The Sacrificial Layer

Temporality, Decay, and Re-Imaginations of the Rainscreen

by

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ABSTRACT

The rainscreen, the outermost layer of contemporary wall construction, exists as the first barrier between elemental forces and interstitial wall assembly components. Direct and constant exposure to stresses from its external environment ages a building's cladding much faster than the materials behind it, necessitating thoughtful acts of rehabilitation, re-protection, and occasional replacements of this sacrificial layer. Alongside the progressions of building science, questions about the replacement of this sacrificial cladding layer are presented through lenses of conservational responsibility, historical reflections, and the search for material meaning.

This thesis examines wood as natural cladding through various material explorations, meditative representations, and narrative speculations, to re-imagine it as a vehicle for design discovery. It will investigate design potentials inherent in the histories, impermanence, and sacrificial nature of wood as a rainscreen material. These discoveries will communicate the narrative expression of the rainscreen, its experiential materiality, and its existence through and with time.

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INTRODUCTION

The inevitability of the passage and effects of time on the physical materials of a building's cladding impact its aging and decay. Architectural materials, through their foresight and reactions to object impermanence and physical destruction, treat the act of sacrifice as a key component in the sequence of purposeful loss. By accepting and working with the phenomenon of material dissolution, and the cyclical repurposing and re-formation of matter, one can influence the aging and passage through time of one material to craft and protect that which replaces it.

Cladding design, from historical vernacular to the most contemporary systems, cultures, craft, and everything in between, has often embraced and integrated the ever-changing nature of material lifespan. Recursive processes of deconstruction and subsequent reconstruction of the exterior-most cladding layer of the wall – the 'skin' of a building – are founded on its sacrificial qualities. Their intrinsic characteristics allow for acts of preservation and conservation to become a form of architectural invention.

The notions of material temporality and decay necessitate actions of re-imagination through forms of rehabilitation, re-protection and replacement. These continuous acts of re-building allow for the unmasking and showcasing of the memory and stories of materials. By unfolding layers of time, re-making reveals the invaluable possibilities of conservational

imagination.¹ Between the cycles of their construction, decay, and replacement lie the concepts of materials' narratives and the human experience of these stories, which this thesis defines as their *materiality*.

This thesis proposes that wood – and by extension, all natural cladding materials – exists in a hybrid interpretation of time. Linear, unidirectional movement forward from a defined start to a singular end (the *objective*), intertwines with the ancient Janus-like cyclical repetitions of sequential returns that create new beginnings (the *subjective*).

Figure 1: Diagram of cyclical and linear time, and their combination

¹ Federica Goffi, *Time Matter(s): Invention and Re-Imagination in Built Conservation: The Unfinished Drawing and Building of St. Peter's, The Vatican* (London: Ashgate, 2013), 3.

As materials traverse the linear temporal timeline, they are subsequently being transformed in an effort to return them to their primal states.² The arrival at the restarting points of *subjective* time fall on continually progressive marks along the 'straight line' of *objective* time.

It is important to note, also, how this thesis defines the comparison of 'objective' and 'subjective' qualifiers – objective is typically regarded as the truth, and conversely, subjective is illusory. However, when seen through the lens of this thesis' definition of materiality as a conduit for narrative and communication, 'object' or 'objective' refers to the idealized gold-standard state of a material's quality that people try to maintain, while the 'subject' and 'subjective' are the nuances of the realities shaped by materiality. Through this new definition, the objective (as an illusory and physically unattainable goal) lives as fallacy, while the subjective consequently becomes the material's new truth.

Advances in engineering and material science have created synthetic and natural-synthetic hybrid materials that are objectively more durable and longer lasting than natural materials. The aim of this thesis is not to discredit or devalue the progress demonstrated by these new material forms; rather, it is an argument for the parallel re-evaluation and suggested rediscovery

² "Primal", herein, refers to the initial form and properties of the material in question. As materials move along the cyclical timeline, they never truly return to what can be considered their absolute first iteration (their primal identity); they merely attempt to get as close to this state as possible, before starting their next cycle of life.

of the merits found in learning from the experience with, and phenomenology of, natural material narratives.

How can wood in its natural state, with its inevitable degradations and imperfections, celebrate these changes as an unveiling of its embodied character and history?

How can these marks, traces, and transformations be used to further inform details and designs of the rainscreen as a communicator of material narratives?

PART I: **TEMPORALITY**

Figure 2: Tree growth rings and cracks

CONSERVATION IN TIME

Materials, as a defining element of the architectural experience, react to the catalyzing element of time and are attributed values concurrent with their physical and metaphorical aging. As materials age, they gain surface faults – stains, erosions, sediments, and patinas – through acts of purposeful physical sacrifice. Through the materials' wills to endure, accept, and often succumb to the forces and outcomes of nature, they gain layers of historical value and add to their buildings' character identities, allowing them to exist symbiotically with their environments through time and history.

