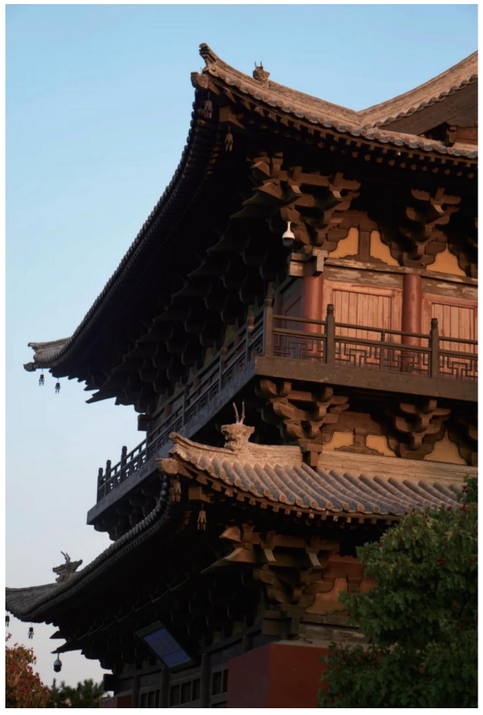
I focus on the traditional Chinese mortise and tenon structure and try to combine this type of architectural structure with furniture design.

While giving the product stability, it also gives it a strong cultural background.

Unit 10
Bangbo Zhu

Enquiry: The Brief - Design application of wooden structures

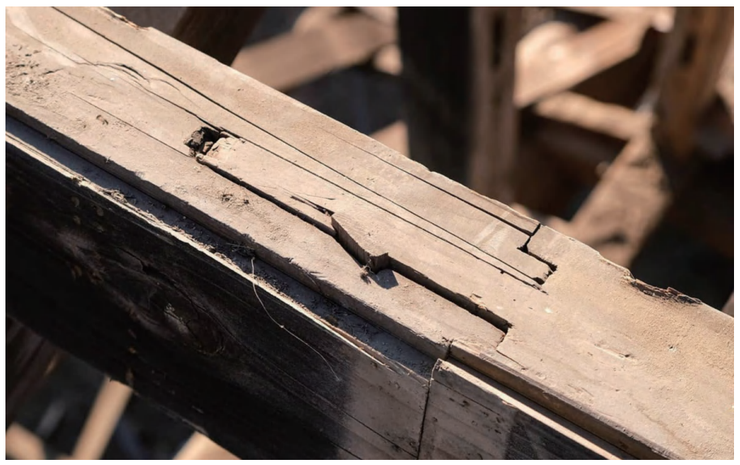
HMW： How do we incorporate the structure of ancient Chinese buildings into furniture design?



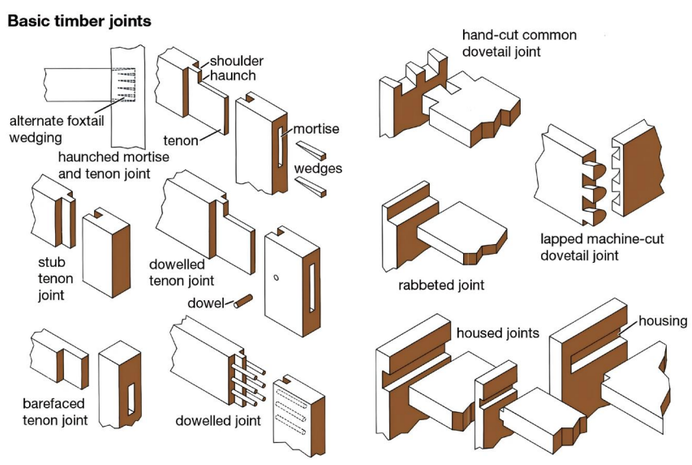
The mortise and tenon structure

As one of the oldest building structural systems, wooden structures are widely used in traditional buildings around the world. In China, the application of mortise and tenon structures is particularly prominent. It not only reflects the ancient craftsmen's profound understanding of the properties of wood, but also is a concrete manifestation of oriental structural aesthetics and philosophical thought.

I focus on incorporating the structural aesthetics of ancient Chinese architecture into furniture design, exploring assembly methods that do not require nails or chemical adhesives. In design, I emphasize the beauty of the structure itself, and hope to arouse people's attention and cognition of the wisdom of traditional Chinese architecture. Users can not only participate in the assembly and disassembly process of furniture by themselves, but also experience the charm of this culture and the exquisite craftsmanship in the interaction.



Mortise and tenon structure in architecture



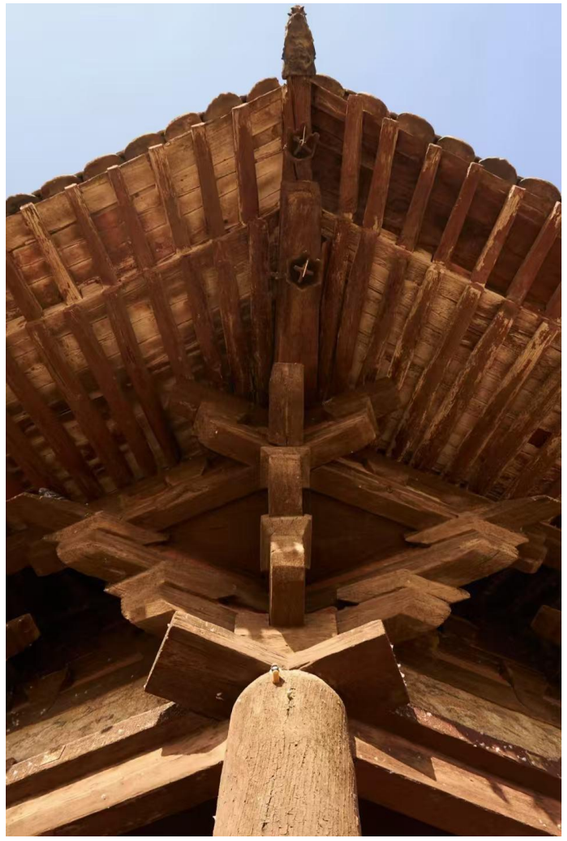
Mortise and tenon technique

China Pavilion at World Expo

Enquiry: Research Probe & Insights

Research Methods:

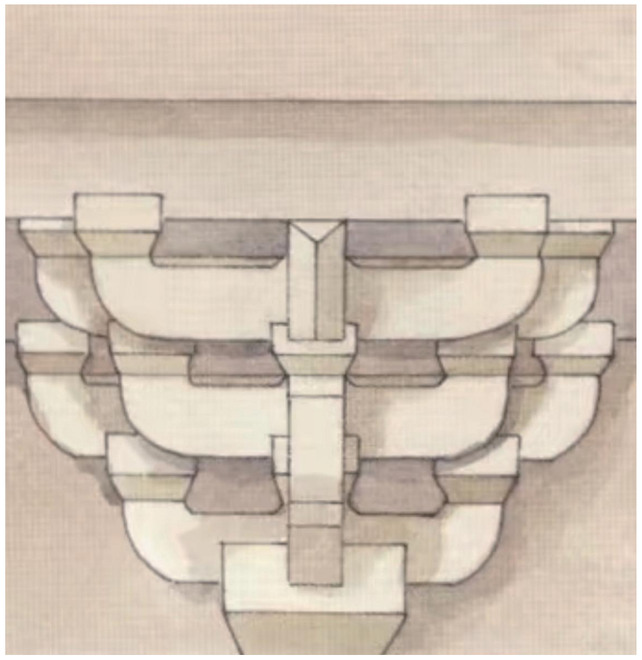
In December 2024, I visited the Nanchan Temple in China. Built in 782 AD, the Nanchan Temple is the earliest wooden structure in China. This sparked my interest in the structure of ancient Chinese buildings and I wanted to incorporate it into furniture design.



Nanchan Temple

Key Insights:

Ancient Chinese buildings exposed their supporting structures, which gave me inspiration. The structure itself can become a design language. In contemporary products, we often seem to try to hide the structure and pursue a simple appearance, but the Dougong structure does the opposite, making the structure the core of the visual connection and integrating function and form.

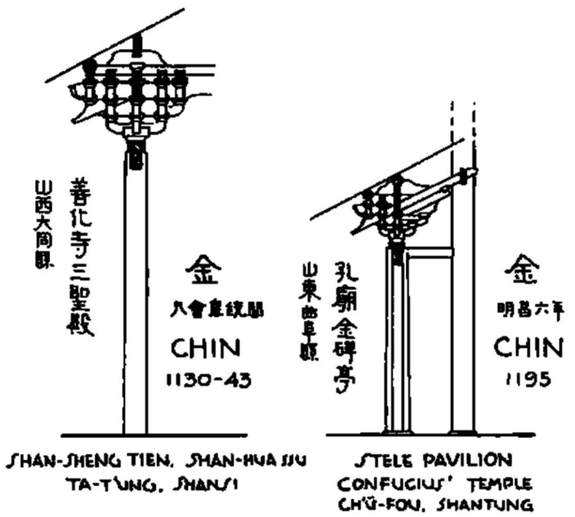


Ancient Dougong architectural features

Application to Design:

When studying traditional Chinese architecture, I was greatly inspired by the bracket structure. It not only has a clear load-bearing logic, but also has a strong decorative effect, turning the structure itself into a visual language.

I will explore the application of traditional mortise and tenon joints in modern furniture design, and how to reinterpret traditional Chinese craftsmanship into contemporary structural language.



Dougong architectural features (1130-43,1195)

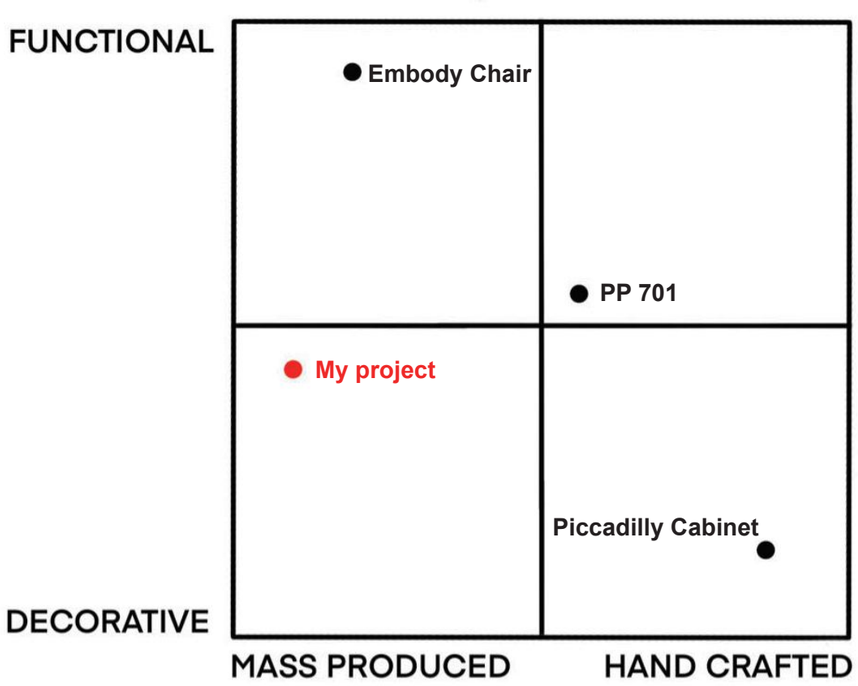
Critical Analysis:

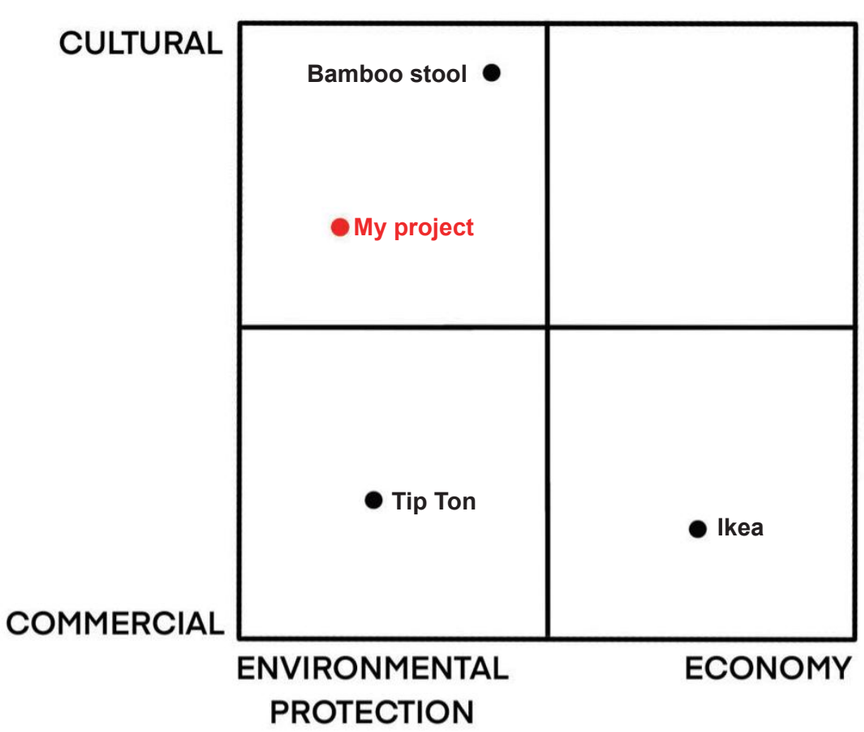
Careful study and observation of the structure of brackets allowed me to clearly understand their specific construction. However, this also limited my vision and made me lose the opportunity to create special structures myself.

Yusuhara Wooden Bridge Museum, Kengo

CLT PARK Harumi, Tokyo, Kengo

Knowledge: Value Framework and design values





Project Focus:

The beauty of ancient Chinese wooden buildings

Combined with modern CNC machine tool technology processing

Integrate Chinese ancient architectural culture

No adhesive is used, increasing recycling efficiency

Piccadilly Cabinet

PP 701

Embody Chair

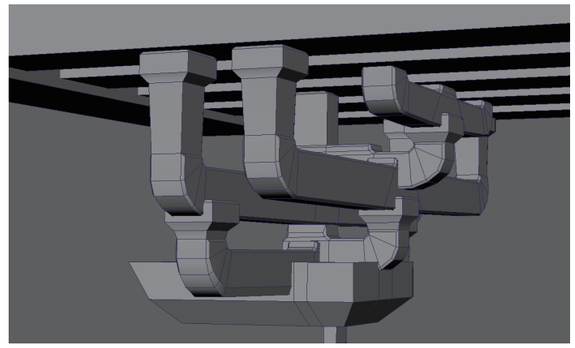
Tip Ton

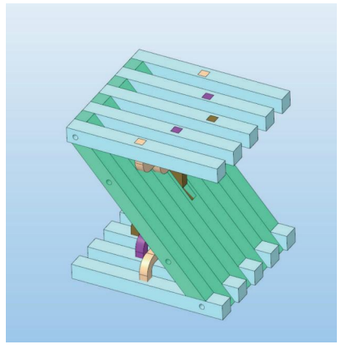
Ikea

Bamboo stool

Knowledge: Technical constraints, and user needs

Category	Requirement	Justification
Material	The product is not easy to wear and tear, and the service life is extended	Choose durable materials and consider structural stability.
Manufacturing	CNC, manual work	The finished product is made by CNC technology through the model file. Some details are processed manually.
Function	Space Efficiency	The use of detachable and combinable features makes transportation easy.
	Product parts are easy to disassemble and replace	No chemical adhesives or nails used
Aesthetics	Fusion of ancient Chinese archi-tectural style	Survey users and ask them what they think of this style. And combine digital technology to make this kind of traditional structure
User needs	Make people use the process more comfortable.	The size of the product should be suitable for use
	User-friendly	Easy to disassemble, assemble and trans-port.
Safety	Need to be stable enough and not easy to collapse	Consider structural stability, mechanics and testing
	Ensure joint stability and prevent loosening	Use fine processing to ensure that the slots fit perfectly when assembled.
	Strong load-bearing capacity	Using stacked structures to distribute gravity
End of Life	Make products easy to recycle	Use environmentally friendly materials without any chemical adhesives.



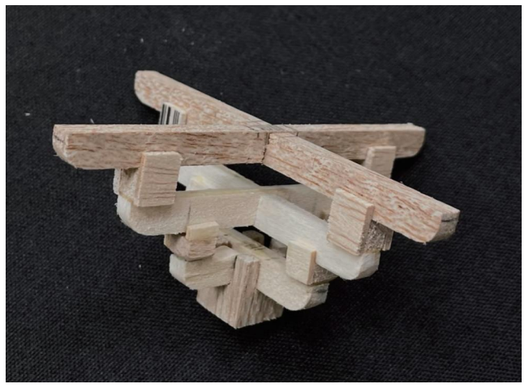


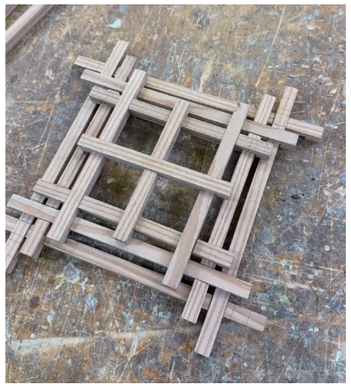
Classic design meets more stable structure

Increase support area of the Dougong strucure

Use layered structures to distribute support pressure

Use detachable structure to save transportation cost





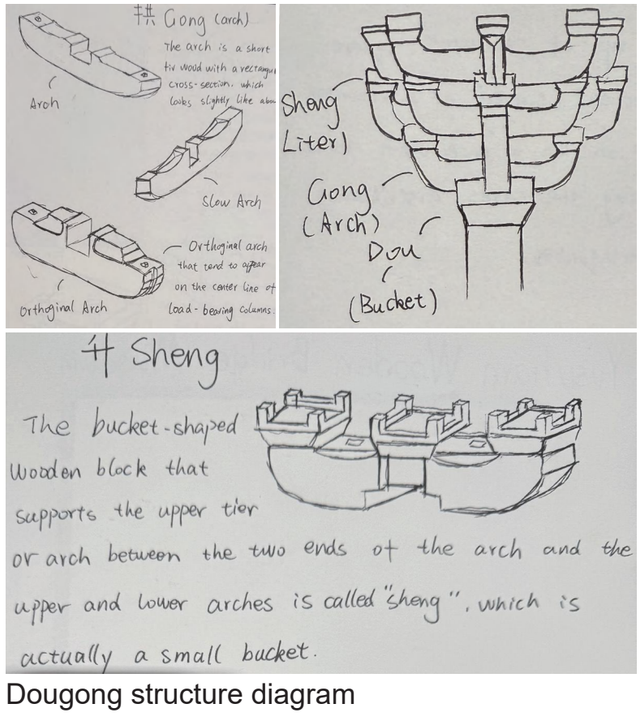
Imitation and simplified testing of bracket structure

Small pieces of wood can be used for processing, which reduces the threshold for material use

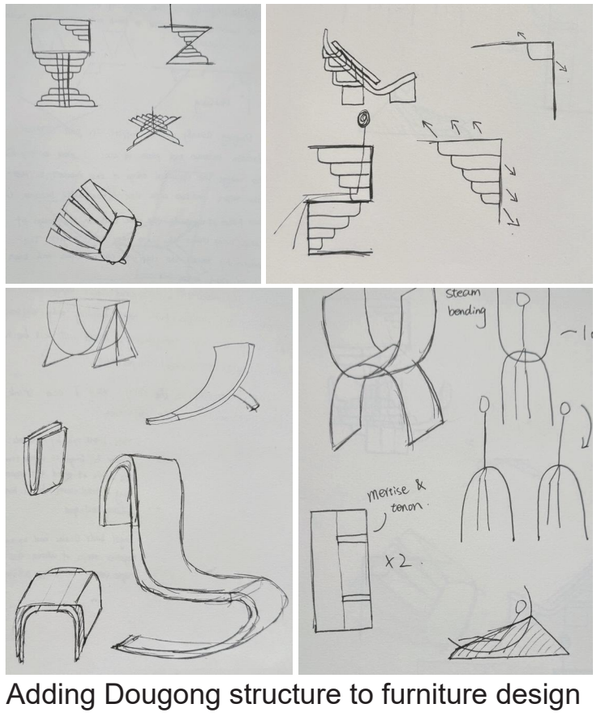
Delete unnecessary details to reduce processing difficulty

Stability testing proves structural feasibility

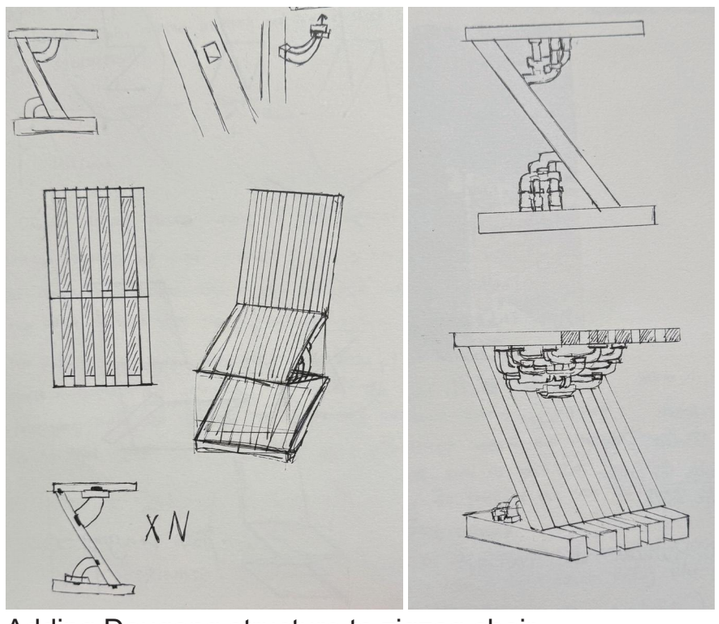
Process: Ideation Iteration & validation



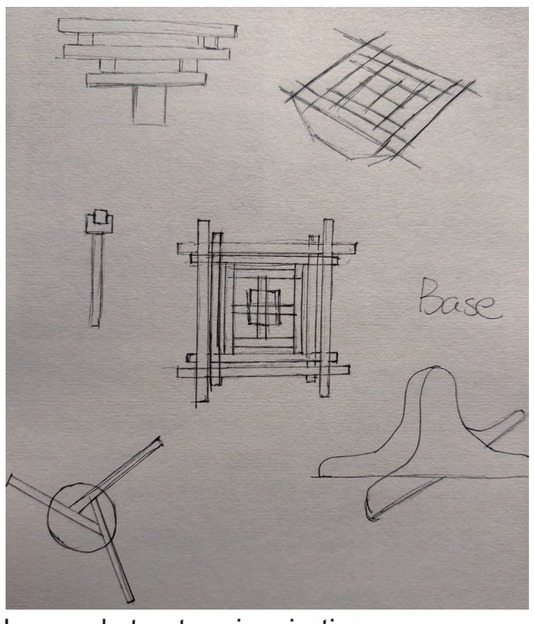
Dougong structure diagram



Adding Dougong structure to furniture design



Adding Dougong structure to zigzag chair



Layered structure inspiration

NOW

Although modern furniture has various forms, it lacks structural expression. Try to combine the structure of ancient Chinese architecture with furniture design.

