WP 5 – TEXTILE-LIKE MATERIALS FROM A PAPER MACHINE

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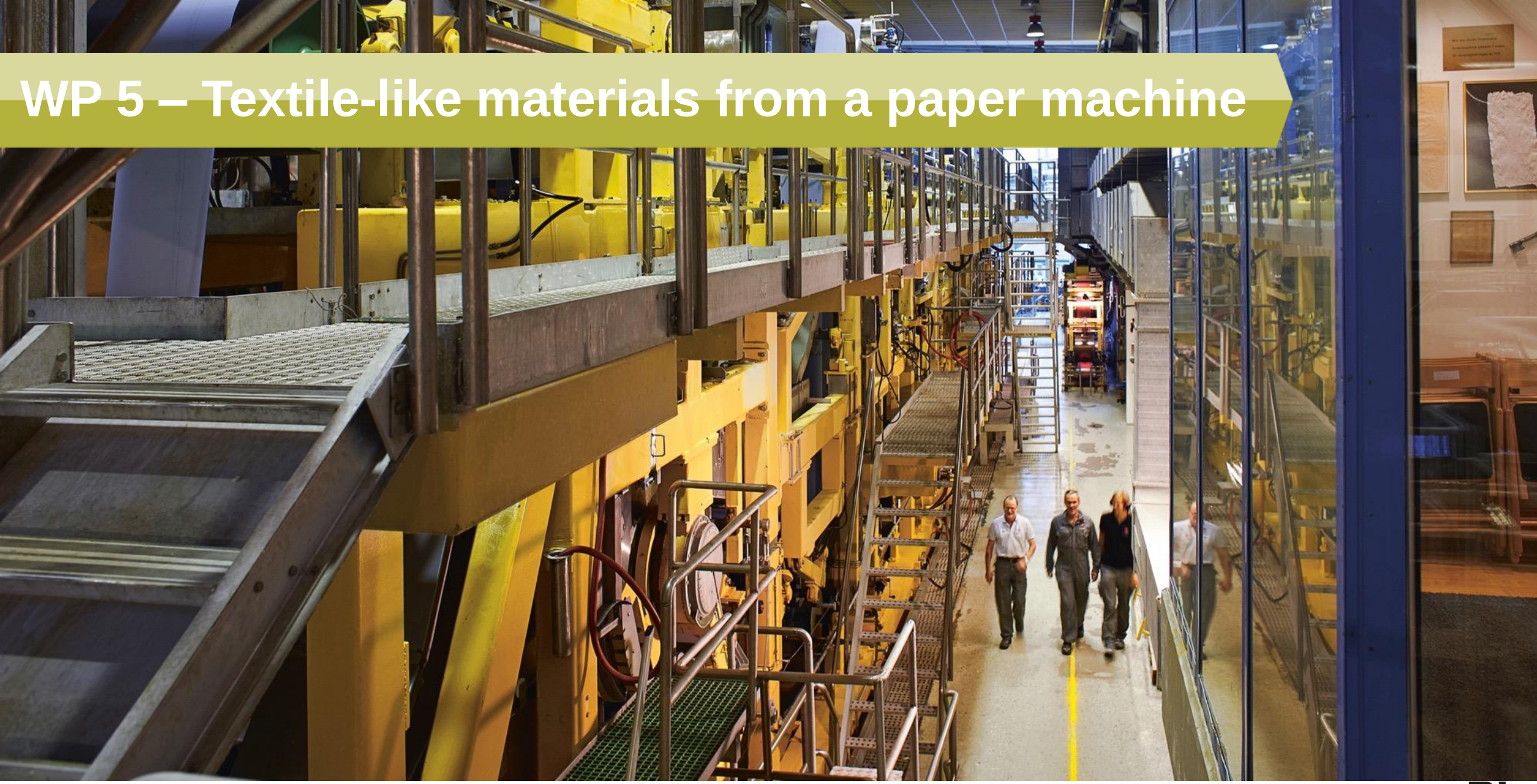
Bioeconomy

