



Digital Tools, Wool Traditions

– Digital Fabrication for Heritage Revitalisation

Elina Luiro

Digital fabrication has transformed craft, design and contemporary art by expanding how objects can be imagined, tested and produced. In the context of craft heritage, it offers technical efficiency and new ways of reactivating traditional knowledge through modern tools, materials and forms of participation. In the VillaInno project, digital fabrication was used in the prototyping of wool-based products, craft kits and learning tools, as well as in the redesign of heritage-inspired craft tools (Figure 1). Rather than treating tradition as something to be preserved unchanged, the project approached revitalisation as a living process in which traditional craft techniques can be reinterpreted in relation to present-day materials and user needs.

In VillaInno, Elina Luiro contributed as a specialist in digital fabrication and as an artist-designer-educator working between heritage and contemporary design and craft. This visual essay examines selected design cases from the project in which laser cutting and 3D printing supported the development of wool-related concepts and tools. The focus is on how digital fabrication can contribute to heritage revitalisation, while also bringing forth the technical, material and ecological considerations involved in the process.

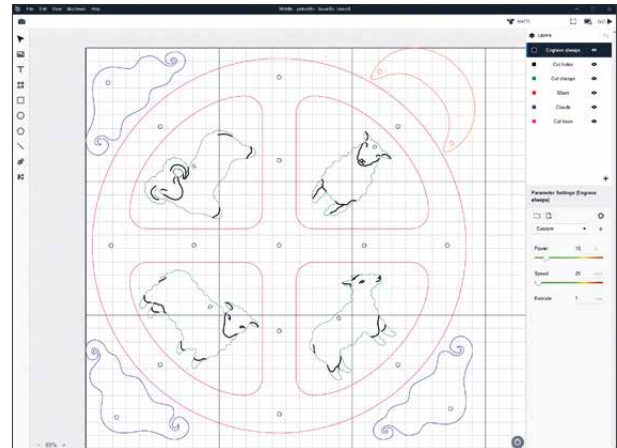
Digital Fabrication

Digital fabrication refers to design and production processes that combine computer-aided design (CAD), vector drawing, or 3D modelling with machine-based fabrication methods such as laser cutting, 3D printing or CNC milling. In the VillaInno project, the prototyping work focused especially on laser cutting and desktop-scale 3D printing. The laser-cut prototypes were prepared as vector files in Adobe Illustrator and processed for

◀◀ **FIGURE 1.** 3D-printed lucets placed among wool yarns in an old wooden dough bowl inherited from Luiro's grandparents. The image reflects a material dialogue between contemporary digital fabrication and inherited craft traditions. Photograph: Elina Luiro, 2025.

▶ **FIGURE 2.** Luiro working in the Fab Lab with the Flux Hexa laser cutters. Photographs: Tatiana Kravtsov (top), Elina Luiro (below), 2025.

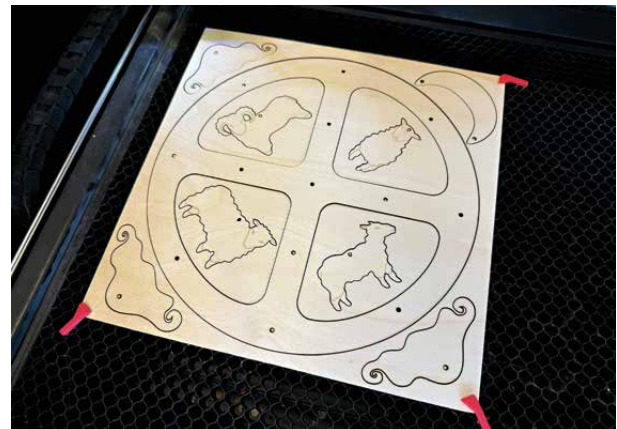
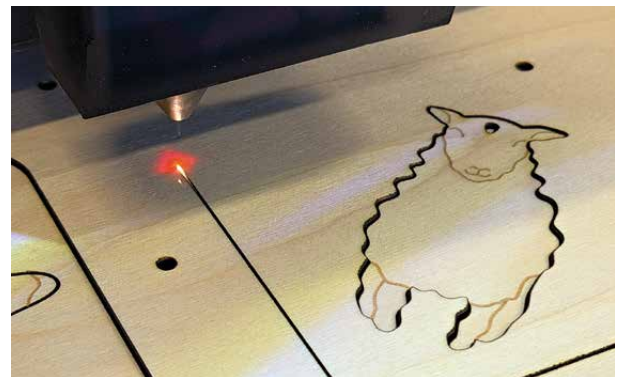
▶ **FIGURE 3.** Preparing laser cutting paths in Beam Studio: assigning engraving and cutting operations to separate layers and calibrating laser power, speed, and number of passes for optimal cutting quality. Screen capture: Elina Luiro, 2025.



