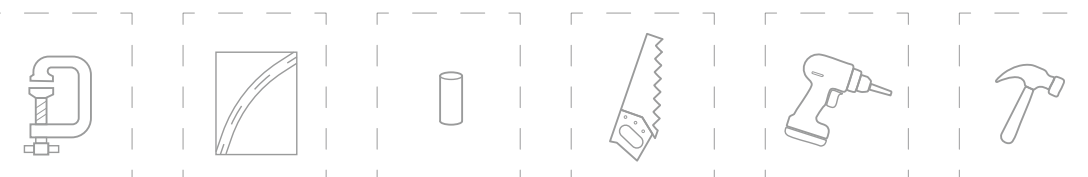
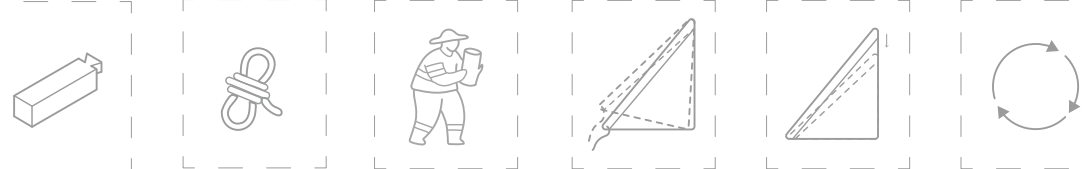


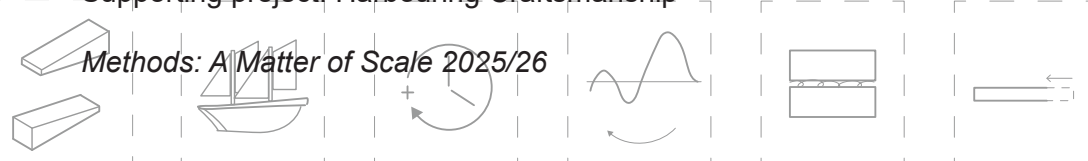
design manual:

architectural lessons from *shipbuilding*



Manual designed by Tjitske Henstra
Supporting project: Harbourside Craftsmanship

Methods: A Matter of Scale 2025/26



strength	wrap	lash	peg	tenon	scarf
fire	caulk	steam	glue	demount	cog
timber	block	cleat	hook	cnc	axe
dovetail	line	harvest	rig	reef	cycle
clamp	mold	peg	saw	drill	hammer
burn	steam	lamine	carve	rivet	tools
chafe	fair	store	flexible	round	span
join	preserve	extend	cycle	seal	adjust

introduction

This booklet has been constructed as a design manual summarising findings from the research within the graduation studio of *Methods: A Matter of Scale 2025/26*. It exists of knowledge gathered from talking to shipbuilders and carpenters in Estonia and the Netherlands, as well as gaining insights from historical research and building manuals within the carpentry and shipbuilding disciplines.

This booklet can act as a starting point for others to design using shipbuilding principles, or merely function as a summary of some research findings of the project called *Harbouring Craftsmanship*.

This is also a starting point for myself, shifting from a student to an architect with a strong interest in the craft of shipbuilding and the nautical discipline. This means that the story of this manual will also continue to grow, new knowledge and skill can be gathered and added to the information already present.

The findings have been categorised, including both structural logics as well as material handling and techniques. Each chapter first summarises the principle, reflect on its historical background and a short library of all the tools, techniques and possible.

A short bibliography is seen on the next page, for people who would want to further explore this topic and read into it in more detail.

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36	seasonal cycles



Wooden planks, photo taken at Ambachtelijk Botenbouw Centrum Amersfoort, by author

Material intelligence begins with an intimate understanding of materials and their behaviour. Shipwrights select timber according to its species, growth patterns, grain direction, moisture content, and natural curvature, recognising that these characteristics directly influence performance. The craft extends beyond shaping and assembly; many shipbuilders consider the selection and sourcing of timber to be as important as the construction itself.

Materials are understood not as standardised products, but as resources embedded within local landscapes and ecological cycles. Knowledge of where a tree grows, when it is harvested, how it is seasoned, and how it is cut informs its eventual use within a vessel or structure. Particular components are often matched with naturally occurring forms, such as curved branches or roots, reducing the need for processing while enhancing structural performance.

Material intelligence also involves understanding the relationship between different materials. Timber, iron, copper, tar, and rope each possess distinct properties and age, expand, contract, and deteriorate at different rates. Successful construction depends not only on the qualities of individual materials but also on their compatibility within a larger assembly.

Rather than forcing materials into predetermined forms, construction emerges from an understanding of what is available, how it behaves, and how its properties can be enhanced through careful handling. Material knowledge is therefore both ecological and technical: a continuous negotiation between resource availability, environmental conditions, and structural performance.

material

historical background

The earliest boats are carved from a single tree trunk. Construction relies entirely on the natural properties of wood, requiring a deep understanding of grain direction, moisture content, and the structural limits of the material. Form emerges through subtraction rather than assembly.

As vessels grow in size, builders begin combining multiple timber elements. Naturally curved branches and roots are incorporated for structural corners and reinforcements, while overlapping planks fastened together create lightweight yet flexible hulls. The introduction of joinery and fastening systems allows larger vessels to absorb movement and dynamic loads while extending beyond the limitations of a single tree. The development of frame-based construction later enables planks to be placed edge-to-edge on an internal structure, creating smoother hull surfaces and larger vessel capacities. Construction shifts from shaping individual components to coordinating integrated systems of frames, planking, fasteners, and waterproofing materials.

