

# MEETING THE MATERIAL HALFWAY

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# INTRODUCTION

My research examines spring wool from the double-coated, pigmented breed Norwegian Old Spæl sheep. In this booklet, I have categorized the empirical data gathered during my practical work. The booklet can be read either together with the felted textiles from the practical research or as a database for achievable aspects of felted textiles made from this type of wool.

The booklet is constructed by analysing performance aspects like aesthetic, technical, and functional aspects of the felted samples. In addition, I have added information about felting stages and ratio of wool on a given surface. The three stages of felting are described as pre-felt, hardening, and fulling. Ratio is calculated as g / cm<sup>2</sup>.

In my research lustre, halo and **hand** are important. **Hand** is a wide term for the kinaesthetic and tactile - the movement aspects of a textile. The term **hand**, refers to the emotional sensations resulting from touching, moving, or squeezing the textile surface with the human hand. Aesthetic features also cover inner-structure aspects like: compressibility, density, extensibility, texture, and flexibility.

The wool used was sorted into four colours: black, grey, brown and light natural, and given numbers for samples names.

Before felting, the wool was processed industrially. Below is an overview of the five different manipulations the wool has been through:

- Samples ending with 0 - process were almost all guard hairs have been removed
- Samples ending with 1 - opening of the wool with a picker
- Samples ending with 2 - opening of the wool with a picker and then separated
- Samples ending with 3 - opening of the wool with a picker, then separated and carded
- Samples ending with 4 - opening of the wool with a picker and then carded

# TEST A 1.0 - 4.0

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>1.0</b>    | Fulling       | 0.025 |
| <b>2.0</b>    | Fulling       | 0.025 |
| <b>3.0</b>    | Fulling       | 0.025 |
| <b>4.0</b>    | Fulling       | 0.025 |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST A</b>    |                        |
| <b>1.0</b>       | 66                     |
| <b>2.0</b>       | 66                     |
| <b>3.0</b>       | 58                     |
| <b>4.0</b>       | 66                     |



| <b>Aesthetic</b>       |             |                 |               |             |
|------------------------|-------------|-----------------|---------------|-------------|
| <b>Inner Structure</b> |             |                 |               |             |
|                        | Flexibility | Compressability | Extensibility | Density     |
| <b>TEST A</b>          |             |                 |               |             |
| <b>1.0</b>             | Medium      | Low             | Low           | High        |
| <b>2.0</b>             | Medium      | Low             | Low           | Medium-high |
| <b>3.0</b>             | Medium      | Low             | Low-medium    | Medium-high |
| <b>4.0</b>             | Medium      | Low             | Low-medium    | Medium-high |

# TEST A 1.0 - 4.0

| Aesthetic |  |  |      |                   |       |
|-----------|--|--|------|-------------------|-------|
| Surface   |  |  |      |                   |       |
|           | Hand-soft/coars  | Hand-features  | Halo | Color Consistency | Shine |
| TEST A    |  |  |      |                   |       |
| 1.0       | These samples are very soft to the skin. When touching it with the upper palm of my hand, I do not experience it as coarse. When moving it up and down on the soft skin of my inner wrist, I notice that there are coarser hairs that prickle my skin. | The surface is rather even with few light fibres that protrude, giving the samples a light halo. 1.0 and 4.0 do show some tendency to bulk. The samples all have a smooth surface, with a slightly dull and matte finish.  | Low  | Low-medium        | Low   |
| 2.0       | These samples are very soft to the skin. When touching it with the upper palm of my hand, I do not experience it as coarse. When moving it up and down on the soft skin of my inner wrist, I notice that there are coarser hairs that prickle my skin. | The surface is rather even with few light fibres that protrude, giving the samples a light halo. 1.0 and 4.0 do show some tendency to bulk. The samples all have a smooth surface, with a slightly dull and matte finish.. | Low  | Low-medium        | Low   |
| 3.0       | These samples are very soft to the skin. When touching it with the upper palm of my hand, I do not experience it as coarse. When moving it up and down on the soft skin of my inner wrist, I notice that there are coarser hairs that prickle my skin. | The surface is rather even with few light fibres that protrude, giving the samples a light halo. 1.0 and 4.0 do show some tendency to bulk. The samples all have a smooth surface, with a slightly dull and matte finish.  | Low  | Low-medium        | Low   |
| 4.0       | These samples are very soft to the skin. When touching it with the upper palm of my hand, I do not experience it as coarse. When moving it up and down on the soft skin of my inner wrist, I notice that there are coarser hairs that prickle my skin. | The surface is rather even with few light fibres that protrude, giving the samples a light halo. 1.0 and 4.0 do show some tendency to bulk. The samples all have a smooth surface, with a slightly dull and matte finish.  | Low  | Low-medium        | Low   |

# TEST A 8.1 - 8.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>1.0</b>    | Fulling       | 0.025 |
| <b>2.0</b>    | Fulling       | 0.025 |
| <b>3.0</b>    | Fulling       | 0.025 |
| <b>4.0</b>    | Fulling       | 0.025 |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST A</b>    |                        |
| <b>8.1</b>       | 75                     |
| <b>8.2</b>       | 66                     |
| <b>8.3</b>       | 66                     |
| <b>8.4</b>       | 66                     |



| <b>Aesthetic</b>       |             |                 |               |         |
|------------------------|-------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |             |                 |               |         |
|                        | Flexibility | Compressability | Extensibility | Density |
| <b>TEST A</b>          |             |                 |               |         |
| <b>8.1</b>             | Low         | Low             | Low           | High    |
| <b>8.2</b>             | Low         | Low             | Low           | High    |
| <b>8.3</b>             | Low         | Low             | Low           | High    |
| <b>8.4</b>             | Low         | Low             | Low           | High    |

