steam shapes

experiments

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To explore new construction methods utilizing steam bending, I conducted experiments as part of my research. Consequently, I built a small steam chamber in a DIY manner at ONA, yet large enough to experiment at a scale of 10. The experiments covered various aspects of my research, including experiments on wood types and their accuracy in achieving the desired shape, as well as research on bending techniques such as hand bending, clamping, or shaping with weights or formworks. These experiments yielded valuable insights into structural capacity, potential methods of combination, and various implementation strategies.

For the construction of the steam chamber, I used a steam production machine originally designed for wallpaper removal, leveraging its capacity to generate a significant amount of water vapour. To create the chamber itself, I employed a steel pipe equipped with a closable lid. Positioned atop two bricks, the pipe was strategically set with one end slightly elevated to ensure proper drainage of condensation water, preventing the wood from becoming excessively moist from liquid water. Additionally, I implemented several layers of towels to temporarily seal the chamber when the lid required opening during the bending process, maintaining a relatively closed environment. This upgraded steam chamber offered greater sophistication, enabling the bending of longer pieces, up to 1 meter in length and approximately 1 cm in thickness, in a reliable manner.

When bending wood pieces with a thickness of 1cm, optimal results were achieved in the second steam chamber by leaving the wood in the chamber for approximately 45 minutes. Naturally, as the thickness of the wood increases, the required steaming time also increases. A duration of 45 minutes for 1cm wood is notably extended, considering that large-scale steam benders such as the K. Winkler AG typically adhere to a rule of 1 minute per millimetre of thickness. This variance in steaming time can be attributed to the differing efficiency levels of the steam chambers employed in various workshops.

Both bending methods, using weight and employing formwork, yielded positive results, yet pressing the wood in between formworks offered greater precision, particularly in mass production scenarios. Nonetheless, formwork usage occasionally caused minor fractures at the midpoint of the wood due to compression between the wooden planks and resultant friction during bending. This challenge can be effectively addressed by incorporating metal inserts between the wood


WAGNER
SteamForce


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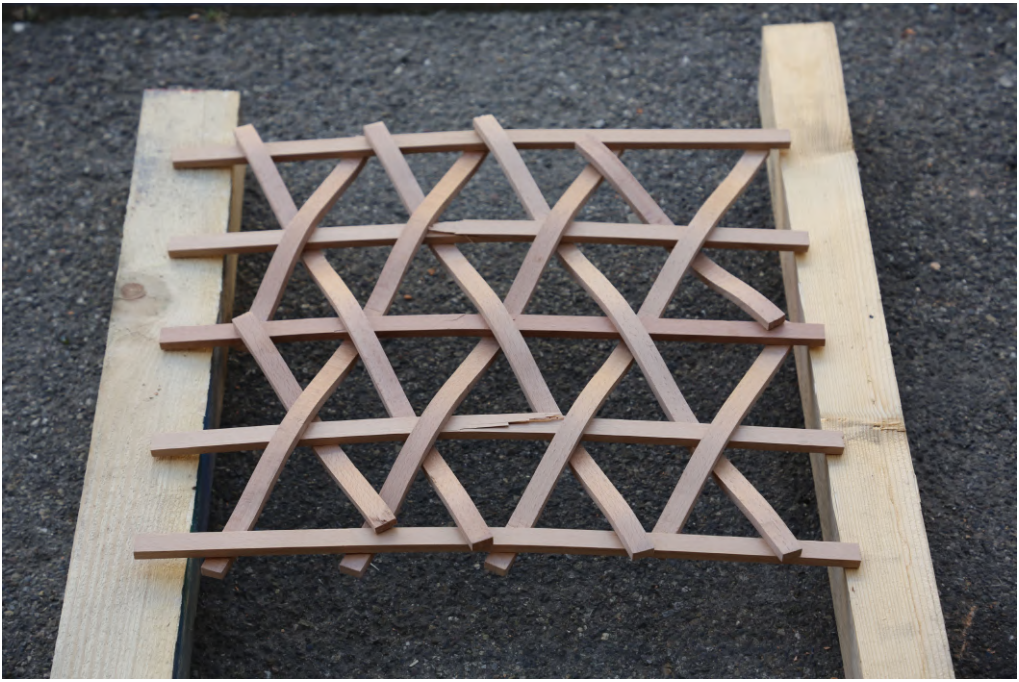