The introduction of iron and later steel transforms shipbuilding once again. Initially used for fasteners, fittings, and reinforcement, metals eventually become structural materials themselves, requiring new knowledge of corrosion, material compatibility, and structural behaviour. At the same time, sails, rigging, and caulking introduce additional material systems such as hemp, flax, linen, and cotton, making shipbuilding increasingly dependent on the combination of materials with different properties.

Industrialisation brings steel and aluminium hulls, larger spans, and standardised production methods.

material

library

Structure

Wood, steel, iron, glass fibre

Connection

Iron, steel, copper, bronze, trenails, rope

Protection

Tar, pitch, resin, oils

Flexibility

Rope, hemp, flax, textile, nylon

shaping



Bending a haabjas with fire in Estonia, craft by Jaan Keerdo.

shaping principle

In shipbuilding, shaping is a process of negotiation between material, environment, and performance. Hulls, frames, and structural components are formed to move efficiently through water, withstand waves and wind, carry loads, and respond to changing environmental conditions. Rather than imposing geometry onto a material, form emerges through the interaction of forces, available resources, construction techniques, and functional requirements.

The shape of a vessel evolves over generations through continuous adaptation. Local climates, sea conditions, available materials, and patterns of use all influence its development. Curvature, tapering, and streamlined forms are not merely aesthetic choices but responses to movement, resistance, stability, and efficiency. Shaping therefore becomes a way of embedding environmental intelligence into the construction itself.

Material transformation plays a central role in this process. Timber is bent, carved, laminated, or selected in naturally curved forms to achieve geometries that would otherwise require greater material use or structural complexity. Through shaping, performance and material efficiency become inseparable.

shaping

historical background

The shaping of timber begins with an understanding of its natural behaviour. Early shipbuilders often selected naturally curved branches, roots, and trunks to form knees, frames, and structural transitions, taking advantage of the tree's growth patterns rather than reshaping the material extensively. Where natural forms were unavailable, timber was shaped by hand through carving, hewing, and planing, gradually transforming rough logs into structural components.

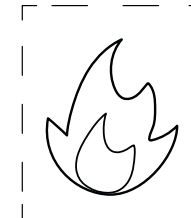
As vessels grew in size and complexity, techniques for bending timber became increasingly important. Wood could be heated over open fires or softened with steam, allowing it to be bent into curved forms. Steam bending later became a widespread technique, enabling shipbuilders to produce frames and ribs with consistent geometries while maintaining the strength of continuous wood fibres.

The industrialisation of shipbuilding introduced new methods of shaping and new materials. Laminated timber allowed multiple thin layers of wood to be bent and glued together, creating larger spans and more complex geometries than solid timber alone could achieve. Similar principles were later applied to plywood, cold-moulded construction, and composite materials.

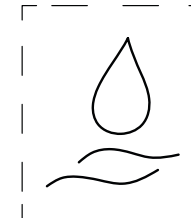
Alongside material innovations, shaping techniques evolved from manual craft to mechanised production. Components that were once individually carved and adjusted by hand became increasingly standardised through industrial machinery and later through digital fabrication technologies such as CNC milling and robotic manufacturing.

shaping

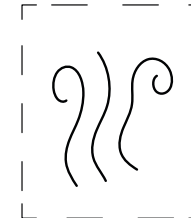
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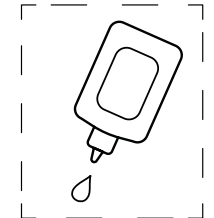
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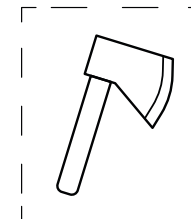
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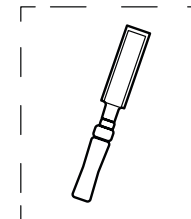
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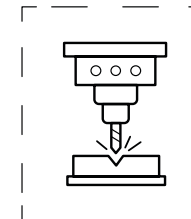
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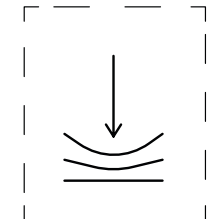
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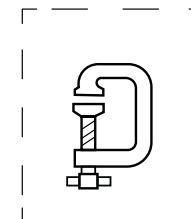
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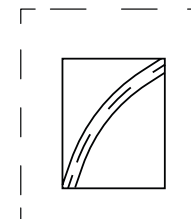
CNC-milling



pressure



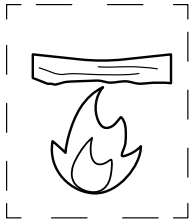
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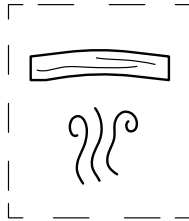
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shaping