fabrication in Beam Studio, while 3D-printed tools were modelled either through simple CAD applications or adapted from existing open-source files. Prototyping took place mainly in the Fab Lab facilities of the Faculty of Art and Design at the University of Lapland (Figure 2).

Case 1 – Sleep Catcher mobile

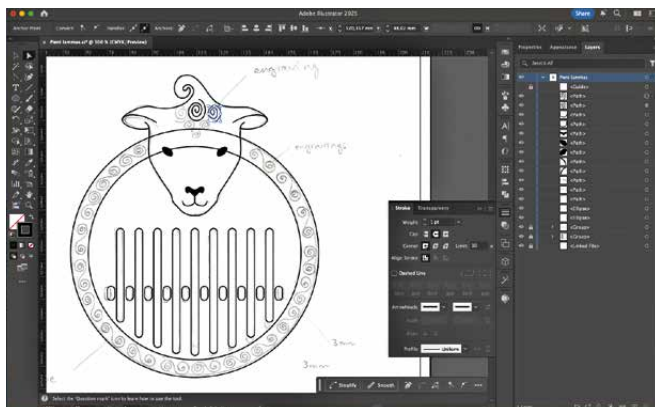
For the *Sleep Catcher* mobile – a DIY product concept introducing native Finnish sheep breeds and their wool – digital fabrication enabled the transition from hand-drawn and hand-cut cardboard models to a more stable and production-oriented prototype. Initially ideated by master's students Iida Stöckell and Jenna Väliäho and further co-designed by Minna Kovero and Tatiana Kravtsov of VillaInno team, Luiro continued the development process with digital fabrication methods. The mobile first had to be redrawn in vector format and adjusted to improve balance, hanging structure and manufacturability (Figure 3). Laser cutting also supported material-efficiency considerations: the size of the frame and placement of the sheep, moon and cloud elements were refined in relation to the 30 x 30 cm plywood sheet to minimise material waste (Figure 4).



▶ **FIGURE 5.** The laser-cut pieces of the mobile ready to be assembled, and a detail of the finished product with wool incorporated. Photographs: Elina Luiro, 2025.



▲ **FIGURE 4.** The design laser-cut out of 30 x 30 cm width, 3 mm thick birch plywood sheet. Photographs: Elina Luiro, 2025.



◀ **FIGURE 6.** The manufacturing workflow of the Lamb heddle from hand-drawn sketch to digital vectors, and to laser-cut prototypes from cardboard and plywood. Screen capture and photograph: Elina Luiro, 2025.



▼ **FIGURE 7.** A Collection of successful and failed prototypes. Photograph: Elina Luiro, 2025.



At the same time, the process revealed the material realities of laser cutting. Large plywood surfaces require attention to sheet flatness, internal variations in the material, and the calibration of speed and power of the laser to ensure clean cutting throughout the entire form. These adjustments shaped not only the technical outcome, but also the final aesthetics of the product (Figure 5).