# TEST A 8.1 - 8.4

| Aesthetic  |   |  |              |                    |        |
|------------|---|--|--------------|--------------------|--------|
| Surface    |   |  |              |                    |        |
|            | Hand-soft/coars   | Hand-features  | Halo         | Colour Consistency | Shine  |
| TEST A     |   |  |              |                    |        |
| <b>8.1</b> | Rough and coarse, but not as sticky as in samples 8.2-8.4   | Texture is vivid and detailed. Guard hairs are caught in-between softer fibres, giving the surface a bulky and dynamic look. There are swirling loops of long hairs on the surface. This feature contributes to extra shine in the felt. The inconsistency in colour adds to the vibrant and lively look of the textile in the same way that the bulky and loopy texture does. | High         | Low                | High   |
| <b>8.2</b> | Rougher to touch than both 1.0-4.0, and 8.1. These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed colour. The felt has a slightly dull exterior.   | Low - medium | Medium             | Medium |
| <b>8.3</b> | Rougher to touch than both 1.0-4.0, and 8.1. These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed colour. The felt has a slightly dull exterior.   | Low - medium | Medium             | Medium |
| <b>8.4</b> | Rougher to touch than both 1.0-4.0, and 8.1. These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed colour. The felt has a slightly dull exterior.   | Low - medium | Medium             | Medium |

# TEST A 9.1.1 - 9.1.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>9.1.1</b>  | Fulling       | 0.025 |
| <b>9.1.2</b>  | Fulling       | 0.025 |
| <b>9.1.3</b>  | Fulling       | 0.025 |
| <b>9.1.4</b>  | Fulling       | 0.025 |

| Technical     |                         |
|---------------|-------------------------|
|               | Total Area Shrinkage %% |
| <b>TEST A</b> |                         |
| <b>9.1.1</b>  | 74                      |
| <b>9.1.2</b>  | 60                      |
| <b>9.1.3</b>  | 67                      |
| <b>9.1.4</b>  | 66                      |



| Aesthetic       |             |                 |               |             |
|-----------------|-------------|-----------------|---------------|-------------|
| Inner Structure |             |                 |               |             |
|                 | Flexibility | Compressability | Extensibility | Density     |
| <b>TEST A</b>   |             |                 |               |             |
| <b>9.1.1</b>    | Low         | Low             | Low           | High        |
| <b>9.1.2</b>    | Medium      | Low             | Low-medium    | Medium-high |
| <b>9.1.3</b>    | Low         | Low             | Low           | High        |
| <b>9.1.4</b>    | Low         | Low             | Low           | High        |



# TEST A 9.1.1 - 9.1.4

| Aesthetic    |   |   |            |                   |        |
|--------------|---|---|------------|-------------------|--------|
| Surface      |   |   |            |                   |        |
|              | Hand-soft/coars   | Hand-features   | Halo       | Color Consistency | Shine  |
| TEST A       |   |   |            |                   |        |
| <b>9.1.1</b> | Rough to touch and coarse to my palm and hand.  | Texture is vivid and detailed. Guard hairs are caught in-between softer fibres, giving the surface a bulky and dynamic look. There are swirling loops of long hairs on the surface. This feature contributes to extra shine in the felt. The inconsistency in color adds to the vibrant and lively look of the textile in the same way that the bulky and loopy texture does. | High       | Low               | Medium |
| <b>9.1.2</b> | Rougher to touch than both 1.0-4.0, and 9.1.1<br>These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.   | Low-medium | Medium            | Medium |
| <b>9.1.3</b> | Rougher to touch than both 1.0-4.0, and 9.1.1<br>These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.   | Low-medium | Medium            | Medium |
| <b>9.1.4</b> | Rougher to touch than both 1.0-4.0, and 9.1.1<br>These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.   | Low-medium | Medium            | Medium |

# TEST A 10.1 - 10.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>10.1</b>   | Fulling       | 0.025 |
| <b>10.2</b>   | Fulling       | 0.025 |
| <b>10.3</b>   | Fulling       | 0.025 |
| <b>10.4</b>   | Fulling       | 0.025 |

| Technical     |                        |
|---------------|------------------------|
|               | Total Area Shrinkage % |
| <b>TEST A</b> |                        |
| <b>10.1</b>   | 71                     |
| <b>10.2</b>   | 69                     |
| <b>10.3</b>   | 70                     |
| <b>10.4</b>   | 71                     |



| Aesthetic       |             |                 |               |         |
|-----------------|-------------|-----------------|---------------|---------|
| Inner Structure |             |                 |               |         |
|                 | Flexibility | Compressability | Extensibility | Density |
| <b>TEST A</b>   |             |                 |               |         |
| <b>10.1</b>     | Low         | Low             | Low           | High    |
| <b>10.2</b>     | Low         | Low             | Low           | High    |
| <b>10.3</b>     | Low         | Low             | Low           | High    |
| <b>10.4</b>     | Low         | Low             | Low           | High    |

