On Making

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Grasping the wooden handle of a *dozukime* saw with both hands, I make a rip-cut into a block of eastern white pine, leaving behind a 1/64-inch wide kerf. I am cutting a dovetail: a wood joint developed over five-thousand years ago by the hands of our ancestors. Even now, a well-fitted dovetail joint remains one of the strongest, most elegant ways to join wood.

I knew nothing about traditional woodworking when I first picked up a hand-plane, but I was soon inspired by the richness of the craft: the quality of a hand-planed finish, the spirit of craftsmanship, and the nature of material. I was amazed by the wealth of knowledge embodied in craftwork. The tools and materials I encountered spoke to me; I learned to care for them and for my work. How would the things I make endure through time? How would the things I make affect others? In an era where materialism has come to represent a spiritless relationship to the things around us, traditions of craft can teach us how to imbue the human spirit in our work.

After making a harvest table, four chairs, ninety-four earthenware pots, and a lamp, I reflect on the act of making as a means of discovery. Making affects our thinking and our approach to material and environment. Making can help us develop a craftsman's capacity to listen, a great respect for material, and a desire to make better objects for posterity. Making is learning.

Acknowledgments

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To my family. Thank you for instilling in me, the value of tradition. Undoubtedly, this value has influenced my work.

To my partner, Nikola Nikolic. Thank you for everything.

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Photography by Melissa Ng and Nikola Nikolic

Preface

In the summer of 2011, my partner and I salvaged twenty 12ft long framing timbers from a historic building in downtown Cambridge, Ontario. The timbers varied from 6 to 8 inches wide, had accumulated a hundred years of dust, and were littered with iron and steel nails. With the intention of building a wood table, my partner and I transported the timbers to our school's workshop and carefully removed the hundreds of nails by hand. During this process, the workshop managers informed us that due to the risk of concealed nails, which could damage tool blades, we would not be allowed to use the school's power tools. I was disheartened by the news and felt somewhat clueless with how to proceed. Without access to power tools, the only alternative was to build the table using hand tools. At the time, I barely knew what a hand plane was, what it did, or how it worked. To plane and level 12ft long boards by hand would be a daunting task. With little knowledge of manual construction methods, my partner and I chose to build the table by hand, unknowing where this exploration would lead. I recommend that for anyone who is interested in learning more about the creation of the table shown in this thesis, to read Nikola Nikolic's dissertation as well.

Building the table—a year-long process—was physically, mentally, and emotionally demanding. The circumstance of having to work without the aid of power tools, revealed to us the lessons that comes from direct bodily engagement. We learned that the body—a primal means to understanding the world—has an incredible capacity to store knowledge. Direct sensual feedback refined our sensitivity to the material. Without the guidance of a Master, we

learned to be guided by the material itself. Wood, like any material, has unique characteristics and its own laws. And in order to work the wood effectively, we found that it was first necessary to develop a respect and understanding of these characteristics and laws. Design decisions that were inconsiderate of the material, always resulted in failure.

Direct bodily engagement also cultivated our appreciation for craftsmanship. Craftsmanship demands a thorough knowledge of a material being worked, a refined set of skills, and most importantly, care. The aspect of *care*, distinctly separates the craftsman from other makers. Often taken for granted, *care* is something that is cultivated over time and permeates every part of the craftsman's working process. The craftsman cares for the material, where it comes from, and how his work will affect its user. He also cares for the tools, the maintenance of a workspace, and the spirit of his craft. *Care* is reflected in the craftsman's work. Through the writings of George Nakashima, a mid-century Master Woodworker and architect, we can begin to grasp the intensity of care that is required from the craftsman:

> [The craftsman] is completely dedicated, with a strong sense of vocation. He has a special intensity, a striving for perfection, a conviction that any task must be executed with all his skill. ...not driven by commerce, but by a need to create the best object he is capable of creating. Even if the object were to be destroyed when finished, the craftsman would still give the task his all. (113)

In another passage, Nakashima elaborates on the craftsman's vocation:

> The will must aspire to produce as fine an object as is humanly possible... The endeavor must be to bring out the beauty and proportion, the textures and depth of the material used, to produce something that may last forever. ... The maker... reaches out into hundreds of lives, listens to voices and shares in the lives of so many people, giving and receiving. (138)

This level of care, is rare in an age that prioritizes expediency over benevolence, and quantity over quality. I am inspired by the work of George Nakashima, and hope that one day, I will achieve this level of care in my own work.

Since building the table, I have continued to explore craftsmanship through the making of objects that relate to the table. My intention was to maintain coherence to the overall undertaking of this thesis, while continuing to develop my manual skills. I built four chairs to accompany the table, pottery to sit on the table (and to carry food), and a paper lamp that would be suspended above the table. Like the various parts of a building, my intention was to create objects that would constitute a space.

In this thesis, I argue for the importance of direct bodily engagement in design education. **Part I** of this document is composed of four written essays that summarize my thoughts on the importance of developing a relationship with the materials we choose to work with. **Part II** is a photographic essay that

describes the slow process of making the objects over the past two and half years. Although the photographs only document a fraction of the work, I found that they communicate a sense of slowness, patience, and intensity better than text. **Part III** emphasizes the importance of *listening* in craftwork, and serves as a conclusion to this thesis.

In the writing of this thesis, I briefly discuss the inner properties of wood, clay and paper. However, I recognize that woodworking, pottery, and papermaking are lifelong journeys in themselves, and I am merely a beginner.

After seven years of architectural education (as both an undergraduate and graduate student), I believe that the act of making is one of the best ways to gain insight into material and craftsmanship. Therefore, I encourage students to engage the design process through their hands and to work with real materials. Build something that is of functional use: a bench, a side table, a box. Make the object with an eye toward quality; make it last a hundred years.

There are many lessons to be discovered in the making of an object, however, there is one that resonates with me: we are imbued in everything we make. When we decide to make something, our entire being is reflected in the work. The aim of this thesis, is to share what I have learned through the making of material objects and as a reminder of the profound potential of our man-made world.

All Man-made things are worthy of life. They may live to the degree that they not only served utilitarian ends, in the life they served but expressed the nature of that service in the form they took as things. That was the beauty in them [...] love entered into the making of them. Only the joy of that love gives life to the making of things...

Frank Lloyd Wright (109)

Figure 001 Earthenware, by Melissa Ng

1 Reflecting

Material and Spirit

When I began exploring handcraft traditions such as woodworking, pottery, and papermaking, I realized that there is *another* way to consider the mind/body dichotomy. Far from being opposites, the body is our most primal means to reach out into the world. Craftwork, when practiced wholeheartedly, allows a maker to contemplate and develop his relationship to the cosmos. The craftsman who works with wood also works with the soul of a tree. The potter's clay comes from the slow metamorphic process of living rocks. Paper is made from the flesh of plants. The craftsman knows that all materials—natural and synthetic—first come from the earth, the life force of our world. By developing an intimate relationship with the material being worked, the act of making things by hand reveals the sacred nature of materials, and compels us to appreciate a much larger continuum of time. The act of making, as understood by many traditional craftsmen throughout human history, is a way of bridging the material and spiritual worlds.

Take, for example, the Bambara craftsmen of Mali. Amadou Hampâté Bâ, founder of the Institute of Human Sciences of Bamako (Mali), writes that the people of ancient Africa made no distinction between the sacred and the profane. Bâ explains that Bambara craftsmen were not simply makers of utilitarian objects, but they and their craftwork had sacred significance:

> [The craftsman's] knowledge was always about the mystery of the primal cosmic unity, of which each trade was one particular aspect and form of expression [⋯] While the art of the ironsmith is linked with the

> mysteries of fire and the transformation of matter, the art of the weaver is bound up with the mystery of rhythm and the creative Word acting through time and space. In ancient times, not only was a trade or art considered to be the embodiment of a particular aspect of the cosmic forces, but it was also a means of making contact with them (14).

According to African tradition, great works of art were not the result of the craftsman's handwork alone. Rather, the craftsman acted as the medium through which the Supreme Being expressed Himself. A great work of art was "a porthole through which one can contemplate the infinite horizon of the cosmos" (16).

In another example, ancient Japanese papermakers were highly respected by Shinto priests. Paper, cherished for its physical purity, was a mediator between man and the spiritual world. Formed using purified water in the hands of devoted papermakers, paper *Washi*, which was both strong and delicate, was regarded as a noble element and a metaphor for life itself. The Japanese word for 'paper' is pronounced in the same manner as the word for 'god', and though these words have different written characters, *kami* means both paper and god. Shinto priests believed that the "tangible *kami* could represent the intangible *kami*, and a man-made material could reflect spiritual entities" (Horiki, and Okuma16).

In an era where materialism has come to represent a spiritless relationship to the things around us, traditions of craft can teach students of architecture how to develop a symbiotic relationship with the materials they work. Traditions of craft can reveal a more holistic approach to the design process when the

prevailing tendency is to value ideas over reality.

The making process, as practiced by ancient African and Japanese craftsmen, is approached wholeheartedly. In fact, it cannot be *truly* approached in any other way. The benefits of making, are revealed to those who are open to listening and who approach the making process by their own volition. A student of architecture, entering an increasingly virtual profession, stands to learn much about material and construction through the time-honoured lessons that come with direct bodily engagement. They learn to develop their ideas *with* material and its natural laws, and embodies the spirit of craftsmanship over time. The relationship between material and spirit is not an abstract theory conceived in the armchairs of great thinkers; it is an embodied, tangible reality. Man, material, and the cosmos are brought together in the process of making.

Inner Properties

When working with solid wood, the properties of the material are evident in the grain and knots that we see on its sawn surface; these are a physical record of a tree's life. Every fibre of a tree's being affects the wood that is obtained from it. And even though wood is technically considered 'dead' when the tree is felled, wood is far from inert. The white pine timbers my partner and I used to construct a table—inanimate as they may seem—continue to expand, contract, and produce sap a century after the trees were cut down from the forest. When designing with wood, knowing its inner properties can determine the success or failure of the constructed thing. To understand the properties of wood, it is first necessary to gain an understanding of trees. After all, the essence of wood is found in the living organism.

The bole (or trunk) of a growing tree is primarily composed of bark, wood, and the pith (see Figure 002). All parts are critical for the survival of the tree. For example, the outer bark (the rough outer layer that we see) is made up of dead tissues that protect the tree from external threats. The inner bark is hidden behind the outer bark and transports food from the leaves. Between the inner bark and the wood is the microscopic cambium layer, which forms both wood and bark cells. Wood is divided into sapwood and heartwood: sapwood carries water and nutrients to the leaves; the latter provides structural support to accommodate the tree's growth. Finally, the pith is at the centre of these layers and are the base of new twigs and branches. ("Wood Handbook" 1)

Wood cells—often described as fibers or tracheids—carry water. Even though warping is greatly reduced when wood is properly dried and excess

water is removed, wood will continue to shrink and swell with changes in humidity ("How Woods React to Moisture"). When constructing the table, my partner and I foresaw the possibility of movement in wood. Thus, we designed 1/16-inch expansion joints between the table-top boards. In August 2013 (eight months after we applied the final coat of tung oil finish), we noticed that the wood had expanded to fill the joints. Three months later, the wood had contracted to once again expose the 1/16-inch expansion joints due to the dry, indoor air. It is rewarding and educational to see the expansion joints at play.

When we see a knot on a sawn surface, we are looking at the basal stump of a branch emerging from the pith. Understanding the nature of knots is important when choosing wood for a specific purpose. For instance, when selecting wood for an aesthetic purpose, one must account for the fact that loose knots are encased branches that may dislodge over time and leave a knothole in the surface. Live embedded knots, as its name implies, are intergrown and will not dislodge from the wood.

We can differentiate the two types of knots by examining the fibres that surround them. A live embedded knot has fibres that are continuous (see Figure 003). This type of knot tells us that there was continuous growth between the limbs and the bole of the tree and that the branch remained alive at the time the tree was cut down. A live embedded knot can also be the result of a tree's natural

pruning mechanism owing to overcrowding or lack of light, or by the hand of an arborist. In the latter instance, the cambium layer is able to heal over the wound (Joyce 85). A loose knot is a branch that has broken off, leaving a partial limb with a ragged, uneven edge. The cambium layer is unable to cleanly heal around the dead branch, so the stump dies resulting in a loose knot. We can recognize a loose knot by the dark ring of bark and the discontinuous fibres that surround it (see Figure 004).

If wood is required for structural purposes, timbers with minimal knots are the most suitable. Regardless of the type, knots reduce the structural integrity of wood due to the severe distortion of the grain that surround it. Because tensile strength is reduced more so than compressive strength, in structural beams, knots located closer to the underside (where the beam acts in tension) can significantly effect the beam's maximum loading. In columns, knots are less of a structural concern ("Wood Handbook" 94).

To develop an intuitive understanding of wood, we must go into the forest. We will see that all tree branches grow in an upward direction (see Figure 005). We will also see that the roots and trunk of a tree, resist the gravity of its crown. Through these basic observations, we already know more about wood than we might actively comprehend. By understanding the upward growth of branches, we can determine which end of a wood board was closer to the crown and which end was closer to the roots by examining the growth rings around a knot. This distinction becomes important when we are orienting the vertical members of a chair, table, or timber-frame building. Likewise, by understanding that a tree

naturally resists the gravity of its crown, we can reason that wood is inherently denser near the roots and lighter near the crown. Wood, therefore, should maintain this vertical orientation to maximize its structural strength (Brown 56).

Trees endure various environmental conditions throughout their lifespans that naturally affect the strength of their wood. Evidence of floods, droughts, fire, infestation, and even airborne chemical pollutants can be seen in their annual growth rings (Nakashima 80). All these factors determine the unique character of every piece of wood. The craftsman uses the wood wisely, makes well-informed decisions, and prevents waste. As designers of the man-made environment, these are admirable goals to work toward. The life of a tree is written on wood surfaces. By cultivating our sensitivities toward it, we can better harness its potential.

Figure 002 Cross Section of a Tree (Genus Unknown)

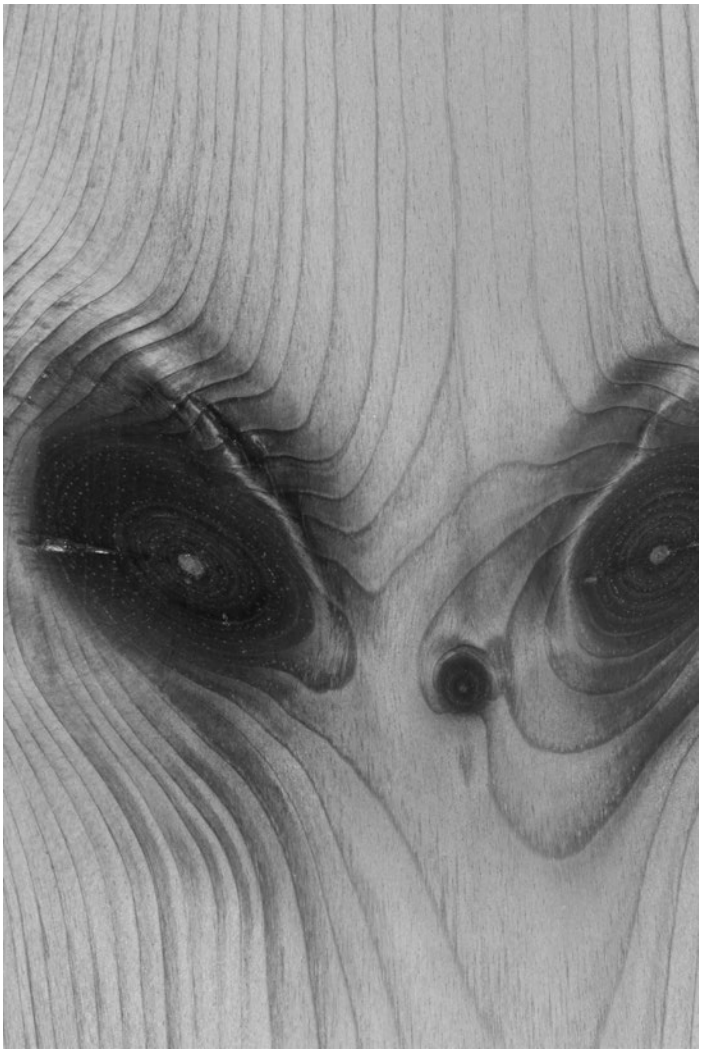

Figure 003 Live embedded knots: discernible by the continuous fibres around the knots.

Figure 004 A loose knot: discernible by the dark ring of bark and discontinuous fibres around it.

Figure 005　A Maple Tree

Bernard Leach, a renowned mid-century British potter, maintained that the ultimate worship of life is found in work that is carried out with the heart and the hand. He writes, "Such a pot, or indeed any work of art, is not an expression of the maker alone, but of a degree of enlightenment wherein infinity, however briefly, obliterates the minor self" (Yanagi 90). He argues that man's inner nature is best expressed through the employment of his first tools—that is, his own hands. For Leach, craftwork comes from man's whole physical and spiritual being.

Although most of the material things we encounter today greatly differ from Leach's description of craftwork, there remain objects and spaces in our material world that we still hold close to our hearts. A hand-thrown pottery cup, a beautifully made wood box, an old stone cottage: these are things that recall the touch of other human beings—things that allow us to gain a palpable sense of the human spirit. For the craftsman, the material world is the most effective means of expressing qualities of the human spirit, their ambitions, and thought processes. Language cannot fully account for the intuitive thinking and care behind the making of an object nor can it replace the sensual and sacred experience of working with a tactile substance. The breadth of knowledge that come from the physical act of making can only be understood through direct contact as learning begins from the body.

Two years ago, a local carpenter came into the school workshop while my partner and I were hand-planing wood boards. Although we had started to work with the reclaimed wood, we had trouble identifying the wood based on the grain

pattern. The carpenter—taking a handful of shavings to his nose and without hesitation—identified for us the genus of wood (in this case, eastern white pine). Every genus of wood has a distinct scent and taste that is recognizable. The craftsman uses his entire body to perceive the world, and it is inspiring to see this happen.

In March 2011, the New York Times published an interview with the Pritzker Prize-winning architect Peter Zumthor wherein he expresses his view on contemporary architectural education: "We should force universities to train carpenters and woodworkers and leather workers [...] Architects [have] lost contact with the real business of building" (Kimmelman 32). To expect architects to have a basic knowledge of construction is a truism, yet, it is only when I began to work directly with materials that I started to understand the meaning of Zumthor's words. In the few years that I have spent working directly with wood, clay, and paper, I can attest to the lessons that come from manual pursuits. Craftwork is a mutual exchange: I give shape to the material and in turn, the process of making changes the way I think, design, and construct. Meanwhile, failures in the making process forced me to re-evaluate my methodology and to make better design decisions.

I once had the romantic notion—while standing in heaps of white pine shavings from my table build—that I could make paper from this 'waste' and use it to fabricate a lampshade. Beyond the functional and spatial relationship

that ties together a table and a lamp, in my case, the two would also be made of the same raw material. It was not long after that I encountered the material's resistance to my idealistic urges. My first attempt at making paper from those wood shavings was unsuccessful. The resulting paper was incredibly weak. In fact, most sheets did not form well on my paper screen; the fibres had trouble bonding (see Figure 009). Making paper by hand requires cooking and beating the raw material (in this case, wood shavings) in order to remove the non-cellulose material from the cellulose (see Figure 007). Once removed, the pure cellulose fibres can physically and chemically bond with other fibres to make strong, lasting paper.

I had mistakenly assumed that paper is best made from wood. While industrial paper mills do use wood pulp in the manufacturing process, wood is almost never used for handmade paper, due to the difficultly in removing the non-cellulose material, specifically lignin. Lignin is the binding agent between the cellulose and cell walls: it is physically and chemically weaker than cellulose fibers, and it is very difficult to separate. Newspapers that discolour and deteriorate from prolonged exposure to the sun, is a result of residual lignin in paper (Hiebert 52). Paper made from wood is an industrial invention whereupon paper mills chemically treat the wood pulp with a noxious, sulfurous solution to break the bond that ties the lignin to the cellulose ("History of Papermaking").

Handmade paper, on the other hand, is generally made using the inner bark of tree branches or the stalks of annual and perennial shrubs (see Figure 006). Paper is also made from other raw materials such as hemp, cotton, and flax. In

fact, paper can almost be made from any natural fibrous material. These raw materials are fleshy in nature (see Figure 008); have long cellulose chains, and can create archival quality paper that lasts for centuries. Over the two-thousand-year evolution of the craft, papermakers have proved that the aforementioned raw materials are well suited for use.

After more failed attempts at making strong paper with wood shavings, I surrendered to the material. Wood naturally does not want to become paper and though we have the technology to overcome its physical limitations, this technology does not come without a heavy environmental burden. When we have a creative vision, it is sometimes difficult to accept that materials have a life of their own. However discouraging, it is important to remember that the road to success often begins with failure. When I eventually decided to take the traditional route, a successful batch of paper was made from combining the fibres of *kozo* (paper mulberry) with cornhusks (see Figure 010). By using konnyaku starch (a natural starch from the root of the devil's tongue plant) to treat the sheets, the paper became strong, water resistant, and will hopefully last for years.

Figure 006 *Kozo* (Paper Mulberry) Fibre

Figure 007　Cooking Fibre with Soda Ash

Figure 008 *Kozo* After Cooking

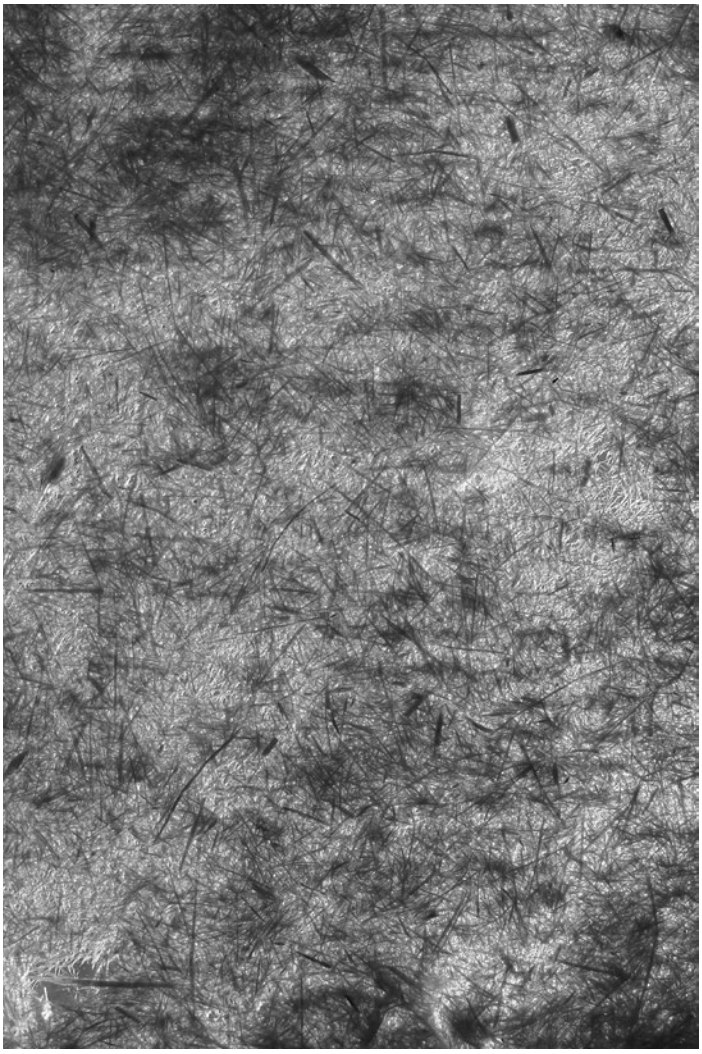

Figure 009 Handmade Paper with Wood Shavings

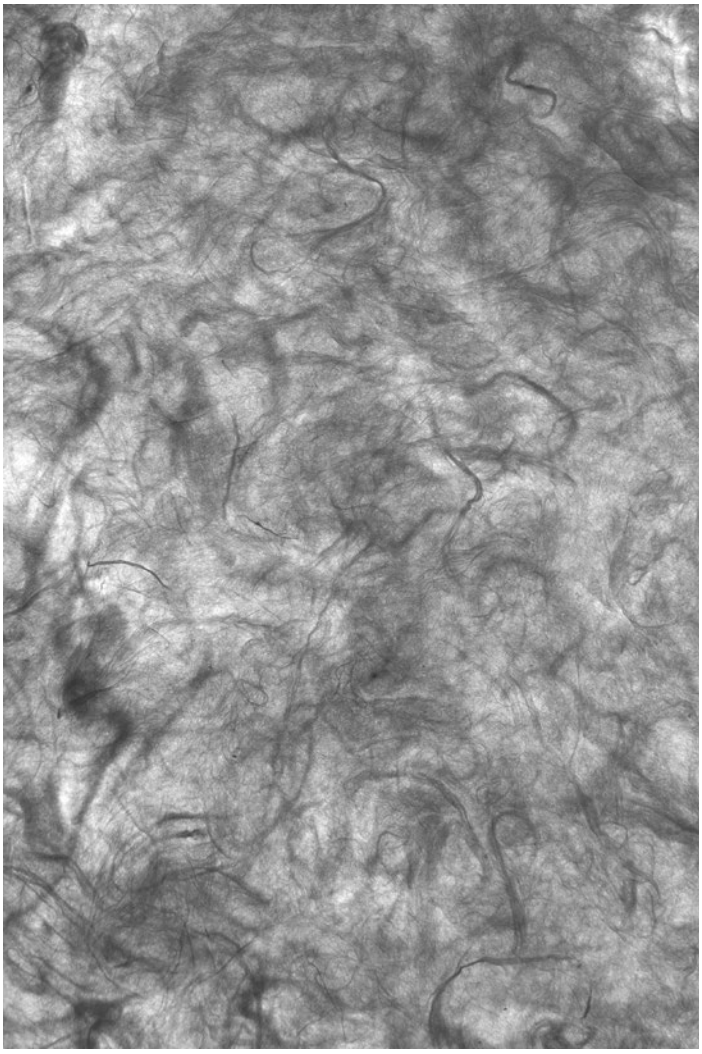

Figure 010　Handmade Paper with *Kozo*

Tools and Technology

One of the great misconceptions about handwork is that technology is avoided for the sake of nostalgia. This is a rather large misunderstanding. Take, for example, the field of Japanese temple carpentry, where many woodworkers will choose to use hand tools even though power tools are readily available. S.Azby Brown, author of *The Genius of Japanese Carpentry,* observed "hand tools [...] provide a tremendous amount of subtle tactile information about a particular piece of wood. The delicate readings and detailed observations possible when working slowly by hand are lost with a noisy, dangerously gyroscopic blade or drill " (63). In addition to the invaluable knowledge gained from learning to use hand tools, Japanese carpenters acquire the widest range of skills possible by learning to use both hand and power tools and are therefore well equipped to take on any woodworking task. The tool "is the soul of the Japanese carpenter just as the sword was the soul of the samurai "(Brown 69). More than a means to an end, the tool also shapes the carpenter.

