding our research within industry through an exciting ‘design researcher in residence’ project to be launched in 2017. This dual approach aims to deliver actionable ideas for industry alongside our academic results and offer new insights to the field of circular fashion. The final work will be exhibited in 2018.

Dr Kate Goldsworthy,
University of the Arts London

Circular Design at UAL

At UAL the need for design research to inform and support the local agenda, as well as make significant global impacts, underpins the shift for TED / TFRC researchers towards a focus on circularity. This conference marks the beginning of a new era – our own *circular transition* – through the development of a Circular Design research group at Chelsea College of Arts, UAL. The skills and interests of TED’s Circular Design researchers, and the community it supports, align with all four elements of the university’s Research Strategy for 2015–2022.

Living with Environmental Change: through creative practice increasing understanding of environmental change, communicating the issues and designing for new business models, social innovations and sustainable living. Using design to reduce waste and to change producer and consumer behaviours.

Circular Design is staffed by creative, practising design researchers all working towards closing the loop across a multitude of contexts. Waste as a resource is at the heart of CD and collaboration and communication is the in-house expertise on offer.

Lifelong Health and Wellbeing: designing for people’s lifelong economic, social and health impact, in order to maximise societal gains and minimise issues of dependency, isolation and inequality.

Circular Design projects are conducted in collaboration with other institutions and disciplines – for example, social scientists at Copenhagen Business School – which enable the design researchers to understand how circular design can promote social and economic benefits.

Digital Futures: exploring through practice how technology affects lives, changes the way society interacts and impacts on communities, cultural production, future society and economic growth.

Circular Design researchers work at the forefront of technology development, collaborating with scientists, material researchers and institutions across Europe on concepts to improve the design and production of new materials – for example short life materials with Innventia in Stockholm – the way in which people use goods during the lifespan, and technology to aid recovery of resources.

Community Resilience: using art and design to support communities in understanding how to develop innovative and sustainable solutions to the issues they face, through co-design, co-creation, socially responsive practices and social entrepreneurship.

Circular Design researchers are concerned with how circular design can create new opportunities for people. This is not just about material flows – it’s about making sure that what we make is needed and desired by people, through processes that involve them from the outset, so that they will play a part in improving use and recovery of goods in a way that benefits their immediate community. In other words, CD researchers are interested in the way in which circular design can improve people’s lives.

Prof Rebecca Earley,
University of the Arts London

Materials

3 Material and production processes

2 Designing within current industrial and economic systems

5 Improving and intervening with upcycling, low toxicity, closed loop

4 Recycling, the circular economy

> Cyndi Rhoades > Keynote

> Worn Again is questioning if textile waste has value, how do we capture that value and how do we design waste out of the picture altogether

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>> Think about a new kind of resource which has been designed to be reused again and again...and the term 'waste' suddenly takes on a new meaning

>

>>> I'm convinced that we all need to go closed-loop or wear nothing, because one day we are not going to have a choice.

1 Transforming Industry

Meet Cyndi Rhoades, Founding Director of Worn Again

Cyndi is the founder / CEO of Worn Again and has led the business from its early 'upcycling' days to its focus as a technology innovation company. With a vision to eradicate textile waste, she has worked on a series of ground breaking products and projects with world leading designers and global brands, including Virgin Atlantic, Eurostar, Virgin Balloon Flights, M&S and most recently, a collaboration with H&M and Kering's Sports and Lifestyles brand, Puma. In addition to activating circular economies Cyndi is also passionate about canal boating and car boot sales.

What are you working on at the moment?

We are in development of a textile to textile recycling technology that can recapture polyester and cotton from end-of-use textiles to be reintroduced into the beginning of the supply chain as new. The technology will provide a crucial enabler for the industry to transition to a circular resource model.

What is the one thing that you will share at the conference that people haven't heard before?

I'll be talking about how a new generation of technologies that have the potential to transform the way we produce and consume clothing – forever. And how this technology is set to achieve the biggest technological advance the industry has seen since the Industrial Revolution.

Tell us about one thing that you are excited to bring back from the conference?

Information and inspiration to share with our team and to inform our developments.

Eugenia Smirnova, Elina Ilén, Herbert Sixta,
Michael Hummel, Prof Kirsi Niinimäki
(Aalto Arts, Finland)

Colours in a Circular Economy

A circular economy is an industrial system that is restorative or regenerative by intention and design. In a circular economy approach it is necessary to develop processes to design textiles that are easy to recycle. All existing textiles exhibit some colour whether it is achieved by the means of dyeing or being the textile's own natural colour. At a time when worldwide textile flow is at its highest and new technologies of textile remanufacturing are introduced, one of the issues faced by developers will be the presence of finishes and dyes in the textiles. The presence of colour in a disposable textile might be seen at the same time as a burden or design-wise as a possible asset in remanufacturing. Through colour design, previous dye work applied to the disposable textile could be utilised as such and manifest in the remanufactured fibre as an attractive design element.

This paper reports on preliminary results on the recycling of coloured cellulose-based textiles using a novel dry-jet wet spinning denoted as the loncell-F process. The objective of the research pilot is to study the stability and possible modifications of colours during the dissolution and regeneration processes with the intention to avoid dye stripping and further dyeing of recycled fibres. This is essential knowledge for a textile industry that aims to transform its practices towards circularity. The practical possibility of colour circulation is useful knowledge for colour designers in the industry. The findings can help define further parameters for circular economy products.

Dr Rosie Hornbuckle
(University of the Arts London, UK)

What else do we know? Exploring the Application of Design Knowledge and Skills for the Circular Economy Beyond Materials Selection and Design for Production

It has been suggested that designers could play a significant role in the circular economy; it is estimated that 80 to 90% of a product's lifecycle impacts are decided during the design phase. Yet the implications of this statement – that designers have the power to make sustainable choices – is far from the reality of mainstream design practice. Moreover, there has been an awakening in recent years in the field of design research to the idea that designers can take on a number of roles other than the traditional narrow focus on products, evident in the emergence of 'co-design'.

This paper draws on existing research to explore new ways of applying design knowledge in the circular economy, and in particular in relation to the development of materials. Early observations from the current EU H2020 Trash-2-Cash project have added new insights to current understanding on how design knowledge and skills can be applied and developed within a consortium project. The synthesis of this research is presented as *three ways that designers have been seen to apply their knowledge to positively influence materials used in the circular economy*: Experiential knowledge of materials and the social context; Materials translation and project interpretation; and Design tools and methods: visualisations to support the collaboration.

The paper concludes that these are just a few of the ways that designers could contribute to materials circularity beyond their traditional role of 'design for production'; opportunities for designers to act towards material circularity need to be identified and design roles clearly communicated in a collaborative context.

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Models

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Designing for new business models
and systemic models collaborative
consumption, ethical social systems
(fashion libraries, production,
local communities).
>

> Sophie Thomas > Keynote

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If you want to design for a circular system, you cannot
design on your own, you cannot produce on your own'

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'Waste has to redefine itself for a circular world'

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>'We are designing things that we can't take apart.