# TEST A 10.1 - 10.4

| Aesthetic   |  |  |            |                   |        |
|-------------|--|--|------------|-------------------|--------|
| Surface     |  |  |            |                   |        |
|             | Hand-soft/coars  | Hand-features  | Halo       | Color Consistency | Shine  |
| TEST A      |  |  |            |                   |        |
| <b>10.1</b> | All these samples feel rough and coarse to the skin. Not so many differences between the four samples. | Texture is less vivid and detailed due to its more homogenic colour. Guard hairs are caught in between softer fibres, still giving the surface a slightly dynamic look. But they are more difficult to observe against the evenly brown surface. Loops of swirling, long hairs on the surface, which contributes to extra shine. | High       | High              | High   |
| <b>10.2</b> | All these samples feel rough and coarse to the skin. Not so many differences between the four samples. | Guard hairs and softer fibres almost have the same color in these samples, giving the surface a very even and homogenic look in color. The surface is slightly dull.   | Low-medium | High              | Medium |
| <b>10.3</b> | All these samples feel rough and coarse to the skin. Not so many differences between the four samples. | Guard hairs and softer fibres almost have the same color in these samples, giving the surface a very even and homogenic look in color. The surface is slightly dull.   | Low-medium | High              | Medium |
| <b>10.4</b> | All these samples feel rough and coarse to the skin. Not so many differences between the four samples. | Guard hairs and softer fibres almost have the same color in these samples, giving the surface a very even and homogenic look in color. The surface is slightly dull.   | Low-medium | High              | Medium |

# TEST A 10.1.1 - 10.1.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>10.1.1</b> | Fulling       | 0.025 |
| <b>10.1.2</b> | Fulling       | 0.025 |
| <b>10.1.3</b> | Fulling       | 0.025 |
| <b>10.1.4</b> | Fulling       | 0.025 |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST A</b>    |                        |
| <b>10.1.1</b>    | 71                     |
| <b>10.1.2</b>    | 69                     |
| <b>10.1.3</b>    | 70                     |
| <b>10.1.4</b>    | 71                     |



| <b>Aesthetic</b>       |             |                 |               |         |
|------------------------|-------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |             |                 |               |         |
|                        | Flexibility | Compressability | Extensibility | Density |
| <b>TEST A</b>          |             |                 |               |         |
| <b>10.1.1</b>          | Low         | Low             | Medium        | Medium  |
| <b>10.1.2</b>          | Low         | Low             | Low           | High    |
| <b>10.1.3</b>          | Low         | Low             | Low           | High    |
| <b>10.1.4</b>          | Low         | Low             | Low           | High    |

# TEST A 10.1.1 - 10.1.4

| Aesthetic     |  |  |             |                   |        |
|---------------|--|--|-------------|-------------------|--------|
| Surface       |  |  |             |                   |        |
|               | Hand-soft/coars  | Hand-features  | Halo        | Color Consistency | Shine  |
| TEST A        |  |  |             |                   |        |
| <b>10.1.1</b> | Rough and coarse, but not as sticky as the samples 10.1.2 - 10.1.4. Almost a noticeable soft spot here and there.  | Texture is vivid and detailed. The lighter grey and beige guard hairs display beautiful loopy patterns on the surface. Guard hairs are caught in between softer fibres, but not so dramatic as in 8.1 and 9.1.1. The surface still has an uneven and lumpy look. Loops of long hairs are still visible, which contribute to an exciting feature of shine. The inconsistency in color contributes to the vibrant and lively look of the felted textile. | Medium-high | Medium            | Medium |
| <b>10.1.2</b> | Rougher to touch than both 1.0-4.0, and 10.1.1. These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.  | Low-medium  | High              | Low    |
| <b>10.1.3</b> | Rougher to touch than both 1.0-4.0, and 10.1.1. These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.  | Low-medium  | High              | Low    |
| <b>10.1.4</b> | Rougher to touch than both 1.0-4.0, and 10.1.1. These samples are very comparable in touch as they tingle and prickle the hand with the coarser, sticky hairs. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.  | Low-medium  | High              | Low    |

# TEST A 11.1 - 11.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>11.1</b>   | Fulling       | 0.025 |
| <b>11.2</b>   | Fulling       | 0.025 |
| <b>11.3</b>   | Fulling       | 0.025 |
| <b>11.4</b>   | Fulling       | 0.025 |

| Technical     |                        |
|---------------|------------------------|
|               | Total Area Shrinkage % |
| <b>TEST A</b> |                        |
| <b>11.1</b>   | 77                     |
| <b>11.2</b>   | 71                     |
| <b>11.3</b>   | 64                     |
| <b>11.4</b>   | 69                     |



| Aesthetic       |             |                 |               |         |
|-----------------|-------------|-----------------|---------------|---------|
| Inner Structure |             |                 |               |         |
|                 | Flexibility | Compressability | Extensibility | Density |
| <b>TEST A</b>   |             |                 |               |         |
| <b>11.1</b>     | Low         | Low             | Low           | High    |
| <b>11.2</b>     | Low         | Low             | Low           | High    |
| <b>11.3</b>     | Low         | Low             | Low           | High    |
| <b>11.4</b>     | Low         | Low             | Low           | High    |

# TEST A 11.1 - 11.4

| Aesthetic   |   |   |        |                   |        |
|-------------|---|---|--------|-------------------|--------|
| Surface     |   |   |        |                   |        |
|             | Hand-soft/coars   | Hand-features   | Halo   | Color Consistency | Shine  |
| TEST A      |   |   |        |                   |        |
| <b>11.1</b> | The coarsest samples in all of test A. Rough, sticky, and prickling sensation everywhere on the skin. | The most vivid sample with long, loopy guard hairs almost jumping out from the felted textile. The sample is crazy and wild in surface appearance. Guard hairs create loops, curls and even small bubbles all over the surface of the felt. | High   | Low               | High   |
| <b>11.2</b> | The coarsest samples in all of test A. Rough, sticky, and prickling sensation everywhere on the skin. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.   | Medium | High              | Medium |
| <b>11.3</b> | The coarsest samples in all of test A. Rough, sticky, and prickling sensation everywhere on the skin. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.   | Medium | High              | Medium |
| <b>11.4</b> | The coarsest samples in all of test A. Rough, sticky, and prickling sensation everywhere on the skin. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly speckled and mixed color. The felt has a slightly dull exterior.   | Medium | High              | Medium |

