

WOOLBRIDGE

Acoustic Panels as a Mosaic of Possibilities

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INDEX

01 – A NOTE ON THIS EXPLORATION

The origin and intent of this research

02 – THE WOOL PROBLEM

Why Alpine wool is discarded

03 – THÔNES & MARTHOD – THE MATERIAL

Fiber properties

04 – WHY ACOUSTICS?

Sound, space, and the opportunity in construction

05 – INNOVATION FRAMEWORK

Double Diamond, Jobs-to-be-Done, Systems Thinking

06 – ANATOMY OF A PANEL

The three functional layers

07 – PROCESS & FABRICATION METHODS

From raw fleece to finished panel

08 – MATERIAL RECIPES

Five working recipes with ingredients and process

14 – PANEL CONFIGURATIONS & TESTING

13 configurations, NRC values, results

16 – TESTING METHODOLOGY & RESULTS

Near-field insertion loss

18 – MATERIAL APPLICATION SYSTEM

Wool in the construction ecosystem

20 – RESOURCES & PARTNERS

Programmes, networks, and documentation

A NOTE ON THIS EXPLORATION

Woolbridge is a design research project born from an existing problem: every year, tonnes of coarse wool from the Thônes & Marthod sheep of the French Alps are discarded this is because the textile industry considers it too coarse to be in touch with the skin.

What follows is an exploration of what that wool could become if directed not toward garments but toward buildings specifically toward the management of sound, one of the biggest growing sectors in contemporary construction and interior design.

THESE ACOUSTIC PANEL MVPS ARE NOT FINISHED PRODUCTS.

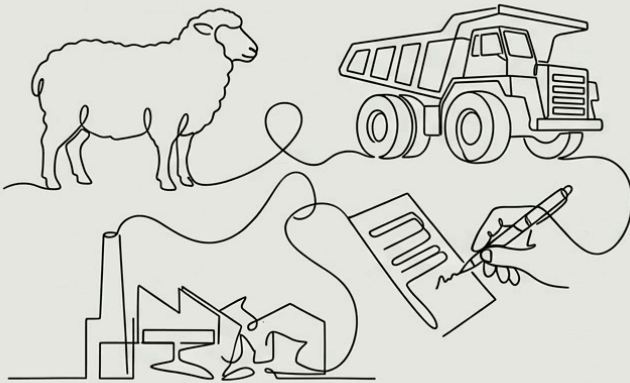
They are a mosaic each tile revealing something different about the material's potential, its limits, and the questions still to explore.

THE WOOL PROBLEM

The Thônes & Marthod is among the most ancient sheep breeds of the French Alps. Hardy, prolific, adapted to elevations above 2,000 meters, it has sustained mountain communities in Savoie for centuries providing milk for cheese, meat for local markets, and wool for knitting. Today, that wool no longer has a place.

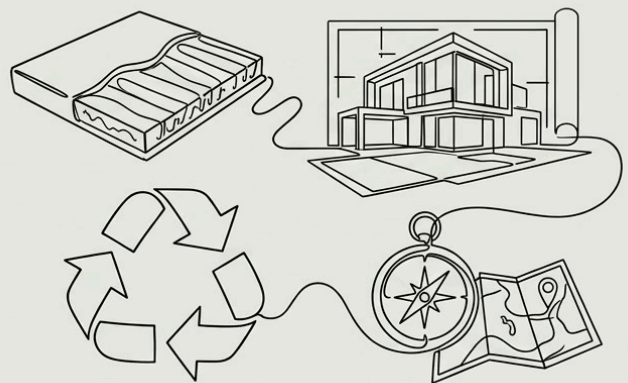
The annual output is significant but there is nowhere for it to go. Disposal costs money and illegal dumping is common.

THE PROBLEM



Coarse wool has no viable textile market.
Disposal is costly & often illegal.
Processing infrastructure has collapsed.
Breed survival depends on economic viability.

THE OPPORTUNITY



Construction values bio-based materials.
Acoustic comfort is a growing priority.
Circular economy regulation creates demand.
Local sourcing narrative is commercially compelling.

WOOLSHED A transnational cooperation programme co-financed by Interreg Alpine Space 2021–2027. Its main objective: encourage and enable the use of rustic Alpine wool and avoid waste of the material.