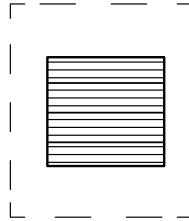
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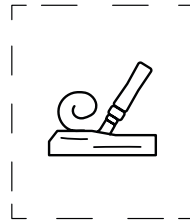
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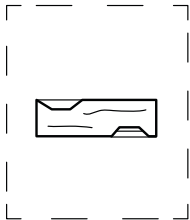
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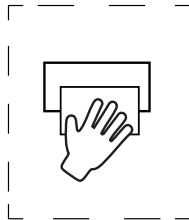
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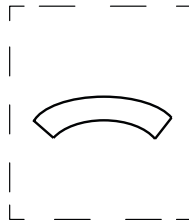
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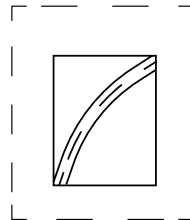
hewing



fairing



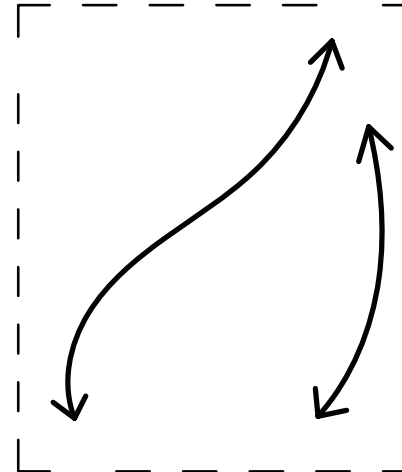
bending



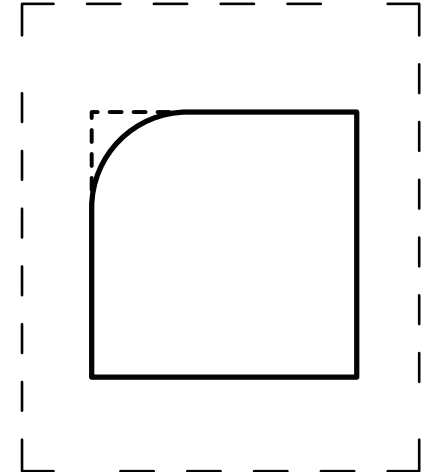
moulding

shaping

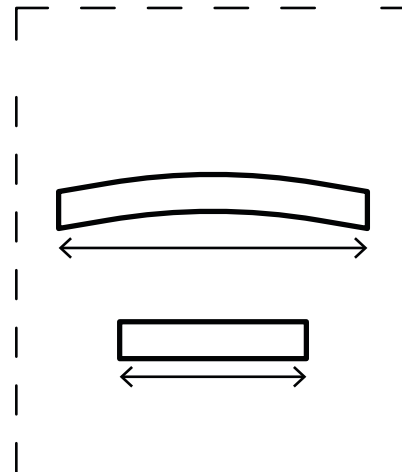
outcomes



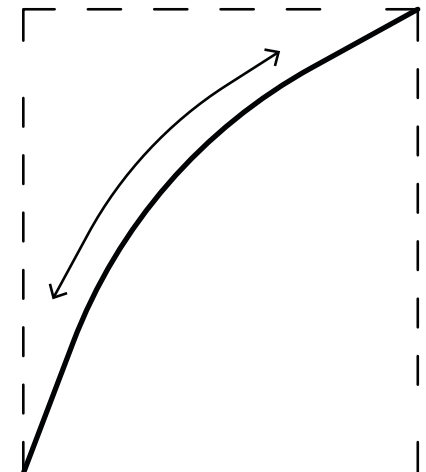
bent shapes



curved edges



larger spans



streamlined forms



Knee joint, photo taken at Ambachtelijk Botenbouwen Centrum Amersfoort, by author

In shipbuilding, joints are often the most critical part of a structure. They transfer forces between components, accommodate movement caused by waves and moisture, and allow vessels to be assembled, maintained, and repaired over time. Rather than resisting material behaviour, successful joints work with it, allowing timber to expand, contract, flex, and age without compromising the integrity of the whole.

Early shipbuilding relies heavily on wooden joints, where geometry alone creates strong connections. Mortise-and-tenon joints, scarf joints, coggled joints, and wooden pegs transform individual components into larger structural assemblies without introducing additional materials. As vessels become larger and more complex, metal fasteners, rivets, bolts, and nails are introduced to increase strength and simplify assembly. Rope and fibre lashings provide another form of connection, allowing flexibility and movement where rigid joints would fail.

Joinery therefore represents more than a technical detail. It is the point where materials, forces, craftsmanship, and future maintenance come together. The quality of a vessel often depends less on the individual components than on the intelligence of the connections between them.

joinery

historical background

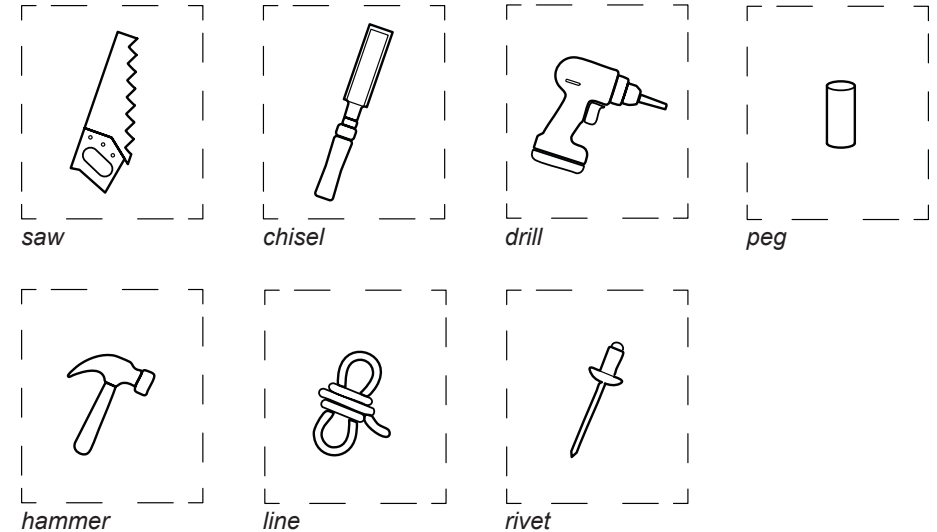
The development of shipbuilding can be traced through the evolution of its joints. Early vessels rely on carved and interlocking timber connections shaped by hand using axes, chisels, and saws. Every joint is individually adapted to the unique geometry of the timber being used, requiring a high level of craftsmanship and material knowledge.