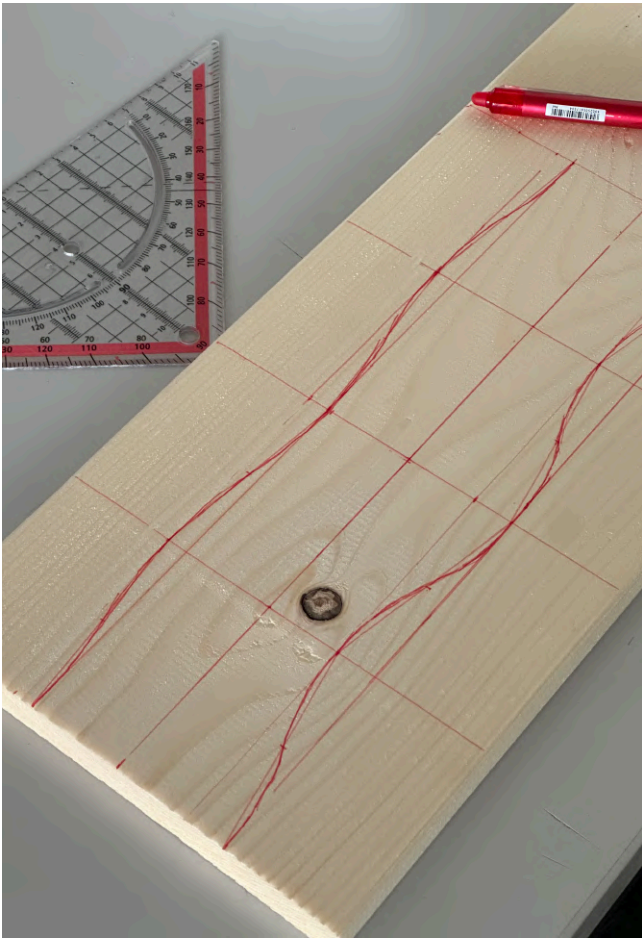

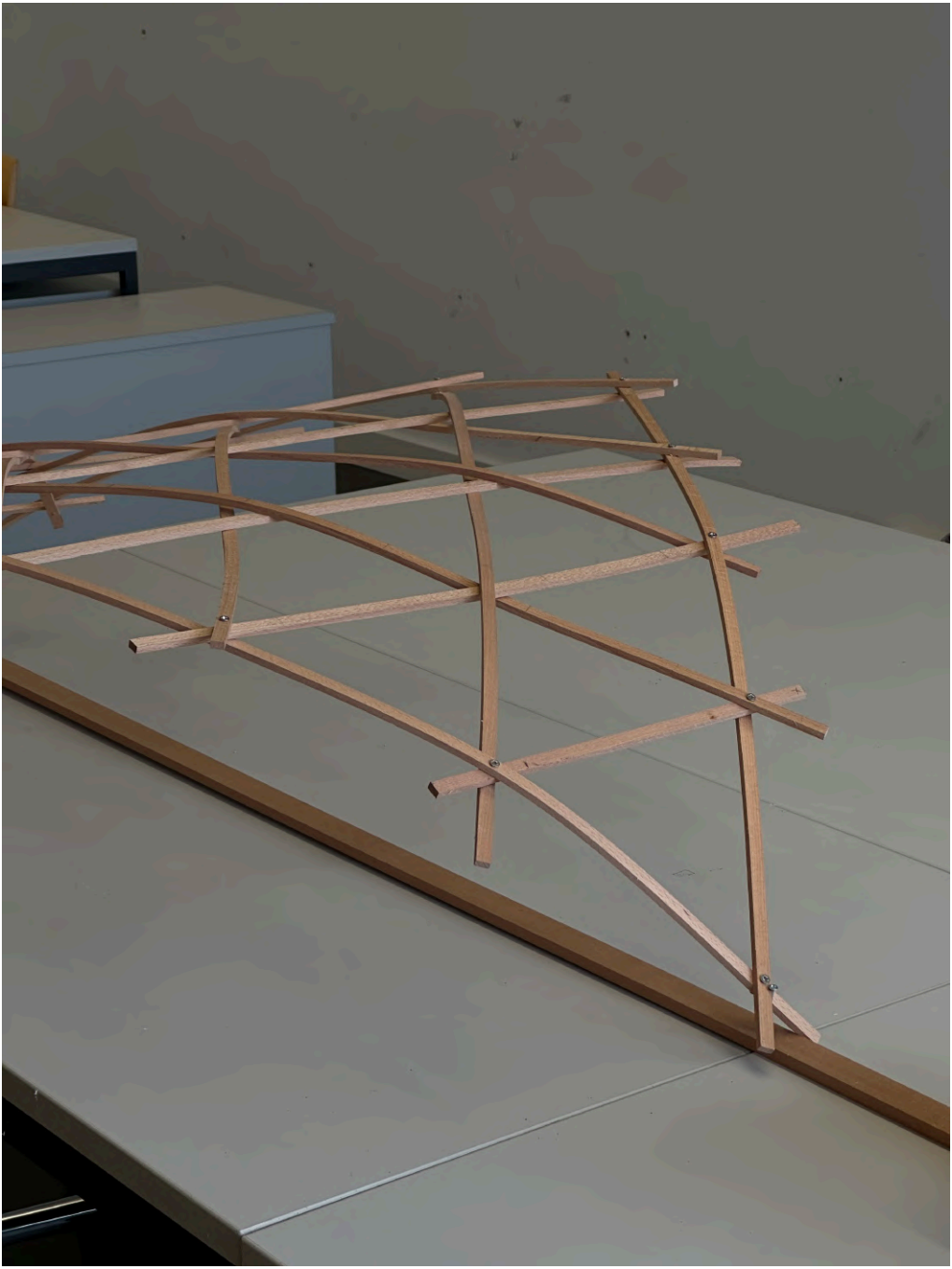

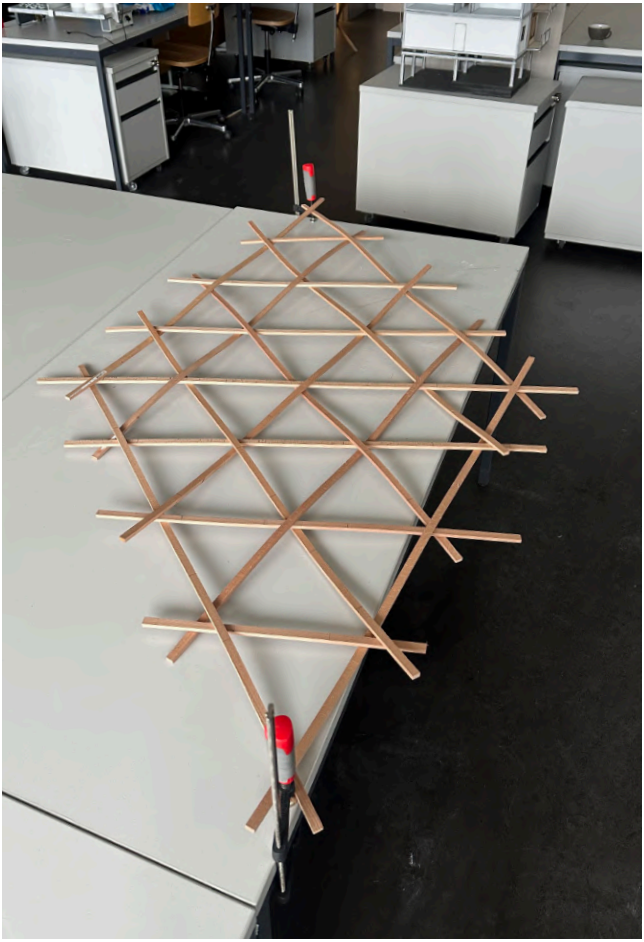

