

The Joinery

Sascha Bauer
Daniel Pauli

Compendium

Learning from
Traditional
Woodworking

With
English,
German, and
Japanese
Terminology

Ruby Press

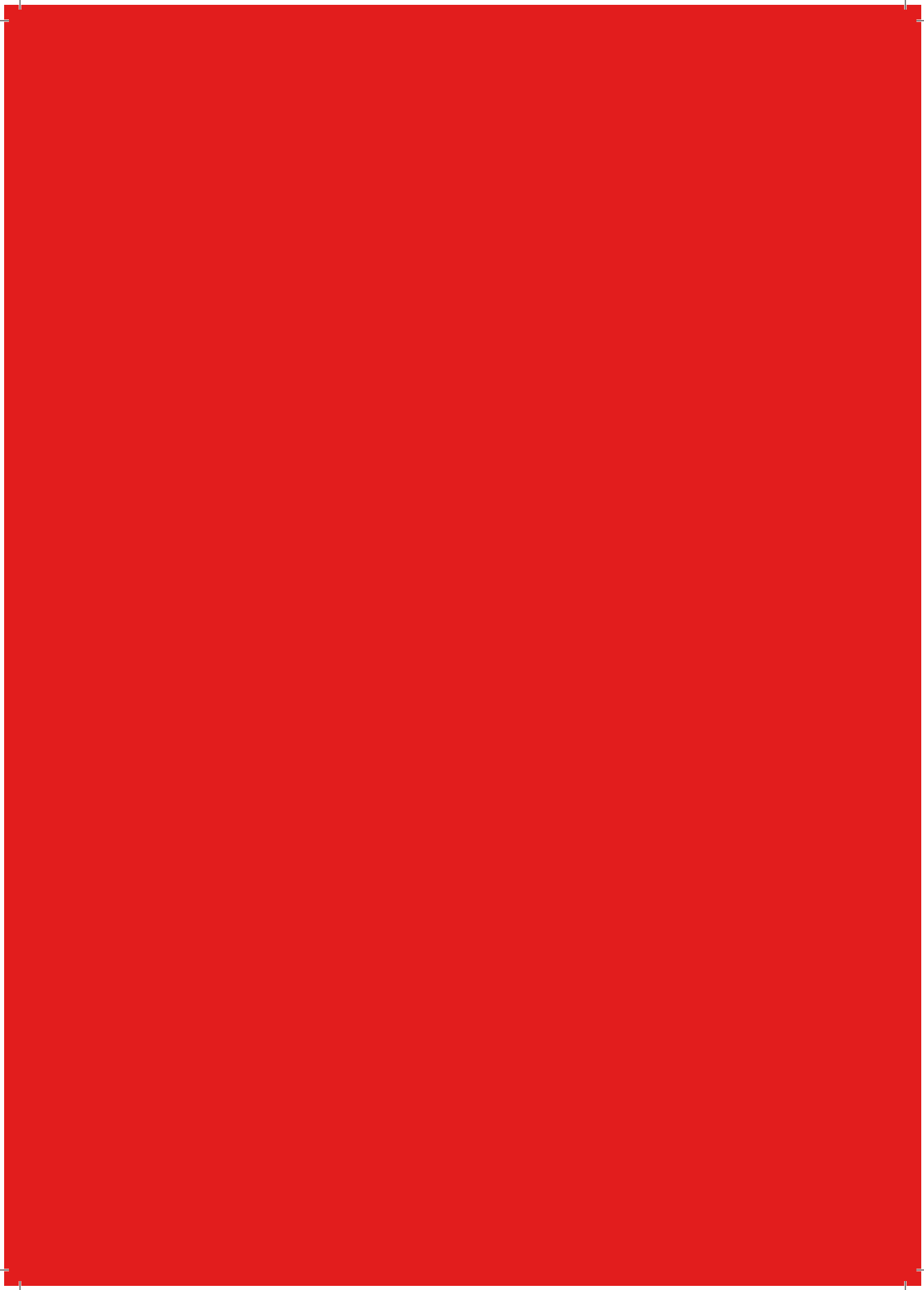
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Preface

Throughout history and until the nineteenth century, the fundamental principles of architectural construction remained largely the same. There was no compelling reason for change, given the limited choice of building materials — primarily wood, natural stone, and bricks. Due to the limitations of hand tools and manual production, a high level of craftsmanship was achieved.

Notably, wood held a distinct position. Unlike stone, which was largely used to build wall-like structures, timber beams were harmonized in intricate spatial frameworks. In the twelfth century, the introduction of half-timbered houses in central Europe brought a revolutionary shift in wood construction. Different from the log houses, pile dwellings, and post construction methods prevalent since the Bronze Age, this innovation vastly improved the structural protection of wood and facilitated easier repair and replacement of load-bearing components. It allowed buildings of up to six floors, prefabricated under sheltered conditions and swiftly erected on-site.

Even if the conditions and production techniques have changed over time, the principle of “prefabrication and quick assembly” still applies today. Then as now, the key lies in the precise joining of structural elements and their ability to transmit forces effectively.

The tradition of wood joinery has existed since the introduction of half-timbered construction. To craft strong wooden connections, one must consider the inherent properties of wood and its ability to distribute forces. While traditional wood joints remain relevant in construction and furniture making, since the mid-twentieth century they have increasingly been replaced by metal fasteners.

In European half-timbered construction, wood joints are primarily subjected to vertical forces — essentially compression — with horizontal forces absorbed by diagonal struts. All the structural load-bearing elements of a story-high facade, from the sill to the studs and diagonal struts to the frame, are linked together in such a way that they can be regarded as a braced wall.

