



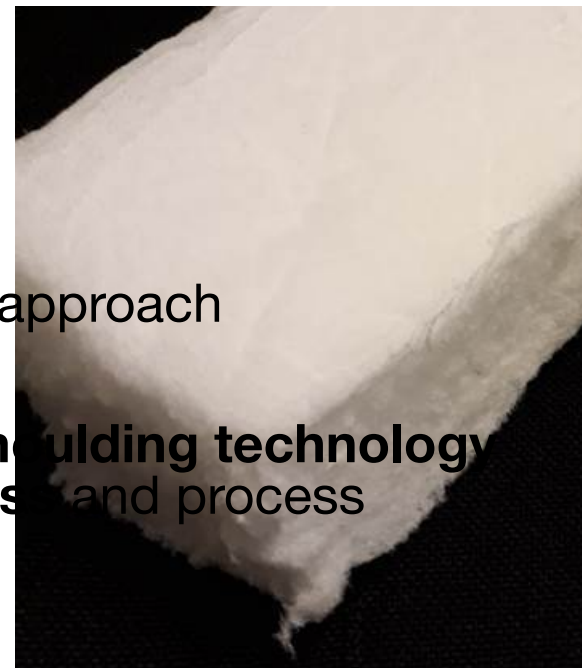
# Foam formed acoustic elements

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# Targets and motivation

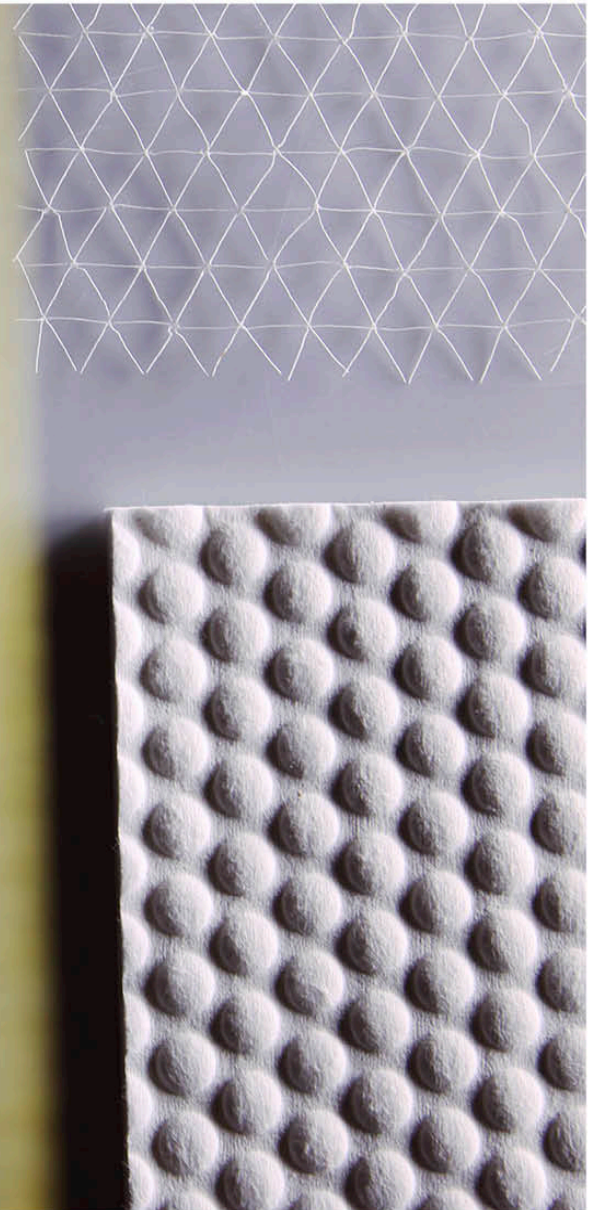


- **Overall goal**
  - To combine technological solution and design approach
- **Technologies**
  - In this study, **foam forming technology** and **moulding technology** was examined through a **design-driven process** and process entailing iterative prototyping.
- **Interactions**
  - Interactions between **wood-pulp fibres**, the **perforated mould** and the **forming process** opened opportunities for multi-scale material design, which re-defined the direction of the research.
- **Modified structures**
  - This finding entailed the simultaneous formation of macroscopic **3D forms, surface textures**, and micro-porous material structures.
- **Application**
  - The studied application was **sound insulation in interior spaces** based on a **foam-formed monomaterial** structure made of renewable and recyclable biomaterials.