# TEST A 12.1 - 12.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>12.1</b>   | Fulling       | 0.025 |
| <b>12.2</b>   | Fulling       | 0.025 |
| <b>12.3</b>   | Fulling       | 0.025 |
| <b>12.4</b>   | Fulling       | 0.025 |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST A</b>    |                        |
| <b>12.1</b>      | 70                     |
| <b>12.2</b>      | 70                     |
| <b>12.3</b>      | 67                     |
| <b>12.4</b>      | 67                     |



| <b>Aesthetic</b>       |             |                 |               |         |
|------------------------|-------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |             |                 |               |         |
|                        | Flexibility | Compressability | Extensibility | Density |
| <b>TEST A</b>          |             |                 |               |         |
| <b>12.1</b>            | Low         | Low             | Low           | High    |
| <b>12.2</b>            | Low         | Low             | Low           | High    |
| <b>12.3</b>            | Low         | Low             | Low           | High    |
| <b>12.4</b>            | Low         | Low             | Low           | High    |



# TEST A 12.1 - 12.4

| Aesthetic     |  |   |              |                   |        |
|---------------|--|---|--------------|-------------------|--------|
| Surface       |  |   |              |                   |        |
|               | Hand-soft/coars  | Hand-features   | Halo         | Color Consistency | Shine  |
| <b>TEST A</b> |  |   |              |                   |        |
| <b>12.1</b>   | 12.1 - 12.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | This sample is calmer on the surface. Some loops of guard hairs are visible, protruding the surface, but mostly it is quite even. | Medium - low | High              | Medium |
| <b>12.2</b>   | 12.1 - 12.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | Samples have a even black color and surface is neat and calm. Just a few lighter, coloured hairs are visible.                     | Medium - low | High              | Medium |
| <b>12.3</b>   | 12.1 - 12.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | Samples have a even black color and surface is neat and calm. Just a few lighter, coloured hairs are visible.                     | Medium - low | High              | Medium |
| <b>12.4</b>   | 12.1 - 12.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | Samples have a even black color and surface is neat and calm. Just a few lighter, coloured hairs are visible.                     | Medium - low | High              | Medium |



# TEST A 12.1.1 - 12.1.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST A</b> |               |       |
| <b>12.1.1</b> | Fulling       | 0.025 |
| <b>12.1.2</b> | Fulling       | 0.025 |
| <b>12.1.3</b> | Fulling       | 0.025 |
| <b>12.1.4</b> | Fulling       | 0.025 |

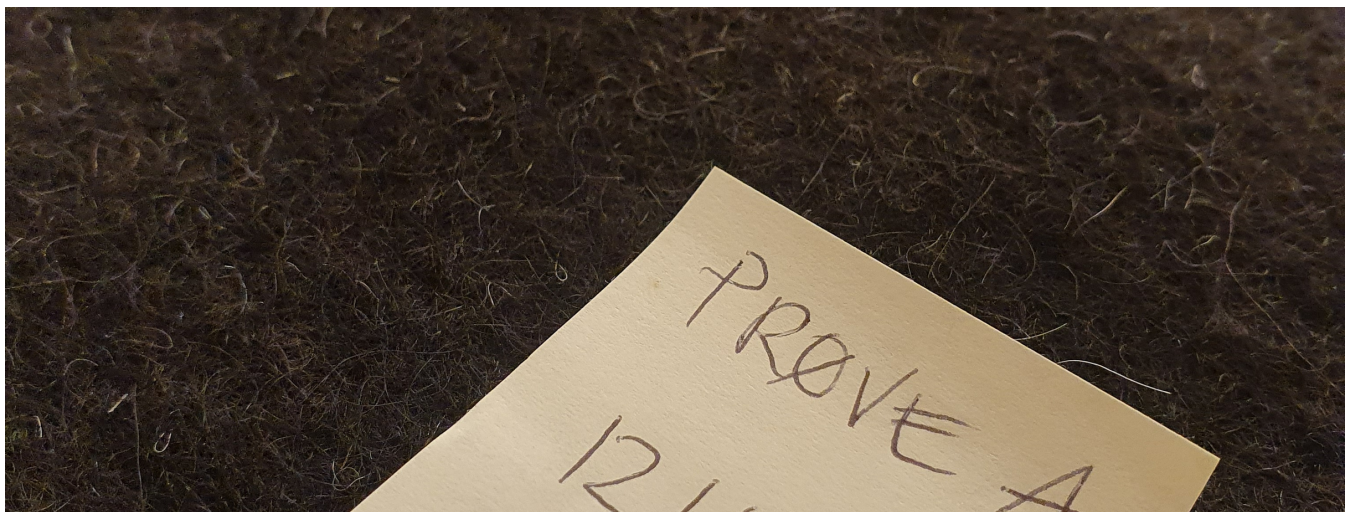
| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST A</b>    |                        |
| <b>12.1.1</b>    | 73                     |
| <b>12.1.2</b>    | 70                     |
| <b>12.1.3</b>    | 70                     |
| <b>12.1.4</b>    | 69                     |



| <b>Aesthetic</b>       |             |                 |               |         |
|------------------------|-------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |             |                 |               |         |
|                        | Flexibility | Compressability | Extensibility | Density |
| <b>TEST A</b>          |             |                 |               |         |
| <b>12.1.1</b>          | Low         | Low             | Medium        | High    |
| <b>12.1.2</b>          | Low         | Low             | Low           | High    |
| <b>12.1.3</b>          | Low         | Low             | Low           | High    |
| <b>12.1.4</b>          | Low         | Low             | Low           | High    |