In contrast, the Japanese evolution of timber construction was influenced by Chinese building techniques introduced in the sixth century. The fundamental system involves a post-and-beam framework with a non-load-bearing infill and an expansive cantilevering roof. Its optimal application in a rainy climate, characterized by moist summers and dry winters, is the reason it became part of the Japanese culture and lifestyle as we know it today.

Unlike European timber framing, Japanese wooden architecture must withstand substantial horizontal forces due to frequent earthquakes.

This necessity significantly influenced the properties of wood joints, ultimately shaping the architecture. The Japanese timber house is a post-and-beam structure without braces or diagonal struts. The overall stiffness of the structure relies solely on the wood joints. This has resulted in a variety of highly complex wood joints and node solutions tailored to different structural demands. To withstand extreme stresses, these joints have to be crafted with precision and skill. As a result, they appear object-like, abstract, and artistic, possessing a unique aesthetic.

Wood joinery, esteemed for its aesthetics and craftsmanship, enriches timber constructions and furniture, exemplifying efficient material use and structural integrity while serving as a model for sustainability in various applications. This publication aims to provide a comprehensive overview of traditional wood joinery gathered from around the world, possibly in a format not seen before. It comes at the right time, because contemporary timber constructions can benefit from it. Today, centuries-old wood joinery from traditional woodworking and timber construction methods can be easily produced with high precision, utilizing cutting-edge modern technology and high-strength timber materials.

It is very likely that we will encounter traditional wood joints in one form or another in the near future.

Prof. Peter Cheret
University of Stuttgart, Germany

Editor's Note

Introduction

New technical solutions are changing the way timber constructions are built and manufactured. Traditional artisanship today competes with modern production techniques. Detailed knowledge of the craftsmanship of timber joints and their application can help us understand and challenge these potential changes in manufacturing and construction. Since wood was first used as a construction material, various methods have been developed to join individual parts. Over time, many types of connections have emerged. The mid-nineteenth century saw the development of timber-steel structures with large spans in train stations, market halls, and gymnasiums, as well as a shift in the relative costs of labor and materials, with the former rising and the latter falling. Taken together, that significantly contributed to the addition of mechanical fasteners such as steel connections, nails, and nail plates. The introduction of machinery into manufacturing has further diminished the relevance of timber connections that have been used in everyday practice.

Yet joinery and timber structures are regaining popularity. The growing understanding that wood is an important renewable resource has hastened a shift toward timber construction. This development, though, is threatened as increasingly dry and over-logged forests are destroyed by wildfires and insect infestations. The availability of renewable resources is increasingly restricted, and fast-growing varieties are thinning out old-growth forests. Given the threat of climate change, we are once again starting to appreciate the importance of resources, repairability, and approaches that preserve rather than destroy. For a resource-efficient and reusable approach of buildings and construction elements, we must relearn the repairability of traditional wood joints and adapt them to make them future-proof.

In times when there is a shortage of skilled workers, this in turn requires expertise in craftsmanship shared by many instead of specialized machine knowledge for a few. Craftsmanship can be internalized through experience and doing. A central feature of craftsmanship is that it requires both physical and mental acuity and can be learned through observation.

For example, if an artisan repeatedly encounters similar damage when repairing or deconstructing, this understanding can be incorporated into the work and corrected accordingly.

Therefore, working with traditional timber connections means that the right proportions must be found between the resources of working time, materials, production methods, and energy, as well as the conceptual design decisions. The balance in terms of appropriateness has a corresponding impact on the design.

This experiential knowledge can be passed from generation to generation through rituals or traditions. The formalized, ritualized framework of traditions is intended to restrict the further development of forms and techniques to safeguard knowledge over time. In fact, however, traditions can change as new tools and methods are introduced into production.

At the same time, mistakes, oversights, or experiments, as well as the preferences of the respective master artisans, also play a role in the production of wood joints. So in addition to technical requirements, there are cultural, functional, and social factors that accompany the development of these joints.

Changing environmental conditions, observations, or external influences, for example, from traveling artisans, have led to further adaptations of wood joints. In the broader context of material consumption, handcrafted wood joints can help reform construction by encouraging repair instead of replacement.

The current upswing in timber construction and the growing importance of wood as a building material contribute to this compendium's relevance. Technical possibilities and production techniques can serve not only as a guide for direct reproduction but may also offer a starting point for innovative connections and concepts. Without claiming to be exhaustive, this book aims to present as many traditional wood joints from different cultures as possible and make them accessible and easy to understand using simple drawings and guides to manufacturing processes.

The attempt to create an initial and uniform terminology for wood joints from different regions is intended to facilitate further research into analog and digital media. The resulting publication should contribute to a greater understanding of historical constructions and building methods and their maintenance and preservation. It should foster new, independent, and outstanding solutions across disciplines.

