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MASTER THESIS

ANTE PORTAS

An exploration into non-human
ornamentation for an entry door

POLITECNICO DI MILANO

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Faced with the disasters of anthropogenic climate change, the design discourse is slowly shifting away from the tenet of human-centered design. Instead, approaches with a non-anthropocentric worldview that considers the planet's non-human cohabitants are increasingly gaining attention. Designing for sustainability includes the renunciation of humanity's exceptional position and, instead, the devotion to principles of planet-centric design. Translating this abstract maxim into tangible design results is one of the fundamental design challenges of the 21st century. This thesis proposes an aesthetical approach through the means of an ornamental design that manifests non-anthropocentric principles in visual expression. With the topology of the residential entry door as a canvas, ornamentation is explored as a cultural signifier of a worldview that no longer prioritizes human over non-human.

The entry door is chosen as the carrier of an ornament due to its passive function of communication within the urban landscape. Through visual research and documentation, the history of cultural ornamentation and the symbolic potential of ornamentation is explored. Subsequently, the ornament's potential as visualization of a new, biophilic culture is explored. This hypothesis is then fed with case studies of natural pattern formation and showcase projects from art and architecture. Finally, after briefly laying out functional and sustainable principles for designing with timber, two exemplary design proposals for ornamental patterns on a wooden entry door are presented.

Di fronte ai disastri del cambiamento climatico antropogenico, il dibattito sul design si sta lentamente allontanando dai principi dello human-centered design. Al contrario, hanno guadagnato sempre più attenzione gli approcci con una visione del mondo non antropocentrica, che prendono in considerazione gli abitanti del pianeta non umani. Progettare per la sostenibilità significa rinunciare alla posizione eccezionale dell'umanità e dedicarsi invece ai principi della progettazione incentrata sul pianeta. Tradurre questa massima astratta in risultati progettuali tangibili è una delle sfide progettuali fondamentali del XXI secolo. Questa tesi propone un approccio estetico che manifesta principi non antropocentrici nell'espressione visiva attraverso un progetto ornamentale. Con la topologia della porta d'ingresso residenziale come tela, l'ornamento viene esplorato come significante culturale di una visione del mondo che non privilegia più l'umano sul non umano.

La porta d'ingresso è scelta per la sua funzione passiva di comunicazione all'interno del paesaggio urbano e resa vettore di un ornamento. Attraverso la ricerca visiva e la documentazione, viene esplorata la storia dell'ornamento culturale e il potenziale simbolico dell'ornamento. Successivamente, viene esplorato il potenziale dell'ornamento come visualizzazione di una nuova cultura biofila. Questa ipotesi viene poi alimentata con casi studio sulla formazione di motivi naturali e progetti di vetrina dell'arte e dell'architettura. Infine, dopo aver esposto brevemente i principi funzionali e sostenibili per la progettazione con il legno, vengono presentate due proposte progettuali esemplari di motivi ornamentali su una porta d'ingresso in legno.

ANTE PORTAS

A BRIEF AND PERSONAL INTRODUCTION



ILL.001 RENÉ MAGRITTE "La réponse imprévue", 1963

As I leave Milan at the beginning of September 2022, I close the door to my flat in Loreto. Behind me lie two years of master's education, and ahead of me lies the uncertainty of new, closed doors. Over two years of a worldwide pandemic this feeling of uncertainty was surprisingly familiar and, in a way, weirdly comforting. The protective condition of being a design student is now about to be lifted and although I learned a lot during my time at Politecnico, my definition of design has widened even more. Asking myself what to do in my role as a designer, I find myself at a crossroads.

For my final project, my thesis in LM Integrated Product Design, I want to design a wooden entry door. The typology of the door is one that has been surprisingly neglected by designers. While almost every big name in the design field has a door handle in their portfolio, very few have ever designed the door itself. After all, they are technically architectural elements and, as such, barely ever touched by a user. They may be considered simple and passive. But it is precisely the antonymous functionality of two states, "open" and "closed" – that may allow the door to promote its additional level of function – one that is purely aesthetical and representative. Even though this work starts from the framework of designing a clearly defined typology, it is by no means a traditional product design thesis. It has a structure, but none that can be credited to conventional design methodology. Instead, this work is more of a stream of consciousness, combining different research with design and reframing it as an exploration into aesthetics and representation.

The visual expression and impression of everyday objects and their subsequent perception are severely abstract and subjective. It has been and is a controversial topic of philosophical discussion that will likely stay without definitive answers. Despite, or possibly because of this charged ambiguity, the embodied aesthetics of the everyday objects surrounding us influence our daily lives. This is precisely why this is the subject that I want to explore in this work. Aesthetical expression is a signifier of civilization and culture; within this frame, decoration and ornamentation play a distinct role. This distinction is crucial. An element becomes decorative when placed on an object that already has a distinct function-in-use. The object would not lose that technical function without the ornament or decorative element placed on its surface. Of course, eliminating decorative elements has been the main feature of modernist architecture and design. Any non-functional element was deemed superficial and, therefore, superfluous.

Contrary to this, I want to argue for a different level of function; let's call it the function-in-image. This purely visual expression has a different level of functionality, one that is way less tangible but present nonetheless – it exists on an unconscious and emotional level. Yet a big part of culture is visual expression. Culture defines and manifests its values and core principles in its visual outcomes. With globalized modernism came the dominance of minimalism and a displacement of these levels of expression. Instead, a universal culture of clean, minimalist aesthetics has taken over the world and replaced individual expressive patterns, decoration, and ornamentation. While this thesis does not aim to go back to localized, protectionist cultures, it does argue for a comeback of decoration, one that reestablishes visual stylistic elements as a means of cultural expression.

INTENT

FROM HUMAN-CENTERED TO WHERE?

The tenet of human-centered design has been the gold standard of industrial design since the emergence of the New York design consulting firm IDEO. Over the last 25 years, these creative approaches and the methodology of design thinking have become the benchmark of corporate product and industrial design. To improve the products we interact with daily, designers try to discover the users' reality. Human-centered design is an approach that aims to achieve innovation through empathy with the human user. After all, this approach is sensible: Almost all objects designed and manufactured by humans are used by humans in some direct or indirect form. Human-centered design aims to innovate from deep within a given framework, tediously investigating through tools like journey maps and user diaries.^(IDEO, 2015) By using these highly developed method catalogs, innovative design becomes a reproducible routine aimed at streamlining a standardized creative practice.

Unfortunately, there is an inherent problem with a design approach restricted to the boundaries of a single design context. It is often limited to specific stand-alone situations, aiming for comfort and convenience of active use while losing sight of the broader planetary context. These contextual restraints have one fatal flaw. On a planet with limited resources, industrial design cannot keep focussing on creating an ever-growing amount of products for use and consumption without considering the consequences of this exceedingly unsustainable practice. A design approach solely oriented on the users' world is insufficient. Instead, designers need to consider a variety of contexts of social, cultural, and environmental dimensions. The sole focus on the present falls short when trying to develop long-term and truly future-oriented strategies for planetary survival. In a crisis as urgent as the climate crisis, mindsets must shift. We must attain a critical distance from the current standard practice of industrial design and widen our awareness. Inevitably, this includes a challenge to the exceptional position of Humankind in relation to the planet and all non-human entities. The dramatic increase in extreme weather events in all human habitats shows the planet's limits and starts to deny the delusion of continuous growth through the exploitation of natural resources.

A necessary consequence of the dire planetary circumstances is questioning our self-image as human beings. Such a critical perspective on human presence and standing has been explored in the humanities over many years, a prominent advocate being the science theorist Donna Haraway. She demands to reject the idea that we alone, as humans, inhabit the planet and that we can not undo our wrongdoing all by ourselves. Instead, we need allies. With all the non-human species that share habitat and, consequentially, fate, we should become akin and subsequently renounce our anthropocentric worldview.^(Haraway, 2016) First and foremost, this newfound kinship is characterized by respect and consideration for the non-human. Instead of falling back on human privilege, we must tie our own species' destiny to the planet and explore the benefits of symbiosis.

The century-old assumption of human exceptionalism is strongly influenced by traditional Western philosophy, going back to Immanuel Kant. In philosophy, idealism refers to the position that reality is radically determined by cognition and thought and that reality, knowledge, and morality are based on ideas and ideals. This focus on rational thinking gives the human a salient feature that leads many to believe that there can be no reality without the human in the center of it all.

Consequently, the exceptional position of Humankind – anthropocentrism – is seen as an entitlement to dominance over and exploitation of everything non-human. Applying an abstract ontological concept to culture and, subsequently, human behavior has led to disastrous consequences for our planet.^(Ellis, 2018) Humankind has set itself apart from the holistic ecosystem of the planet and is now reaping the consequences. We must reconsider our relationship with the world in light of an impending future without a life-sustaining environment for human and non-human life. In doing just that, philosophical concepts known as New Materialism and Speculative Realism are attracting attention in recent discourses. In thinking of human being and the world - subject and object - as independent of each other, they produce decidedly anti-anthropocentric perspectives. Further, these theories refute the long-held notion that we can never recognize the world as it is but that it instead reveals itself to us. Reality is only perceived reality and, in fact, exists without human participants or observers.^(Avanessian, 2013)

With these ontological ideas offering a possible perspective for a sustainable design practice, the transfer into tangible design outputs offers a substantial challenge. A problem as complex and complicated as the global climate crisis can not be comprehended as one, resulting in the lack of simple, clear-cut solutions. Everything is connected. Correlations become too complicated to untangle, let alone control or solve the underlying issues. The British scholar and ecologist Timothy Morton coined the term “hyperobjects” to describe these incomprehensible concepts.^(Morton, 2013) When facing hyperobjects, it is hard not to fall into an abyss of helpless despair. However, in “The ecological thought,” Morton still tries to offer an approach to handle them in applied practice.

“The ecological crisis we face is so obvious that it becomes easy -- for some, strangely or frighteningly easy -- to join the dots and see that everything is interconnected. This is the ecological thought. And the more we consider it, the more our world opens up.”^(Morton, 2010)

And further:

“The ecological thought affects all aspects of life, culture, and society.”^(Morton, 2010)



ILL-002 “Thank you, Miss Prada.” ANDREA TRIMARCHI at Prada Frames

In dealing with hyperobjects and, specifically, the ecological crisis we face, it is essential to approach it both in its partial details and holistically at the same time. It has to impose both applied and ideological direction, meaning that design has to follow a particular set of applied guidelines while also working under a cultural attitude that no longer prioritizes human over planetary concerns. In the face of imminent and devastating danger, the shift toward sustainable change has to be all-encompassing, influencing the details of the specific design case as well as inspiring a holistic revolution of culture. The urgency of developing an appropriate design approach is especially drastic, with humanity running out of time if we want to limit the consequences of planetary destruction to an acceptable minimum.

This abstract awareness is slowly moving to the center of recent design discussions, and the realization of a need for a shifting mindset is becoming increasingly apparent. In a refreshing turn from the otherwise reactionary environment of the recent 2022 Milan furniture fair, the design duo Formafantasma organized a series of talks and panels. Notwithstanding an eponymous main sponsor with a questionable ethical and environmental record, the three-day event could represent a turning point that brings niche talking points into the attention of the design industry. The presentations were focused and alternative non-anthropocentric approaches, specifically in relation to Formafantasma's trademark topic, the forest. Ranging from multidisciplinary research to specific design approaches, many buzzwords of the theoretical discourse on non-anthropocentrism were mentioned. Among the panelists of the last session of the event, titled „Inhabiting,“ was the anthropologist Anna Tsing who underlined the need for „new morphologies,“ indicating that the physical output of design should incorporate the values of these manifold non-anthropocentric design approaches.^(Tsing, 2022) Form has to become the expression of concept, a manifestation of ideas and values. In talking about form and shape, we are a step further from the abstract calls for action in recent philosophical discourse.

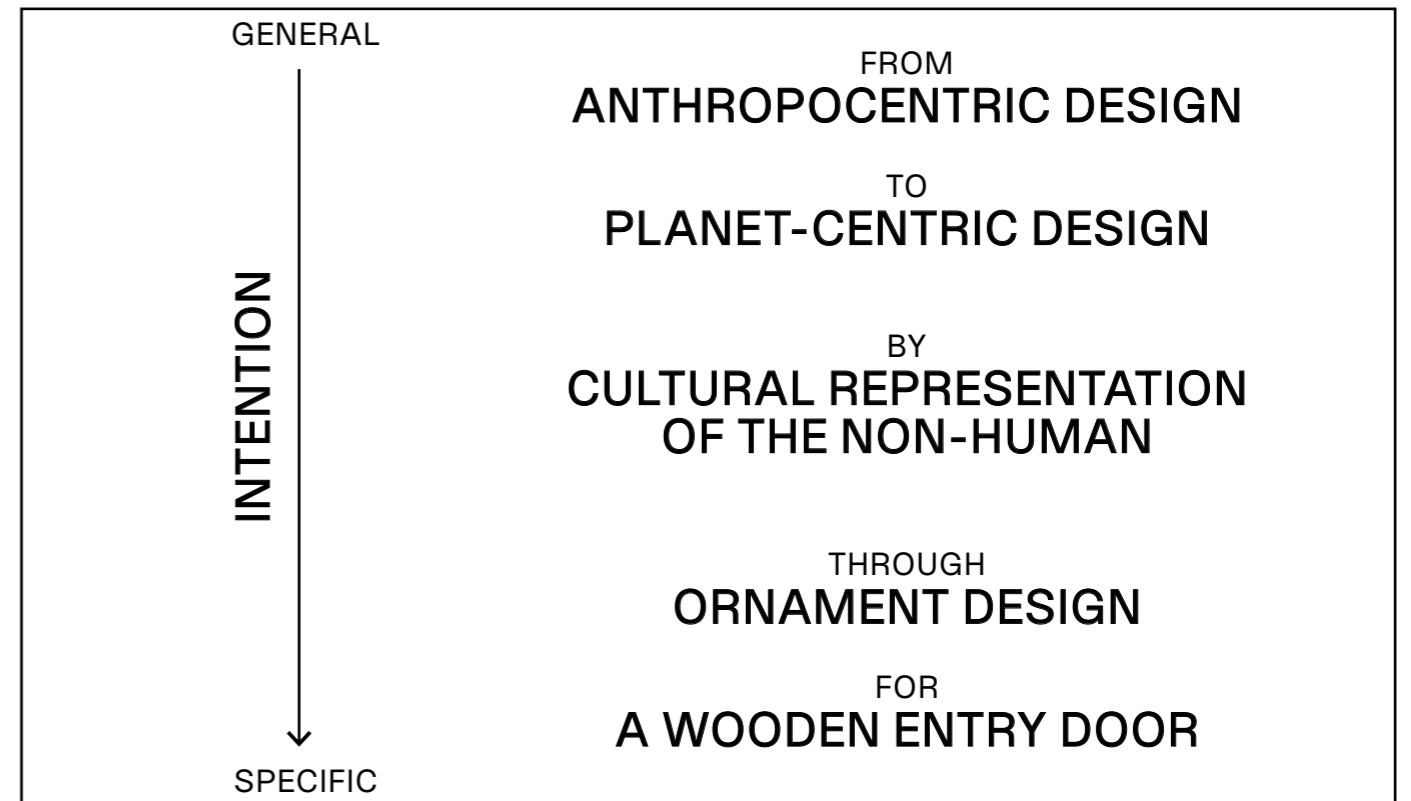
In an event with like-minded creatives where no one denies the emergency of human-made climate change, this is certainly easier said and accepted by all listeners. However, when looking at the actual design industry, it becomes apparent that while there are certainly inspiring case studies that exhibit precisely such a change in attitude towards a non-anthropocentric design, they are often found in a field of speculation. Figurative narratives and possible future scenarios are conceptualized and presented as a means of creating awareness. In a way, this contributes to building the needed „culture of change.“ However, in many instances, works within the field of „design for awareness“ are limited to an audience that is paradoxically already aware of what the design is trying to promote.

Planet-centric design will require significant transformation in the culture of consumption, changing behavior in questioning habits and convenience. While it remains questionable whether this is realistic in today's economic paradigm, we must find new ways to create value and value exchange to combat the crisis we currently face. For this, we need to reduce the extraction processes prevalent in the consequences of our work. Instead, planet-centric design must prioritize circular and no-waste solutions. Furthermore, to be clear, being circular does not create a magical switch that will allow consumption patterns to continue as is. Design must lay out its case with integrity. Educating clients and consumers on new approaches and ways of thinking will require a great deal of time and effort. It will not be possible to realize these new visions by meeting current expectations of convenience and comfort. In many cases, this will entail renunciation and degrowth. Respecting the non-human requires taking a step back. Or better, a humbling step down to an equal hierarchy of needs. The educational effort to achieve such a drastic shift in mindsets will have to become part of contemporary culture. Moreover, while this certainly includes the need for speculative design projects to paint possible future scenarios, it also includes a change in the present.

This work will try to present a purely visual expression of such a cultural paradigm shift. In particular, it tries to articulate a cultural representation through the means of the ornament. Ornaments and decoration can be traced back to the origins of human culture and have always been a public expression of the narratives and virtue of the culture they represent. In a way, they are a signifier of culture and its values. There is a language of the ornament that has a grammatical structure and is laced with symbolism and meaning.^(Trilling, 2001)

Much of this is lost in today's modern environment. Over the course of the twentieth century, Western taste tended to marginalize the ornament and instead favored minimalist, unadorned forms. Perhaps it is time for a revival of the ornament as an expression of a culture that embodies and embraces the values of a non-anthropocentric worldview. As a carrier of this visual expression of culture, this work proposes the typology of the entry door. As variable barriers between a known present and another potentially unknown future, doors are inherently symbolic. Doors embody transition. They allow passage from one space to another. In one way, they are purely functional and unambiguous objects: they are either entry or border: They are simple. However, in another way, they are the carriers of iconography and symbolism. Placed within the urban context, entry doors are part of the facade and thereby highly representative – they show, but also hide. As such doors are seen by many but entered by few, one side is private; the other is public.

ILL 003 conceptual framework of this thesis



Choosing the entry door as a canvas for an ornamental element meant to represent and promote the cultural values of a non-anthropocentric worldview might seem contradictory at first glance. After all, the invention of the first door, the artificial creation of an “inside” vs. an “outside,” can be seen as a step in the history of civilization that led to the significant emancipation of the human race from its earthly cohabitants.^(Siegert, 2012) The first concept of the door likely was a gate within a fold, serving to domesticate the first farm animals and marking a drastic step of human dominance over the non-human. Nevertheless, despite the cultural heritage, maybe the entry door can redeem itself by using its public face as a promotion canvas for the non-human cause. In combining a simplistic technical function with an abstract symbolic one, owned by private individuals but seen by the public, the door can present a platform for the ornamental expression of a transitional culture that puts humans and non-humans at eye level.