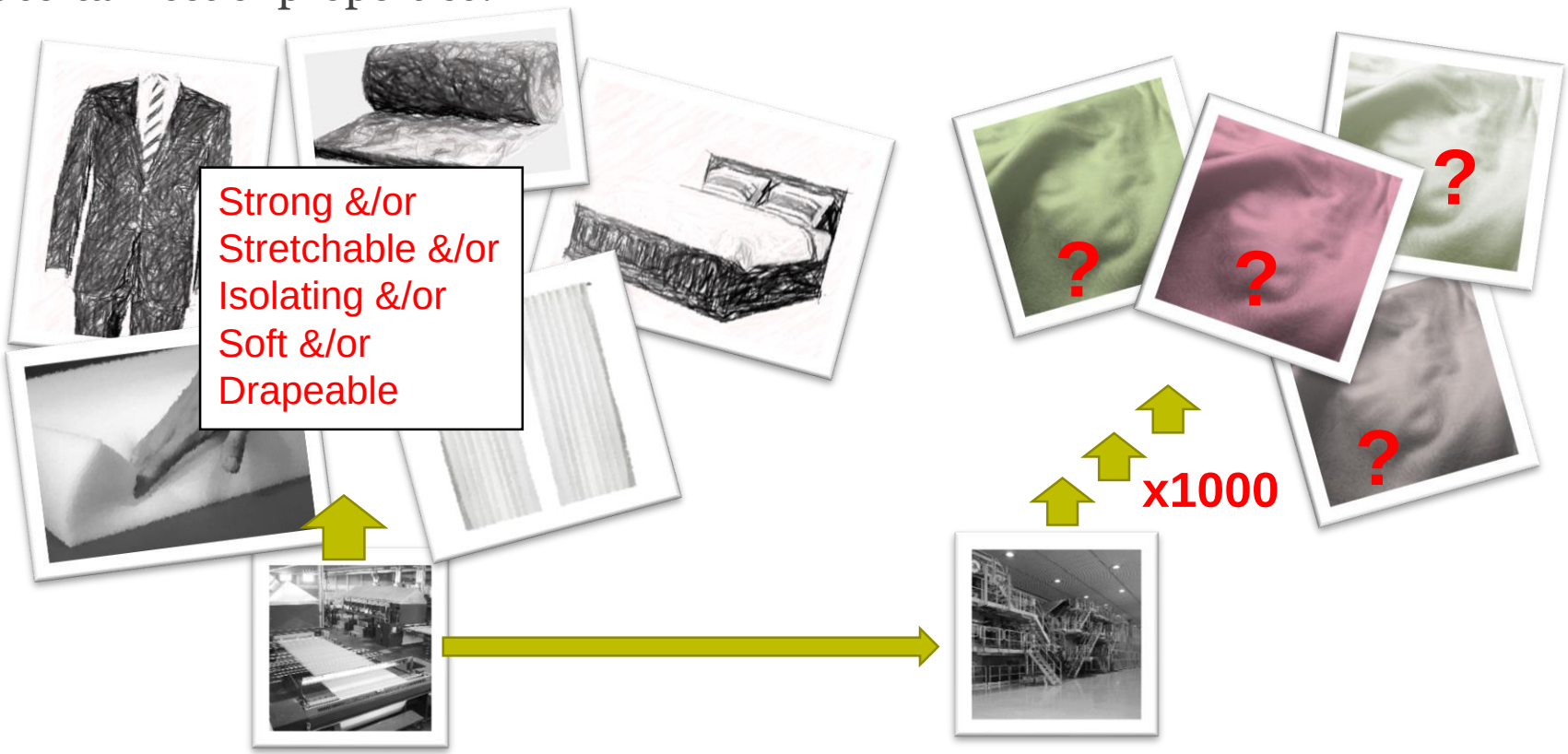
Papermaking & Packaging

WP 5 – Textile-like materials from a paper machine



Textile-like materials from a paper machine

- Materials of today that are perceived as textile-like typically have **two or more** of a certain set of properties.
  - Moreover they are typically permanent and not recycled
- What about materials produced in a sustainable way, much faster and cheaper and with typically **one or more** of a certain set of properties?



WP5 - Consortium

Institutes

Innventia

Swerea

Suppliers & Producers

Domsjö

Billerud Korsnäs

Fibre-X (pilot infrastructure)

Ricoh (printing)

OrganoClick (functional chemisty)

Needs Owners

Guringo (ultra-fast fashion)

Ecophon (interior design & sound insulation)

Trifilon (multi-layer laminates)