We are >very good at making objects that are desirable but
we are not thinking about end of life'

>

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>

Meet Sophie Thomas, Founding Director of Thomas Matthews

Graphic and communication designer Sophie Thomas has been working in the fields of sustainable design and material process for over 15 years. She is the Founding Director of Thomas Matthews and Director of Circular Economy at the RSA. Her long term interest in sustainability and materials has led her to share her experience of closed-loop thinking with other designers, and in 2012 she founded The Great Recovery, a programme to build capacity and understanding of circular design in the materials supply chain through practical exploration.

What are you working on at the moment?

I have gone back into my communication design practice and am beginning to work with businesses who want to 'be circular' but are unsure how to start and what it actually means.

I am also developing ideas around how designers can develop Ocean Friendly Design, specifically tackling marine plastic through active programmes.

Both these pieces are continuing my conviction that *seeing is believing* and the way to learn this stuff can be kicked off through kinaesthetic learning. As Great Recovery participant Rich Gilbert said: you can read blogs and reports all you like, but you will never forget the smell of a landfill site.

What will you share at the conference that people haven't heard before?

I will be sharing the developed methodology of how you can design a circular business and how to understand which of the circular design models you should be designing to. We have been developing the circular economy edition of the double diamond.

Tell us about what you are excited to bring back from the conference?

For me it's all about people, their projects and research and networking. When I meet a bright spark with a 'crazy but it might just work' idea I get very excited and go through my mental rotadex to see who I can connect them with.

Jennifer Whitty (Massey University, NZ)

Operating in the Third Space; the Space Between

Space Between is a social enterprise / research platform at the College of Creative Arts in Massey University founded in April 2015 which enables students, recent graduates and fashion researchers to work together with a shared philosophy to bring about 'positive change' in industry. It works according to two distinct but complementary strategies to design with the textile waste from the current system and to ultimately eliminate waste from industry by design in 'closed loop' solutions. Space Between aims to design out textile waste by initially using redundant corporate clothing (and other waste material) and design in closed-loop solutions to eliminate the creation of waste from the outset through services, education and research.

Space Between explores a new green business model (Niinimaki 2013) for fashion design, which acts as a platform for social innovation and enterprise. Working in conjunction with the not-for-profit and private sectors, it takes the form of design-led activism as described by Alastair Fuad – Luke (2009) and Von Busch (2012). It adopts new systems thinking (Niinimaki 2013) with an agenda to address issues of waste and bring about 'positive change' in industry.

Space Between proposes a new social dimension for design practice, social development and for increased societal participation in the design process. It is oriented towards addressing sustainability issues such as resource depletion, consumption and production. It asks whether we can find a sustainable balance (Niinimaki 2013) between the design, manufacturing and consumption of garments by reducing the speed, volume and impacts of 'waste-ready' global consumerism by examining the product-service system to transforming negative consumption and production patterns.

Dr Jen Ballie, Dr Paul Smith, Dr Lynn-Sayers McHattie (Glasgow School of Art, UK)

Re-Mantle and Make: the role of maker spaces in empowering a new wave of circular thinking for textile designers

We live in a 'throwaway and replace' culture; our growing population and demand for new products has placed huge pressures on our planet's resources. As a result industries such as textiles, e.g. fashion, apparel, interiors and manufacturing, are experiencing raw material shortages and resource price increases. To address this complex problem, the Scottish Government recently announced a £70 million fund with the aim of catalysing new and innovative approaches to design, fostering repair and reuse and encouraging service and leasing models for material recovery, with the premise of fostering innovation to support closed-loop innovation.

Currently, there are limited practical examples and it is unknown if it is truly possible to implement close-the-loop innovation and on what scale. This paper will discuss how we might expand upon the role, skills and capabilities of the textile designer to equip them to operate within a circular economy. Through a review of 'Re-mantle and Make', is an exploratory approach for repurposing textile waste within Scotland. This approach utilises Maker Spaces as local hubs to experiment with new processes, provide support and educate designers and citizens alike around sustainable design and build up material awareness with the aim of reducing the rapid replacement of textile artefacts.

This paper will position a range of novel methods alongside a series of sustainable design strategies to explore a future scenario that equips emerging designers to utilise waste in a productive way and adopt design approaches that support systemic change to encourage a circular economy model. This is alongside making recommendations for further research to consider how industry, higher education (HE) and academia might collaborate with Maker Spaces in the future to enable a more considered circular approach to textile design.

Mindsets

...

Designing to change mindsets and culture, activist approaches and mindful 'user behaviour'. Institutional change and 'embeddedness'. Encouraging inner knowledge, reflexivity, altruism, empathy.

> > > ...

Elin Larsson. . . . Keynote

. . . .

We realised we needed to start from within. We needed to question our normal way of doing things, to step out of the routine and the regular process.

. . . .

. . . . Our ambition is to design a circular mindset where anything goes and materials can be reused and recycled.

. . . Going forward, it doesn't matter from what company you come from, if you haven't transformed, you will not be able to do business. You need to change. The ones who don't shift won't survive.

. . . .
. . . .
. . . .

Meet Elin Larsson Sustainability Director at Filippa K

Elin Larsson has been Sustainability Director at Filippa K since 2011, and has worked in many roles for the company since 1996: from Sales Coordinator, Project Leader, Sales Support Manager, Logistics Manager to Supply Chain Director. Elin is driven by a passion for finding sustainable solutions for business and society, as well creating change together with people in the whole ecosystem of our industry. She has worked a lot with developing and implementing overall strategies for the company. She studied Sustainable Transition (the relationships between economic, political and environmental crises) at Jönköping University in Sweden.

What are you working on at the moment?

Testing out new business models together with my colleagues to define a more stable and diverse business model in line with circular economy and the planetary boundaries, a model that can take us into the emerging future where completely new conditions, rules and expectations set the game. We are still in the beginning of our journey and we have a long way to go, but we are highly motivated and determined to succeed. Our industry needs to change. Either you choose to ignore that or you become part of the transformation and that is what we have chosen.

What will you share at the conference that people haven't heard before?

We are on a mission, a mission to help our users build a sustainable and curated wardrobe. We believe one crucial aspect to succeed with that, is for us to adapt to the circular economy. I will share with you how our initiatives are connected and guide us into trying out new business models and solutions.

Tell us about what you are excited to bring back from the conference?

It is a big system change that is needed. We are looking for meetings and seminars where we are able to expand the limits of what we think is possible. We want to get inspiration for new solutions and ideas on how to transform. We all need to work together and to create new connections to the ecosystem in order to drive change. All of this is what I hope to bring back.