# TEST A 12.1.1 - 12.1.4

| Aesthetic     |  |   |        |                   |        |
|---------------|--|---|--------|-------------------|--------|
| Surface       |  |   |        |                   |        |
|               | Hand-soft/coars  | Hand-features   | Halo   | Color Consistency | Shine  |
| <b>TEST A</b> |  |   |        |                   |        |
| <b>12.1.1</b> | 12.1.1 - 12.1.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | Texture is quite vivid and detailed, displaying some white coarser hairs as loops and curls on the surface. This effect creates a lumpy and dynamic look.                     | High   | Medium            | High   |
| <b>12.1.2</b> | 12.1.1 - 12.1.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly mixed black, greyish color. The felt has a slightly dull look. | Medium | Medium            | Medium |
| <b>12.1.3</b> | 12.1.1 - 12.1.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly mixed black, greyish color. The felt has a slightly dull look. | Medium | Medium            | Medium |
| <b>12.1.4</b> | 12.1.1 - 12.1.4 all have similar touch. They are coarse all over, and the skin prickles a lot. | Guard hairs are evenly mixed within the structure of the felt and on the surface, giving the samples an evenly mixed black, greyish color. The felt has a slightly dull look. | Medium | Medium            | Medium |



# TEST B 8.1

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST B</b> |               |       |
| <b>8.1</b>    | Pre-felt      | 0.05  |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST B</b>    |                        |
| <b>8.1</b>       | 25                     |



| <b>Aesthetic</b>       |                |                 |               |         |
|------------------------|----------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |                |                 |               |         |
|                        | Flexibility    | Compressability | Extensibility | Density |
| <b>TEST B</b>          |                |                 |               |         |
| <b>8.1</b>             | Medium to high | Medium          | Medium        | Medium  |

# TEST B 8.1

| Aesthetic  |   |   |      |                   |       |
|------------|---|---|------|-------------------|-------|
| Surface    |   |   |      |                   |       |
|            | Hand-soft/coars   | Hand-features   | Halo | Color Consistency | Shine |
| TEST B     |   |   |      |                   |       |
| <b>8.1</b> | This sample is coarse, but despite that there is almost no prickle on the skin. | The surface is vivid and vibrant due to the very visible guard hairs. They create an exciting and dynamic aesthetic look with colour shifts of grey, beige and black. The surface is lumpy and uneven. Loops of long hairs are visible, both on the surface and on most of the edges where they stretch outwards like wool on a sheep. The very visible guard hairs contribute to an exciting feature of shine. The inconsistency in color gives the felted textile a thrilling look, and adds extra shine. | High | Low               | High  |



# TEST C 11.1 - 11.4

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST C</b> |               |       |
| <b>11.1</b>   | Pre-felt      | 0.025 |
| <b>11.2</b>   | Pre-felt      | 0.025 |
| <b>11.3</b>   | Pre-felt      | 0.025 |
| <b>11.4</b>   | Pre-felt      | 0.025 |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST C</b>    |                        |
| <b>11.1</b>      | 43                     |
| <b>11.2</b>      | 38                     |
| <b>11.3</b>      | 39                     |
| <b>11.4</b>      | 40                     |



| <b>Aesthetic</b>       |             |                 |               |         |
|------------------------|-------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |             |                 |               |         |
|                        | Flexibility | Compressability | Extensibility | Density |
| <b>TEST C</b>          |             |                 |               |         |
| <b>11.1</b>            | High        | Medium          | High          | Low     |
| <b>11.2</b>            | High        | Medium          | High          | Low     |
| <b>11.3</b>            | High        | Medium          | High          | Low     |
| <b>11.4</b>            | High        | Medium          | High          | Low     |

# TEST C 11.1- 11.4

| Aesthetic     |  |   |        |                   |        |
|---------------|--|---|--------|-------------------|--------|
| Surface       |  |   |        |                   |        |
|               | Hand-soft/coars  | Hand-features   | Halo   | Color Consistency | Shine  |
| <b>TEST C</b> |  |   |        |                   |        |
| <b>11.1</b>   | All these samples are soft to the skin. There are no harsh prickling when striking the surface with my hand. When placing the felt against the soft skin on the inside of my wrist, I experience resistance when moving it back and forth. This is still not enough to get a coarse or itchy feeling.  | Frequent locks of guard hairs are close to the surface, and in this sample, they are much more accessible than in test A. Some of the hairs are not felted completely into the textile. Instead, they hover somewhat over the surface, giving the felt a natural, vivid look. This feature also gives the felt a natural change in color and a dynamic, vibrant look. The exterior has a lot of resemblance to the wool when it was still on the sheep. The surface is uneven, so is the structure. | High   | Low               | High   |
| <b>11.2</b>   | All these samples are soft to the skin. There are no harsh prickling when striking the surface with my hand. When placing the felt against the soft skin on the inside of my wrist, I experience resistance when moving it back and forth. The resistance of fibres are just slightly more prominent in samples 11.2-11.4. But, still not enough to get a coarse or itchy feeling. | Samples 11.2-11.4 are very similar. The surface is covered with beige guard hairs that with the darker brown finer fibres have intertwined to create a felt that is monotone and seems calm. The colours have mixed evenly all over giving the felt a speckled nuance.  | Medium | High              | Medium |
| <b>11.3</b>   | All these samples are soft to the skin. There are no harsh prickling when striking the surface with my hand. When placing the felt against the soft skin on the inside of my wrist, I experience resistance when moving it back and forth. The resistance of fibres are just slightly more prominent in samples 11.2-11.4. But, still not enough to get a coarse or itchy feeling. | Samples 11.2-11.4 are very similar. The surface is covered with beige guard hairs that with the darker brown finer fibres have intertwined to create a felt that is monotone and seems calm. The colours have mixed evenly all over giving the felt a speckled nuance.  | Medium | High              | Medium |
| <b>11.4</b>   | All these samples are soft to the skin. There are no harsh prickling when striking the surface with my hand. When placing the felt against the soft skin on the inside of my wrist, I experience resistance when moving it back and forth. The resistance of fibres are just slightly more prominent in samples 11.2-11.4. But, still not enough to get a coarse or itchy feeling. | Samples 11.2-11.4 are very similar. The surface is covered with beige guard hairs that with the darker brown finer fibres have intertwined to create a felt that is monotone and seems calm. The colours have mixed evenly all over giving the felt a speckled nuance.  | Medium | High              | Medium |