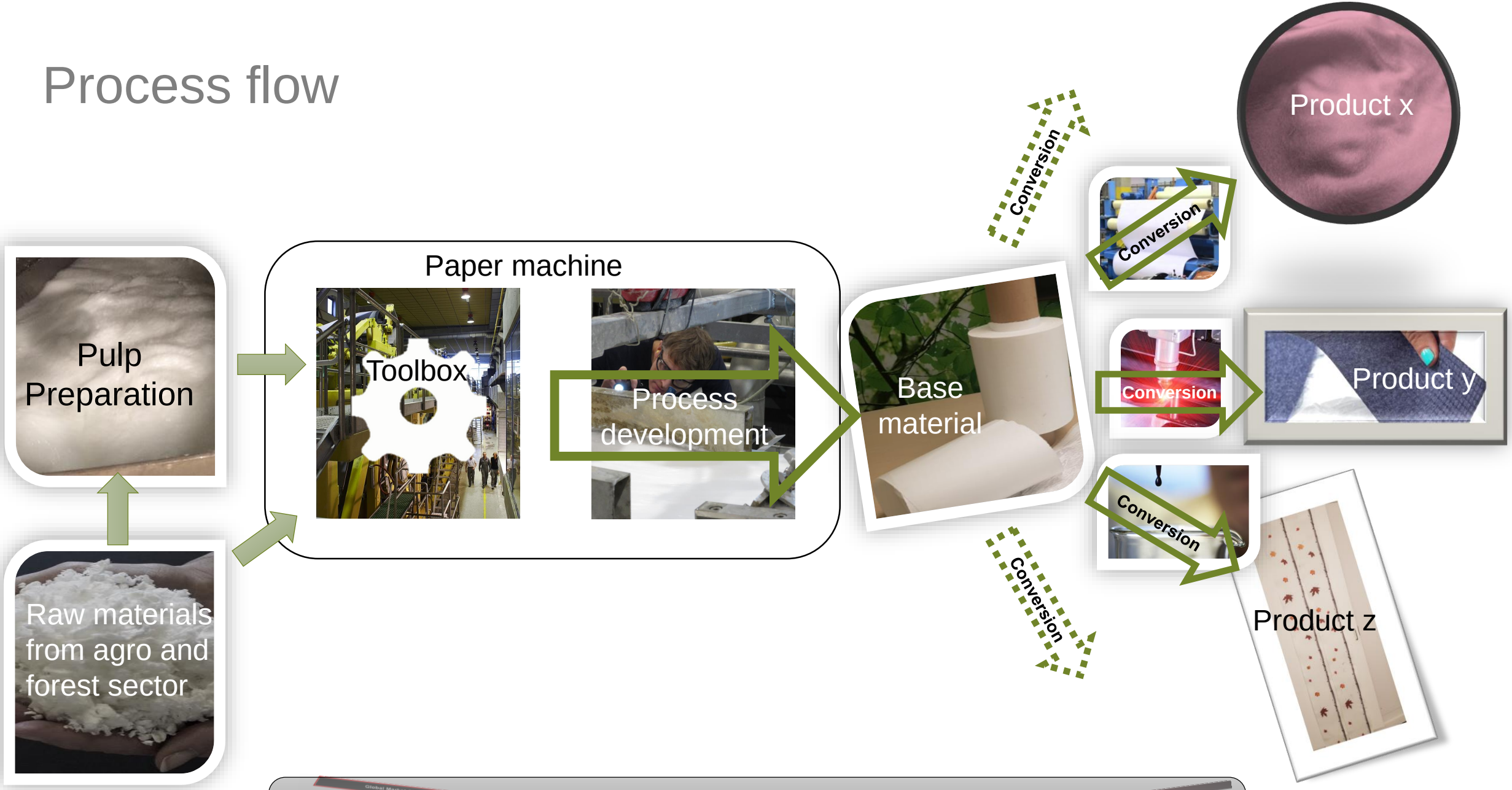
Material Hub + Activities

Paper Production and Modification
BillerudKorsnäs (+ Innventia)

Pulp dryer for textile-like materials - Domsjö
Domsjö (+ Innventia)

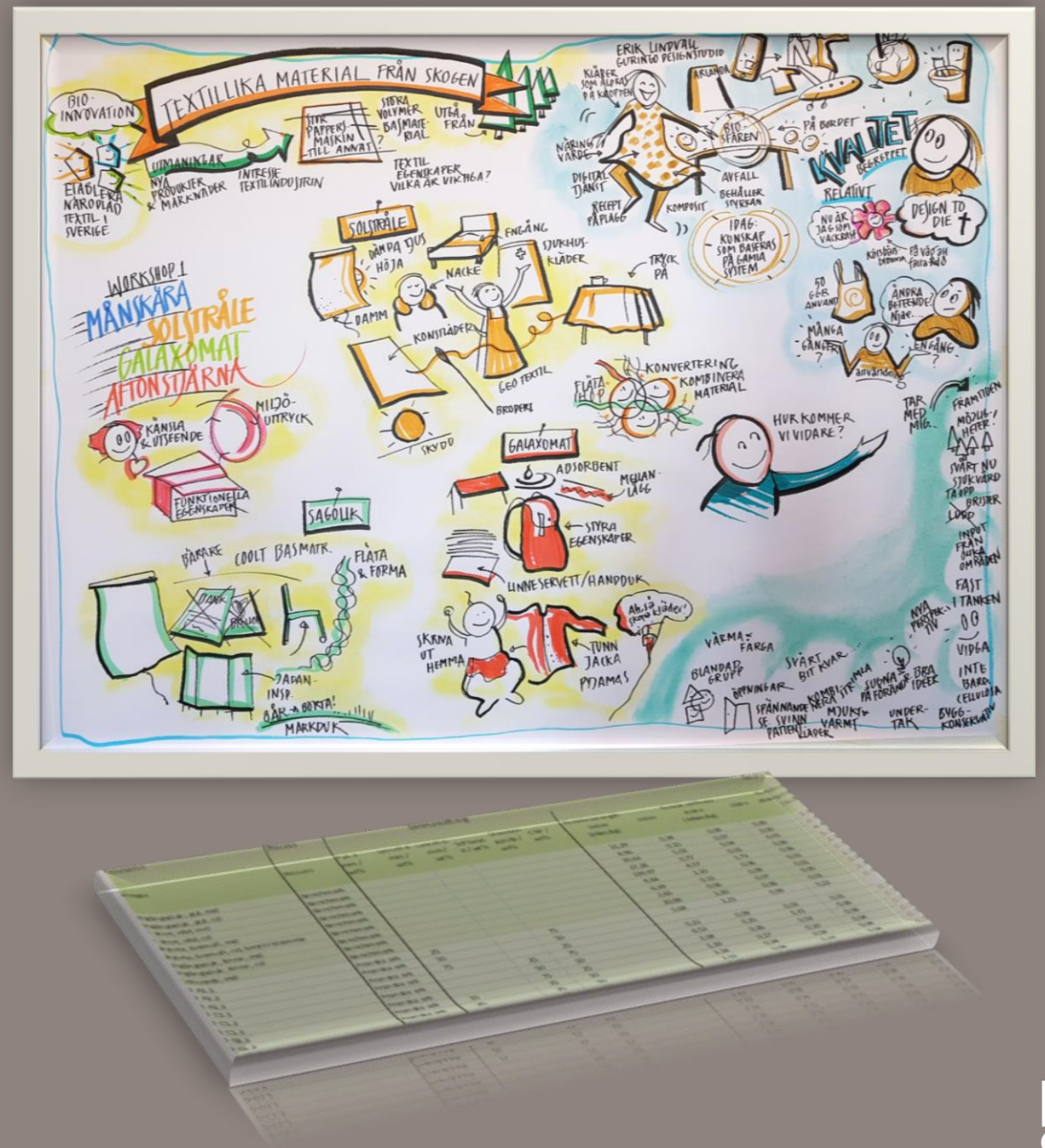
Development of binders for textile-like materials
OrganoClick (+ Innventia)

