TEX-BREIN

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7th Webinar TexBrein

Designing for Circularity & Longevity

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GO TO GREEN TEXtile

PROGRAMME

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11.00 – 11.05	Welcome & Introduction
11.05 – 11.35	• What Is Circularity and Longevity • Three Core Principles of Circular Design • Circular Design = Smart Design • Modular & Upgradeable Design • Timeless & Emotional Design • Material Selection & Impact • Empowering the User • Challenges & Trade-offs
11.35 – 11.45	Q & A

Circularity & Longevity in the Textile Industry

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Focus Areas

- **Circular Design:** Textiles engineered for reuse, recycling, and regeneration within circular systems.
- **Longevity:** Development of durable, high-performance fabrics that extend product life and reduce replacement cycles.

Key Benefits

- Lower raw material demand, water use, and carbon emissions.
- Enabling pathways for repair, upcycling, and advanced recycling technologies.
- Accelerating the transition to sustainable fashion models, reducing dependency on fast fashion.

Consumer Engagement

Empowering mindful purchasing and garment care practices to maximize lifecycle.

Vision

Integrating **circularity + longevity** to drive the textile industry toward a **sustainable, waste-free ecosystem**.

Three Core Principles of Circular Design

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Design Out Waste & Pollution

Material Innovation

- Replace hazardous dyes and finishes with blo-based, non-toxic alternatives; integrate closed-loop chemical systems

Process Efficiency

- Digital prototyping and additive manufacturing reduce overproduction and sampling waste

Predictive Tools

- AI-driven design and LCA (Life Cycle Assessment) to anticipate environmental impact early in the design phase

Three Core Principles of Circular Design

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Keep Products & Materials in Use

Modular & Disassemblable Design

- Fasteners, multi-material blends engineered for automated separation

Extended Use Models

- Product-as-a-service, digital product passports for traceability and recycling

Advanced Recycling

- Mechanical + chemical recycling integration to préserve fiber quality (e.g., depolymerization of PET, enzymatic recycling of cellulose)

Three Core Principles of Circular Design

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Regenerate Natural Systems

Regenerative Fibers

- Scaling organic and regeneative cotton, hemp, wool—restoring soil health, biodiversity, and carbon sequestration

Biomaterial Development

- Mycelium, bacterial cellulose, algae-based textiles designed for biodegradability

Circular Bioeconomy

- Nutrient recovery and reintegration into agricultural systems, reducing dependence on fossil-based inputs

Circular Design = Smart Design

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- Circular design maps material flows to optimize textile lifecycle efficiency.
- Modular garment construction allows replacement of worn components without discarding the whole piece.
- Advanced dyeing techniques, such as supercritical CO_2 and digital printing, cut water and chemical use.
- Smart textiles with embedded sensors or phase-change materials extend functionality and reduce product duplication.
- 3D knitting and zero-waste patterning minimize offcuts and raw material waste.
- Supply chain traceability technologies, like blockchain, ensure material provenance and recycling feasibility.
- Circular textile design integrates material science, engineering, and lifecycle thinking for sustainable innovation.

Modular & Upgradeable Design

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Modular & Upgradeable Design

Incremental Adaptation

- Durable components enable iterative improvements and long-term wearability

Ease of Disassembly

- Integrated attachment systems and reversible fasteners facilitate repair and component replacement

Material Resource Efficiency

- Averting early obsolescence and reducing waste through adaptable system architecture

Modular & Upgradeable Design

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- Modular and upgradeable design in textiles allows components to be replaced, reconfigured, or enhanced without compromising structural integrity.
- These frameworks support circular economy goals by enabling repair, upgrades, and material recovery to extend product lifespans.
- Precision joining technologies—mechanical, chemical, or hybrid—are essential to balance durability with disassembly potential.
- Digital product passports ensure traceability of materials and compatibility for future module integration.
- Fiber-level modularity through hybrid yarns or composite filaments enables adaptive functionalities such as thermal regulation, conductivity, or antimicrobial action.
- Standardized interfaces and tolerances are critical for interoperability across textile systems and scalable upgrades.
- Predictive lifecycle modeling and advanced manufacturing (3D knitting, weaving, additive methods) support modular units with built-in upgrade pathways.
- Economic viability depends on reverse logistics and service-driven business models, positioning modular textiles as a systemic shift requiring cross-disciplinary collaboration.