THÔNES & MARTHOD: THE MATERIAL

Before designing anything, we need to understand what we are designing with. The Thônes & Marthod fleece is not typical wool. It is long-staple, coarse, and structurally heterogeneous which makes it uncomfortable against skin but extraordinary as a technical fiber.

BREED

Thônes & Marthod

FIBER LENGTH

17mm staple

FINENESS

35–39 microns diameter

COLOR

Ecru, with some natural black

PROCESS

Washed, carded

ROLE IN PANELS

Core, face, backing

WHY COARSENESS IS THE POINT

In textile manufacturing, coarse fibers are a problem because they scratch and resist fine weaving. In acoustic applications, the same coarseness is a strength. The irregular, crimped structure of coarse wool creates air pockets that trap and dissipate sound waves. By not being in contact with the skin, we can leverage the characteristics of the material without compromising comfort.

Property	Value
Hygroscopicity	Up to 35% moisture absorption
Thermal conductivity	0.035–0.042 W/(m·K)
Fire behavior	Low flame spread, self-extinguishing
Felting potential	High
Biodegradability	Fully biodegradable at end of life
Embodied carbon	Very low vs. synthetic alternatives

WHY ACOUSTICS?

Acoustic comfort is one of the fastest-growing concerns in architecture and interior design. Open-plan offices, hospitality spaces, healthcare environments, and schools all face significant acoustic challenges. Current solutions are largely synthetic.

WHAT WE KNOW ABOUT SOUND AND MATERIAL

- Softer materials = more absorption. Harder materials reflect sound.
- Thickness affects effectiveness.
- Geometry and irregular surface = better absorption.
- Air gap matters: mounting a panel 5 cm from the wall can increase NRC by approximately **0.25** a significant jump without changing the material at all.

WHY WOOL, SPECIFICALLY

- Porous fibrous structure dissipates sound energy through friction
- Irregular surface prevents specular reflection
- Hygroscopic behavior adds mass, which aids absorption
- Multiple fabrication paths (felt, composite, foam) give design range
- Fully local and bio-based – aligns with emerging construction standards

☑ The same panel can perform very differently depending on how it is installed.

INNOVATION FRAMEWORK

This project applies a layered approach drawing on four complementary methodologies, adapted for material research.



DOUBLE DIAMOND

The Design Council's Double Diamond frames the overall arc. **Discover** → **Define**: Understanding the material, the market, and the problem space through physical handling, processing experiments, and contextual research. **Develop** → **Deliver**: Fabricating multiple panel formats using different processing techniques. In this context, *deliver* means not a final product but a refined shortlist of directions with evidence behind each one.



JOBS-TO-BE-DONE

Behind every acoustic panel is a person with a problem. The idea with the material application system is that the concerns of each player are addressed so that we can adopt wool as a material.



SYSTEMS THINKING

Systems thinking is about the big picture: where does the wool come from, who processes it, how does it travel, who installs the panel, and what happens when the building is demolished? Mapping these flows reveals opportunities and constraints alike. Although the mapping is beyond the scope of this project, it is important to consider that this is not a stand-alone problem.