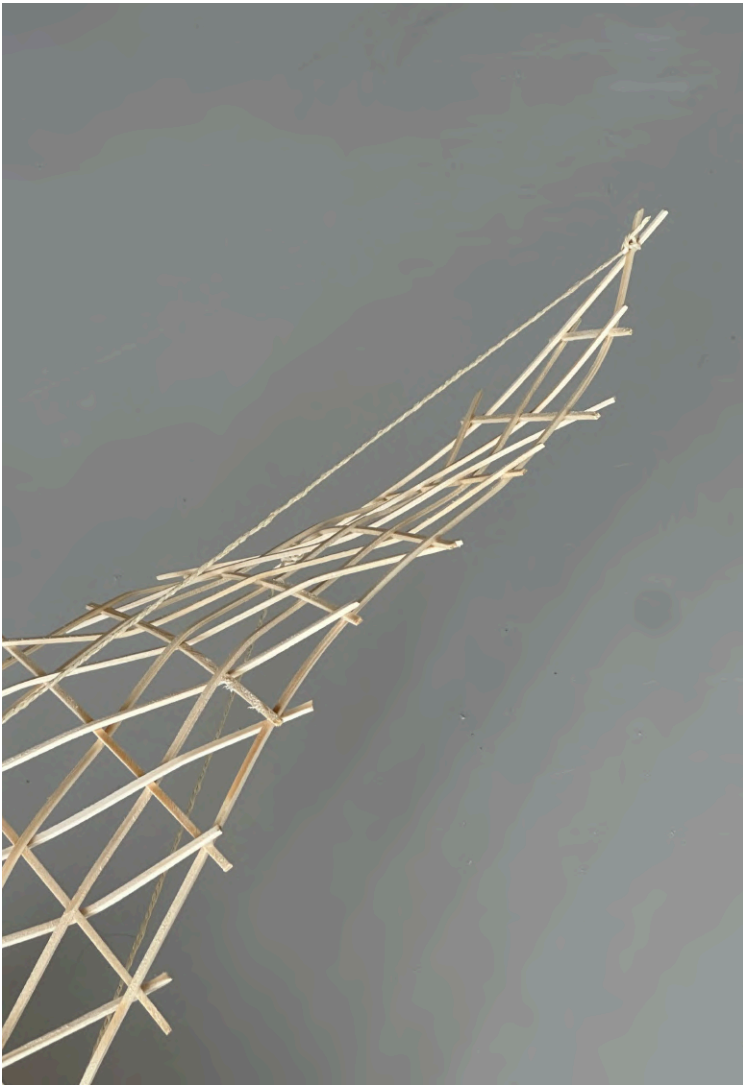


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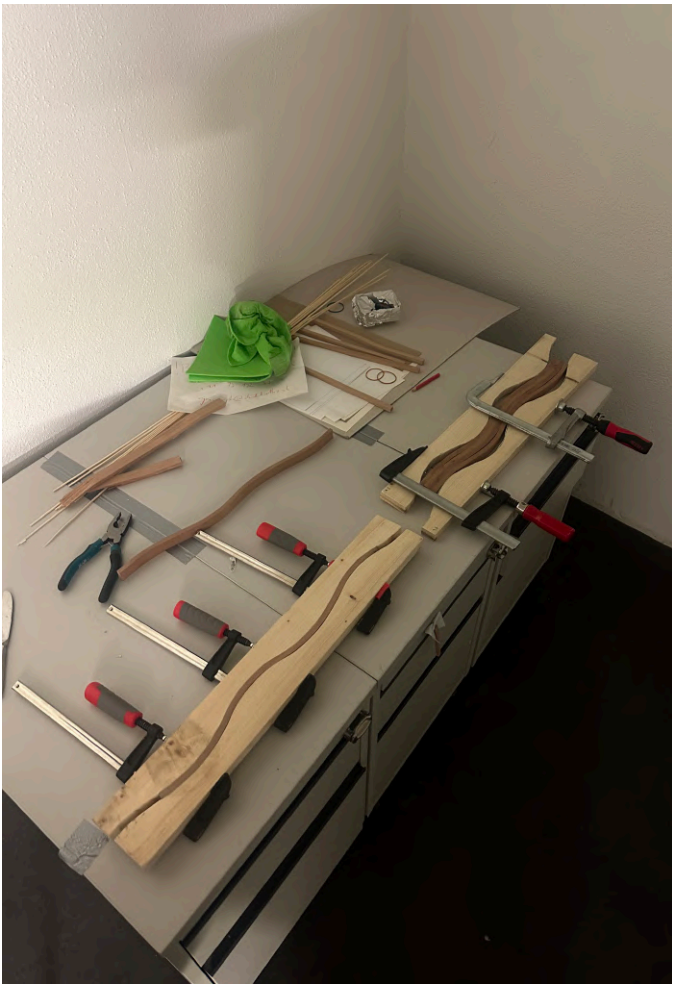