BACK- GROUND

DOORS: STORYTELLING AND REPRESENTATION

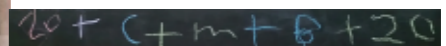
There is a proverb that portrays the door as the “mouth of the house.”^(Lenclos, 2005) Although the anthropomorphic meaning of this saying was probably originally meant to represent the door as a point of entry, it is equally fitting to interpret it as the door as a “mouth-piece”: It is an organ of communication, expressing the views of the private inside and projecting them toward the public outside. There was a historical tendency to use the door as a canvas for representation of status and imagery, both symbolic and depictive. The door was meant to represent the entire house and the owner’s social standing and was therefore plastered with illustrative and decorative elements. Through this, a door tries to impress - given that it is the first point of contact of visitor and host, bridging public and private space.^(Musil, 1936) Vivid examples where these patterns become apparent are the often awe-inspiring portals of religious buildings. Many of the most famous doors on this planet mark the entry point to a place of sacrality. A famous example of such prominent religious gates are the “Gates of Paradise,” the entry to Cattedrale di Santa Maria del Fiore in Florence. Similarly renowned are the gates to Notre Dame in Paris, decorated with intricate floral ornamental detail dating back to the 13th century. In Milan, the main portals of the Duomo are all carriers of elaborate ornamentation, elaborately designed down to the last detail.^{ILL 004}

The bronze doors of the central portal are about five meters in height and show the Seven Joys of the Virgin Mary opposite a depiction of her Seven Sorrows. First unveiled in 1906, the virtuously modeled reliefs combine neo-Gothic elements with those of Art Nouveau. Its design is the work of Italian sculptor and decorator Lodovico Pogliaghi. The biblical depictions of the bronze door are framed by marble decorations featuring ornamental flowers, fruits, and animals. The fine sculpting of the figures gives the work of art great liveliness, a homage by the sculptor to the traditions of the Renaissance. At the same time, Pogliaghi inserted the sculptural themes, which contain decorative elements reminiscent of the contemporary Liberty style, the Italian variant of Art Nouveau. This mix of artistic and stylistic periods is typical for European churches due to the complexity and ambition of the structure. They were often constructed over long periods, spanning multiple stylistic eras. In addition to the main door, there are four more bronze doors at the side of the cathedral. They were all added after the central portal, with the latest dating back to 1965.^(Veneranda Fabbrica del Duomo di Milano, 2022) Because of this, these side doors feature less ornamental extravaganza and instead display narrative imagery. Featured are f.ex milestones of Milanese history or a storyboard-like depiction of the life of Ambrose, the patron saint of Milan. In their complexity and stylistic eclecticism, the design of the Duomo doors provides an illustrative example of the representative “function-in-image” of ornamental elements on the canvas of the door. Ornamental depictions displayed on the surface of the gates effectively communicate a narrative, all without words. While they use both abstract and explicit figurative elements, they still manage to convey a story that is part of the cultural meaning of the building that the gates are guarding.

Historically, the entrances to private houses had a similar representative function. As the first point of contact with the house, the door had the purpose of illustrating the social standing of the homeowner.^(Musil, 1936) In a sense, the representative meaning applied when architects describe the door handle as the “handshake of a building” also applies to the house entrance in its entirety - it is the first impression. This function is further amplified by the use of various smaller objects (functional and decorative) in the periphery of the door. While doorbells, letterboxes, and doormats all do have functional elements, they often also feature some type of ornamental element aiming to welcome visitors. Aside from these secular objects, various objects or rituals accompany the door with spiritual and religious symbolism.



ILL 004 LODOVICO POGLIAGHI Main Door of Milan Duomo, 1906

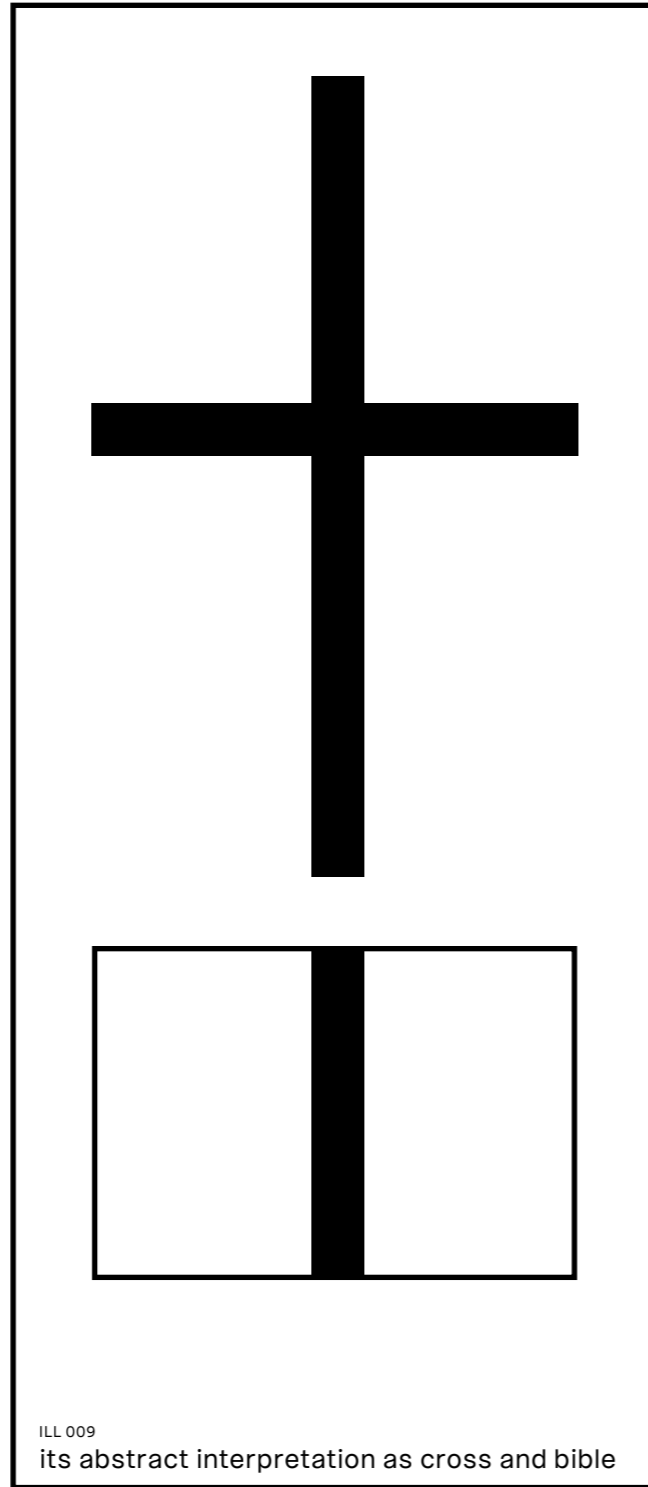
ILL 005
a brass mezuzahILL 006
door chalking “20+C+M+B+20”ILL 007
a rusty horseshoe

The mezuzah is a capsule attached to the door post, containing a short excerpt of the Tora and bearing significant meaning in traditional Jewish households.^{ILL 005} It is meant to be a constant reminder of divine presence and should be mounted at every doorframe (except bathrooms and storage rooms) in the household. In Christianity, similar symbolism is found f.ex in the traditions surrounding Saint Nicholas on December 6th or the annual ritual of “chalking the door” on Three Kings’ Day.^{ILL 006} A widely known, non-religious, superstitious practice is the display of a horseshoe on the door as a protective talisman and lucky charm.^{ILL 007} Besides adding ornamental detailing to the door panel or peripheral objects to the door, the symbolic meaning can also lie hidden in the construction method.

The design of the traditional six-panel door represents such an example, dating back to the 1800s and its origin in Georgian architecture, specifically its use in American colonial dwellings. Attentive eyes may recognize the top four panels as a representation of the Latin cross, with the lower two panels serving as an abstract depiction of an open bible. ILL008-009 Today, historians are discussing whether the symbolic meaning of the six panels as “cross-and-bible-door” was an intended visual representation of the Christian symbols or simply a subsequent misinterpretation of a construction method derived simply from stability reasons. (Kohlhaas & Boom, 2014) Before moving on to a more detailed look at residential doors in Milan, it is worth examining one additional historical example of a door being



ILL 008
a traditional Georgian six-panel door



ILL 009
its abstract interpretation as cross and bible

the carrier of communication. Yet another portal to a church, the gates to the church of Wittenberg bear great historical importance. Here, Martin Luther essentially proclaimed the Protestant Revolution by nailing his “95 Theses” for religious reform to the wooden gates of the All Saints’ Church. ILL010 While Luther’s theses are probably the most famous example of the intentional use of a door as a bulletin board, messages attached to the

church door were and still are an efficient means of communicating with the members of a religious community. Of course: if a message is to be read in all cases, a note on the door is a surefire method, even in non-religious settings. ILL011-013 All these cases illustrate the inherent function of the door as a carrier of symbolic meaning and communication.

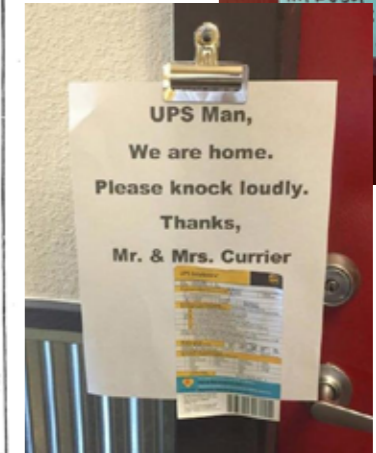
ILL 010 MARTIN LUTHER attaching his 95 theses to the church door



MILAN: A COLLECTION OF ENTRY DOORS

Aside from the impressive gates of its most famous religious building, the urban landscape of Milan offers a variety of impressive entrances to residential building. So much so that there is a coffee table book showing the most imposing “Entryways of Milan. Ingressi di Milano”. Although the 144 documented house entries and passages fall into the time period of 1920 to 1970 and thereby not into an era of pompous ornamentation, many of the entries nevertheless feature decorative and highly symbolic imagery meant to represent the status of the inhabitants and subsequently impress the visitors. (Kolbitz et al., 2017) Over the course of my last months in Italy, I personally noticed the representative grandeur of Milan’s entry doors, many constructed from massive wood and decorated with intricate ornamentation. The following pages show a selection of eye-catching doors that I captured while walking through the streets of Milan.

ILL 011, 012
notes left for the delivery service



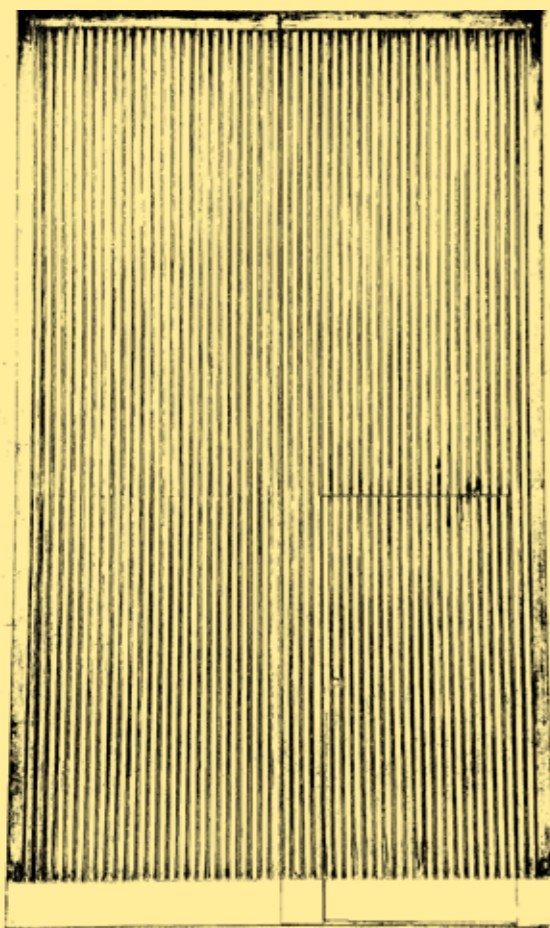
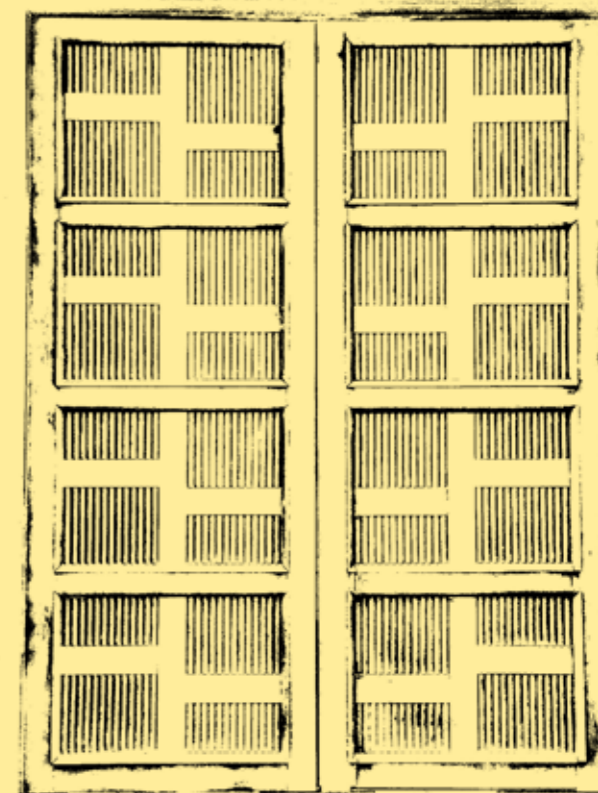
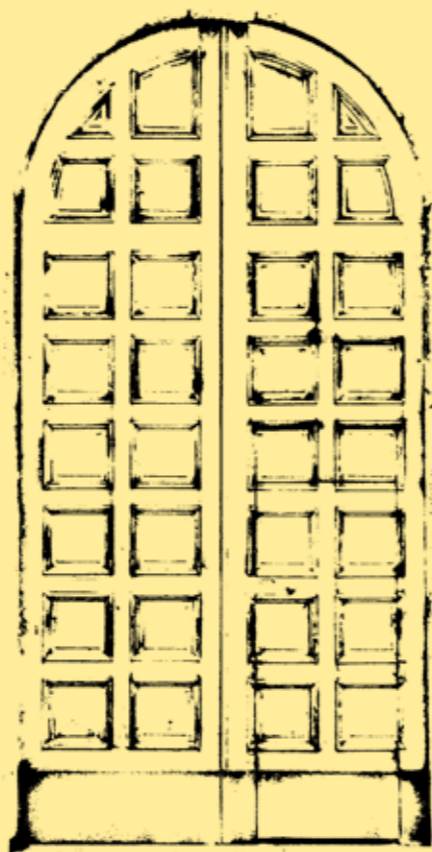
ILL 013
“DO NOT DISTURB” sign on a hotel room door





Especially in the streets around the Milanese city center, house entries are guarded with impressively large wooden doors. Many are decorated with beveled or embossed elements of ornamentation, using floral motives in the shape of palmettes or scrolls, geometrical elements of classical architecture, or a combination of both.





In many cases, the paneling structure of the wooden door, combined with simple straight cuts and grooves, can create a geometrical ornamental pattern that only consists of primitive shapes such as rectangles and circles.





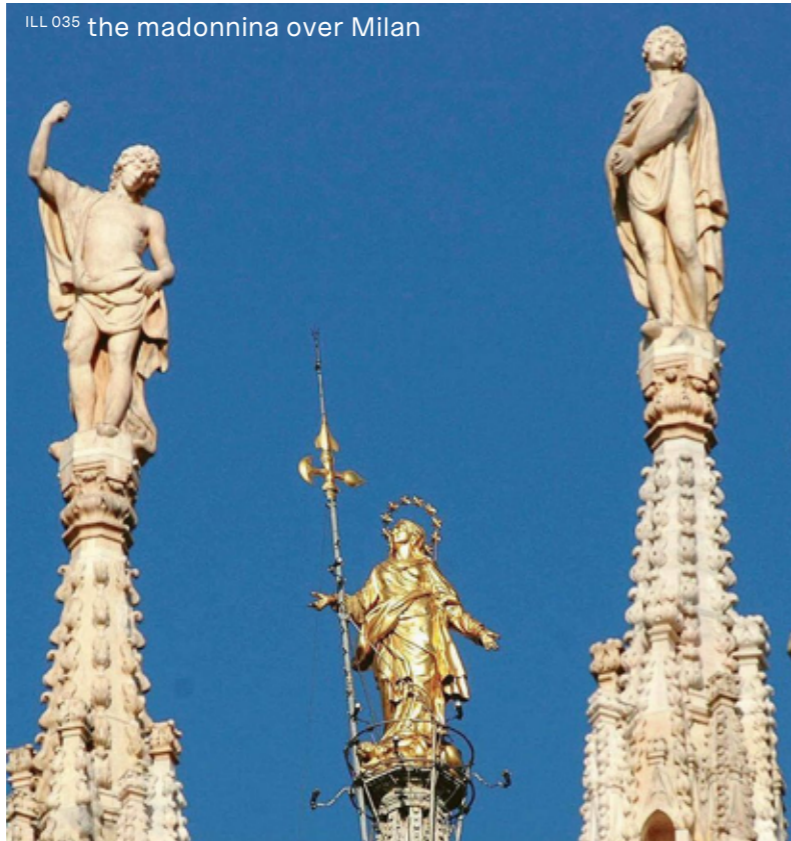
Over the last centuries, tall and intricate doors were built according to the high ceilings of the splendid townhouses and commonly used as a show of wealth. But they also served a practical function: doors built this big could fit carriages, cars, statues or furniture, or almost any scale. In order to avoid opening the large gates every time a person enters or leaves, smaller doors are added: The door inside the door is for the people. An interesting phenomenon occurs after a longer time of use. The small door, which is supposed to be hidden inside the big gate, becomes more visible only through the traces of everyday use of the inhabitants.



ORNARE

THE ORNAMENT AS A CULTURAL SIGNIFIER

An ornament is a usually repeating, often abstract, or abstracted visual element without function but a decorative or symbolic function in itself. Ornaments are found on fabrics, buildings, or as decorative additions to other artificial objects. It is essential to distinguish between the single ornament and ornamentation or decoration, which describes the agglomeration of ornamental elements in embellishing applications. Each ornamental element differs formally from the background surface and is often characterized by a combination of color, engraving, and relief.



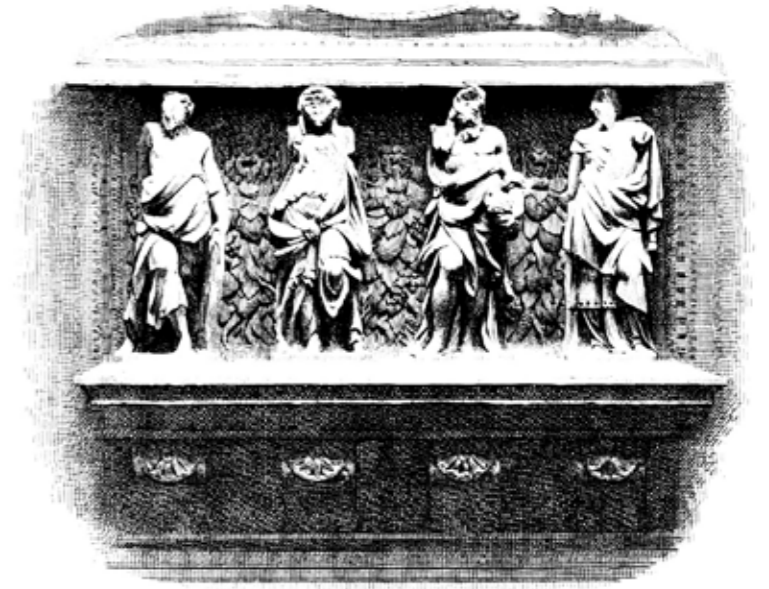
ILL 035 the madonnina over Milan

Figurative and plastic ornaments are opposed to abstract or stylized ones. Stylization may involve individual elements, forms, or movements. The more abstract an ornament is, the stronger it appears as independent from its figurative meaning. When arranged in a repetitive structure, ornamental elements can be characterized as patterns. In addition to their arrangement and degree of abstraction, ornaments differ in their relationship to the supporting surface. Ornaments can accentuate, divide, fill, and frame. Until the turn of the 20th century, the practice of ornamentation played a vital part in classical architecture and design; thorough knowledge of the “language of the ornament” and current ornamental practices was important for every creative process, but essential for architecture. (Trilling, 2001)

Single ornamental elements often depict imagery with symbolic or representational meaning. If we are to maintain the commonly used analogy of ornamentation as a language, it makes sense to take a closer look at the vocabulary. We can divide ornamental elements into six main categories: human, animal, botanical, artifacts, geometrical and typography.