In an age where the relevance of hand skills is questioned, we must be reminded that, like the woodworker, architects too are shaped by the manner in which they work and the tools they use. Richard Sennett, the Centennial Professor of Sociology at the London School of Economics, quotes a young MIT architect: "When you draw a site [by hand]... it becomes ingrained in your mind. [...] You get to know a terrain by tracing and retracing it, not by letting the computer 'regenerate' it for you" (40). Sennett continues to argue that simulations cannot take the place of direct, tactile experience. The making process shares the same concerns as the drawings process. Finnish

architect Juhani Pallasmaa writes, “Creative work calls for a bodily and mental identification, empathy and compassion”(“The Eyes of the Skin” 13). When planing a wood board by hand, the body experiences immediate sensual feedback: wood tears out when planed against the grain, a continuous shaving indicates the flatness of the board, and the scent of freshly cut fibres signal the genus of wood. Knowledge is gained as the senses are refined. You get to know a material by working and re-working it, not by letting a tool do the work for you.

In any making process, there lies the dilemma of tool choice. Although hand-tools are conducive to meditative work, these tools are rather slow. When building my chairs, I reduced many weeks of preparation work by hand to only a few days by harnessing the speed and efficiency of power tools. The jointer and thickness planer can ‘true’ (square the edges) large planks of wood far more expediently than hand-planes. The bandsaw rip cuts in a matter of seconds; on a dense hardwood plank, this task could take hours with a handsaw. Likewise, the drill press is useful for quickly wasting out wood in the initial stages of cutting a mortise (see Figure 124). Therefore, power tools are useful in the earlier stages of roughing out and dressing timbers, and allows me to divert more energy into cutting precise joints and shaping chair parts.

All of the chair joints are cut by hand using mainly chisels and a handsaw. The fine teeth of my dozukime saw—a marvelous tool—allows me to cut a kerf only 1/64-inch wide (see Figure 077). Chisels excel at cleaning out wood on the inside corners of a joint. I shape and smooth every member of the chair with a drawknife or spokeshave (see Figure 086, Figure 087). A spokeshave allows me

to take paper-thin shavings while leaving a glassy smooth finish. Additionally, a spokeshave allows for an incomparable level of precision when shaving wood at a smaller scale. Some of the details in my chairs are carved with knives; this allows the form to be gradually discovered (see Figure 134). When constructing a chair, a 1/32-inch gap is visible to the naked eye (see Figure 102), therefore, furniture requires stricter tolerances. The process of manually marking out each cut with a carpenter's square tunes one's sensitivities to these small dimensions. Although the chairs are primarily built by hand, the full process involved a synthesis of hand and power tools. Every tool had its place and was used for a specific purpose.

When finishing a piece of furniture, the hand-planed finish is unrivaled. George Nakashima wrote about the hand-planed finish: "For the best work, the [blade] is sharpened after each stroke, not because it is dull, but because the finest finish demands it" (128). This is not an exaggeration. After a few minutes of hand-planing, I can feel a tangible difference in the surface finish of my own projects. Nonetheless, even a dull blade can often leave a rather smooth finish when compared to sandpaper. Sanding abrades the surface of wood and tears the wood fibres. Repeated sanding fills in the damaged wood pores with dust created in the process. By working with ever-finer grits of sandpaper, a smooth surface can be achieved with the caveat that light cannot penetrate the torn, dust-filled fibres on the surface. This has the unintended consequence of making the surface look and feel worn down. Sandpaper finer than 600-grit is required to achieve a quality that even begins to look like a planed finish (Wynn 8). Hand

planing, shears wood fibres cleanly and leaves a crisp edge. Light is able to penetrate the surface and reflects back to reveal the three-dimensional grain structure (see Figure 013). For these reasons, I like to use a hand-plane for the finishing process, and sandpaper only around joints and acute curves—wherever I cannot maneuver my cutting tools.

The finishing process is one of the most underestimated stages of any built work. Achieving a fine finish can sometimes take as long as the entire making process leading to the finishing stage. When finishing wood in environments with higher humidity levels, a single coat of pure tung oil can take several weeks (sometimes over a month) to fully cure. Even though architects are generally not involved in the physical building process, knowing about various finish qualities elucidates the difference between excellent, satisfactory, and poor craftsmanship. Ultimately, architects are responsible for the quality of craftsmanship evident in their work.

The finish on a material surface is important because it is the final surface that another human being comes into contact. Like all craftsman, an architect touches the world through their work. The material world is the means by which an architect communicates; how he is able to participate in the shaping of human experience through time.

Figure 011 Hand-planes

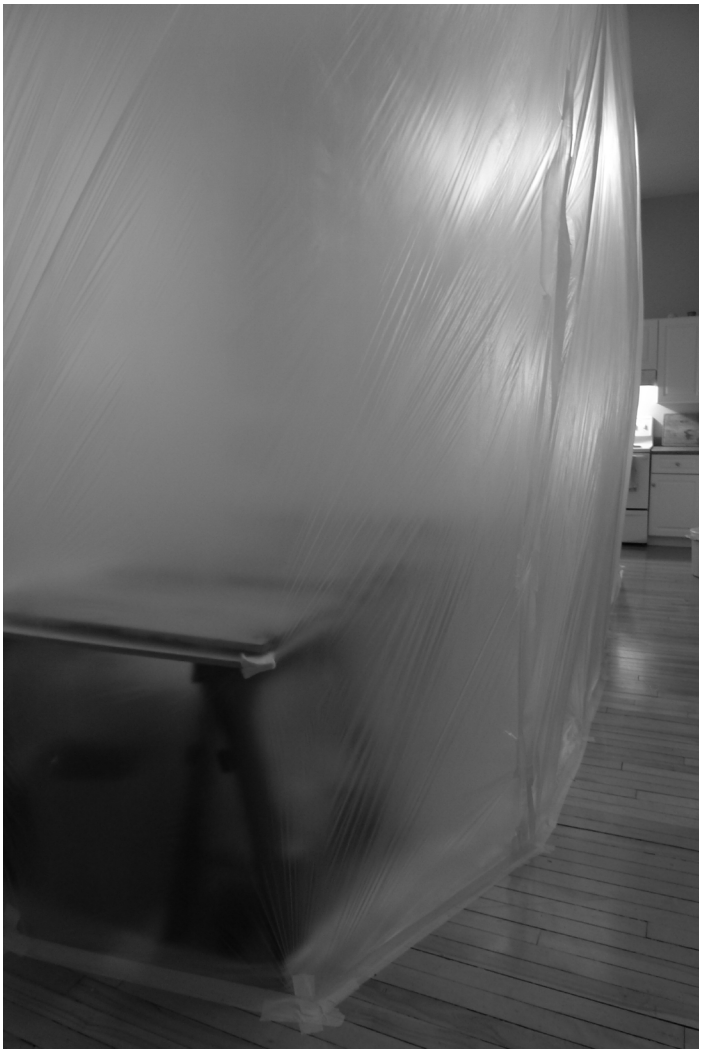

Figure 012 The ‘finishing room’: to prevent dust from settling onto my table when applying a tung oil finish.

Figure 013　[Left] Sanded Wood Surface, [Right] Hand-planed Wood Surface

Digital fabrication technology is generally regarded as a benefit to the student of architecture. It liberates the student from having to know traditional methods of working a material and expedites the making process. While my experience with digital fabrication technology is limited, my experience using the CNC router has confirmed my suspicion that digital fabrication technology further removes and disengages the design student from material.

In a recent encounter with a student using the CNC router to carve wood, I realized that the amazing capabilities of digital tools are lost when knowledge of the material worked is not present. The student was routing out furniture legs from a slab of wood, however, the wood was oriented with the grain across the width of the leg as opposed to its length. As a result, the leg, unbeknownst to the student, would be subject to shear failure due to short-grain.

While digital tools have amazing capabilities, it is problematic when knowledge of the end material is not present, and thus, those capabilities are rarely utilized efficiently and never to their full potential. This problem lies not in the tool itself, but in the fact that students increasingly use digital fabrication technology as a sole means of working with and investigating the use of material(s). With little or no knowledge of other fabrication methods, students are limited by their understanding of materials (or lack thereof) and their use of digital fabrication technology reflects this deficiency. The student, separated from the material by the machine, becomes a spectator of the making process.

Finely tuned hand tools, on the other hand, have evolved as extensions of the body, allowing an extraordinary amount of tactile information to pass

through the body. The limitation of hand tools lies in the fact that the learning curve is steep. Even though I have spent hundreds of hours sharpening plane blades and chisels, I am only beginning to achieve a somewhat sharp edge. Clean cuts are not made with a dull blade. Thus, knowing how to sharpen steel properly is vital to good work. And this type of work demands time, patience, and dedication.

The lessons about material and construction that come from slow handwork, by way of the sensual process, are retained in the body. The student, upon their informed use of tools, is better suited to innovate in the age of digital fabrication and rapid technological change. For these reasons, learning to work materials by hand is well worth the time. Without first developing a healthy attitude toward material, a student of architecture—quick to adopt and depend on recent and new technologies like the CNC router or 3D printer—risks perpetuating an attitude of indifference to the material.

In an essay concerning the onslaught of industrial technology, German philosopher Martin Heidegger discusses the impact of productive manufacturing in the modern era. Even though we live in a post-industrialized society today, the metaphysical issues raised in his essay are perhaps even more relevant in the digital age. Heidegger writes about the dangers inherent in the use of technology when we do not understand the full implications it has on the individual, society, and environment. Although machines can reveal some aspects of the material

and natural world not otherwise apparent, they may also conceal other aspects. In many ways, manufacturing technology dematerializes whatever is put in front of it. For instance, regardless of whether one is working with wood, foam, or plastic, the maw of the machine will force its way through. As a result, less is revealed about the true nature of the material. Heidegger writes that technology, wrought by modern science, redefines nature as a calculable set of forces and diminishes it to a finite ordering and system of information. He elaborates: "Thus when man, investigating, observing, ensnares nature as an area of his own conceiving, he has already been claimed by a way of revealing that challenges him to approach nature as an object of research, until even the object disappears into the objectless of standing-reserve" (9).

The "standing-reserve" refers to modern man's treatment of nature. Man no longer extracts only the raw materials he needs. Instead, he takes from the earth, transforms material for energy, and stores it for future distribution. He commodifies it. When the general population comes into contact with whatever material is extracted from the earth, they no longer recognize it as something that originates from nature. One of the dangers of industrial technology is that it makes possible a condition whereby the common man, surrounded by standing reserves, forgets that the energy that he requires, the materials he chooses to work with, come from the exploitation of Mother Earth. Despite the 'dematerialization' of natural materials and the increasing presence of synthetic materials, in truth, all material is first extracted from the natural environment. Heidegger expands his thesis in another passage: "As soon as

what is unconcealed no longer concerns man even as object, but does so, rather, exclusively as standing-reserve, and man in the midst of objectless-ness is nothing but the orderer of the standing-reserve, then he comes to the brink of a precipitous fall; that is, he comes to the point where he himself will have to be taken as a standing-reserve" (13,14).

Heidegger's argument reminds us of our post-industrial relationship with material. Today's architect is precariously balanced between the physical and virtual worlds, but their constructions impact the Earth on an unprecedented scale. According to the textbook *Fundamentals of Building Construction* and based on the findings of Worldwatch Institute, forty-percent of the world's energy consumption comes from buildings. Architecture contributes "one-third of carbon dioxide and two-fifths of the acid-rain-causing compounds that are released into the atmosphere"(12). Although a caring sensibility toward material does not solve the environmental impact of buildings, recognizing and caring for this impact is first necessary to making a more sustainable architecture. It behooves future architects to navigate the dangers inherent in the mindless use of machine and digital technologies as they continue to fuel the standing-reserve. Whether making a chair or managing the construction of an entire building, every material an architect specifies exacts a life from the world. It is imperative that materials—precious resources of the Earth—are valued and not wasted. Because of the power of machine technology, its effects can be far reaching. If the architect worships the machine above nature, the architect will unwittingly become a standing reserve—a mere machine operator.

Phenomenology

Perhaps it is a biological impetus that motivates us to work with our hands in an age that no longer requires us to do so, or it may be our desire for individual expression that draw us toward these means. Either way, there is a phenomenology behind the act of making: a visceral, emotional experience from direct bodily engagement. James Krenov, after decades of woodworking, writes about how "fine, unspoiled wood affects [him] emotionally... gives [him] a sense of richness"(13). When we work directly with a material, observe it over time, we are affected by its life. Beyond the refinement of technical skills, the act of making cultivates the human spirit.

S. Azby Brown describes how Japanese temple carpenters observe time: "Indeed, the most remarkable thing about [Master carpenter] Nishioka is his sense of time, time as measured in centuries and millennia" (33). In an age that celebrates speed, traditions of craft teach us to appreciate a different measure of time. In another passage, Brown elaborates on the carpenter's perspective of time by again quoting Nishioka:

> "If a carpenter dedicates himself spiritually to the construction of a temple, and that temple lasts a thousand years, then he will have a thousand-year interval between this life and the next... And when you think that a tree takes a thousand years to grow large enough to use for a temple column, and that temple may stand for a millennium or more, even a decade spent in its construction is infinitesimal." So, [Nishioka] believes, one should take as much time as necessary. One must

> concentrate completely all the while, and be in good spirits, because a craftsman's frame of mind permeates every aspect of his work, and the work will bear the imprint of its creator as long as it exists" (Brown, pp.35).

Time, as understood by the temple carpenter, alters our sense of mortality and makes possible an active participation in a much larger continuum. The physical act of making allows the temple carpenter to participate in the immensity of the world. Architecture, as a result, persists as a testament of the human spirit.

Similar to the East, the significance of direct bodily engagement in the cultivation of one's Being is also recognized in Western thought. Mid-century French philosopher Maurice Merleau-Ponty argues that everyone is united with the immensity of the world through the body: the flesh is the medium between the mind and the outside world. In his essay, *The Intertwining - The Chiasm*, he states, "The thickness of the body, far from rivalling that of the world, is on the contrary the sole means I have to go unto the heart of things, by making myself a world and by making them flesh" (397). The *flesh* of our body enables us to understand the *flesh* of the world's body—the cosmic body—through direct experience. Cerebral understanding, Merleau-Ponty argues, comes from direct experience and is refined by it, thereby changing our ensuing actions. Through the making process, we learn about materials by embodying them and developing a symbiotic relationship with them. We develop an intimacy with material when the *flesh* of our body is joined with the "*flesh* of things" (Merleau-

Ponty 395).

Michel Serres, a philosopher, professor, and one of modern France's most gifted and original thinkers, discusses the primacy of the body when cultivating knowledge. He writes, "The origin of knowledge resides in the body, not only intersubjective but also objective knowledge. We don't know anyone or anything until the body takes on its form, its appearance, its movement, its habitus, until the body joins in a dance with its demeanor"(71). Serres argues that all knowledge is first felt through the body; that the body is our memory, a vehicle for understanding the world, and our most primal means of engaging the world.

Architecture is experienced through the body, and is physical and sensual as much as it is cerebral or aesthetic. With the onslaught of virtual spaces and ocular-centric trends in architecture, we must call upon our bodily experiences with the world; meditate on these experiences, and refine the senses so that we can create well-informed architecture. Above all, the timeless task of architecture, as Pallasmaa describes,

> [...] is to create embodied and lived existential metaphors that concretise and structure our being in the world. Architecture reflects, materialises and eternalises ideas and images of ideal life. Buildings and towns enable us to structure, understand and remember who we are. Architecture enables us to perceive and understand the dialectics of permanence and change, to settle ourselves in the world, and to place our ourselves in the continuum of culture and time" (71).

Through making, the student of architecture learns about material and construction firsthand, via a sensual, spiritual, and intellectual process. Far from being mindless, the embodied making process teaches the student humility, patience, and most importantly, to care for their work. As prospective architects, it is important for students to forge a sacred relationship to their work, to embody the life forces they will inevitably affect, and hopefully, impart this knowledge through the buildings they design.

The making of a material thing is an act of love. Alberto Pérez-Gómez writes, "As humans, our greatest gift is love"(3). Above all, there is great pleasure in working material and giving life to something that previously did not exist. We are embodied in the material things that we make, and these things will be our legacy. Making cultivates our sense of Being *in* this world and is grounded by the materials *of* this world. Nakashima writes,

> Craftsmanship is a silent skill. [...] We meditate with a [wood] board sometimes for years. We search for the essence, to share its joys and tragedies. A thousand experiences and skills spring into action. We are making something! (121).

The act of making materializes the spirit; reveals the life latent in materials and the life within us. Making, is growing.

Figure 015　Clear-Glazed Earthenware Teapot

Figure 016　Clear and White-Glazed Earthenware Vase

Figure 017 Clear-Glazed Earthenware Teacups

Figure 018 Tea-Stained Teacup

Figure 019　Paper Lantern

2 Making

White Pine Table

... the proportion of the whole construction arises our of all of the parts. Whence something very absurd follows, that things which are not beautiful in their own nature give birth to beauty...

Alberto Pérez-Gómez (77)

Figure 022

Figure 023

Figure 024

Figure 025

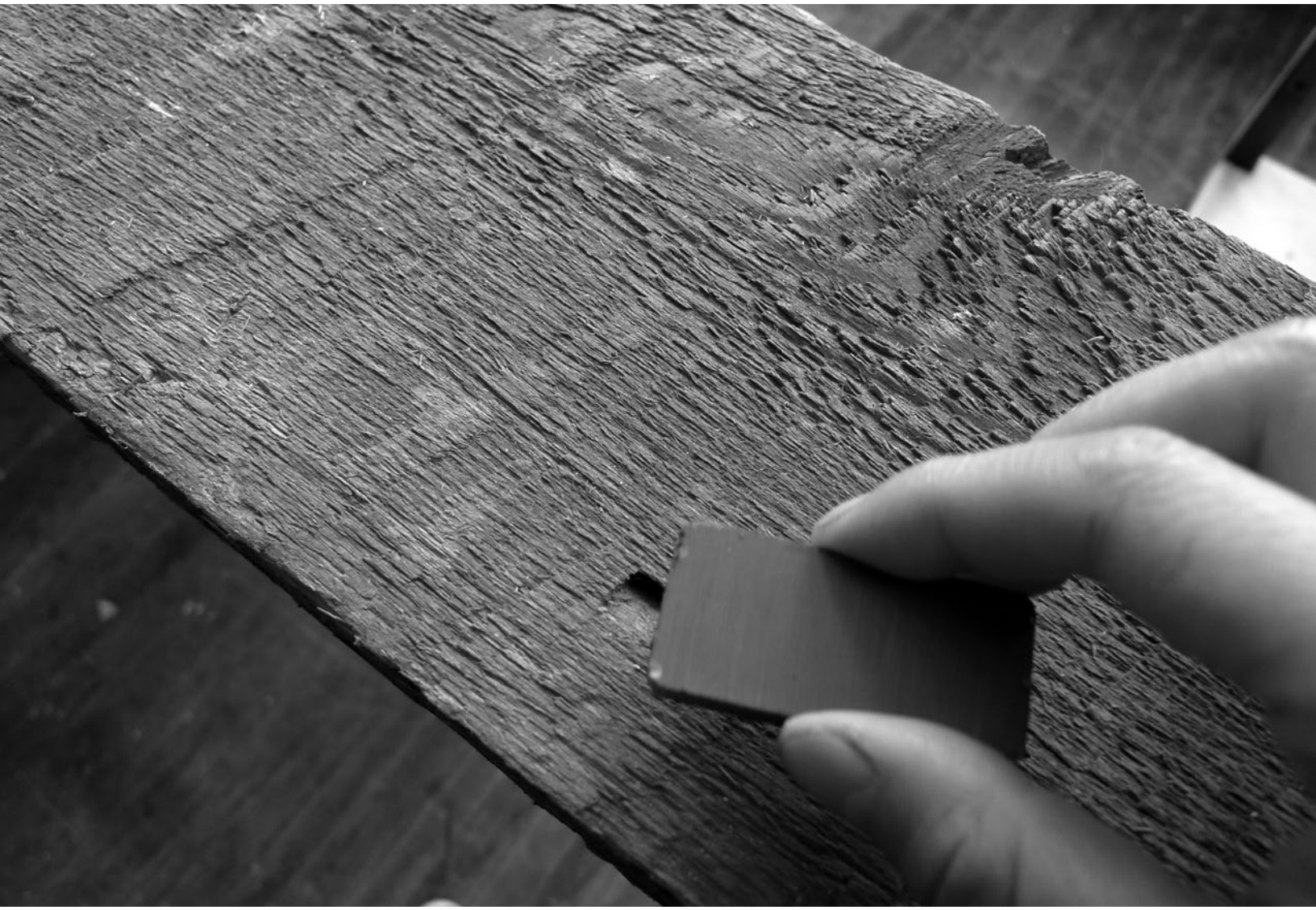

Figure 026 Searching for Concealed Nails

Figure 027 Scrub Plane

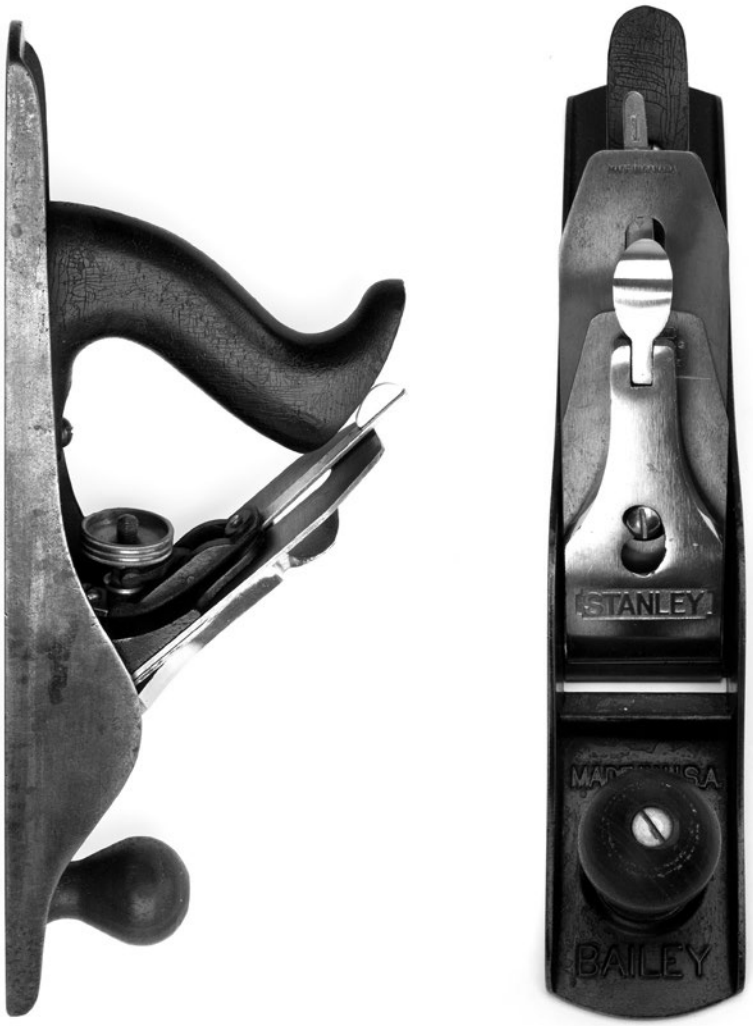

Figure 028　Jack Plane

Figure 029　Japanese Smooth Plane

Figure 030 Various Plane Blades

The blade is the heart of any plane. An exotic, expensive hardwood, or marvelously machined bronze and iron may hold it in place, but it is the blade that does the work. If the blade is not up to the job, the plane becomes more of a curious decoration than a valued tool.