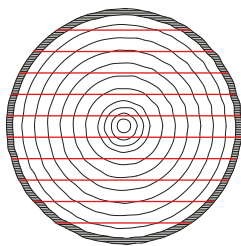
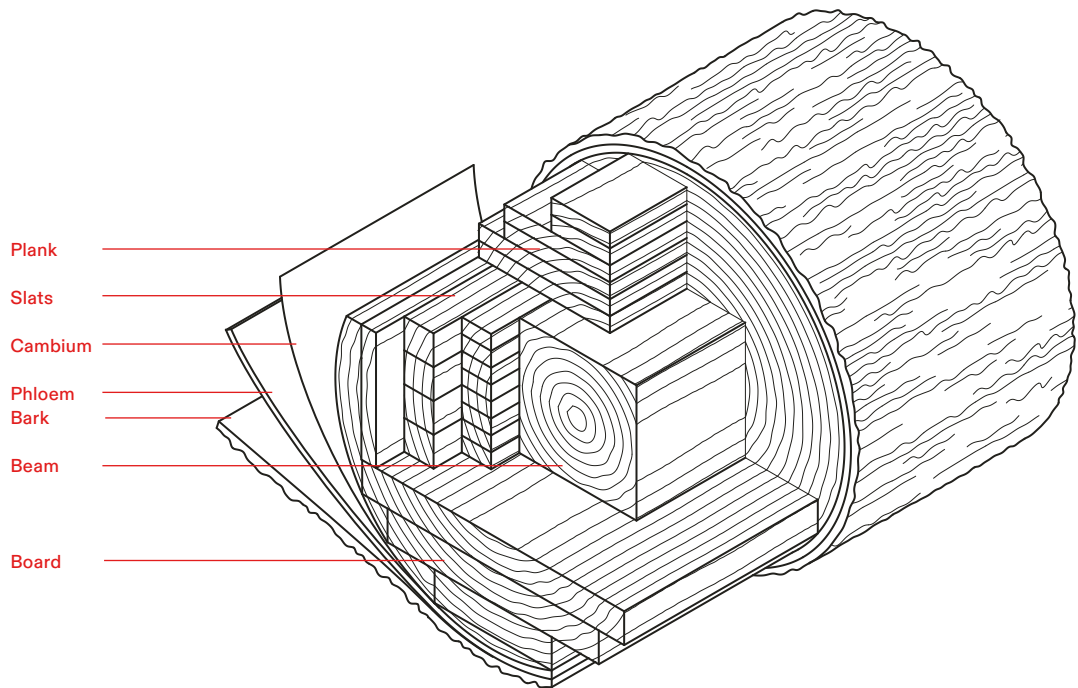
How to Use *The Joinery Compendium*

The Joinery Compendium makes the research and design of joinery projects easy. The joints are divided into chapters according to their geometric orientation and complexity. For easy access, the visual glossary offers a quick overview of the content and makes it simple to locate the appropriate connection.

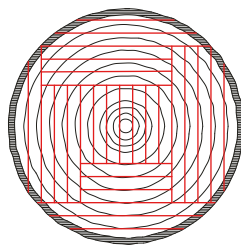
The 400-plus wood joints are provided with their English, German, and Japanese names to make it easy to communicate with project partners and offer a starting point for further research.

Wood, Tools, Terminology

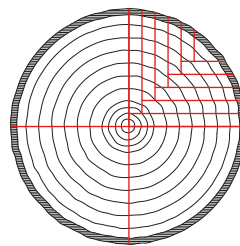
Wood Quality



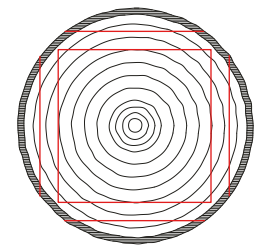
Live Sawn



Plain Sawn



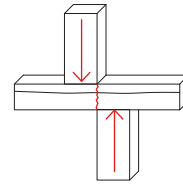
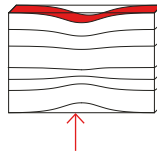
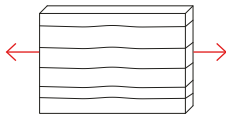
Quarter Sawn



Whole Piece

The structure of the tree—thicker and denser at the base and thinner and lighter at the crown—is naturally designed to resist gravity. But the characteristics of the wood, and therefore its usability, depend on where the tree was grown, as various environments obviously mean different sun, wind, soil, altitude, and moisture conditions. Trees grown at higher elevations and in deserts often produce denser, more resilient wood owing to challenging climates and slower growth rates.

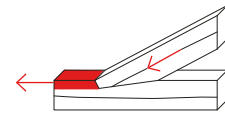
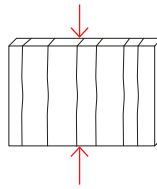
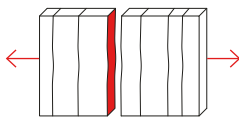
However, the most vigorous trees grow above the midpoint of a mountain, where they receive the best sunlight and air circulation. Trunk diameters are thicker since trees there can rapidly branch out and develop the necessary girth to support many leaves or needles. Simultaneously, the wood of more exposed trees is impacted by the wind, resulting in higher density and an altered fiber structure on the compression and tension side.



Tension along Grain

Compression against Grain

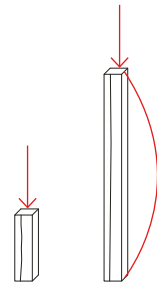
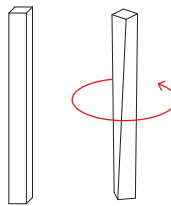
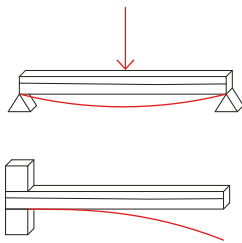
Shear against Grain