ILL 036 a variety of mascarons



ILL 037 human statues as architectural ornaments

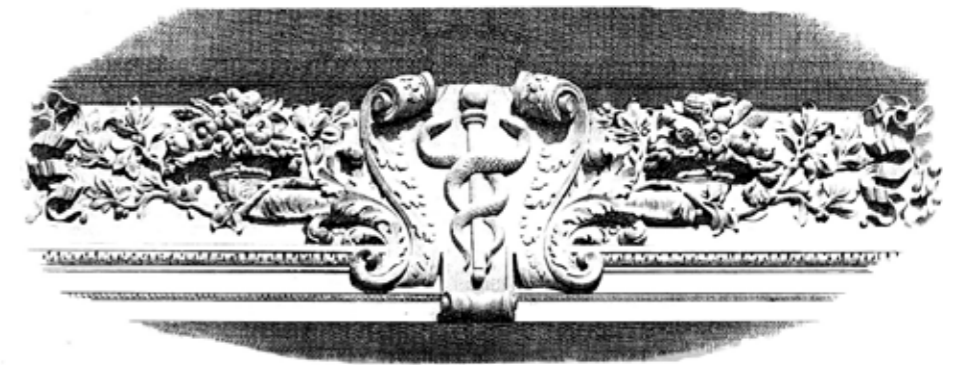
HUMAN: An ornamental element with substantial representative value is the recreation of human-like shapes in ornaments such as figurines, statues, or heads and faces. These could depict mythical, religious, or historical personalities with symbolic or allegorical meanings. In many European cities, these can be found on the facade of churches, often depicting biblical figures. An interesting subtype of human ornament is the mascarón, a depiction of a human or mythical, often chimeric, face intended to keep away evil spirits. ILL 036



ILL 039 sketches for animal head ornaments

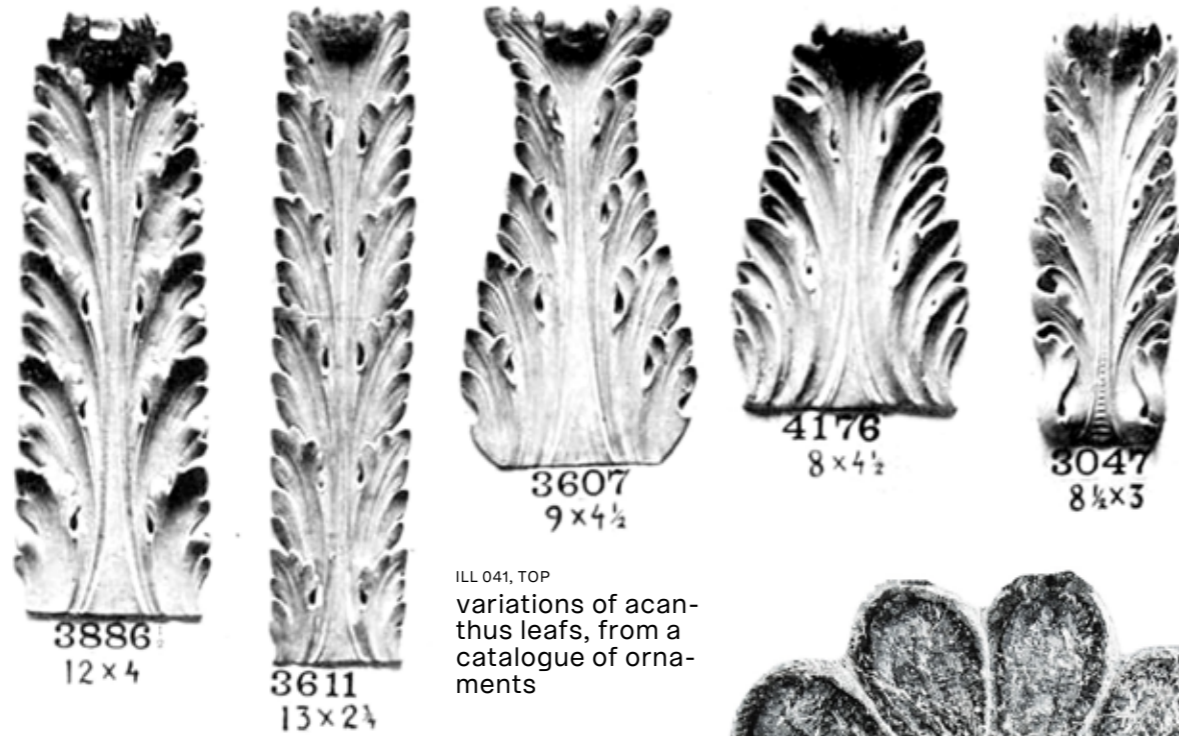


ILL 038 ornamental interpretation of the Venice lion



ILL 040 “Caduceus”, two serpents winding around a staff

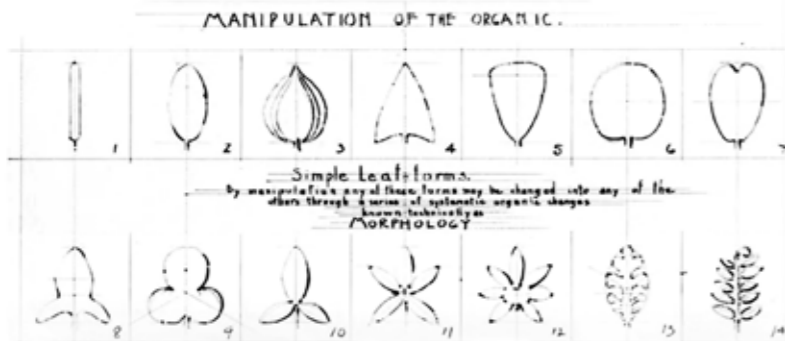
ANIMAL: A type of ornament that even more employs allegory and symbolism is the depiction of animal motifs. An animal ornament can depict real or mythical creatures but is seldom free of meaning. A lion or dragon almost certainly signifies strength, whereas a lamb is commonly depicted with the underlying meaning of a religious sacrifice. Of course, as with any ornamental feature, the meaning of the depicted animal varies throughout different civilizations. A different geographic location and the determined fauna lead to a variation in the animals depicted in culture and subsequently, ornamentation.



ILL 041, TOP variations of acanthus leaves, from a catalogue of ornaments

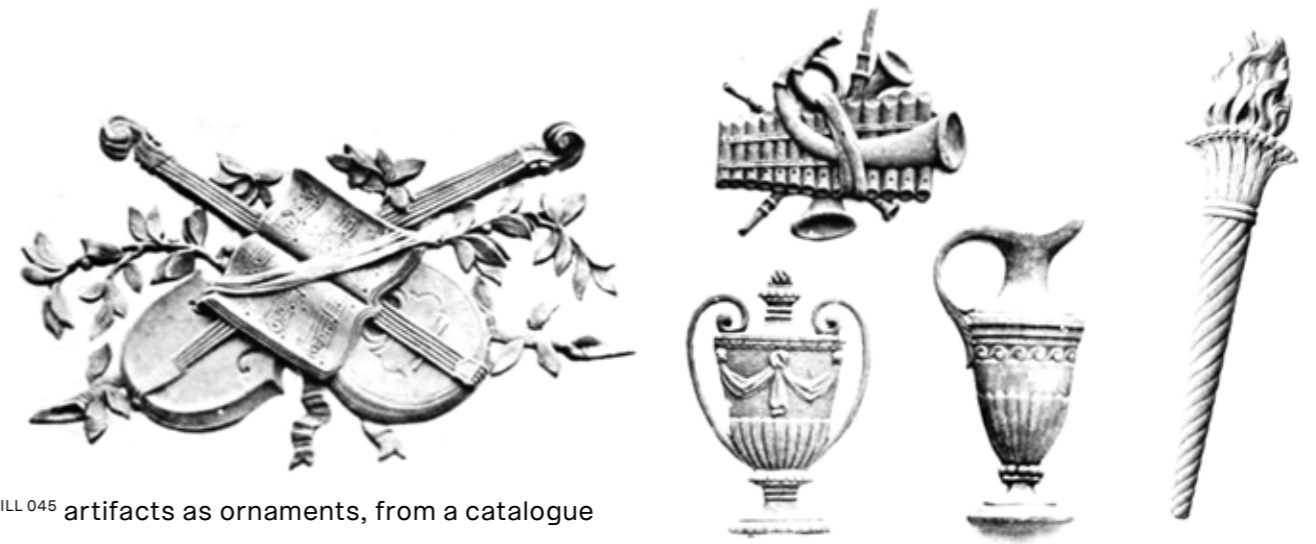


ILL 042, RIGHT lotus flower ornament



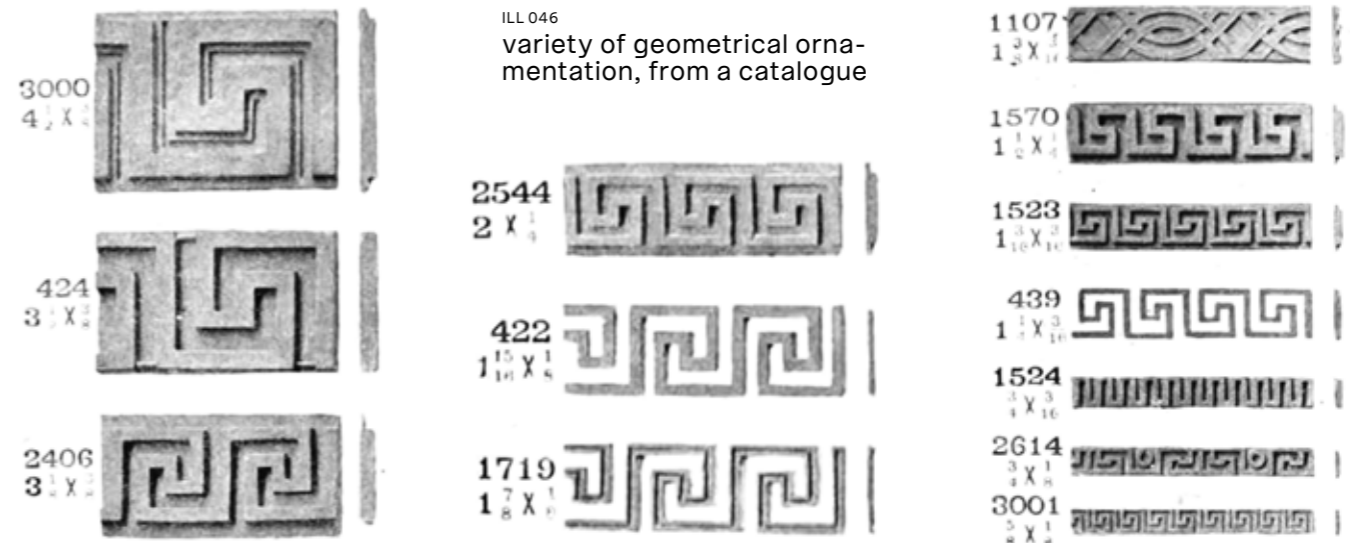
ILL 043 (LEFT), 044 (RIGHT) Louis Sullivan's sketches for floral ornamentation (LEFT), one of its applications in architecture (RIGHT)

BOTANICAL: Perhaps the most common depictive type of ornamentation is the one using vegetational motifs. Other than human or animal ornamental features, botanical decoration is often organized in patterns or distinct formations. Of course, also botanical motifs hold their share of symbolic meaning. A famous example in Western civilizations is the foliage ornament of the acanthus leaf, generally seen as a symbol of rebirth and resurrection. ILL 041 A Non-Western equivalent botanical is the lotus leaf, associated with a similar symbolic connotation. ILL 042 The architect Louis Sullivan, who, as the originator of the infamous phrase "form follows function," is often mistaken for a pure functionalist, was a master of the botanical ornament. He made detailed studies of leaves, petals, and plant growth patterns to design his intricate ornaments. ILL 043 - 044

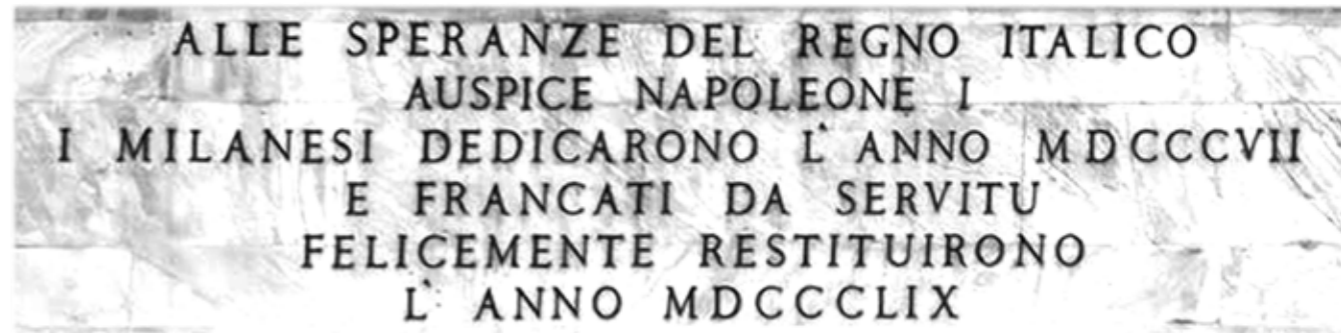


ILL 045 artifacts as ornaments, from a catalogue

ARTIFACTS: As a more recent and relatively rare classical type of ornament, the depiction of artifacts is equally high in symbolic meaning. Artifacts employed as ornamental features can be, f.ex, tools, instruments, or relics, many of which display symbolic or representative meaning.



GEOMETRICAL: The most abstract and, therefore, the least pregnant with meaning are ornamental features that consist of geometrical elements. Often employed in patterns or arrangements, these ornaments can be constructed from primitive shapes but also contain more complicated abstract geometrical figures. Often geometrical ornaments are combined with abstracted versions of other ornamental categories.



ILL 047 the inscription on the Arco della Pace in Milan

TYPOGRAPHY: In terms of meaning, writing represents the most explicit type of ornamentation. It often has no allegorical but mnemonic function and is used to convey direct meaning through unequivocal communication. Words can represent dates, themes, and concepts or serve as a monument to specific people, places, or events.

The process of selecting and combining ornamental elements, as well as their placement on the building or object, could be portrayed as the grammar of the ornament. In the same way as grammar, ornament relies on repetition and slight variation while remaining founded on memorable and recognizable principles. Over the centuries, manifold go-to principles and methods have been invented, developed further, and passed on to the next generation of artists, architects, and designers.^(Semmes, 2004)

ILL 048 "Cueva de los manos", Argentina, between 7000 - 1000 BC



Ornamentation is one of the earliest practices of human creative expression. Although the distinction between art and decoration is undoubtedly complex, there is evidence of using ornamental elements as early as 20 000 years ago.^(Lewis, 1990) Decorative drawings on the walls of stone caves depicted stories, and ceramic vessels decorated with ornaments can be found as early as the Stone Age. With the development of human civilization, the means of visual expression through ornamentation evolved. Different periods were shaped by different civilizations with particular cultural foundations. This resulted in distinctive forms of ornamentation. With each civilization building on and reinterpreting the visual language of their precursors and counterparts, ornamentation has grown a versatile history. Surely the creation of an anthology of stylistic epochs would go beyond the scope of this work and has already been done several times and long before by thematically more competent researchers. Some of the most intricate encyclopedic collections of ornament of such collections interestingly date back to the 19th century, a period where the ornamental practice was still the norm in architecture before becoming increasingly disdained at the beginning of the 20th century. Notable works include Owen Jones' "Grammar of Ornament" from 1856 and Alois Riegls' "Stilfragen. Eine Geschichte des Ornaments." (1893) A more recent publication (2001), "The Language of Ornament" by James Trilling, delivers a view on ornamental history from the perspective of modernity.

Ornament is studied not only as a genre of artistic expression but also in its development in the history of style and the context of cultural history. Ornamental elements of a stylistic era that are still a part of the urban landscape are those that can be attributed to art déco. Dating back to the start of the 20th century, art déco represents a rather literal attempt to come to terms with an accelerating modernization by incorporating sharp-edged, dynamic forms that seemed compatible with the impersonal energies of industrial society. As a last resort in a creative world otherwise swept by functionalist minimalism, art déco ornaments are the most prominent that can still be observed in many Western cities. This can be seen quite literally in some interpretations of geometrical ornamentation on Milanese wooden doors.

A MODERN ORNAMENT

With the rapidly accelerating reality of the twentieth century, Western taste tended to marginalize the ornament and instead favored minimalist, undecorated forms. With the exemption of a few fringe post-modernist counterrevolutionists, this development persisted until today. Very few newly-designed structures for public space embrace the ornament – instead, the public space design often favors minimalism over decoration. Ornamental and decorative applications have been displaced to the margins of visual expression, no longer present in the permanent manifestation of architectural structures but instead limited to superficial applications of short-term or one-use such as gift wraps or wallpaper. But, perhaps it is time for a revival of the ornament as an expression of a culture that embodies and celebrates the values of a non-anthropocentric worldview. Before arguing for and outlying a potential comeback of the ornament, it is crucial to examine the development that got us to where we are today.

By the turn of the century, ornaments and decorative elements were getting an increasingly scorned reputation. Conceptually, many attribute the renunciation of the ornament to the Austrian architect Adolf Loos. In his 1908 classic essay "Ornament and crime," Loos criticizes his contemporaries for ostensibly attempting to imitate ancient styles in what we now know as the eclectic epoch of neo-classicism. Instead, he calls on his generation to abandon the idea of the ornament altogether as he argues that modern society has evolved past the need for decoration.^(Loos, 1908) A modern building or object will find its shape through function; any ornamentation is superfluous. Many creatives, architects, and artists followed suit. What started as an ideological trend towards functionalism was further amplified by fresh creative impulses from newly founded creative hubs such as the Bauhaus.

From a purely economic perspective, the renunciation from ornamental practice made perfect sense. The increasingly industrialized manufacturing processes are, in fact, the most prominent and apparent reason for the displacement of ornamental features. With the rapid acceleration of industrialized processes came a dramatic increase in production capacity, and adding ornamental features was both skillfully challenging and highly time-consuming. While at first a consideration purely based on time efficiency, the effects remain today. In a world where almost every aspect of our daily lives is affected by globalization, the individual peculiarities of culture become generalized and blurry. Individualism got thrown under the bus when a significant part of public space and the market was synchronized in a globalized push for modernity. Although there is little research to back up this claim, one could argue that the practice of graffiti is a counter-movement to visual modernism. Placed within public view and executed without permission, graffiti is an expression of protest against the staleness of unordained, modern life. Although it would be wrong to reduce graffiti art to a purely aesthetic form of protest, it can be interpreted as an expression of the

VORTRAG
VERANSTALTET VOM AKAD.
ARCHITEKTEN VEREIN.