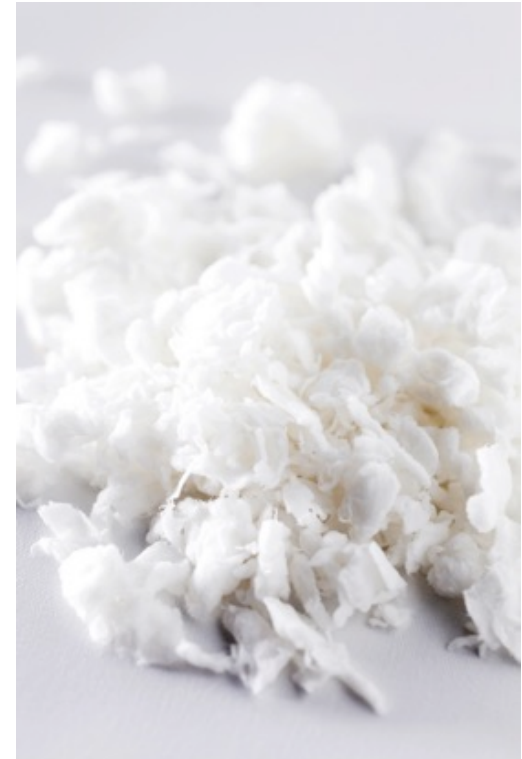
**DESIGN DRIVEN  
VALUE CHAINS  
IN THE WORLD  
OF CELLULOSE  
DWoC 2.0**

Design-driven mould  
development and results



# Materials

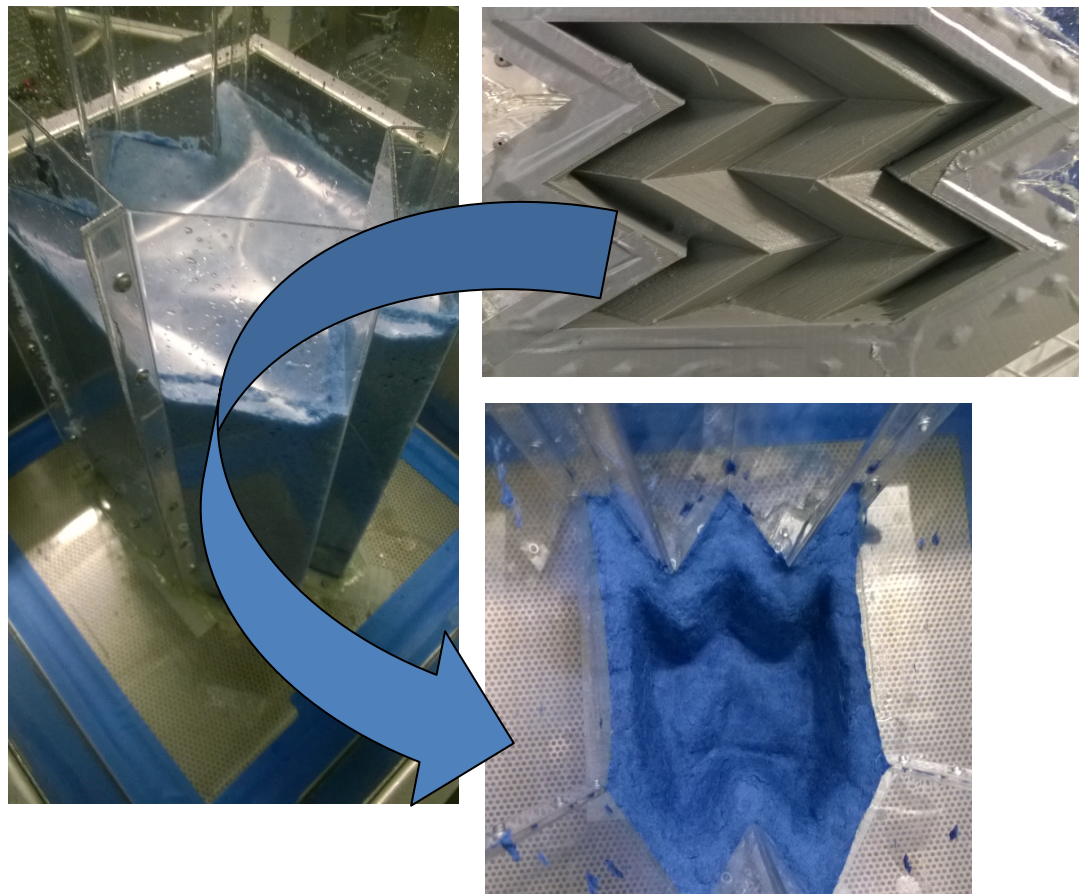
- The cellulosic fibre material was gently refined bleached kraft pulp (pine, coarseness 142  $\mu\text{g}/\text{m}$ , 20°SR).
- The pulp (dry solids content 13.8%) was dyed with commercially available colours.