As maritime technology advances, specialised joints emerge for different structural tasks. Scarf joints extend the length of available timber, mortise-and-tenon joints connect frames and planking, while treenails secure components without introducing metal. The introduction of iron and later steel fasteners allows larger vessels to be constructed with greater speed and consistency.

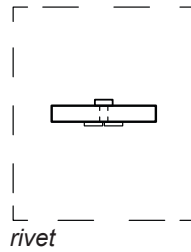
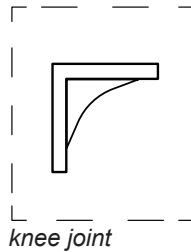
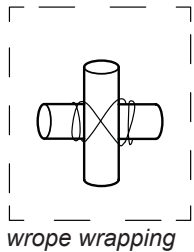
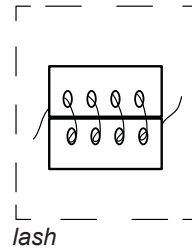
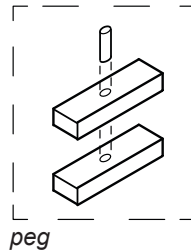
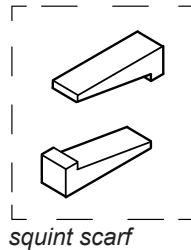
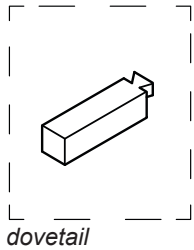
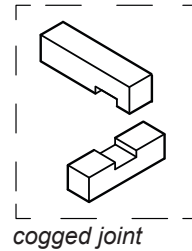
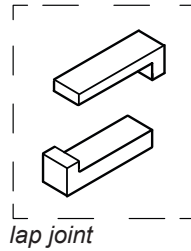
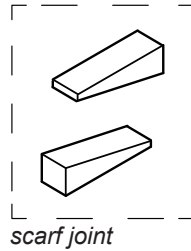
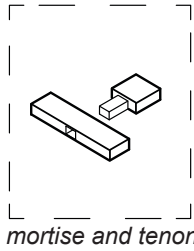
Industrialisation transforms joinery from a largely manual craft into a more standardised process. Mechanised saws, drills, and milling machines increase precision and production speed, while contemporary CNC fabrication and robotic manufacturing make it possible to produce highly complex joints with minimal manual labour. Although the tools evolve, the challenge remains unchanged: creating connections that efficiently transfer forces while accommodating material behaviour and future adaptation.

joinery

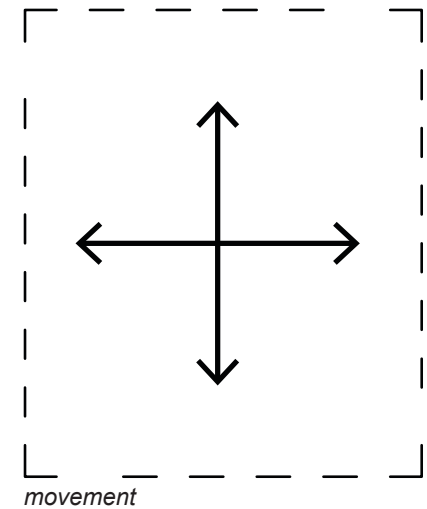
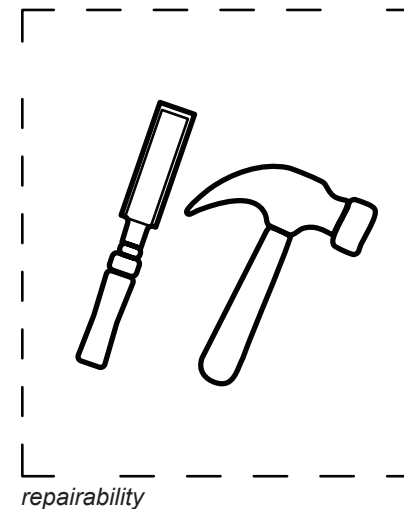
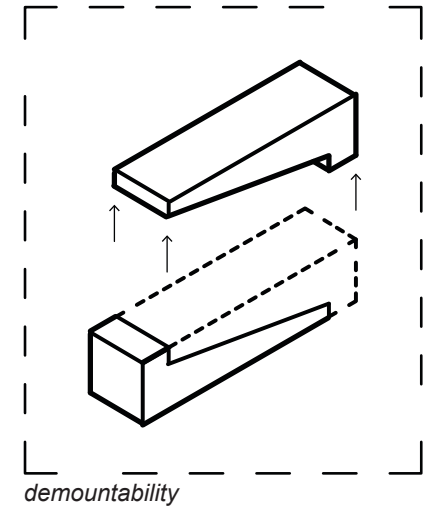
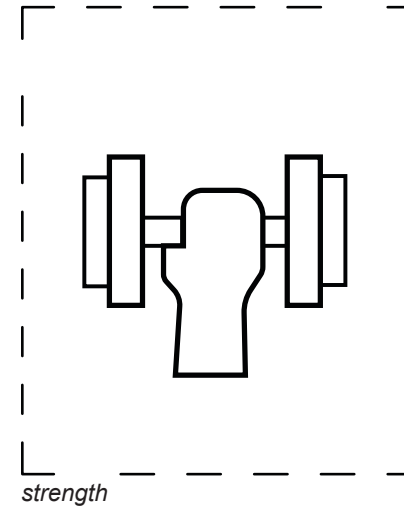
tools