**ADOLF LOOS:
ORNAMENT
UND
VERBRECHEN.**

**FREITAG, DEN 21. FEBRUAR 1913,
1/8 ABENDS IM FESTSAAL DES
ÖSTERR. ING. U. ARCH. VEREINES,
I. ESCHENBACHGASSE 9.
KARTEN ZU 5, 4, 3, 2, 1 K
BEI KEHLENDÖRFER**

**12. MÄRZ:
MISS LEVETUS: ALTENGL. KATHEDRALEN.
MITTE MÄRZ:
DR. HABERFELD: ÜBER ADOLF LOOS.**

ILL 049 poster advertising a talk by ADOLF LOOS



ILL 050 AKIM "Bringing ugly back", 2008



ILL 052 - 055 collage of popular ornamental tattoos



ILL 051 etching on a pane of glass

inclination for ornament. Graffiti practices include additive (spraypainting), and destructive (scratching, etching) visual techniques and often display the need for individual expression. While graffiti was not around when Loos wrote "Ornament and crime," another technique of individualization was – Tattoos. While in Loos' text framed as a fashion exclusively appealing to either a "criminal or a degenerate," tattooing has sharply risen in popularity over the last thirty years, again showing signs of a trend towards individual ornamentation in the modern world.^(STATISTA, 2022)

In the context of the architectural work following his essay, it makes sense to take a second glance at Adolf Loos: While he indeed called for the abolition of ornament and was among the first to incorporate this principle in his practice, his reasons were more complex and less dogmatic than we remember today. Additionally, he himself found a way around his dogma. By highlighting the natural patterns of the building materials, mainly stone and wood, Loos introduced a type of ornamental style hidden behind his own diatribe against the ornament.^(Trilling, 2001) ILL 056 In doing so, Loos delivers a crucial clue for the comeback story of the ornament. While the somewhat paradoxical modernist ornament may have never existed, we might be on the trail toward a language of meta-modernist ornamentation.



ILL 056 ADOLF LOOS, Interior of Klatovská 12 in Pilsen, built in 1928

Historically crafted ornamentation draws a significant part of its fascination from the admiration for the skillful capabilities of the authoring craftsman. This artistic awe of a skillfully sculpted ornamental element fades when seeing the same element produced by a CNC mill. One could argue that the appreciation of craftsmanship comes from a human-centered mindset. By emphasizing the mastery of the craft in the production process, the process of manufacturing, done by a human, gets a meaning that is invisible in the end product. Today, computer-controlled machinery allows for manufacturing processes that save the time spent in production and remove all the emphasis of "man-made" in the artifact. With recent technological democratization and trends shifting towards local and small-batch manufacturing, we should see an increase in cultural differences in products compared with globalized mass manufacturing.^(Anderson, 2012) The ornament could serve as a remarkable cultural identity signifier that might embody the changes in both production methodologies while also representing a more conscious mindset that entails a sustainable consumption pattern. In order to achieve this shift in mindset, the ornament must represent the invisible entity behind the materiality of the product, and become a manifestation of the non-human. In the case of a wooden entry door, it should emphasize and visually express the reality of the tree whose wood was used to manufacture the door.

By empowering the entity behind and in the materiality, we lay the foundation for new meaning in the objects we design and produce. Like this, every object, through the use of ornament, can become an individual piece representing more than just a product of a globalized consumption pattern. Consequently, we as consumers could gain a new-found appreciation for the things we buy and own. If the ornament returns as a cultural and symbolic means of communication, it could translate and visualize the otherwise invisible reality behind the origins of production and manufacturing. As a result, it may lead us to develop more sustainable consumption habits: Finding appreciation for the objects we have and challenging whether a new purchase is really necessary.

ILL 057 WW



MERGING CULTURE AND NATURE

Without the overwhelming efficiency of industrialization and Loos' fatal blow, the fate of the ornamentation might have taken a different turn. In the late 19th century came an exciting approach emphasizing the importance of the craft and expression of the ornament that drew a remarkable connection to nature. Still today, the Arts and Crafts movement offers possible inspiration for a contemporary approach to ornamentation. As a counter-movement to proliferating growth of industrial production, the Arts and Crafts movement offered a different perspective on manufacturing. The focus was on returning to the handmade craft and the material's natural beauty. Although not the main objective, through the appreciation for materiality, this conceptual approach comprised principles of ecology and sustainability. Many of the motifs employed by Arts and Crafts artists and designers were derived from natural forms. One of the ideological spokespeople of the movement, John Ruskin, was particularly fond of the artistic connection to the natural environment, essentially stating that beauty can only come from nature.^(Ruskin, 1881) The aesthetical infatuation with the shapes of nature can also be observed at the start of the 20th century. Building a conceptual bridge between scientific research and artistic inspiration and beauty, publications like "Kunst-

formen der Natur" (1904) by the zoologist Ernst Haeckel and, in 1917, "On Growth and Form" by the mathematical biologist D'Arcy Wentworth Thompson sparked interest in the shapes of natural beauty and influenced artistic movements of the time. Especially Haeckel's book, a collection of lithographies including 100 depictions of organisms in colorful illustrations, is said to have influenced artistic and ornamental works of the art nouveau at the time.

If we look at the relationship between scientific research and artistic expression today, it becomes apparent that the transfer is more challenging than it seemed about 100 years ago. An imagery of ecology, let alone an ornamental style, can not be adapted from climate data research. Yet still, we have stripped our lives of any depiction of the non-human part of nature. Is it that modernity, not only through an extractive, globalized economic system but also through the concurrent style of visual expression, has detached humanity so far from the rest of the world that there is no longer any representation of nature? Something will change significantly when we understand that we are primarily destroying ourselves, not our environment. As humans, we are not above but part of the global ecosystem. We need to recognize that every form of culture is an extension of evolutionary processes that continue on a spiritual and collective level. There is an inherent human fascination for the beauty of nature and the non-human, and it can drive us towards a more sustainable mindset. Unfortunately, in cities, the habitat of more than half of human life, there is very little representation of this natural beauty. For us to act in a non-anthropocentric manner, we have to transform the urban environment according to the values of sustainability that we strive for. To act on our biophilic tendencies, we must confront and surround ourselves with nature and constantly be reminded of the equal presence of the non-human.^(Fromm, 1964) Nature has to become a part of human cultural expression, which is why this work would like to propose the expressive visual potential of ornamentation as a means to do just that: Merge culture and nature.

At this point, it is appropriate to lay out the conditions of this maxim further. What does it mean to (re-)integrate nature into cultural expression? Ergo, what does a non-anthropocentric but planet-centric visual expression of culture entail? A quote from the philosopher Emanuele Coccia may provide some clarity for answering this open question.

"The city must become what makes the contemporaneity of nature possible. Nature is not the prehistory of civilization. It is our present and above all our future. It is always a futuristic projection of the present – its metamorphosis."^(Coccia, 2021)

The focus on urban environments here is evident: As cities have become the main venue of human life, the urban habitat has to incorporate more representations of nature, and cities will have to incorporate biophilic design ideas. This includes creating living space for non-human species; animals, microorganisms, and trees. In the long run, many cities worldwide have already recognized this necessity. In the most literal consequence, this means integrating more green spaces and trees in the urban environment: greener streets, squares and facades. In addition to the obvious health benefits for both human and non-human city residents, the adaptation of these planet-centric design strategies will make cities more resilient when dealing with the consequences of the climate crisis in the long run. These functional changes to city infrastructure should already be able to shift a city's culture towards a more sustainable attitude. But, it is not advisable to simply slap plants and flowers on every part of a modern city. Therefore, the biophilic shift of cities should be accompanied by a visual language of the ornament, one that symbolizes the non-human element behind the objects it decorates. The first steps of this proposed biophilic aesthetic will be ascertained in the next part of this thesis.

INSPIRE

NON-HUMAN STYLE



ILL 058 ROSEMARY LAING Greenwork: Aerial wall, 1995

So far, this work has established some potential of a comeback of the ornament. In using the function-in-image of explicitly non-functional, decorative visual elements, a meta-modern style of biophilic aesthetics can be explored. An expressive visual style that embodies a post-idealist philosophy that grants equal representation to non-human agents. But here's where it gets a little tricky: The designed object is an entry door, and by definition, placed purely in a human context. While it would likely be an intriguing exercise to challenge the typology of the door itself and design a speculative door for the non-human, this work's conceptual focus lies in the cultural potential of the ornament. Culture in itself is the ultimate inherently human construct, which is where the abstract paradoxes of a non-anthropocentric worldview become painfully apparent. If we as humans establish a mindset that merges culture with nature and give equal attention to the concept of non-human agency, the mindset itself is anthropogenic and therefore doesn't do the essential prerequisite justice. While advocates of object-oriented ontology dismiss similar objections as mere tautologies, there is undoubtedly some questionable mind acrobatics required to overlook this specific paradox. Nevertheless, I would like to argue that those philosophical contradictions do not matter when the abstract becomes material reality. There is little benefit in dwelling in further metaphysical objections when shifting from abstract thinking to practical application. As a matter of fact, it is impossible to find a satisfactory solution to these paradoxes. Philosophy is, by definition, not supposed to reach a definitive answer. After all, "Philosophia" is the love of wisdom, not wisdom itself.^(Harman, 2012) Which is why this work now happily leaves its abstract chapter behind to instead tackle conceptual explorations through the examination of real-world physical phenomena.

At first glance, this seems like a somewhat cheap and easy way out. And to be clear, this is not to say that there is no way to extract tangible principles from the preceding philosophical excursion. However, it is important to be aware of the first deductive step

that occurs when leaving the field of philosophical theory and entering creative practice. In this particular case of ornamentation on an entry door, a simple set of applicable guides can be derived from the foregoing discussion. With the ornament being a cultural signifier, we can now outline the virtues behind a non-anthropocentric approach. The argument for a departure from a Kantian, anthropocentric approach often comes from the same standpoint, only in the opposite direction. In the abstract act of placing the human in the center of the universe, we encouraged and reinforced behaviors that disregarded and harmed the non-human. Equally, we can now establish principles that are derived from the non-anthropocentric worldview, a morality of the planet-centric.

In fact, there are plenty of creative thinkers and makers that we can reference at this point for a definition of non-anthropocentric values and design guidelines. Simply said, designing with a planet-centric mindset requires a focus on ecological sustainability on every level. This includes but is not limited to designing for long-lasting use, appropriate choice of materials and manufacturing methods and applications. In this it is essential to acknowledge and respect the agency of the non-human entities directly or indirectly involved and affected by any part of the designed process. These tenets of planet-centric design are two-fold as they contain both a practical and a symbolic approach. A design that respects the non-human must reflect these principles both through applied process and visual representation. The focus of the following examples is on the side of visual expression. Therefore, they aim to explore angles of inspiration from the aesthetics of naturally occurring phenomena.

When exploring contemporary ornamentation that combines a non-anthropocentric worldview with a biophilic attitude, it seems logical to turn to non-human actors of nature. The following chapter will explore the formation of existing imagery in non-human contexts, laying out the scope of naturally-occurring pattern formation in general and presenting three case studies in particular. In addition to these nature studies, examples of adaptations from the fields of art and architecture that show remarkable integration of non-human entities in creating will showcase what are essentially multi-species designs.



ILL 059 a different type of non-human style

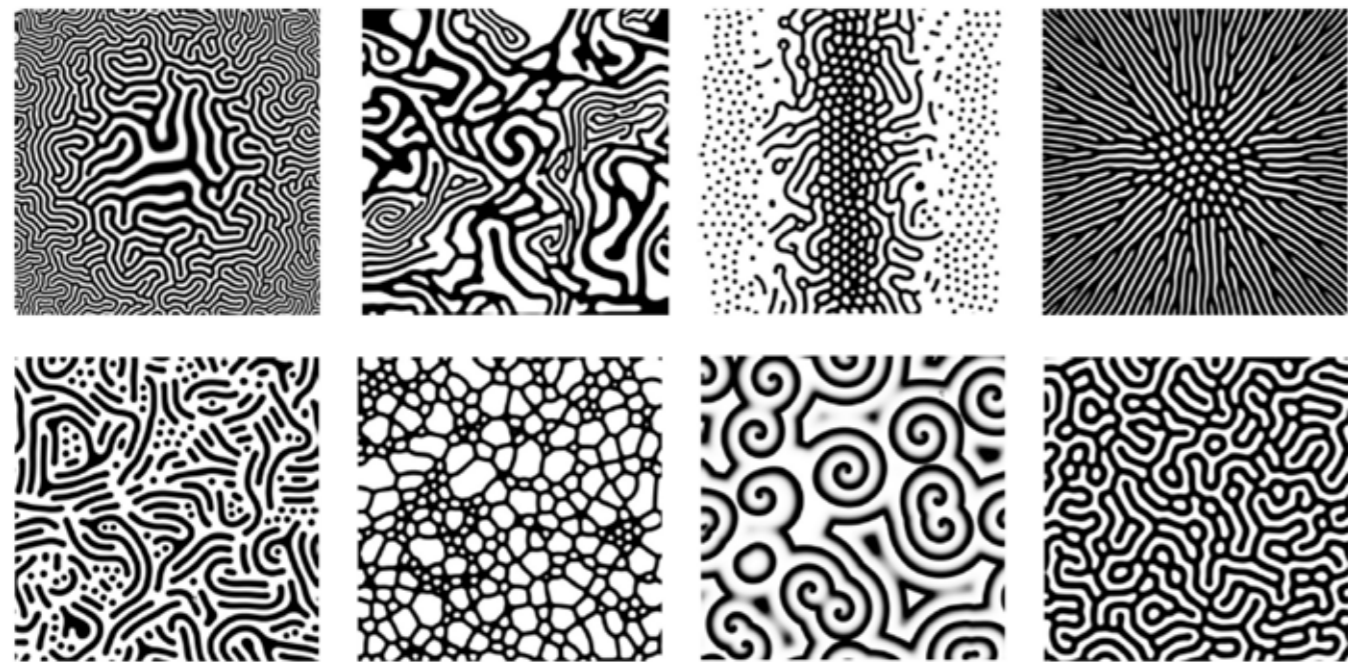
PATTERNS IN NATURE

The apparent randomness and irregularity of naturally-occurring phenomena make the perception of such phenomena fascinating. Yet, at a closer look, there is order in chaos. How a single cell, a zygote, can generate the complex pattern of an organism is a fundamental question in developmental biology. Scientific consensus today states that chemicals known as morphogens dictate the distribution of an organism's morphology, or overall form, as it develops. This "morphogenesis" is the driving principle behind the formation of patterns in nature. Already in 1952, the mathematician Alan Turing outlined the theoretical foundation of a mechanism that explained how and why morphogens distribute in organisms.^(TURING, 1952) Turing demonstrated that a specific structure materializes within a chemical reaction and diffusion. These emerging structures are nowadays eponymously known as Turing patterns.

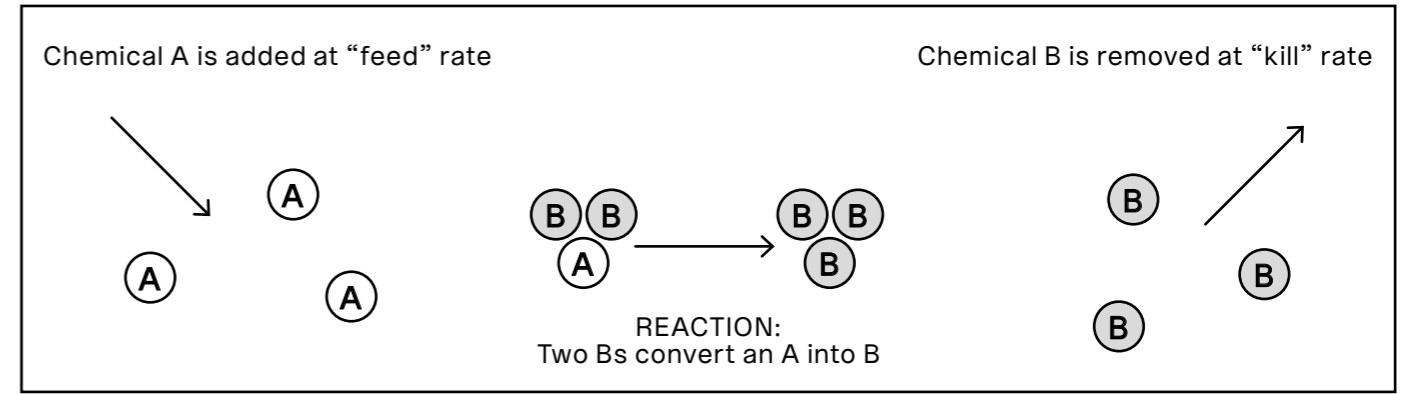
Reaction-diffusion systems appear in various areas throughout nature. The most visible occurrences of Turing patterns are on the skin: F.ex, the pattern found in a leopard's spots, has been explained as a Turing pattern. Other reaction-diffusion structures within the animal world include the stripes on a zebra or the maze on a pufferfish. Humans also feature instances of Turing patterns: our fingerprints are similarly driven by reaction and diffusion.^{ILL 060} While the reaction-diffusion system was initially conceived as an exclusively biological model, many other phenomena throughout the universe arise from the combining movement of material with the formation of structures. For instance, the shape of sand ripples in a desert,^{ILL 064} as well as star formations within galaxies, can be linked to Turing-like patterns.^(Schöneberg et al., 2014)



ILL 060
the human fingerprint is based on reaction-diffusion systems



ILL 061 visual simulations resulting in various manifestations of Turing patterns



ILL 062
schematic process of two chemicals reacting and diffusing

ILL 063
simplified equation of a reaction-diffusion simulation in a 2D grid, can be used to generate patterns like the ones in ILL 061

$$A' = A + (D_A \nabla^2 A - AB^2 + f(1-A)) \Delta t$$

$$B' = B + (D_B \nabla^2 B + AB^2 - (k+f)B) \Delta t$$

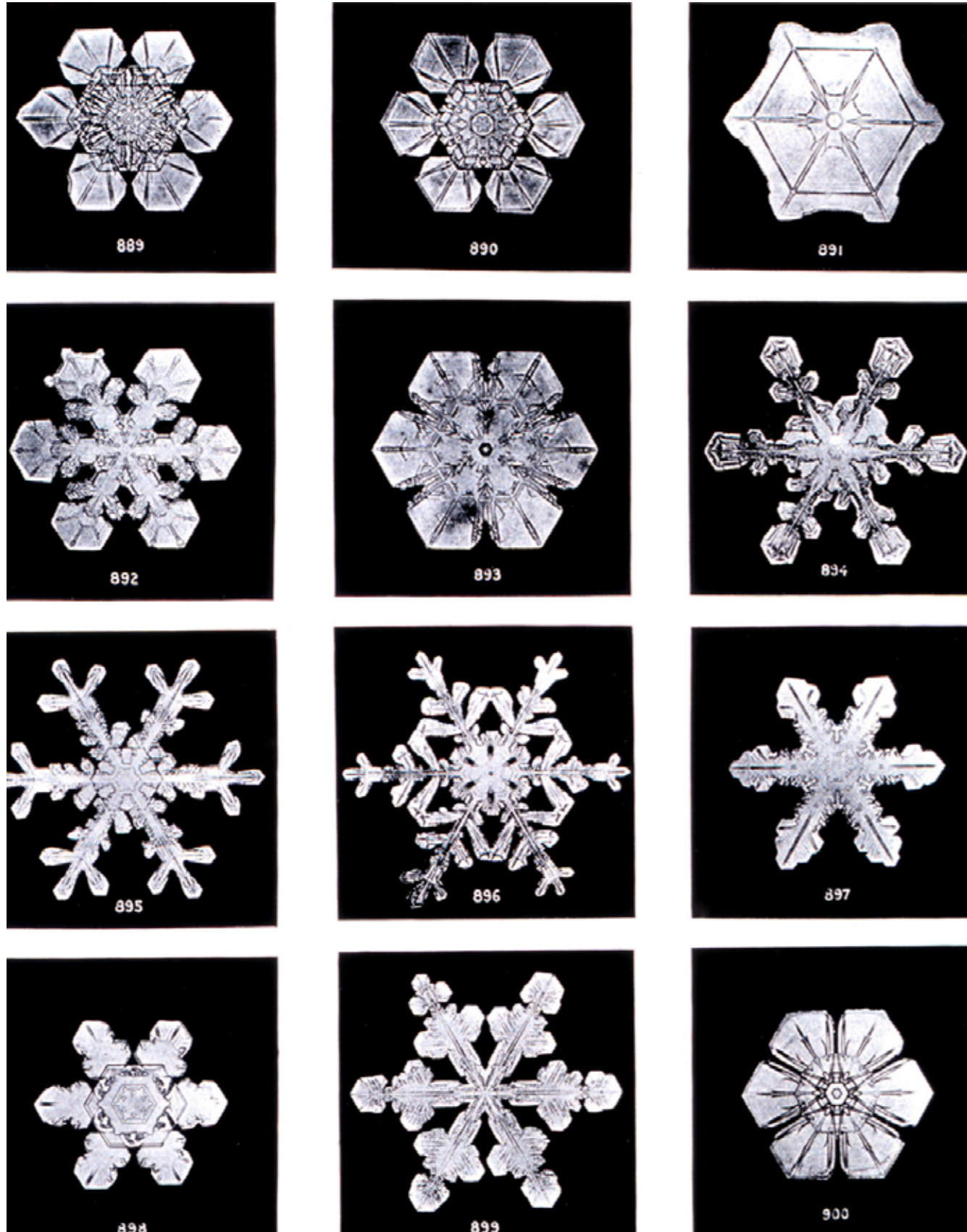
Labels in the diagram:
 - "feed" rate f (points to $f(1-A)$)
 - iteration speed Δt (points to Δt)
 - "kill" rate k (points to $(k+f)B$)
 - DIFFUSION rates for A & B (points to D_A and D_B)
 - REACTION (points to the reaction terms $-AB^2$ and $+AB^2$)