Case 2 – Rigid heddles and shuttles

A more demanding application of digital fabrication emerged in the development of rigid heddles and weaving shuttles for Kravtsov's and Kovero's *Weaving with the Lamb* craft kit and for Kravtsov's and Kovero's concepts related to *weaving with trees*. In these cases, digital fabrication was not merely a production aid but a way of rethinking heritage-inspired tools for contemporary use.

The process required repeated translation from hand-drawn sketches to balanced and functional vector-based designs (Figure 6). Decorative references to traditional forms had to be adapted to the logic of laser cutting, while the heddles themselves required precision: perforations, symmetry, and overall proportions of the heddle directly affect the usability of the tool in band weaving. Multiple iteration rounds were needed to refine both the structural and ornamental elements of the heddles (Figure 7).

Once the digital and technical challenges had been solved, laser cutting made it possible to produce multiple consistent tools for the VillaInno exhibition (Figure 8), and for future workshops and educational use. This repeatability is significant for heritage revitalisation: it supports accessibility, sharing and collective learning rather than leaving heritage tools as singular – often museumised – objects with limited access.



◀ **FIGURE 8.** *Weaving with trees heddles on display at the Villainno: Sensing the Local Wool exhibition.* Photograph: Elina Luiro, 2025.

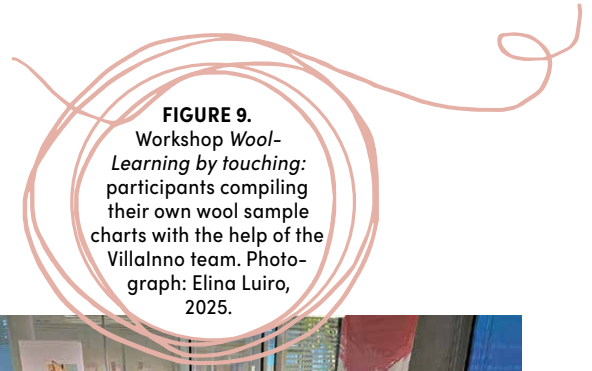


FIGURE 9. *Workshop Wool-Learning by touching: participants compiling their own wool sample charts with the help of the Villainno team.* Photograph: Elina Luiro, 2025.