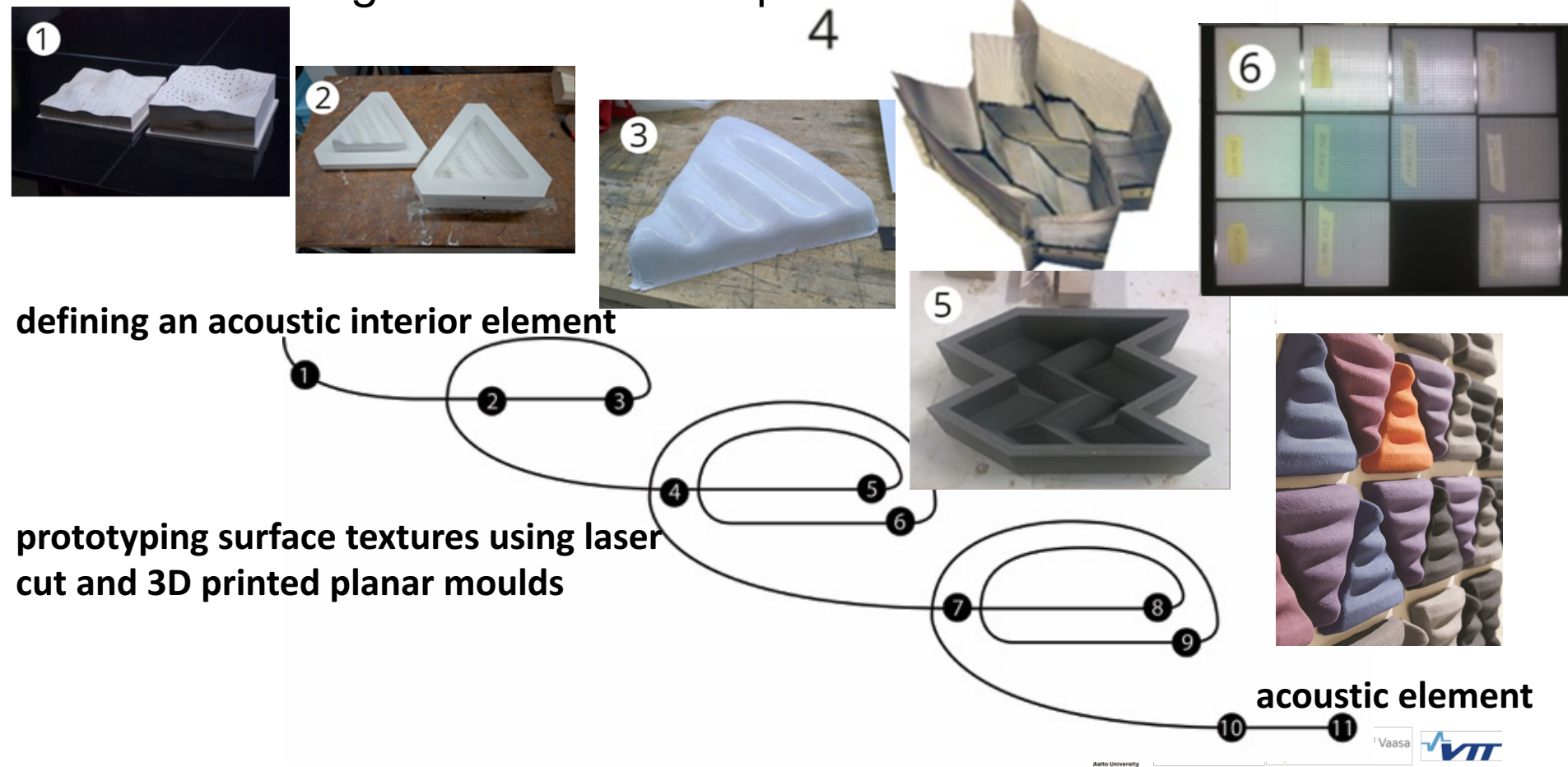
## Foam forming of 3D-forms and surface textures