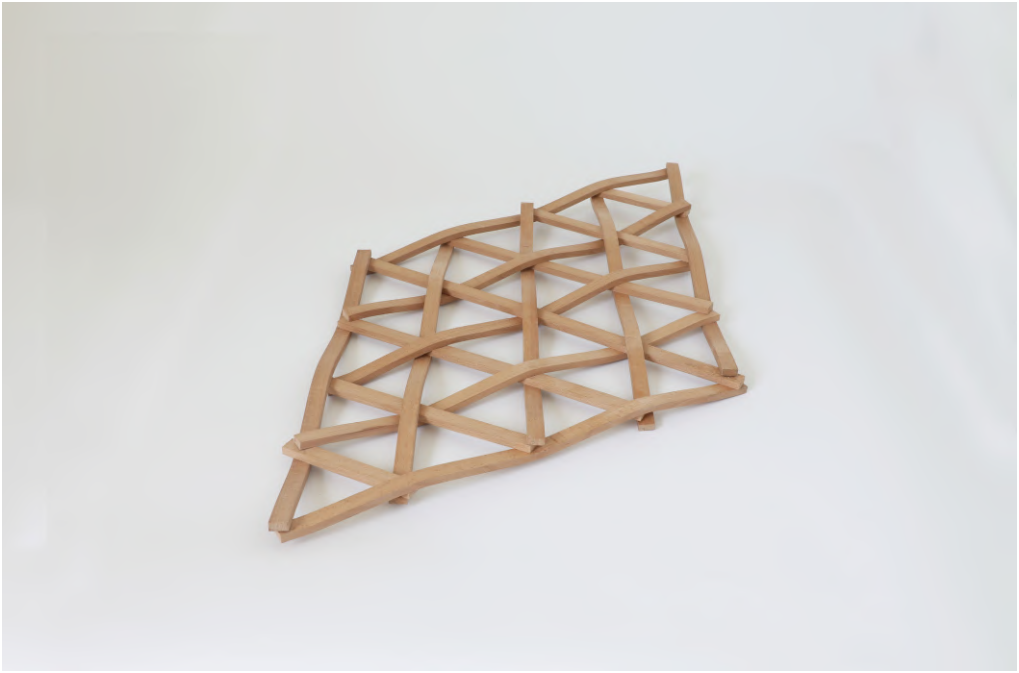

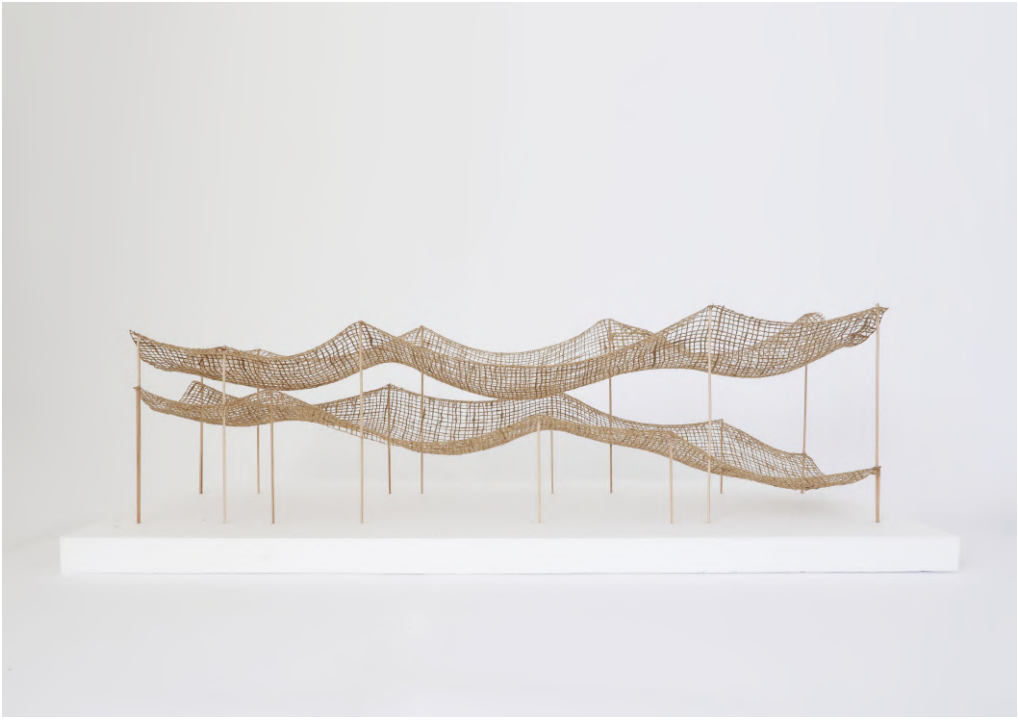

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workshop visits