Dr Amy Twigger Holroyd
(Nottingham Trent University, UK)

Shifting Perceptions: the reknit revolution

This paper discusses an ongoing initiative that seeks to encourage hand knitters to expand their craft practices to encompass reknitting: reworking existing knitted items using knit-based skills, techniques and knowledge. This activity offers potential benefits in terms of promoting repair and re-use by individual users within the domestic sphere, thereby contributing to the constellation of initiatives that, together, will build a circular economy. The 'domestic circular economy' provides an important opportunity to extend product life and delay the need for more energy-intensive processes of re-use, remanufacture and recycling.

Following a recent resurgence of interest in making clothes at home, a significant community of knitters have the skills required to rework existing garments. Yet a range of barriers currently discourage this community from contemplating reknitting projects, including a lack of awareness that it is possible to knit without 'knitting new'. A pilot project demonstrated that skilled knitters can be encouraged to engage with reknitting, but that support is needed to help makers to shift their perceptions of what is both possible and desirable.

Analysis of the support provided in the pilot project identified three interconnected elements: *inspiration, information and confirmation*. All three are needed to help knitters to embark upon and to accomplish reknitting projects in the home, and will need to be constructed at a larger scale if reknitting is to gain in popularity. Furthermore, this research suggests that these three elements will be crucial to any initiative seeking to promote activity within the 'domestic circular economy'.

Prof Rebecca Earley
(University of the Arts London, UK)

Whole Circles

This paper reflects on the experience of a textile designer – the director of a university Research Centre – to identify insights to support design leadership. The work of the researchers at the Centre focuses on practice-based textile design research for the circular economy.

New leadership approaches are needed to plan future material loops and cyclability; new processes and systems are needed which will require textile designers to embrace a range of expanded roles. To understand and prepare for these roles designers need to consider leadership. The opportunity here is for progressive leadership approaches from industry to be applied to academic design research units, so that they can create the systemic change the textile industry requires (LeJeune 2016).

The conceptual model *Attributes of High-Performing Research Units* (HEFCE 2015) puts people in the middle of the model surrounded by strong leadership, culture and values. Collaboration, networks, strategy, funding and institutional and departmental practices are also seen as key. Inspired by this model, the author has written about building the Centre and delivering circular fashion textile projects, within a five-year timeframe. In seeking to describe and systematically analyse personal experience in order to understand cultural experience (Bochner & Ellis 1992: 165–172), the author used Ayelet Baron's seven signposts (Baron 2016) and seven questions to frame a reflective, auto-ethnographic study. From this study and subsequent mapping of insights against the HEFCE concept, the author presents a revised model for design research leadership in the circular economy.

6–7pm

As we finish our Day 1 discussions at the Tate, conference attendees are invited to attend the Private View of *Making Circles*, an exhibition curated by Prof Rebecca Earley and Dr Kate Goldsworthy.

7.30–10pm

The Gala Dinner menu has been specially created for guests to a brief of local, organic, vegetarian and vegan dishes. The centre-pieces for the tables have been created by dipping charity shop finds in paint, arranged with local and seasonal foliage historically related to the Millbank site.

Professor David Cross, Pro Vice-Chancellor of Chelsea, Camberwell and Wimbledon, will welcome dinner guests to Chelsea and the film trailer marking TED's 20 years in research – Reverse Forward – will be screened.

Professor David Crow

Pro Vice-Chancellor and Head of Colleges for Camberwell, Chelsea and Wimbledon Colleges of Arts

David Crow studied Communication Design at Manchester Metropolitan University. He subsequently worked as a designer in London for Assorted iMaGes and as Art Director for Island Records before running his own consultancy. As a freelance designer he worked for clients in the cultural sector including Rolling Stones Records, Virgin Records, Phonogram and the Royal Shakespeare Company. He then moved into academia as Head of the Department of Graphic Arts at Liverpool John Moores University. Before joining UAL David was Pro Vice-Chancellor and Dean of Manchester School of Art at Manchester Metropolitan University. Amongst his achievements there, he reclaimed the heritage of the School – one of the UK's oldest providers of creative education – after its identity had been subsumed for a generation as the university's Faculty of Art and Design. He also led the recent prize-winning redevelopment of the School's buildings.

After dinner, Orsola de Castro will speak about her personal journey through the creative circles of upcycling label From Somewhere, to the curator's role at Esthetica, and her recent efforts with Fashion Revolution.

Orsola de Castro

Co-Founder, Fashion Revolution

Orsola is a pioneer and internationally recognised opinion leader in sustainable fashion. In 1997 she founded From Somewhere, a label designing clothes made entirely from pre-consumer waste. The label combined sustainable thinking with fashion-forward design, bringing quality and craftsmanship to 'exquisite rubbish'. From Somewhere collaborations include Jigsaw, Tesco, Speedo, and four best selling capsule collections for Topshop from 2012 to 2014. In 2006, she co-founded the British Fashion Council pioneering initiative Esthetica – London Fashion Week's showcase for labels designing sustainably: ethics and aesthetics combined – which she curated until 2014. In 2013, with Carry Somers, she founded Fashion Revolution, marking the disaster in Dhaka, Bangladesh on 24 April 2013 when the Rana Plaza factory collapsed killing and injuring thousands of workers. Raising public awareness of the continuing social and environmental catastrophes in our global fashion supply chains, Fashion Revolution has become a global campaign with participation in over 90 countries around the world.

Session 1

Design and User Engagement

Chair

Dr Lucy Norris

UCL and UAL Visiting Fellow, London

Marium Durrani, Prof Kirsi Niinimäki
(Aalto University, Finland); Louise Ravnløkke
(Design School Kolding, Denmark)

Shared Emotional Values in Sustainable Clothing Design Approaches

Recent sustainable initiatives in fashion companies are framing design practices that challenge the traditional role of clothing designers. This preliminary study aims to open discussion on challenging traditional clothing design, through an exploration of the shared (emotional) values between user and designers, when designing for longevity. Alternative practices, such as these, have resulted in the flow and sharing of aesthetically and ethically driven emotional values between users and designers.

This paper aims to explore the implications of these values in relation to clothing life spans. Additionally, the study tries to understand the design challenges that arise when such sustainable initiatives are put into practice. We propose to look through the lens of two sustainable clothing design approaches. In doing so, two case studies are presented, each illustrating a separate production approach (zero waste design and production on demand) underuse by small-scale fashion companies, which both adopt to user involvement. Thus, the objective of the paper is to draw attention towards the overlapping of values brought on through novel approaches in designing for garment longevity.

Rachael Taylor
(Southampton Solent University, UK)

Designing Alternative Economies to Create Cultures of Sustainability

At present, designers create new innovations and sustainability to fit within unchanging systems based upon profit and growth. Design decisions ripple out to circulate within society, affecting the whole framework. Even if ideas are radical or sustainable, sitting within the same system weakens their impact. The aim of this paper is to re-define what design could become when not based solely within the current economic system of profit and growth, and to highlight how designers can utilise alternative forms of economics and engage with post-consumer mindsets. These alternatives include: collaborative consumption's movement for sharing, renting and swapping, use of virtual currencies, hashtags as payment, communities of exchange in repair culture and crowd sourcing.