The value of material aging, as discussed by Alois Riegl, can be identified with the notion of aging as enhancement, and the idea that the various markings and layers of a surface record and allow one to recollect earlier stages in the history of buildings and the human life associated with them.^{3,4} He positioned himself apart from the Modernist idea that architecture exists in a singular moment, arguing that buildings are not snapshot artefacts and that their value appreciates over time.

³ David Leatherbarrow and Mohsen Mostafavi, *On Weathering: The Life of Buildings in Time* (Cambridge: The MIT Press, 1993), 84.

⁴ Riegl commented on "age value" particularly as it related to his studies of architectural monuments and his comparative juxtaposition of the old and the new. He posed his argument for the celebration of material aging against Le Corbusier's affinity for whiteness and the newfound 'purity' of the Modern, in which any perceptible marks of use or surface aging subtract from the ideal condition and 'complete' realization of the project as a piece of architectural art. (Leatherbarrow and Mostafavi, *On Weathering*, 82-86.)

The ever-changing layers within materials as they age, coupled with the need to preserve, study, and learn from them, define the relationship between architecture and its making-in-time. The roots of this relationship form the basis of a hyphenated form of built conservation practice that architect, author, and Carleton University Associate professor Federica Goffi labels “architectural-conservation”.⁵ The conscious combination of the acts of imagination and preservation into a singular design process combats the orthodox applications of basic conservation principles, which can have significant limits toward the possibilities of creative interventions onto a wide array of extant buildings and building materials.

CONTINUOUS RE-MAKING

The aging of buildings and their materials through time opens avenues of critical thinking toward the conservational practices of preservation ‘as is’ versus restoration ‘as was’.⁶ The notions of memory and cycles of life are omnipresent in the generation, lifespan, deterioration and decay of materials. This suggests the possibility of a middle-ground form of conservation, wherein beneficial aspects of material soundness are preserved while the more storied are left to their own devices, allowing time

⁵ Goffi, *Time Matters*, 10.

⁶ This distinction, its limitations, and possibilities for imagination, penned by Goffi in *Time Matter(s)*, has formed the basis of some of her doctoral and post-doctoral research - notably, her investigations of the role of time in drawings of St. Peter’s Basilica in the Vatican, and the works of Carlo Scarpa (1906-1978).

and the natural courses of the environment to develop their futures by exposing cues from their pasts.

Should Western conservation practice embrace cyclical narratives of sacrifice in materials and design to reveal the individual character and time-based transmutations of buildings and architecture? Materials themselves have stories, and their individual physical histories are layered and complex. Over time, some materials can build up resistance to environmental factors, both naturally and through man-made intervention.

The act of cyclical building – its repetitive construction processes and sensitivity toward reuse and respect of materials – of any building or its components works to strengthen both the building's embodied identity and also the cultural identity of the people or place to which it belongs. Physical changes to any parts of a building can begin to question its cultural and symbolic identities, raising the debate over the values of time and aging toward architectural character. A preservation of exterior likeness, altered by slight variations of material/technique/craft through the material's progression of regenerative iterations, can attempt to create either a temporally frozen snapshot of the façade material or a refurbished rejuvenation through near-identical material replacement. In turn, this endeavor to reach the objective goal of ideal quality preserves the essence of the building itself.⁷

⁷ Goffi, *Time Matters*, 3.

CASE STUDY

GRAND SHRINE OF ISE (Mie Prefecture, Japan)

The practice of ritual reconstructions as a cultural phenomenon is notable particularly in Japan, where the pride of making and precision of handcraft is paramount to the identity of their built forms. The 20-year cycle of symbolic de- and re-constructions of the two main buildings within the Grand Shrine of Ise complex, *Ise-jingu*, the most sacred Shinto shrine in Japan, brings forth conceptual and intellectual notions that contribute greatly to the “complex substratum of making architecture.”^{8 9}

Figure 3: The Naiku shrine in the Ise-jingu complex

⁸ Ibid.

⁹ Both of the Ise Shrine's main buildings are thatched huts built in the ancient Japanese style with unpainted Japanese cypress (*hinoki*) wood. The reconstruction ritual began in the 7th century AD; since then, the buildings of the two shrines and the bridges leading to each shrine's compound were reconstructed every 20 years in a ritual called the *shikinen sengū*. Trees used for building materials are raised in the extensive forests that are part of the shrine complex. (<https://www.britannica.com/topic/Ise-Shrine>)

Memory, manifested here as a facet of craftsmanship and knowledge of construction techniques, combines with the investigative notions of time as they relate to material processes of decay and deterioration, and on a humanistic level, to cultural patterns, economy, and religion.

Every twenty years – along with costumes, furnishings, and auxiliary ornamentation – the two main shrine buildings and their bridges are deconstructed and rebuilt in a years-long ceremonial festival to honour the Japanese Shinto sun god, Amaterasu Ōmikami. This ceremony represents the Shinto belief of death being the renewal of nature and signifying the impermanence of all material and immaterial things. The current extant buildings each sit adjacent to equally sized parcels of empty land, on which the next iteration will be constructed. As the shrine undergoes its cyclical reconstruction every two decades, the buildings themselves alternate between these two neighbouring locations. This subtle displacement symbolizes the birthing-new of successive regenerated versions of the shrine's buildings after each reconstruction ceremony, allowing the buildings to be forever new in physical material, and simultaneously, forever traditional in their methods of construction and ritual of meaning.