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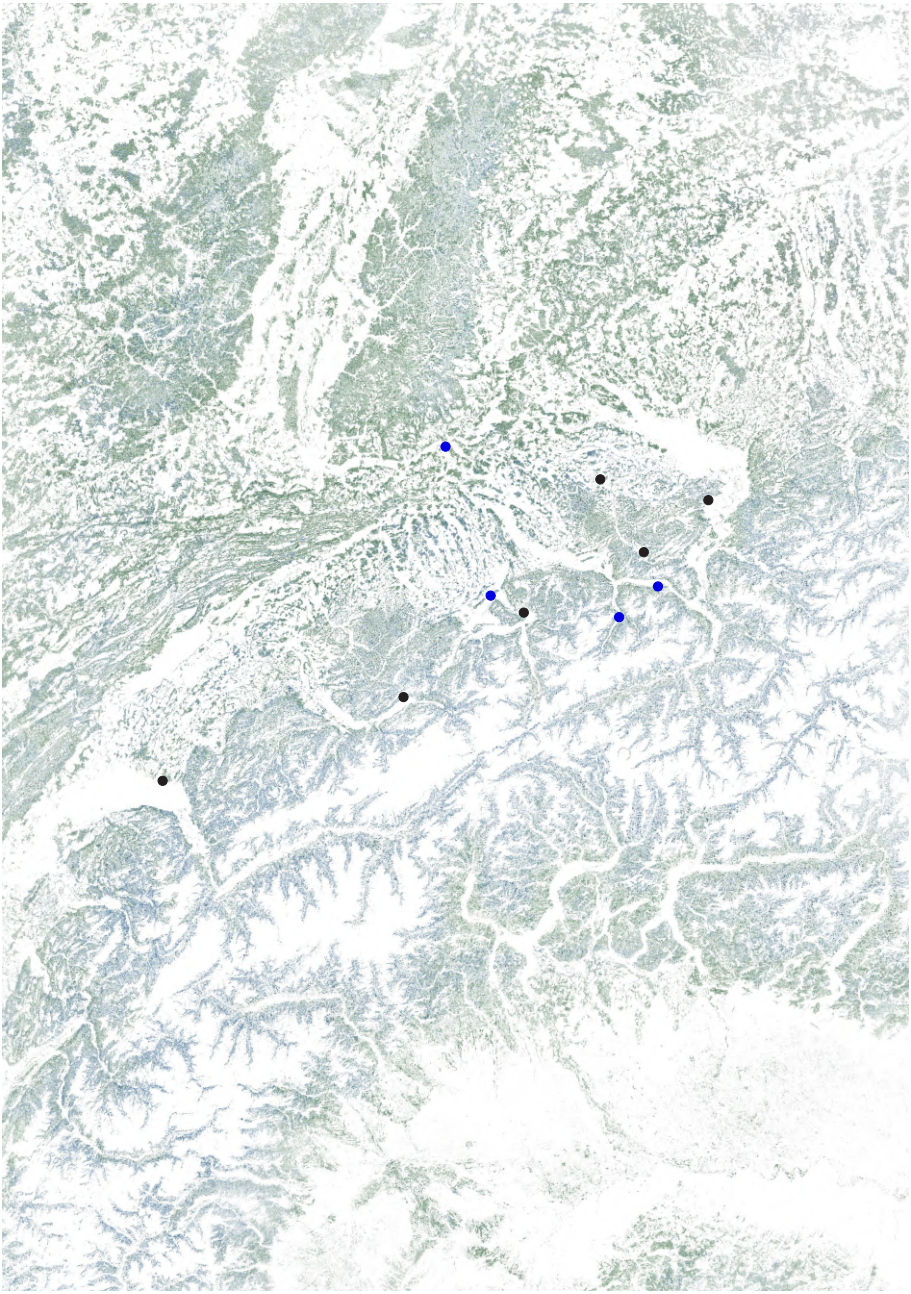
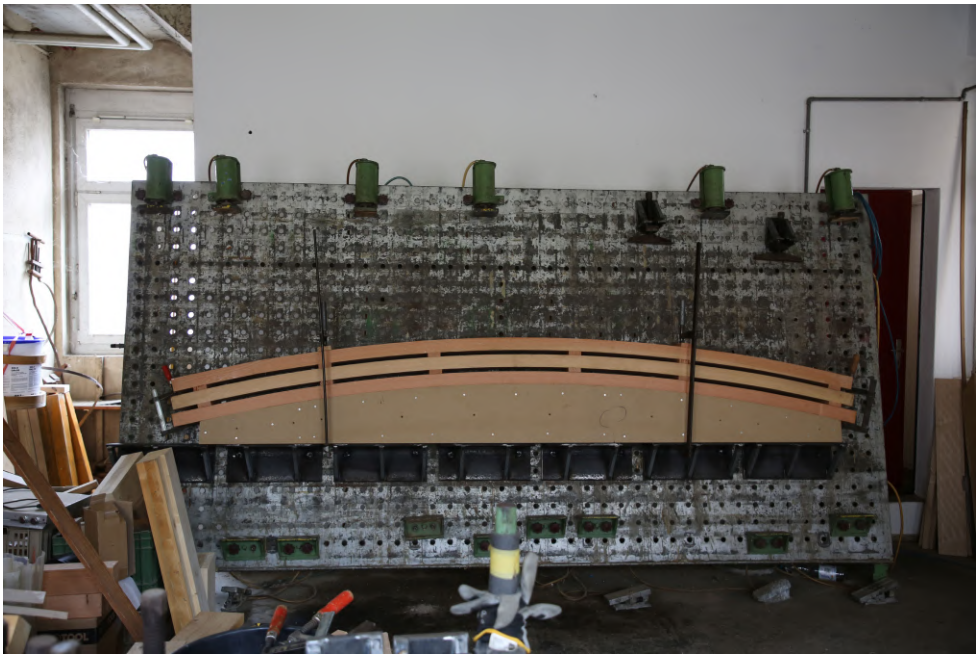