Scott Wynn, author of *Woodworker's Guide to Handplanes* (3)

Figure 031

Figure 032

Figure 033

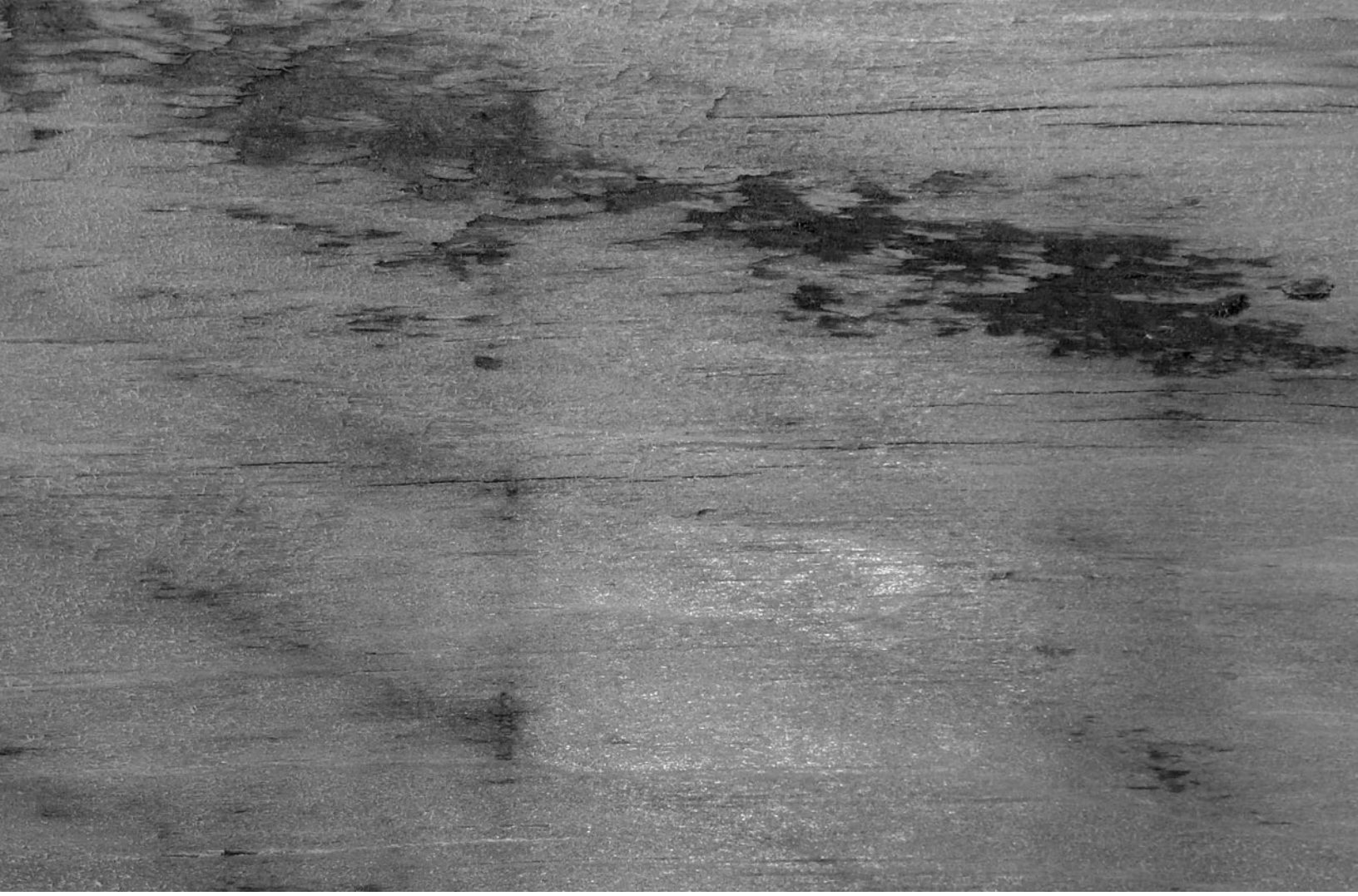

Figure 034

Figure 035

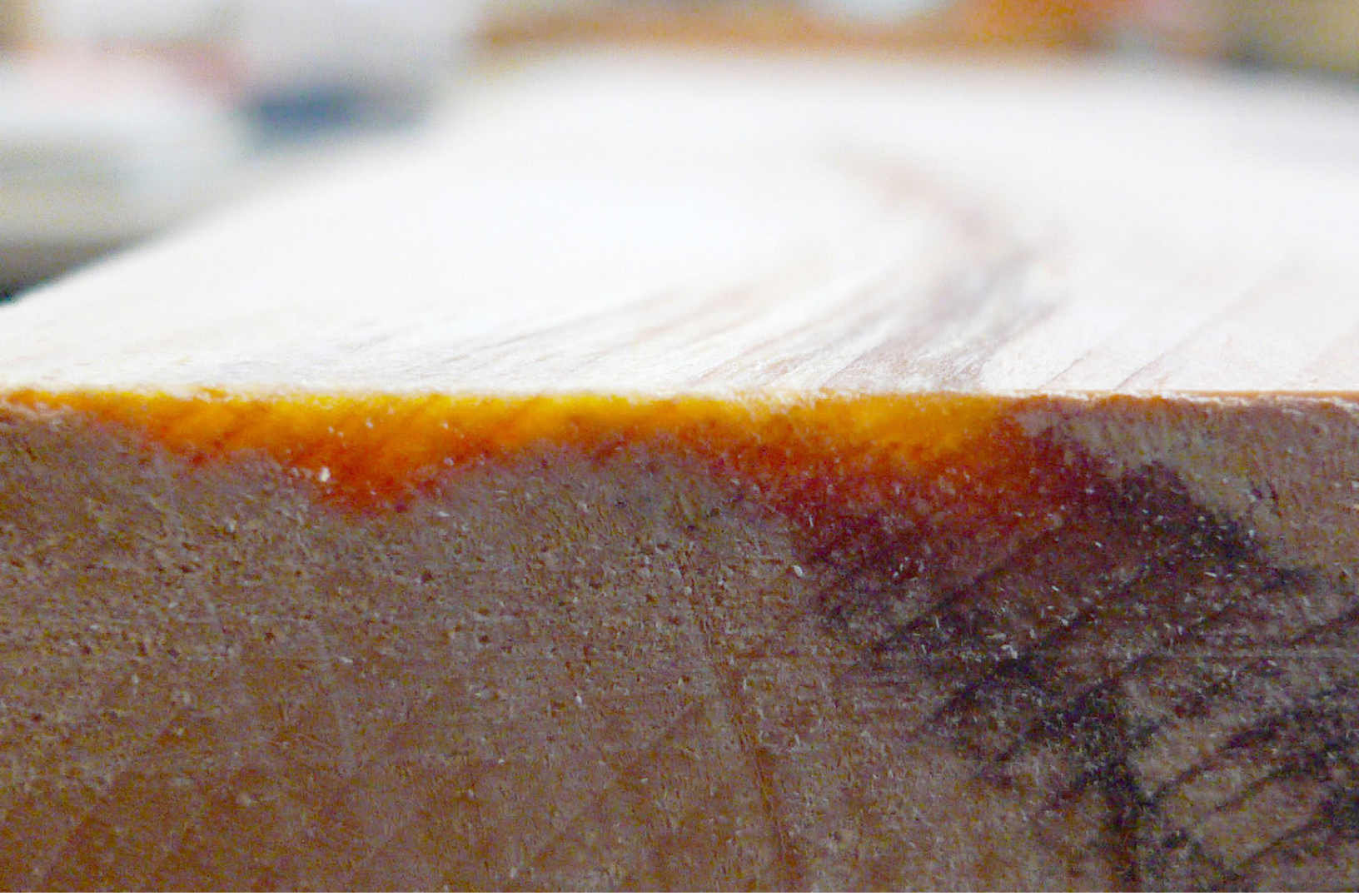

Figure 036

Figure 037

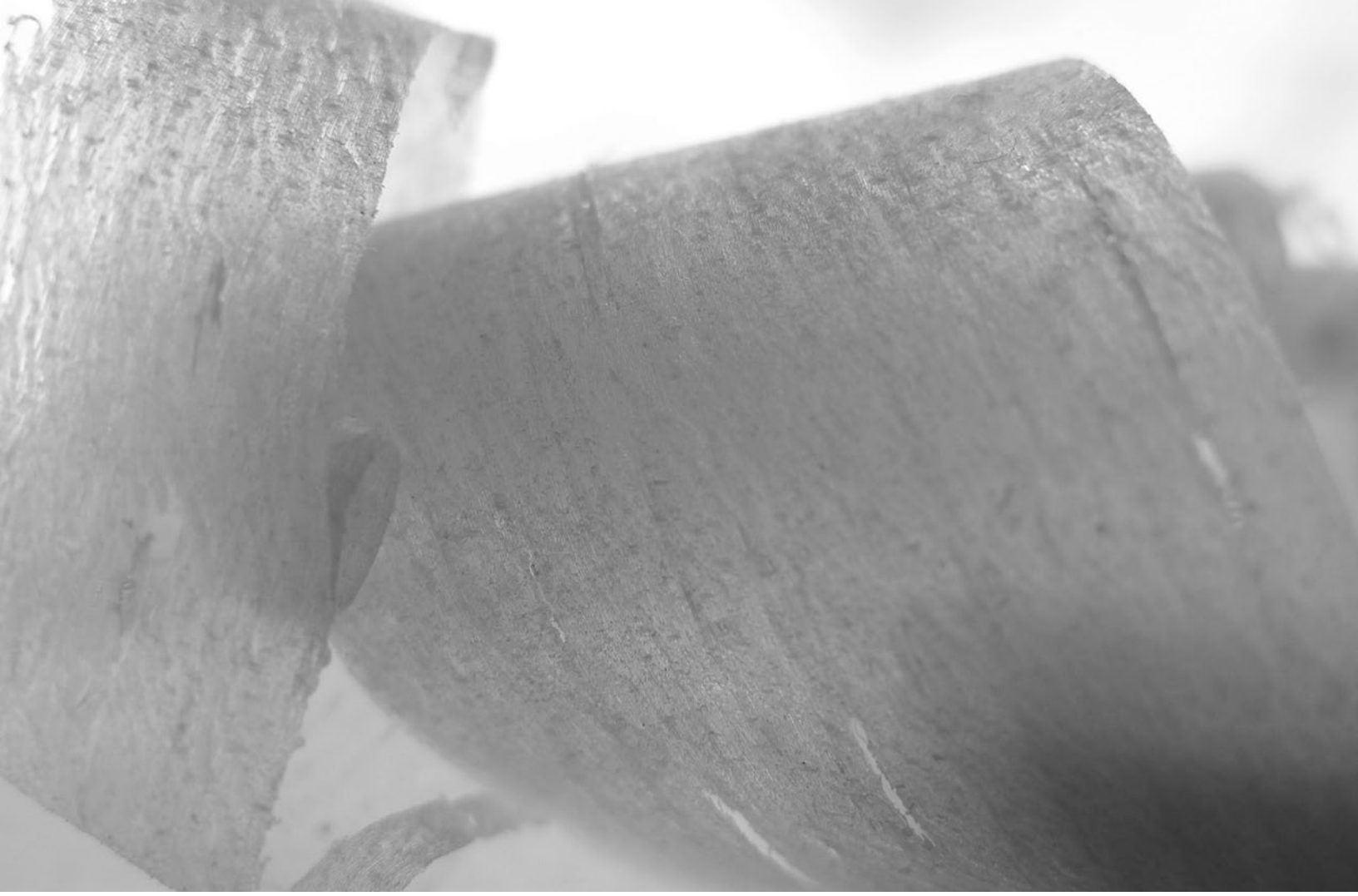

Figure 038

Figure 039　Ryoba Saw

Figure 040　Dozukime Saw

Figure 041

Figure 042

Figure 043 Marking Gauge

Figure 044 Plough Plane

Figure 045

Figure 046

Figure 047

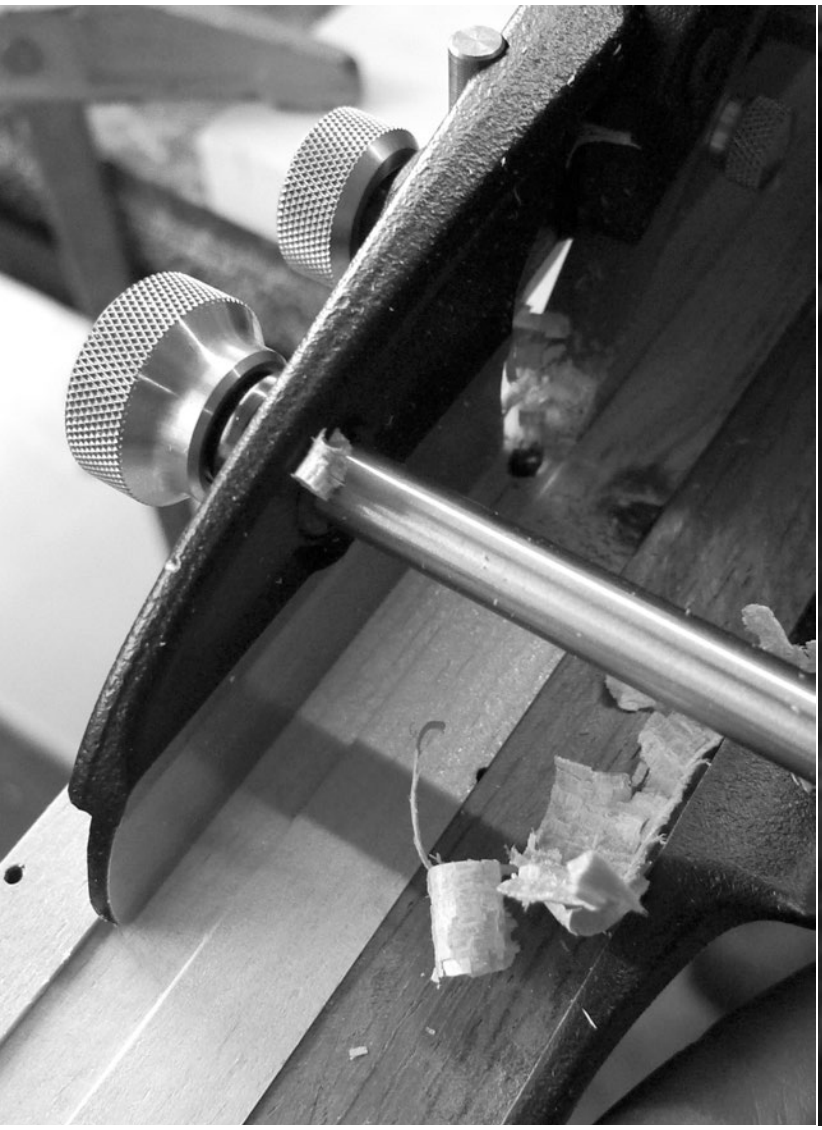

Figure 048

Figure 049

Figure 050

Figure 051

Figure 052

Figure 053 Japanese Carpenter's Square, Engineer's Square

Figure 054 Butt Chisels

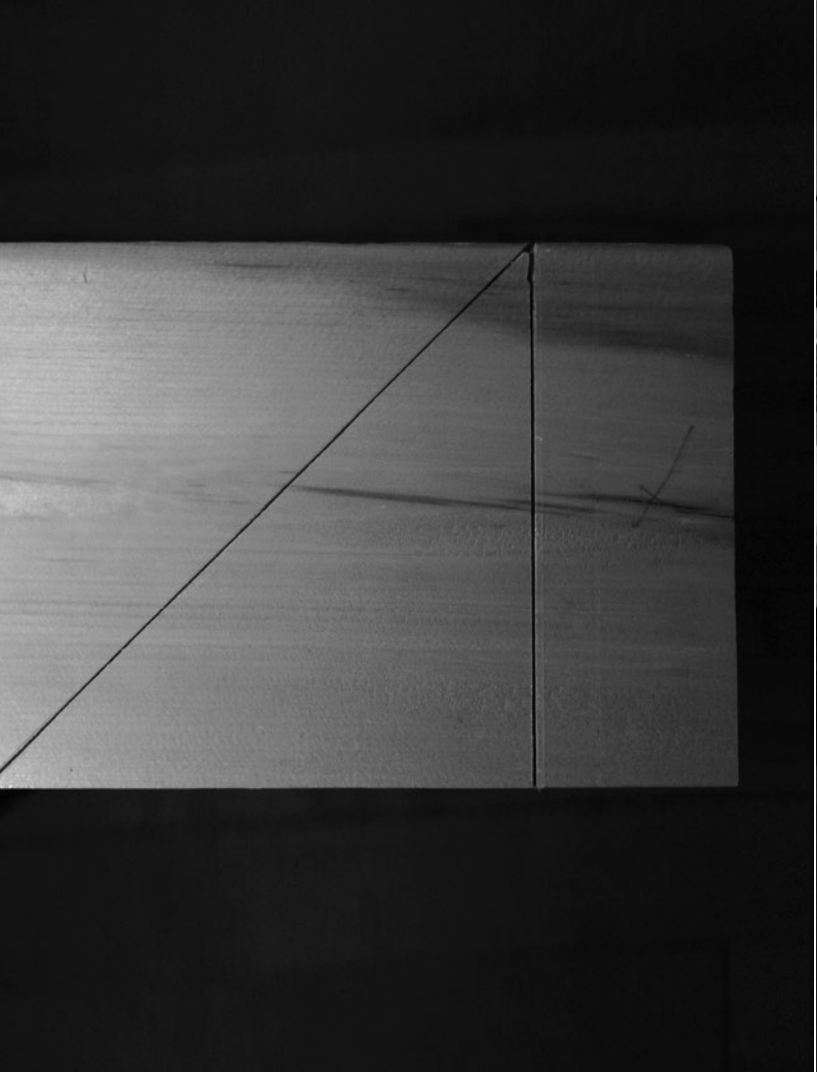

Figure 055

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Figure 058

Figure 059

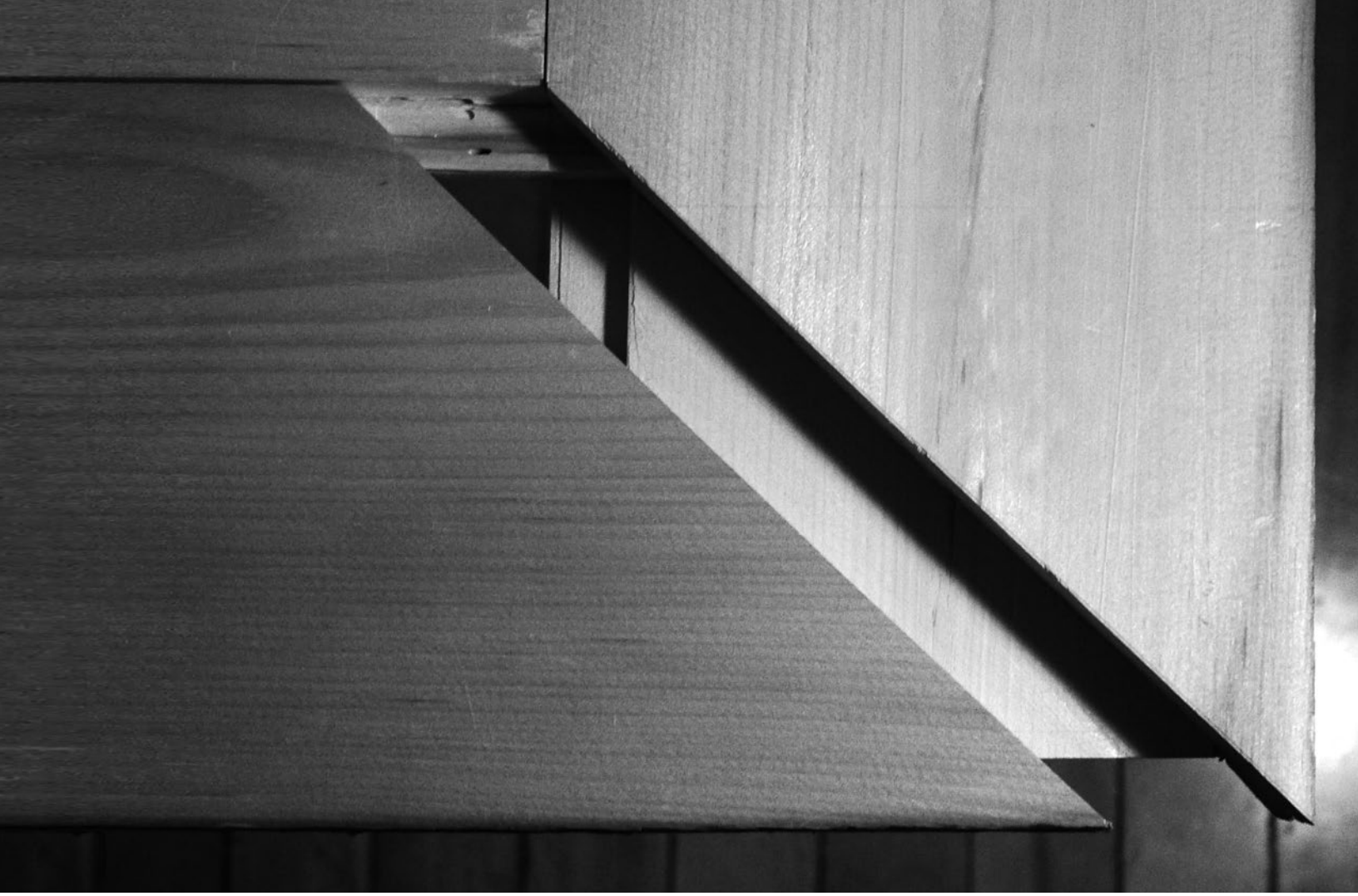

Figure 060

Figure 061

Figure 062

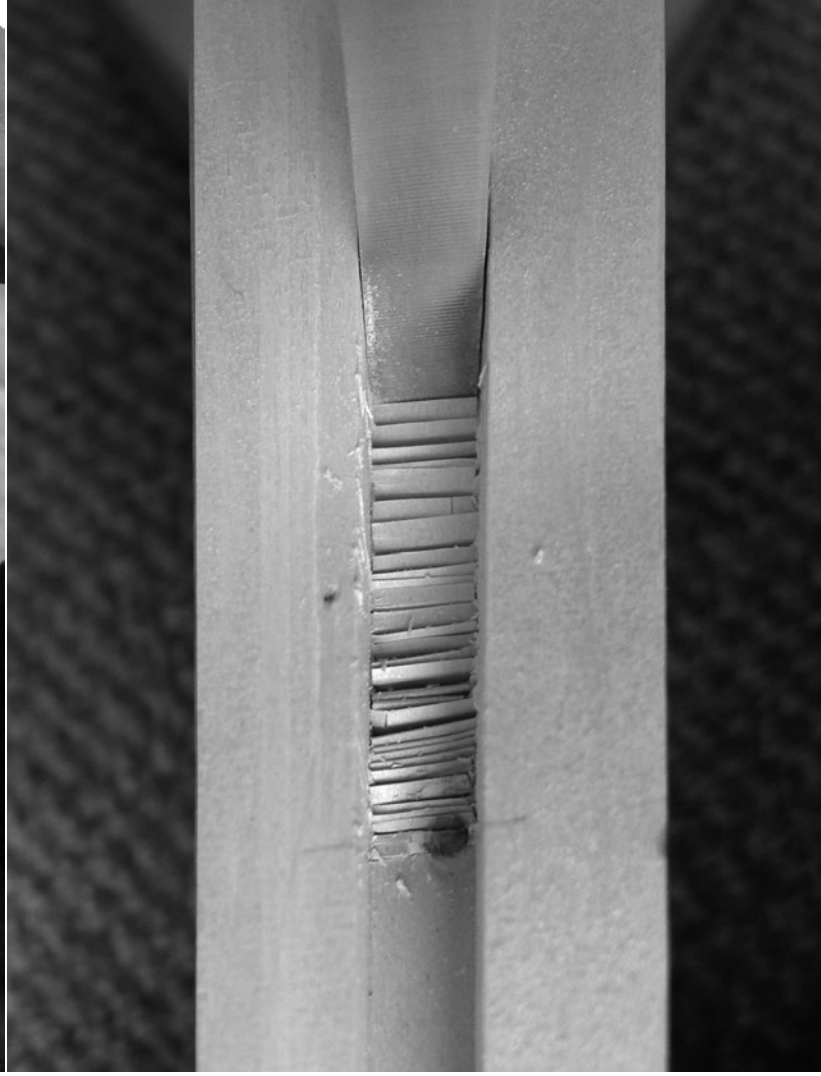

Figure 063

Figure 064

Figure 065

Figure 066

Figure 067

Figure 068 Sliding Bevel

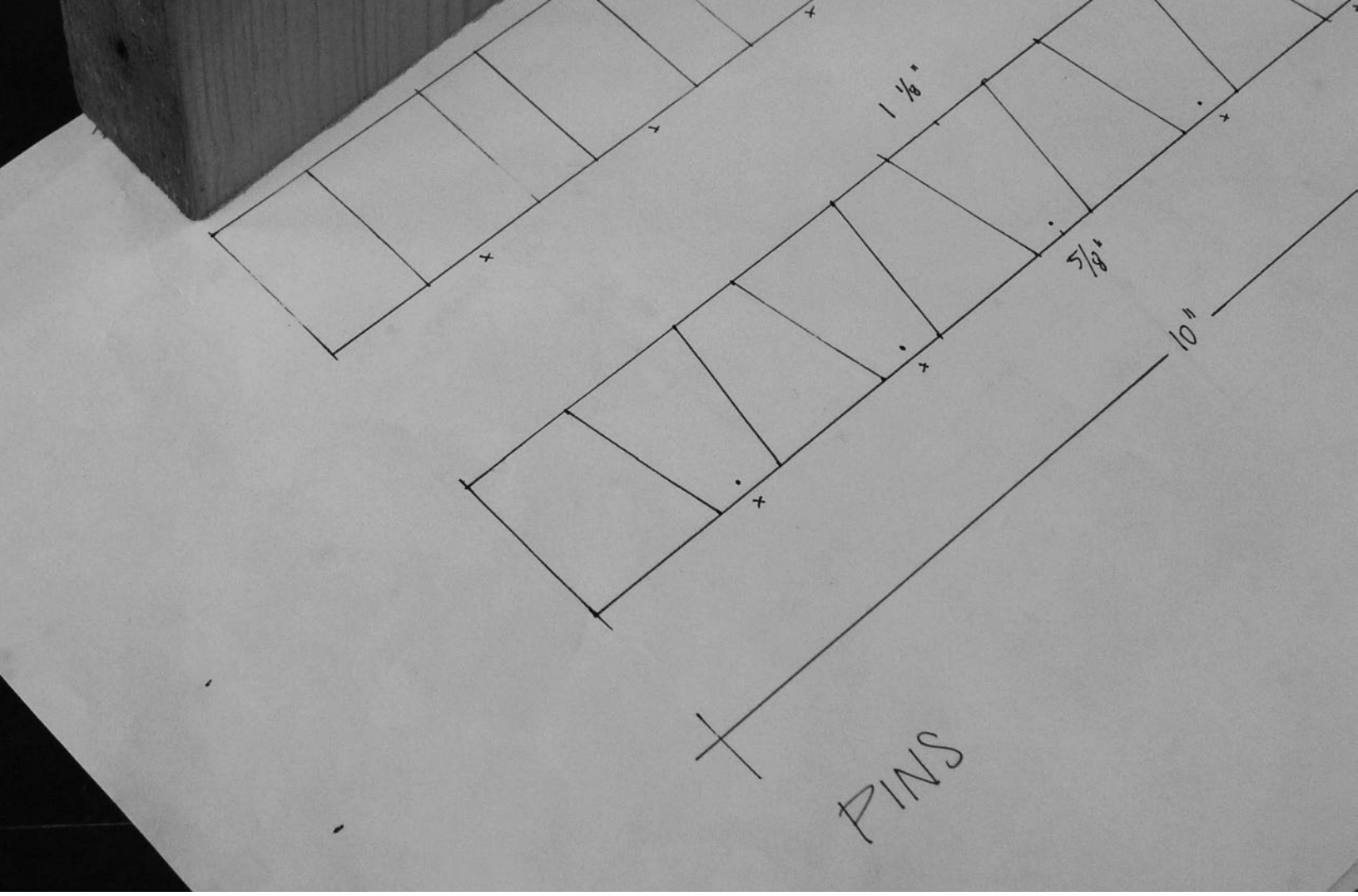

Figure 069 Laying out a Dovetail Joint

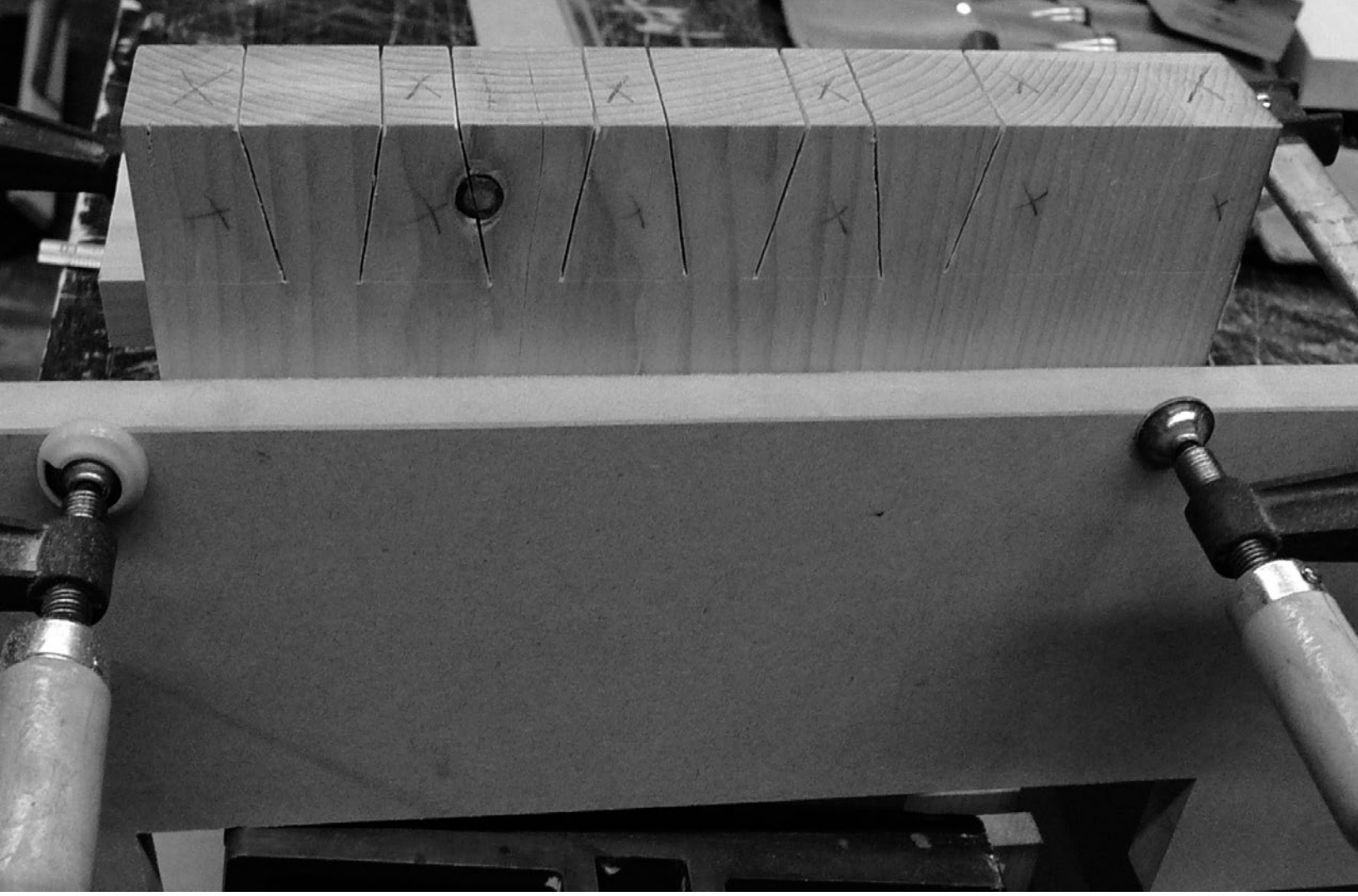

Figure 070 Sawcuts: the “X” always marks the waste side

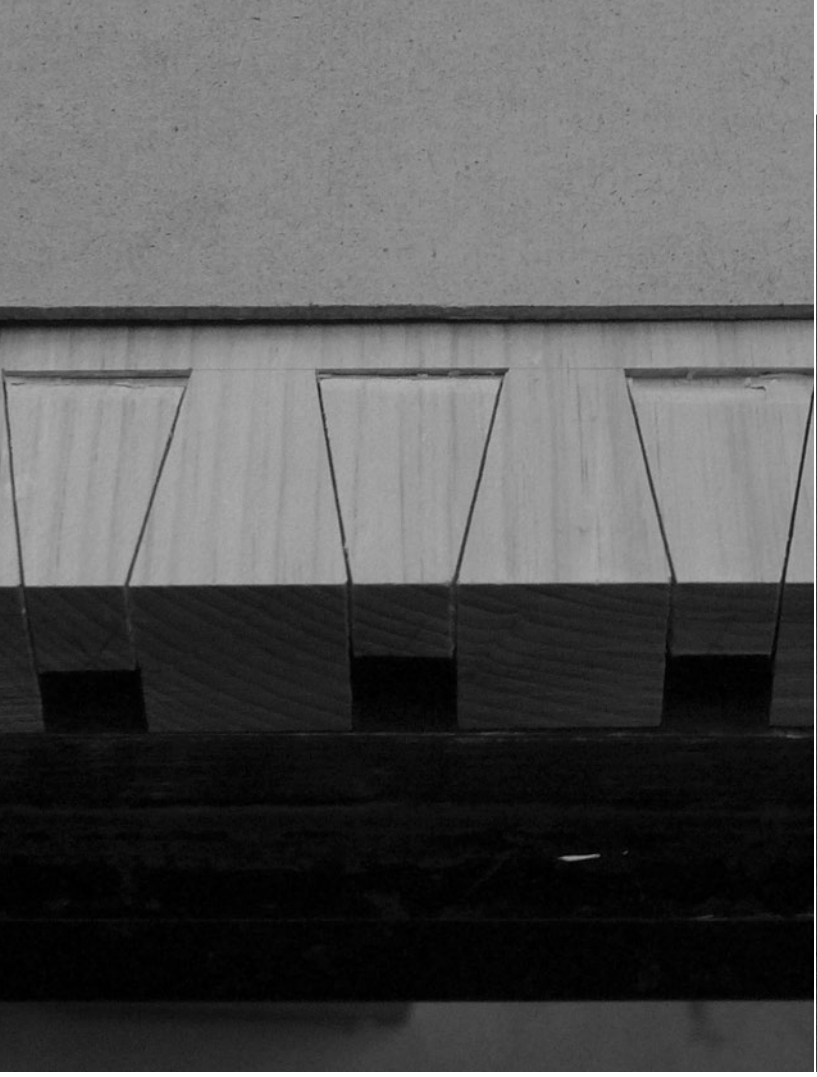

Figure 071

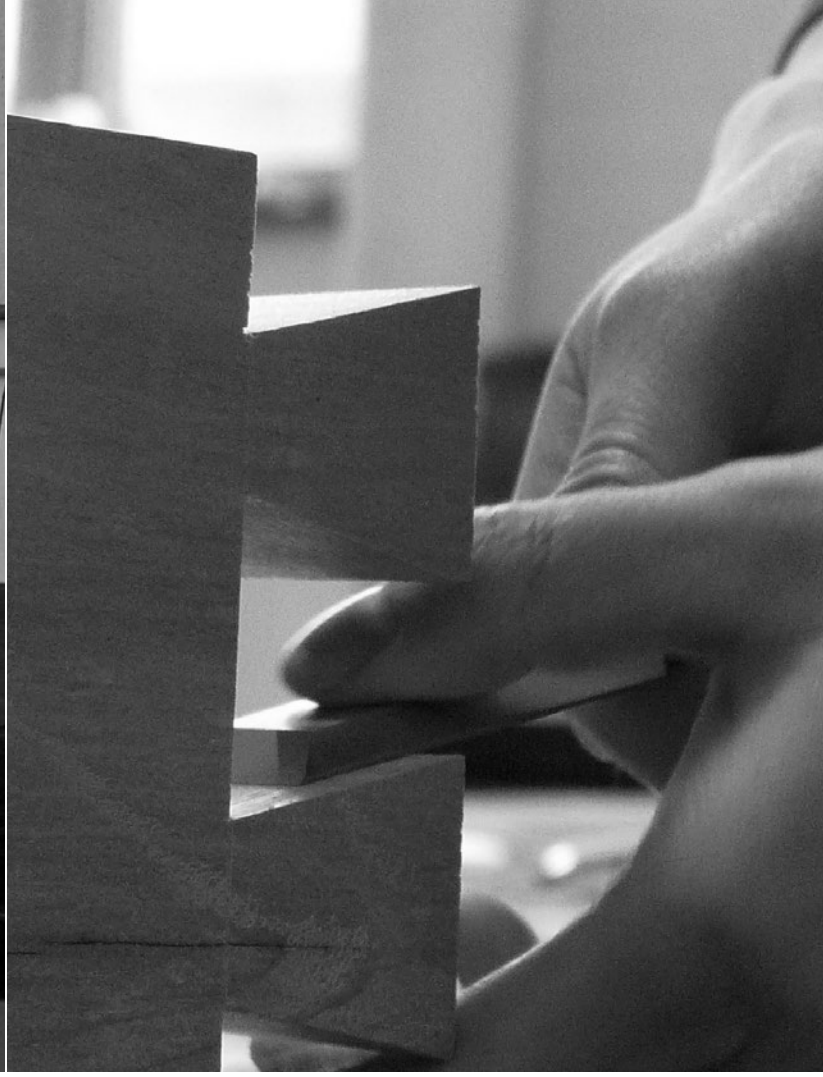

Figure 072

Figure 073

Figure 074

Figure 075

Figure 076

Figure 077

Figure 078

Figure 079

Figure 080