- Foam moulding process with dyed kraft fibres and wet fibre network after vacuum assisted dewatering.
- Vacuum level around 50 kPa in dewatering phase.



# Design-driven iterative process

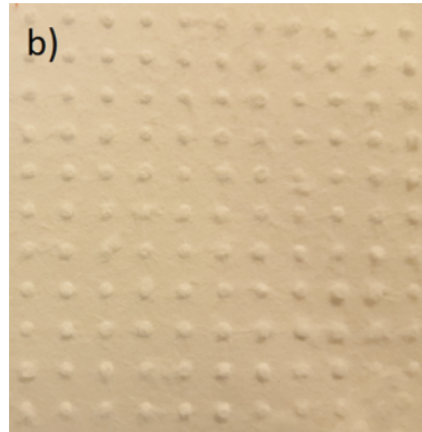
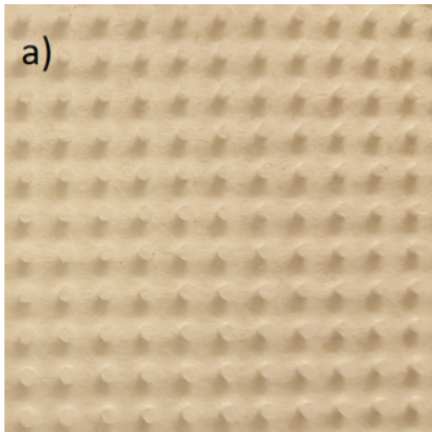
- Research was executed through a design-driven iterative process and this diagram represents the stages and sequences of the design-driven iterative process used in the research.