Steam bending of wood holds a significant tradition in Switzerland, although this tradition is diminishing today, with only ten workshops still practicing it in the country. Three of these are Weissküfereien, including my uncle's workshop, Dieter Gmür, located in Unterterzen, as well as Roman Räss in Brienz, Weissküferei Stauffacher. Additionally, there are four remaining coopers, known as Küfereien in German. The most established among them is Küferei Suppiger in Küssnacht am Rigi, followed by Küferei Hoch Drei in Schwyz, Küferei Thurnheer in Berneck, and Tonnellerie Hüsler, which is the last running steam bending workshop in the French speaking part of Switzerland. Lastly, two furniture producers continue the tradition in Switzerland: K.Winkler AG, which practices steam bending on the largest scale in the country, and horgenglarus, the most established and well known practice left in Switzerland.

winkler holzbiegewerk

The Winkler Holzbiegewerk, a wood bending company with a legacy spanning three generations, is renowned for its commitment to the gentle and natural production of bentwood parts. Through a harmonious blend of tradition and innovation, it stands at the forefront as a producer of bentwood and solid wood moulded parts in Switzerland. Situated near Zurich and equipped with a spacious workshop capable of producing the largest steam bent wood in the country, K. Winkler AG emerges as the ideal partner for projects pushing the boundaries of the steam bending process.

This workshop visit marked the project‘s first exposure to large scale steam bending, essential for assessing the feasibility of implementing steam bent wood in architectural applications. Witnessing the bending of pieces up to 5 meters long and 12 cm thick first-hand provided crucial insights. The visit highlighted a key limitation: the size of wood planks suitable for steam bending is primarily determined by plank production and the diameters of available hardwood trees, rather than by the steam oven or bending machinery. While producing larger planks is possible, it results in significant material loss and offcuts during the sawing process. Furthermore, the length of the pieces is constrained by the capacity of the steam oven and bending machinery. The workshop also confirmed the suitability of beech, ash, or maple for the project. Detailed information on the steaming and drying process was provided, emphasizing the importance of air drying wood before bending to enhance bending behaviour. Additionally, they shared practical knowledge, such as the rule of needing approximately one minute of steam per mm of wood thickness, valuable for guiding future experiments in the project.

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Winkler
HOLZBIEGEWERK


Etiketten
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weissküferei gmür

Weissküferei is a traditional Swiss craft characterized by intricate wood bending techniques and sophisticated connection patterns, employing only wood to create objects such as wooden vessels. Living and working in the village of Unterterzen, my uncle stands as one of the last three Weissküfers, preserving this traditional craft. The craft involves the skilful use of bending, enabling craftsmen to shape rings that hold wooden vessels together, without the need for synthetic adhesives. Central to Weissküferei is the utilization of connection patterns, where wooden components are intricately joined using wooden elements alone. Despite its skilful heritage, Weissküferei has not significantly evolved over time, continuing to produce milk utensils that are no longer in high demand. Therefore, fewer people are motivated to continue the tradition. This circumstance underscores the need to preserve the craft and its unique knowledge through this research, as it stands at the intersection of tradition and contemporary relevance. The craft, passed down through generations, serves as a source of inspiration for my research, aiming to translate this traditional knowledge into innovative architectural forms and construction methods, particularly through the exploration of bending techniques and mechanical wood connections.

A particularly intriguing aspect of this research is the connection joints used for Weissküferei employed for the tension ring of the produced objects, enhancing the formal expression of the vessels and contributing to their stability. Various connection patterns are utilized based on the required strength for the tension ring, ranging from single to multiple fingers resembling keys, as well as repetitive patterns with over ten points of overlap. Due to the small and thin nature of the wood pieces, both cold and warm water bending techniques are employed. For cold water bending, the wood is submerged in a tub of lukewarm water for approximately three days before hand bending. This method offers the advantage of prolonged flexibility for about half a day, albeit with limitations in flexibility. Alternatively, for pieces requiring smaller radii or higher accuracy, hot water is used to prepare the wood, resulting in much greater flexibility, yet only for a couple of minutes.


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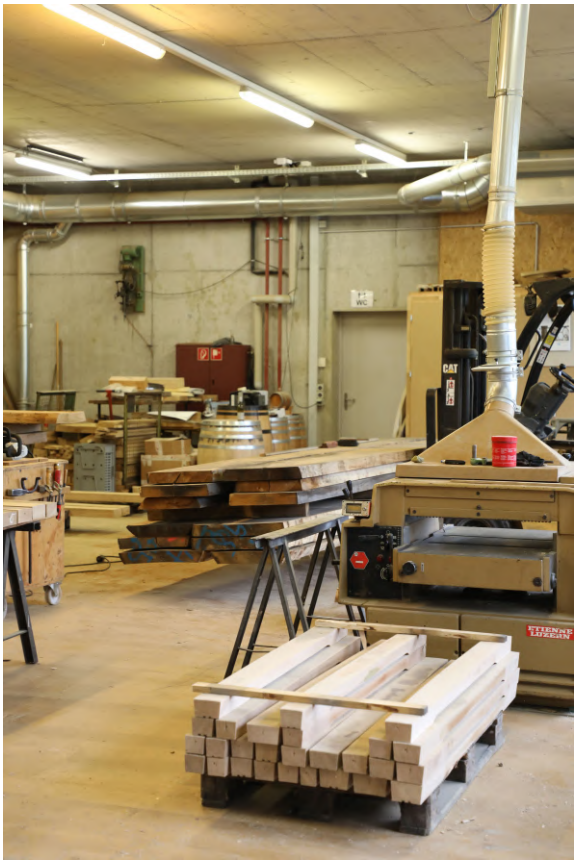
TROESCHAE - GUGGAE

küferei suppiger

Küferei Suppiger is not only established in producing normal sized barrels, known as barriques, but also specializes in crafting large scale barrels, reaching up to 5 meters in diameter. This ability to create barrels of both circular and oval shapes, as well as their size, has ensured the firm's survival to this day. Most interestingly, steam bending is not confined to closed containers like a steam chamber but can also be conducted in a more open manner using water and open fire, enabling work with even larger scales of wood.