When we build, let us think that we build forever. Let it not be for present delight nor for present use alone. Let it be such work as our descendents will thank us for; and let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them, and that men will say, as they look upon the labour and wrought substance of them, "See, this is father did for us."

John Ruskin (339)

Figure 081

Seagrass Chairs

Figure 082　Flush-cut Saw, Keyhole Saw

Figure 083　Stab Carving Knife, Convex Carving Knife

Figure 084　Skew Carving Knife, Curve Carving Knife

[Tools and skills], in the dawn of the world were a man's first, best friends. They remain his best friends still in a world grown old and infinitely complex. By means of them he can unlock the doors to a life of creative activity that is full of interest. Without them, he is a mere shadow of the man he might be.

Charles H. Hayward, quoted by Christopher Schwarz (12)

Figure 085 Drawknife

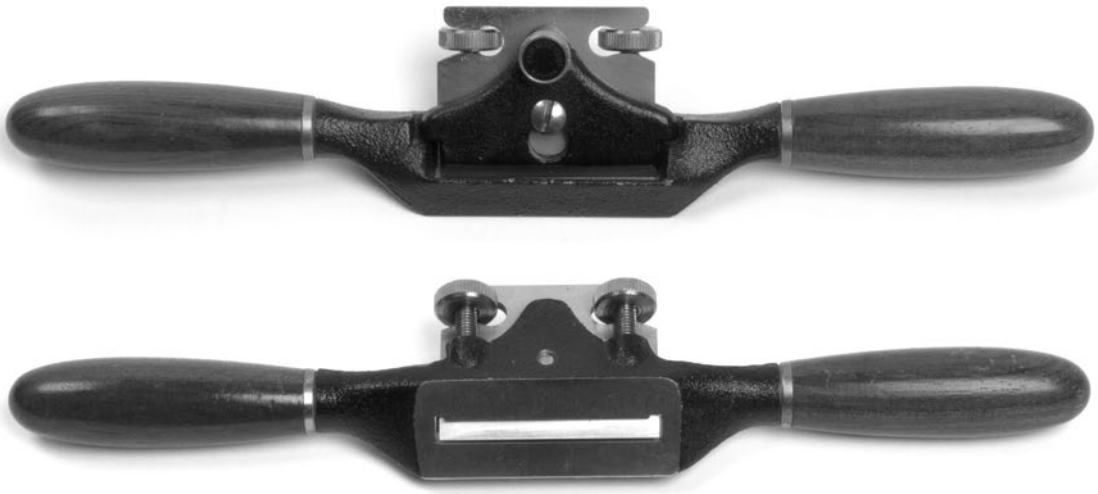

Figure 086 Flat Spokeshave

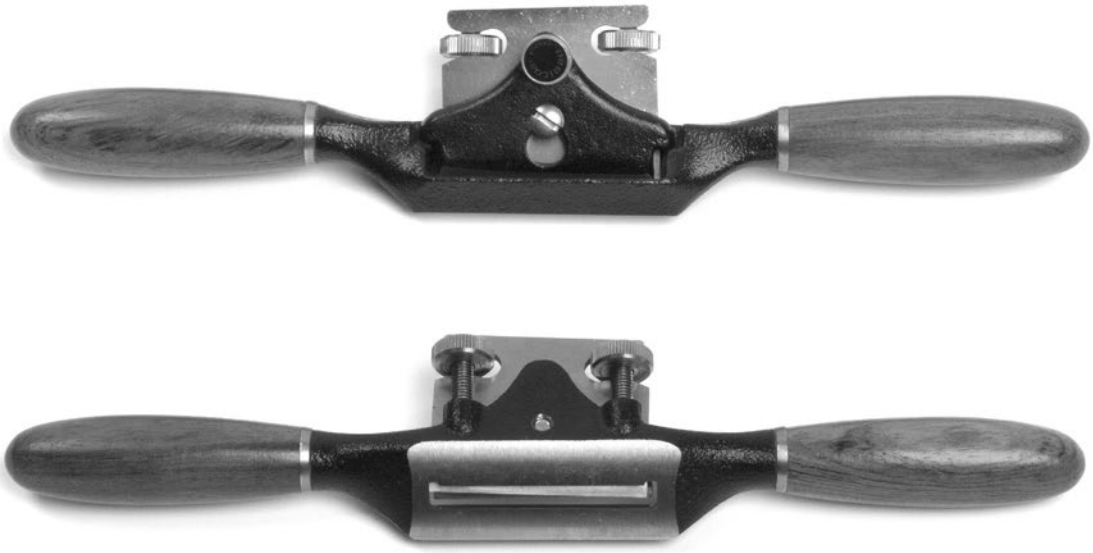

Figure 087 Round Spokeshave

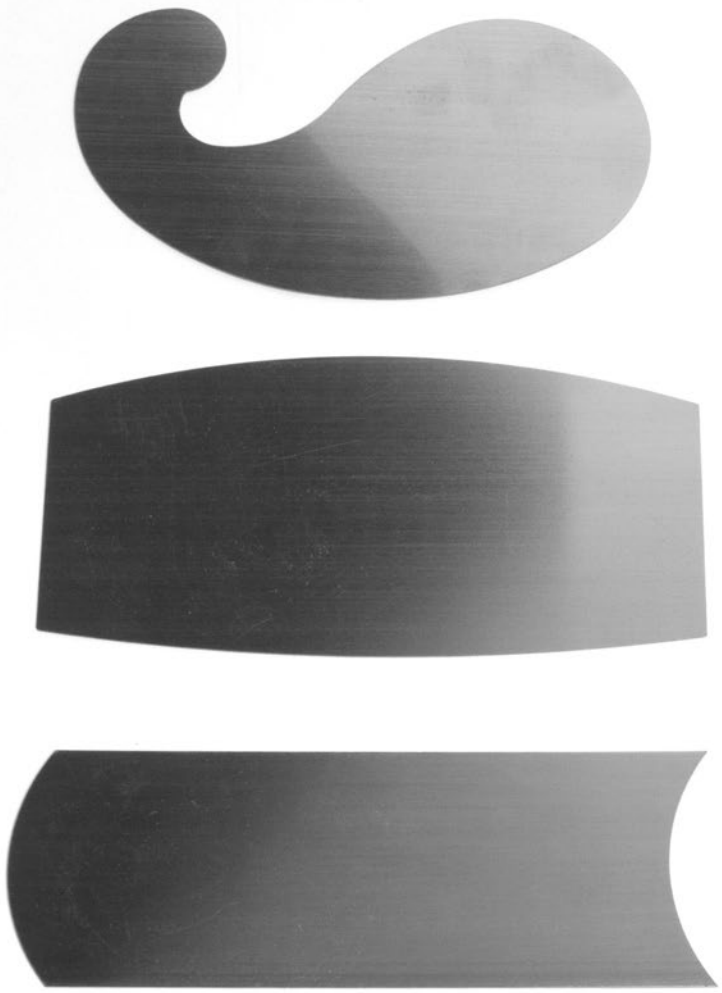

Figure 088 Card Scrapers

Chair One

Here the carpenter must examine such characteristics as wood grain and knots, and try to predict how the wood will change. He must visualize the finished components that lie dormant within the rough lumber, and do so in such a way as to take full advantage of each log's idiosyncracies. Many carpenters consider this to be the single most important stage of their work; the skills it requires are not physical, but mental: imagination, visualization, an intuitive grasp of the wood's personality.