NO

It is impossible to mass-produce by hand, the product requires very high precision, and it is difficult to control processing errors.

HOW

Using CNC technology to make products can greatly speed up production efficiency, or you can use mold opening to carry out mass production and reduce processing costs.

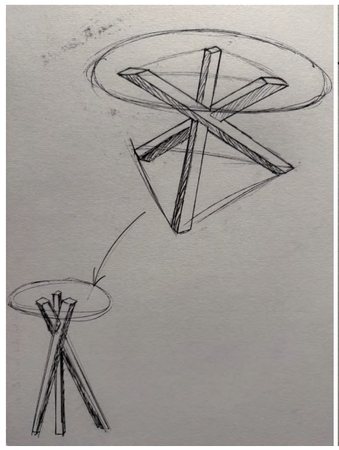
WOW

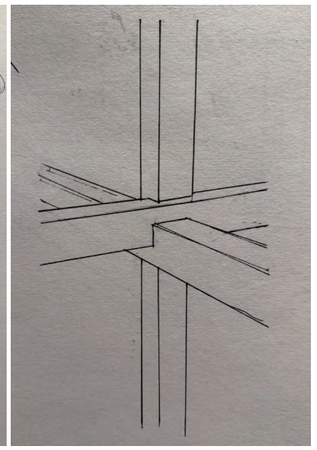
Combining 3D modeling and traditional craftsmanship for design, and designing CNC path diagrams, CNC technology can be used for precise processing and reduce processing errors.

Process: Experimentation, Evaluation, and Expertise

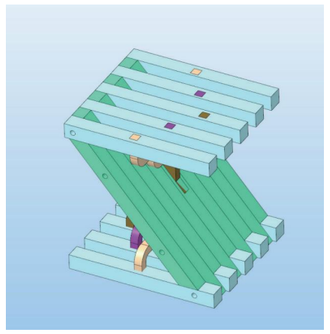
1. Experimentation

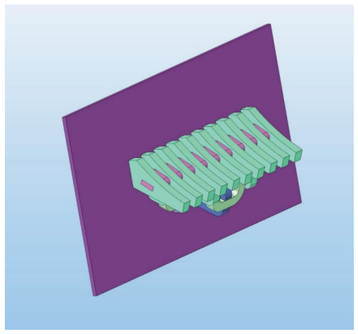
Try to design the mortise and tenon structure





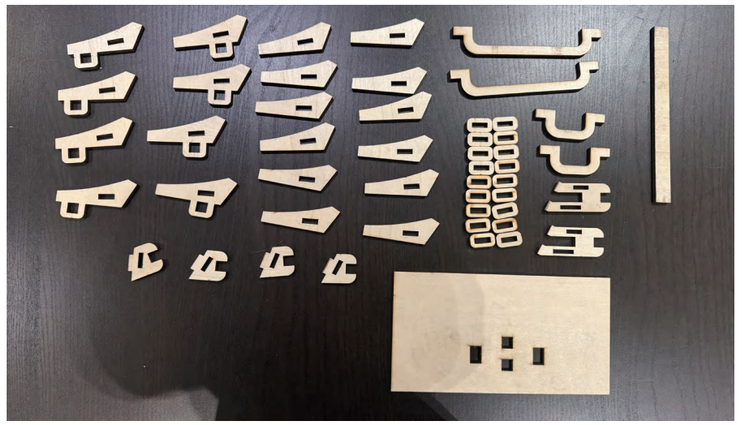
Some structural ideas



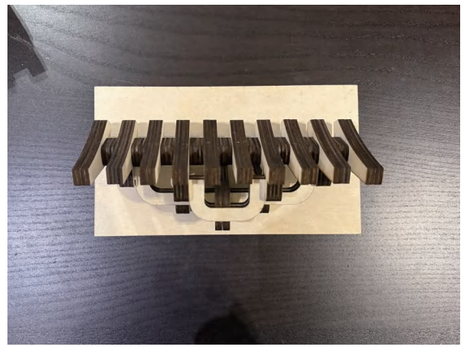


Use 3D modeling to visualize structures
and simulate structural feasibility

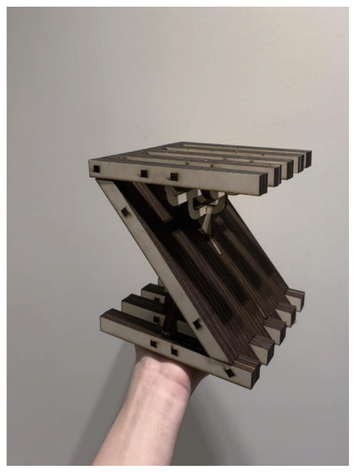
2. Evaluation



Laser cutting seat model parts

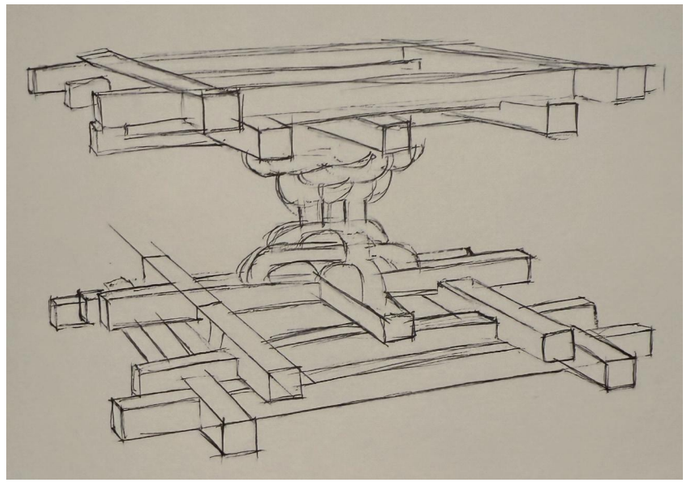


Urban hostility design integrated with Dougong

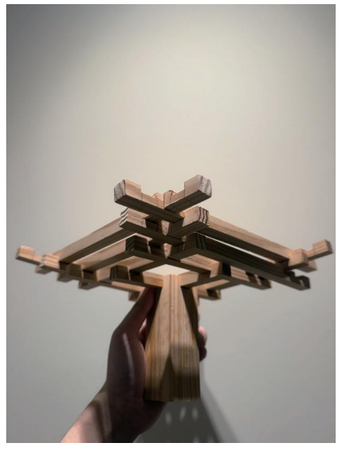


Redesign of zigzag.（Add Dougong structre）

3. Expertise



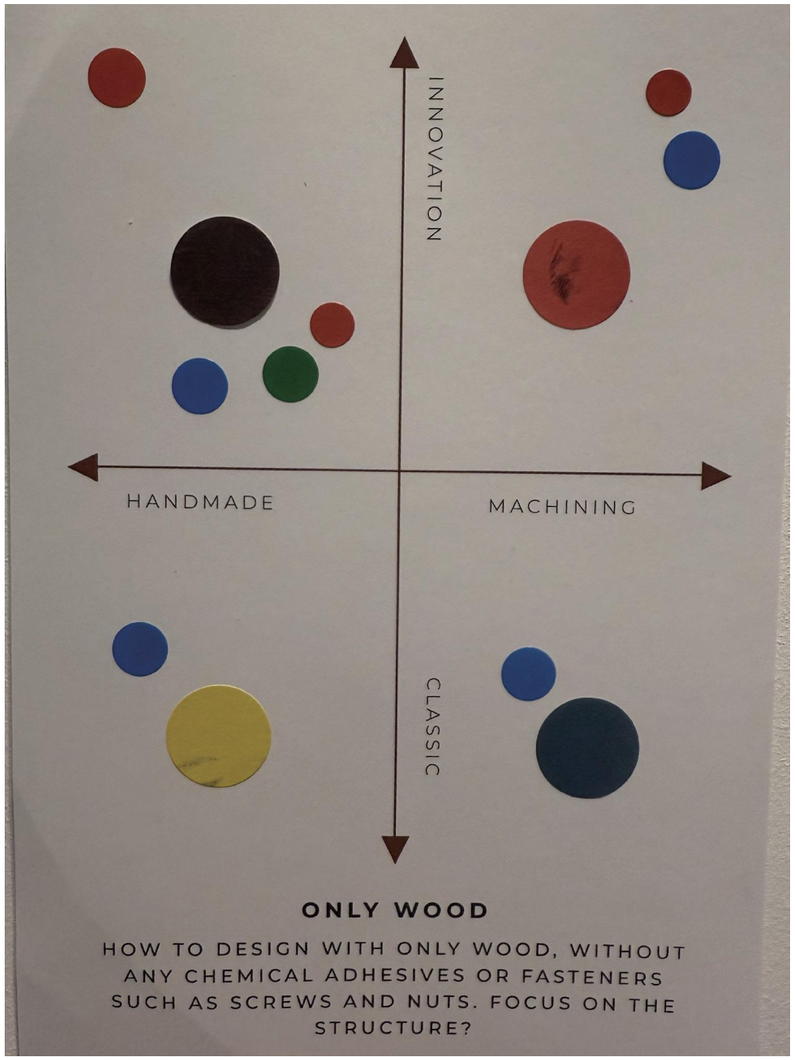
Final idea sketch



Reference building Dougong structure

Laser cutting can only simulate the appearance and cannot be used as a rigorous test. In the subsequent production, it is more reasonable to use hard wood. CNC processing will become the main processing method

Communication:Pitch Slide (Poster)



-People seem to prefer innovative designs

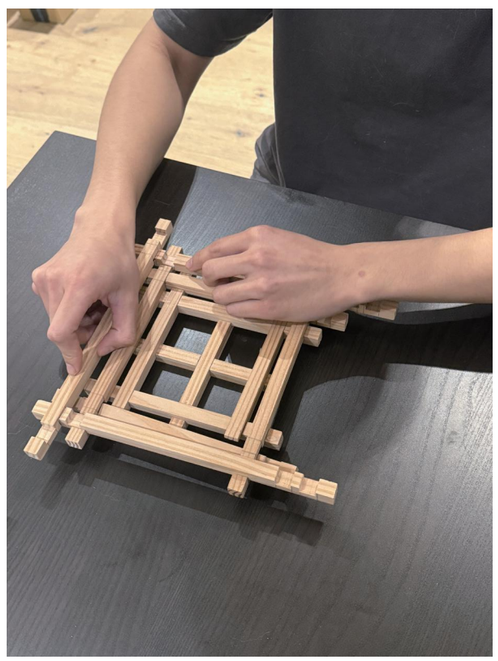
-Handmade products seem more attractive

-Feedback on the Zig Zag chair redesign has been less than favorable

During the WIPshow, I received a lot of suggestions, and they seemed to like the table model more. This simple and stylish design is more attractive. The cultural background also adds narrative to the design.The design focus will be on simplifying details and enhancing structural vision.