Tension against Grain

Compression along Grain

Shear along Grain



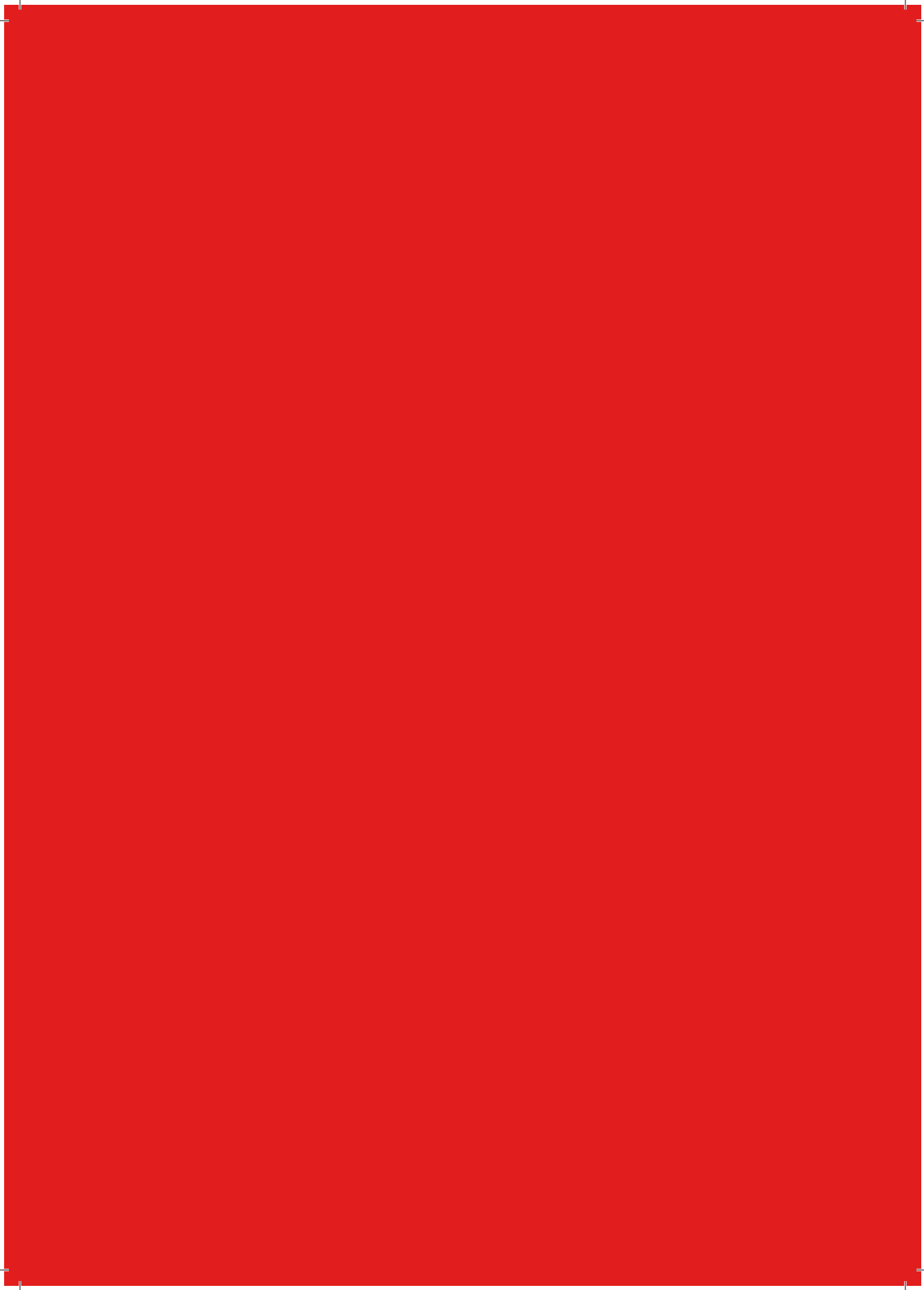
Bending

Torsion

Buckling

Shrinkage and movement are inherent properties of wood that affect its dimensional stability and structural integrity. Wood movement occurs primarily because of changes in humidity and temperature. It varies depending on its fiber orientation and is approximately 10 % tangential, 3 % radial, and 0.3 % longitudinal. This differential shrinkage and swelling often leads to deformations such as buckling, warping, bowing, and twisting, which can affect the performance of wood products and lead to cracks and other damage. The delicate balance between the wood's moisture content and the environment's relative humidity is a criterion for the subsequent location of the wood joint. The choice of wood and its orientation must also correspond to the application to account for tension, pressure, shear, bending, torsion, and buckling in the structure.

Wood is generally more resilient to tensile forces along the grain rather than perpendicular to the grain. When pressure is applied perpendicular to the grain, it is advisable to use hardwood to minimize deformation. Sophisticated joinery techniques for controlling movement, such as bread-board ends, floating panels, or sliding dovetail battens, are just some of the possibilities for dealing with the movement of the wood in a way that suits the material. Understanding the mechanisms of timber movement and stresses is critical to designing and constructing wooden structures and products to mitigate potential problems and ensure their durability and functionality. However, taking account of deteriorating components can also be a conscious approach to sustainable design.