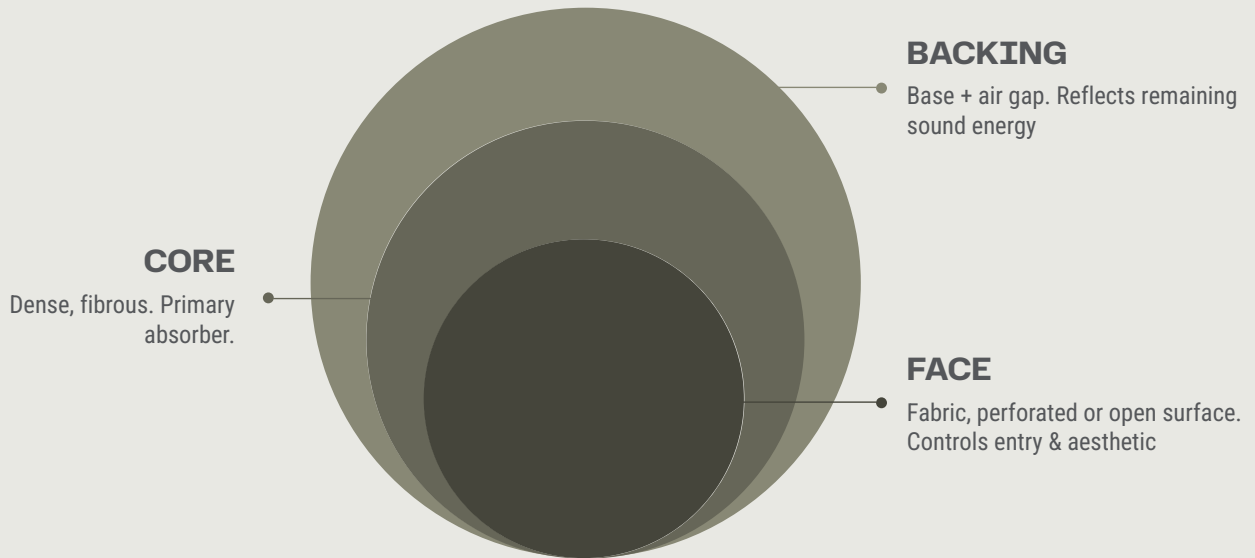


MVP THINKING: BUILD TO LEARN

Each panel configuration in this project was designed to test a specific hypothesis about the wool's behavior, the fabrication process, or the aesthetic potential. Together, they form a mosaic of what is possible to do with wool.

ANATOMY OF A PANEL

Every acoustic panel is built around three functional layers. Understanding these layers explains why different Woolbridge configurations perform differently.



01 – BACKING

A metal grid is felted inside the core for structure. An air gap shifts absorption to lower frequencies.

02 – CORE

Dense fibrous or foam core. This is where most absorption happens. This is the needle-felted wool layer.

03 – FACE

Fabric, perforated skin, or open-structure surface. Controls aesthetics and how sound enters the core. Can add diffusion if textured or perforated. The face is often the most experimental layer with biomaterials.

PROCESS & FABRICATION METHODS

THE WOOL PREPARATION

Thônes & Marthod fleece arrives raw unwashed and loosely organized. The first step in any fabrication process is **scouring** (washing) to remove lanolin, soil, and organic debris. The washed wool was sourced from a local association, Defrisse ton Mouton which saves 300kg of wool per year from going into landfills.

After washing, the wool is **carded** (mechanically combed) to open and align the fibers into a loose, airy web ready for further processing. A series of different processes were tested for this project:



NEEDLE FELTING

Barbed needles mechanically interlock fibers without heat or adhesive. Produces dense, flat panels. Surface can be embossed or textured. Used for flat, layered, tufted, and engraved configurations.



WET FELTING

Traditional process using water and agitation to interlock fiber scales. Better for big pieces of felt.



BIOCERAMIC / STARCH COMPOSITE

Corn starch + sodium bicarbonate + short fiber wool. Produces a smooth, rigid face/decorative layer. Can be laser-cut, molded, or sculpted.



BIOPLASTIC SHEET

Rice starch + MCC + glycerin + water + wool. Creates a fiber-marbled, translucent decorative skin. Flexible but papery. Requires thin casting.



ALGINATE FOAM / POROSITY

Alginate + glycerin + cellulose + water + fine wool fibers (not mixed). Soft, spongy discs used as core or face elements. Wool is dipped into alginate, preserving fiber porosity.



EXTRUDED ALGINATE YARN

Alginate + glycerin + wool. Syringe-extruded into calcium chloride solution. Creates yarn or flat sheets used as decorative outer skins.

MATERIAL RECIPES

These are working recipes that can have variations based on casting thickness, molds, and drying times.

RECIPE 00 – STRUCTURAL CORE (NEEDLE FELTED SLAB)

CORE

PRIMARY ACOUSTIC ABSORBER



Ingredient	Notes
Thônes & Marthod wool	Washed, carded
No binder required	Fibers interlock mechanically

Tools: Foam block, felting needles.

1. Start with 2 layers of carded wool, alternating the direction.
2. Needle felt until fibers lock, check density by feel
3. Trim edges with sharp scissors

Look & feel: Flat, dense, flexible.