Communication:User testing & feedback

Feedback from classmates:

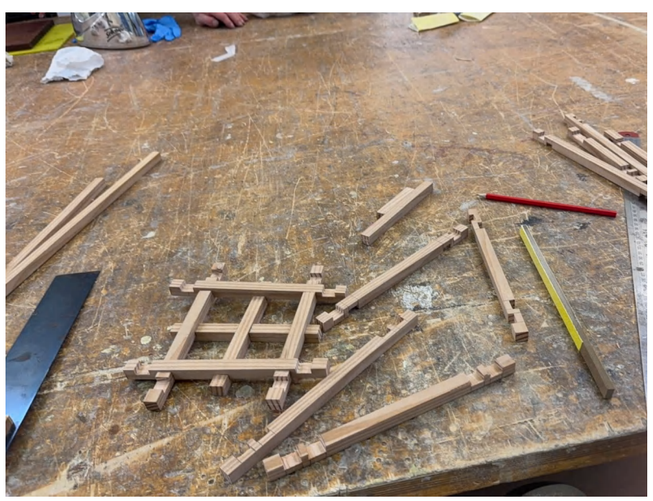




Advantages of laser cutting and invisibility
-Laser cutting is a low-cost and efficient method for making models
-There will be visual and structural differences in the final model

Structural load-bearing capacity
-If made of real hard materials, the structure should have good load-bearing capacity

structural understanding
-The stacking structure is not easy to understand in a short time

Structural understandability
-Use some materials as transparent



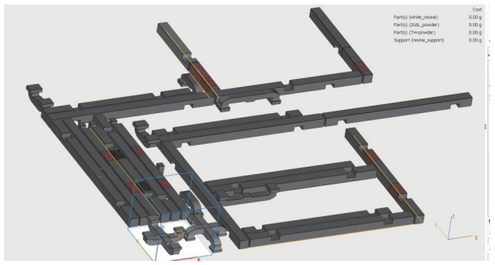
Feedback from Work Shop Tutor:
· If the product has the function of "supporting", it can refer to the structure of the brackets to express the structure.
· The bifurcated support logic of the brackets can be used to optimize the force structure of the product.
· Try to simplify the component types in a modular way to achieve the possibility of mass production.
· Combine plug-in assembly to allow people to participate in the assembly process and enhance cultural interactivity and educational value.

Realisation Production, manufacturing or making

1.

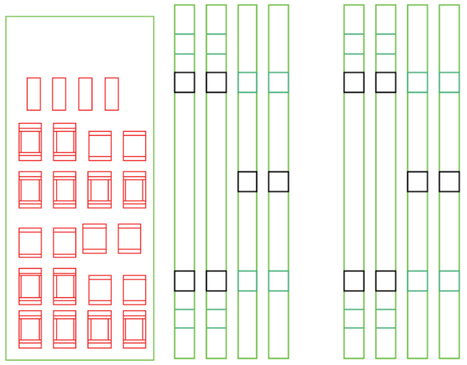
Preliminary 3D model production

2.



Determine the processing size and split the parts

3.

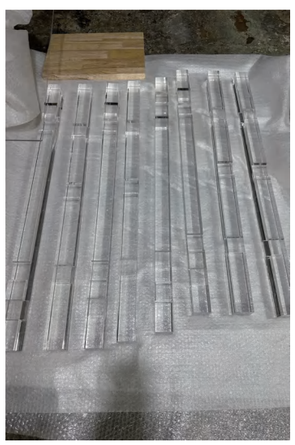


Design CNC path diagrams

4.

CNC production process

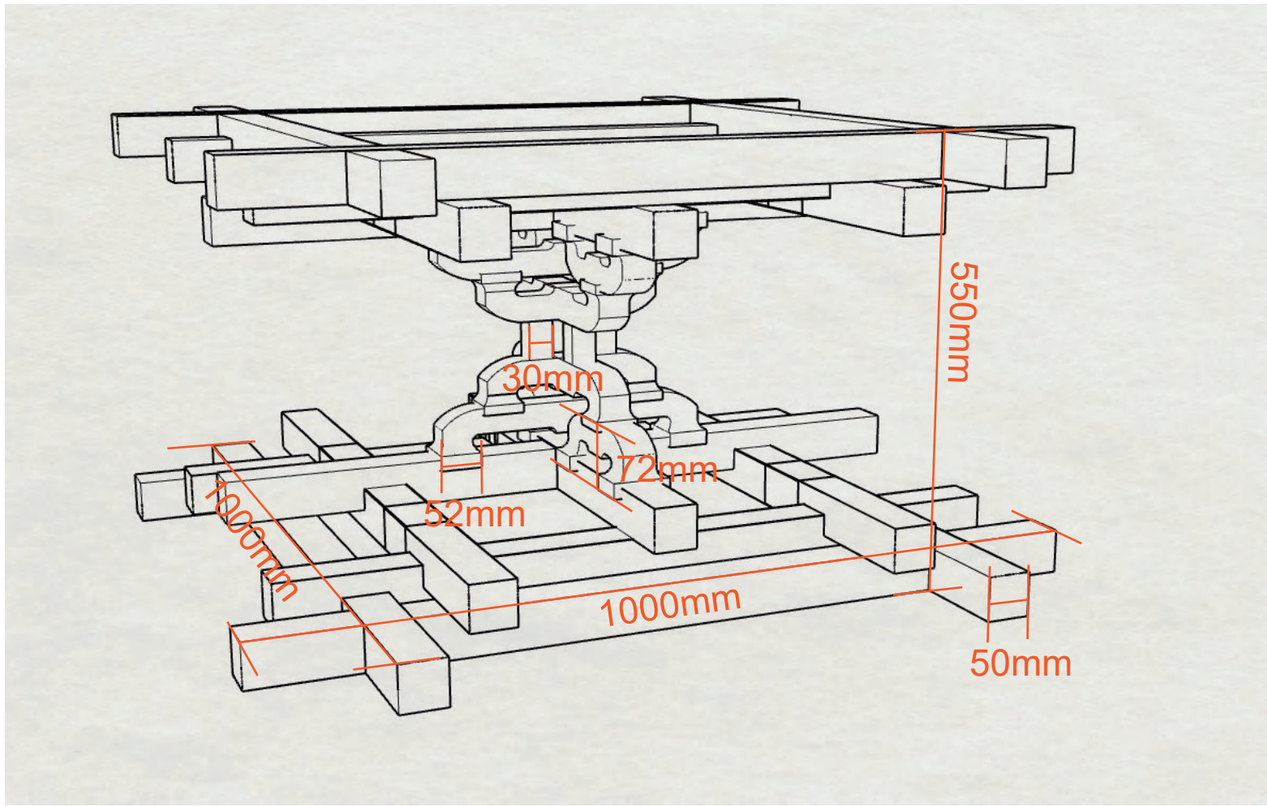
5.



Sanding and number each part

6.

Assemble the table



Summary

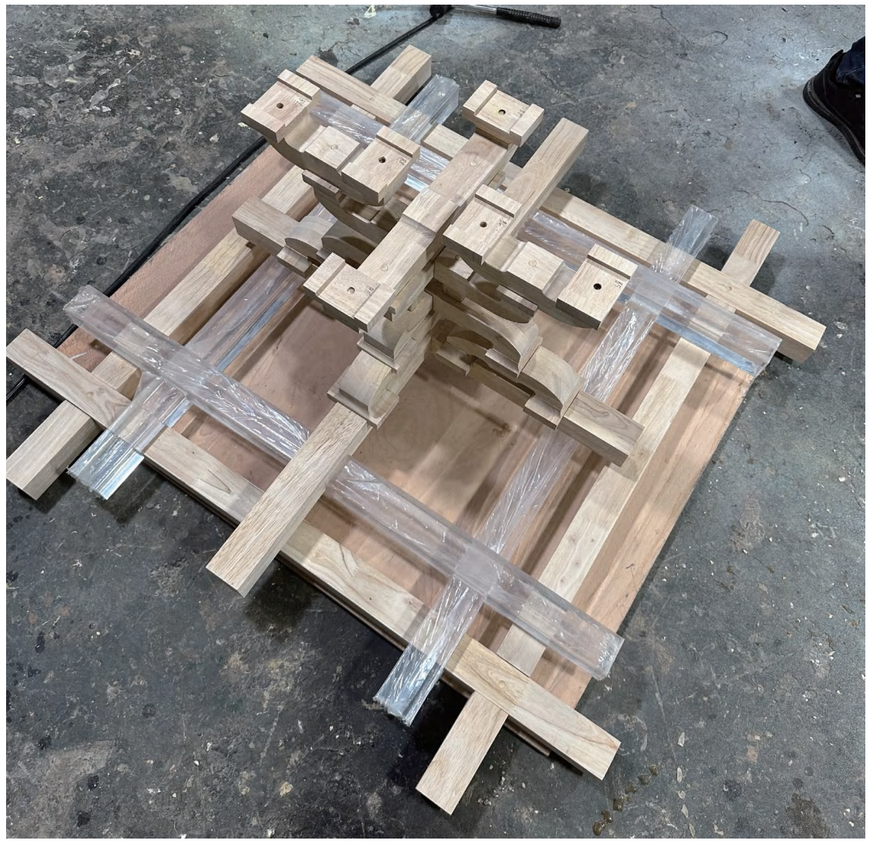
In the process of learning CNC technology, I think it is not to completely hand over the work to the machine. Although the machine can roughly complete the product, the participation of people in the process is also indispensable. I need to be responsible for creativity and translation, and the machine is responsible for production. Every step must be accurate, otherwise the final processing result will fail.

Realisation: End-of-Life and Sustainability

Use rubber wood as the main material

- Reduce transportation costs: Since my target user group is in East Asia, and rubber wood is also mainly distributed in Asia, the transportation costs will be reduced.

- By-product attributes: Rubberwood is often cut down after the rubber trees are old and no longer produce rubber. Wood becomes a by-product and is used efficiently.



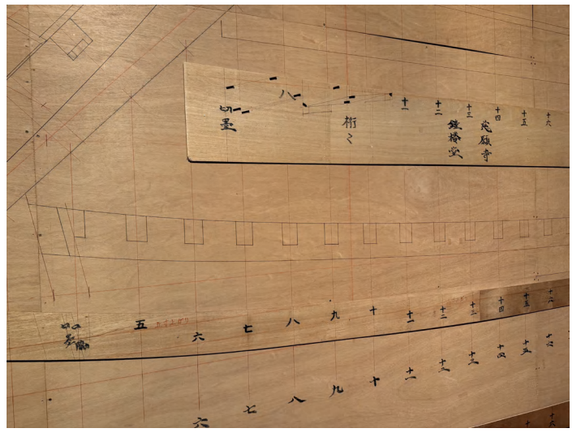
No chemical adhesives or nails are used

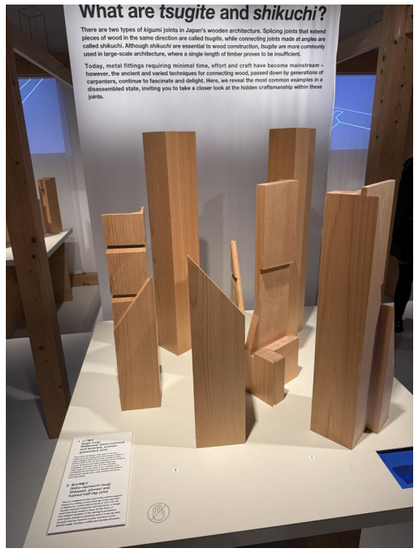
- Reduce carbon emissions: The manufacturing process of many industrial glues and metal fasteners is accompanied by high energy consumption and high carbon emissions

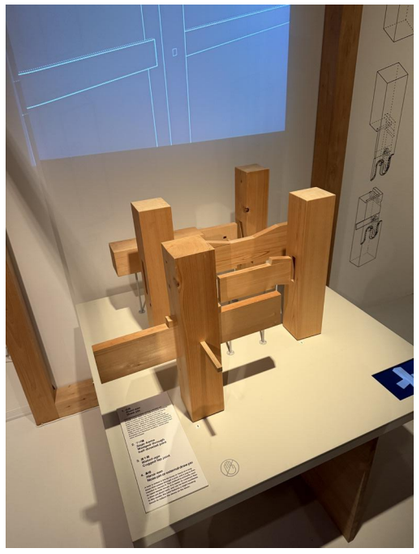
- Easy to recycle: Made of a single pure material, it reduces the amount of non-recyclable waste during product manufacturing and scrapping. It increases recycling efficiency.