Discussion will draw attention to how alternatives can encourage sustainable narratives and choices, as practical and digital opportunities that re-invent buying and selling. Whilst connecting communities to participate and engage with alternative economies and consumption of fashion, as interventions that enable designers' and users' ways to create cultures of sustainability. This paper illustrates the inter-connecting relationship of combined alternatives which are visually represented in a circular diagram as the 'ripple effect'.

The interconnecting circles are interpreted as exchange values, sharing and giving networks, meaningful relationships and experiences. The 'ripple effect' concept emphasises the need to embed alternative mindsets of economies and consumption into the design process and sustainable outcomes; to reveal how circular ripples can avoid fixing ideas, instead enabling evolvement through use and moving contexts to create sustainable opportunities in everyday life.

Monica Buchan-Ng (UK)

Weave Your Economy: speculative economic design

This paper explores the term 'economy' within the context of future textile design, calling on designers to consider how they would change economic structures to create an economy of their own. It argues that designers are particularly placed to do this, from skills in synthesis, interdisciplinarity, and dissemination, to the scope and proximity of design production.

It follows three strands: designing a preferable future, designing a speculative future, and designing within an existing alternative worldview. Case studies including Pearce and Turner's Circular Economy (1990), Fletcher's Craft of Use (2016), Dunne and Raby's Speculative Design (2011), Papanek's Design for the Real World (1984), and traditional Māori circular economies, are analysed as examples of each method.

From these strands a single framework is built, offering textile designers a process by which to design their own economy. Based on their dissatisfactions with existing systems and the changes they would see implemented, it asks them to create an economy for the future. This is tested to produce the author's own version: a fictional system that becomes both an alternative possibility and a structure to design and create within, one driven by circular sustainability and ethics rather than the profit motive.

The paper aims to give agency to textile designers over economics both as a discipline and a system, moving it from an insurmountable, esoteric structure into a medium that can be questioned, played with, experimented on, improved, and – most importantly – is able to be changed.

Jade Whitson-Smith
(University of Huddersfield, UK)

A Dematerialised Approach to Sustainable Fashion Design

It is increasingly important for all disciplines to consider their impact on the environment; fashion design is no exception, as garment consumption behaviour has significant environmental impacts. Initially, efforts into making the fashion industry more sustainable were focused on the impacts of material production. More recently, lifecycle thinking has grown in prevalence, and there is an increasing awareness of the environmental impacts that occur at other phases in a garment's life.

Fashion designers have begun to work with a range of design approaches to changing the impacts of the garment lifecycle. Many of these approaches attempt to influence consumer behaviour; examples include design for durability, design for modularity, and design for reuse. These approaches often rely on designing and making new garments, rather than working with existing garments. There is an estimated £89 billion worth of clothing in the collective British wardrobe, providing a significant opportunity to rethink how consumers behave with their existing garments.

The role of the fashion designer could be developed beyond material garment design, and their skills and influence could be applied to dematerialised approaches. Research into post-purchase garment behaviour suggests that a dematerialised approach could have a more significant impact on consumer behaviour than material-focused sustainable garment design.

Dr Emma Dulcie Rigby
(University of the Arts London, UK)

Mundane Matters: laundry, design and sustainability

Clothes laundry is known to be a highly resource demanding and polluting domestic activity. As a collective practice it annually uses massive quantities of finite resources such as energy and water, and in the process contributes towards greenhouse gas emissions, global warming and climate change (Bain et al. 2009). A growing body of research also recognises laundry as the source of wide scale microfibre pollution in oceans and other aquatic environments across the globe (Browne et al. 2011). However, many approaches to reducing impacts from laundry do not recognise the diverse range of reasons why laundry is carried out.

This paper draws on a subset of findings from a yearlong laundry study which surveyed the use and laundry of sixteen garments to ascertain the relationship between garment design and laundry behaviour. It reveals some of the hidden dynamics present within laundry practices and reconsiders the role of design in relation to these dynamics. In doing so this paper focuses on design-based opportunities for reorganising laundry practices in support of more resource efficient and circular economies.

The findings evidence that laundry behaviours are complex and unpredictable, and often not directly linked to producing cleaner clothes. Laundry routines are underpinned by social factors including: reconstructions of cleanliness, social sensitivity, garment aesthetic and longevity, perception, knowledge and understanding of fibre types.

This paper invites discussion around the significance of the social in design-based research and its part in developing methodologies for design in support of more circular economies.

Session 2

Finishing and 3D Technologies

Chair

Prof Marie O'Mahony
OCAD University, Canada

Kirstie Burn, Dr Samantha Vettese Forster
(Edinburgh Napier University, UK);
Dr John Shackleton (University of Glasgow, UK)

An Exploration of the Sustainable and Aesthetic Possibilities of 3D Printing onto Textiles as an Alternative to Traditional Surface Decoration

In large-scale textile recycling plants items must be free of all trims to facilitate reprocessing. They can be difficult and labour intensive to detach, or remain on the garment meaning that otherwise recyclable yarns or fabrics are passed by and sent to landfill. Such detailing on garments is essential to our aesthetic enjoyment of fashion, thus textile design research has the opportunity to explore more sustainable alternatives.

This PhD project intends to address the ecological impact of the waste that can be caused by discarding goods at the end of a garment's lifecycle. Currently, 3D printing is used in a fashion context for novelty rather than to approach any issues around sustainability. By creating embellished textiles using 3D printing – and utilising biodegradable cellulosic materials that can be returned to the soil as 'food' – this research aims to develop a design approach for extending the user life of fashion textile products.

Through this practice-led investigation, there is emphasis on the techniques and their aesthetic appeal; and the usability/viability of the processes, so that it may be a real alternative to current practices. The outputs were tested for their strength of adhesion, in addition to their potential visual attributes. Initial findings from the research at this stage show that there is potential to develop this technique, aesthetically and structurally, for wider use within the mainstream fashion and textiles industry.

Dr Laura Morgan, Prof John Tyrer (Loughborough University, UK); Dr Faith Kane (Massey University, NZ), Prof Jinsong Shen (De Montfort University, UK)

Laser Moulding for Textiles: supporting sustainability in design and manufacture

The use of laser technology as a multipurpose tool for textile design and garment finishing offers environmental and economic benefits. Lasers offer digital control with potential to support sustainability through energy efficiency and direct-to-garment processing opportunities. This paper considers the potential for digital laser technology to facilitate sustainable innovation in the field of textile design and manufacture, enabling transition towards a circular economy.

Using recent design research as a case study, it discusses a newly developed laser moulding method and its significance in relation to circularity. The practice-based, interdisciplinary study combined material-led approaches, design practice and technical, scientific enquiry. The synthesis of scientific and creative approaches proved essential in developing the laser moulding technique, creating a platform for innovation beyond creativity as discussed through potential applications and opportunities for the technique.