Timeless & Emotional Design

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Material Authenticity & Provenance

Emotional durability is anchored in the tactile honesty and cultural heritage of fibers, where authenticity fosters long-term attachment beyond seasonal aesthetics.

Cross-Generational Aesthetics

Employing archetypal forms, enduring color harmonies, and culturally resilient motifs ensures designs retain relevance across shifting fashion epochs.

Multisensory Engagement

Textiles that stimulate tactile, thermal, and even emotional memory pathways (softness, warmth, scent retention) generate deeper bonds that transcend functional utility.

Narrative & Ritual Integration

Products tied to personal or collective stories, traditions, or digitally embedded histories cultivate intergenerational value and emotional longevity.

Repair-Integrated Beauty

Designing for graceful aging and visible mending (patina, adaptable surface finishes, dye reactivation) turns wear into narrative enrichment rather than obsolescence.

Material Selection & Impact

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Natural & Regenerative Materials

- Organic cotton, hemp, flax
  grown with reduced pesticides and water: promotes soil carbon sequestration, improves local biodiversity, and reduces nutrient runoff into waterways
- Regenerative farming practices
  enrich soil structure, restore microbial health, enhance water retention, support pollinators and increase long-term fiber yield and quality

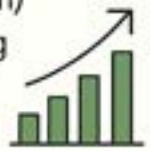
Next-Gen Bio-Based Materials

- Mycelium leather (Bolt Threads, MycoWorks)
  biodegradable, low water and energy footprint, and a sustainable alternative to conventional leather
- Algae-based fibers and natural dyes
  renewable, non-toxic, and actively capture carbon during cultivation, can replace synthetic dyes and fibers with high environmental

Low-Impact Processing

- Waterless dyeing
  (supercritical CO_2, digital printing) minimizes water use, reduces harmful chemical effluents, and lowers overall energy demand
- Plant-based, biodegradable colorants
  replace synthetic dyes, reducing chemical pollution and supporting end-of-life biodegra libility

Lifecycle Assessment (LCA) Tools



- Higg Index (Sustainable Apparel Coalition)
  enables consistent environmental scoring of fibers and production processes
- Textile Exchange Impact Assessment
  evaluates fiber sourcing, carbon, and water footprints globally; identifies hotspots for improvement

Material Selection & Impact

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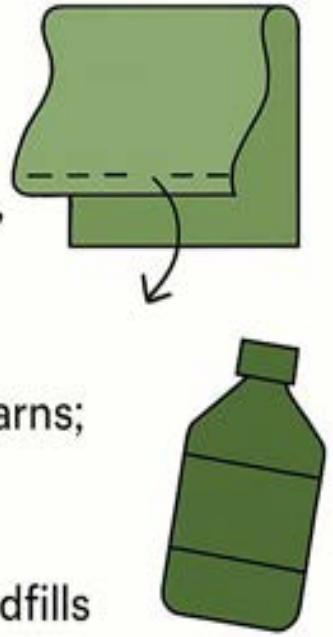
Comprehensive Evaluation and Reduction of Textile Environmental Footprint While Maximizing Circularity

Fiber-Level Impacts

- **Cotton** – water-intensive, high pesticide use; contributes to soi degradation and water scarcity in major production regions
- **Polyester** – petroleum-based, contributes to greenhouse gas emissions and microplastic pollution in aquatic environments
- **Viscose/Rayon** – often linked to deforestation, chemical pollution from pulping processes

Recycled Inputs

- Post-consumer textile waste regenerated fibers (Refibra™, Intinited Fiber) reduce landfill load, lower raw material extraction, and decrease energy use compared to virgin fibers
- Recycled PET bottles- polyester yarns; significantly reduces virgin plastic consumption, saves energy, and diverts plastics from oceans an landfills



Material Selection & Impact

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Circular Metrics

Durability
ensures longer product life, reduces waste, and increases recyclability

Recyclability
designing fibers and garments for efficient end-of-life material recovery