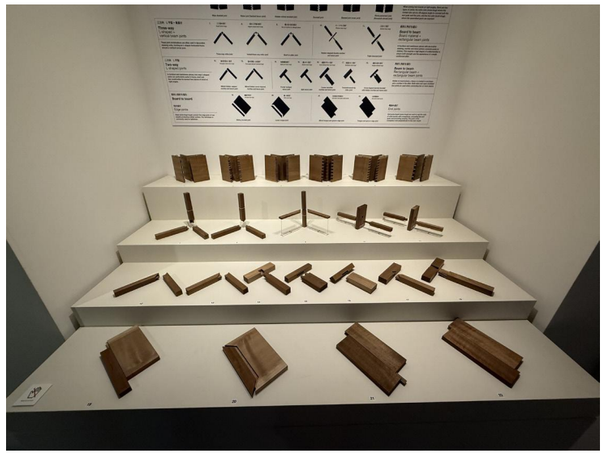
- Easy to replace: easy to disassemble structure, you can avoid discarding the entire product when it is damaged, just replace the parts.

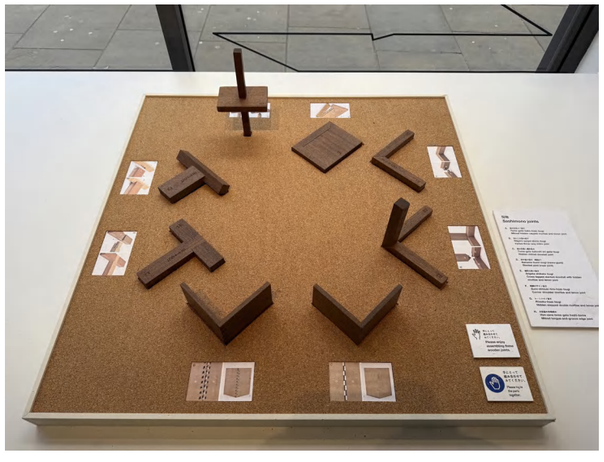
Appendix
Japan House

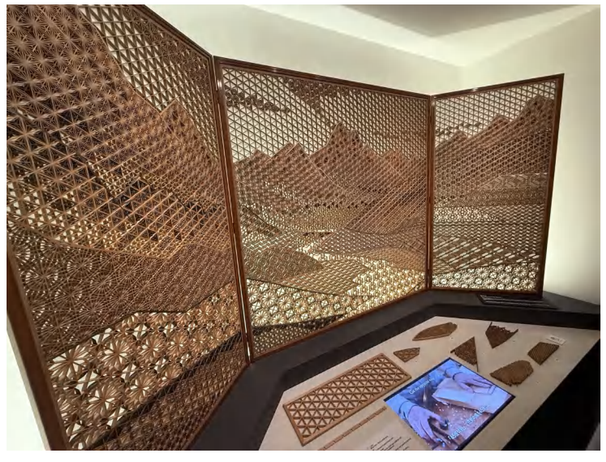




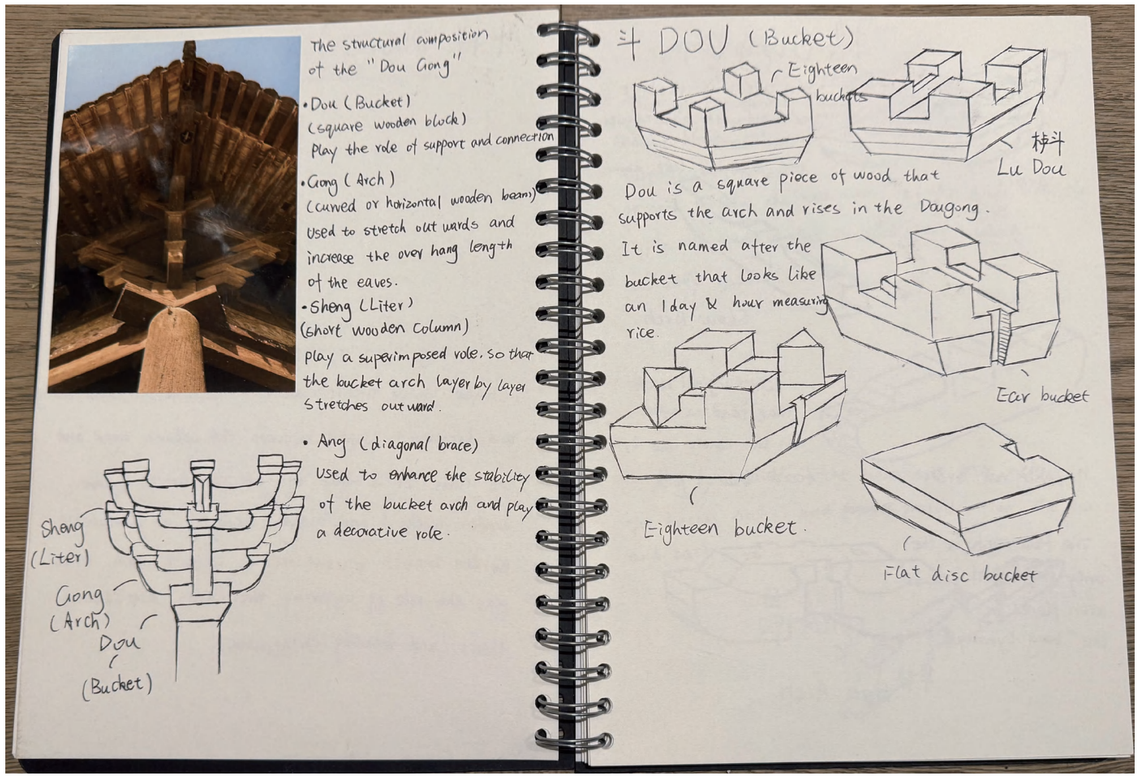


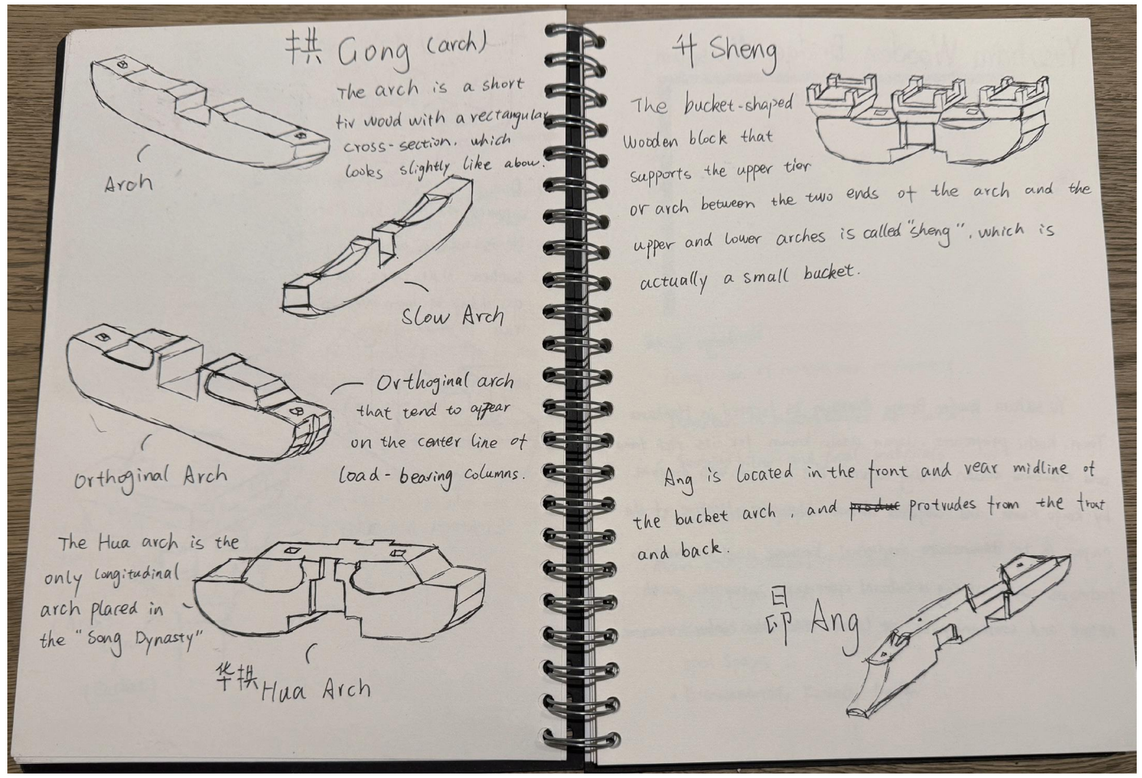






Appendix