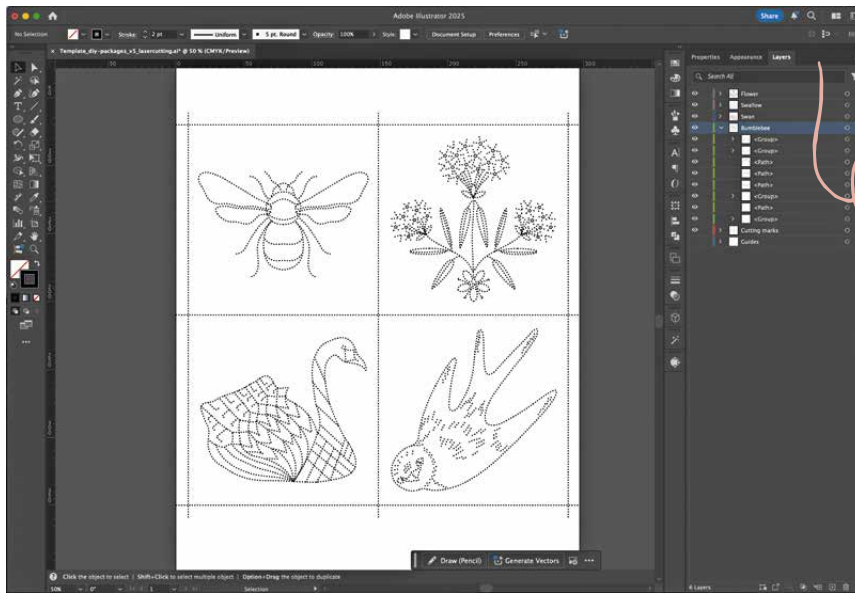


Case 3 – Wool material charts

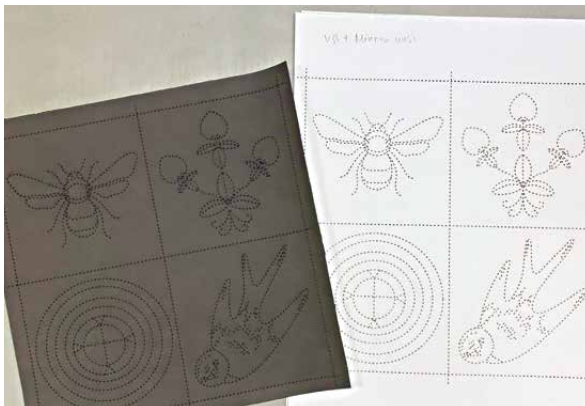
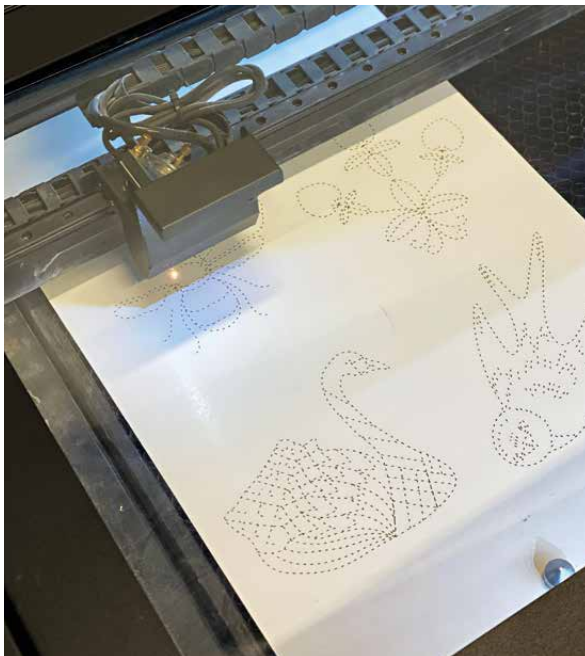
A smaller but pedagogically relevant application was the production of material charts for VillaInno's final seminar and workshop. Laser-cut from thin birch plywood, the charts allowed seminar participants to assemble their own sample sets from Finnish wool yarns collected during the project (Figure 9). Functioning simultaneously as promotional material and as an educational tool, the charts supported sensory engagement with different sheep breeds and their wool. Later, the material charts were also utilised by Kovero and Moen for creating a wool sample section to the Art and Design Faculty's material library (Figure 10).



▲ **FIGURE 10.** *The laser-cut material charts utilised for the faculty's material library. Assembly of the wool samples made by Kovero and Moen.* Photograph: Elina Luiro, 2026.



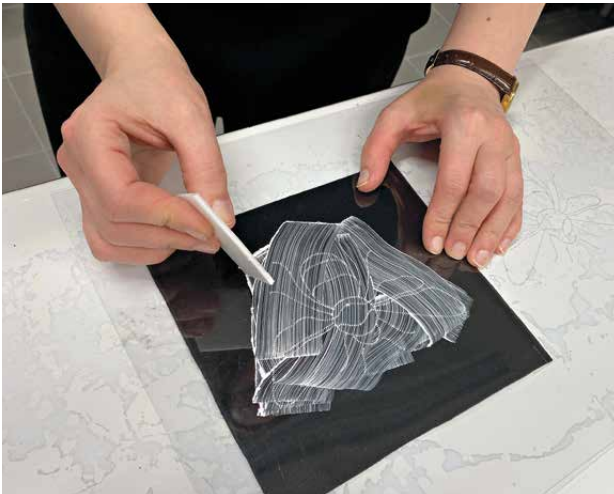
◀ **FIGURE 11.** The prototyping process of transforming the embroidery motifs into stencils in Adobe Illustrator and testing with laser to find the suitable perforation of the motifs. First stencils cut on cardboard and faux leather. Screen capture and photographs: Elina Luiro, 2025.