- ☐ More layers = better acoustic absorption, but minimal effect below 3 layers. Irregular surfaces consistently outperform flat ones.

RECIPE 01 – FIBERPLATE (BIOPOLYMER BOUND)

CORE

STRUCTURAL, DENSE



Ingredient	Notes
6g Agar	
10g MMC (microcrystalline cellulose)	+8g of CMC for Variation 1
8g Guar gum	Adds flexibility
30g Long/short fiber wool	Thônes & Marthod
300ml water	

1. Mix agar, guar gum and cellulose with water.
2. Heat until fully dissolved
3. Add guar gum, stir thoroughly
4. Fold in wool fibers, distribute evenly throughout the mixture
5. Pour into molds, press under weight
6. Allow to cure and use dehydrator at 30C for at least 3h, demold and continue drying process to avoid mold from moisture.

Look & feel: Dense, firm, porous depending on wool content and fiber length. Fiber length strongly affects porosity and surface texture. Longer fibers = more open, airy structure.

RECIPE 02 – BIOCERAMIC FACE (STARCH COMPOSITE)

FACE

DECORATIVE / REFLECTOR



Ingredient	Notes
62g Corn starch	
125g Sodium bicarbonate	
15g Short fiber wool	Structural reinforcement
88ml Water	
5g glycerine	Add/reduce for desired flexibility

1. Mix corn starch and sodium bicarbonate with water
2. Heat gently, stirring until paste thickens
3. Add short wool fibers, distribute evenly
4. Press into molds or spread flat on silicone mat
5. Dry in dehydrator at low temperature (30°C) or air dry 48h
6. Once firm, laser cut, sand, or sculpt as desired

☐ Acts as a reflector when sealed. Use strategically as face layer with porous wool core behind it for combined absorber/diffuser behavior.

RECIPE 03 – ALGINATE FOAM DISCS (POROSITY)

CORE + FACE

POROUS, SOFT



Ingredient	Notes
12g Sodium alginate	
25g Glycerin	
5g Cellulose	
20g Fine wool fibers	Not blended, dipped separately
350ml water	

1. Dissolve alginate in water (allow 30 min hydration)
2. Add glycerin and cellulose, mix until smooth
3. Pour into disc molds
4. Separately dip pre-formed wool discs into the alginate solution (do not mix wool into the bath)
5. Cure in calcium chloride solution (5%) for 5–10 minutes
6. Dry flat

Look & feel: Soft, spongy. Surface retains wool texture. Individual discs can be assembled into larger panel compositions.

RECIPE 04 – WOOL PAPER / WOOL RESIN

FACE

DECORATIVE OUTER SKIN



Ingredient	Notes
40g Rice starch	
5g MCC (microcrystalline cellulose)	
10g Glycerin	plasticizer
300ml Water	
10g Wool fibers	

1. Mix rice starch and MCC in cold water
2. Heat on medium, stirring constantly until it thickens (paste stage). Incorporate wool slowly
3. Add glycerin, stir well, remove from heat
4. Spread thinly and evenly on casting surface
5. Allow to dry flat (12–24h at room temperature, or 30°C oven for 3h)
6. Peel when fully dry.
7. Heat press 20sec at 180C for uniform surface and release excess moisture.

☐ Requires thin casting for translucency (paper). Thick casting results in a resin-like material. Excellent as a light-diffusing decorative face layer. Heat press optional but recommended.

RECIPE 05 – ALGINATE YARN

FACE

DECORATIVE OUTER SKIN



Ingredient	Notes
12g alginate	
20g glycerine	
400ml water	
25g finely chopped wool	20g max. recommended for syringe extrusion

1. Mix alginate and glycerine in water
2. Heat, stirring constantly until it thickens. Incorporate wool slowly and remove from heat.
3. Use a spatula to put the mixture in a syringe.
4. For yarn: extrude directly into calcium chloride solution.
5. Yarn will shrink after fully air-dried.

☐ It can also be extruded flat then cured with calcium chloride for a different effect.

PANEL CONFIGURATIONS

Each configuration is a specific combination of fabrication technique, surface geometry, and layer count. Tested as a 15x15cm tile. NRC values measured without air gap. For PoC purposes only.