This presents processing advantages over traditional methods; it can be used to design accurate surface architectures providing three-dimensional design features for textile product applications, and when combined with dyeing procedures, can enable digital laser shibori effects. The laser offers ease of pattern change through digital generation of designs and dry processing, without requirement for additional materials, such as thread for stitching.

The method allows decoration and functionality to emerge from the structure of the cloth without contaminating the mono-material fibres, which may provide additional sustainability benefits for ease of recycling at end of life. The paper considers potential for digital laser moulding to offer alternate procedural modes for efficiency, agility and circularity in textile processing.

Emma Grain
(University of Huddersfield, UK)

A Closed Loop Model for 3D Printing Fashion

This paper discusses the Two Way Closed Loop Model using recycled polyester (PET polyethylene terephthalate) developed by Grain (2014), and its relativity to the development of sustainable practices in fashion and 3D printing in fashion. Bringing together sustainability and innovative technology, the focus of this practice-based study aims to evaluate the possibilities of such a model through design and manufacturing by interviewing fashion and technical experts from academia and industry for their views on the model, possible methods, final usability, constraints and opportunities. Approaching this from a fashion design background the researcher has used the properties of the PET material to design new 3D printed textiles which could be developed into garments going forward. Exploring through a series of evaluations, testing and design iteration the researcher will devise a plan for future studies, which will ultimately evolve towards forming collaborations within the industry. Working with leaders and innovators in textile recycling and manufacturing companies to 3D printing bureaus, may help to close the loop in the future of fashion.

From the hypothesis that 3D printing is part of the future of fashion, it should be carried out with sustainable considerations, and refrain from adding to the already abundant landfill and waste problem, instead of using what has already been consumed, in the form of polyester clothing or PET bottles.

Dr Karen Shah
(University of Huddersfield, UK)

A Space of Waste

In the UK we waste 350,000 tonnes of clothes and textiles annually. Fast fashion, inbuilt obsolescence and over-consumption are to blame. Products generated from our current manufacturing processes lack longevity and permanence. Methods for dealing with this waste need exploring especially in relation to its re-appropriation into sustainable manufacturing systems. In order to foster a vibrant and meaningful circular economy waste outputs need to be made useful again. Within the context of second-hand clothes this waste has transcended global borders and now exists in a number of cultural, political and economic contexts. This paper, drawing on 20 years' experience of recycling in a UK-based context, proposes a number of design solutions aimed at tackling the vast amount of discarded clothes that find their way, in particular, onto the streets of Leeds, UK and the market places of Dar Es Salaam, Tanzania. Utilising practice-led research and findings from workshops, this paper takes a two-pronged approach. It begins by reflecting on the nature of waste and the techniques that have been developed in the refashioning of items from a UK context and hypothesises how these methods may have resonance for the Tanzanian /global textile and clothing industry. With an estimated 14 million tonnes of clothes leaving American wardrobes every year, much of which is exported to African shores, initial discussions with tailors and businesses has revealed an interest in the re-fashioning of clothes and how in this reformed state they may be able to be re-exported to close the loop.

Session 3

Design Driven Material Innovation Interdisciplinary Research

Chair

Nick Morley

Faering, UK &

Mistra Future Fashion, Sweden

Marjaana Tanttu, Cindy Kohtala, Prof Kirsi Niinimäki
(Aalto University, Finland)

Can Design-Driven Material Innovation Approach also Drive Circularity?

Design-Driven Material Innovation is espoused as a win-win solution for consumers, economies and circularity. Several ongoing material development projects in Europe are explicitly using design as a driving force to seek new perspectives. The policy rhetoric suggests that design-driven processes produce outcomes including greater economic growth, added customer value and increased environmental sustainability. However, there is little empirical research on design-driven processes, their methods or their potential outcomes. Thus there is a need for further clarification of the design-driven material innovation approach, and its applicability for different purposes.

This paper presents the results of an ethnographic study that examined the first nine months of a design-driven project in the field of textile fibre development. In addition, the project places strong emphasis on material recovery and product recyclability. It therefore provides an excellent case to observe an attempt to direct the design-driven material innovation process towards circularity. Through this study we aim to find out if the adoption of a design-driven innovation process appears to help or hinder circularity-oriented material development processes. The preliminary findings of this research show that there is tension between added value and material circularity, suggesting a potential trade-off or a need for further discussion on the concept of value in this context. On the other hand, the way that collaboration was arranged in this design-driven project may have helped different professional fields to have their voice in the process, and enabled the dialogue between different Design for Circular Economy approaches.

Dr Kate Goldsworthy (University of the Arts London, UK); Sandra Roos (Swerea), Gustav Sandin (SP), Gregory Peters (Chalmers), Sweden

Towards a Quantified Design Process: bridging design and lifecycle assessment

There is broad consensus that the sustainability challenges of the fashion and textiles industry could be better met through a multidisciplinary approach [1]. Designers, design researchers and environmental researchers need to collaborate, but there can be difficulties in doing so, with scientific analysis and creativity seemingly at odds, even when both are aiming towards better environmental solutions. This paper provides the results of an analysis of the processes of fashion design, design research and lifecycle assessment (LCA) in order to identify and describe the barriers and potential opportunities for collaboration, and build a bridge between disciplines.

Several prototype garments are under investigation in the second phase of the Mistra Future Fashion research programme [2], among them a paper jacket, a laser-finished recycled polyester dress and an upcycled polyester shirt, all from the 2015 'Textile Toolbox' exhibition [3] and will act as case study objects for this interdisciplinary analysis. The process will be used to highlight and record potential obstacles for collaboration such as the different perspectives, agendas, vocabulary etc., and facilitated the understanding of products as systems and not static products, the windows where LCA information can provide design guidance, insights from the information input to and output from both design and LCA processes.

The foreseen generic end result of an exercise such as this is a model for 'quantified design' that is inclusive enough to leave room for both engineering and artistic mindsets, and relevant for designers and design researchers as well as LCA researchers.

Dr Dawn Ellams
(University of the Arts London, UK)

Designing Cycles: an interdisciplinary approach to coloured fashion and textiles

The interdisciplinary research presented was conducted at the design/technology interface in collaboration with fibre manufacturer, Lenzing. The doctoral research focused on the use of design thinking as means to explore the lifecycle and end-of-life relationship between fibre, colour and garment to address the challenges and limitations in reducing the environmental impact of coloured fashion and textiles through a cyclical approach to design.

The research evolves the traditional linear design process into a cyclical model. Lifecycle design thinking and technical inquiry were incorporated within the design process balancing aesthetic value with environmental value. Innovative approaches to colouring textiles were developed through this method of 'Cyclical Design', examples of which are presented within the paper. The creative design research was underpinned by experimental research methods for textile and coloration technology, interweaving the creative outcomes with technical inquiry.