The visit also provided insights into forestry practices, emphasizing the importance of diverse forests with mixed tree types for optimal hardwood growth, resulting in taller, straighter trunks with fewer branches. Of particular fascination for my research is their method of creating double curved surfaces by shaping the wood into trapezoidal pieces before bending them with water and open fire. The rich tradition and its connected knowledge became evident during this visit, particularly when considering the meticulous process of individually cutting each piece of wood to minimize offcuts. This task is indefinitely complex due to the ever-changing width of wood planks and required radii, which is why it's performed manually and passed down verbally, accentuating the intricate craftsmanship embedded in the tradition.


WC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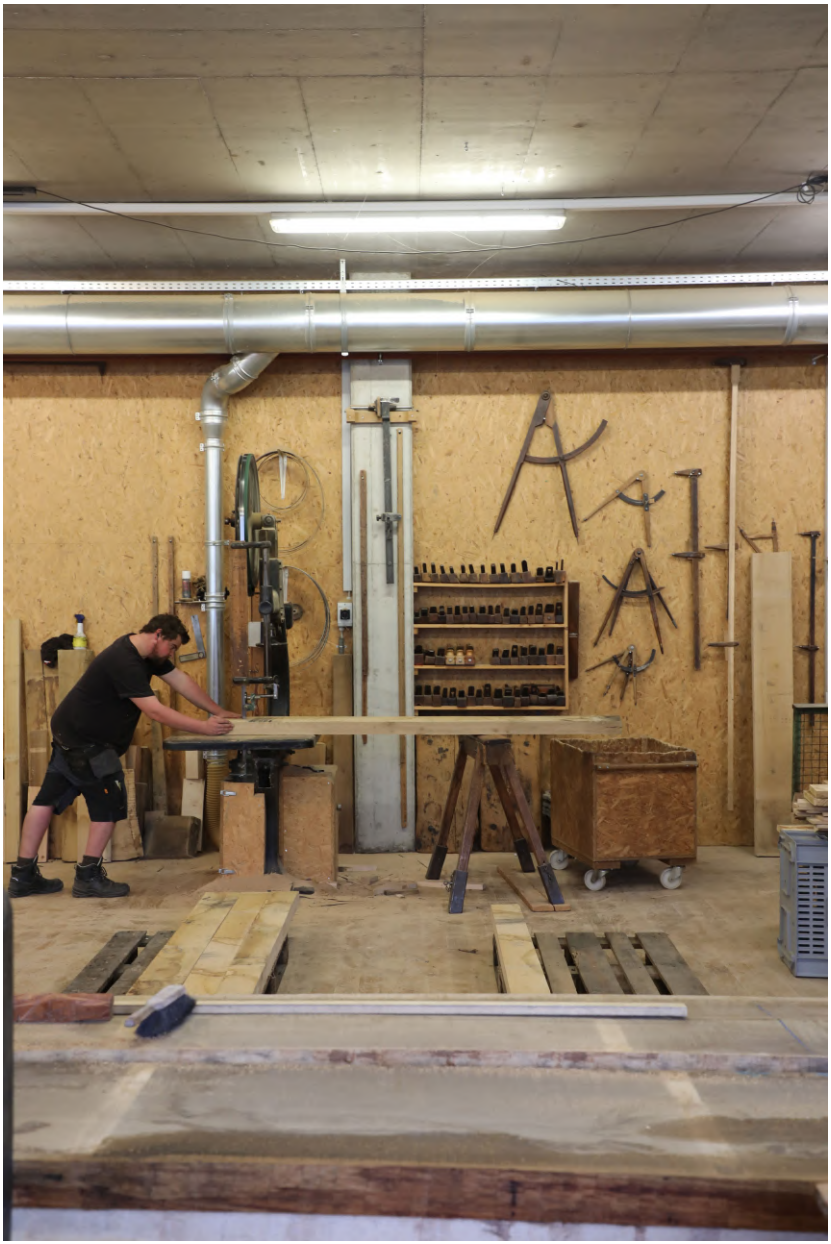


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horgenglarus

Horgenglarus is a Swiss furniture manufacturer, epitomizes traditional steam bending craftsmanship. Their blend of heritage and innovation makes them a prime example for studying steam bending in Switzerland. With a legacy dating back to the 19th century, Horgenglarus showcases the beauty and durability of steam bent wood while embracing modern design and sustainability efforts. Therefore, Horgenglarus stands out as perhaps the most established steam bending practice in Switzerland, producing about 20,000 chairs and 6,000 tables annually.

What's most striking is their ability to produce tightly bent wood pieces with small radii with unprecedented precision, achieved through their use of metal guides, which they keep attached during the drying process. However, this requires the availability of many moulds, as the pieces stay in the drying room for a couple of days. Moreover, it was interesting to see the high capacity of wood bent, and also that the process is quite redundant. Even though the steam oven is opened every couple of minutes to bend another piece, the wood does not lose its bending qualities or structural properties.