S. Azby Brown (61)

Figure 089

Figure 090

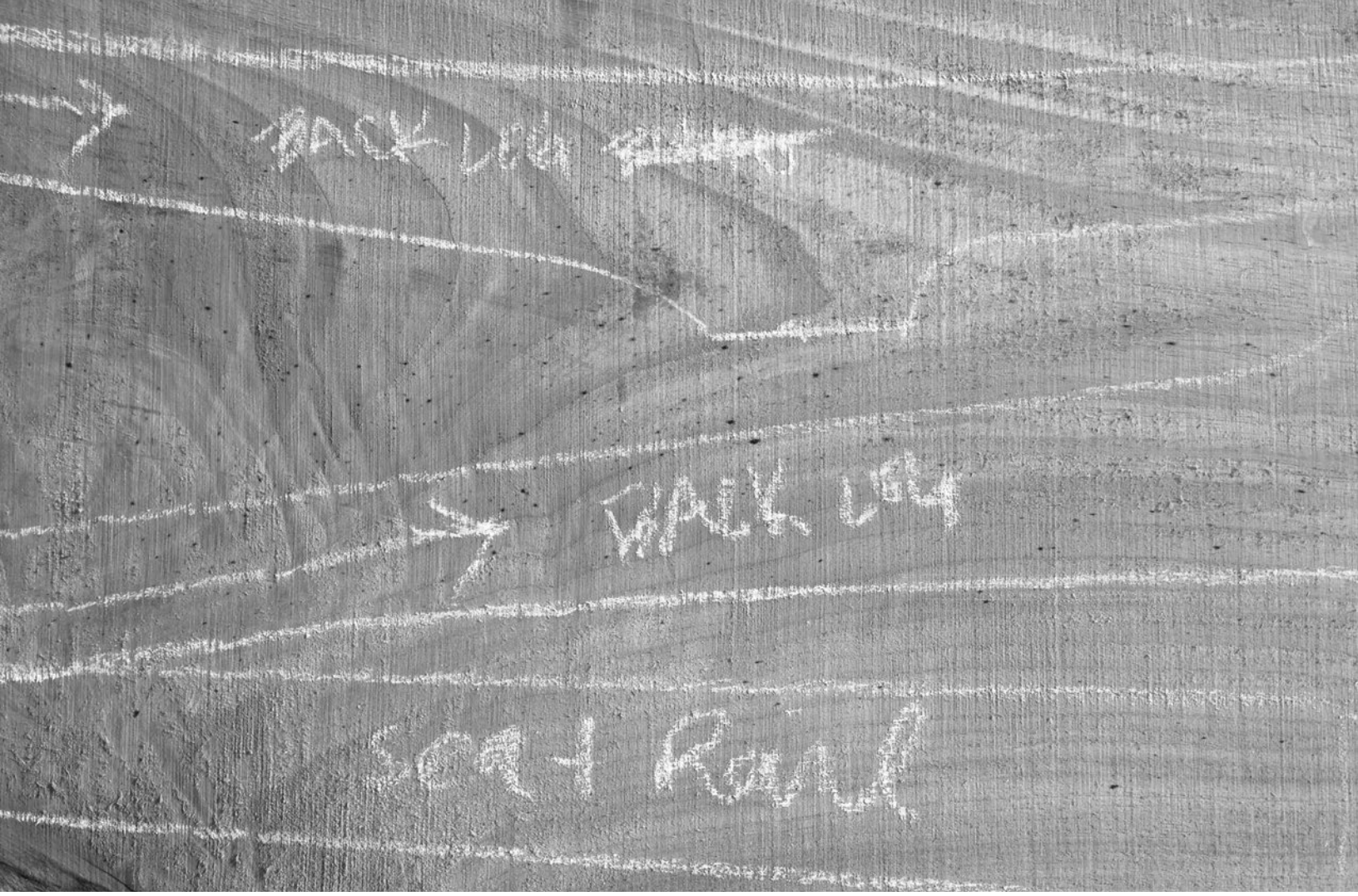

Figure 091

Figure 092

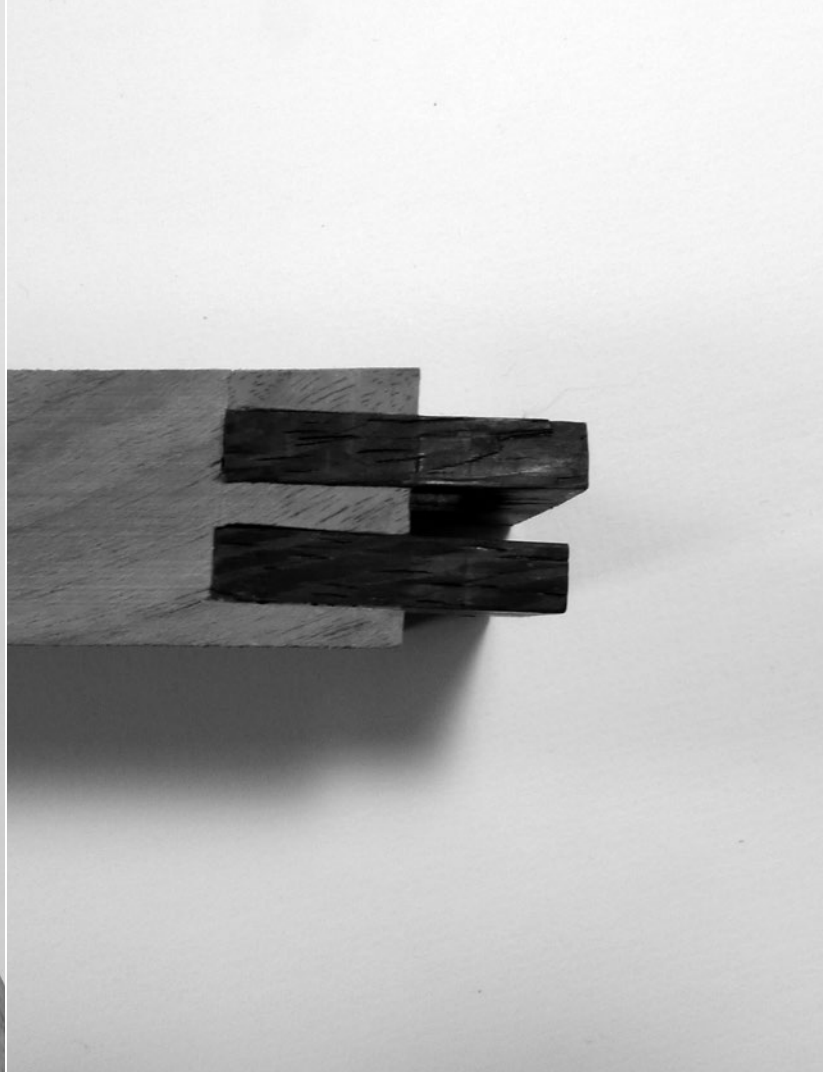

Figure 093

Figure 094

Figure 095

Figure 096

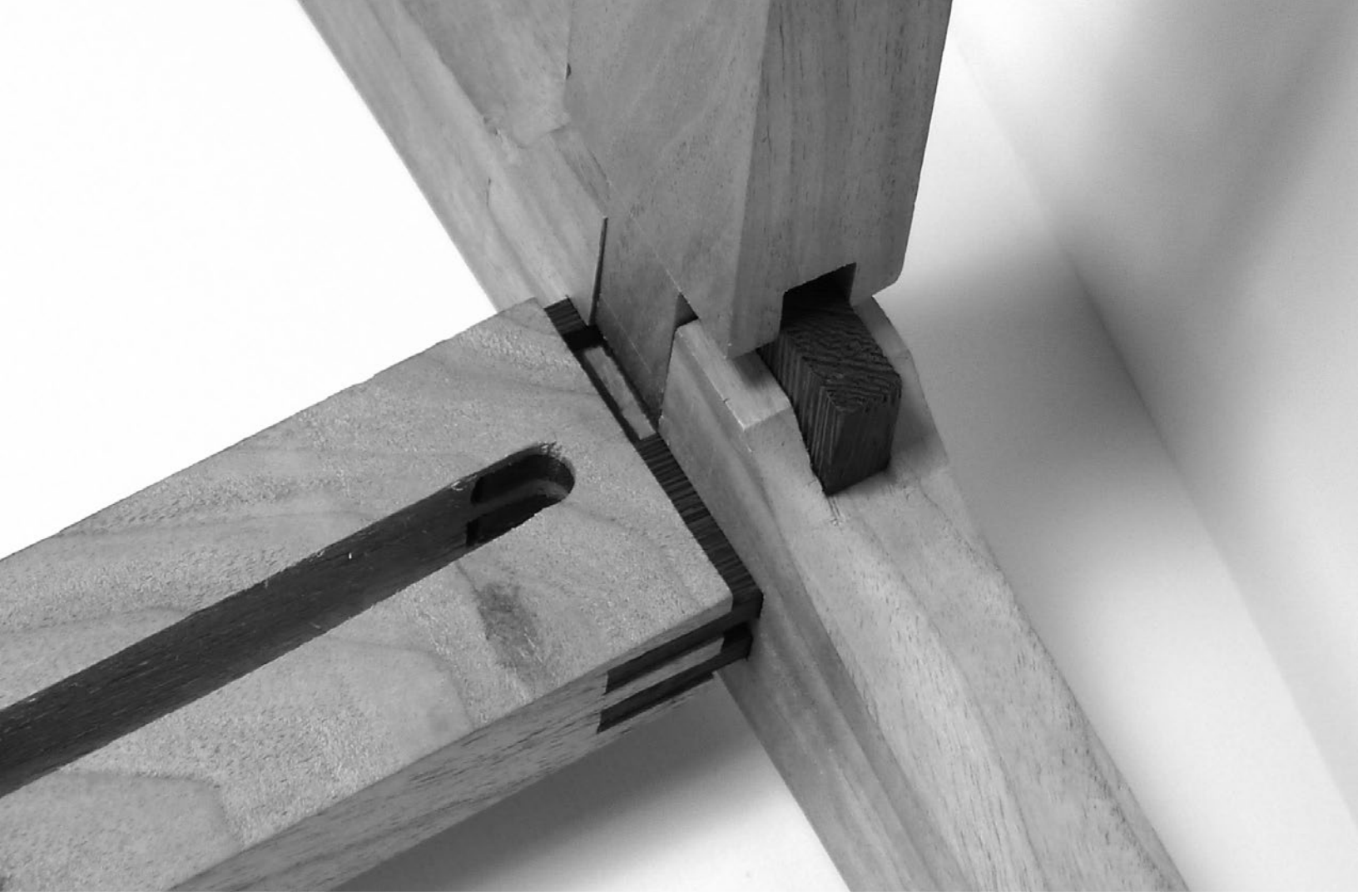

Figure 097

Figure 098

Figure 099

Figure 100

Figure 101

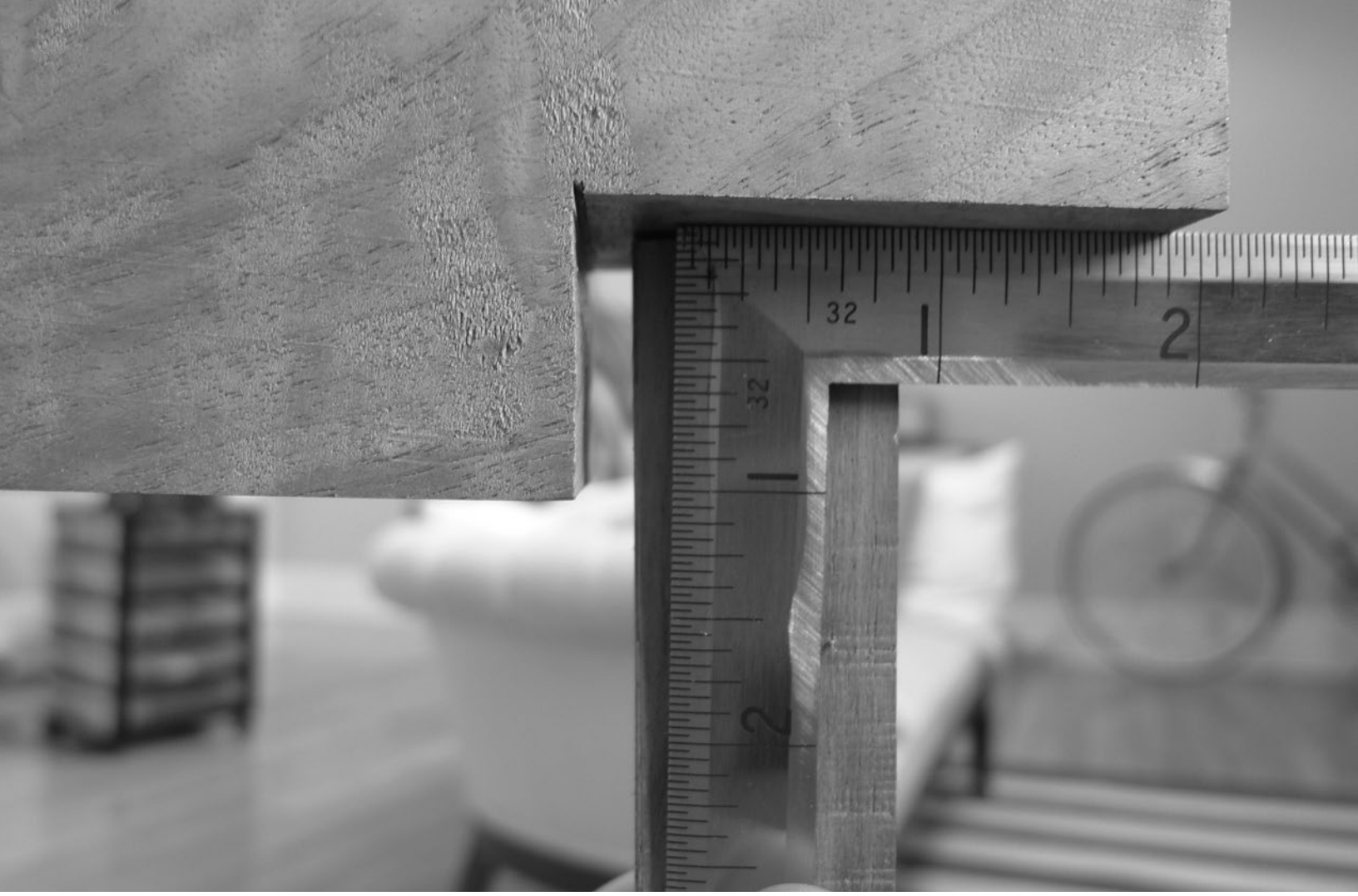

Figure 102

Figure 103

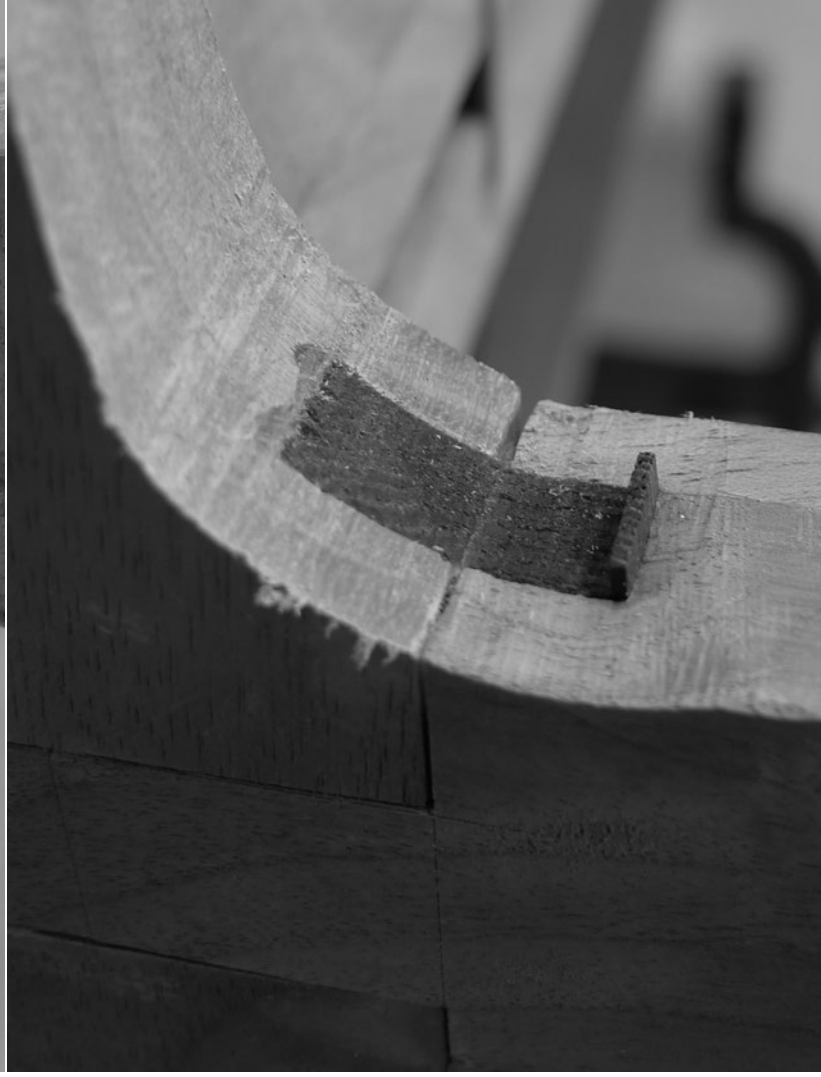

Figure 104

Japanese carpentry, as so many of the crafts of Japan, did not spring fully developed from the mind of some genius. Rather, Japanese carpentry and architecture are the products of 1500 years (in Japan alone, not to mention China, their origin) of cumulative knowledge, collected and passed on from teacher to disciple... Fifteen years is considered necessary for becoming a temple carpenter [working 70-80 hours per week], the equivalent of 30 years at 40 hours a week.

Len Brackett, Foreward to *The Complete Japanese Joinery* (viii)

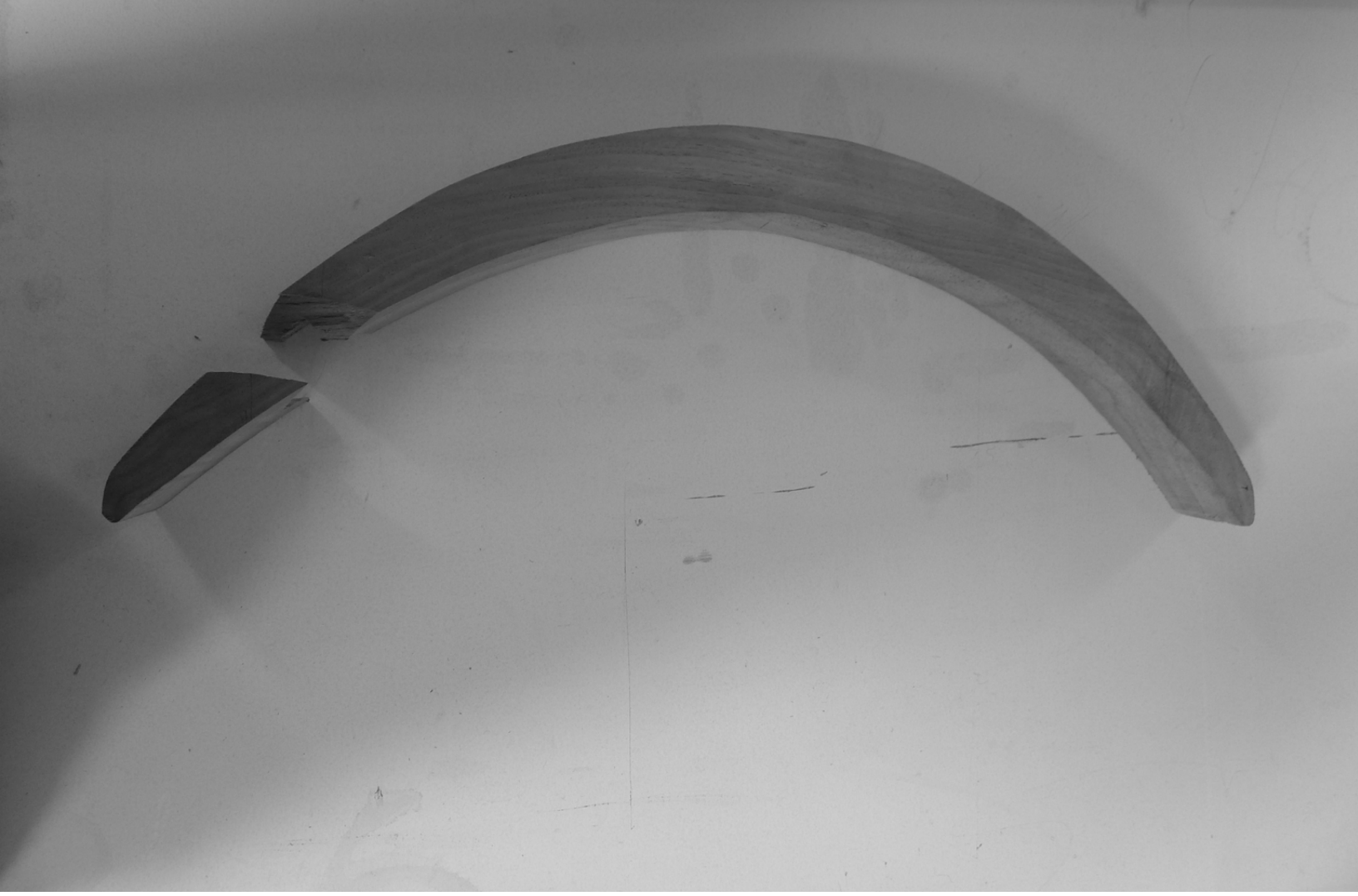

Figure 105

Figure 106

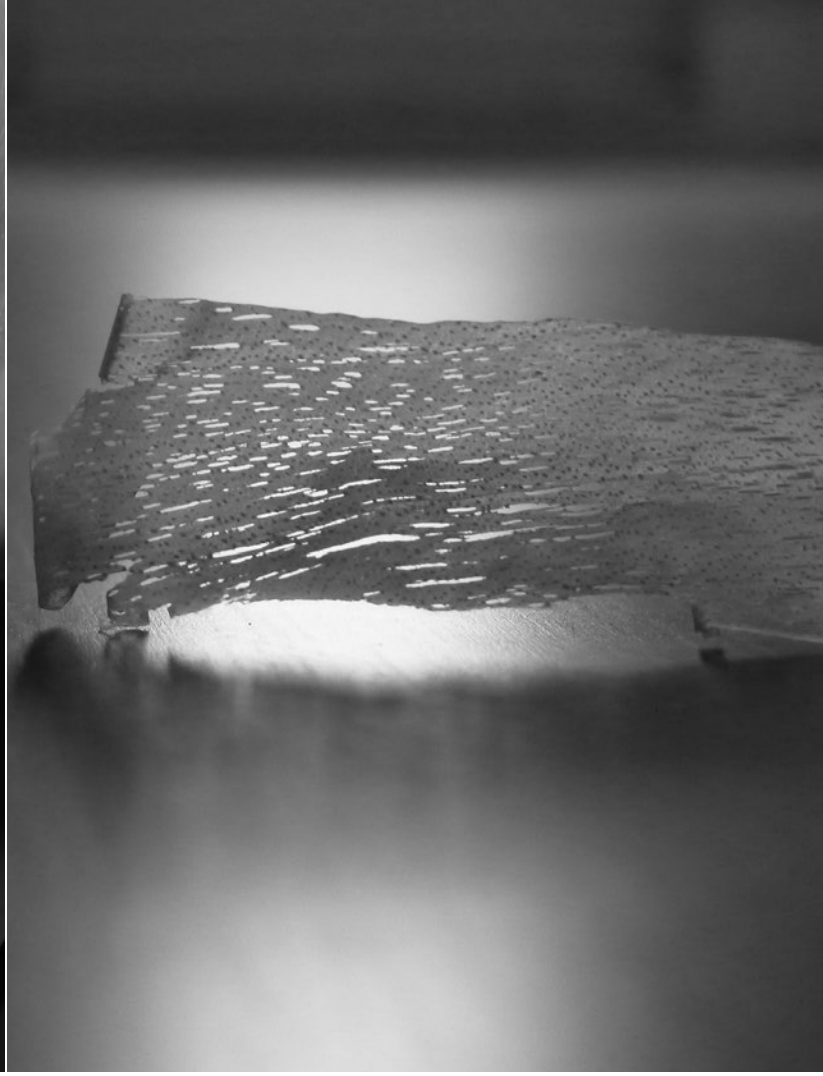

Figure 107

Figure 108

Figure 109

The tree's fate rests with the woodworker. In hundreds of years its lively juices have nurtured its unique substance. A graining, a subtle coloring, and aura, a presence will exist this once, never to reappear. It is to catch this moment, to identify with this presence, to find this fleeting relationship, to capture its spirit, which challenges the woodworker.

George Nakashima (113)

Figure 110

Figure 111

Figure 112

Figure 113

Figure 114

Figure 115

Figure 116

Figure 117

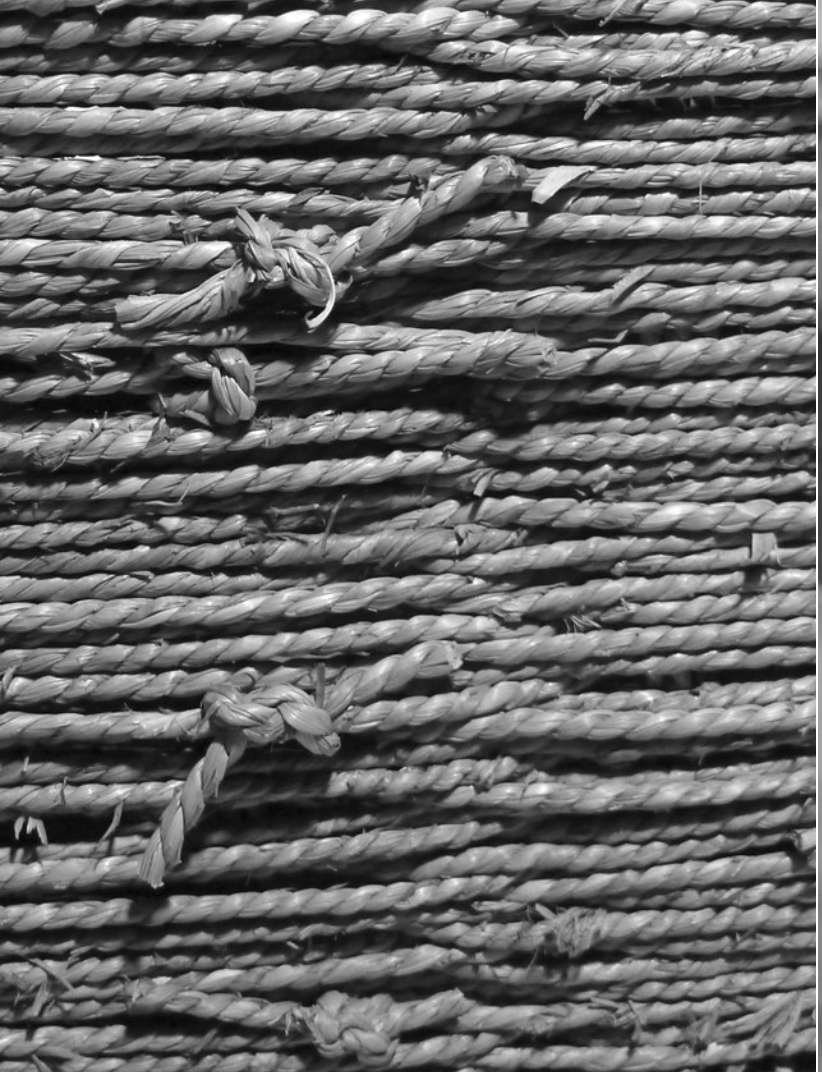

Figure 118

Figure 119

Figure 120

Figure 121

Figure 122

Chair Two, Three, Four

To make a box is an act of creation, for one is producing an object that never existed before. One is also making something that is useful. A box leads to a chair, a chair to a house, a house to a shrine. To create a cathedral one must only search for the divine truth, to look for the hand of the charioteer in the Battle of Kurukshetra to point the way.

George Nakashima (116)