Research outcomes provide two lifecycle design strategies incorporating 'Cyclical Colour'. The first presents sustainable colour for fashion and textiles; design within a biological lifecycle is explored; and research utilises by-products from which to develop natural colour. The second focused on responsible coloration for fashion and textiles. Methods for reducing the environmental impact of synthetic dyes were explored, technical inquiry and design for longevity informed the design process. The processes developed within the research demonstrate that designing cycles for coloured fashion and textiles from the fibre stage within an interdisciplinary cyclical model can reduce environmental impact.

Miriam Ribul (University of the Arts London, UK), Hanna de la Motte (SP Technical Research Institute, Sweden)

The Material Affinity of Design and Science for a Circular Economy

This paper presents a design science collaboration at SP Technical Research Institute of Sweden where a design researcher was a participant observer in a material science laboratory for regenerated cellulose. Design and science are connected through a materials practice, and by collaborations at the raw material stages of the lifecycle, a connected understanding of properties and behaviours may facilitate resourceful material circularity. The brief for the design residency was to explore how design and science can inform each other when working with regeneration of cellulose for a circular economy. To explore this question, the design researcher was embedded in the laboratory work at SP, documenting the scientific processes and introducing design tools into the scientific environment. The collaboration has led to identifying that the exploration of a comparable material process in design and science can develop connected approaches in both disciplines. This was explored through making regenerated cellulose films in the science laboratory and bio-plastic films in a design studio lab. This paper proposes how material processes for design and science can evolve to establish a transdisciplinary practice for a circular economy.

In this paper, a definition of the material affinity and how both disciplines explore materials with their hands is outlined. Key approaches to materials experimentation in both disciplines emerged from the lab work and studio practice. The outline of these approaches for each discipline will link to processes and tools for material experiments. The use of different language will demonstrate how this can create barriers and innovation in this context. A final map will field two new areas for design and science in a materials context.

Session 4

Repair and Models for ReUse

Chair

Dr Amy Twigger Holroyd
Nottingham Trent University, UK

Bridget Harvey
(University of the Arts London, UK)

RepairAbility Through Repair Thinking

Repair Thinking is a framework for extending material and object lifespan within a circular economy model, increasing personal skills through enabling RepairAbility in design and use.

I see repair as prevention as much as cure and my focus is on use, ability and accessibility. In this paper I introduce the tenets of Repair Thinking: Openness, encouraging tinkering, hacking and open source information; Conscious Construction, using modular construction and universal fixings; Visibility, making repairable-ness and repair services visible and accessible; Expanded User, enabling deep cooperation between designer and user, including environmental considerations; and, Social Values, where Repair Thinking promotes a reconstruction of social and material tools and values, and the consequent redefinition of ownership and power.

Repair could be considered a necessary skill for resilience, a way of passing time, of exploring and developing new skills, or, simply, just making something you need/want work. Its activism comes through political statement applied to repair: it isn't necessarily inherent in the act alone. Repair always stands against replacing broken with new, and can be seen as a dynamic mode of sustainability, moving materials and knowledge back into the use cycle, and potentially adding value and creating communities. Where a single repaired thing or act may seem insignificant, visible process and material manifestations of repair give further agency. Repairs display personal resistance and resilience in the face of relentless pressure to buy new.

Emmeline Child (University of the Arts London,
University of Northampton, UK)

Developing Models for Successful Upscaled Upcycling of Fashion

One of the key challenges facing the textile industry is how to successfully upscale the current upcycling textile systems from micro pioneers to commercial upcycling. By analysing data collected from micro pioneers in the industry and through reflections from an interview with the Salvation Army Trading Company (2016), a model has been developed to support the development of designing within the circular economy and to act as frameworks to guide individuals through the key determinates that support upscaling. 'Upcycling ... should be considered a new way of "thinking about and working with" a resource abundantly available.' (Torres, A, & Gardetti, M, 2013 p. 154)

Disseminating this information to young designers via a developed Venn diagram, the purpose of this paper is to see if the model is successful in acting as a design toolkit, and if appropriate techniques can be refined to support the prototypes developed, suitable for upscaling upcycling. Additionally the model has been tested and a prototype produced by a micro pioneer in the field to see if prior knowledge in the discipline is needed. Reflections have been made on the garments developed to understand how successful they have been at supporting a circular system, while further refinements have been made to develop a finished Venn diagram that supports upscaling, with the purpose to guide designers and manufacturers wanting to upscale forms of remanufacture and support more circular systems of manufacture in the future.

Andre West, Sanjaykumar Patil
(North Carolina State University, USA)

The Creation of Made to Measure Recycled Garments

In 2011, 7.5 million tons of polyethylene terephthalate (PET) was collected for recycling globally, greater than any previous year. Hence, there is a growing infrastructure whereby thermoplastic polyester products could form a closed recycling loop that produces 'zero waste' in the production process. Making textiles from recycled PET is now a feasible option.

This research focuses on incorporating three converging technologies; recycling of PET plastic bottles, 3D body scanning to provide personalised accurate sizing measurement data to make fitted knitted garments, and WholeGarment® knitting technology. The process of WholeGarment® knitting not only eliminates the garment construction process and its associated waste, but also provides garments with much more accurate and repeatable construction parameters.

The objective is to produce a garment that is constructed without the need for sewing and zero waste, manufactured from 100% recycled materials. The final challenge is to complete the circle by recycling the polyester knitted garment rather than simply delaying its journey to the landfill, to repurpose it yet again into a similar product.

Alexandra Kiki Lo (UK)

Visibly Mended by Design

This paper posits the need for an alternative system facilitating the mainstream uptake and acceptance of visible mending in order to effectively slow down consumption thus making a significant shift towards a circular economy. The investigation poses to challenge the current preference of invisible mending as well as the existing systems that places an over-reliance on the consumer to achieve a repair (with little or no professional help) that elevates a garment's desirability sufficiently to prevent early disposal. The research identifies the shift of responsibility and skills associated with the act of repair away from the consumer as a key factor to initiate wider acceptance of visible mending.

Creating a framework with mending as a design feature anticipated from the outset and facilitated by the industry would guide the consumer through an aided process integrating narrative of choice to a visible repair whilst equally ensuring its execution to a high finish. Such a framework would enforce the positive aspects of mending whilst eliminating negative aspects, thus tasking the industry to share responsibility in extending the lifecycle of a garment and ensure an elevated design-led visible repair that is comparable to customised embellishment.

A prerequisite is the industry's shift towards different business models that expand past their current involvement from basic repair or replacement of faulty goods to include visible mending thus creating a consumer interface beyond the point of sale which can be utilized to further influence consumer patterns. This shift in dynamic does not dilute the impetus of business ensuring mutual benefit of both the model and the executer, prompting a shift towards a circular economy.

Session 5

Production Technologies

Chair

Gwen Cunningham

Programme Lead

Circle Textiles Program, NL

Dr Anne Prahll (concept+design, UK)

Design for Circularity: Material Innovation for Wearable Technology

While the global textile and clothing industry is beginning to embrace the challenges of designing for circularity, the domain of wearable technology is lagging behind, despite the issues that these types of products could cause at end-of-life. A particular concern for textile-based wearable technology is the seamless embedding of electronics and other enabling components, as this manner of permanent and often invisible integration could cause significant problems for traditional textile recyclers and existing processes.