Timber Joints

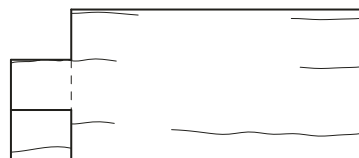
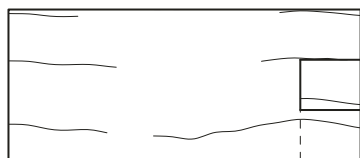
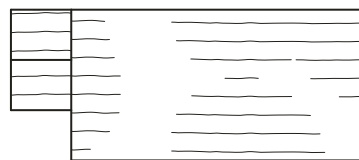
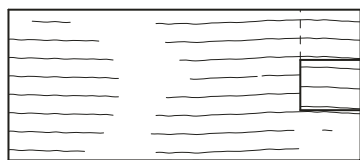
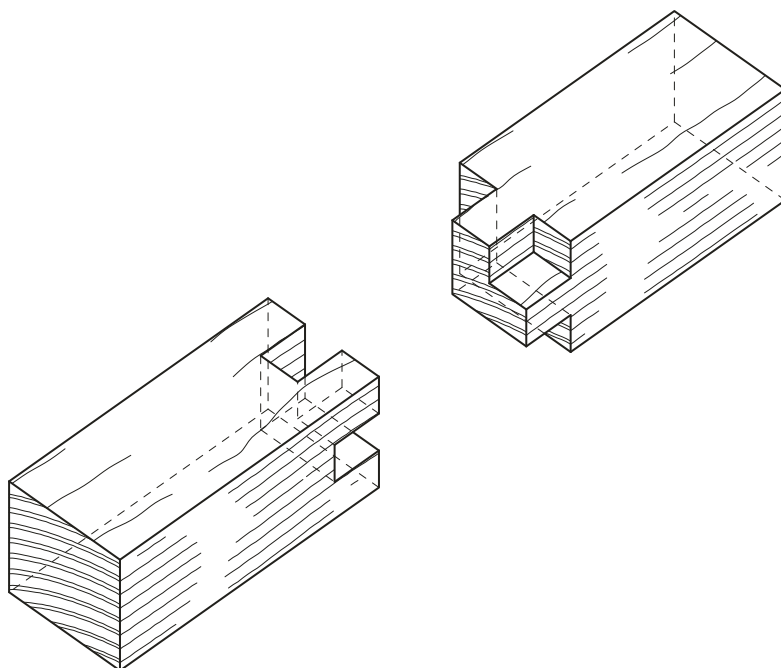
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| Splicing Joints | 042 | Corner Joints | 262 | T-Joints | 420 |
| Angled Joints | 584 | Cross Lap Joints | 646 | Specialty Joints | 708 |

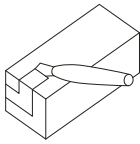
Splicing Joints

Half-blind L-shaped stub tenon joint

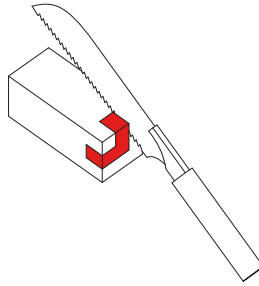
kane-ori-mechi-tsugi
矩折目違継ぎ

Winkelzapfen

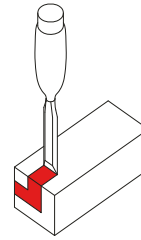




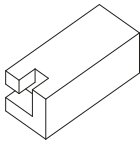
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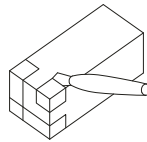
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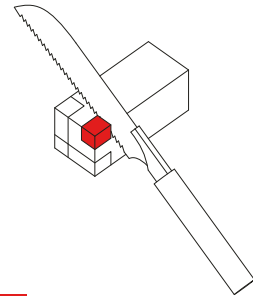
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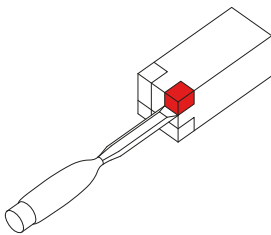
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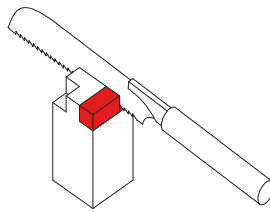
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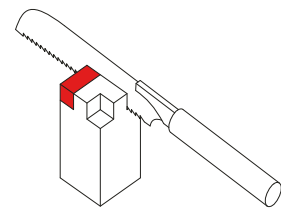
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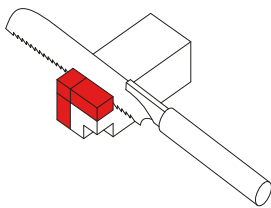
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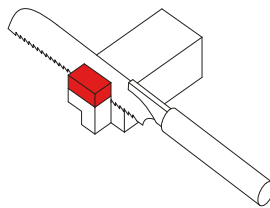
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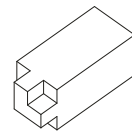
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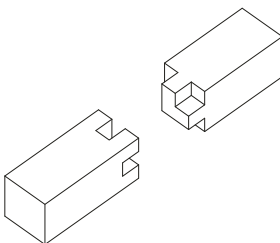
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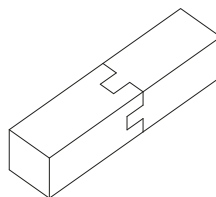
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B



A+B



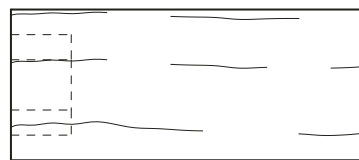
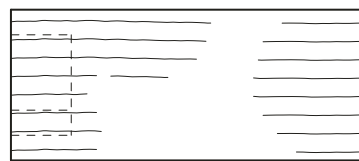
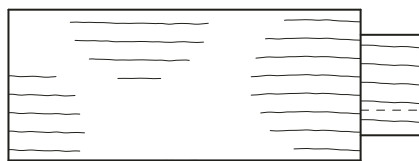
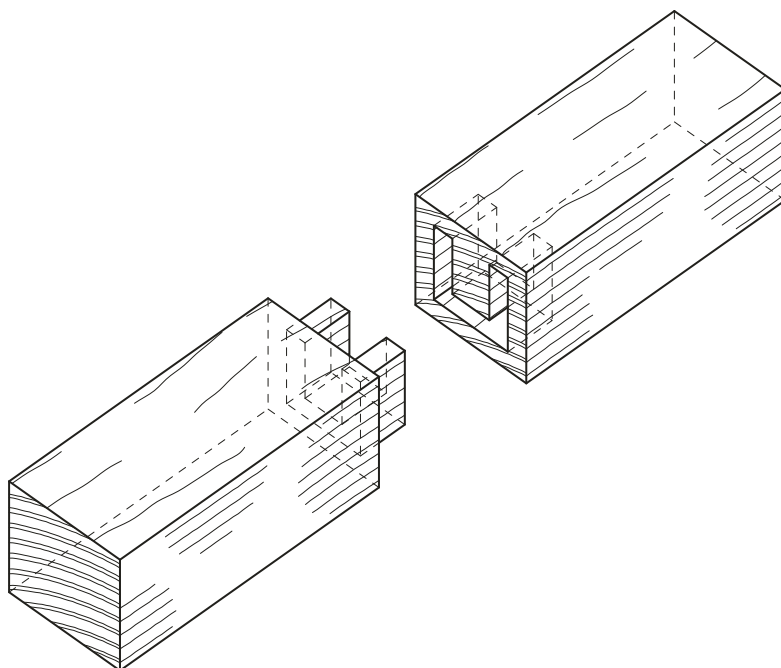
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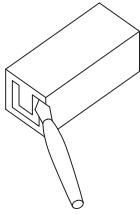
Splicing Joints