# TEST D 11.1, 11.3

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST D</b> |               |       |
| <b>11.1</b>   | Pre-felt      | 0.025 |
| <b>11.3</b>   | Pre-felt      | 0.026 |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST D</b>    |                        |
| <b>11.1</b>      | 38                     |
| <b>11.3</b>      | 30                     |



| <b>Aesthetic</b>       |             |                 |               |            |
|------------------------|-------------|-----------------|---------------|------------|
| <b>Inner Structure</b> |             |                 |               |            |
|                        | Flexibility | Compressability | Extensibility | Density    |
| <b>TEST D</b>          |             |                 |               |            |
| <b>11.1</b>            | High        | Medium          | High          | Low-Medium |
| <b>11.3</b>            | High        | Medium          | High          | Low        |



# TEST D 11.1, 11.3

| Aesthetic     |   |  |  |  |  |
|---------------|---|--|--|--|--|
| Surface       |   |  |  |  |  |
|               | Hand-soft/coars                         | Hand-features                              | Halo   | Color Consistency                            | Shine  |
| <b>TEST D</b> |   |  |  |  |  |
| <b>11.1</b>   | Results here do not differ from test C. | Surface appearances are similar to test C. | Color, shine, and halo are similar to test C | Color, shine, and halo are similar to test C | Color, shine, and halo are similar to test C |
| <b>11.3</b>   | Results here do not differ from test C. | Surface appearances are similar to test C. | Color, shine, and halo are similar to test C | Color, shine, and halo are similar to test C | Color, shine, and halo are similar to test C |



# TEST E 11.1, 11.3

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST E</b> |               |       |
| <b>11.1</b>   | Fulled        | 0.025 |
| <b>11.3</b>   | Fulled        | 0.025 |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST E</b>    |                        |
| <b>11.1</b>      | 70                     |
| <b>11.3</b>      | 66                     |



| <b>Aesthetic</b>       |             |                 |               |         |
|------------------------|-------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |             |                 |               |         |
|                        | Flexibility | Compressability | Extensibility | Density |
| <b>TEST D</b>          |             |                 |               |         |
| <b>11.1</b>            | Medium      | Medium          | Medium        | Low     |
| <b>11.3</b>            | Medium      | Low             | Medium        | Low     |

# TEST E 11.1, 11.3

| Aesthetic   |   |  |        |                   |       |
|-------------|---|--|--------|-------------------|-------|
| Surface     |   |  |        |                   |       |
|             | Hand-soft/coarse  | Hand-features  | Halo   | Color Consistency | Shine |
| TEST E      |   |  |        |                   |       |
| <b>11.1</b> | A softer surface with areas of coarse hairs prickling the skin on my hand and palm. | Frequent locks of guard hairs are close to the surface, creating a vivid and detailed surface appearance. This feature also gives the felt a natural change in color. Beige and darker brown guard hairs loop, mix and move on the surface, giving the felt a dynamic, bulky exterior. Edges have longer locks that protrude, making it uneven, hairy and organic in its shape. Lots of resemblances to natural wool on a sheep. | Low    | Low               | Low   |
| <b>11.3</b> | Rough and coarse all over when striking it with my palm and hand.                   | The felt has an almost evenly mixed colour with a darker brown look. It is quite even in shape, only edges displaying a few hairy parts. The visual effect is monotone and seems calm, but still small uneven areas are visible. When touching it with the palm of my hand it generates a feeling of pebbles - bumpy aspect.   | Medium | Low               | Low   |



# TEST F

|                  | Felting Stage | Ratio    |
|------------------|---------------|----------|
| <b>TEST F</b>    |               |          |
| <b>8.1 + 3.0</b> | Pre-felt      | No Ratio |
| <b>8.1</b>       | Pre-felt      | No Ratio |

| <b>Technical</b> |                        |
|------------------|------------------------|
|                  | Total Area Shrinkage % |
| <b>TEST F</b>    |                        |
| <b>8.1 + 3.0</b> | Not Measured           |
| <b>8.1</b>       | Not Measured           |



| <b>Aesthetic</b>       |             |                 |               |         |
|------------------------|-------------|-----------------|---------------|---------|
| <b>Inner Structure</b> |             |                 |               |         |
|                        | Flexibility | Compressability | Extensibility | Density |
| <b>TEST F</b>          |             |                 |               |         |
| <b>8.1 + 3.0</b>       | High        | Medium          | High          | Low     |
| <b>8.1</b>             | High        | Medium          | High          | Low     |