Figure 123

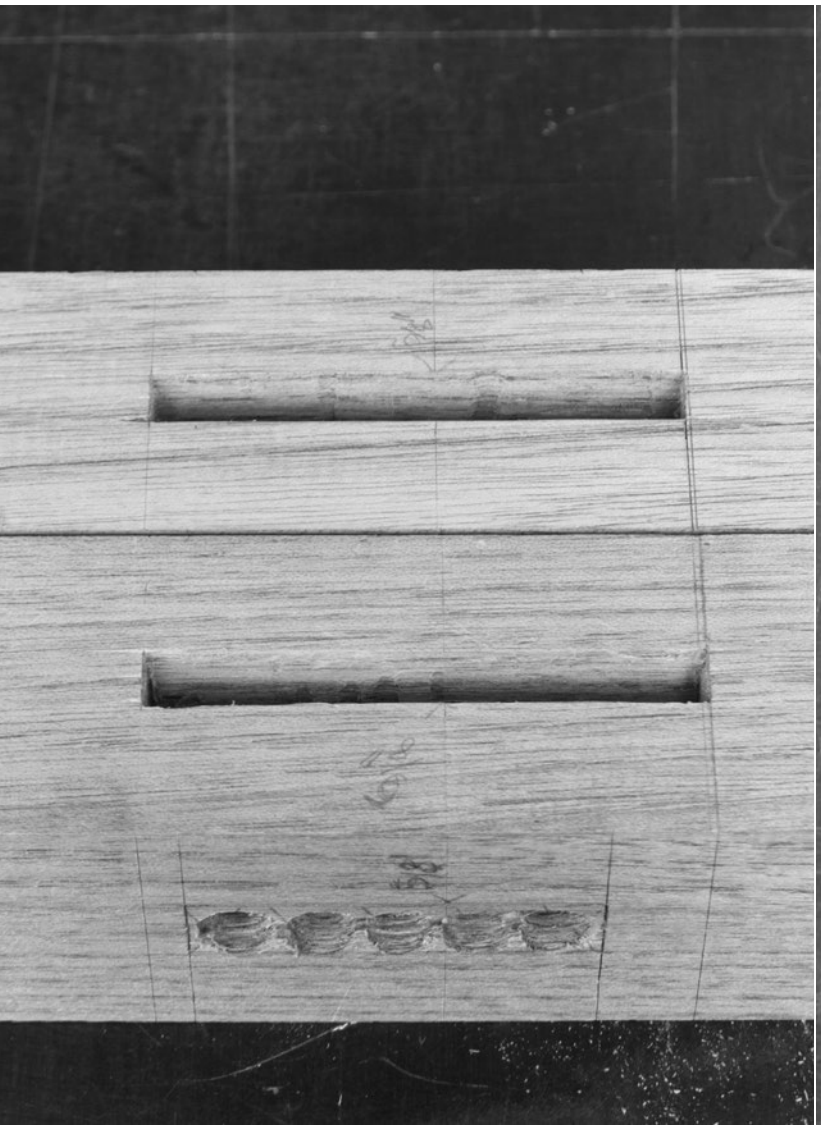

Figure 124

Figure 125

Figure 126

Figure 127

Figure 128

Figure 129

Figure 130

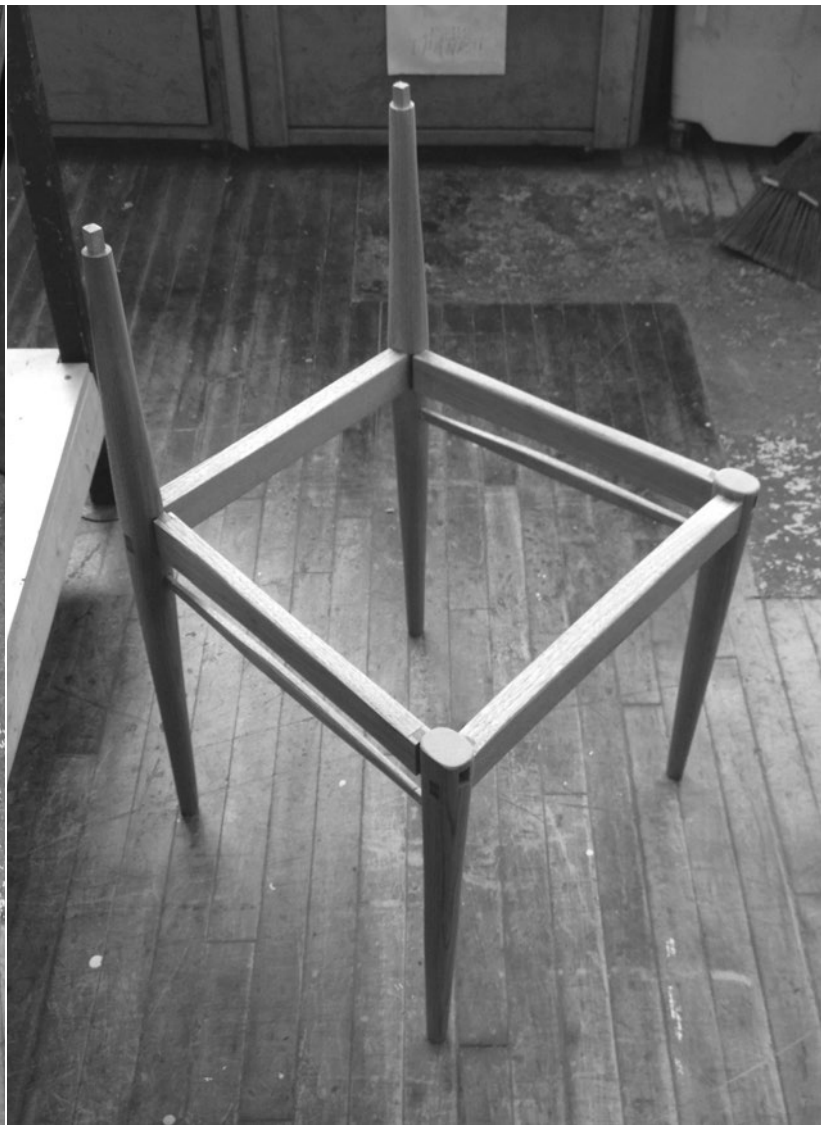

Figure 131

Figure 132

Figure 133

Figure 134

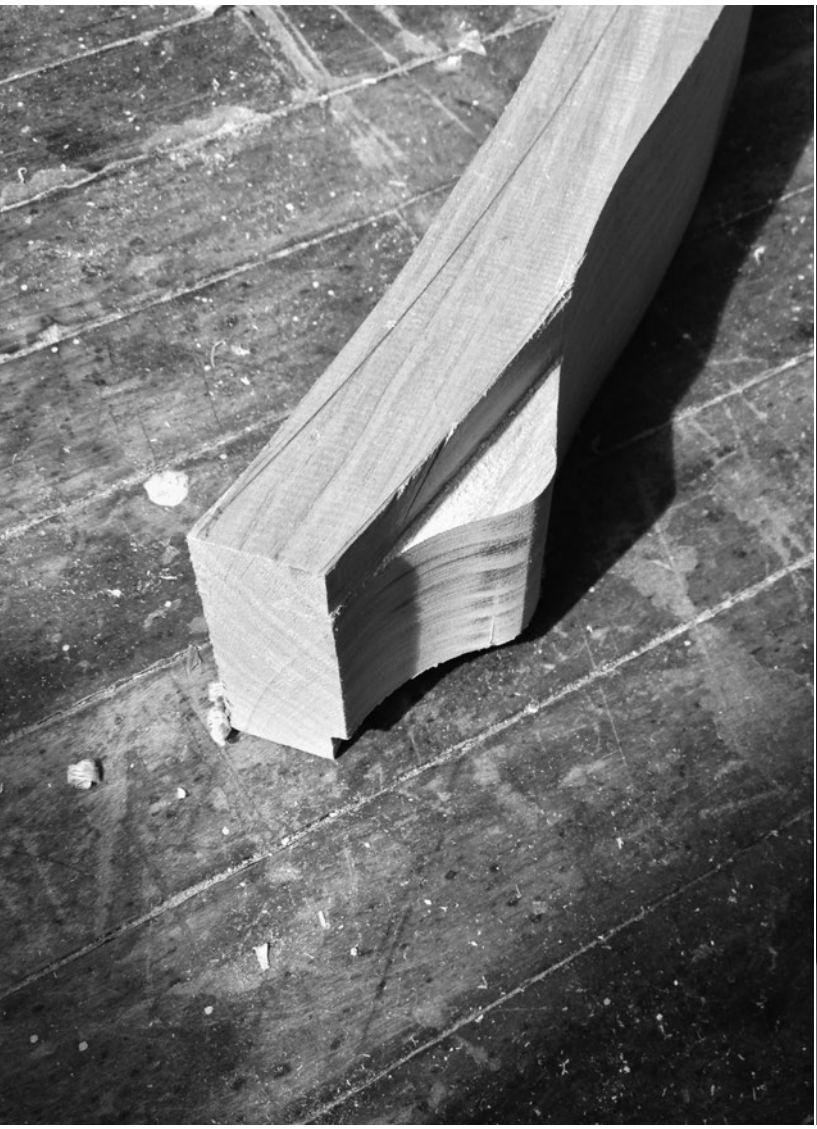

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Figure 138

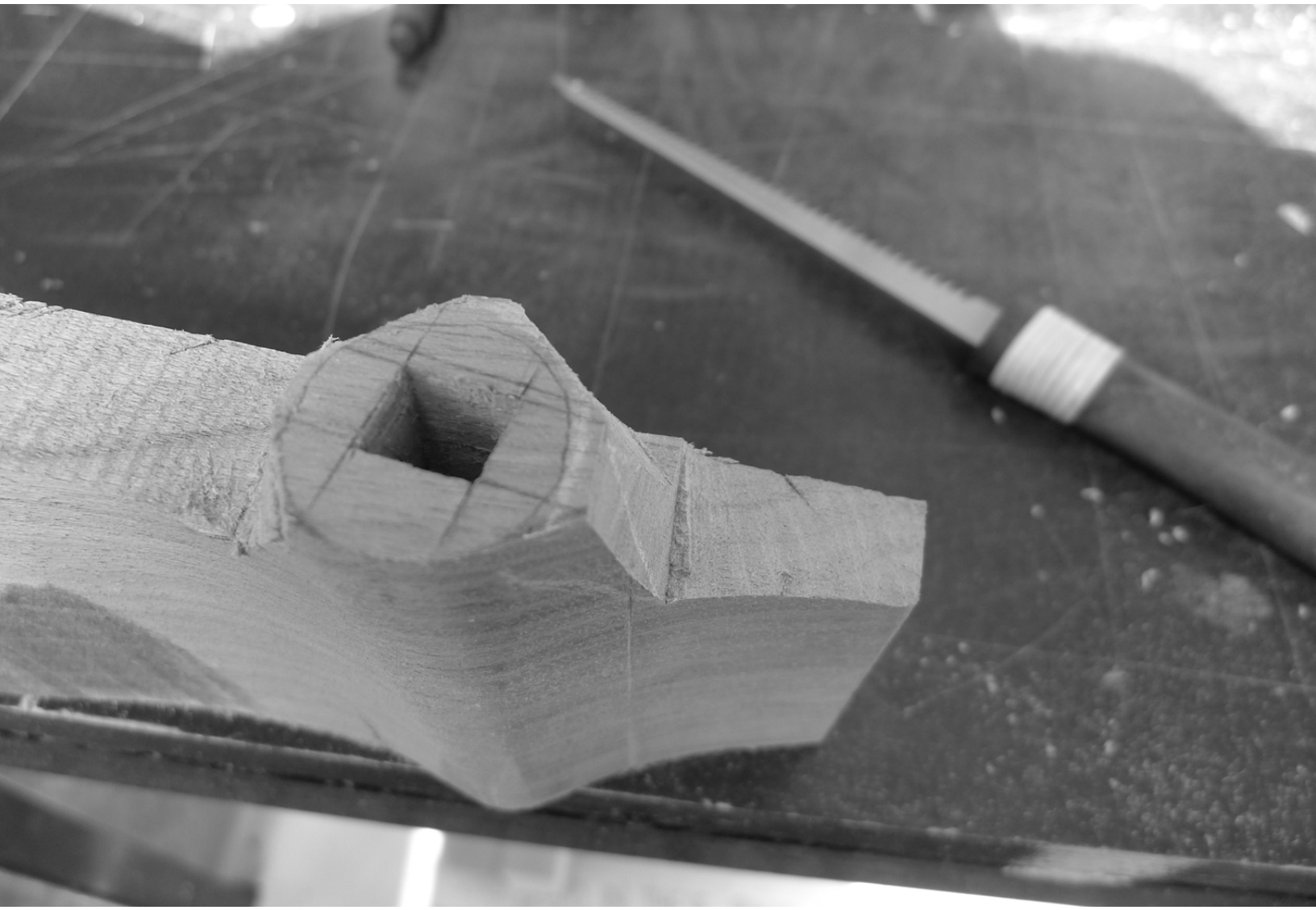

Figure 139

Figure 140

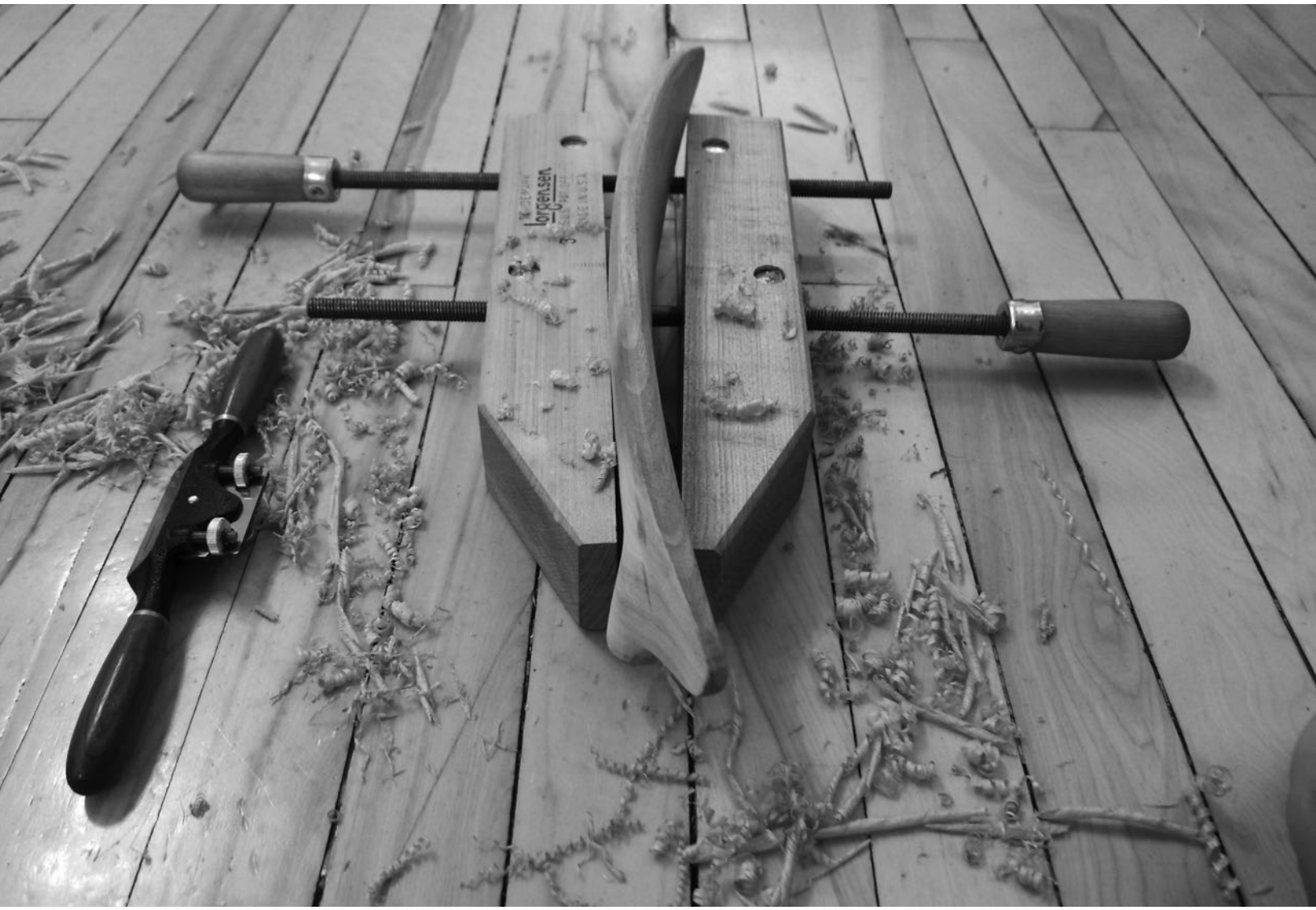

Figure 141

Figure 142

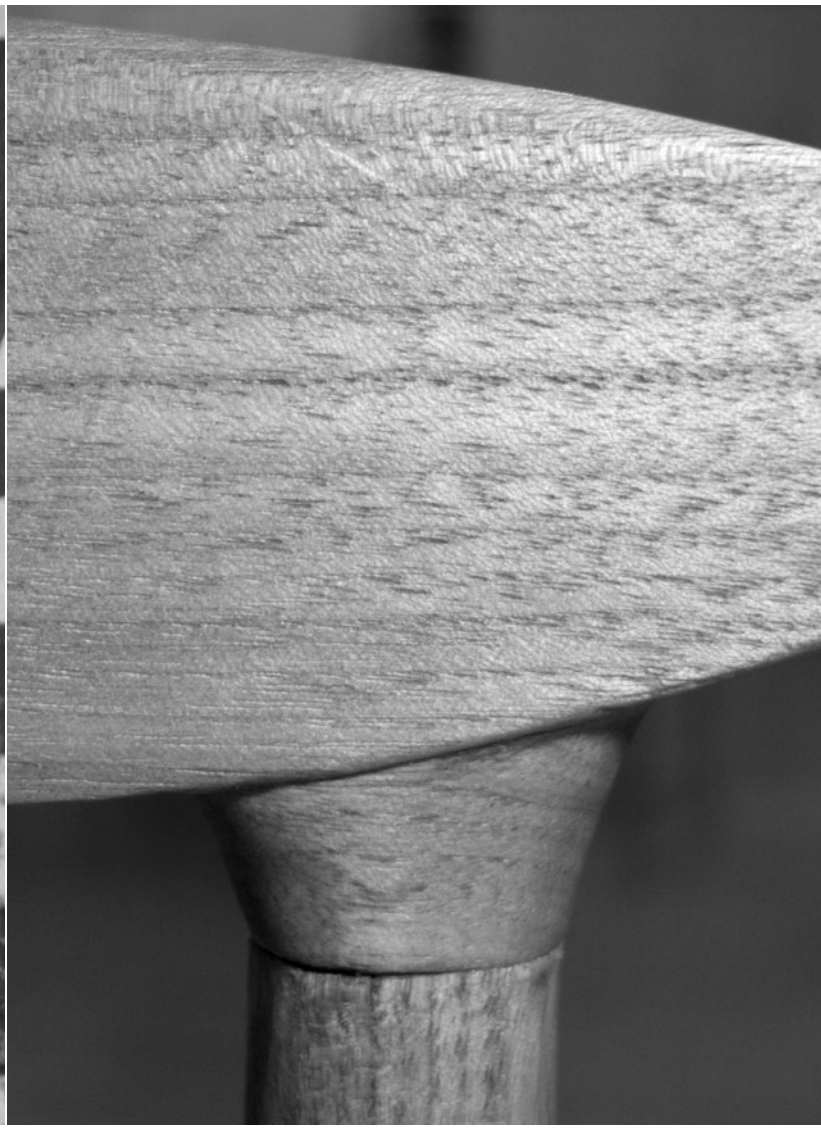

Figure 143

Figure 144

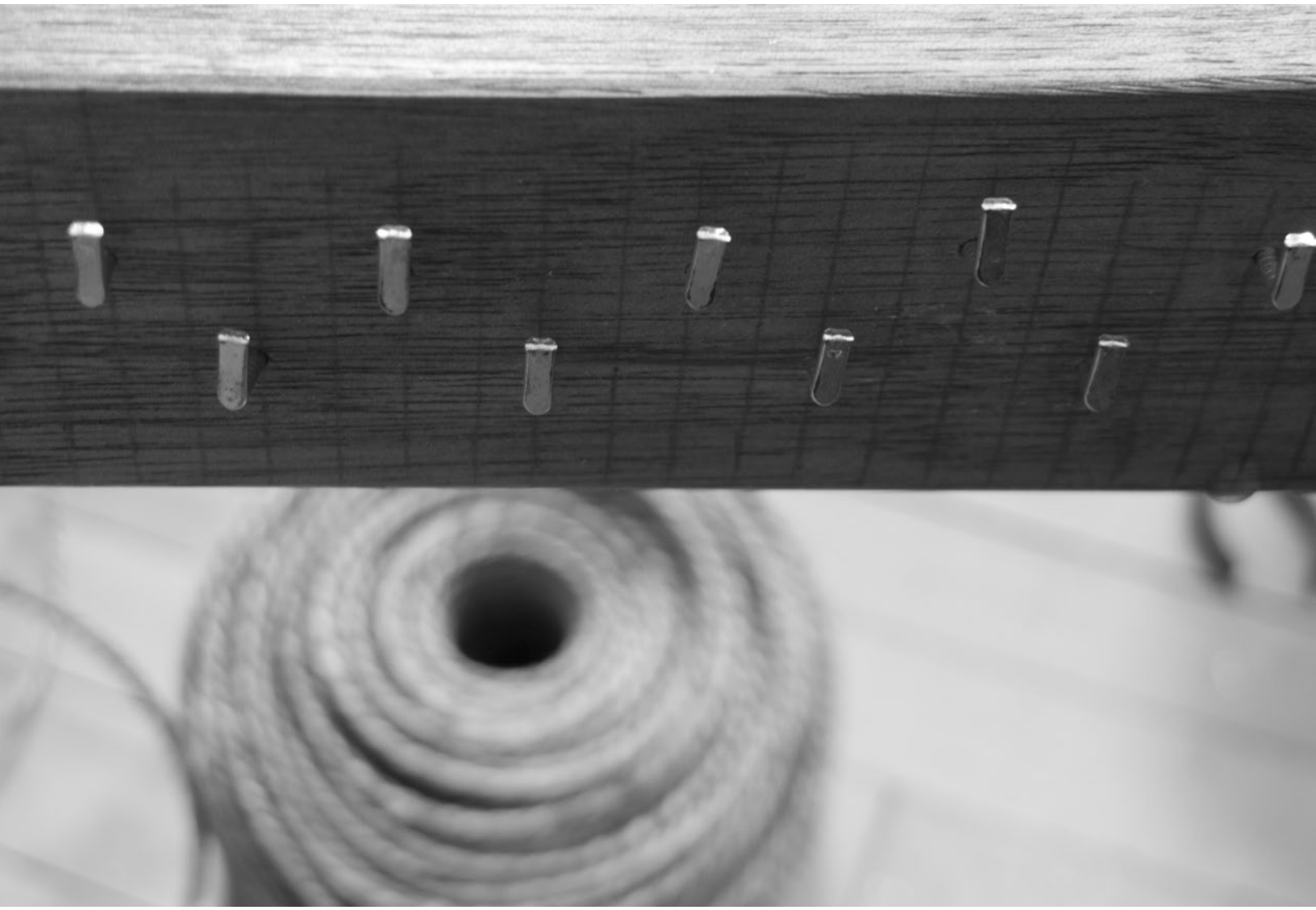

Figure 145

Figure 146

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Figure 149

Figure 150

Figure 151

Figure 152

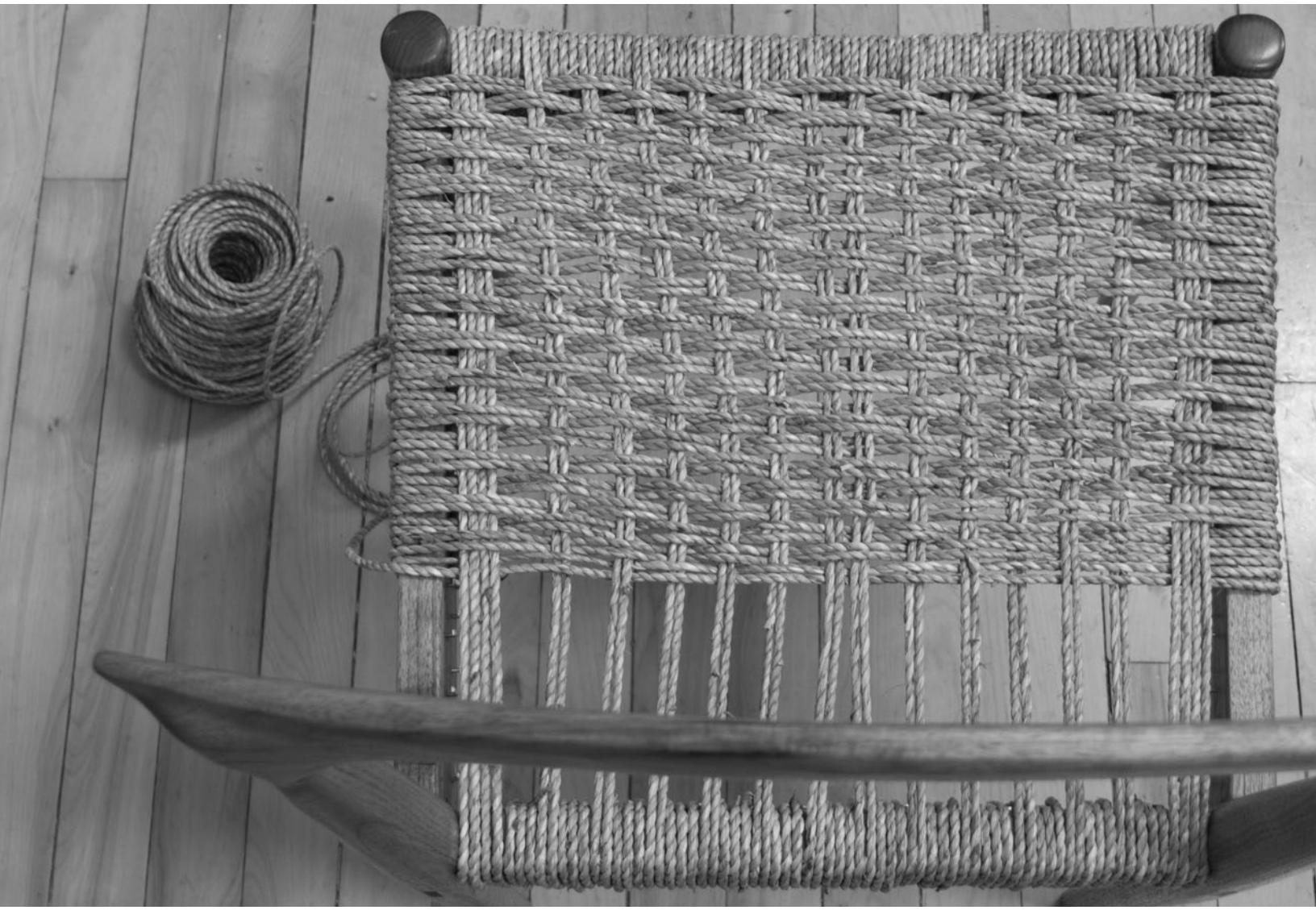

Figure 153

When someone asked Kawai, “Why do you not sign your name on your work?” he said, “My work itself is my best signature.

Soetsu Yanagi quoting Kanjiro Kawai, Japanese potter (224)

Figure 154

Figure 155

Earthenware

For objects themselves imitate one another and mutually copy each other. Stones trace on the ice the sentences of a writing that has no need for us; in memory of its slow advance, the glacier leaves on the mountain giant moraines and steep-sided valley; fire leaves in the ashes the marks of its ravage; at the bottom of the valley, the thalweg immobilizes the course of the river; on the Indian Ocean, a hotspot vertically marks a long track running from the Deccan Traps to Reunion's volcano, passing through a string of islands; similarly, in the Pacific, in the Galapagos and Hawaii; the ebbing tide writes lines of music in sandy pleats on the foreshore; thus the gust of wind composes on the mobile sea surge and the heat on the till recently tranquil air... Yes, the elements imitate one another, conserving in their possession the memory of things, neighboring and distant. The names for various conservatories: for ancient magnetism, the rock: for the torrent, the valley; for the eruption, the atoll; for the scorching front, the hurricane... time is graven on space. The world's body plays the role of memory.

Michel Serres (80)

Figure 156

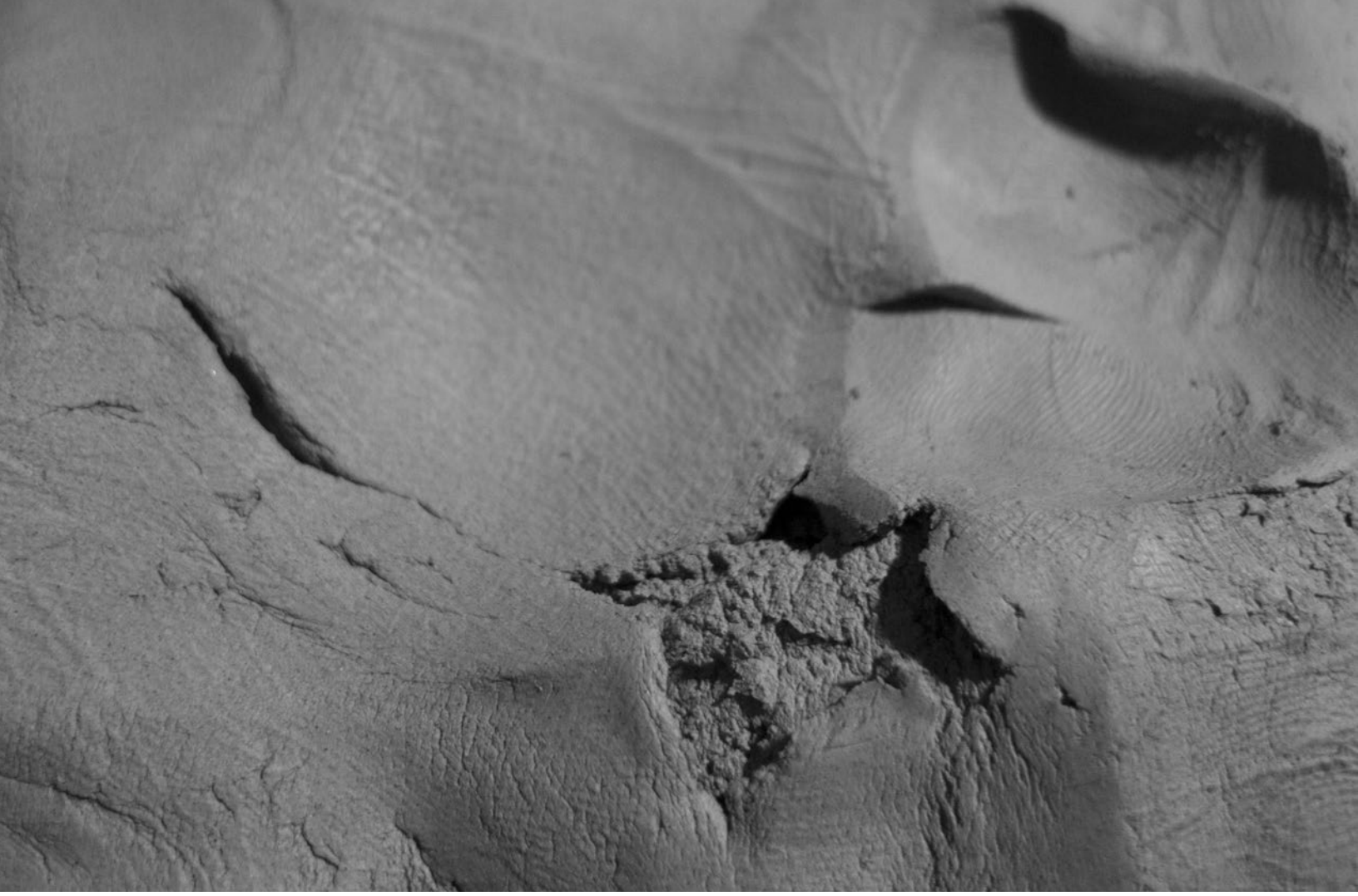

Figure 157

Figure 158

Figure 159

Figure 160

Figure 161

Figure 162

Figure 163

Figure 164

Figure 165

Figure 166

Throwing is very much a synthesis of mental and physical processes. Coordination is one of the most important lessons to be learned and a relaxed mind and body are also important. Tension robs you of your fluidity of movement, upsets your timing, tightens the muscles and thereby diminishes the sensitivity of your reaction to the clay.