This paper aims to raise awareness of these issues, as previously identified by other researchers in the field (Köhler 2008; Timmins 2009; and Ossefor 2013), before exploring innovation opportunities, which could address them. Alternative approaches comprise the investigation of what a 'wearable material' could constitute, as well as the design and development of new types of *non-integrated* form factors for wearable technology products.

The practice-based research therefore extended beyond conventional knitted and woven textiles, focusing on designing *rubber-like*, *paper-like* and *felt-like* synthetic or natural nonwoven substrates, which could be recyclable or biodegradable at end-of-life. Furthermore, the creative exploration of form factors led to the design of new types of *skin-worn*, *body-worn* and *clothing-attached* wearable sensors, which could provide more affordable, accessible and easy-to-wear products, while offering alternatives to seamless integration directly into clothing.

Based on the conceptual proposals developed as part of the project, the paper concludes that in order to develop these concepts in a commercial realm, it will be necessary to explore effective ways of cross-disciplinary collaboration between academic and industrial stakeholders, as well as providing designers with adequate skills and support to design products fit for a circular economy.

Prof Marie O'Mahony (OCAD University, Canada),
Dr Alison Gwilt (Sheffield Hallam University, UK)

Where Does Wearable Technology Fit in the Circular Economy?

Environmental concerns have become a core focus in today's fashion and textile industry. Sustainability underlies all aspects of the industry from sourcing raw materials through design, manufacturing, consumer use and end-of-life disposal. Wearable electronics has emerged from a niche industry to one with an estimated market value of US\$ 20 billion in 2015 and expected to rise to US\$ 70 billion by 2025 (Harrop 2015). Although still a relatively immature industry, it is starting to recognise environmental concerns but thus far it has not become an industry driver.

In this paper we first look at the current state of sustainability within wearable technology. In the second section we identify key drivers and issues then propose ways in which wearable technology can more fully embrace the circular economy. In the concluding section we look at future technologies and their likely environmental impact.

As wearable technology has now started to mature all aspects of sustainability need to be addressed. We will look at lessons that can be taken and applied from the textile and fashion industry such as the sourcing, use, reuse and disposal of material. We will also examine issues unique to wearable technology for example the need for a power supply and the problem of technological obsolescence within the garment. From a design perspective we examine the ways in which wearable technology is applied within fashion and how this could more closely relate to the activity of garment use. From this position we then question whether it is possible for wearable technology to contribute to garment longevity by examining issues and concepts related to fashion-ability, durability, and repair.

In the concluding portion of the paper we consider the introduction of future technologies and disruptive manufacturing processes that have the potential to provide challenges that demand design and manufacturing solutions that are both sustainable and innovative.

Dr Dawn Ellams (University of the Arts London, UK),
Nick Morley (Faering, UK)

Digital Denim by Design

Lifecycle assessment research has shown that denim is a disproportionately polluting part of the textile manufacturing sector. The linear industry structure is reliant on cotton with its well-known land use, water and pesticide issues. The traditional manufacturing of denim fabric uses environmentally and socially detrimental processes in the dyeing and finishing stages. The distressing of denim compounds these impacts whilst reducing technical performance and longevity. At the end of life, the materials, chemical and embedded energy from initial production stages are also lost when garments are disposed of.

As a way of increasing material circularity, there has been increased interest in re-spinning denim and incorporating it into new products. Re-spun content is typically limited to around 20%, so most denim is today largely recycled into low grade industrial products such as insulation.

The paper explores a more radical approach which combines lower whole lifecycle impacts whilst enabling new materially circular business models. The initial interdisciplinary research presented was conducted at the design/technology interface in collaboration with fibre manufacturer, Lenzing as part of a larger extensive programme of doctoral study and is being used to inform future stages of research. Digital inkjet printing was explored as an alternative coloration method for denim. Denim dyeing and distressing are combined in a single, low impact design-led process. Material circularity involving re-distressing and reprinting to enhance and rejuvenate denim products are then possible, as well as ultimately, conventional recycling.

Dr Manju Sugathan
(Nottingham Trent University, UK)

The Design of a Speciality Hand Knitting Yarn using Appropriate Technology

In the village of Vellanchery, Tamil Nadu state, India, the main source of income is through the weaving of traditional silk saris. This activity is completed by the males of the families and it is a domestic process carried out on handlooms using a warp of approximately twenty-one metres; from which, three six-metre sari lengths are produced. This leaves close to three metres of remnant silk yarns on the warp beam. In this context, the study investigates the development of a process of a speciality hand spun knitting yarn using 30% of these silk remnants collected from handlooms blended with 70% scoured lamb's wool. Alluring and unique yarn colours that are non-repeatable, and have excellent handle and knit-ability can be produced.

Notably, non-repeatable yarn colours make this product unsuitable for the mainstream fashion market; however, bespoke designs are extremely desirable for craft hand knitters. The idea is to use an eco-friendly method of production that can be easily adapted by the women in the village. In order to make the technology used successful within a particular locality, it has to be firmly related to the technical, economic and social conditions in existence. Accordingly, field study observations are used as a method to generate knowledge about specific issues in the village and identify an appropriate method for the production of speciality yarn.

Session 6

Lifecycle Thinking for Design

Chair

Sigrid Barnekow

Mistra Future Fashion, Sweden

Yuval Etzioni, Ziv Neeman (Shenkar College of Engineering, Design and Art, Israel)

A Sustainability Textile Design Course as a Transformative Process

The paper describes and analyses a sustainability-informed textile design course in a design school from the perspective of the instructor. The most significant aspect that the analysis brings to light is the manner that the students not only embraced the principles of sustainable circular reuse, but also that engagement with environmental and sustainability issues generated engagement with other critical, complementary progressive aspects, such as: critical gender and labour issues, questions of hybrid identities and critical engagements with their own cultural heritage.

The course methodology is based on approaches to circular reuse of textile materials and articles, together with experimental practice-based students' projects utilising such approaches. It also exposed the students to the ways that the textile/fashion industries rank high among the global sectors having adverse effects on the environment, as well as on issues of traditional and ethical labour practices.

The paper is based on selected student post-course interviews, together with analysis of their final course projects. The interview utilises a qualitative research approach in order to distinguish central themes from the students' responses, to identify the new critical understandings they received from the course and how they incorporate them into their design practices. The selected (visual) final projects are analysed using a visual and material culture perspective that reflects how engagement with environmental and sustainability issues together with circular reuse principles may affect their future practices as textile designers and practitioners.