# TEST F

| Aesthetic        |  |   |        |                   |       |
|------------------|--|---|--------|-------------------|-------|
| Surface          |  |   |        |                   |       |
|                  | Hand-soft/coarse   | Hand-features   | Halo   | Color Consistency | Shine |
| <b>TEST F</b>    |  |   |        |                   |       |
| <b>8.1 + 3.0</b> | Both these samples generate a soft, pleasant touch when stroking them on my palm and inner wrist. This sample is very soft to the skin, but when sliding my hand back and forth it detects a resistance in one direction. Here, coarse fibres meet my skin and almost try to hold it back. My delicate skin on my neck complains when touching the sample, indicating that while it is still softer than almost all other samples, the softest skin on my neck does not want it close. | Guard hairs build and create networks of fibres throughout the whole felt. When held against light, an intricate pattern inside consisting of coarser hairs becomes visible. Sample is uneven which enhances the spectrum of light that shines through.   | Low    | Low               | Low   |
| <b>8.1</b>       | Both these samples generate a soft, pleasant touch when stroking them on my palm and inner wrist. On this sample, the skin just slides over, easy and without interruptions. This sample was also tried against the delicate skin on my neck, which did not complain as much as the previous sample did. 7.1 is the absolute softest and most gentle sample in all of my trials.   | Guard hairs build and create networks of fibres throughout the whole felt. When held against light, a very intricate pattern inside becomes visible. It is bulky and has a messy, uneven surface. The unevenness is enhancing the spectrum of light that shines through. In this sample, locks of guard hairs are still connected and are organised in curves, lines, and organic directions on the exterior. They attract the attention of my eye. | Medium | Low               | Low   |



# TEST G-I, AND C FUNCTIONAL PERFORMANCES

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST G</b> |               |       |
| <b>1.0</b>    | Fulling       | 0.025 |
| <b>9.1.1</b>  | Fulling       | 0.025 |
| <b>9.1.3</b>  | Fulling       | 0.025 |

| Technical     |                        |
|---------------|------------------------|
|               | Total Area Shrinkage % |
| <b>TEST G</b> |                        |
| <b>1.0</b>    | 54                     |
| <b>9.1.1</b>  | 64                     |
| <b>9.1.3</b>  | 59                     |

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST H</b> |               |       |
| <b>1.0</b>    | Pre-felt      | 0.025 |
| <b>9.1.1</b>  | Pre-felt      | 0.025 |
| <b>9.1.3</b>  | Pre-felt      | 0.025 |

| Technical     |                        |
|---------------|------------------------|
|               | Total Area Shrinkage % |
| <b>TEST H</b> |                        |
| <b>1.0</b>    | 38                     |
| <b>9.1.1</b>  | 46                     |
| <b>9.1.3</b>  | 42                     |

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST I</b> |               |       |
| <b>1.0</b>    | Hardening     | 0.05  |
| <b>9.1.1</b>  | Hardening     | 0.0   |
| <b>9.1.3</b>  | Hardening     | 0.05  |

| Technical     |                        |
|---------------|------------------------|
|               | Total Area Shrinkage % |
| <b>TEST I</b> |                        |
| <b>1.0</b>    | 34                     |
| <b>9.1.1</b>  | 38                     |
| <b>9.1.3</b>  | 34                     |

|               | Felting Stage | Ratio |
|---------------|---------------|-------|
| <b>TEST C</b> |               |       |
| <b>11.1</b>   | Pre-felt      | 0.025 |
| <b>11.2</b>   | Pre-felt      | 0.025 |
| <b>11.3</b>   | Pre-felt      | 0.025 |
| <b>11.4</b>   | Pre-felt      | 0.025 |

| Technical     |                        |
|---------------|------------------------|
|               | Total Area Shrinkage % |
| <b>TEST C</b> |                        |
| <b>11.1</b>   | 43                     |
| <b>11.2</b>   | 38                     |
| <b>11.3</b>   | 39                     |
| <b>11.4</b>   | 40                     |

# TEST G-I, AND C FUNCTIONAL PERFORMANCES

| Aesthetic       |             |                 |               |             |
|-----------------|-------------|-----------------|---------------|-------------|
| Inner Structure |             |                 |               |             |
|                 | Flexibility | Compressability | Extensibility | Density     |
| <b>TEST G</b>   |             |                 |               |             |
| <b>1.0</b>      | Low-Medium  | Low             | Low           | Medium-High |
| <b>9.1.1</b>    | Low-Medium  | Low             | Low           | Medium-High |
| <b>9.1.3</b>    | Low-Medium  | Low             | Low           | Medium-High |

| Aesthetic       |             |                 |               |         |
|-----------------|-------------|-----------------|---------------|---------|
| Inner Structure |             |                 |               |         |
|                 | Flexibility | Compressability | Extensibility | Density |
| <b>TEST H</b>   |             |                 |               |         |
| <b>1.0</b>      | High        | Medium          | High          | Low     |
| <b>9.1.1</b>    | High        | Medium          | High          | Low     |
| <b>9.1.3</b>    | High        | Medium          | High          | Low     |

| Aesthetic       |             |                 |               |         |
|-----------------|-------------|-----------------|---------------|---------|
| Inner Structure |             |                 |               |         |
|                 | Flexibility | Compressability | Extensibility | Density |
| <b>TEST I</b>   |             |                 |               |         |
| <b>1.0</b>      | Low         | Low             | Low           | High    |
| <b>9.1.1</b>    | Low         | Low             | Low           | High    |
| <b>9.1.3</b>    | Low         | Low             | Low           | High    |

| Aesthetic       |             |                 |               |         |
|-----------------|-------------|-----------------|---------------|---------|
| Inner Structure |             |                 |               |         |
|                 | Flexibility | Compressability | Extensibility | Density |
| <b>TEST C</b>   |             |                 |               |         |
| <b>11.1</b>     | High        | Medium          | High          | Low     |
| <b>11.2</b>     | High        | Medium          | High          | Low     |
| <b>11.3</b>     | High        | Medium          | High          | Low     |
| <b>11.4</b>     | High        | Medium          | High          | Low     |