Process flow



Market Analysis & Benchmarks

Market analysis & Benchmarks



Market analysis & Benchmarks

- Objective was to define target market segments

Global textiles fiber consumption of 82 Mtons in 2012 is expected to grow 3-fold (240 Mtons) by 2050

Cotton

60%

The Sunshine Sector of textiles: Technical Textiles

- The textiles market is generally split up in 3 large segments:
  - **Apparel** ~54% including fashion
  - **Home** textiles ~ 25%
    20 Mtons 2012 – to 60 Mtons 2050
  - **Technical textiles and non-wovens** ~21%, including app
    and home segments if there is a technical component to t
    material, i.e. something more than aesthetics/decoration.
    10 Mtons 2012 – to 30 Mtons 2050
- The technical textiles segment is today being referred to
  the "sunshine sector" because of its enormous potential
  future growth

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Technical Texiles can in long run contribute to the other segments

Apparel

Why technical textiles market?

- Increasing demand for performance/high-end performance properties: quality, durability, versatility, light-weight, sustainability, strength, sound insulation, vibration insulation, formability, UV-resistance, rigidity, wear-resistance
- Global market for technical textiles relies on extensive research for innovation
- Need for new application-specific products
- New applications being found for existing products
- About 70% of all technical innovations depend on the material properties, i.e. the need for new materials is spurring on research and development

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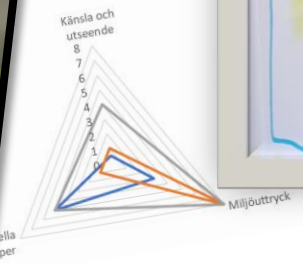
Market analysis & Benchmarks

- A number of target sectors were identified
  - Basis of volume and growth
    - Mobiltech (Acoustic insulation e.g.)
    - Hometech (Cushioning, insulation, linen, draperies, furniture, apparel e.g.)
    - Medtech (drapes, bedding, gowns e.g.)
    - Clothtech (Ultra fast fashion)
- The application of the new material has a potential for both:
  - competing with existing products
    - With renewable, compostable and sustainable material
    - With cheaper once-or-twice use of products that need not be permanent
  - or be completely new applications
    - With functions such as sealability, thermo formability, softness, absorption or insulation

Market analysis & Benchmarks

- Workshop – Textile-like material from the forest
  - Invited participants from: fashion, construction, design, and medtech
  - How do different industries perceive the novel materials and their use?
  - “The future holds many exciting opportunities”