Sara Li-Chou Han, Nick Hall, Phoebe Apeageyi, David Tyler (Manchester Metropolitan University, UK)

Whole Systems Thinking for Circular Economy Design Practice

To develop the role of designers in the context of the circular economy, this paper aims to investigate the significance of the concept of Whole Systems Thinking (WST) for design practice. The paper presents individual case studies of environmentally motivated fashion design that displayed differing levels of positive impact based on their breadth of design activity, and whether a wider systems-based design approach was successfully incorporated.

The methodology employed a review of literature relating to circular systems approaches to WST, and combined this with primary data from semi-structured interviews. Interview data from ethical fashion brands and designers identified barriers to the wider adoption of circular economy fashion strategies. The interrogation of current techniques employed to bring products to market and effectively communicate their wider features and benefits to consumers established where knowledge gaps exist.

The paper concludes that the designers taking a systems-based approach are more congruent with the circular economy model and the wider skills and attributes that enable such approaches, such as research skills and entrepreneurial methods. Findings on the effectiveness of current circular design systems offer key industry insights on the changing role of designers and the necessary mindset for systemic change. Academic implications of the research include the establishment of Whole Systems Thinking in the training and development of a new generation of designers, to improve and enable positive design decisions. Originality lies in developing circular fashion approaches that draw from and improve upon existing strategies to create sustainable innovation.

Karen Marie Hasling
(Design School Kolding, Denmark)

Using a 'Five Perspectives of Sustainable Design' Model

This paper demonstrates how a 'five perspectives of sustainable design' model can be used to discuss, communicate and develop approaches to sustainable fashion and textiles design. It can be used to analyse how existing products and companies are dealing with sustainability issues and to overview and map and how to work with sustainability in new products, systems and strategies.

The model is based on the shift in perception of what sustainable design can be, from considering sustainability endeavours as being primarily singular and non-interactive entities, to embracing large and complex systems with constant interactions between human and non-human actors.

The model operates with five perspectives being: 'raw materials and production processes', 'products and use', 'services and systems', 'strategies and business models' and 'culture and experience'. In the model, the perspectives build on each other in a hierarchical structure with 'raw materials and production processes' as the core. Using the model, approaches to sustainable design are placed in the related perspectives and related and interdependent approaches are linked. Experience is that the model facilitates the argumentation of relevance of choices and to discover the role of experience as a means to work with sustainable design.

In the paper, examples of existing products and companies from the fashion and textiles sector that emphasise sustainable products in different ways will be analysed and discussed using the model.

Dr Jen Ballie, Dr Cara Broadley, Dr Lynn-Sayers McHattie, (Glasgow School of Art, UK)

Material Futures: Crafting Circular Conversations

Heightened awareness of the economic value being lost through waste coupled with a rise in resourcing risks have elevated business interest in the circular economy. Within the UK, the Scottish Government have been lobbying policy initiatives to implement a £70million European Regional Development fund with a £17million Circular Economy Investment fund to help SMEs to catalyse innovative approaches to design, fostering repair and reuse and encouraging service and leasing models for material recovery, with the premise of supporting closed-loop systems, most notably, additional support for collaboration; the evaluation of different methods; and further understanding of future material ecologies.

This paper will explore the work in the area of *Material Futures* – undertaken by a research collective based at The Glasgow School of Art (GSA). Throughout this work the researchers seek to raise awareness of the circular economy to support the Scottish textile sector. By identifying the most appropriate design-led approaches for crafting conversations that attend to addressing gaps in knowledge and practice, these seek to connect textile designers with other stakeholders across the supply chain. Through posing the research question 'which design principles are required to craft conversations around the circular economy?', We begin by discussing current debates within the textiles and craft industries and outline the challenges of articulating the applications of a circular economy.

This paper articulates current challenges within the textiles and craft industries towards reframing new uses of raw materials and community resources. Presenting a case study, we discuss the changing role of the designer in a circular economy. This paper concludes by making recommendations for future research, policy, and practice to support closed-loop innovation, and outlines how the findings might be expanded upon to support emerging designers.

Dr Kate Goldsworthy, Prof Rebecca Earley, Prof Kay Politowicz (University of the Arts London, UK)

Circular Speeds: towards a new understanding of designing for fashion textile rhythms

During the first phase of the Mistra Future Fashion project researchers from the University of the Arts London identified a gap in knowledge. Although 'lifecycle thinking' has become a widely adopted and tested approach in academic and industry contexts, the dimension of 'time' or 'speed' was not fully resolved as a factor within existing guidelines for design. Thus 'speed of cycle' became the focus of the research as it moved into the second phase.

Carl Honoré's *In Praise of Slow* (2004) proposed that we seek balance – *the right speed* – and that we question the notion that faster is always better. Rather than pursue this polarised approach to viewing 'speed of use', the authors here argue that a more nuanced method of analysing speed is needed which acknowledges the entire lifecycle of a product. We should in fact be considering *the right speed* for each garment within specific lifecycle stages. We need tools to help designers with this.

In this paper the authors set the scene for Mistra Future Fashion Phase 2 research. The intention is to develop the discourse on from simply *fast* and *slow*, to a level where multiple and proportionate speeds can be both understood, tested via LCA and ultimately engineered, to improve the *circular efficiency* of a product. The idea presented here is that we consider both long-life (slow) and short-life (fast) as models for clothing to suit a broad range of user contexts – different needs, tastes, incomes and styles.

The results from this research will feed into ongoing research (2015–2019), which will publish design guidelines for the circular fashion industry in 2018.

Meet Ed van Hinte from Lightness Studio, DSR22 Foundation

Ed van Hinte is a Dutch engineer, design critic, writer and educator with a degree in Industrial Design and Engineering at the University of Technology in Delft. He has written and published many books some of which concerned a theme that is important to him: the consequences of diminishing material production and consumption, by-product lifespan extension (with Eternally Yours) and mass reduction (with Lightness Studios). He is well known for delivering workshops on design and architecture all over the world. He is involved in design research at DRS22 in The Hague, a multidisciplinary research facility for young designers that he started with graphic designer Renate Boere. In December 2014 he received the Pierre Bayle lifetime achievement award for design criticism.

What are you working on at the moment?

Currently I am continuing the exploration of the design for a lightweight standard house. As a sideline I am researching ways to cultivate the value of used fleece, in support of fashion designer Conny Groenewegen. Mainly I am working on an entirely new book as a core part of a campaign on understanding lightweight structures, together with expert Adriaan Beukers, graphic designer Erik Wong and Nai010 Publishers, working title: *Designing Lightness*.

What is the one thing that you will share at the conference that people haven't heard before?

My focus will be on a mix of cultivating value over time and minimising the flow of materials from the viewpoint that circularity is not a correct aim. By definition transitions are not circular. Cultivating value time involves much more than mere technical interventions.

Tell us about one thing that you are excited to bring back from the conference?

Hopefully I will learn about projects and insights that show the way to both a richer and a much more modest future civilisation.

>
You could represent technological development as a cruise ship which happens to be one of the most polluting developments on this earth, and we are the captain'

>>
Products are entitled to dignified ageing. Their contribution to waste needs drastic reduction'

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