techniques



outcomes



flexibility



Rigging on mast, photo taken at Ambachtelijk Botenbouw Centrum Amersfoort, by author

flexibility principle

Ships operate in constantly changing conditions. Waves, wind, moisture, temperature fluctuations, and shifting loads continuously act upon the vessel, making movement inevitable rather than exceptional. Durability is therefore achieved through controlled flexibility rather than absolute rigidity. Components are designed to absorb forces, accommodate movement, and adapt to changing conditions without failure.

This principle extends beyond the structure itself. Rigging systems can be adjusted to changing wind conditions, sails can be reefed or expanded, and cargo can be redistributed in response to weather and stability requirements. Shipbuilders understand that resilience depends not on resisting change, but on the capacity to respond to it.

Material flexibility plays an equally important role. Timber bends before it breaks, rope stretches before it snaps, and joints allow components to move relative to one another. Rather than eliminating movement, shipbuilding often incorporates it as a mechanism for reducing stress, preventing failure, and extending the lifespan of the vessel.

Flexibility also emerges through resourcefulness. At sea, repairs and adaptations must often be made with the materials and tools available on board. Structures, connections, and systems therefore benefit from simplicity, adaptability, and the capacity for modification under changing circumstances.

flexibility

historical background

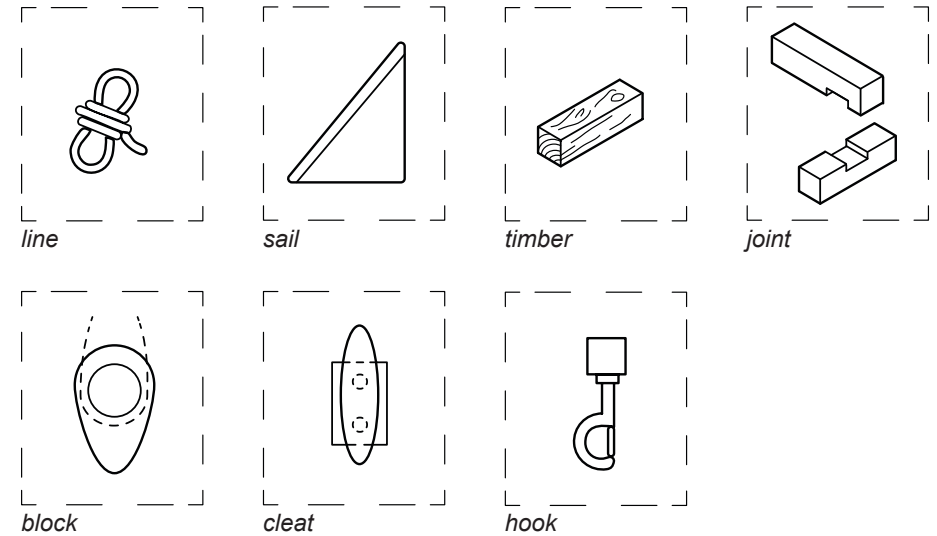
Flexibility has been embedded in shipbuilding since the earliest vessels. Dugout canoes, skin boats, and early plank-built craft are developed in direct response to local waters, available materials, and patterns of use. Different coastlines, rivers, and seas produce distinct vessel types, each adapted to specific environmental conditions rather than following a universal model.

As maritime networks expand, ships continuously evolve in response to new demands. Changes in cargo, fishing practices, warfare, exploration, and trade lead to new hull forms, rigging systems, and construction techniques. The development of larger sail plans, adjustable rigging, and specialised vessel types allows ships to travel further, carry more cargo, and operate in increasingly diverse conditions.

The growth of overseas trade during the early modern period accelerates this process. Competition between trading nations encourages the development of faster, lighter, and more efficient vessels capable of transporting goods across greater distances. Shipbuilders refine hull shapes, optimise sail configurations, and adopt new materials and construction methods to improve performance while maintaining reliability.