Blind U-shaped stub tenon joint

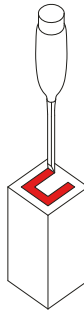
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verdeckter u-förmiger Zapfen

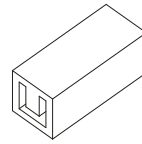




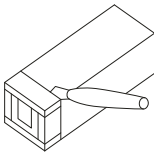
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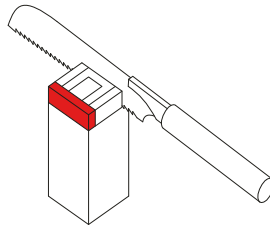
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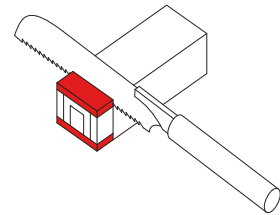
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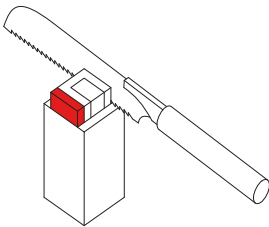
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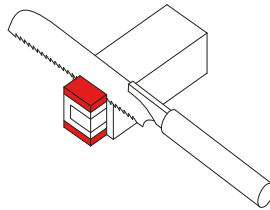
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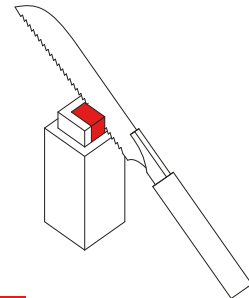
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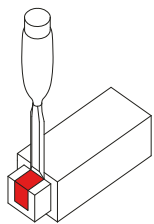
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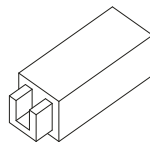
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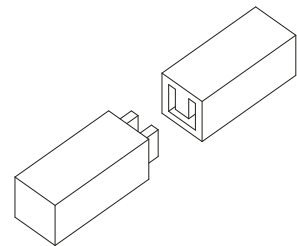
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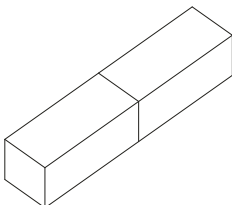
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B



A+B



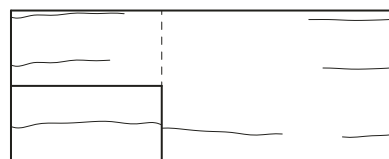
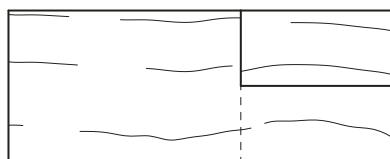
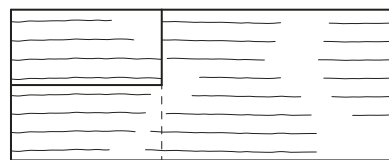
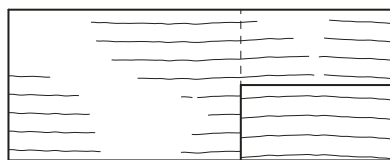
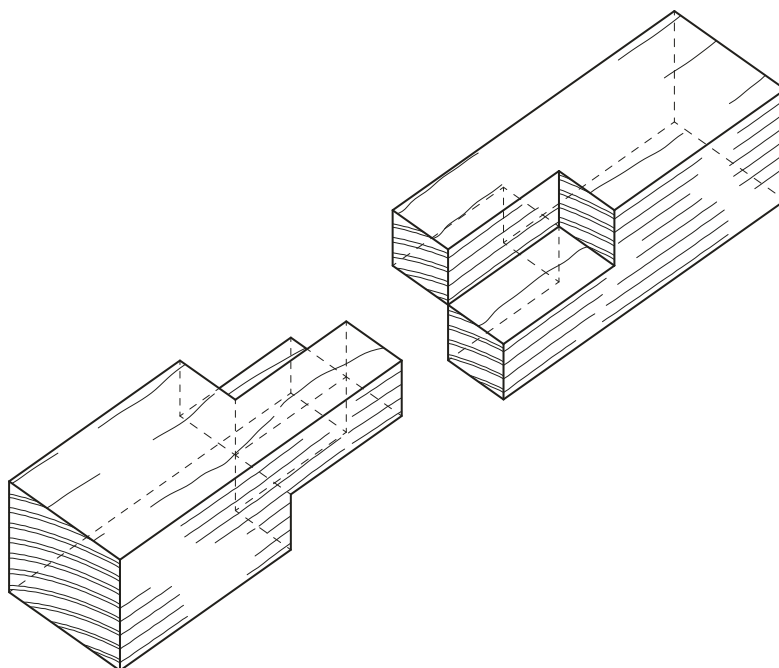
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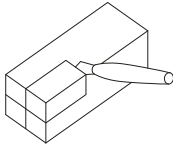
Splicing Joints