John Dickerson (61)

Figure 167

Figure 168 [Left] Trimming Tools, [Right] Hole Cutter

Figure 169 [Left, Bottom Right] Wood Trimming Sticks, [Top Right} Cutting Wire

Clearly something was lacking that mechanized labour did not supply. I have often called it the heartbeat in work. Enthusiasm and play of imagination, for example, occur as wet clay spins under fingers, but take place with varying degrees of intensity, depending on how free of inhibitions one is. [...] In an artist-craftsman it is the degree of life force canalized into a craft. The degree; the purity; the intensity.

Bernard Leach (Introduction to *The Unknown Craftsman* 97)

Figure 170

Paper Lanterns

The dovetail has been and still is the mark of fine cabinetmaking. Correctly made, a dovetail is a strong and durable joint. It has a decorative effect and adds a sense of strength to a piece.[...] The angle of dovetail was arrived at a long time ago through experimentation. The angle is about 80°. If the angle were less the tail might slip out; if the angle were greater the wood on the tail would break.

Tage Frid (64-65)

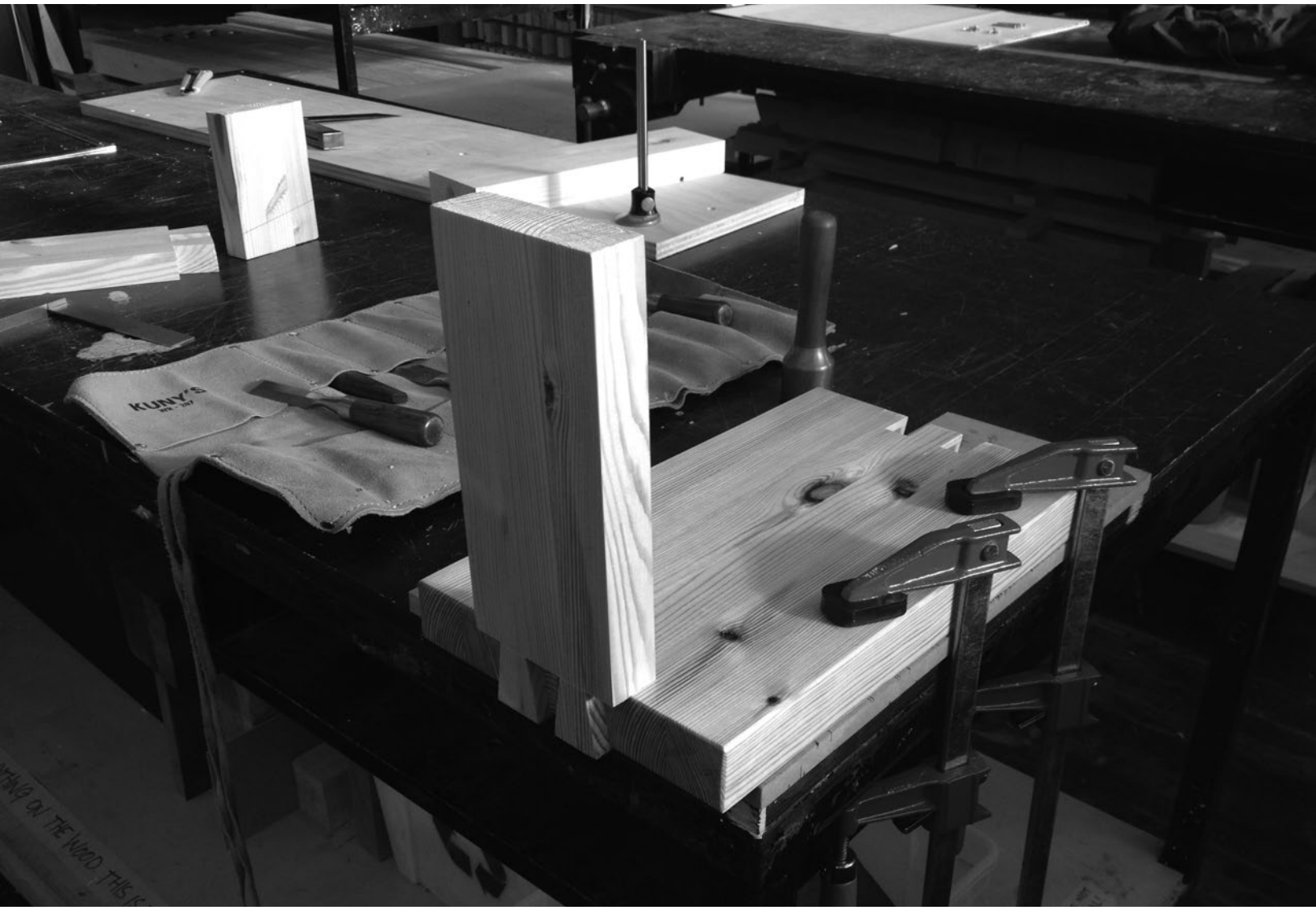

Figure 171

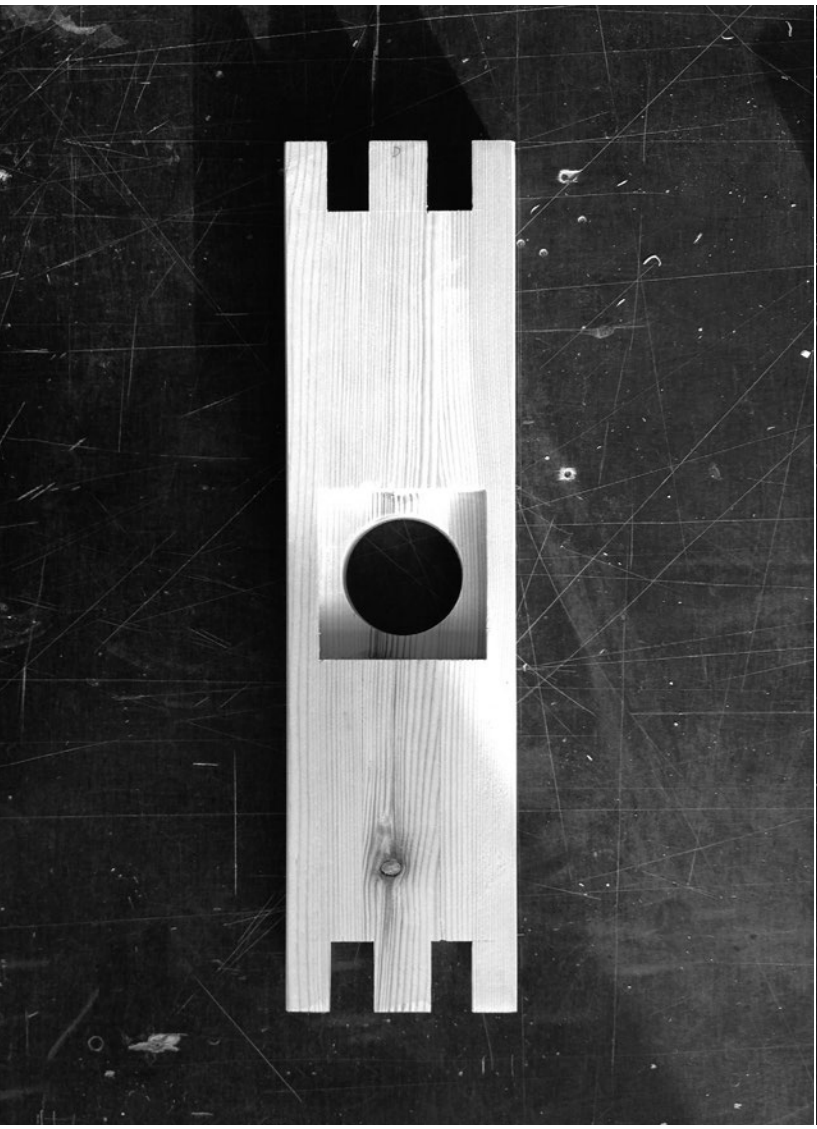

Figure 172

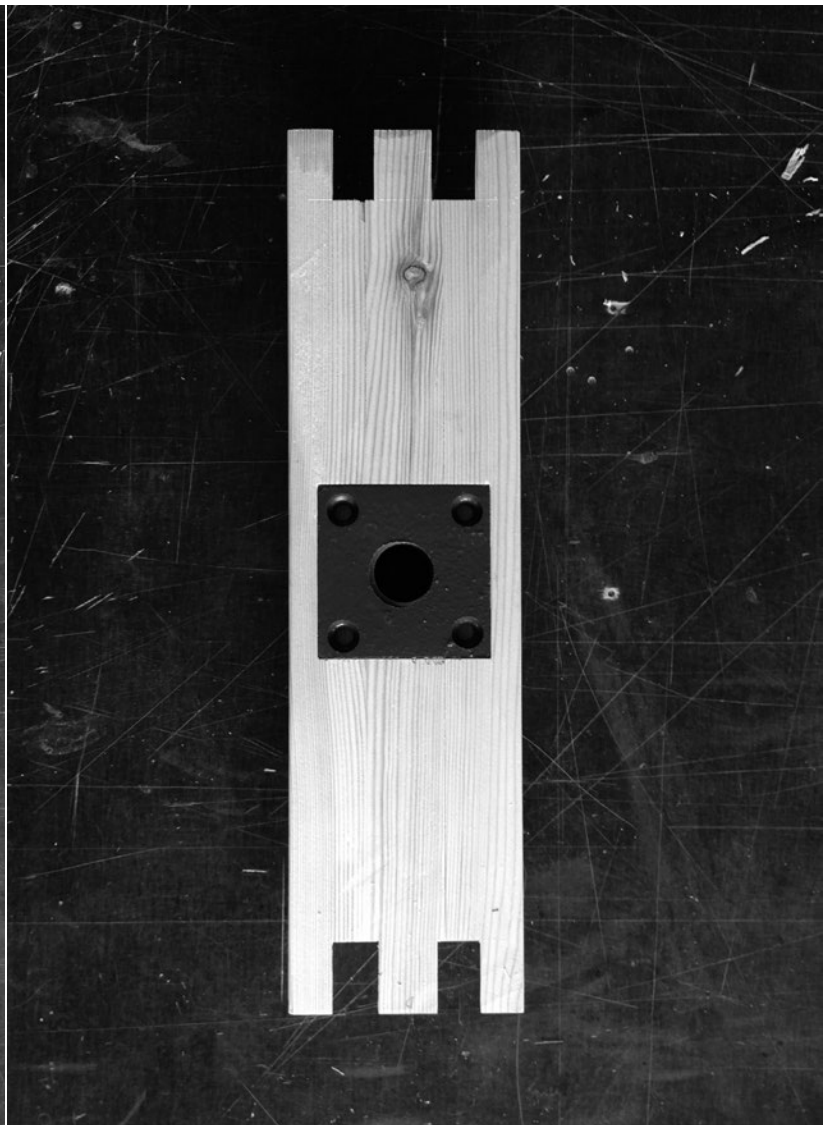

Figure 173

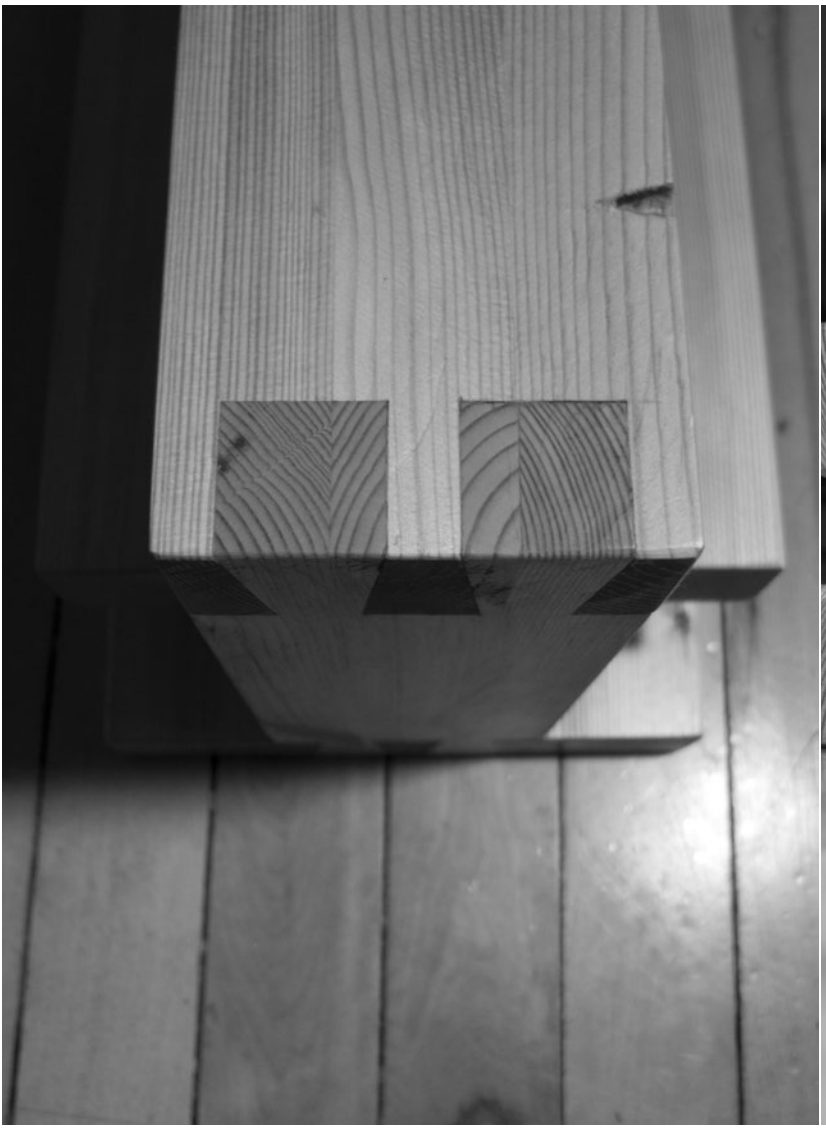

Figure 174

Figure 175

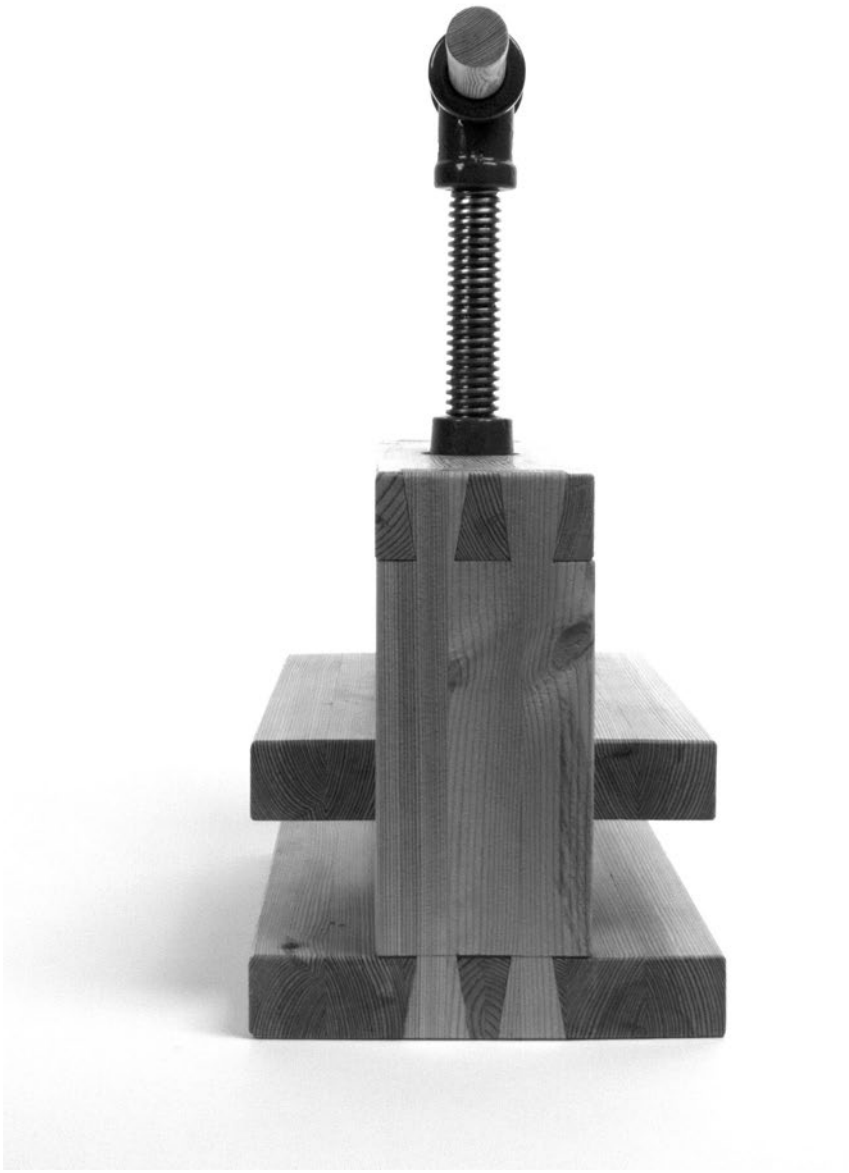

Figure 176

Figure 177

Making the Lamp Frame

The problem is not a matter of either hand or machine, but of utilizing both. We have yet to discover just what is suitable work for each... Beyond all question of old or new, the human hand is the ever-present tool of human feeling, whereas the machine, however new, is soon out of date. Young people nowadays judge according to whether a thing is new or old, but more important is whether it is true or false. If true, whether it is handmade or machine-made, it will always preserve its newness.

Soetsu Yanagi (108)