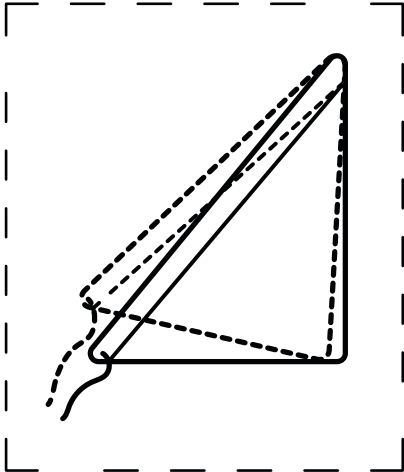
flexibility

tools

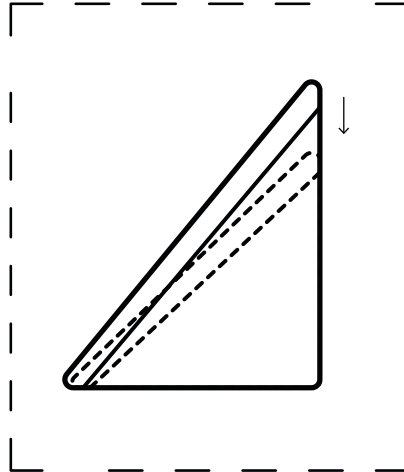


flexibility

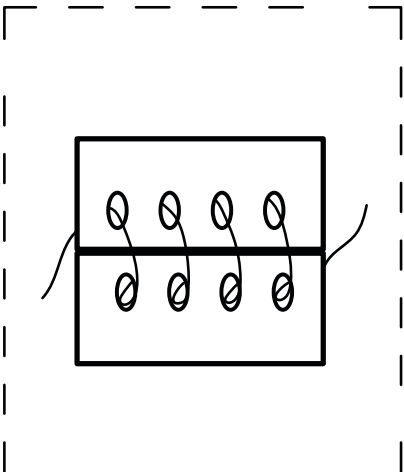
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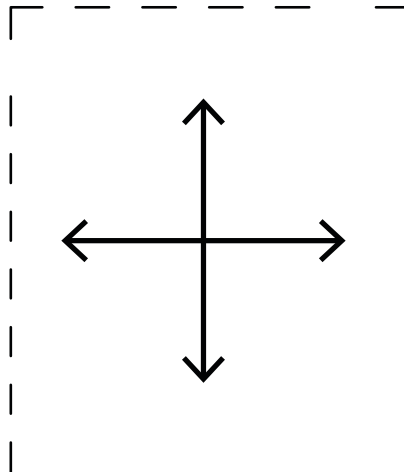
adjust rigging



reef



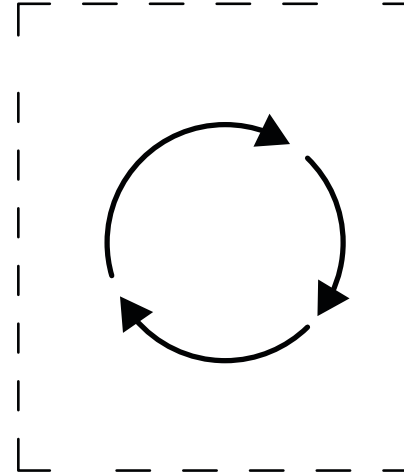
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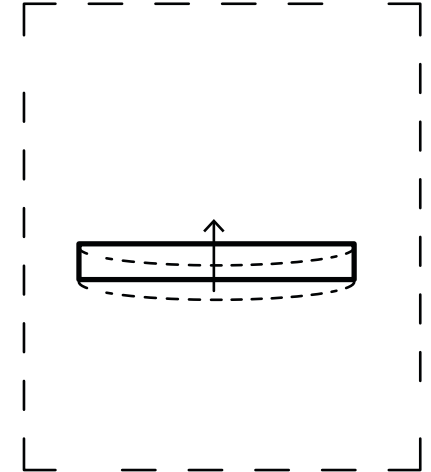
redistribute

flexibility

outcomes



adaptability



resilience

repair



Ship repair, photo taken at Ambachtelijk Botenbouw Centrum Amersfoort, by author

repair principle

In shipbuilding, longevity is achieved through repair rather than permanence. Exposure to water, salt, wind, sunlight, and mechanical stress ensures that every vessel will deteriorate over time. Rather than treating this as a failure, shipbuilders anticipate wear and design vessels as assemblies of maintainable and replaceable parts.

Repair begins at the design stage. Components are shaped, connected, and arranged so they can be inspected, removed, and replaced without dismantling the entire vessel. Planks, ribs, rigging, sails, and fittings each possess different lifespans and require different maintenance cycles. The vessel therefore becomes a layered system of components that age and are renewed at different rates.

This approach also requires a shift in perspective. A ship is not understood as a finished object, but as an evolving artefact that is continuously adapted through use. Maintenance, repair, and replacement are not separate activities but integral parts of the vessel's lifecycle. Longevity emerges from the capacity to repair rather than from resistance to change.

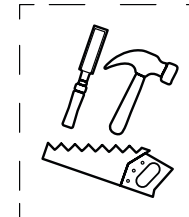
Repair has been fundamental to shipbuilding since the earliest watercraft. Dugout canoes were patched, reinforced, and reshaped as they aged, while plank-built vessels allowed individual components to be replaced without rebuilding the entire structure. As ships became larger and more complex, maintenance evolved into a specialised practice alongside construction itself.

Traditional wooden vessels were designed around regular cycles of inspection and repair. Damaged planks could be replaced, seams re-caulked, rigging renewed, and worn components exchanged while preserving the majority of the vessel. Shipyards, dry docks, and harbour workshops became centres not only of construction but also of continuous maintenance, allowing vessels to remain operational for decades or even centuries.

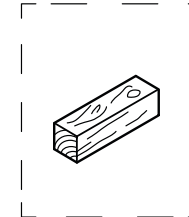
The introduction of iron and steel altered repair techniques but not the underlying principle. Riveted plates, metal fittings, and later welded structures introduced new maintenance challenges related to corrosion and fatigue. In contemporary shipbuilding, modular components, prefabricated systems, and standardised parts continue this tradition by enabling damaged elements to be repaired or replaced without affecting the whole vessel.

Throughout the history of shipbuilding, repair remains inseparable from construction. The most successful vessels are not those that avoid deterioration, but those that can accommodate it through accessible, adaptable, and replaceable systems.