Double halved lap joint

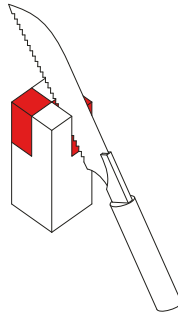
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貝口箱継ぎ

diagonal versetztes abgesetztes Blatt

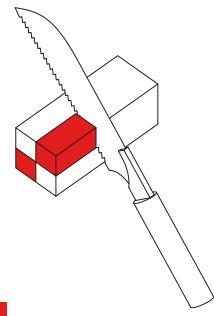




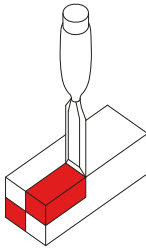
A1



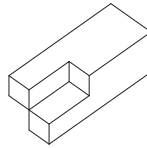
A2



A3

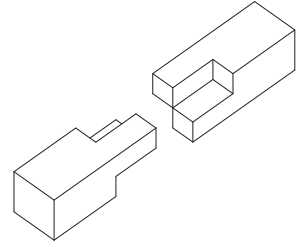


A4

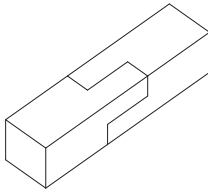


A

2x



A+A



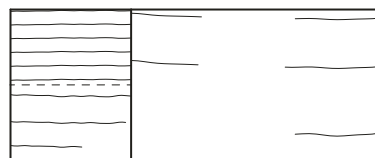
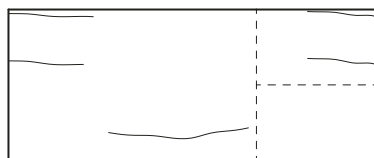
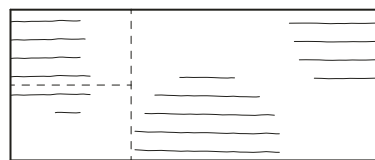
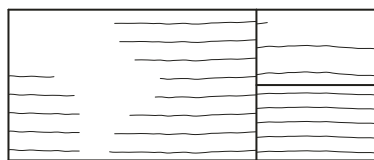
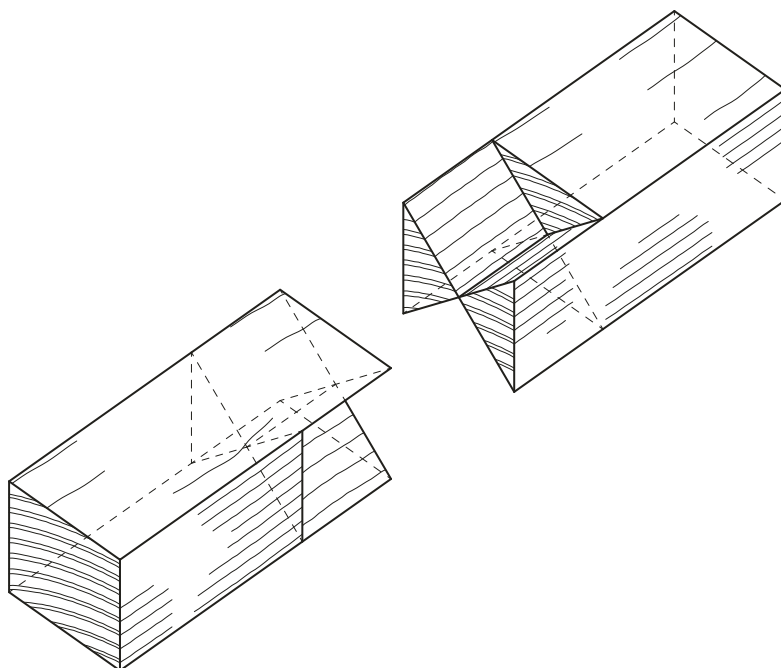
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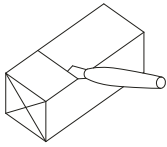
Splicing Joints

X-shaped tenon joint

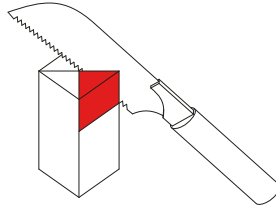
kainokuchi-tsugi
貝口継ぎ

Kreuzzapfen

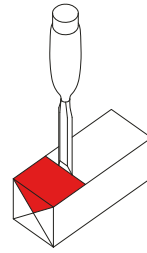




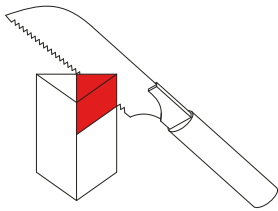
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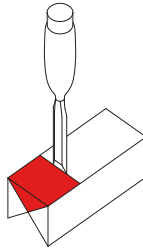
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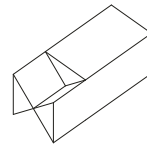
A3