Sketchbook





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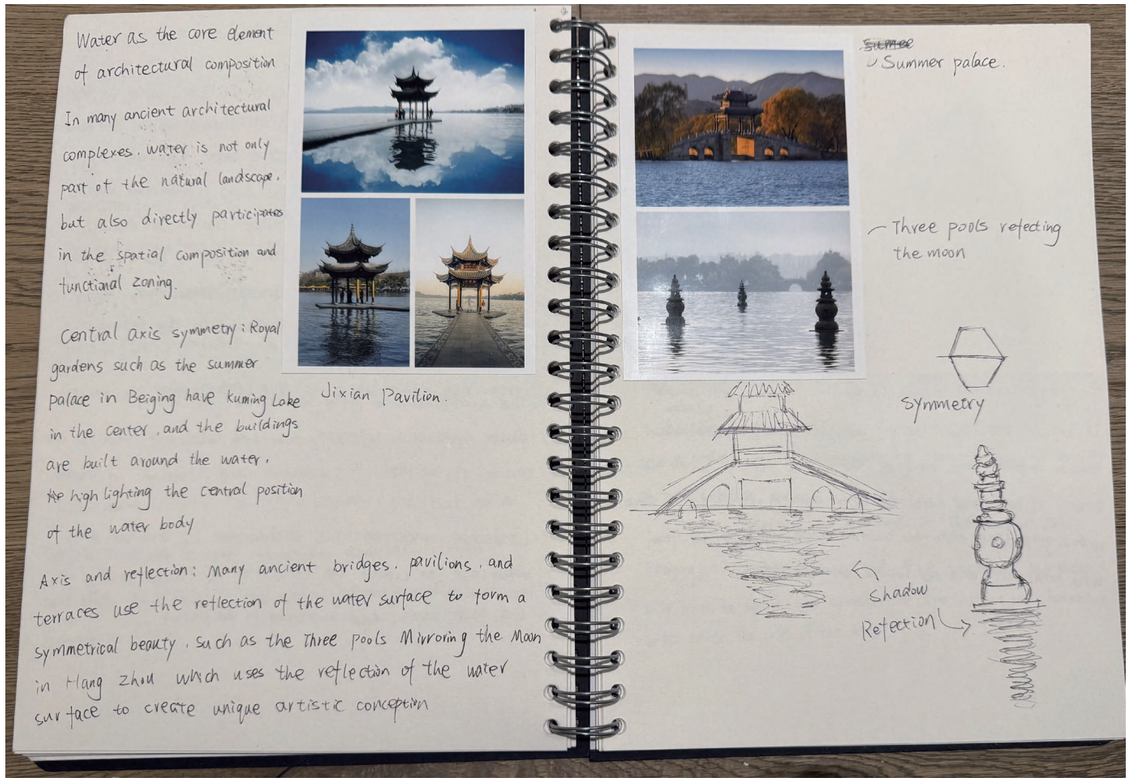
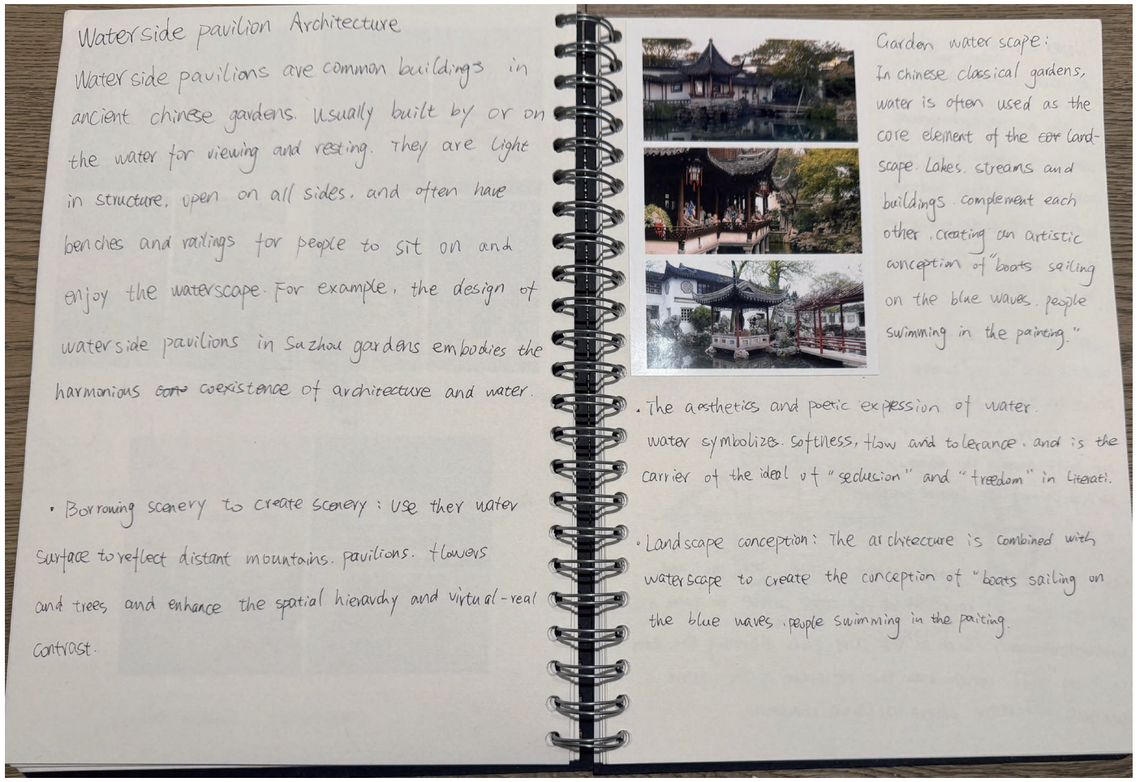
Sketchbook





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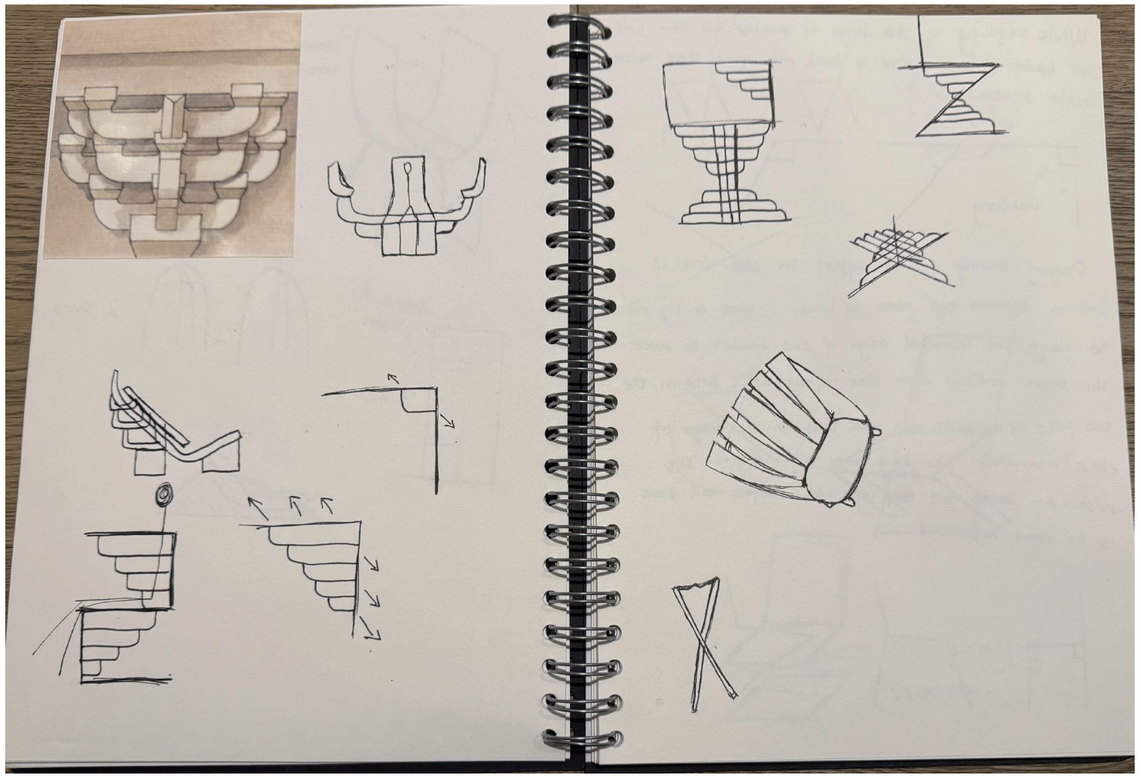
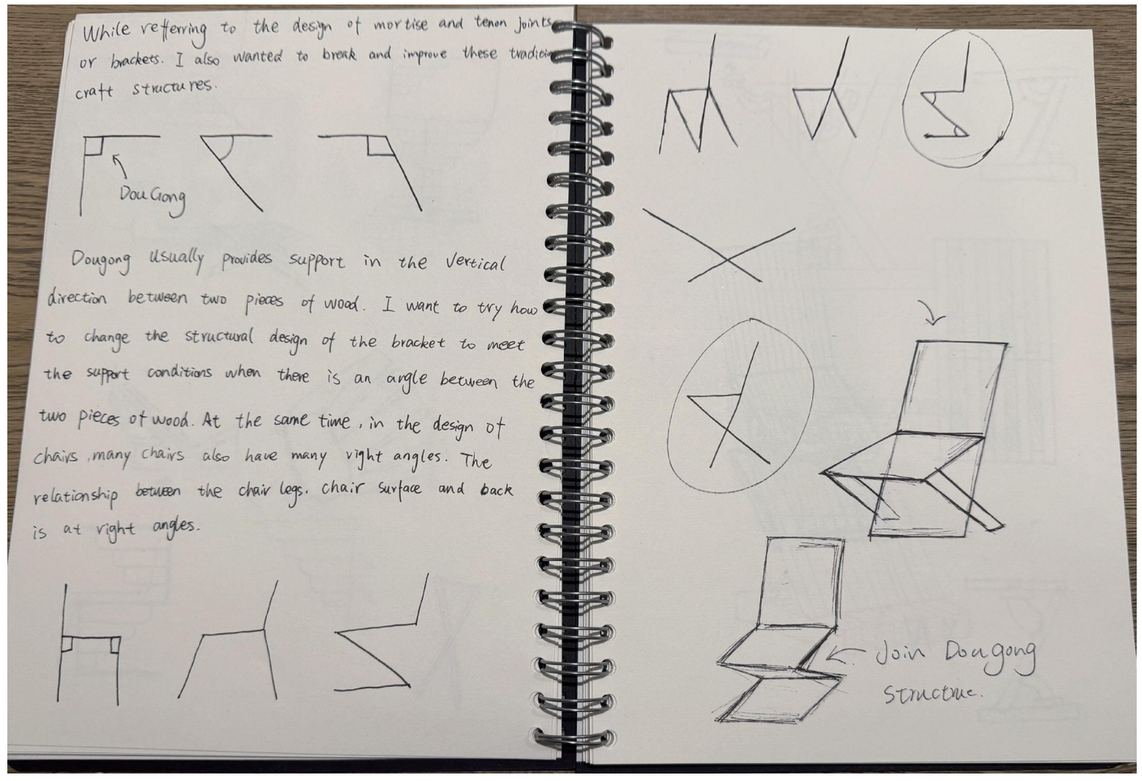
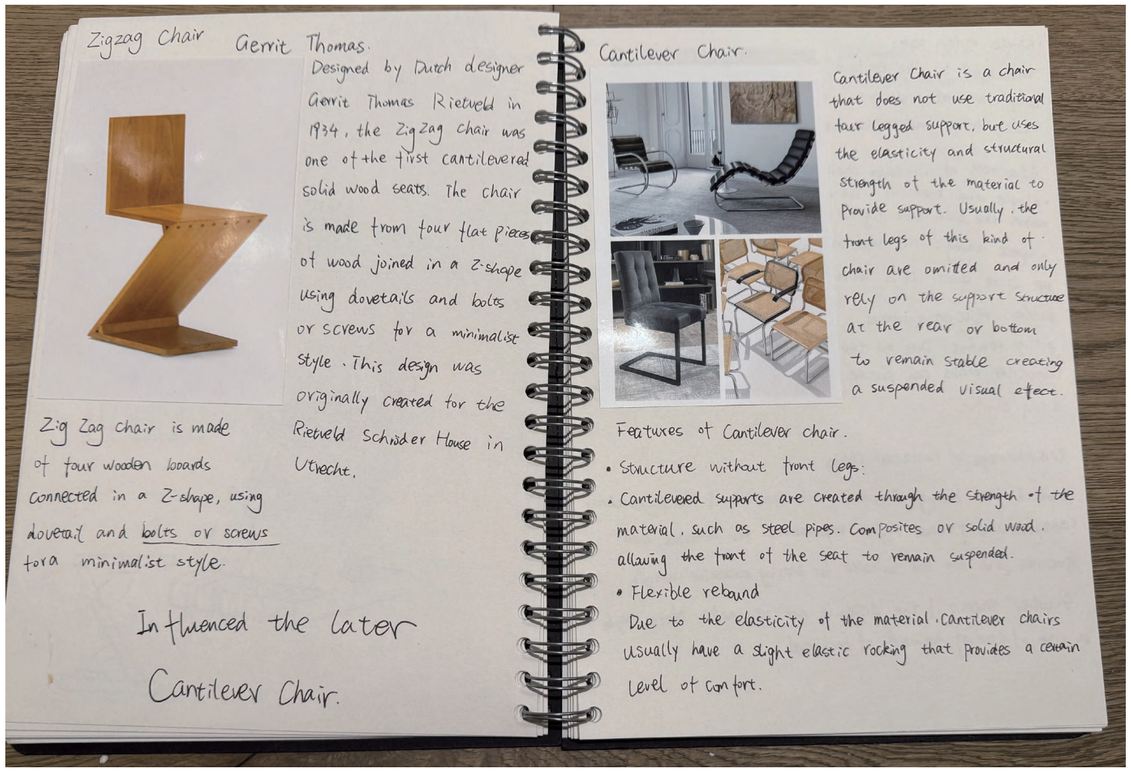
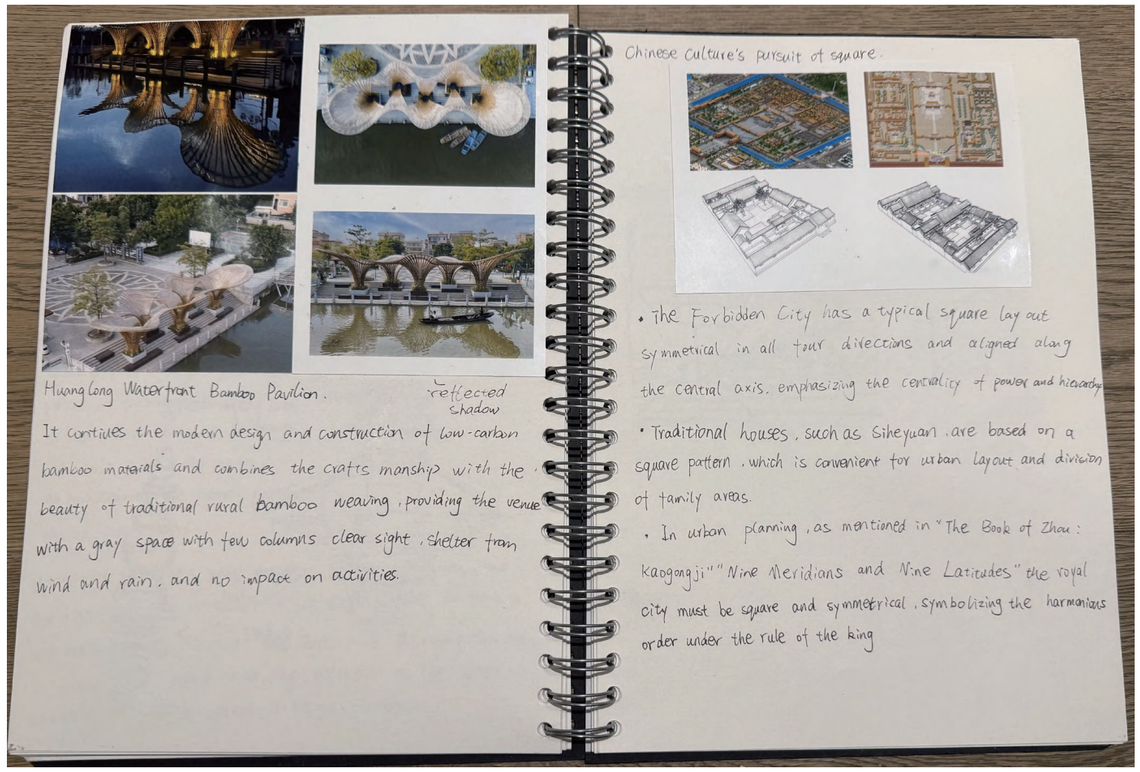
Sketchbook