Configuration	NRC	Acoustic Role	Notes
Bubbles	0.55	Absorber – good	Best performer. Needle felted wool balls on felted base.
4 Layer	0.50	Absorber – good	4 needle-felt layers
Noodles	0.50	Absorber – good	Irregular extruded yarn flat surface on felted base.
Clay Cutout	0.50	Absorber – good	Bioceramic frame with wool core visible
Woven	0.50	Absorber – good	Woven wool surface, open structure
Engraved	0.50	Absorber – good	Needle-felt with embossed relief pattern
Tufted	0.50	Absorber – good	Raised fiber clusters on flat base
Waves	0.50	Absorber – good	Laser cut felted layers assembled on a felted core.
2 Layer	0.45	Absorber – good	Thin baseline configuration
3 Layer	0.45	Absorber – good	Mid-density stacking
Leather Skin	0.45	Absorber – good	Bioplastic face over wool core
Sun	0.45	Absorber – good	Radial relief curly wool pattern
Clay Drape	0.35	Resonant cavity	Rigid bioclay + 4cm air gap creates Helmholtz-type resonance



MORE LAYERS ≠ LINEAR GAIN

More layers = better absorption, but with diminishing returns. Geometry matters more than thickness alone.

SEALING = REFLECTING

When porosity is reduced (as in the wool "leather" or the bioceramic face) the panel reflects rather than absorbs. Useful for designing diffuser behavior.

CUTOUTS IMPROVE ABSORPTION

Perforated geometry lets sound in while the structure adds diffusion outperforming a fully sealed surface.

IRREGULAR SURFACE = BEST

Waves, Bubbles, Engraved configurations all benefit from surface relief. Comparable to commercial foam panels with NRC > 0.50.

⚠ Note on Clay Drape: The rigid bioclay panel with a 4cm air gap produced an unexpected resonant cavity effect. A Helmholtz-type resonance that decreased apparent absorption at 1kHz rather than increasing it. It opens an option for targeted low-frequency design.

TESTING METHODOLOGY & RESULTS



The method used was **near-field insertion loss**, a comparative method that measures how much sound is absorbed by a sample relative to a bare surface. The results are valid for comparing samples against each other. Not ISO-certified acoustic data.

NRC = average of absorption coefficients at 500 Hz, 1kHz, and 4kHz.

TOOLS

- Microphone: UMIK-1 calibrated measurement microphone (facing down, 10cm above sample)
- Software: REW (Room EQ Wizard) – free, open-source acoustic measurement software
- Speaker: Laptop speaker angled at 30–45° from the sample, 35cm distance
- Panels: 15×15cm each, placed flat on a hard table surface
- Reference: Bare table measured before each session

THE SETUP, STEP BY STEP

1. Place the table in the center of the room, away from walls to reduce reflections
2. Mark the exact center with tape. every sample goes here
3. Mount the UMIK-1 facing down, 10cm above the sample surface
4. Lean the speaker at 30–45°, 20cm high, 35cm from sample center
5. Load the mic calibration file into REW
6. Measure the bare table 3 times>get average (this is your reference)
7. Place each sample, measure 3 times> get average>compare to reference
8. For air gap tests: place 4cm spacers under each sample corner, re-run

FINDINGS

The most important result is simple: **surface geometry matters more than layer count.**

IRREGULAR SURFACES WIN

Irregular, raised, or perforated surfaces consistently absorbed more sound than flat surfaces of the same material and thickness.

BUBBLES IS THE BEST PERFORMER

NRC 0.55 – soft, round alginate discs on a needle-felt base. The irregular three-dimensional surface creates multiple absorption events as sound bounces between and around the hemispheres.

FLAT PANELS PLATEAU AT NRC 0.50

More wool without changing the surface geometry does not proportionally improve performance. Geometry is what makes the difference.