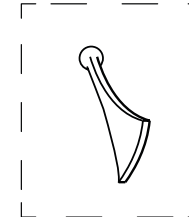
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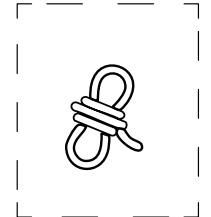
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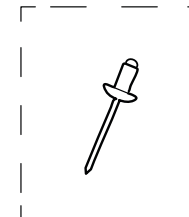
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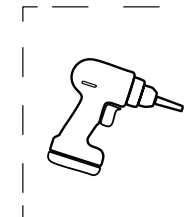
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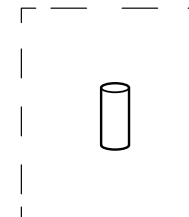
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rivet

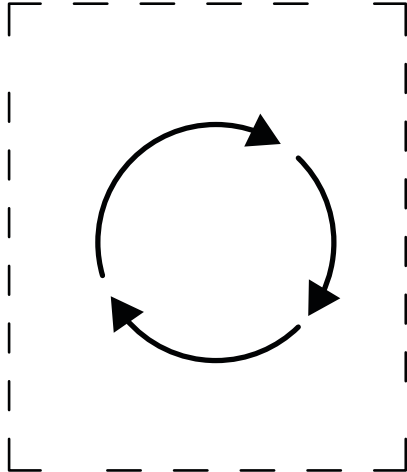


drill

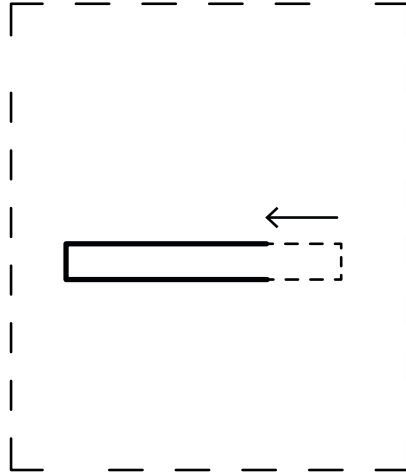


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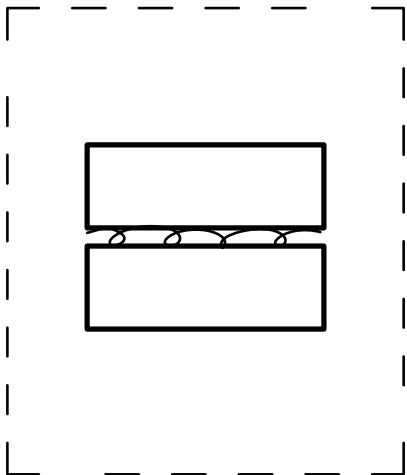
techniques