Appendix
Sketchbook





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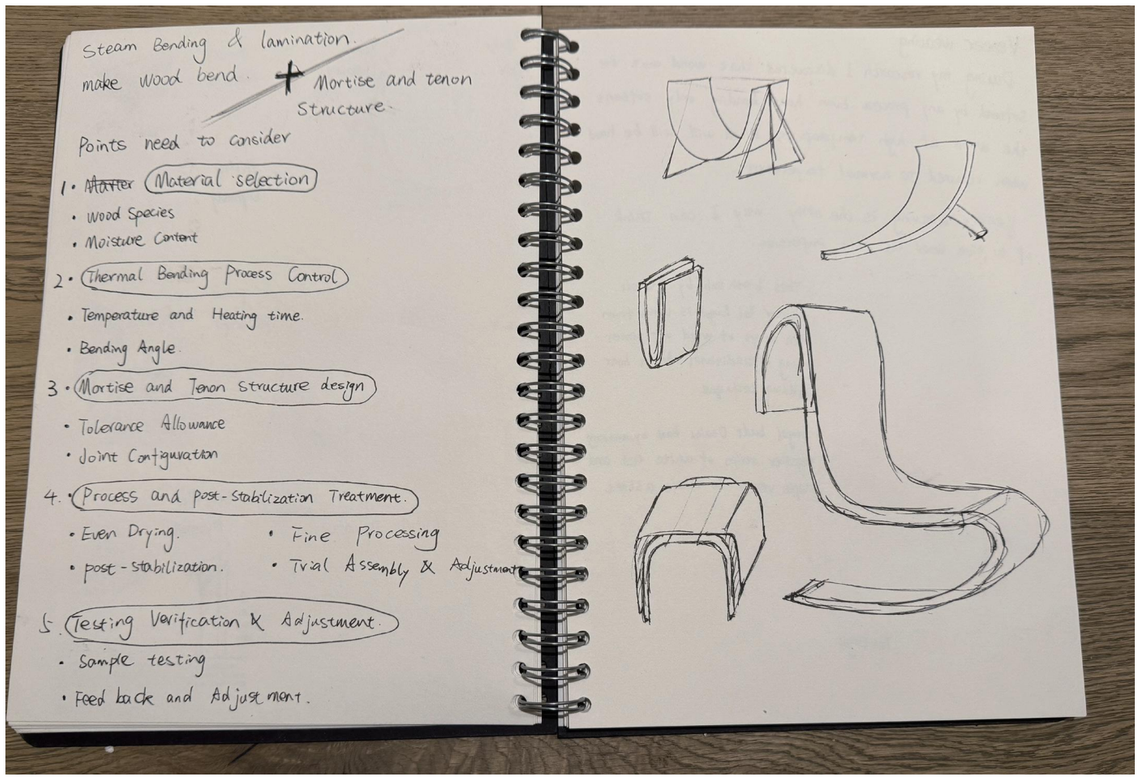

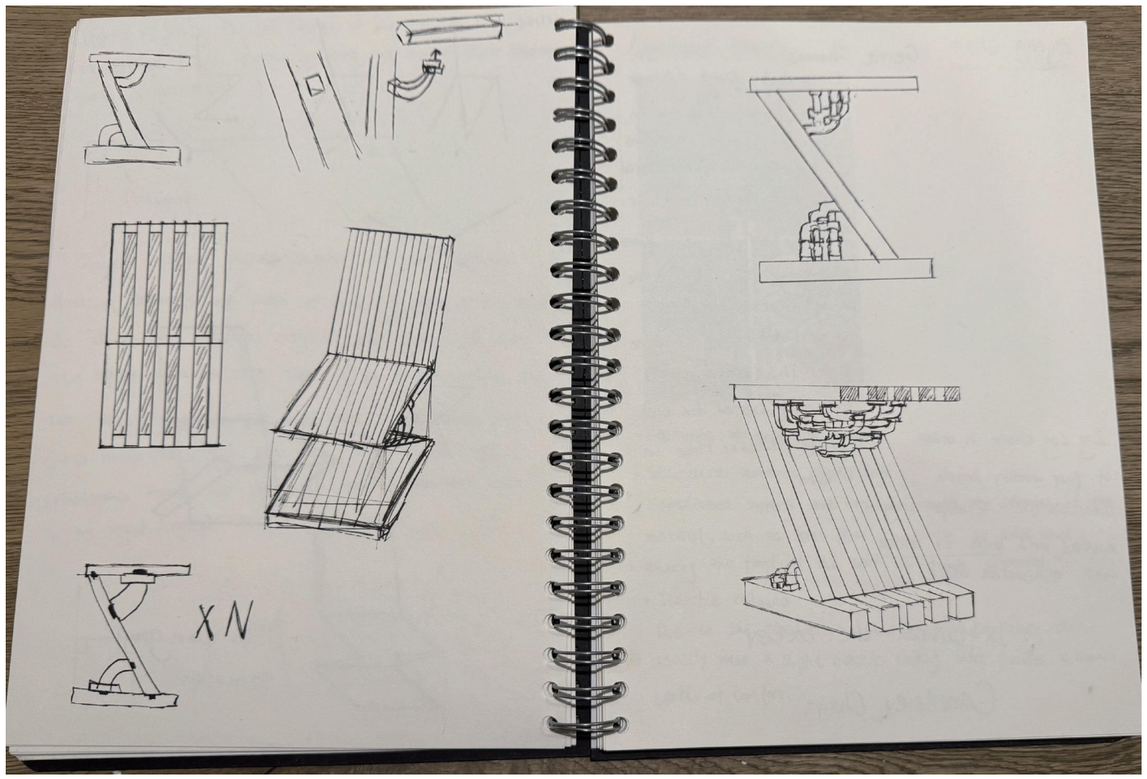

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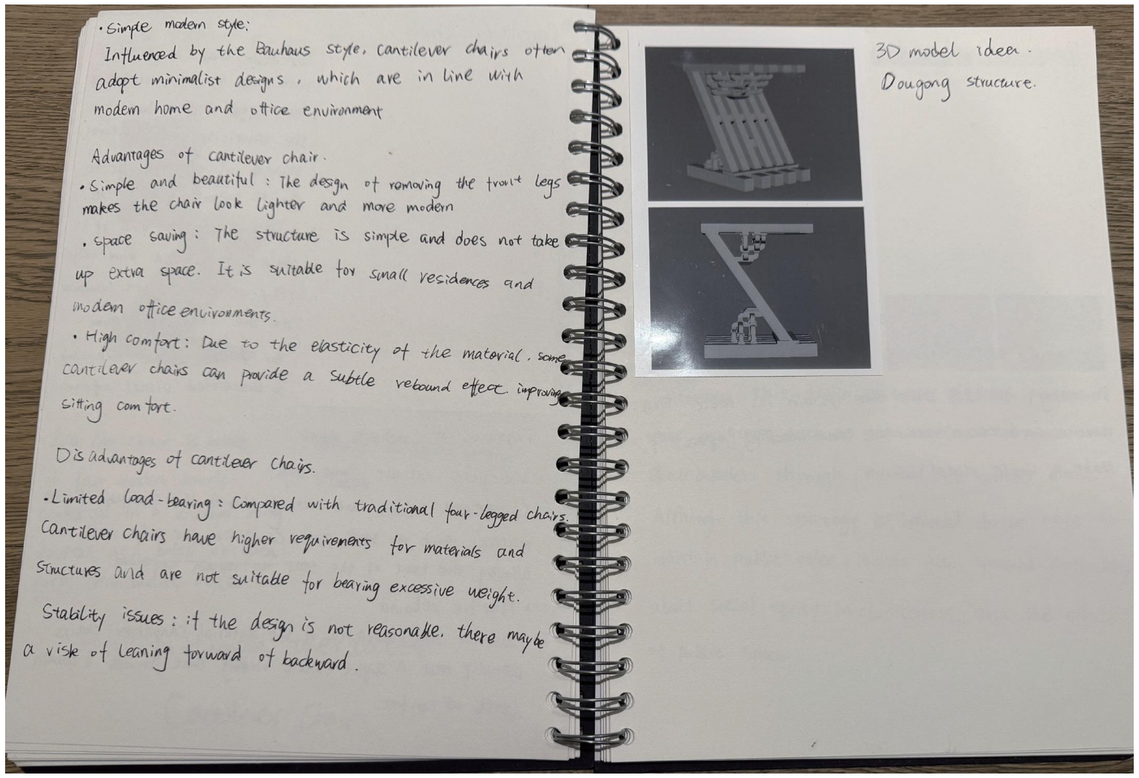
Sketchbook