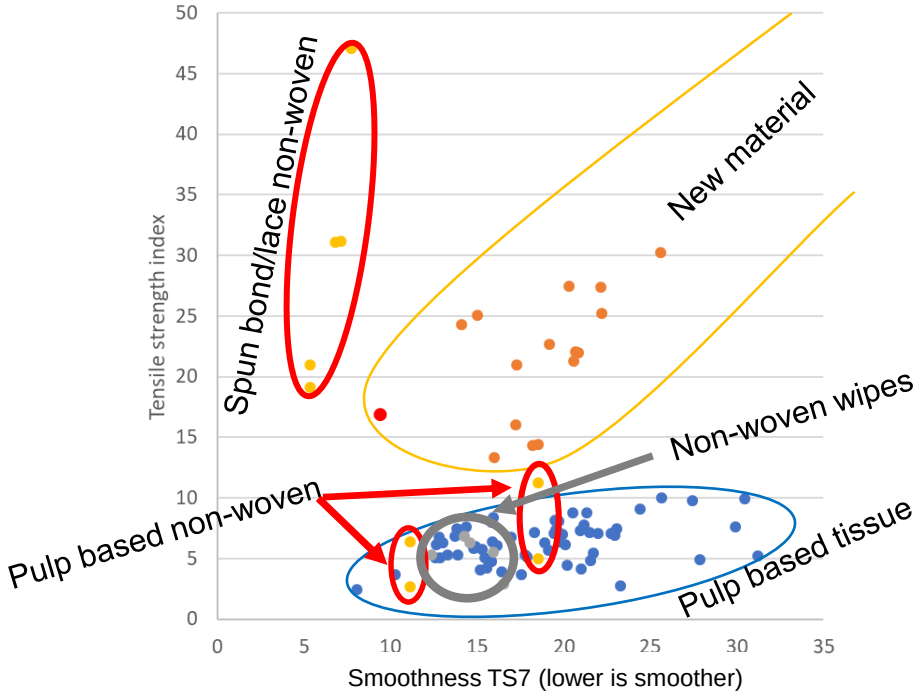


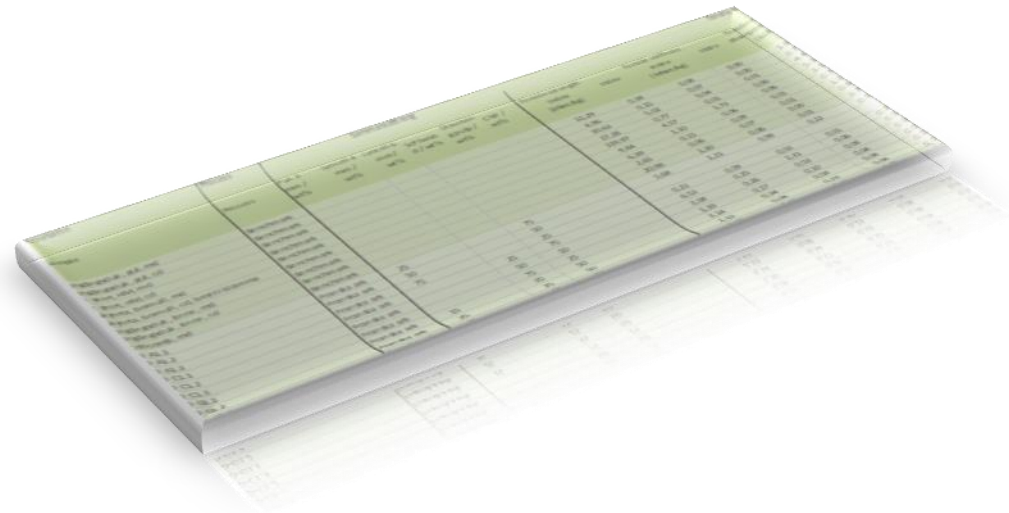
Market analysis & Benchmarks

- Comparisons between selected benchmark products/materials

(from identified market segments)

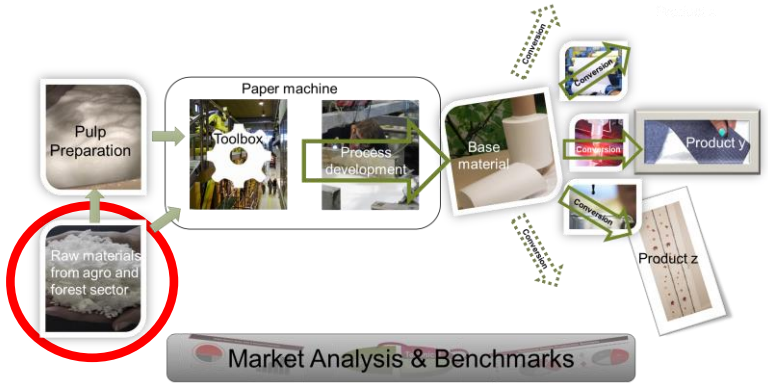
- Target properties were defined in terms of:
  - Strength, stretch, drapeability, softness, smoothness etc.
- Property space for WP5 materials defined and compared to existing materials





Raw materials from agro and forest sector

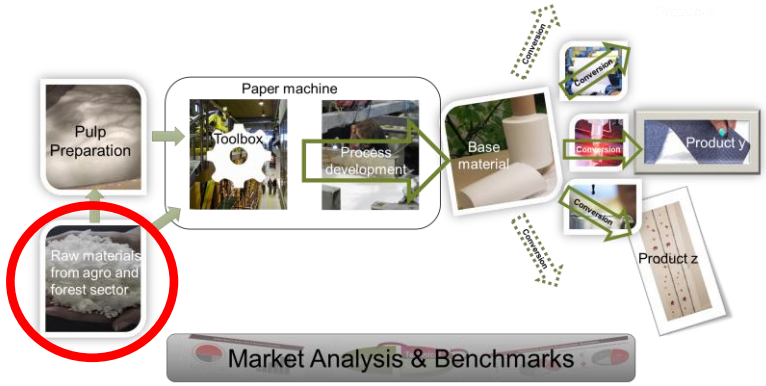
Raw materials from agro and forest sector



- Evaluation of different functional fibres and chemical additives that commingled with forest-based papermaking fibres give desired textile-like material properties. → Recipes
- Fibre screening of renewable and compostable raw materials

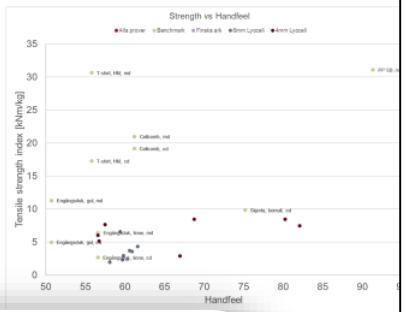
Material	Fibres	Processes	Strength mechanism	Production speed
Nonwoven	• Synthetic cellulose fibres • PP • PE • PLA • Agro fibres • Wood pulp fibres	Various: • spun lace • wet laid • dry laid	• Fibre friction/interlocking • Added adhesive chemicals • Heat	~500 m/min
Paper	Short Wood fibres	Papermaking (similar to wet laid)	Self-binding	~1800 m/min
Textiles	Continous or long yarn of natural (cotton, wool or other animal hairs) or synthetic fibres	• Weaving • Crocheting • Knitting	Typically fibre interlocking or friction (felt)	15 m/min
Non-paper?	Wood fibres and synthetic fibres	Papermaking (similar to wet laid)	Self-binding	1800 m/min?