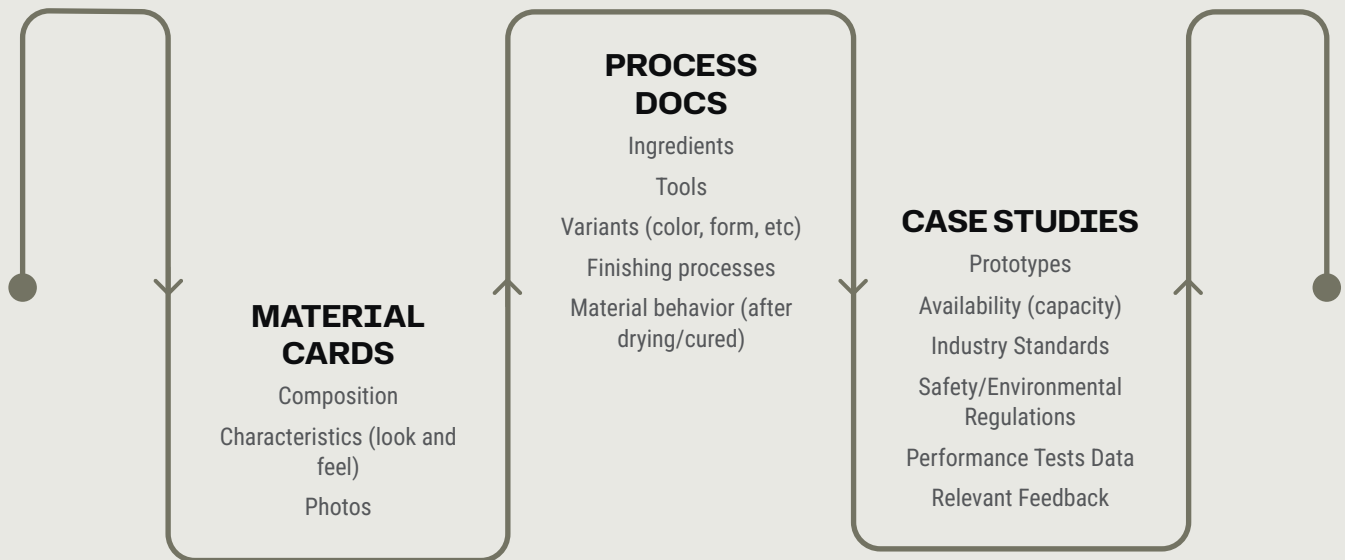
THE CLAY DRAPE ANOMALY IS A DIRECTION

A rigid panel with an air gap does not automatically absorb more. The air cavity created a Helmholtz resonance that interfered with absorption at 1kHz. Helmholtz resonators are a legitimate acoustic design tool. The material is teaching us something.

What we tested	What we learned
Surface geometry (flat vs. textured)	Textured surfaces consistently outperform flat ones
Layer count (2, 3, 4 layers)	More layers help, but geometry matters more
Sealed vs. open face	Sealed = reflective. Open = absorptive
Air gap effect	+0.25 NRC potential – but cavity geometry matters
Rigid bioclay + air gap	Unexpected resonant cavity behavior at 1kHz
Best overall config	Bubbles – NRC 0.55

MATERIAL APPLICATION SYSTEM

For this to become an active part of the economy, the process around wool must be as carefully thought out as a more complete solution. My proposal is that this can evolve into a material application system that not only considers the material and its uses but also how to use it and where has it been successful. This can allow the different actors in the system to understand the possibilities and limitations of working with wool.





RESOURCES & PARTNERS

This project is co-funded by the European Union through the Interreg Alpine Space programme.

WOOLSHED – WOOLSHED FACTORY CATALOGUE

Open-source processing documentation covering machinery guides, felting techniques, biocomposite fabrication methods, and scouring protocols. A foundational reference for this project.

woolshed.letextilelab.com

ALPINE SPACE PROGRAMME – WOOLSHED PROJECT

Technical and performance data. Transnational cooperation programme co-financed by Interreg Alpine Space 2021–2027.

alpine-space.eu/project/woolshed

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Thônes valley association – Thônes & Marthod wool collection. Current partial collection infrastructure and key supply chain partner.

LE TEXTILE LAB

Fabrication, testing, and documentation. Host institution for this research and the Interreg Alpine Space Programme partnership

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i **Testing Documentation** – Testing methodology, REW setup guide, and full results dataset available at: class.textile-academy.org/2026/diana-castillo/project/04-acoustic-panels/