A4

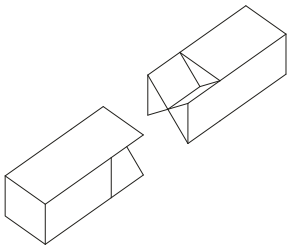


A5

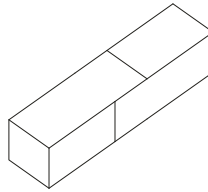


A

2x



A+A



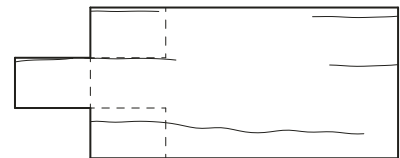
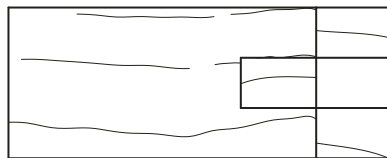
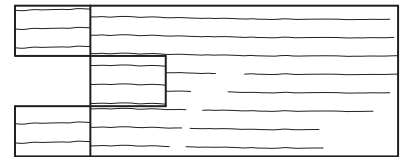
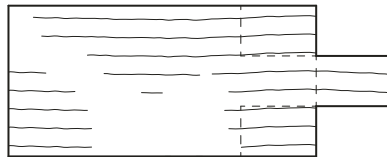
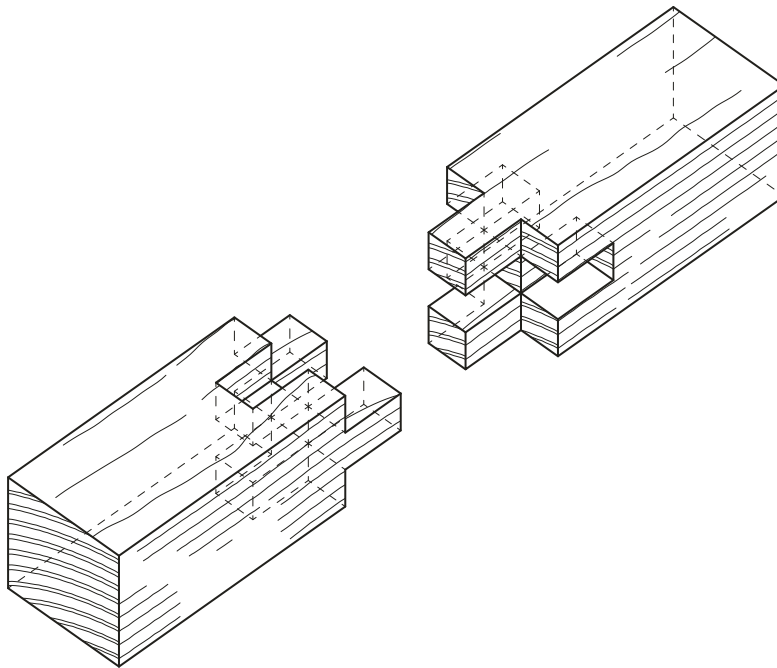
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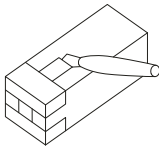
Splicing Joints

Double mortise and stub tenon joint

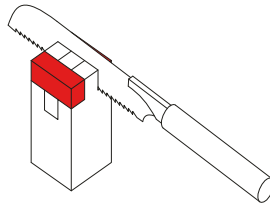
mata-jūji-mechi-tsugi
股十字目違継ぎ

geschlitzter Zapfen
mit beidseitigem Zapfenloch

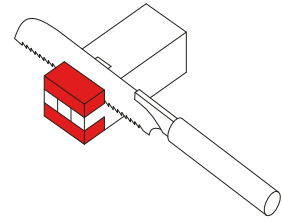




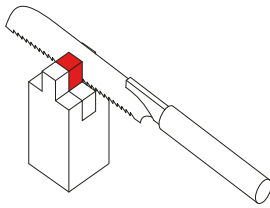
A1



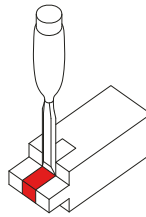
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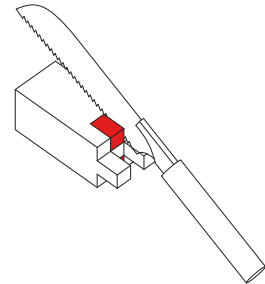
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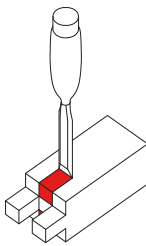
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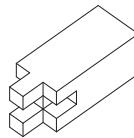
A5



A6

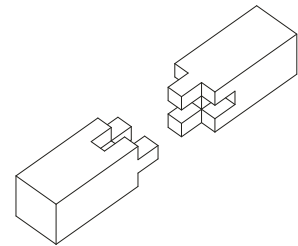


A7

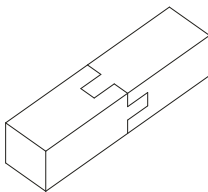


A

2x



A+A



AA

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The Joinery Compendium

Learning from Traditional Woodworking

The Joinery Compendium is an illustrated guide to traditional joinery for woodworking enthusiasts, designers, artisans, architects, and anyone who wants to learn more about the topic. It features more than 400 traditional wood joints from around the world. The index-like structure and simplified illustrations make it easy to find and compare various joints. The properties of wood and essential tools are introduced, and step-by-step instructions for crafting each joint are provided. Detailed terminology in English, German, and Japanese enriches the understanding of the connections and helps encourage further research.

This book aims to offer design inspiration for aesthetically pleasing and sustainable joints. Embracing the timeless artistry and practical ingenuity of the craft provides an understanding of resources and reparability. Whether you are a novice or a seasoned professional, *The Joinery Compendium* is your essential companion to traditional wood joints.