Case 4 – Stencils for embroidery DIY kits

In the DIY embroidery kits, digital fabrication functioned less as a visible aesthetic feature and more as an enabling tool in the design process. Laser cutting was used to produce stencils for transferring embroidery motifs onto wool fabric in Luiro's, Kravtsov's, Kovero's and Hernández Cervantes's DIY-kit designs (Figure 11). The stencil patterns were first cut out of cardboard materials for fast prototyping, and laser-suitable faux leather was also tested, before the final versions were produced on a washable and reusable screen-printing plastic film in collaboration with a laser cutting company, KainorDesign.

The main challenge lay in defining a perforation density and sizing of the stencil holes that would allow textile paint to effortlessly pass through the stencil while maintaining the accuracy of the pattern (Figure 12). Because the embroidery designs also continued to evolve through testing and feedback, the stencil-making process became iterative in parallel with the visual development of the patterns themselves. This case demonstrates how digital fabrication can support craft revitalisation indirectly, yet agilely and vitally, by enabling the translation of heritage-inspired craft and motifs into accessible DIY formats (Figure 13).



▲ **FIGURE 12.** Testing the perforation and usability of plastic-film stencils with printing the embroidery motifs on wool. Photographs: Minna Kovero (left), Elina Luiro (right), 2025.



► **FIGURE 13.** Example of a finalized DIY embroidery package: the embroidery template with leaflet, yarns, needle, and a picture of the embroidery. Photograph: Elina Luiro, 2026.

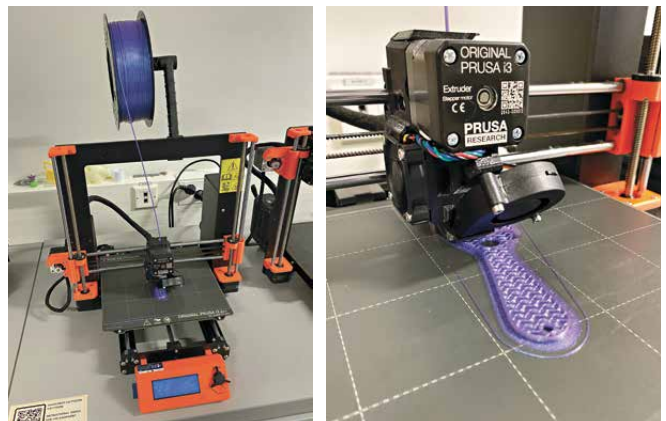


Case 5 – Lucets for cord making

The revitalisation of wool craft tools was also explored through 3D printing. Luiro designed and manufactured simplified lucet models by using accessible modelling environments and desktop-scale 3D printers (Figure 14). In addition, selected open-source lucet models were reviewed as reference points. These experiments highlighted both the potential and limits of additive manufacturing for heritage tools.

3D printing allows fast prototyping, local production, and the possibility of replacing broken or missing parts in old craft equipment. At the same time, however, sustainability depends strongly on design decisions, print settings and material choices. Some more decorative lucet models required excessive support structures and resulted in unnecessary material waste. For this reason, simpler and structurally efficient models seemed more suitable (Figure 15).

PLA filament was used in the tests as it is widely available, easy to print with, and commonly described as a bio-based filament produced from



▲ **FIGURE 14.** Filament – the thermoplastic string is fed into the 3D printer's hotend, melted, and extruded layer by layer to create a three-dimensional object. Photographs: Elina Luiro, 2025.

Lessons learned – Digital fabrication as support, translation and transformation

Across the VillaInno cases, digital fabrication supported product development by fast prototyping as well as by opening specific directions for design. It made possible the precise shaping of tools, the repetition needed for workshops and educational settings, and the transformation of heritage-inspired ideas into accessible contemporary formats. At the same time the process showed that digital fabrication requires more than technical access to machines. As Rylander in Kohtala et al. (2024) emphasises, digital fabrication in art, design and craft should be understood in relation to both its capabilities and its limitations. It demands iterative testing, sensitivity to software and digital workflows, and close understanding of material behaviour. Failed attempts, test versions, and repeated refinements are not peripheral to the process, but central to learning through making.