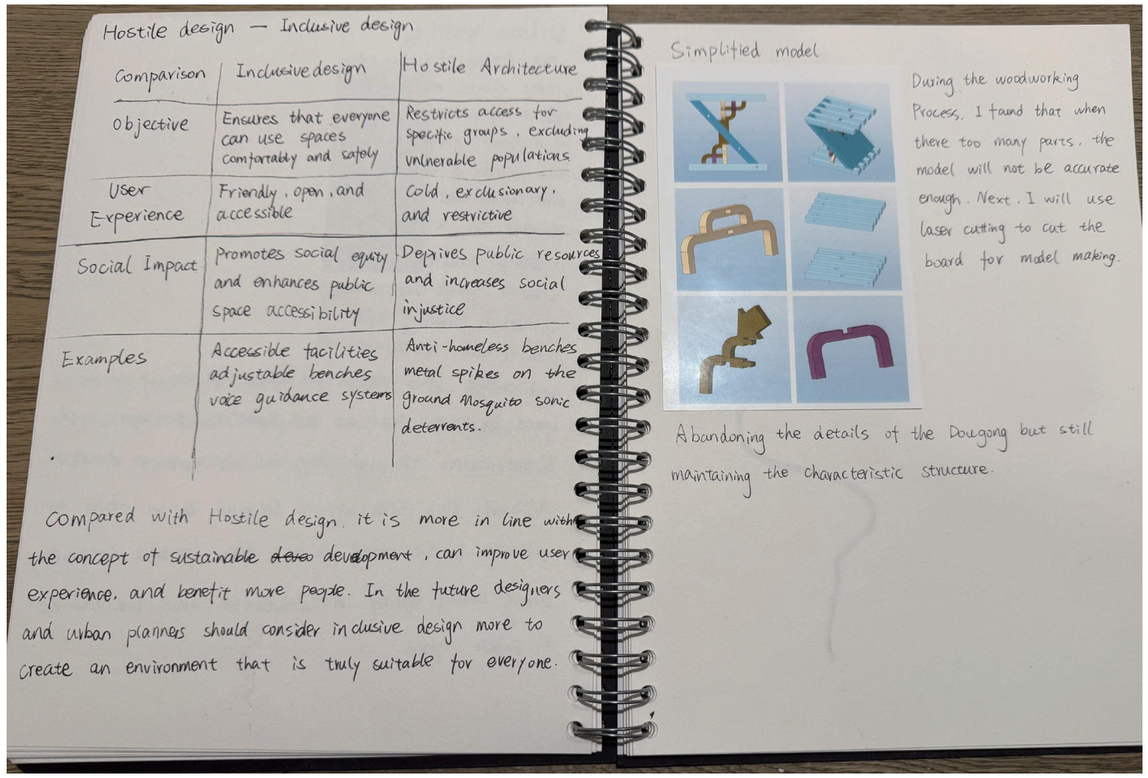


• Simple modern style:
Influenced by the Bauhaus style, cantilever chairs often adopt minimalist designs, which are in line with modern home and office environment

Advantages of cantilever chair.
• Simple and beautiful: The design of removing the front legs makes the chair look lighter and more modern
• space saving: The structure is simple and does not take up extra space. It is suitable for small residences and modern office environments.
• High comfort: Due to the elasticity of the material, some cantilever chairs can provide a subtle rebound effect, improving sitting comfort.

Disadvantages of cantilever chairs.
• Limited load-bearing: Compared with traditional four-legged chairs, cantilever chairs have higher requirements for materials and structures and are not suitable for bearing excessive weight.
Stability issues: if the design is not reasonable, there may be a risk of leaning forward of backward.

3D model idea.
Dougong structure.



Hostile design — Inclusive design

Comparison	Inclusive design	Hostile Architecture
Objective	Ensures that everyone can use spaces comfortably and safely	Restricts access for specific groups, excluding vulnerable populations
User Experience	Friendly, open, and accessible	Cold, exclusionary, and restrictive
Social Impact	Promotes social equity and enhances public space accessibility	Deprives public resources and increases social injustice
Examples	Accessible facilities adjustable benches voice guidance systems	Anti-homeless benches metal spikes on the ground Mosquito sonic deterrents.

Compared with Hostile design, it is more in line with the concept of sustainable ~~deveo~~ development, can improve user experience, and benefit more people. In the future designers and urban planners should consider inclusive design more to create an environment that is truly suitable for everyone.

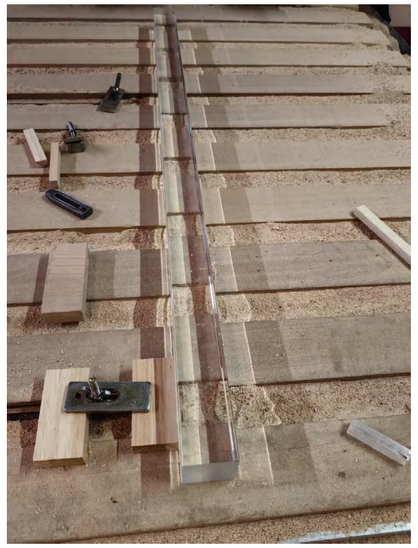
Simplified model

During the woodworking Process, I found that when there too many parts, the model will not be accurate enough. Next, I will use laser cutting to cut the board for model making.

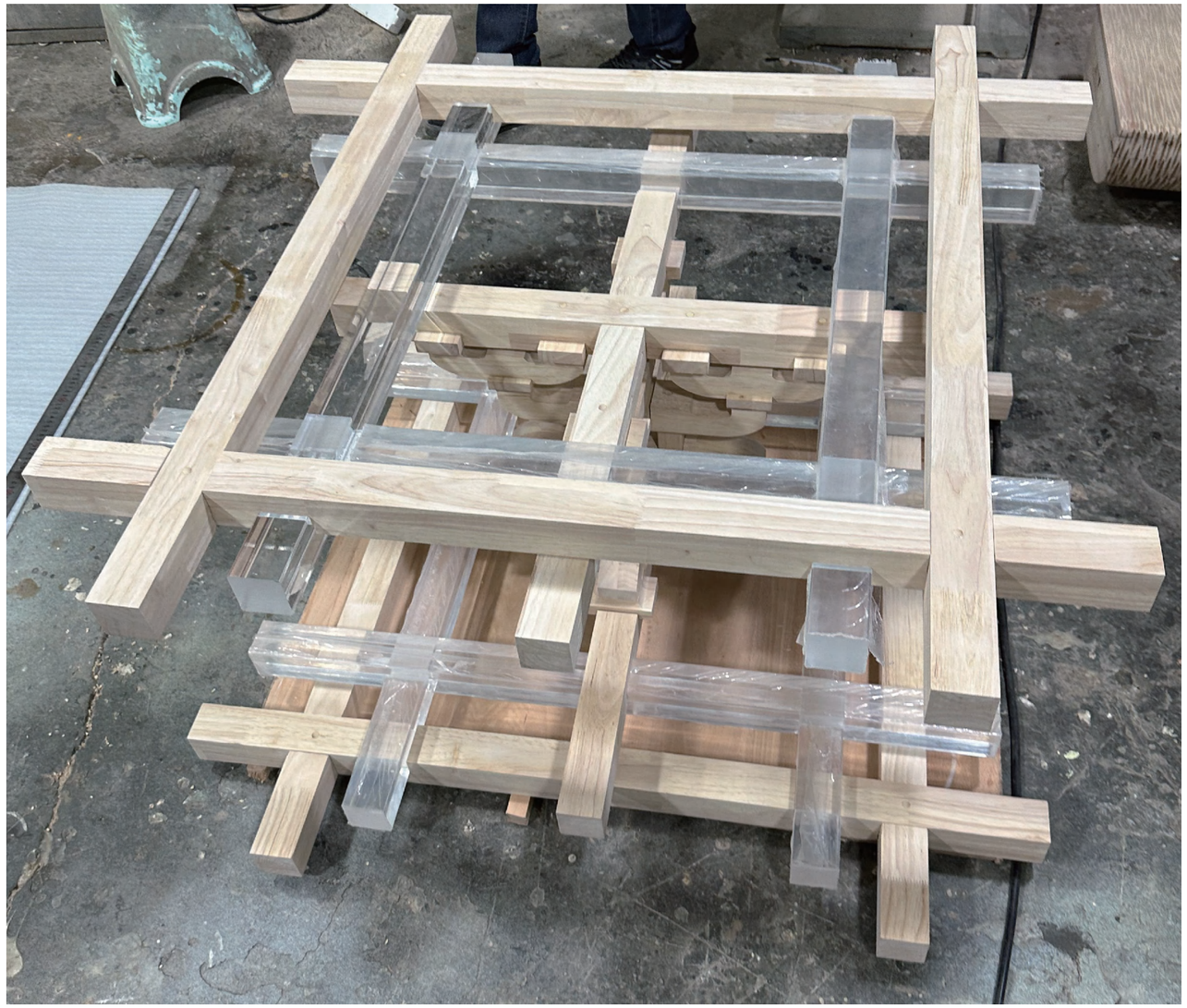
Abandoning the details of the Dougong but still maintaining the characteristic structure.

Appendix
Making process









Appendix
Bibliography

JA: The Japan Architect, （2011）. Yusuhara Wooden Bridge Museum by Kengo Kuma. JA 83, Autumn 2011. Tokyo: Shinkenchi-ku-sha.

Kuma, K. (2021) Kuma: Complete Works 1988–Today. Köln: Taschen.

Cullen, C. (1996) Astronomy and mathematics in ancient China: The Zhou Bi suan jing. Cambridge: Cambridge University Press.

Collectif (2021) Expo 2020 dubai: Site, themes, architecture. France: Assouline.

Postell, J. (2013) Furniture design. Hoboken, N.J: Wiley.

Feirer, M. and Feirer, J.L. (2011) Wood: Technology & Processes. Columbus, OH: Glencoe/McGraw-Hill.

Liu, L. (2006). Three Ponds Mirroring the Moon With Leifeng Pagoda. Retrieved from https://en.wikipedia.org/wiki/File:-Three_Ponds_Mirroring_the_Moon_With_Leifeng_Pagoda.jpg

Zhou, C. (1535). Waterside Pavilion [Hanging scroll]. National Palace Museum, Taipei. Available at: https://commons.wikime-dia.org/wiki/File:Waterside-pavilion.jpg

Author links open overlay panelShahjadi Hisan Farjana a et al. (2023) Life cycle assessment of end-of-life engineered wood, Science of The Total Environment. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0048969723026396

Chen, C. (2021) Huanglong Waterfront Bamboo Pavilion / Atelier CNS + School of Architecture, south china university of technology, ArchDaily. Available at: https://www.archdaily.com/960530/huanglong-waterfront-bam-boo-pavilion-atelier-cns-plus-school-of-architecture-south-china-university-of-technology (Accessed: 28 May 2025).

Kaspersky, E. (2019) Forbidden City 2018., Eugenes Blog 2 English Global eugenekasperskycom. Available at: https://eugene.kasper-sky.com/2018/12/13/forbidden-city-2018/ (Accessed: 28 May 2025).