# Tailoring material surface texture with controlled foam removal

## Strength of foam-based process

- In water forming, one usually tries to get rid of **any “wire marking”**, which is considered undesirable for planar products like paper or board. In relation to foam forming, similar surface effects have not been previously discussed.
- Comparison of surface texture for a) **foam forming** and b) **water forming** using the planar sheet mould
- In the case of foam forming, designed surface structure could be copied from the mould into sheet





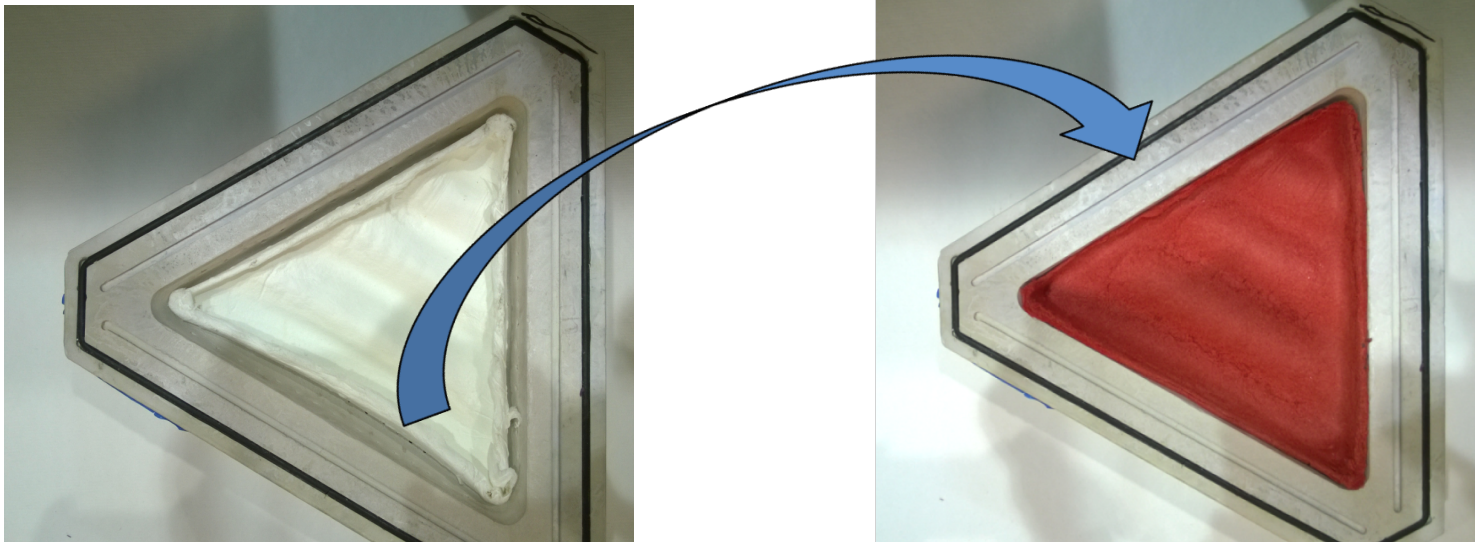
# From planar to 3D-forms

- With **the metal wire mould**, the **panels were found to repeat the relatively sharp edges of the mould** whenever the drainage in that corresponding area was effective.
- **3D-form** with sharp edges and surface texture **copied from the wire mould**.



# Drying and dimensional stability

- Dying and Shrinking
  - Drying of the wet fibre material proved to be a critical operation due to the natural tendency of the fibres to shrink which leads to **dimensional instability**
- Solution
  - This was solved by special mold technology; shrinkage remained below 2% during drying.



## This research led to a demonstration of acoustic wall

- Acoustic wall of 56 panels of varying colour using mould technology at Pulp&Paper exhibition in 2014



Photo: Eeva Suorlahti



# Conclusions

- **Economy:** Competitive /low raw material price. Production process suitable for small companies
- **Foam** can be used **as a carrier medium** that enables controlled forming of uniform surface textures.
- **Design-driven process** entailing iterative prototyping turned out to be **a powerful way to develop cellulosic fibre materials** based on foam forming technology.
- **Dimensional stability** can be **improved through restricted drying** to minimize shrinkage.
- **Interdisciplinary collaboration** linking the design-driven process to a material-based approach led to new findings regarding both technical and perceptual qualities.

# Thank you

**PRESENTED BY**

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