2D Laplacian functions, giving the difference between the average of nearby grid cells and this cell. This simulates diffusion because A and B become more like their neighbors

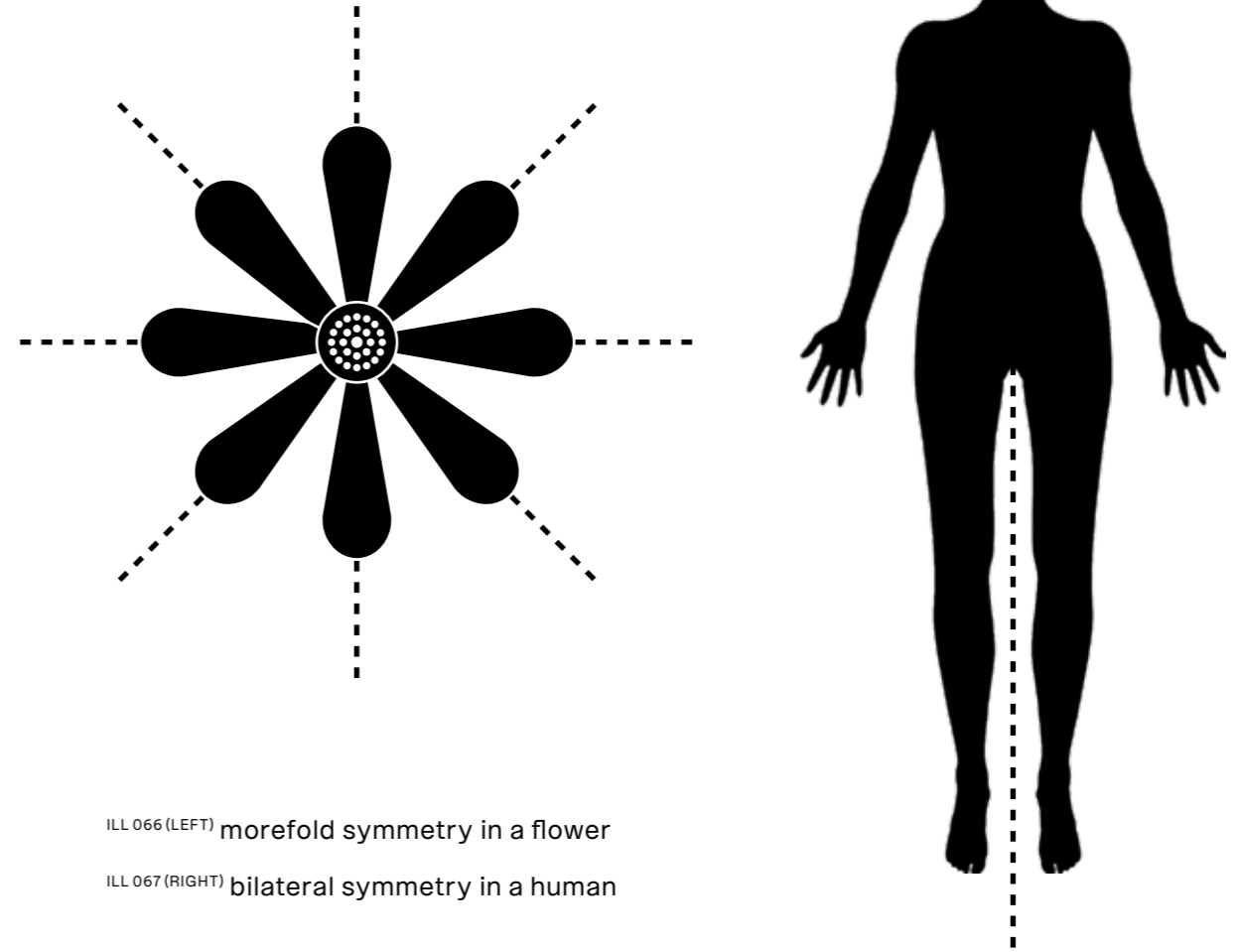


ILL 064
distribution of sand ripples in the desert

Visible regularities and repetitions in nature appear in a wide variety of patterns. Although these patterns can not be limited to any classification and are often part of multiple, the following examples present some of the patterns that form in nature:



ILL 065 WILSON BENTLEY microscopic photographs of snowflakes, 1902



ILL 066 (LEFT) morefold symmetry in a flower

ILL 067 (RIGHT) bilateral symmetry in a human

SYMMETRY

Symmetry, in some way or form, is prevalent in every living organism. Most animals exhibit bilateral or mirror symmetry in many features of their body structure.^{ILL 067} Symmetry can also be found in the leaves and flowers of many plants, often in the form of more-fold, rotational or radial symmetry.^{(Stewart, 2001), ILL 066} The degree of perfectly identical sides in these symmetrical formations can vary. Natural phenomena that approximate perfect symmetry are equally well suited for cultural and stylistic adaptation, such as the aforementioned leaves and flowers. Due to their high recognition value, these graphic adaptations are often rich in symbolism and are well-known staples in human-made ornamental and decorative patterns. Another fascinating case of seemingly perfect symmetrical pattern formation in nature can be observed in the shape of snowflakes. Snowflakes form when cooled water droplets attach to crystallization nuclei (for example, dust particles) in the clouds and freeze there. This process creates the familiar hexagonal shapes, essentially scaling up structural rules from the molecular level to shapes that can be seen with the bare eye. One of the first researchers to capture and classify snowflakes is Wilson Bentley, who managed to photograph over 5000 different snow crystals under a microscope.^{ILL 065} In 1922, he famously claimed “that no two snowflakes are alike.” In fact, despite the mathematical rules behind snowflake formation due to the wide variety of parameters that go into the growth of a single crystal, it is highly improbable to find two identical snowflakes in nature. The iconic shape of snowflakes is easily imitated, which makes them easily recognizable and adaptable for cultural use. Snowflakes are used as the universal symbol for snow and cold temperatures.

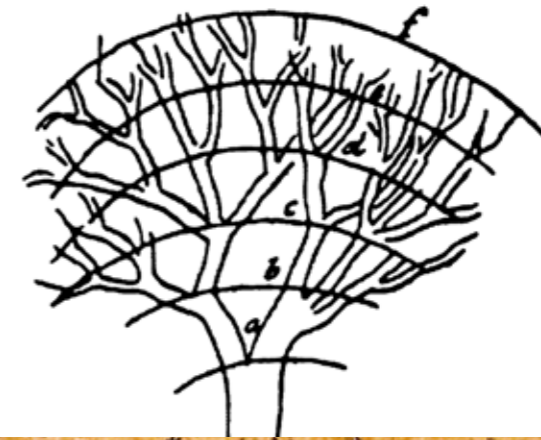


ILL 068 Romanesco cauliflower

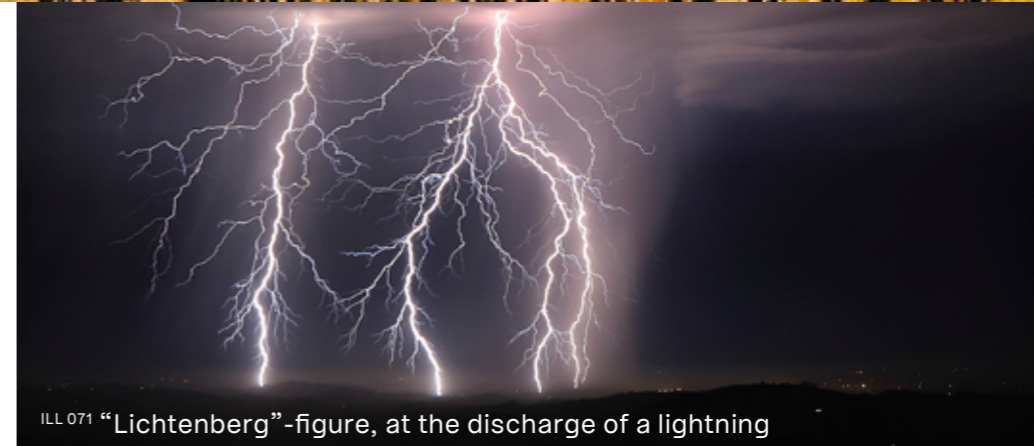
FRACTALS

Another approximation of figures that appear in seemingly organized formations in nature are fractals. ^(Mandelbrot, 1983) In theory, a fractal is a geometrical figure that has infinite self-similarity and scale evidence. But of course, the number of levels of self-similar structures in natural fractals is limited. Typical examples from biology are the fractal structures that can be observed in ferns or the cauliflower species Romanesco. ^{ILL 068} Widespread are fractal structures without strict but with statistical self-similarity. These include, for instance, trees and their branch structure, blood vessels, river systems, clouds, and coastlines. Fascinating permanent visual manifestations of natural approximate fractals are crystal dendrites: Crystals whose shapes evolve with the formation of multiple branches. While the earlier mentioned snowflakes are probably the archetype of dendritic crystals, they can also shape in minerals. ^{ILL 070} Mineral dendrites exhibit a striking visual similarity to the branch structure of plants, hence the name (from Greek: dendron = tree).

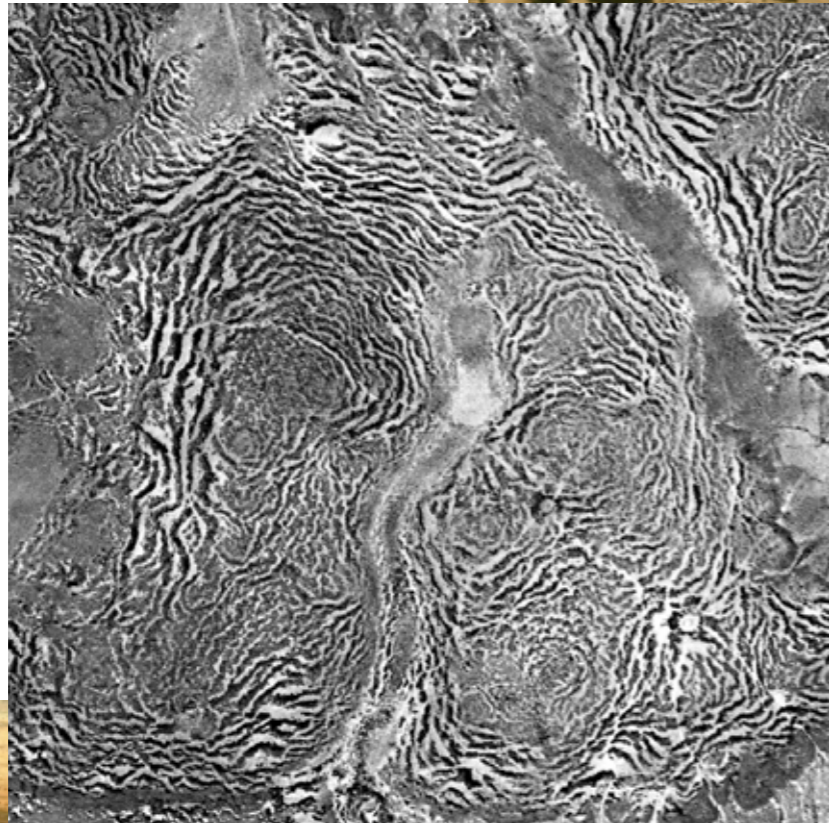
ILL 069 LEONARDO DA VINCI sketch of tree growth pattern



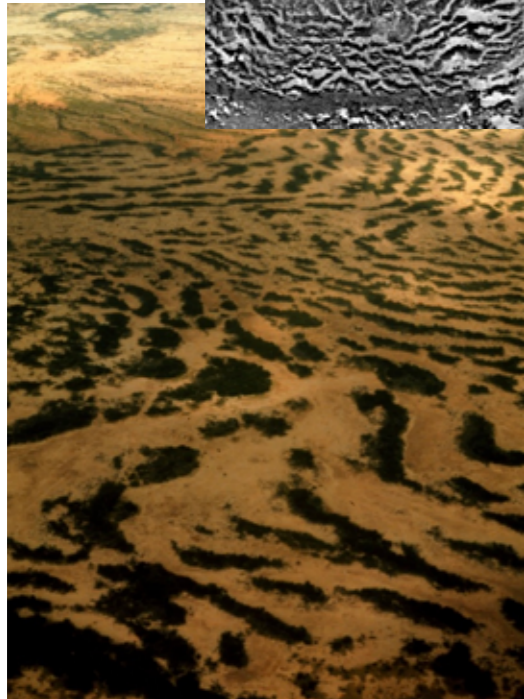
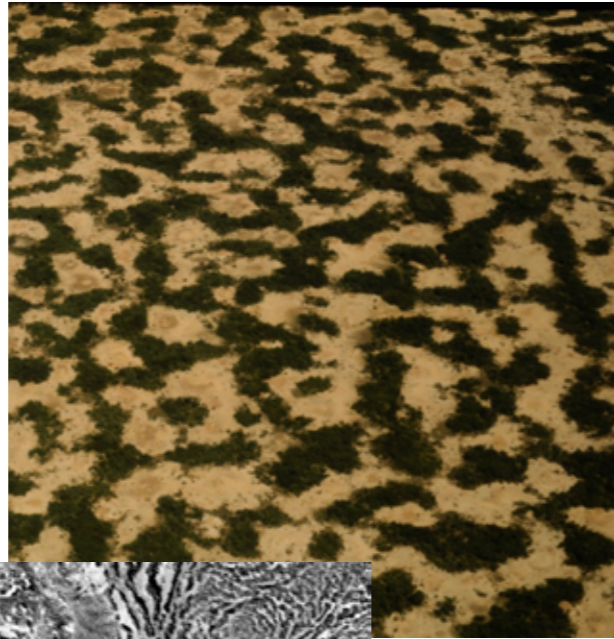
ILL 070 a mineral dendrite in limestone



ILL 071 "Lichtenberg"-figure, at the discharge of a lightning



ILL 072 - 074
variations of tiger bush
vegetation patterns



ILL 075 spots on a leopard



ILL 076 stripes on a zebra

SPOTS & STRIPES

Primarily known from animal skin and fur, many naturally occurring spot and stripe patterns fulfill camouflage functions in a diffuse environment.^(Ball, 2011) In tigers and leopards, this functional pattern makes the predatory cats harder to spot, facilitating the hunt. But also prey animals, a spotted or stripey pattern can eke out a decisive advantage in the wild. The patterns evolved over many evolutionary iterations, as the animals carrying the gene responsible for pattern formation had higher chances of survival.^{ILL 075 - 076} Scientific findings indicate that the patterns form based on processes modeled in the reaction-diffusion model. While the patterns in animal furs are widely-known, spot- and stripe-like arrangements can also arise from the spatial ecology of plant species. The “tiger bush” phenomenon describes a distinctly distributed vegetation community consisting of alternating bands of trees, shrubs, or grass.^{ILL 072 - 074} When seen from an aerial view, these distribution patterns have a striking resemblance to the pattern found on a tiger’s fur. Tiger bush occurs almost exclusively on low slopes in arid and semi-arid regions. Although these vegetation patterns are stable over long periods, the specific patterning requires distinct climatic conditions. For instance, a decrease in rainfall can trigger patterning in formerly dense vegetation.^(Meron, 2018) Physicists and mathematicians continue researching the exact causes and origins of different vegetation patterns. However, the similarity to reaction-diffusion-based systems indicates a correlation, suggesting that the diffusion of water and the reaction of the vegetable community are responsible for pattern formation. Since, due to the ongoing global heating of the planet, more land areas are running the risk of turning into dryland, the spread of tiger bush and similar vegetation patterns is increasingly likely. As such, the pattern could serve as a symbol for the real-world consequences of anthropogenic climate change.

ILL 077 cracks, result of a dried out lake



CRACKS

A pattern with a similar potential of being an allegory for the climate crisis is that of cracks. Openings in a material surface that form as a result of stress are called cracks. Eventually, elastic materials reach their breaking strength and fail suddenly in all directions, creating cracks with 120-degree joints meaning that three cracks meet at a junction.^(Stevens, 1974) These recognizable patterns often form when materials dry up quickly, leading to high material stress. In recent years, imagery of dried-up lakes and rivers has become a staple of climate change journalism, cementing itself as an icon and potential symbolic pattern.^{ILL 077} As such, it connects to the disasters of heatwaves and the depletion of freshwater resources. A crack pattern that is less charged with symbolism appears in tree bark. Here, cracks in the bark appear to relieve stress due to growth. Since different tree species have distinct tissues at the cell level, they all generate a diverse pattern of splitting in their bark.^{ILL 078 - 081}



ILL 078 - 081 different tree bark patterns

BARK BEETLE GALLERIES

Since the final object to be decorated with ornamentation will be a wooden entry door, it makes sense to explore other patterns that arise in trees. Apart from the bark pattern in a healthy tree, the development in recent years gave rise to the fast spread of a different wood pattern. And, as with cracks in dried-up lakes, most likely climate change is to blame, as changing climate and desiccation have significantly strained the European forest. In a silviculture industry that has focussed on a foresting strategy of monocultures, the results are forests that prove to be less resilient. Raising temperatures and water scarcity are massive problems on their own, but have subsequently led to a massive spread of parasitic pests like the bark beetle. Usually, unless it occurs as an overpopulation, the bark beetle is a crucial component of a healthy forest: It plays a critical role in decomposing decaying deadwood. However, under the particular circumstances of drought and higher temperatures, the beetle population can increase so intensely that it spreads to healthy trees – often leading to the widespread death of forest stands. ^{ILL 082}

Under normal conditions, healthy trees can defend themselves against these pests. With the increased production of tree gum, the beetles get stuck and are unable to penetrate the bark. However, if the resin formation is impaired by prolonged water scarcity, the rapid spread of bark beetles can hardly be prevented. In Europe alone, there are over 150 bark beetle species – worldwide, there are several thousand. The most common species in Europe, and the one currently occurring in invasive quantities, is the European spruce bark beetle. Whether bark beetles have infested a tree can be recognized by the fact that the tree crown first turns red and later gray. A closer look at the trunk and thicker branches will reveal holes drilled by the beetle. However, the beetle infestation can be seen particularly clearly under the bark: The beetle's tunnels are clearly visible in the wood and form fine lines in all possible directions. A beautiful pattern were it not the consequence of a devastating pest. In recent years, European spruce populations in particular have suffered massively from bark beetle infestation. Still, in forestry, there are several ways to defend against the bark beetle. These include, for example, the conversion of pure conifer monoculture populations into mixed forests rich in hardwoods. Measures like this take their time, but make the forest much more stable against abiotic and biotic damages, including those caused by pest infestations.