Fibre and Additive Screening
Optimizing for strength and softness



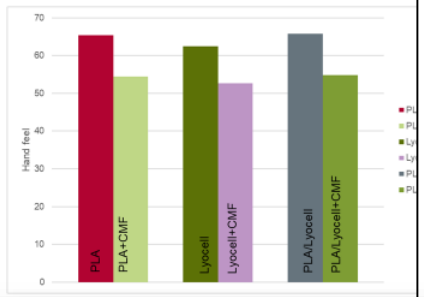
Hand feel and softness

- In general, a hand feel value above 50 are precepted as textile-like
  - 50-Cloth, 56-linen, 75 cotton shirt
- Softness at 20 are suitable as table cloth wh



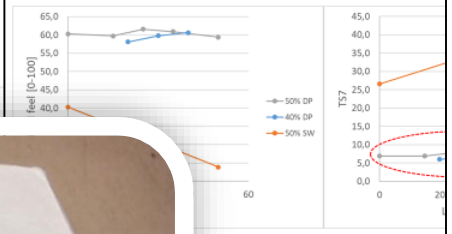
Dissolving (50%) and PLA/Lyocell and CMF

- Addition of 5% CMF worsens the HF by 16-17% independently PLA fibres or PLA/Lyocell mix
  - 42% to 81% worse TS7 with the CMF addition
- The Hand feel is independent on the type of synthetic fibre
- The TS7 is slightly better when 100% PLA is used instead of Lyocell
- 50% PLA is comparable to 25/25% PLA/Lyocell



Influence of PLA and Lyocell

- PLA/DP mix yields better softness than Lyocell
- Even with PLA of 50% (yields Hand feel and softness) 50% SW gives a much too rough TS7
- Replacing SW with DP greatly improves the HF and TS7



Fibre and Additive Screening: In conclusion

- Pressing should be low to obtain any HF and softness values (0.5 bar at the lab scale)
- Longer fibres contribute to both strength and stiffness
- PLA addition significantly improves the HF and softness and the 6mm Lyocell content may be used to increase the strength further
- Replacing SW with DP greatly improves the HF and TS7 but low amounts of SW are needed to obtain enough strength
- Retention of 5% CMF on Lyocell fibres improves consolidation but improves little to the strength
  - 10 wt%(of the sheet) CMF significantly reduces HF and softness
- Biobinders may improve strength without a significant loss of HF and softness

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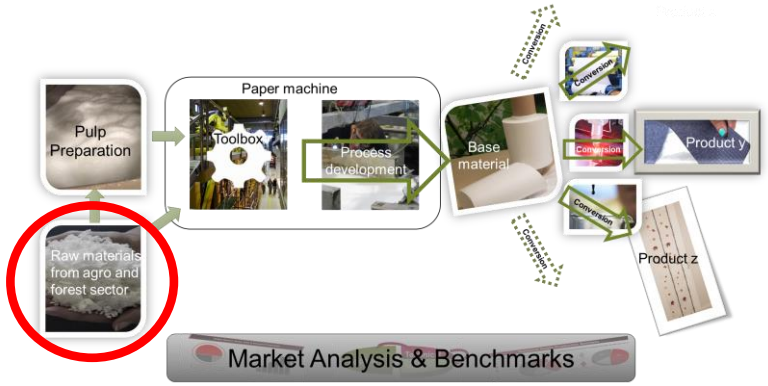
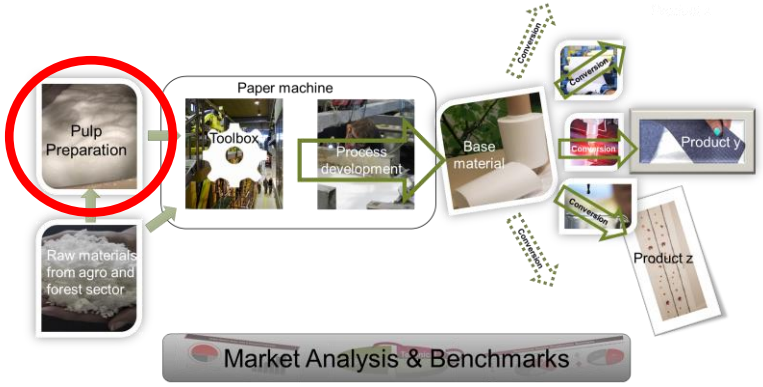
Fibre and Additive Screening
Optimizing for strength and softness



- The ingoing raw material could be tailored to balance the softness to the strength needed for the application
- A completely biobased, renewable and compostable multimaterial could achieve the set target in terms of both softness and strength even for relatively thin qualities (100 g/m²)