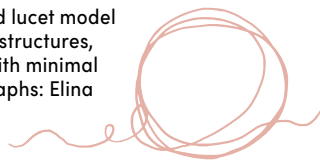
In the context of heritage revitalisation, it is especially relevant to understand that digital fabrication does not preserve tradition by reproducing old artefacts unchanged. Rather, it can facilitate the continuation of tradition by enabling new tools and new forms of participation. In this sense, digital fabrication will not replace handcraft but extend the conditions through which handcraft can be learned, practiced, shared and renewed.

When digital fabrication is applied to the heritage craft, the use of materials is also relevant as the materials become part of the argument – not just a production process. In laser-cut products, the surface of the light plywood and the dark cut edge created by the laser become visible contrasting elements of the final aesthetics. Likewise, the limits of the technique shape the form: what can be cut, engraved, perforated, or assembled affects the visual design of the object. In the VillaInno prototypes, the natural appearance of birch plywood was considered compatible with natural tones of wool, creating a material dialogue between contemporary fabrication and locally rooted craft traditions.

These observations also connect to broader discussions in Arctic and northern design, where sustainability is often approached through material sensitivity, long-lasting functionality and respect for



▲ **FIGURE 15.** 3D-printed lucet model with removable support structures, and simplified models with minimal material waste. Photographs: Elina Luiro, 2025.



renewable materials such as corn or sugarcane starch. However, its environmental value should not be overstated: while PLA is often presented as biodegradable, in practice it requires industrial level composting conditions rather than decomposing effectively in ordinary home composts. Even if a material is marketed as biodegradable, the ecological impacts of its use depend on the entire production, use and recycling chain. In terms of sustainable heritage revitalisation, this broader perspective is important.

fragile environments (Häkkinä & Johansson, 2018). Combining technological development together with thoughtful material and design choices, and an understanding of user experience, can contribute to the process of change towards more sustainable futures (Kirjavainen et al., 2023; Häkkinä & Johansson, 2018).

Final reflections – Towards sustainable craft futures

For artists, designers and crafters, digital fabrication opens a productive field between hand-making, design thinking and technological exploration. In heritage contexts, its significance lies not only in enabling new objects to be made, but that it expands who can make, test, adapt and share them. This democratising potential matters for wool craft revitalisation: tools can be produced for workshops and educational kits, for individual use, small-scale entrepreneurial production, or for artistic purposes, whilst heritage practices also become more approachable to new generations of makers.

Greater accessibility, however, does not automatically guarantee sustainability. The ecological value of digital fabrication depends on how thoughtfully it is applied: what materials are chosen, how much iteration is needed, whether objects are designed for repair or disposal, and whether the technology supports long-term engagement with local resources and craft cultures.

At its best, digital fabrication can contribute to more sustainable and resilient futures by helping craft traditions remain active, teachable and relevant. In relation to wool craft heritage, it also offers a means of connecting local materials and contemporary production methods in ways that are both critical and hopeful. In this sense, heritage revitalisation and technological exploration should not be seen as opposites. When approached mindfully, they can support one another.

References

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Further possibilities

Beyond the cases presented here, digital fabrication also offers possibilities for producing a wide range of wool-related tools, such as drop spindles, niddy-noddies, or small looms, and creating replacement parts for older equipment like bobbins for spinning wheels. Open-source platforms and maker communities such as Thingiverse.com, Printables.com and MakerWorld.com provide access to such files – look for svg-files for laser cutting and stl-files for 3D-printing. Etsy.com is also a global platform for small-scale crafters and makers to sell their fabrication designs. Emerging experiments such as wool-based 3D-printing with robotic fabrication suggest that fibre-based making may also expand beyond textile applications in the future (see more in MaterialDistrict, 2025).

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