If a tree is contaminated, it is vital to act quickly: Infested spruces should be cut down and debarked. The cut wood must be stored in dry conditions and away from other, healthy wood. Once the wood is in the drying process, it is no longer welcoming to the beetles. When completely dried and beetle-free, the timber can be processed like any other non-infested wood. Although the typical bark beetle galleries convey a negative connotation, there are sawmills and woodworking companies that, though born of necessity, offer bark beetle wood as particularly special. Subsequently, a sawmill in the black forest had such a high demand for “bark beetle wood” that it now offers an imitation where the beetle galleries are added artificially with CNC embossing. ^{ILL 085}



ILL 082 large scale bark beetle damage



ILL 083 close up photography of bark beetle damage

ILL 084 illustration of bark beetle galleries



ILL 085 artificial imitation of a bark beetle pattern



ILL 086 illustration depicting different environmental factors and their mark on the growth ring

GROWTH RINGS

Trees respond to their environment and reflect its influences in their growth. The annual stem growth of plants, specifically trees, causes a circular pattern that is referred to as growth rings. Growth rings can be observed in trees that grow in geographical conditions with periodic seasonal changes over a calendar year. Therefore, trees growing in tropical regions do not exhibit this characteristic feature. The width and wood density of the annual rings vary depending on species and age. Additionally, the manifestation of anatomical characteristics in wood is influenced by environmental conditions. Changes in light, temperature, or precipitation conditions lead to variations in cell size and cell wall thickness. Furthermore, tree growth can be affected by abiotic and biotic influences, such as insect infestation, fire, wind, or droughts.^{ILL 086} Additionally, light conditions can lead to forming a larger or smaller ring growth.

Dendrochronology (Greek: dendron = tree, chronos = time) examines tree growth ring patterns to obtain information about the age of the tree, as well as past weather events and overall climate conditions. As such, dendrochronology can deliver vital information on a given tree and its historical climatic environment.^(Baillie 1995) Stem slices of individual Sequoia trees show annual rings that date back as far as 1500 years.^{ILL 088} The process is about much more than just counting tree rings and researchers are not only looking at living trees. Many sources serve to collect suitable material for dendrochronology: Preserved historical wood and subfossil specimens can also be observed and analyzed. Before the analysis, researchers extract wood samples with special increment drills.^{ILL 087} Then, by overlaying the ring patterns of multiple same-species trees with overlapping lifetimes, an averaged tree ring sequence (tree ring chronology) is created, often covering many millennia. This method is called cross-dating.^{ILL 089 (NEXT PAGE)} Dendrochronological research has resulted in combined tree-ring curves that trace the growth behavior of certain species back up to 10,000 years. Linking known climate data with tree-ring chronologies delivers insights into climate-growth correlations. This direction of tree ring research is called “dendroclimatology”: It aims to provide forecasts for tree growth and, subsequently, the spatial ecology of entire forest ecosystems under changing climatic conditions.



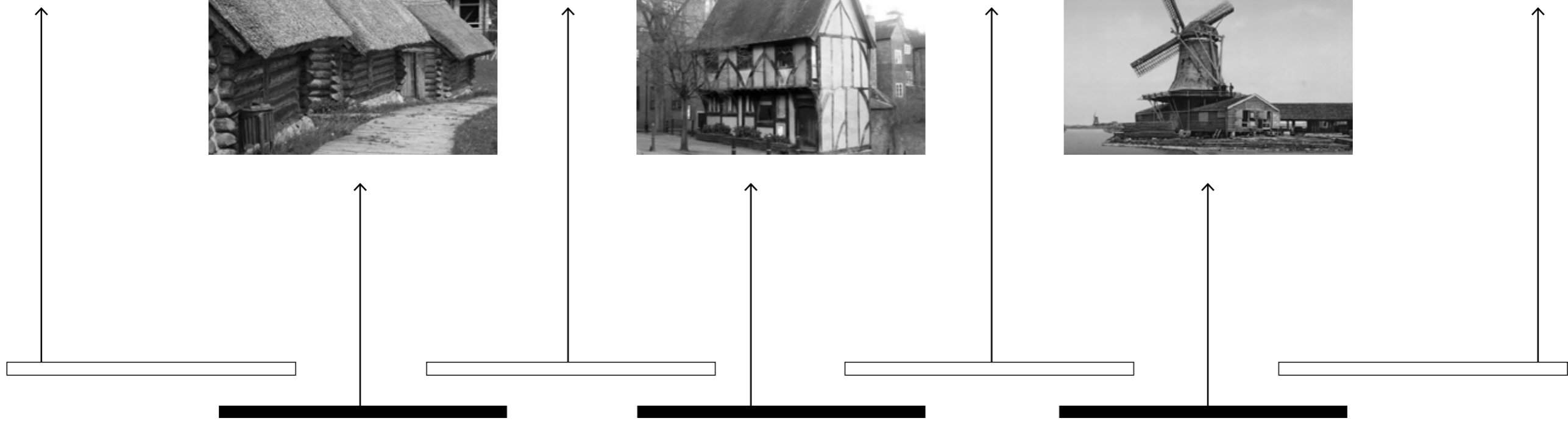
ILL 087 increment drill, used to extract dendrochronological samples



ILL 088 the life of a Sequoia tree in the context of human history

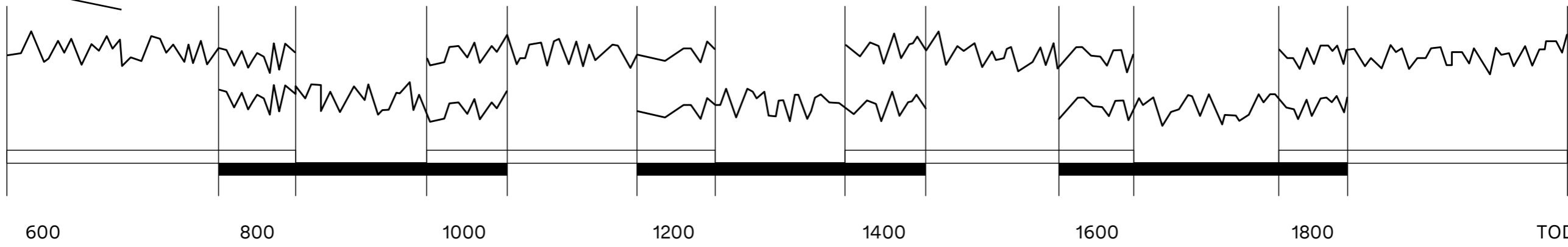
ILL 089 CROSS-DATING: the process of dendrochronology over multiple centuries

sources of the wood samples



wood samples: taken directly from the trunk of a tree or from archeological findings

annual ring chronologies of the single wood samples



APPLIED

CASE STUDIES OF SUCCESSFUL ADAPTIONS OF NON-HUMAN STYLE

The case studies of natural pattern formation deliver vital inspiration for designing an ornament that represents the non-human. But, the transfer process from naturally-occurring patterns and movements onto an artifact of human use comes with a tricky step of abstraction. Here, maintaining an appropriate balance between the referenced material and the new interpretation is crucial. An overly explicit figurative reference without additional conceptual depth is more likely to be perceived as a “flat” imitation and, thereby, kitsch. Instead, ideally, the aesthetic element is not just copied or traced but created by a non-human entity. Possible instances of this non-human creator could be microorganisms, animals such as insects, or conceivably meteorological elements such as wind and rain. For the final design of this work, which is trying to design for more traditional industrialized, hence more plannable production methods, this is not a practical option. However, there are case studies that successfully manage such a translated transfer of non-anthropocentric aesthetics. The most literal of these cases can be found in art. And it seems like a logical step to look at artistic works when searching for new ways of innovating art’s decorative relative: ornamentation.



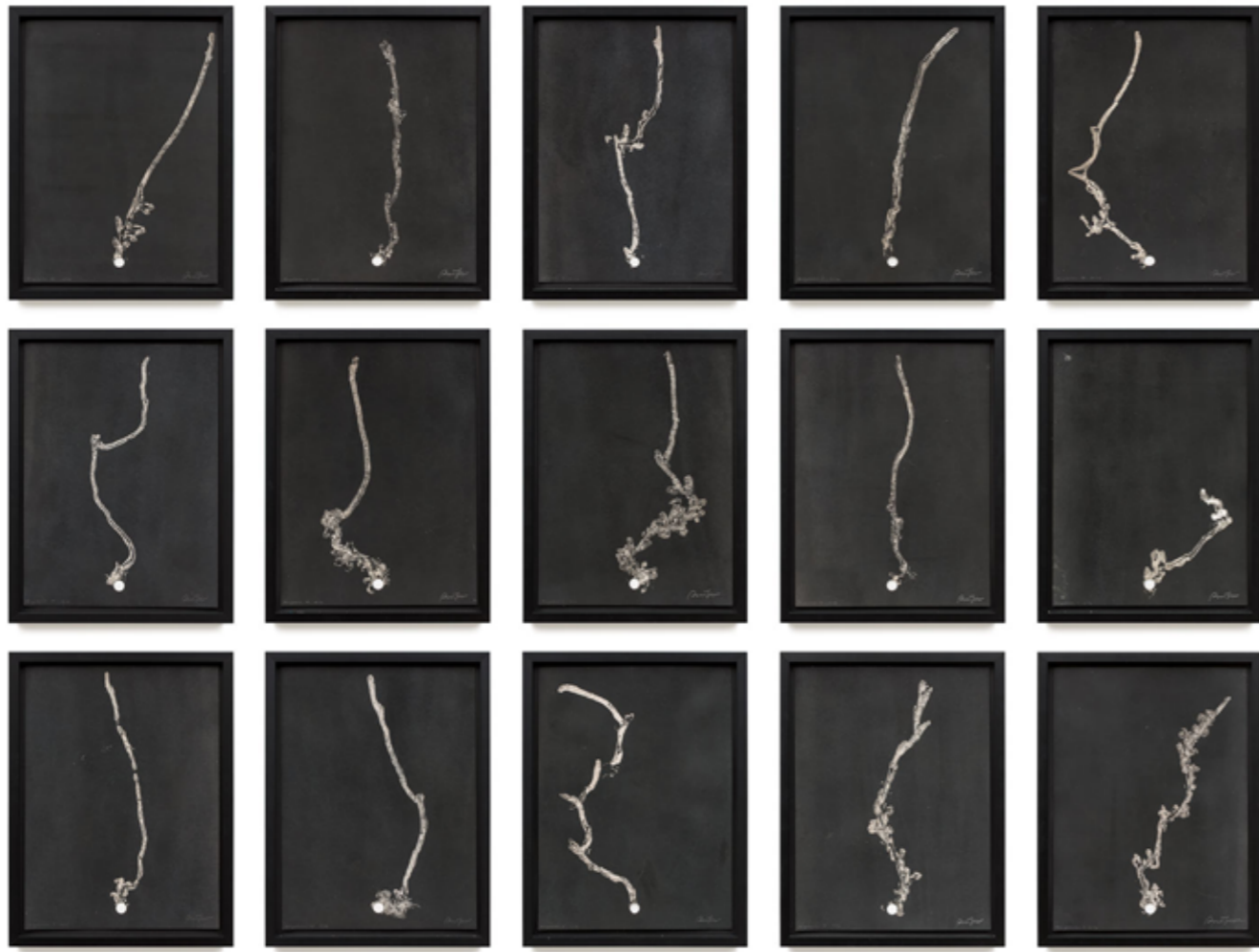
ILL 090 ANICKA YI “Biologizing the machine”, 2021

A fascinating embodiment of symbiotic artistic practice between human and non-human entities is the work of the Korean artist Annicka Yi. Many of her works feature elements that were grown and created with the help of microorganisms or fungi. By incorporating and elevating lifeforms that, while constituting the majority of lifeforms on this planet, remain invisible to the naked human eye, she shows the complexity of symbiotic interdependence in ecosystems. Recently, Yi presented “Metaspore,” a comprehensive solo exhibition at Pirelli Hangar in Milan. The show featured sculptural works from her career to date and a collection of works specifically conceived for the exhibition in Bicocca.



ILL 091 ANICKA YI “Biologizing the Machine” (close up), 2021

“Biologizing the Machine” consists of seven transparent display boxes suspended from the ceiling. They contain Winogradsky cultures, highly diverse micro-ecosystems inhabited by different microbes, namely soil bacteria and algae.^{ILL 090} The results are stunning visual images that abstractly resemble landscape paintings. And in a way, they are depictions of land. Before installation, soil samples were sourced in different locations, and the microbial cultures were grown within the display cases for several weeks. The result is the capture of the specific environments’ local climatic and biological conditions. Although the cases are sealed, the samples are still alive, resulting in images that change over time in reaction to the environment’s oxygen saturation, temperature, and lighting conditions. To ensure a healthy state of the microbial cultures, the cases are equipped with a custom electronic board that monitors the sample based on measuring the levels of hydrogen sulfide, a gas produced by microbial activity. Through this innovative and compassionate practice, Yi’s work is emblematic of an artistic expression that manages to visualize the invisible and create intriguing expressive imagery in collaboration with living non-human entities. Especially the uniquely composed color palettes, vivid in both their ephemeral nature and their vibrant composition, make Yi’s recent work a fascinating example of the artistic expression of natural processes.



ILL 092 MAXIMILIAN PRÜFER "Naturantypie: BORN THERE 1-18", traces of manipulated snails, 2016

Someone who achieves similar creative output is the artist Maximilian Prüfer. His practice of "naturantypie" incorporates non-human entities in creating seemingly randomized patterns through traces. A blank canvas is the starting point for his works; they reflect their own creation through the process. In an evolution from other traditional painters, Prüfer's canvases are a platform for non-human expression. The human artist merely sets the stage, the "Naturantypie": a photo paper with a thin black coating. The actual creators of the images are non-human, leaving their traces on Prüfer's stage. Small animals, insects such as snails, and different species of ants are featured in iterations of the work. Through the randomized movement of the crawling insects, their waningly small traces are left on the coated paper. The single traces are visible from up close, but the animal movement's sum only becomes visible when multiple animals walk in the same pathways. This behavior is especially prominent in the works created with the help of ants, as their typical movement in "streets" becomes more evident throughout the creation process of the "Naturantypie." Reflecting on these images while drawing parallels to collective human behavioral patterns is especially intriguing. Human-made pathways through meadows, fields, and forests similarly only get their shape through collective repetition of the same movement. Drawing these similarities between human and non-human behavior puts them on the same hierarchy level. One is enticed to reflect on the power and significance of collaboration and maybe even multi-species creation. The final images give off a very meditative character, but they really only gain their meaning through the process, a non-human show on a human-made stage. While these "Naturantypies" featuring living beings are a fascinating record of insect traces, Prüfer also worked with a different non-human but also non-living entity. Chasing the weather forecast, he prepared round surfaces coated with his unique black photo finish and set them out in the rain. By leaving the surface outside during rainfall for a short period, this technique creates snapshots of specific weather situations, all drawn by the non-human entity of the rain.^{ILL 093}

Prüfer's work is inspiring for the sheer simplicity of the process that he and his collaborators exhibit. A modest method of capturing traces through a simple but vivid process creates results that are inimitable and, even in the finished, static state, still maintain the fascination of movement in a still image.



ILL 093 MAXIMILIAN PRÜFER "Round rain picture II", 2016



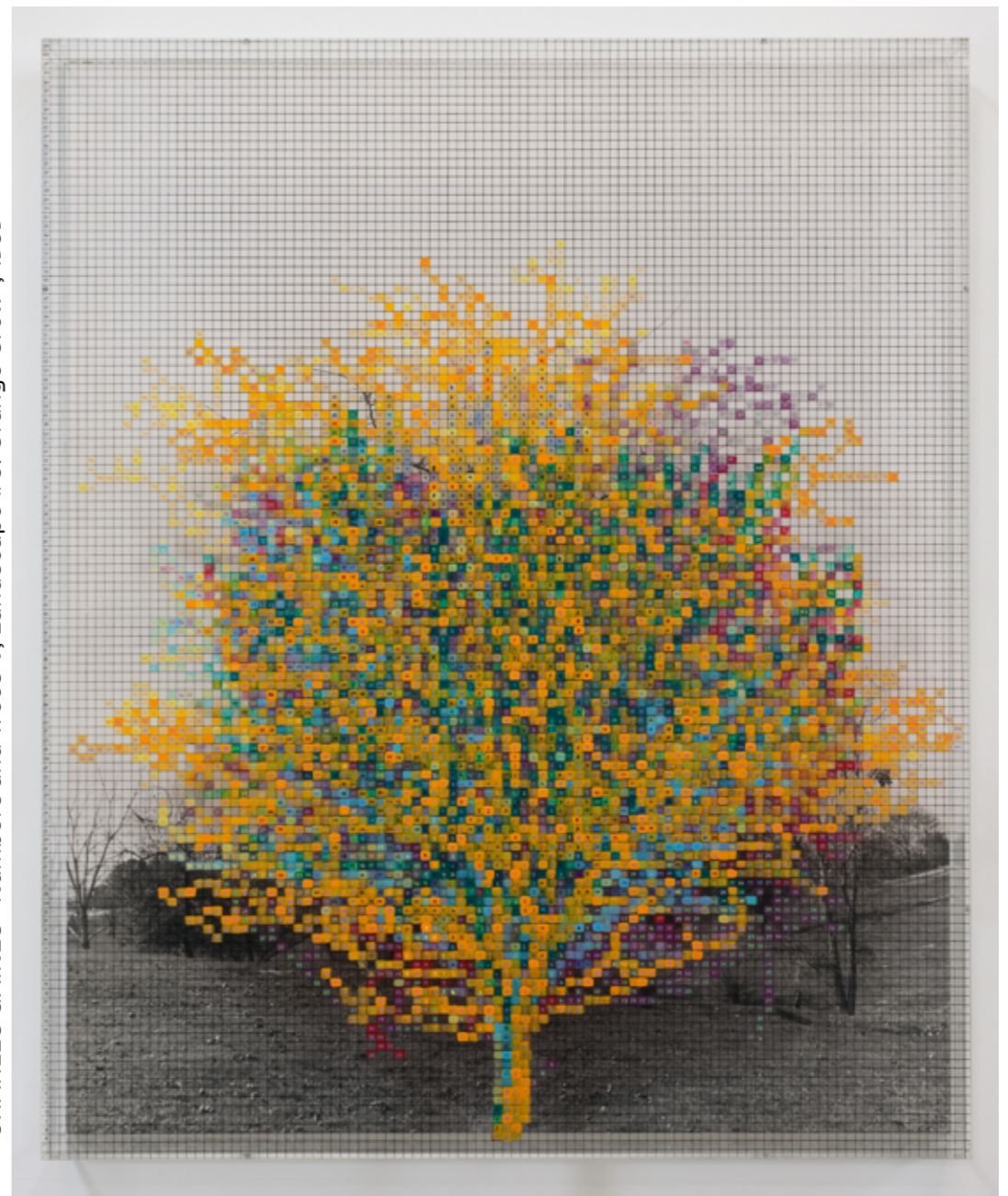
ILL 094 - 096
 CHARLES GAINES
 "Falling Leaves #5", 1979
 1. photograph



ILL 095 2. GRID: ink on paper



ILL 096 3. GRID: ink on paper



ILL 097 CHARLES GAINES "Numbers and Trees V, Landscape #8: Orange Crow", 1989

While works surrounding the aesthetics of nature are not his original artistic focus, it is worth referring to a series of works by the conceptualist artist Charles Gaines. Since the mid-1970s, Charles Gaines has developed a systematic approach to analyzing photographs and turning them into art based on data. Continuing this tradition, he systematically explores the tree's form in his "Falling Leaves" series. Sticking to his signature format, Gaines created a series of triptychs based on photographs of trees.^{ILL 094 - 096} From the original photograph as the first image, the second image traces the tree shape in a grid. The grid squares are then assigned numbers and colors before finally being rearranged accordingly in the third drawing. The resulting works are an excellent example of naturally occurring phenomena being abstracted and mapped into data patterns, providing aesthetical visual expression at the crossway of arts and mathematics.