KÄLIN


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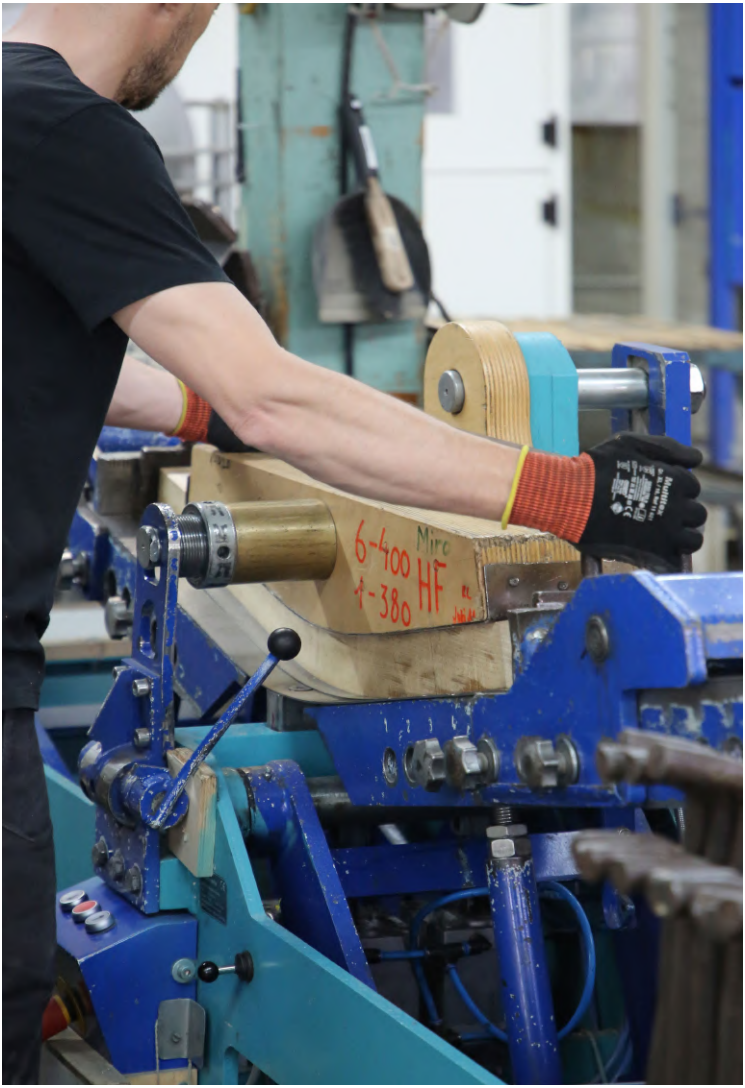
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BECKER&VANHOLLEN

steam shapes

site

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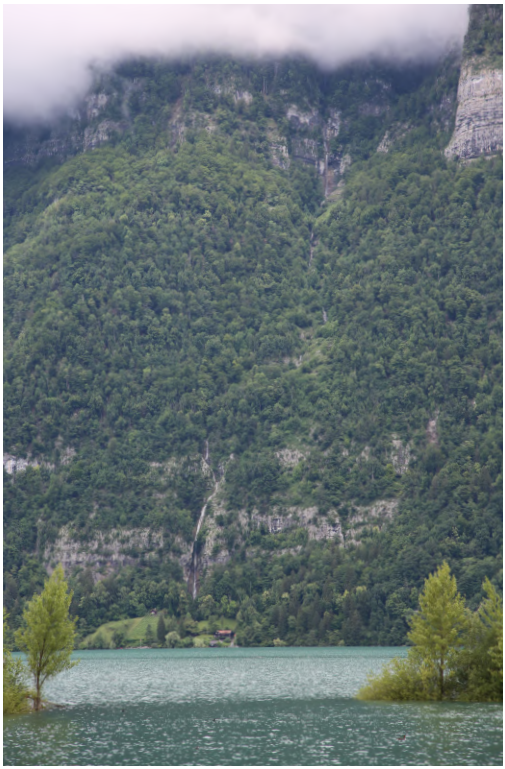
This project aims to return to the original focus of this thesis by locating it at the workshop of the Weissküferei Gmür in Unterterzen. As Unterterzen is situated in the middle of most of the remaining steam bending practices, which can mostly be found in the eastern part of Switzerland, this production space has the potential to serve as a hub for design exploration on the topic of steam bending in architecture. This makes it an ideal location for a production space, enabling the exploration of steam bending in all scales, from objects, to furniture, and even architecture. Moreover, Unterterzen's proximity to multiple schools of architecture can serve as a hub for design exploration centred around steam bending.

Unterterzen is conveniently located near dense hardwood forests in the north of the Churfirsten mountain range, the Voralpen, as well as south of the Walensee, reducing transportation costs and emissions. Additionally, Unterterzen serves as the starting point for both the Walensee Schifffahrt and the cable car of the Flumserberg Mountain Resort. This strategic location allows tourists and visitors to benefit from the facility, gaining insight into Swiss craftsmanship as part of their visit, and thus contributing to its preservation for future generations.

The project aims to utilize the rich local hardwood resources found in nearby forests, such as the Amler or Quartner Forest, where felled trees are a common sight. Currently, much of this hardwood is processed into wood chips and burned to produce energy. This research suggests that the main obstacle to implementing steam bending in architecture is not the process itself or the capability of wood to be bent on this scale, but rather the scarcity of space and the limited number of steam ovens. To address these challenges and implement the woven wood structures developed in the research, this project proposes a dedicated production space specifically designed for steam bending at an architectural scale. The proposed location is to the east of Unterterzen's village centre, on the site of the former match factory, "Zündhölzlifabrik Terza," which was historically supplied with hardwood from the surrounding forests. This site offers access to nearby railway infrastructure and a large, flat terrain in the otherwise steep topography of the area, making it ideal for the envisioned production space.

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