Biodegradability
ensures safe return to the ecosystem when products reach end-of-life

Material traceability via blockchain/ product passports
tracks sourcing, processing, and recycling, enabling accountability and transparency

Research & Innovation Driving Change

Global Platforms

- Ellen MacArthur Foundation – provides frameworks for circular economy adoption, industry guidelines, and systemic change strategies
- Textile Exchange sets global standards for material impact measurement, benchmarking, and fiber sustainability
- Fraunhofer Institute leads research in advanced textile recycling, bio-based fiber development, and scalable circular processes

Emerging Research Themes

- Biofabricated fibers (lab-grown cellulose, protein-based textiles) → reduce reliance on land-intensive crops, lower water and chemical use
- Predictive modeling for material durability & recyclability → allows designers to anticipate performance, wear, and end-of-life outcomes

Empowering the User

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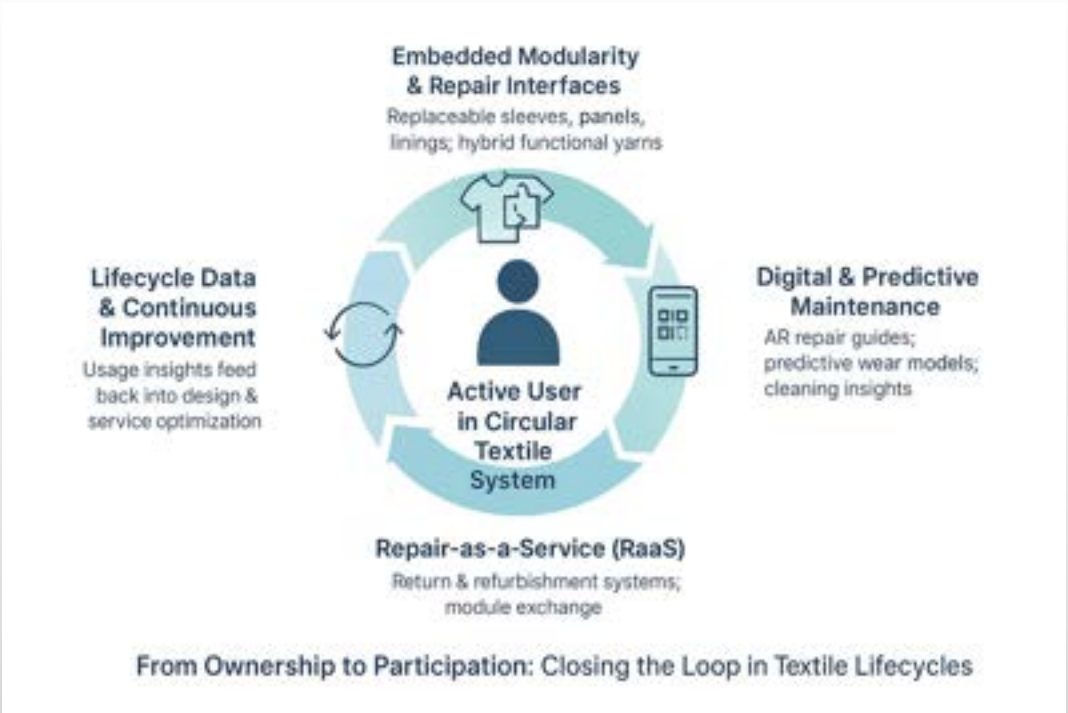
Transforming users into active participants in circular textile systems
Repair, Maintenance & Upgrade Facilitation



Embedded modularity & repair interfaces:

- Garments with **replaceable modules** (sleeves, panels, linings) or **hybrid yarns** that allow functional upgrades (thermal, antimicrobial, conductive).

Maintenance guidance & predictive support:

- Digital apps, AR guides, or QR-linked manuals provide **step-by-step repair, cleaning, and care instructions**.
- **Predictive wear models** analyze user behavior and environmental stressors to suggest preemptive maintenance.

Repair-as-a-Service (RaaS):

- Industry integration allowing users to return worn modules for refurbishment or exchange, enhancing lifecycle extension.