Overcoming the divide between culture and nature has been a notable topic in the art for a couple of years. Art certainly can play a role in challenging existing thinking patterns and changing mindsets in the process. Art can lead the way in exploring multi-species collaboration to create a new visual language. But if culture is to be drastically shifted, it is necessary to integrate the practice into the public space. Inspired by thinkers in anthropology and philosophy as well as the art world, works that try and manifest a non-anthropocentric worldview have also emerged in the field of design and architecture. As the former stronghold of traditional ornamental practice, architecture is an especially

interesting playing field. The following cases exhibit this drive for an aesthetic expression of nature within built structures. The Living is a research- and process-oriented architecture studio based in New York City. Originally initiated as an institution sponsored by software giant Autodesk, the studio is at the forefront of experimental architecture, combining contemporary conceptual ideas and the newest technological tools. Their approach can be observed in the facade design for an installation in a Soho bookstore.^{ILL 098} This project entails a novel experiment in “urban metagenomics” by including design for the 99 percent of urban lifeforms that are invisible to the human eye: Cities have a microbiome encompassing the entirety of urban microbial life. The installation, “Subculture,” makes the non-human reality of microbes visible through three distinct components:

- 1 A wooden facade that serves as a habitat for microbes, facilitating the collection of genetic material.
- 2 An analysis lab that sequences the collected microbiotic DNA.
- 3 A data visualization comparing the microbiome of New York neighborhoods.

The Living’s cross-disciplinary team, including biologists, technologists, and fabricators, has developed an approach to creating a bio-receptive building material. As a result, the facade turns into a case study that reframes buildings as stewards for the urban microbiome. The existing facade is complemented with wood tiles, ground down by sandblasting at various depths, creating unique microclimates that serve as habitats for the urban microbiome.



ILL 098 (TOP)
facade design for
Storefront for Art and Architecture,
SOHO, New York City

ILL 099 (LEFT)
close up of the sandblasted wood tiles



ILL 100 (TOP)
design concept for an extension
of the Glasgow School of Art,
rendering

ILL 101 (LEFT)
sand-printed wall panel,
concept for a co-working space

Exploring new paradigms of non-anthropocentric architecture is also the concern of the last showcased designer in this chapter: Barry Wark is a designer and architect teaching at Bartlett School of Architecture, UCL. His work explores the manifestation of nature in urban structures and reflects on ecological sensibility and humanity’s place within the Anthropocene. His approach is ecocentric, rejecting the notion that humans and the objects we use are separate from the rest of the planet. Instead, the work explores forms of coexistence between human and non-human actors within the city’s built environment.

Wark is one of the co-founders of the academic research and design studio “Biophile.” They address various topics, including green buildings, designing spaces that we humans relate to, and environmentally focused designs that enable passive low-energy systems. Applied research projects include designs for biophilic workspaces and public space design proposals for the Glasgow School of Art.^{ILL 100} All of the designs feature a distinct non-traditional style, characterized by the use of parametric design tools and the innate integration of vegetation. The resulting designs are a refreshing interpretation of what a planet-centric architecture could look like, putting humans and non-humans on equal standing ground.

TREES & WOOD

THE PRECONDITIONS FOR DESIGNING WITH WOOD

The presented case studies display many leads for the initial design proposal:

The design of a wooden entry door that features an ornament or ornamental pattern which embodies the non-human entity “behind” the door.

This ornamentation is to be shaped based on the tree whose wood is used to construct the door. It should represent its reality, its life, and its death. In essence, the design to be created is the fingerprint of a tree on a wooden door in the shape of an ornamental pattern. Metaphorically referring to this pattern as the tree’s fingerprint is, of course, intentional. This humanly-originated wording lifts the tree behind the material wood on the level of a human being, showing that there is an individual lifeform behind every extractive manufacturing process. So, in one way, this integration gives respect to the tree’s non-human entity. But, through the linguistic claim as a human phenomenon, the term fingerprint also refers to the human influence on the life and death of the tree behind the door. Which, in this case, is not meant to be an appropriating action but rather a sign of humanity’s substantial impact on the natural environment. A symbiotic approach to production starts with the acknowledgment of prior extractive practices. As the use of wood is unquestionably an extractive process, the sheer symbolic admission to it does not make it symbiotic per se. The use of the ornamental design has to be the symbolic top layer of a design approach that is sustainable at its core, touching every aspect from silviculture to the final installation of the door itself. A set of guidelines has to guarantee high ecological standards throughout the value chain.

Unfortunately, there is no magical tool that spits out the most sustainable design choices for every part of the process when designing with wood. Nevertheless, it is advisable to look at the factors that should be considered and where existing initiatives, guidelines, and tools can help make sustainable design decisions. When designing a product with wood, the first step is to look at the first link of the value chain: the source of the wood, the forest. The value chain’s last link should consider the use of the door, including parameters like durability, insulation quality, and, eventually, its fate at the end of use. These sustainability parameters are closely linked to the technical aspects of woodworking, including selecting the appropriate wood species and log parts, as well as a suitable construction style, manufacturing method, and finishing technique. The following pages will address some foundational principles for a sustainable design of a wooden entry door. Only after this crucial step can the final proposed ornament be designed, as it has to represent not only the tree behind the door, but be built on the respect and consideration for sustainability within the process.



ILL 102 symbolic depiction of a symbiotic relationship between tree and human

The technical and sustainable principles that underlie the design of a wooden entry door must be present throughout the whole value chain. The aim is the best choice of appropriate methodology throughout the entire production process, the criteria being consideration for the forest, efficient energy and material usage, and low carbon emissions.

SOURCING

Wood is a naturally growing, regenerative material. However, the mere use of wood does not make a product sustainable in itself. When designing an object in wood, the considerations must start at the source: the forest. In an ideal scenario, the material for the product is sourced from a local forestry area, using wood from domestic trees. In addition to a short distance of transportation, the forest should be managed under consideration of sustainability principles. Forestry should go beyond the extraction of resources and focus on preserving the forest's essential characteristics, stability through diversity, and natural regenerative capacity.

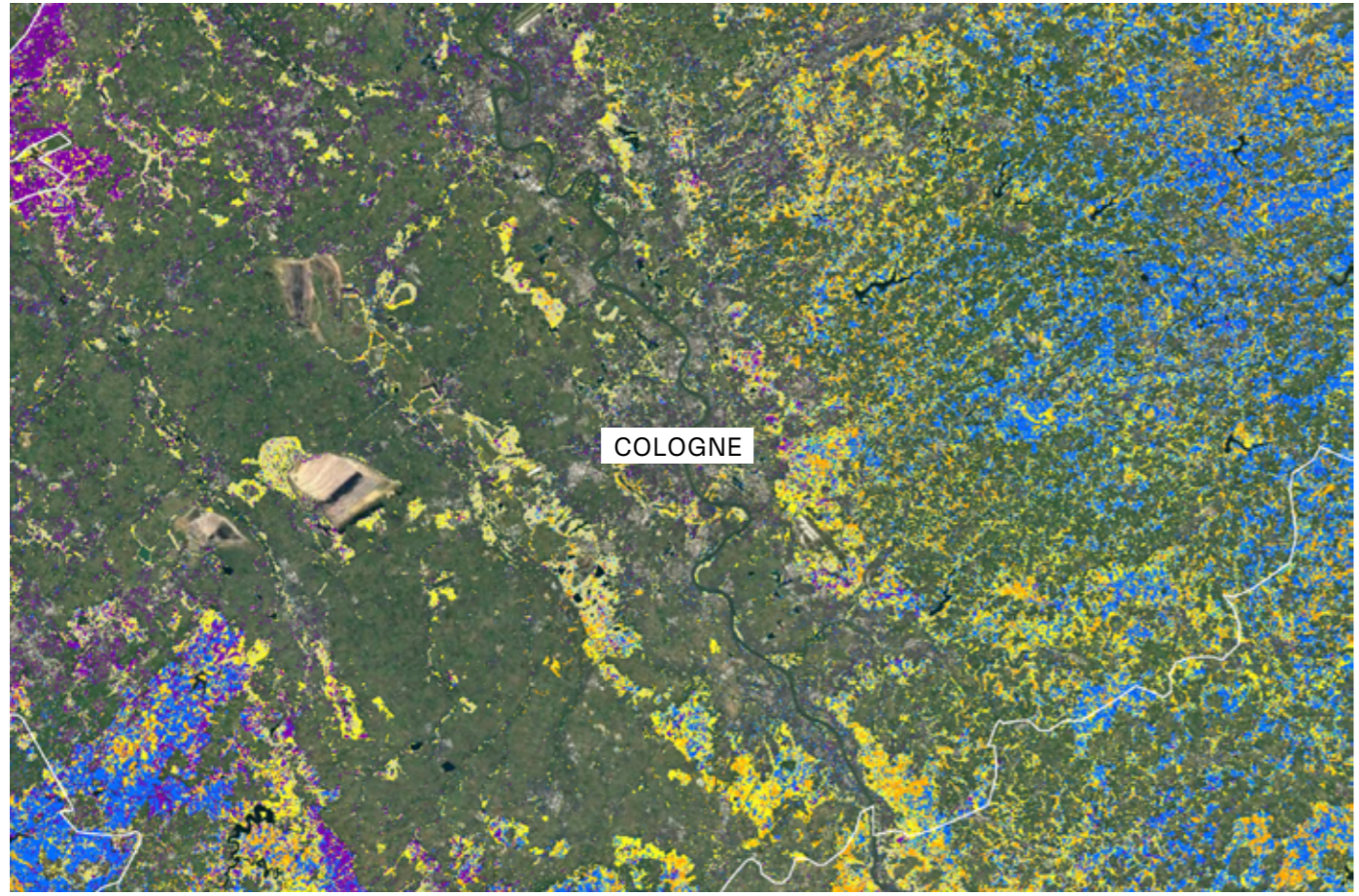
The European forest area has steadily increased over the last decades, although the last years have shown a worrisome amount of damages as a consequence of a heating climate. Currently, about 40% of the European landmass, an area of over 182 million hectares, is covered by forest. The area used by the forestry industry produces an annual output of around 110 000 m³ of timber products, the leading producing nations being Germany, Sweden, and Finland.^(EUROSTAT, 2020) There are several sustainable forest management certification programs run by organizations such as the Programme for the Endorsement of Forest Certification (PEFC), the Forest Stewardship Council (FSC), and the Sustainable Forestry Initiative (SFI). Common forest certification addresses a wide range of economic and ecological aspects of forest management, covering guidelines for afforestation, forest management plans, pest control, and admitted logging rates.

Over 60% of productive forests in the EU are certified to meet these voluntary standards for sustainable forestry.^(European Parliament, 2020) However, the current standards for ecological forestry could fall short. After large parts of European forests have suffered substantial losses due to climate change in recent years, the principles for future-oriented silviculture may need to be revised. Especially a shift towards more mixed forest management in favor of current monoculture practices should be considered. While mixed-species forests complicate the extraction process of wood, the advantages of a forest's increased climate resilience outweigh this inconvenience. To summarize: In order to meet the first requirement for sustainable design with timber products, the wood should be sourced from a local forest whose forestry practice complies with or even go beyond certified standards.



ILL 103
logos of the main certificates
for sustainable forestry

LARCH PINE SPRUCE OAK BEECH



ILL 104 occurrence of palatable wood species in the regional area of Cologne

Besides sourcing from a local forest, choosing suitable wood based on material properties appropriate for the conditions is essential. In central Europe, a variety of tree species, both coniferous soft- and hardwood species, can be considered for the application in an exterior door. In order to deliver tangible results, the wood selection for the design proposed here will be made for the area of Cologne, Germany. Besides the fact that it is the hometown of this work's author, the main reason for this placeholder choice is that there are several helpful online resources that allow an assessment of German forestry areas. These include detailed visualization of local tree species. The tool "Waldmonitor" displays the tree distribution in the regional vicinity of Cologne, indicating noteworthy populations of the following species: larch, pine, spruce, oak, and beech.^{ILL 105} All of these species are originally native to Europe and, in addition, palatable for outdoor usage as a wooden entry door. However, the three conifers (larch, pine, and spruce) lack hardness and durability compared with the two hardwoods, making beech or oak the preferred choice. In fact, a large share of the antique wooden doors still used in European cities today, were made from oak wood. An equally long product life should of course also be the goal of the design proposed in this thesis. At this point however, it should only be noted that the regional context in Central Europe offers a pool of excellent local material choices for the use in a wooden entry door.

CO₂ SEQUESTRATION

In addition to being regenerative, wood has another crucial property that makes it an excellent sustainable material: its ability to store carbon dioxide in the form of biogenic carbon. Roughly half of a tree's mass is made up of carbon, which has been removed from the earth's atmosphere during the tree's lifetime.^(Basin et al., 2019) Conversely, this me-

ans that a tree with a weight of 2 tons stores 1 ton of carbon over its lifetime. In order to represent the actual amount of carbon dioxide stored, the amount of biogenic carbon must be multiplied by the conversion factor 3.67. This is because photosynthesis converts carbon dioxide into solid carbon, a chemical reaction represented in this conversion factor. This brings the CO₂ storage of our exemplary tree up to 3,67 tons, the average annual CO₂ footprint of a citizen of Argentina. When a tree is logged and its wood processed, the carbon stays captured in the final timber product. Only when the wooden biomass is destroyed, usually either by burning or rotting, is the carbon set free in its entirety. There is very little difference in the proportional carbon content of different tree species. The density of different wood species corresponds to their tree growth rate and, subsequently, their ability to store carbon dioxide. Generally, a denser tree species takes longer to grow, but stores more carbon dioxide per volume. Also, fast-growing trees sequester more carbon in the early years of fast tree growth, whereas for slow-growing high-density tree species, the carbon sequestration rate reaches a peak at a later age. Therefore, the optimal rotation age, indicating the number of years a tree should be grown before logging to sequester carbon most efficiently, should be considered for each individual tree species.

ILL 105 a simplified example for calculating the sequestration of carbon dioxide in wood



Example tree (beech)
 Age: 120 years

 Height: 40 m
 Diameter: 50 cm
 Weight: 2 tons

 Biogenic carbon storage:
 Weight x 0,5 (mass share of carbon) =
 2 tons x 0.5 =
1 ton of biogenic carbon

 CO₂ storage:
 Carbon x 3.67 (chemical conversion) =
 1 x 3,67 =
3,67 tons of CO₂

PROCESSING

After logging, the tree has to dry properly to avoid deformation during the final product's service life. This process has to be carried out cautiously because a logged trunk does not dry evenly. It is indispensable to consider this fact to prevent the drying wood from cracking. Additionally, the cut wood should always be dried in one piece or, after being cut in a sawmill, in long planks. The decisive parameter is the wood's humidity content. For a plank of wood to be ready for processing as a high-quality timber product, it has to be "chamber-dry," meaning it should be at 15% or below.^(Editors of Fine Woodworking 1986) The drying process can be carried out in the open or in a drying kiln. While drying in a kiln consumes additional energy, the process of air drying in the open takes years to complete. Usually, woodworking companies use a combination of the two methods to shorten the waiting period after logging. The logs are then cut into the desired shape for further woodworking, usually planks or beams. Optionally, the cut wood can be transformed into massive wood boards, where equal parts are glued together and subsequently planed.

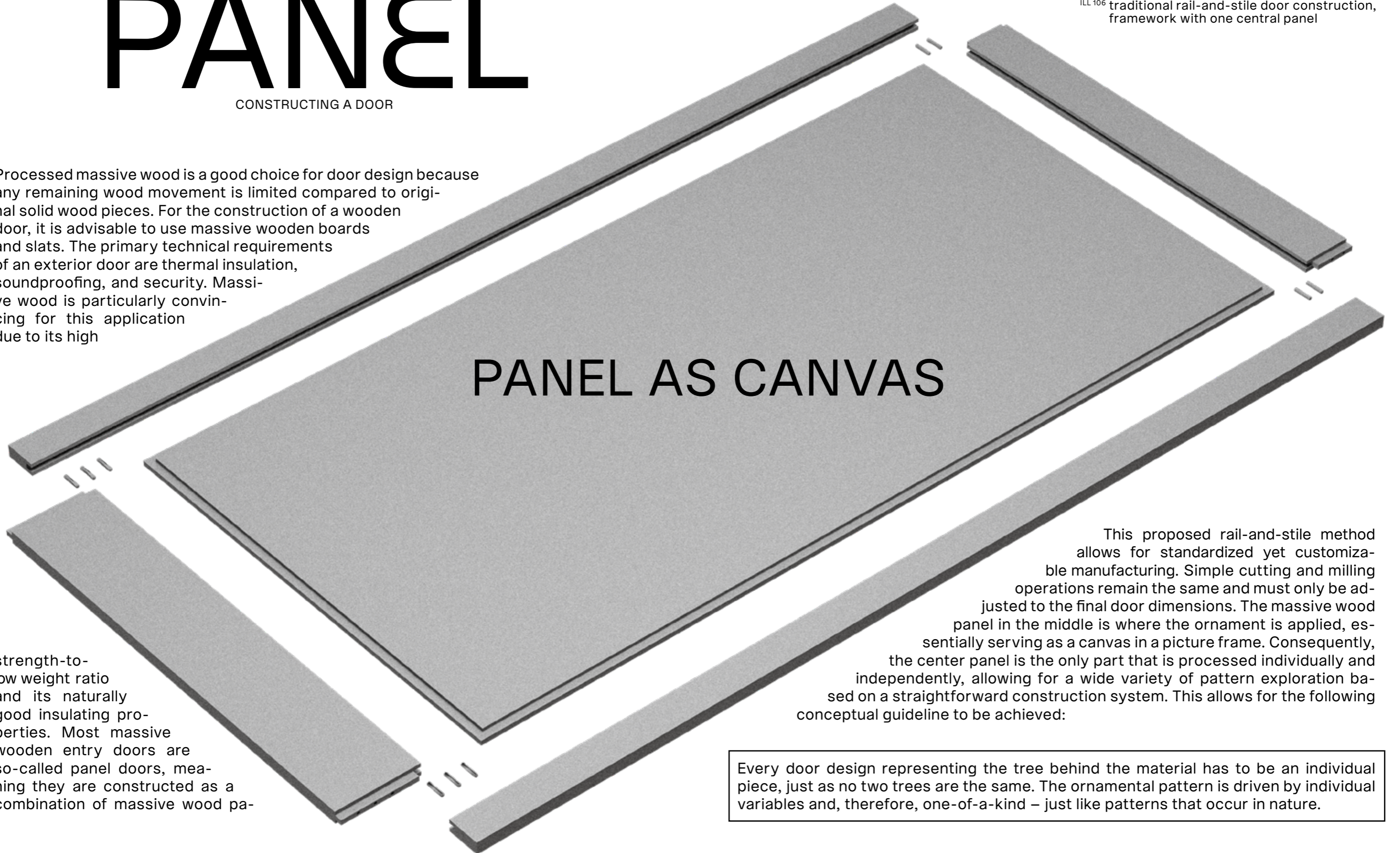
FRAME & PANEL

CONSTRUCTING A DOOR

nels within a frame. These framing slats are referred to as rails (horizontal) and stiles (vertical). In doors using this technique, any locking- and opening hardware is attached to the stiles. The single parts are connected with dowels and glued together. Panel doors are a tried and proven technique and represent the method of choice for the design proposed in this thesis: a wooden door as the carrier of an ornamental design.