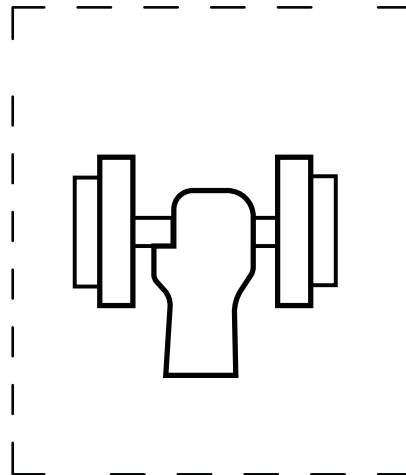
replacing



adjusting

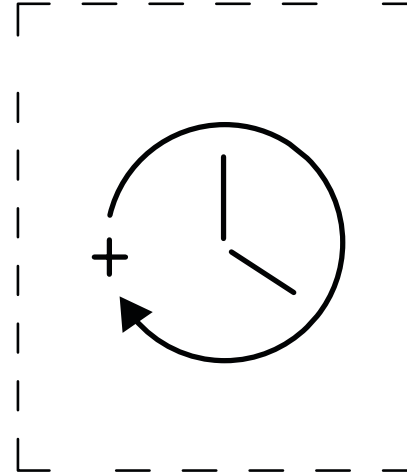


re-sealing

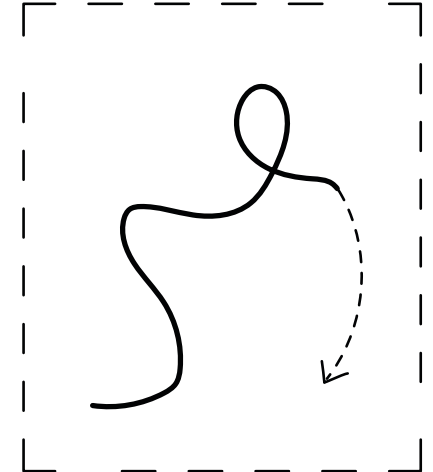


strengthening

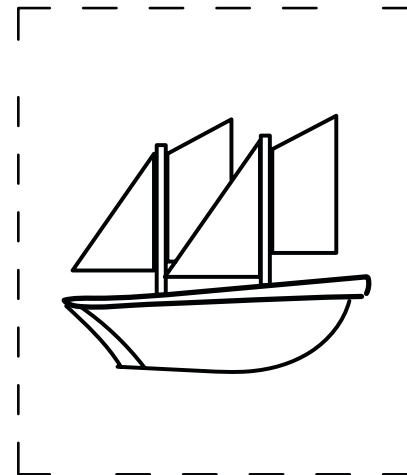
outcomes



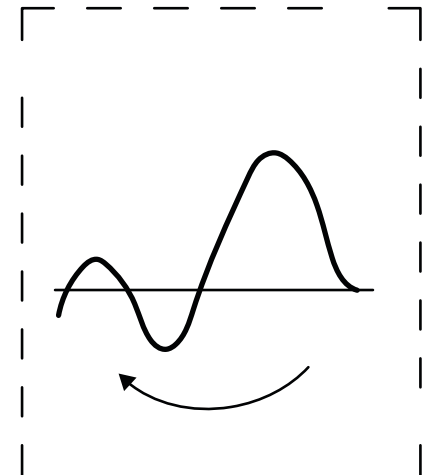
expanded lifespan



adaptation



preservation



cyclical thinking

seasonal cycles



weathered, photo taken at Saare Yachts, by author

seasonal cycles

principle

Shipbuilding operates within seasonal and environmental cycles. The harvesting of timber, drying and seasoning of materials, construction processes, maintenance schedules, and periods of navigation are all influenced by changing weather conditions and natural rhythms. Rather than treating these cycles as external constraints, shipbuilders incorporate them into the design, construction, and operation of a vessel.

Materials themselves are subject to seasonal change. Timber expands and contracts with fluctuations in moisture and temperature, sails and ropes respond to humidity and weather, and protective coatings require periodic renewal. Successful vessels accommodate these changes through adaptable construction methods, regular maintenance, and an understanding of material behaviour over time.

Seasonality also influences patterns of occupation and use. Fishing vessels, trading ships, and working boats often operate according to seasonal conditions, resource availability, and environmental opportunities. Shipbuilding therefore acknowledges that use, climate, and maintenance are not fixed conditions but recurring cycles that shape the life of a vessel.

By working with these rhythms rather than resisting them, shipbuilding demonstrates how longevity can emerge from continuous adaptation to changing environmental conditions.

seasonal cycles

historical background

Throughout history, shipbuilding has been closely tied to seasonal rhythms. Timber is often harvested during winter when sap content is low, reducing the risk of decay and improving durability. Before construction, wood is left to season for months or years, allowing moisture levels to stabilise and reducing future deformation. The production of a vessel therefore begins long before assembly, following biological and environmental cycles that cannot be accelerated indefinitely.

Construction and maintenance activities are similarly governed by climate and weather. Vessels are commonly repaired during periods of reduced sailing activity, hauled ashore during winter months, and prepared for seasonal changes in use. Fishing fleets, trading vessels, and local workboats often develop annual cycles of operation, maintenance, and renewal that align with environmental conditions and resource availability.

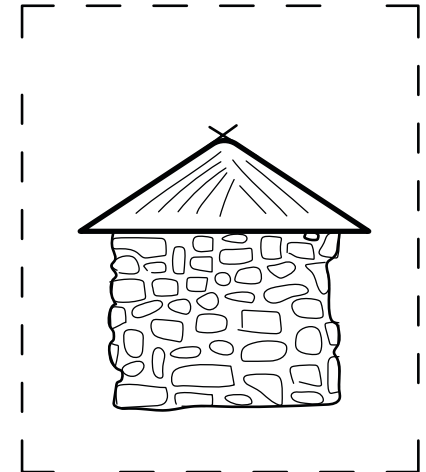
As shipbuilding becomes increasingly industrialised, many of these seasonal dependencies are reduced through global supply chains, controlled production environments, and synthetic materials. Nevertheless, seasonal cycles continue to influence vessel performance, maintenance requirements, and patterns of use. The relationship between ships and their environment remains dynamic, requiring continuous adjustment to changing weather, climate, and ecological conditions.

seasonal cycles

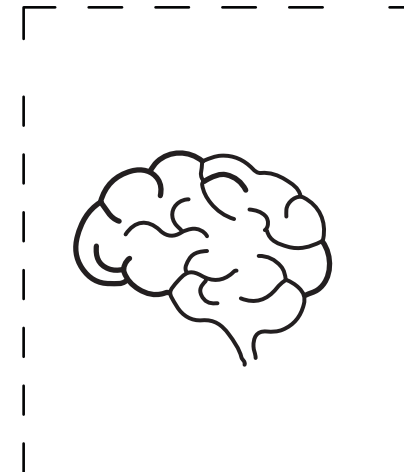
tools



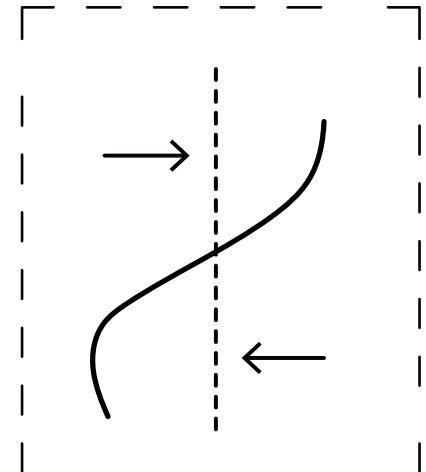
harvesting



storage



knowledge



flexibility

and the story continues...

The value of shipbuilding for architecture lies not in the reproduction of nautical forms, but in the transfer of underlying principles. Material intelligence, skilled joinery, distributed structures, adaptability, repairability, and local resource awareness offer alternative approaches to contemporary construction. Together they suggest an architecture that evolves over time, remains connected to craft traditions, and engages more carefully with material and environmental realities.

Manual designed by Tjitske Henstra
Graduation project: Harboursing Craftsmanship

Methods: A Matter of Scale 2025/26