Empowering the User

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Traceability & Transparency Tools

Digital Product Passports:

- Embedded **QR codes or NFC chips** providing real-time information on fiber origin, processing history, and recycling compatibility.

Blockchain-based Supply Chain Tracking:

- Ensures transparent material flows from fiber sourcing to end-of-life, enabling verified circular claims.

Lifecycle Feedback Loops:

- Data collected from user interactions informs **material selection, durability enhancement, and design improvements**.

Empowering the User

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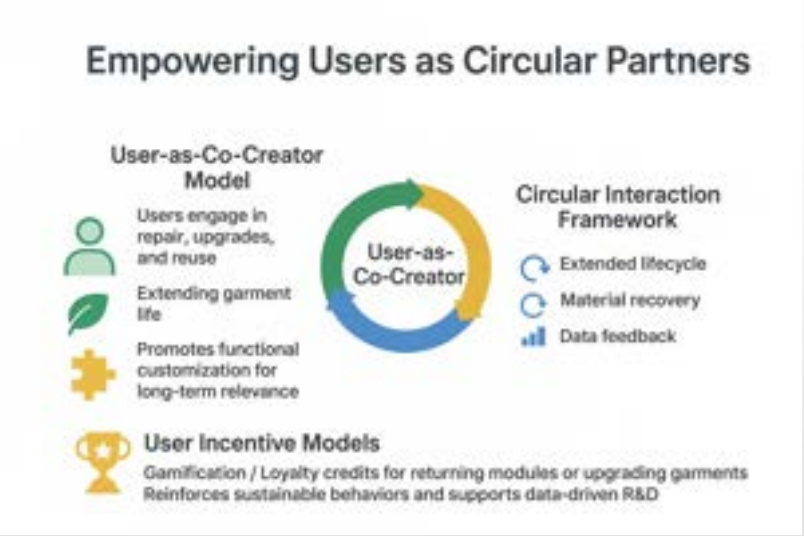
Behavioral & Functional Engagement Models



User-as-Co-Creator Model:

- Users actively participate in **repair, upgrades, and reuse**, reducing waste and maximizing material value.
- Encourages **functional customization**, extending garment relevance over time.

Circular Interaction Framework:

- **Input:** Sustainable material choice, modular design
- **Process:** Use, maintenance, functional upgrade
- **Output:** Extended lifecycle, material recovery, data feedback to designers/researchers

User Incentive Models:

- Gamification, loyalty programs, or service credits for returning modules or performing upgrades.
- Encourages adoption of sustainable behaviors while providing data for R&D.

Empowering the User

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Implementation Examples & Tools

- **I:CO & H&M Garment Collection Programs** → user returns for reuse/recycling
- **Refibra™ & Infinited Fiber** → post-consumer textiles integrated into new fibers
- **Smart garments with embedded sensors** → monitor wear, condition, and usage patterns to inform maintenance

Challenges & Trade-offs

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Headline for Industry "Durability and Circularity Require Courage and Innovation"

Material vs. Function
High-performance fibers and advanced coatings may limit recyclability → **choosing durability requires trade-offs**

Modularity vs. Production Simplicity
Modular garments and interchangeable components → higher costs and manufacturing complexity

Technology vs. Scalability
Smart textiles, bio-based fibers, hybrids → require new supply chains and investment

Predictability vs. User Variability
Wear and lifecycle prediction models → challenging with diverse user behaviors and lifestyles

Transparency vs. Cost
Blockchain and digital product passports → build trust but require investment and process adaptation

"Innovation comes at a cost, but circularity is the future - those investing in durability today will reap the rewards tomorrow."

Challenges & Trade-offs

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Headline for clients : “Users as Co-Creators of Value”

Engagement vs. Convenience
Repair, maintenance, and module replacement → requires time and active participation

Cost vs. Durability
Modular and bio-based products → higher upfront cost, but longer lifespan and functionality

Innovation vs. Understandability
Smart textiles and digital product passports → require user education and awareness

Circularity vs. Immediate Convenience
Returning garments for recycling or repair → requires changes in consumer behavior

Data vs. Privacy
Monitoring product usage and condition → extends product life but requires trust and consent

"Your choices extend product life and protect the planet - less waste, more value."

Q&A

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