ILL 106 traditional rail-and-stile door construction, framework with one central panel

Processed massive wood is a good choice for door design because any remaining wood movement is limited compared to original solid wood pieces. For the construction of a wooden door, it is advisable to use massive wooden boards and slats. The primary technical requirements of an exterior door are thermal insulation, soundproofing, and security. Massive wood is particularly convincing for this application due to its high



strength-to-low weight ratio and its naturally good insulating properties. Most massive wooden entry doors are so-called panel doors, meaning they are constructed as a combination of massive wood pa-

This proposed rail-and-stile method allows for standardized yet customizable manufacturing. Simple cutting and milling operations remain the same and must only be adjusted to the final door dimensions. The massive wood panel in the middle is where the ornament is applied, essentially serving as a canvas in a picture frame. Consequently, the center panel is the only part that is processed individually and independently, allowing for a wide variety of pattern exploration based on a straightforward construction system. This allows for the following conceptual guideline to be achieved:

Every door design representing the tree behind the material has to be an individual piece, just as no two trees are the same. The ornamental pattern is driven by individual variables and, therefore, one-of-a-kind – just like patterns that occur in nature.

FINISHING AND APPLICATION OF THE PATTERN

The coating of wood surfaces with paints, glazes, varnishes, and oils offers a wide range of options for designing the appearance of wooden structures. In the case of an exterior wooden door, however, the coating also has important protective functions to fulfill. A suitable surface treatment is decisive for the weathering behavior over time. Modern varnishes and glazes for exterior wooden components are waterborne. By essentially replacing the use of solvents, these products are very environmentally friendly. Alternatively, the door could be protected by a natural oil coating such as linseed oil. However, the protective surface treatment of the door is not the primary concern of this design. The application case of a wooden entry door is, while being outdoors, usually not one of extreme weather conditions. Usually, entry doors are protected by a lintel and not directly exposed to heavy rain or snowfall.

The part of wood treatment that is more intriguing for the case of this thesis is how the ornament is applied to the center panel. For this step, several processing methods are available, either additive in the form of paint or subtractive in the form of milling operations. One of the central arguments that Adolf Loos once had against the ornament, the fact that its production is a time-consuming act of manual labor, is, of course, no longer a concern. CNC-machining allows for the quick and efficient creation of intricate ornamental designs. Computer-Aided-Manufacturing allows for control and precision in creating ornamental patterns, with a wide choice of options for surface treatment. Most CNC-machining is controlled through g-code, the most common programming language for CAM. CAD designs in 3D or 2D can be transcoded into G-code instructions and then transmitted to the machine, where it tells motors where and how fast to move, and what path to take. Different production methods require different tools. CNC-milling on a multi-axis-milling machine requires different router heads, depending on the speed and precision of the desired operation. Other production methods require less subtractive force and are more suited for surface-only treatments. To mind come CNC-embossing, -pyrography, laser engraving or sandblasting. All these methods can be used to apply one-of-a-kind ornamental designs to the door's center panel.

The mentioned methods allow the transfer of data onto the wood. Since this work wants to refrain from experimental, analog production methods that would enable immediate pattern application without a digital transfer, the realization of the proposed designs relies entirely on these CNC-production methods. Paradoxically, CAM facilitates the production of individual customizable patterns, as well as theoretically enabling their perfect reproduction. However, this thesis proposes a design approach that gives an identity to the tree behind the material of the door. In order to reflect the personal reality of each tree, every pattern will be an individualized representation, making any need for the reproduction of a pattern redundant.

TREES AND WOOD: CONCLUSION

Any design for an ornament proposed in this thesis can only be an exemplary one. As a human designer, it is impossible to come up with a visual representation that adequately represents a tree's reality in its entirety. But, since it is an attempt at shifting the visual output of culture towards an aesthetic representation of non-human entities, the approach has to and can only come from a human perspective. To understand the intricacies of natural processes, we humans measure, collect data, and compare.

We will never fully comprehend a tree's complexity and its relations with the environment, but we can translate some of it into data. We can know a tree's age, from germination to death, and we can trace environmental influences on its health and development. Additionally, we can analyze the tree's physical and chemical composition. Because of this, we know that half of a tree's biomass consists of biogenic carbon, resulting from the absorption of carbon dioxide from the planet's atmosphere. We understand that through photosynthesis, trees and other plants generate oxygen, the essential condition for human life on earth. Trees are life, and life on this planet is one complex holistic system – no exceptional position is reserved for humankind. As part of nature, we can not extract the planet's finite resources but instead have to strive for a symbiotic relationship with the non-human part of life. This newfound attitude towards nature must end our anthropocentric approach toward production and consumption. How we treated our non-human cohabitants throughout history has led the entire planet on a path to mass extinction. Therefore, how we harvest and use natural resources will have to change, and we will have to find symbiotic ways of coexistence. In addition to the forest being a vital part of planetary survival, it is and has been an excellent source of regenerative building material. Wood is not only a material with exceptional properties but a way to replace unsustainable alternatives. Additionally, by being able to sequester carbon dioxide, trees offer a vital strategy to mitigate the consequences of human-made climate change. But, if we want to keep using wood as a resource, we must ensure that forests are healthy, resilient, and able to regenerate.

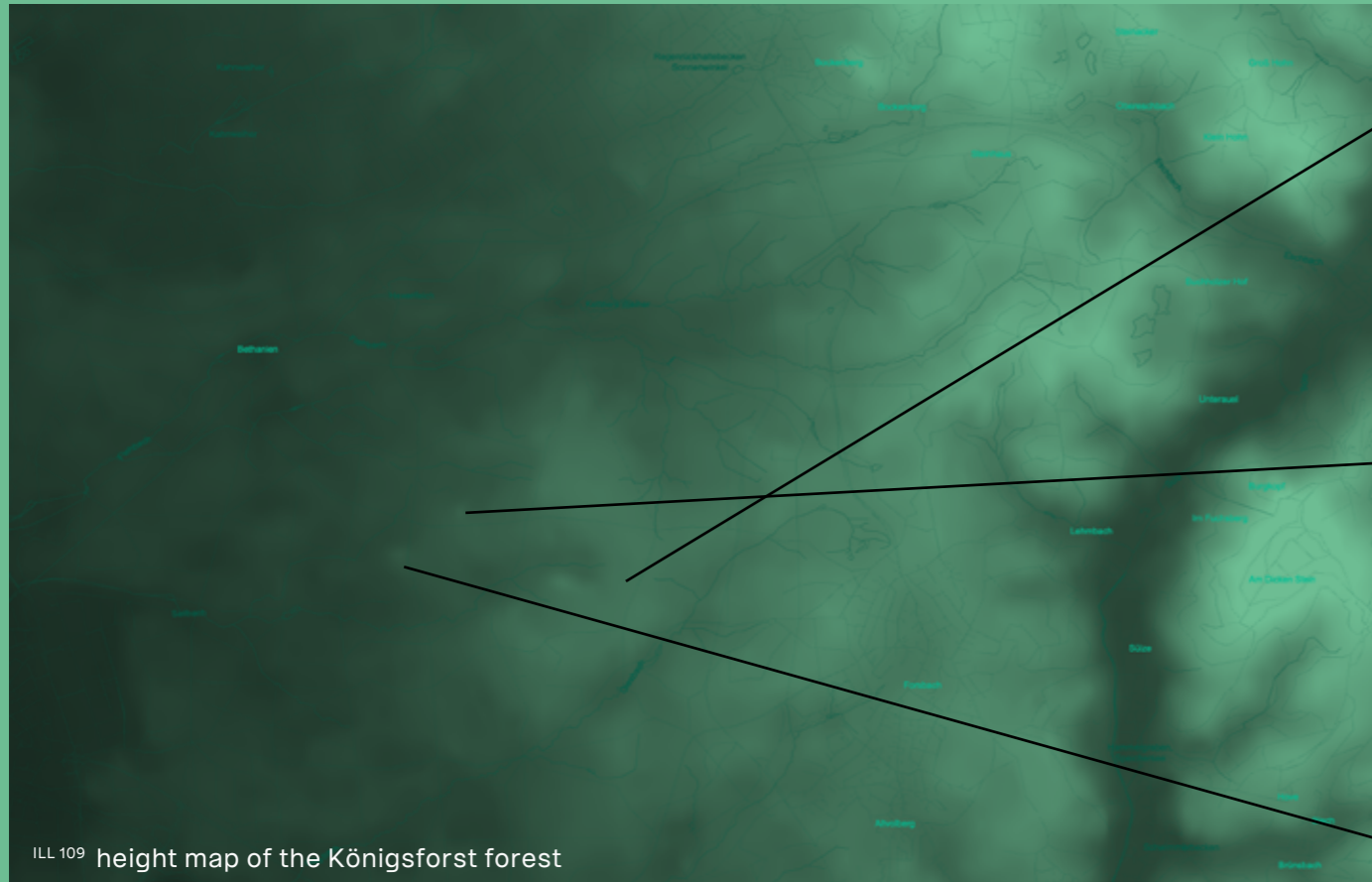
This approach should also be present in the visual expression of our culture. For a product made from timber, this means that the made object should represent the reality of the tree it was sourced from. Two proposals for this approach can be found on the following pages. Both present a design for an ornamental pattern for a wooden entry door. Their unique patterns were generated using data associated with an individual tree's existence. The underlying data relates to a tree's age, location, and its ability to capture carbon dioxide. By turning measurable data into something uncertain and organic, the patterns are meant to represent the abstract reality of the individual tree behind the door. By placing the patterns on the front door, they become part of the urban landscape, bringing a visual representation of nature into the city.

DESIGN #1



The first design proposed in this thesis imagines what the tree's equivalent to a fingerprint would look like. Every human being has an unmatched feature at their fingertips, a pattern that distinguishes them from the rest of the world and manifests their individual existence. As with many naturally occurring patterns, the underlying mechanics of a fingerprint can be modeled with reaction-diffusion systems. The elemental significance of this mathematical system makes reaction-diffusion systems an ideal choice for generating self-organized patterns that represent a tree's particular identity.

There is no need to redesign the way a door is built: This design features a simple massive wood rail-and-stile door, with the focus being purely on the pattern on the central panel of the door. The ornamental patterns in this proposal are generated by feeding an individual tree's data into a computational design tool that visualizes a reaction-diffusion process between two substances (A & B), each time resulting in a unique visual output. In common tools that visualize these patterns, parameters are used to control the simulation process. The most influential parameters are the "feed" and "kill" rates, determining the



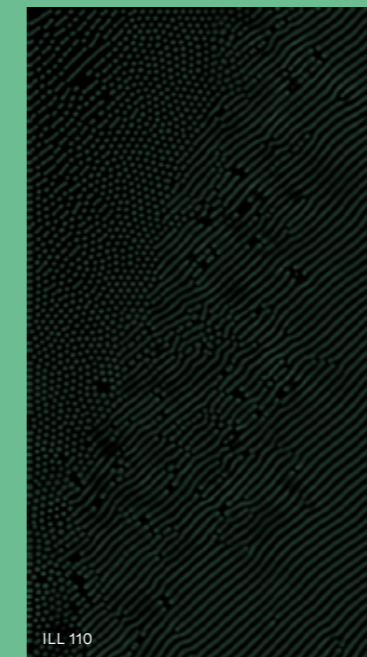
ILL 109 height map of the Königsforst forest

ratio and behavior of the two simulated substances. For the simulation used in this pattern design, the factors "feed" and "kill" reflect the age of the tree whose wood is used for the door. Of course, the dates of germination and logging of the tree have to be adjusted and mapped into an acceptable range for the simulation to generate visually acceptable results. This is done by simply spreading the distance between the two rates according to the tree's age at the time of the felling. Thereby, an older tree generates a different type of pattern than a tree that was younger when felled. Additionally, the two simulated substances (A & B) behavior can be adjusted by their respective diffusion rates – their input is based on the tree's species. On top of the tree's species and age, its location plays into the simulation. A topological height map of the forest where the tree grew is used as the underlying vector field of the reaction-diffusion. Finally, the resulting visualization ILL 110, ILL 113, ILL 116 is translated into a 3D pattern and CNC-milled into the central panel of the door.

The three patterns visualized on the right showcase the patterns generated from three hypothetical trees in the Königsforst area, a forest in the South-East of Cologne.



ILL 109



ILL 110



ILL 111

50.930306, 7.148505, BEECH (germination: 1931, logging: 2012)



ILL 112



ILL 113

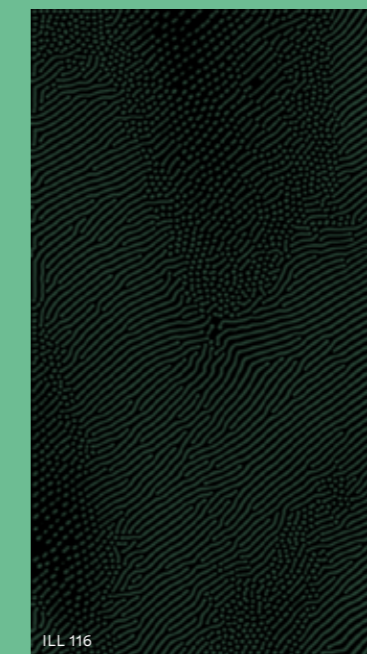


ILL 114

50.930921, 7.128357, OAK (germination: 1918, logging: 2013)



ILL 115



ILL 116



ILL 117

50.929171, 7.123089, LARCH (germination: 1937, logging: 2013)



ILL 118 detail of the patterned panel, framed by rails and stiles



ILL 119 the patterned door, staged in the context of a townhouse

DESIGN #2



The second exemplary design presented in this thesis illustrates a tree's potential for carbon sequestration. By resembling the cracks of a dried-out body of water, this ornamental pattern is meant to evoke a conceptual representation of anthropogenic climate change. Trees and, subsequently, wood products can sequester the greenhouse gas carbon dioxide in the form of biogenic carbon. The carbon "stored" within the timber product door is displayed with a Voronoi pattern; the pattern's size and density relate to the amount of carbon dioxide sequestered. The calculation is straightforward, as approximately half of a timber object's mass consists of biogenic carbon bound from the atmosphere. Multiplying the mass by the conversion factor (1 carbon = 3.67 carbon dioxide) reveals the amount of carbon dioxide sequestered within the wooden door. Factors influencing the pattern are, therefore, the dimensions and, subsequently, volume of the door, as well as the density of the used wood species. A higher amount of CO₂ sequestration results in a denser pattern.

The pattern shown on the door translates and hides this amount in an abstract ornament. As humans cause the problematic share of greenhouse gas emissions, when seeing the door, we are confronted with our impact on the living world as well as with the tree's ability to mitigate the consequences. After the entire central panel is coated with a first coat of oil, the pattern is applied by CNC-controlled sandblasting. This way, the sandblasting has an immediate two-fold effect. On the one hand, the areas where the sandblasting is applied become brighter and stand out visually as they partly remove the first coat of oil. In addition, the wood's characterizing visual feature of the grain is accentuated. After the sandblasting, a second coat of oil, preferably an oil with less color-changing impact, is applied to the entire panel.

The desired long-term effect of this sandblasting treatment is an evolution of the ornamental pattern's look throughout the door's service life. ^{ILL 125 (NEXT PAGE)} Over time, the pattern becomes less evident, as the sandblasted part is more prone to optical patina transformation through aging. Ideally, the pattern indicating the sequestered carbon amount becomes virtually invisible by color but visible only through the more pronounced wood grain in the sandblasted part. After many years, the pattern would essentially wash out. This way, the pattern becomes an abstract clock for the door's service life, losing the mark of anthropogenic carbon emissions over the course of many years – almost like a tree that sequesters carbon throughout its lifetime.

DOOR #1

Tree species: Pine
(density: 490kg/m³)

Door dimensions:
2300 x 1150 x 40mm
Volume: 0,1058 m³

CO₂ sequestered:
58,19kg/2 x 3.67 =
95kg CO₂



ILL 121 - 122

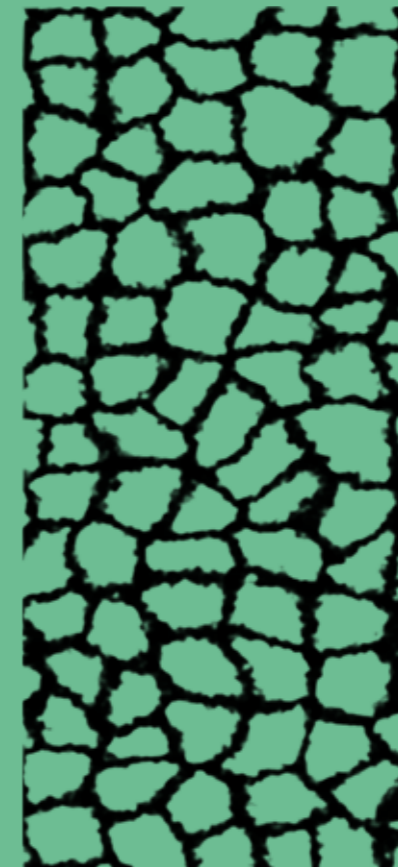


DOOR #2

Tree species: Oak
(density: 650kg/m³)

Door dimensions:
2300 x 1150 x 40mm
Volume: 0,1058 m³

CO₂ sequestered:
68,77kg/2 x 3.67 =
126kg CO₂



ILL 123 - 124





ILL 125
the anticipated development
of the pattern over the
service life of the door



ILL 126 the door design in the context of a modern building



ILL 127 detail of the sandblasted pattern on the door panel

ALLA FINE

This project began with a personal reflection on metaphorical doors. Before closing the door on this thesis, it is worth summarizing and reflecting on its content. Beginning with an essay on the paradigm shift from human-centered to planet-centric design, the need for the visual expression of non-anthropocentric cultural values was laid out. The visual output trusted with executing this ambitious project is the design of ornamentation. Through visual and historical research, the potential of ornamental and decorative elements as cultural signifiers and carriers of symbolism was identified and explored. Subsequently, this thesis made a case for a comeback of the ornament as an aesthetical expression that manifests the merger of nature and culture. In the next step, exploring the formation of naturally-occurring patterns gave further insights into the development of a visual language of contemporary non-anthropocentric ornamentation. Additionally, prominent case studies from other human creatives in the fields of art and architecture were highlighted to deliver further inspiration into how a non-human aesthetic might look like.

As the physical carrier for the designed ornamentation, this thesis proposes the typology of a residential entry door. The door's strength as a canvas for symbolism, communication, and representation was laid out. Being placed within the context of the street, doors are a visible part of the urban landscape. As such, they are prominently placed in the public view, making them ideal canvasses for visual expression. Inspired by the impressive grandeur of the wooden doors that can be observed when walking through the streets of Milan, the design approach proposed in this thesis also chose wood as the chosen construction material. As a regenerative material that is able to sequester anthropogenic greenhouse gas emissions, wood is the optimal choice for designing an object meant to visually represent a cultural aesthetic of sustainability. Finally, after briefly laying out sustainable, functional, and technical principles for designing with wood, this work presents two exemplary designs for ornamental patterns for a wooden entry door. Both try to visually manifest the reality of the non-human entity "tree" behind its materiality in wood. The design proposals introduce ways to abstractly represent the tree's entity through the visual output of the ornament.



ILL. 001 RENÉ MAGRITTE "La perspective amoureuse", 1936

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