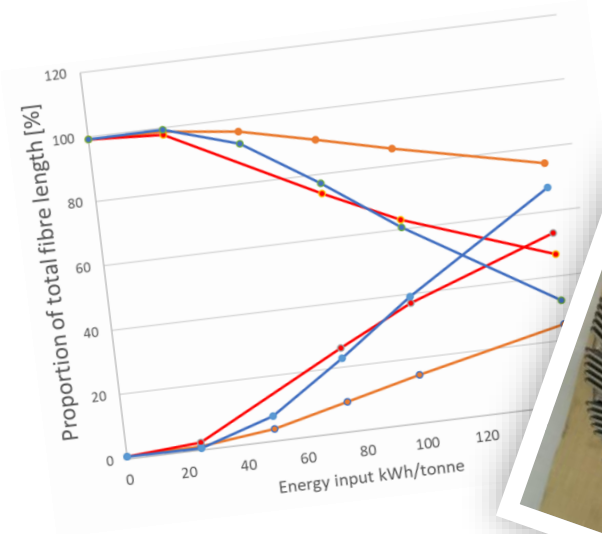
Pulp preparation

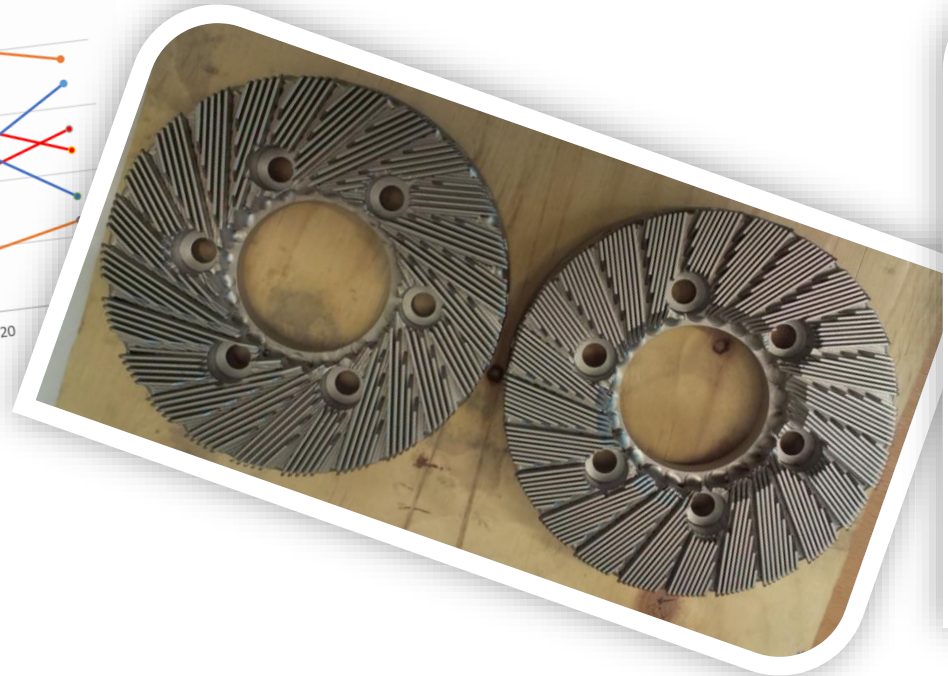
Pulp preparation



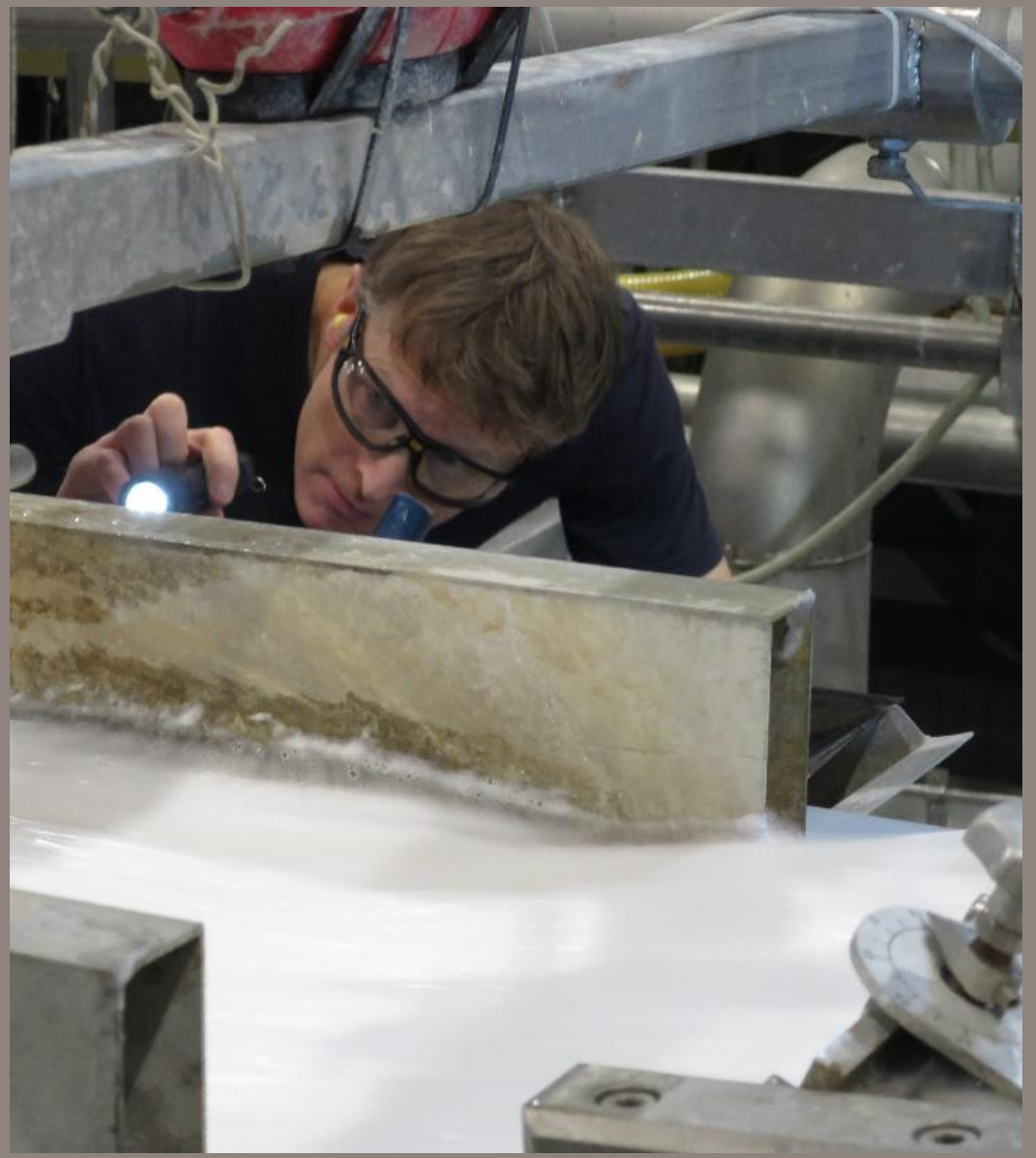
Further possible improvements:

- Refiner fillings could be designed for improved softness (through introduction of micro compressions and kinks) and without significant risk of flocculation of the pulp suspension
  - Especially if treated with charged polymers in the paper making process



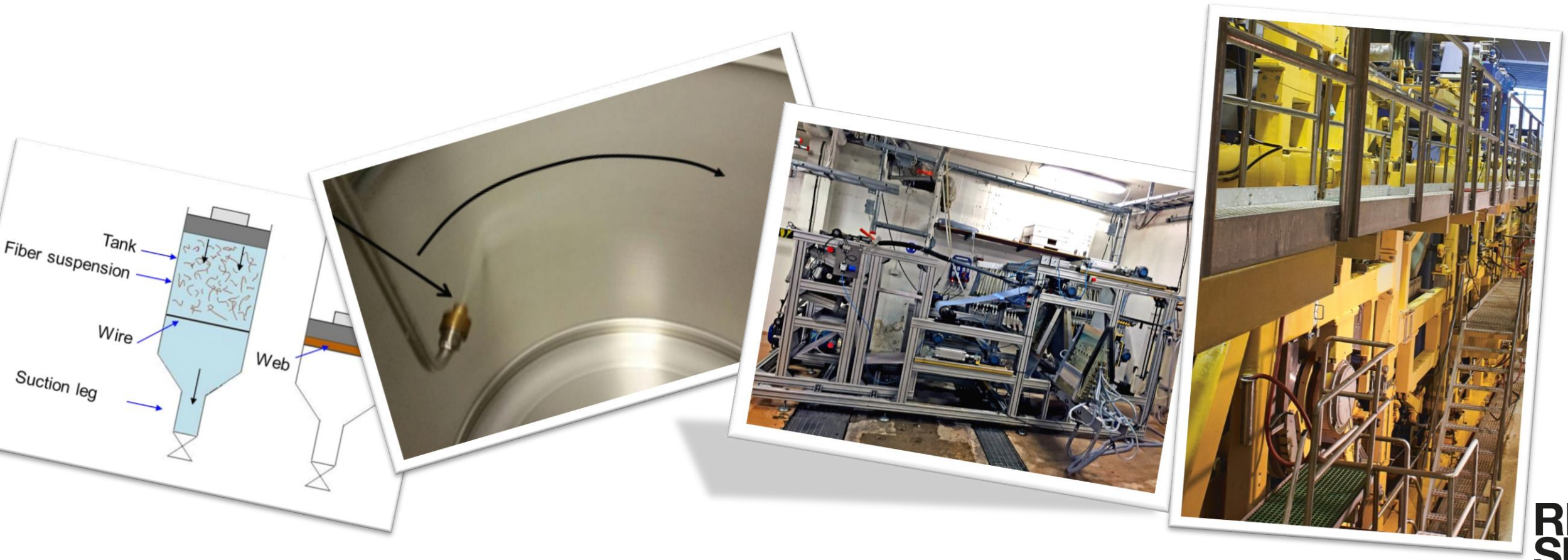


Process development and the paper machine toolbox



Process development

- Developing/optimizing textile-like material production techniques on the paper machine.
- Going from lab to semi-pilot to full scale pilot production



Process development

- Full scale pilot production could be handled continuously as well as in batch-wise productions without risks of contamination of the subsequent product
- Specially designed head box, on line measurements and foam forming was used to introduce 8mm long fibres into the paper making process

One base material to rule them all

- We work with the concept of a base material suitable for an array of applications
  - Readily convertible to different products
- Either when **a new material of a new application** OR when **an alternative material to an existing application** is introduced, the demand is typically low
  - The production rates of a paper machine need to fill several (new) product demands to be cost efficient
    - Each individual annual demand is typically too low on its own

One base material to rule them all

- The base material itself is
  - Twice as flushable as today's wipes
  - Renewable, compostable
  - Sealable, absorbent, warm to the touch
  - Softer than tissue paper but thrice as strong
- Various converting applications and functionalization chemistry are applicable to adapt the base material to textile-like material products.
  - Microcreping for stretch and drapability
  - Weldable for improved strength without loss of textile properties
  - Coating for added functionality
    - Hydrophobic
    - Flame retardant
  - Coloring and Printable
  - Curable for improvement of strength

Demonstrating the potential

- A number of different demonstrators were produced to show the various possibilities
  - A soft, printed curtain
  - A sealed, colored and

  unique patterned bag
  - An ultra fast fashion clothing
  - A sound absorbent for interior design
  - A complex shaped package detail

THANK YOU!

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