# TEST G-I, AND C - FUNCTIONAL PERFORMANCES

| Functional          |           |              |
|---------------------|-----------|--------------|
| Martindale-abrasion |           |              |
|                     | Mass Loss | Permeability |
| TEST G              |           |              |
| <b>1.0</b>          | 40,000    | 565          |
| <b>9.1.1</b>        | 50,000    | 665          |
| <b>9.1.3</b>        | 50,000    | 570          |

| Functional       |            |           |
|------------------|------------|-----------|
| Tensile-Strength |            |           |
|                  | Elongation | Max Force |
| TEST G           |            |           |
| <b>1.0</b>       | 67         | 397       |
| <b>9.1.1</b>     | 76         | 306       |
| <b>9.1.3</b>     | 72         | 662       |

| Functional          |           |              |
|---------------------|-----------|--------------|
| Martindale-abrasion |           |              |
|                     | Mass Loss | Permeability |
| TEST H              |           |              |
| <b>1.0</b>          | 20,000    | 1002         |
| <b>9.1.1</b>        | 25,000    | 1193         |
| <b>9.1.3</b>        | 25,000    | 1021         |

| Functional       |            |           |
|------------------|------------|-----------|
| Tensile-Strength |            |           |
|                  | Elongation | Max Force |
| TEST H           |            |           |
| <b>1.0</b>       | 70         | 317       |
| <b>9.1.1</b>     | 71         | 106       |
| <b>9.1.3</b>     | 69         | 397       |

| Functional          |               |              |
|---------------------|---------------|--------------|
| Martindale-abrasion |               |              |
|                     | Mass Loss     | Permeability |
| TEST I              |               |              |
| <b>1.0</b>          | not performed | 654          |
| <b>9.1.1</b>        | not performed | 640          |
| <b>9.1.3</b>        | not performed | 669          |

| Functional       |            |           |
|------------------|------------|-----------|
| Tensile-Strength |            |           |
|                  | Elongation | Max Force |
| TEST I           |            |           |
| <b>1.0</b>       | 68         | 457       |
| <b>9.1.1</b>     | 72         | 204       |
| <b>9.1.3</b>     | 56         | 715       |

| Functional          |           |              |
|---------------------|-----------|--------------|
| Martindale-abrasion |           |              |
|                     | Mass Loss | Permeability |
| TEST C              |           |              |
| <b>11.1</b>         | 20,000    | 1602         |
| <b>11.2</b>         | 20,000    | 1548         |
| <b>11.3</b>         | 30,000    | 1310         |
| <b>11.4</b>         | 20,000    | 1569         |

| Functional       |            |           |
|------------------|------------|-----------|
| Tensile-Strength |            |           |
|                  | Elongation | Max Force |
| TEST C           |            |           |
| <b>11.1</b>      | 64         | 60        |
| <b>11.2</b>      | 77         | 179       |
| <b>11.3</b>      | 83         | 210       |
| <b>11.4</b>      | 103        | 208       |





# CONCLUSION

This empirical data substantiates that spring wool, with either long or short tog, or long or short tel, felts rapidly and well. It can be processed either with or without carding as an option. The wool gives a vast variety of aesthetical and functional characteristics and could be explored further within product-design, or in the art field.

This research has proven that spring wool felts fast and well. By addressing the affordance of separation, manipulation can be performed by using local, small-scale industries in Norway today. Felted textiles made from this manipulated wool can be felted into at least three different stages. Stages that present a variety of characteristics and properties.

By choosing between several different features like aesthetic, technical and functional performances, a designer, crafter, or artist can achieve multiple different products or pieces. The coarser hairs have proven to play an important role in durability aspects, but so has the way the wool is prepared before felting. It is possible today to separate and receive only the softer fibers, but if doing so it is advised to find another usage for coarser hairs.

# GLOSSARY

## **Functional performances**

Refer to the durability of the textile, in this context – strength and abrasion resistance.

## **Abrasion resistance**

Refers to the amount of rubbing action a fabric can withstand without being destroyed. Each time a textile is rubbed against a hard surface, a small loss of fibre occurs in this limited area. Textiles must withstand degradation from the environment. The determination of the mass loss of specimens covering all textile fabrics including nonwovens

## **Dimensional stability**

The ability of the textile to maintain its original shape and size. It affects elongation and shrinkage. Tensile strength can determine the maximum force and elongation at maximum force of textile fabrics using a strip method.

## **Air permeability**

Describes a method for measuring the permeability of fabrics to air. Velocity of an air flow passing perpendicularly through a test specimen under specified conditions of test area, pressure drop and time.

## **Aesthetic performance**

Refers to the appearance of the textile, and include halo, colour consistency, shine, and hand.

## **Hand**

Hand is a wide term for the kinaesthetic or movement aspects of a fabric. Kinaesthetic describes a perceiving how the body moves, but in this context, it will define how the fabric is perceived or experienced with my hand. The term hand, refers to the emotional sensations resulting from touching, moving, or squeezing the fabric with the human hand. These sensations are presented as aspects of softness and surface experiences.

Hand also covers aspects relating to the inner structure of a textile. Here terms for compressibility, density, resilience, extensibility, texture, and flexibility are presented.

Note! Elements of aesthetic performance on a raw material can be difficult to describe. This due to their subjective nature; it's hard to objectively measure these features and must be taken in consideration when using the data material in this booklet. Technical data are mathematically retrieved after manual and machine felting, which gave indications of similar results. Functional data are from standardised testing and give a more scientific indication of features described. Standardised testing is performed on manually felted textiles.