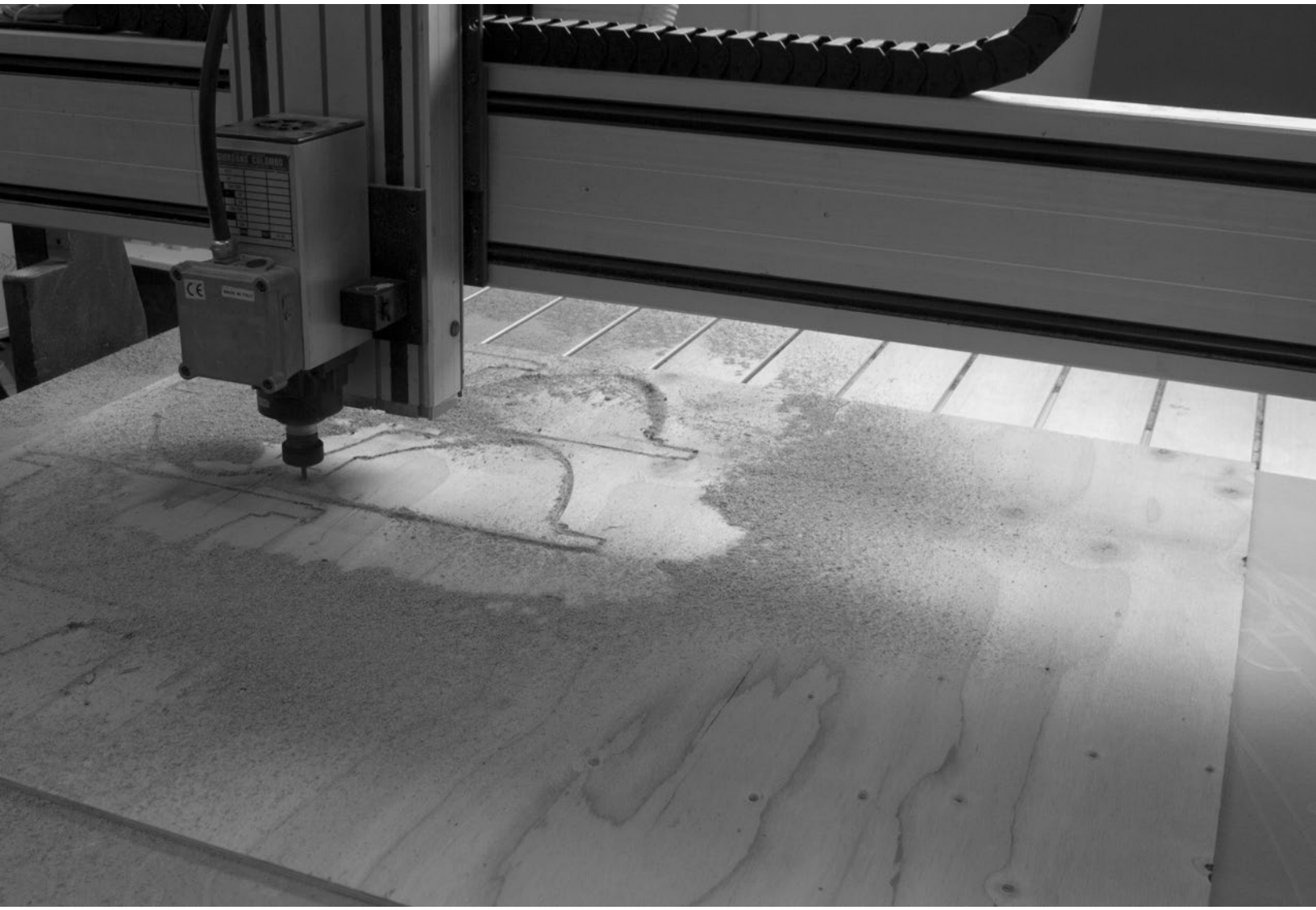

Figure 178 Using the CNC Router

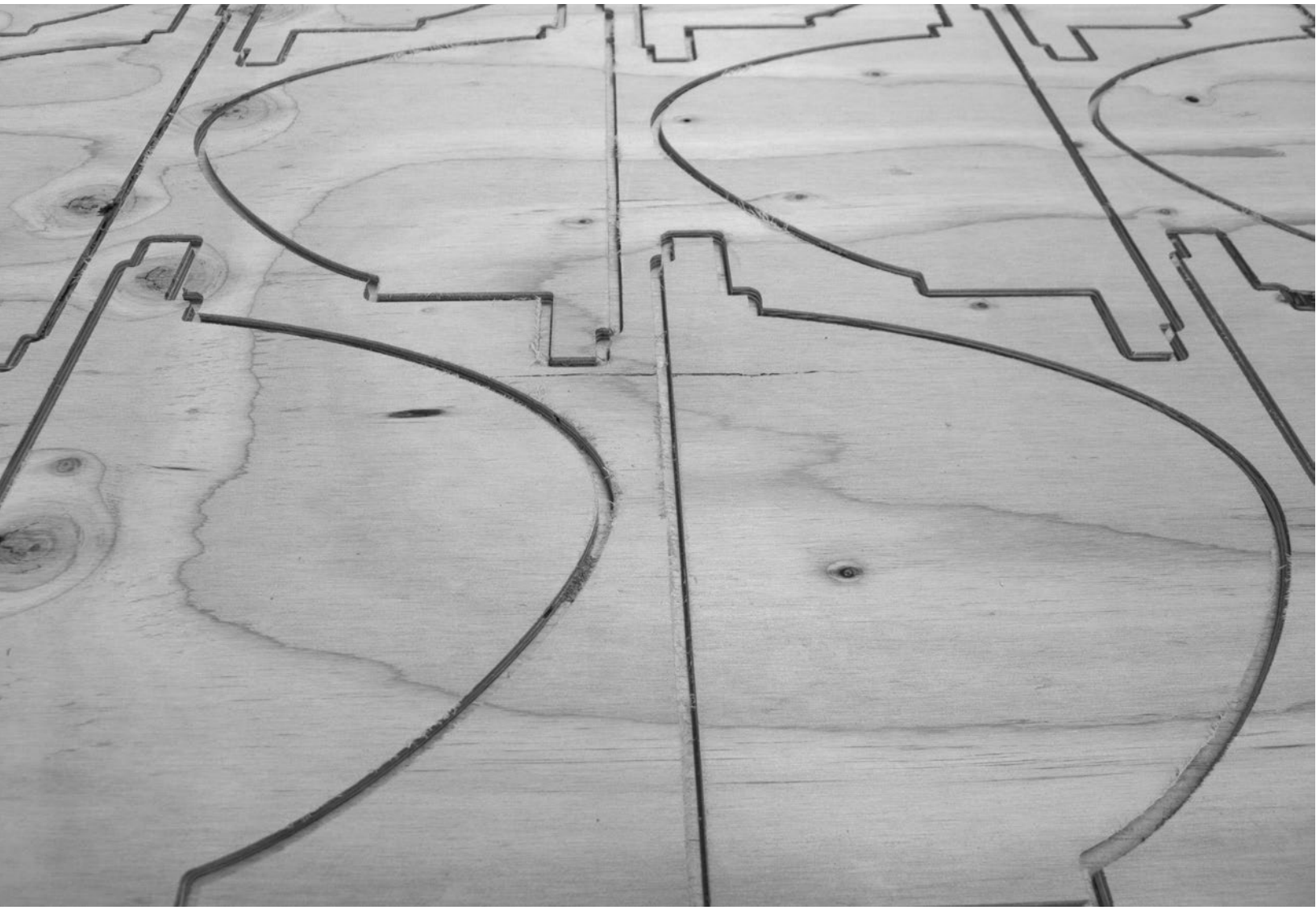

Figure 179

Figure 180

Figure 181　Wood Shavings

Figure 182

Figure 183

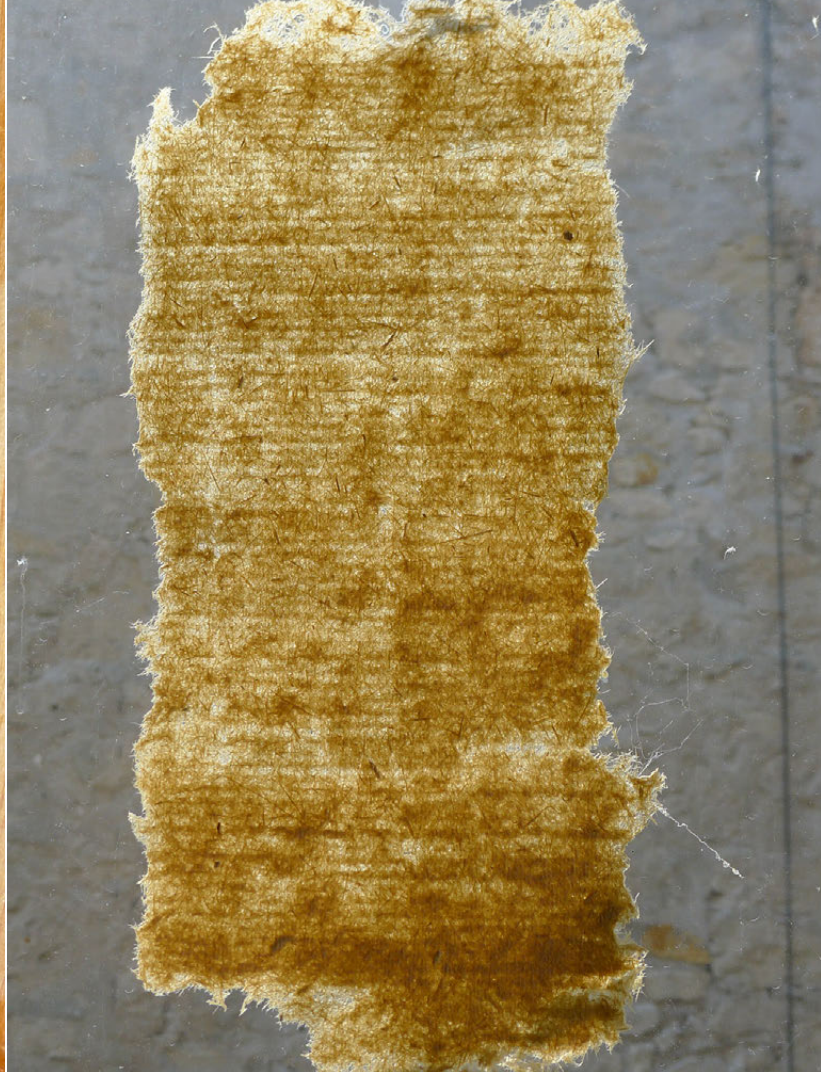

Figure 184

Figure 185 Corn Husks

Figure 186

Figure 187

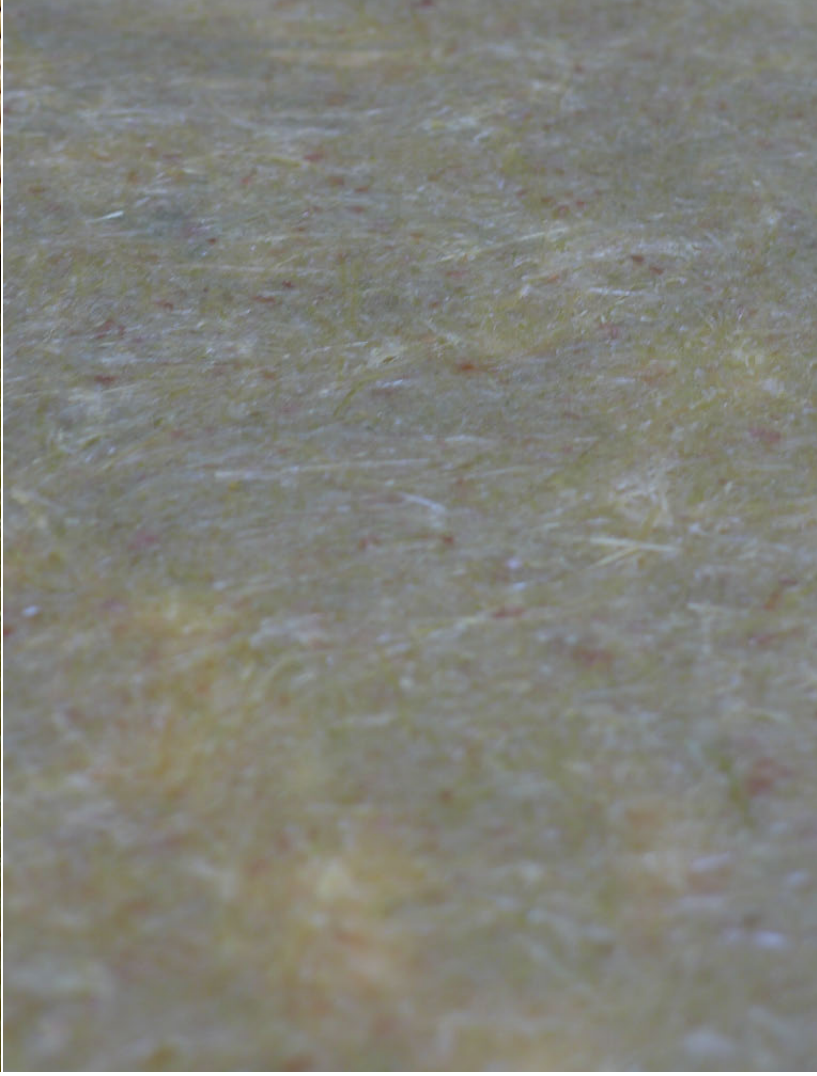

Figure 188

Figure 189 Kozo (Paper Mulberry)

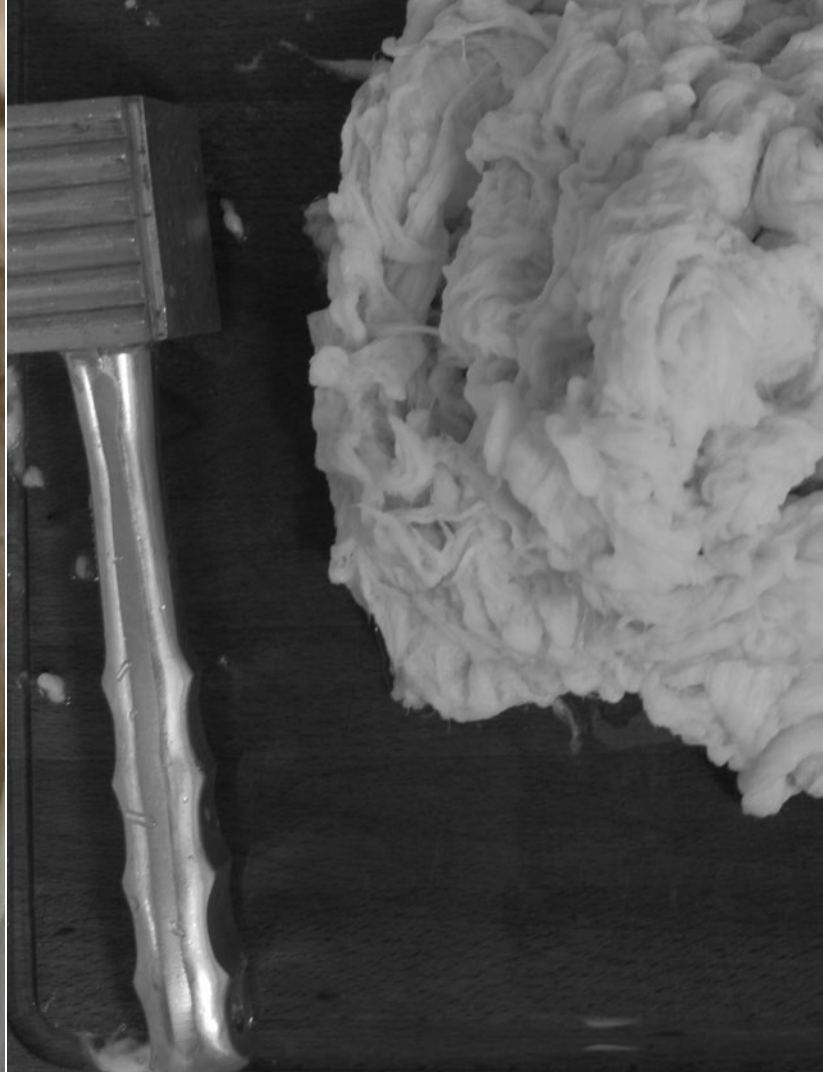

Figure 190

Figure 191

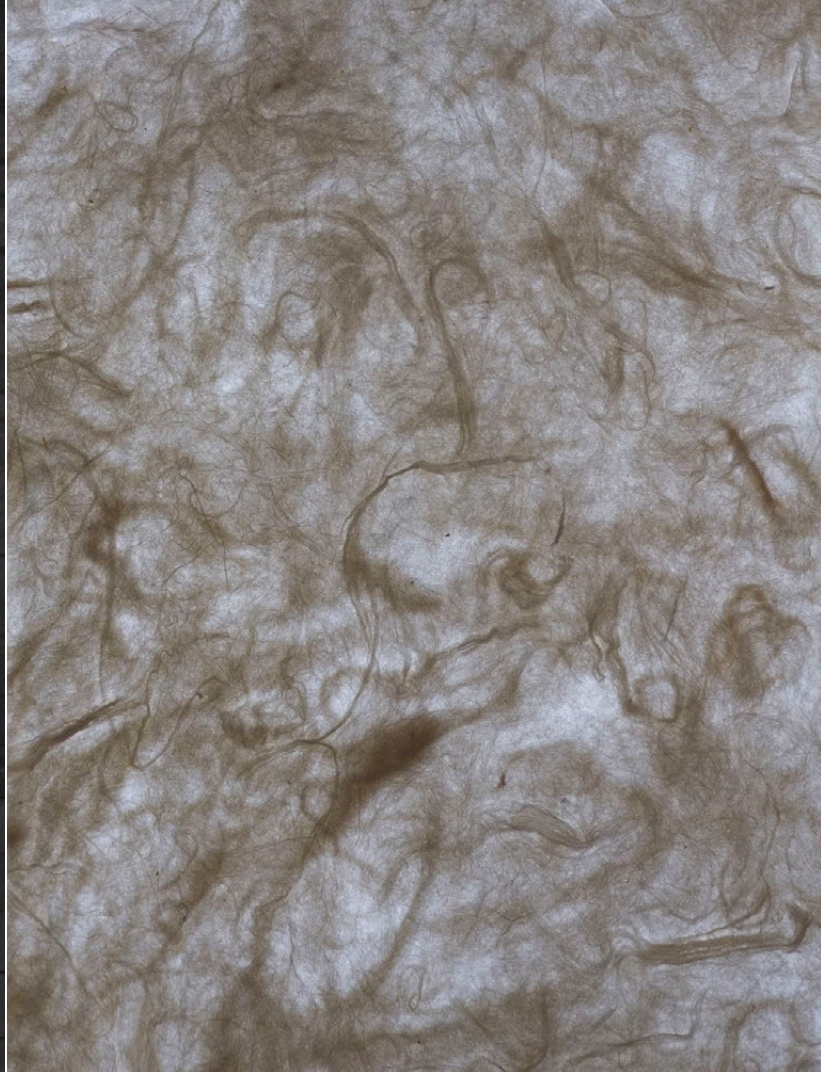

Figure 192

We must have the technique to put our love of life, in our own way, into the things of our life...

Frank Lloyd Wright (109)

Figure 193

Figure 194

Figure 195

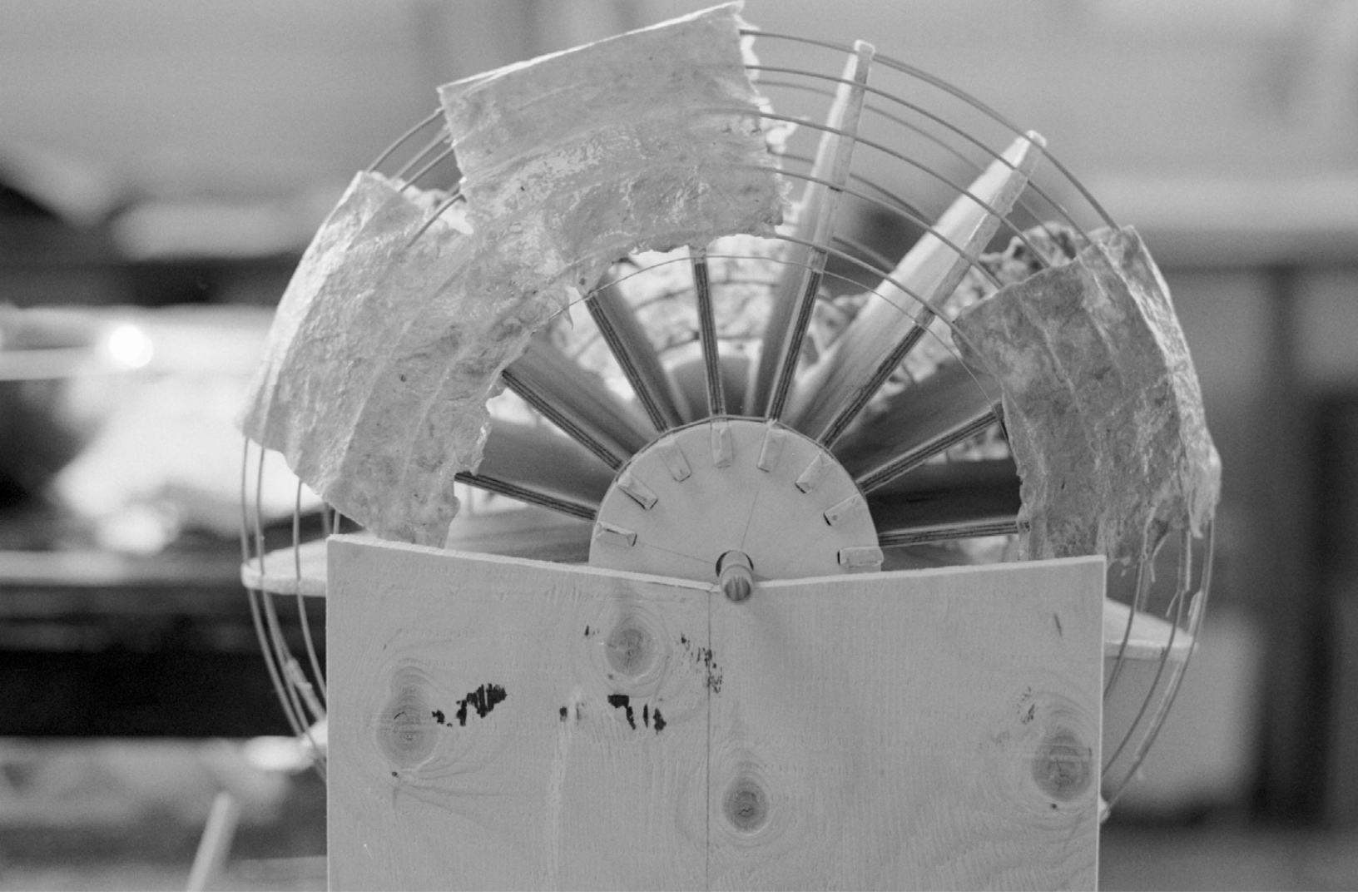

Figure 196

Figure 197

3 Listening

Our listening needs to learn receptiveness, responsiveness, and care. Our listening needs to return to the intertwining of self and other, subject and object; for it is there that the roots of its communicativeness take hold and thrive — and it is there that a non-egological listening-self is sleeping, embedded in the matrix of melodious energies.

David Michael Levin (223)

If you love wood, listen to it. Don't tell it what it must do; listen to what it wants. Work with it from the inside, inside it and inside you. Be self-critical. Something has to tell you whether you have—or will have—what it takes to go all the way, against all odds, and make this your life.

James Krenov (126)

Conclusion

Listening is a skill that requires cultivation. It is the skill of paying concentrated attention and of hearing the spirit behind the word. To listen, is to develop a rapport to the people, objects, and environment around us. It requires patience and care. In the making process, it is crucial that we listen with our entire body, with all of our senses, and with an open mind. Listening allows us to gain insight and these insights are imbued in our work.

I learned to listen carefully when sharpening plane blades. Consistency is the key to achieving a sharp edge, therefore, I listen for that signature pitch to ensure that I am applying a consistent pressure. By continually fine-tuning my sensitivity to the nuances of stone, steel, and flesh, I am able to achieve a sharper edge. As a result, I am able experience one of the finest ways to finish wood.

When working wood by hand, the tools speak to me. I use Japanese handsaws (as opposed to Western-style saws) because the straight, wooden handle fits every shape and size of hand. Developed centuries ago, Japanese handsaws cut downward on the pull stroke and use gravity to ease the task of sawing. With every saw cut, I catch a glimpse into the ingenuity of our ancestors.

When trimming the foot on a pottery bowl, I learned to listen for the thickness of clay. In my inexperience, I would trim through the bottom of the bowl. Being overly-cautious, I would be left with bottom-heavy pottery. In order to make a better, more elegant object for use, I had to develop a certain intimacy with the material; I had to develop an intuitive sense for the thickness of it. I grew to appreciate the thousands of skills behind the making of a simple object.

Using my seagrass chairs, I found that woven seats have a tendency to sag

over time. I had to unravel, modify the pattern, and re-weave the seats many times in order to make a more comfortable chair. In order to create a strong, consistent weave, I had to develop my sense of a consistent tension—to engage the mystery of rhythm (Ba 14).

To find a suitable material to form handmade paper, I had to learn from my failures. I had to listen to the material, to my inner voice, and let go of my ego.

It is the craftsman's desire to produce as fine a work as humanly possible that motivates her to listen to the material at hand and to develop a reciprocity with it. As all craftsmen know, without reciprocity, material and maker seldom come together in the creation of a well-conceived, well-crafted work. Craftsmanship depends on reciprocity—on the craftsman's capacity to listen carefully.

Architecture, much like craftsmanship, depends on listening. Architects must listen to the site: to the direction of prevailing winds, soil conditions, movement of water, movement of the sun, flora, and fauna. Architects must listen for the spirit of their client's desires and their own desires. And like the woodworker, potter, and papermaker, architects must also listen to the materials they specify for use. Peter Zumthor declares, "the real core of all architecture work lies in the act of construction. At a point in time when concrete materials are assembled and erected, the architecture we have been looking for becomes part of the real world " ("Thinking Architecture" 11). Architecture, much like craftwork, is deeply rooted in tradition. Architecture is part of the lifeworld. It is also a testament to the human spirit. Architecture *is* a craft.

I believe that the time-honoured lessons embodied in traditions of craft are worth cultivating. In order for a student of architecture to cultivate these lessons (such as a craftsman's capacity to listen), they require an atmosphere of patience, the opportunity to pay concentrated attention, and a chance to slow down. They require circumstances that make establishing a rapport with material possible: an adequate workspace, encouragement, solitude. Above all, students need to listen to their inner voice and find their own way. I was provided with all of these liberties, for which I am deeply grateful. I hope that future generations of students will continue to have the same opportunity.

The following photographs are of my table. I wish to remind the reader that they are only images of a wood surface. To wholly experience a material, one must experience it in the flesh. I have included these photographs because the wood invokes for me, a sense of the cosmos. The forest is in the wood.

Bibliography

1 Alasheev, Sergei. "On a Particular Kind of Love and the Specificity of Soviet Production." *The Craft Reader.* Ed. Glenn Adamson. New York: Oxford International Publishers Ltd., 2010. Print.

2 Allen, Edward., and Iano, Joseph. *Fundamentals of Building Construction*. 4th ed. Hoboken, NJ: John Wiley and Sons Inc., 2004. Print.

3 Bâ, Amadou Hampâté. "African Art: Where the Hand has Ears." *The Unesco Courier .* (February 1976) 12-17. Print.

4 Brown, S. Azby. *The Genius of Japanese Carpentry: An Account of a Temple's Construction*. Tokyo: Kodansha International Ltd, 1989. Print.

5 Dal Fabbro, Mario. *How to Build Modern Furniture.* New York: F.W. Dodge Corporation, 1957. Print.

6 Dawson, Sophie. *The Art and Craft of Paper-Making: Step-by-step instructions for creating dinstinctive handmade paper.* London: Quarto Publishing plc, 1992. Print.

7 Dickerson, John. *Pottery Making: a complete guide.* New York: The Viking Press Inc, 1974. Print.

8 Emery, Thomas J., and Graham, Frank D. *Audels Carpenters and Builders Guide.* New York: Theo. Audel & Co. Publishers, 1958. Print.

9 Frid, Tage. *Tage Frid Teaches Woodworking: A Step-By-Step Guide to Essential Woodworking Techniques*. Newtown, CT: Tauton Press, 1994. Print.

10 Hale, Jonathan. "Architecture, Technology and the Body: From the Prehuman to the Posthuman." *The SAGE Handbook of Architectural Theory*. By Crysler, Cairns, and Heynen. London: SAGE Publications Ltd., 2012. SAGE knowledge. Web. 14 Dec. 2013.

11 Hale, Jonathan. "Signs of resistance: re-membering technology." The Journal of Architecture. Vol. 5 Spring 2000: 91-97. Print.

12 Heidegger, Martin. *The Question Concerning Technology and Other Essays.* Trans. William Lovitt. New York: Harper and Row Publishers, Inc., 1977. Print.

13 Hiebert, Helen. *The Papermaker's Companion: The Ultimate Guide to Making and Using Handmade Paper.* North Adams, MA: Storey Publishing, 1965. Print.

14 "History of Papermaking." *Maine Pulp & Paper Association*. n.d. Web. 12 Nov. 2013.

15 Hoffman, Donald. *Frank Lloyd Wright's Fallingwater: The House and Its History.* New York: Dover Publications, Inc., 1978. Print.

16 Horiki, Eriko., and Okuma, Jacqueline. *Eriko Horiki: Washi in Architecture.* Barcelona: Triangle Postals, 2011. Print.

17 "How Woods React to Moisture." *Woodworkers Source*. n.d. Web. 21 Nov. 2013.

18 Iwamiya, Takeji., and Takaoka, Kazuya. Katachi: Classic Japanese Design. Tokyo: Chronicle Books, 1999. Print.

19 Joyce, Ernest. *Encyclopedia of Furniture Making.* New York: Drake Publishers Inc., 1976. Print.

20 Kimmelman, Michael. "The Ascension of Peter Zumthor." *New York Times* 13 March 2011. MM32. Print.

21 Krenov, James. *A Cabinetmaker's Notebook*. Fresno, CA: Linden Publishing, 2000. Print.

22 Levin, David Michael. *The Listening Self: Personal Growth, Social Change and the Closure of Metaphysics.* London: Routledge, 1989. Print.

23 Loos, Adolf. "Building Materials." *The Craft Reader.* Ed. Glenn Adamson. New York: Oxford International Publishers Ltd., 2010. Print.

24 Marx, Karl. "Capital." *The Craft Reader.* Ed. Glenn Adamson. New York: Oxford International Publishers Ltd., 2010. Print.

25 Miller, Bruce W., and Widess, Jim. The Caner's Handbook. New York: Sterling Publishing Co., 1991. Print.

26 Nakahara, Yasua., and Sato, Hideo. *The Complete Japanese Joinery.* Vancouver, BC: Hartley & Marks Publishers Inc., 1995. Print.

27 Nakashima, George. *The Soul of a Tree: A Woodworker's Refelctions*. Tokyo: Kodansha International Ltd, 1981. Print.

28 Pallasmaa, Juhani. *The Eyes of the Skin: Architecture and the Senses.* West Sussex, England: John Wiley and Sons Ltd, 2005. Print.

29 Pallasmaa, Juhani. *The Thinking Hand: Existential and Embodied Wisdom in Architecture.* West Sussex, England: John Wiley and Sons Ltd, 2009. Print.

30 Perez, Gomez. *Built Upon Love.* Cambridge, MA: MIT Press, 2006. Print.

31 "Pulp and Paper Production Basics." Reach for Unbleached Foundation. n.d. Web. 18 Dec 2013.

32 Richards, M.C. "Centering." *The Craft Reader.* Ed. Glenn Adamson. New York: Oxford International Publishers Ltd., 2010. Print.

33 Ruskin, John. *The Seven Lamps of Architecture.* London: Ballantyne, Hanson & Co., 1901. Print.

34 Schwarz, Christopher. *The Anarchist's Tool Chest.* Fort Mitchell, KY: Lost Art Press., 2011. Print.

35 Seike, Kiyosi. *The Art of Japanese Joinery.* New York: Weatherhill Inc., 1977. Print.

36 Solomon, Robert C. *No Excuses: Existentialism & the Meaning of Life.* Springfield, VA: Teaching Co, 2000. Sound recording.

37 Sugimura, Tsune. et al. *The Enduring Crafts of Japan: 33 Living National Treasures.* New York and Tokyo: John Weatherhill Inc., 1968. Print.

38 Tanizaki, Jun'ichiro. *In Praise of Shadows.* New Haven, Conn: Leete's Island Books, 1977. Print.

39 *The Merleau-Ponty Reader.* Eds. T. Toadvine and L. Lawlor. Evanston, IL: Northwestern University Press, 2007. Print.

40 U.S. Department of Agriculture. *Wood Handbook*. Agriculture Handbook No. 72. Washington: U.S. Government Printing Office, 1955. Print.

41 Watson, Aldren A. *Hand Tools: Their Ways and Workings.* New York: W.W. Norton & Company Inc., 1982. Print.

42 Wright, Frank Lloyd. "In the Cause of Architecture: The Architect and the Machine." *The Craft Reader.* Ed. Glenn Adamson. New York: Oxford International Publishers Ltd., 2010. Print.

43 Wynn, Scott. Woodworker's Guide to Handplanes. East Petersburg, PA: Fox Chapel Publishing, Inc., 2010. Print.

44 Yanagi, Sōetsu. *The Unknown Craftsman: A Japanese Insight into Beauty.* Tokyo: Kodansha International Ltd, 1972. Print.

45 Zumthor, Peter. *Atmospheres.* Basel, Switzerland: Birkhäuser GmbH, 2006. Print.

46 Zumthor, Peter. *Thinking Architecture.* Basel, Switzerland: Birkhäuser GmbH, 2010. Print.