The 61st iteration of the shrine existed between 1993 and 2013,¹⁰ and the eight years leading up to their reconstruction were documented in the Japanese film, “第六十一回神宮式年遷宮, 総集編” (The 61st Annual Shikinen

¹⁰ “第六十一回神宮式年遷宮, 総集編” (The 61st Annual Shikinen Sengū of Ise – The Complete Collection). YouTube. Video File. October 7, 2013.
<https://www.youtube.com/watch?v=YAvllyLa2r8>

Sengū of Ise – The Complete Collection). This documentary outlines the ritual proceedings and construction techniques used in the rebuilding of both of the shrine's structures, and the blending of modern conveniences with traditional materials and construction methods. The trees for the 61st iteration were felled in a town in neighbouring Gifu Prefecture and subsequently transported to the site in Mie Prefecture by truck. As the trees reached the town of Ise, modern vehicles were eschewed in favour of their transportation via rafts and hand-drawn carts, pulled by a team of men, through the town's main streets.

Figure 4 (L): Felled cypress trees transported down the Ise river
Figure 5 (R): Ceremonial "Okihiki" Festival cart

The preparations, treatment, and cutting of traditional joinery are also achieved through a combination of old and new methods. The advent of modern lumber saws has expedited the cutting process of boards and 'tree blanks' that form the base for the round pillars and roof beams assembled in the final reconstruction. However, all of the ornamentation and connective joints are measured, cut, and fit by hand, by teams of

exceptionally skilled master craftsmen and their apprentices. The entire wood component preparation process leading up to the final construction assembly of the new shrines takes, on average, five years.

Consecutively repetitive cycles of time exemplified by the complete reconstruction of the physical shrine buildings, rife with spiritual symbolism and Shinto beliefs, complement the linear progression of time as seen through the narrative life sequence of a craftsman working on the built projects. The five- to eight-year period of material sourcing and preparations, followed by the fourteen years of the shrine's undisturbed 'life', represent moments of practice and subsequent reflection for the craftsman and their techniques. If the builder starts as a teenaged apprentice on one reconstruction ceremony, he will progress to the rank of a novice in his thirties, a skilled worker in his fifties, and if lucky, a master craftsman through to his eighties. The linear passage of time and accumulative skills picked up along the length of this craftsman's life is directly linked to, and enhanced by, the cyclical reinstitution of the wood's values and symbolic meaning passed from one material and formal iteration to the next.

SYMBOLIC SURFACES

The façade's secondary role of providing protection from environmental stresses gives it the freedom of adaptation and evolution, physical and metaphorical, to dictate how its outward presentations respond to issues both inside and outside the building. David Leatherbarrow and Mohsen Mostafavi, analyzing the building façade as a 'symbolic surface', posit in *Surface Architecture* that the cladding layer of a façade, the outward most projection of a building's character, becomes an immaterial object and a concealing mask layer of the building itself. Through mimesis, and reactions both with and against its external environmental factors, the façade can become a blank slate onto which colour and form can be added to represent culture and community.¹¹

Variations, additions to, and subtractions from the built cladding layer emphasize its sacrificial qualities as the nonprecious 'skin' of buildings. This lack of pedestalization allows the cladding layer to exist along the spectrum of time, because it can change and shift its meaning, purpose, form, and symbolism – back and forth – through iterations of itself from history and into the future.¹² Tectonic shifts and changes to the outward perception of cladding materials allow for atemporal, non-prescribed variations to the building 'skin' and its placements unrelated to material age and the passage

¹¹ David Leatherbarrow and Mohsen Mostafavi, *Surface Architecture* (Cambridge: The MIT Press, 2002), 92-3.

¹² Ibid.

of time, which in turn lead to re-interpretations of the true histories and metaphysical agedness of the cladding itself.

Aldo Rossi's interpretation of mimesis encapsulates actions of reproduction based on image and form, where the resultant architecture references a goal of anonymity and an abandonment of stylistic distinctions, existing on a plane detached from linear time and historical reference. Opining on Rossi, Rafael Moneo asserts that mimesis is better understood insofar as it is a reproduction of that which already exists, an echo of material behaviour and functionalism that is learned, referenced, and preserved through time.¹³ He also recognizes that Rossi's attempts to define an anonymous architecture are more an intellectual endeavour than a literal one.

These changes in attitude toward material verity – sometimes subtle, sometimes brash – can be seen in many of the outer skins on many Herzog and de Meuron buildings heavily dependent on the clear understandings of the artificial nature of materials.¹⁴ Their projects have taken mimetic cues from pre-existing materials, but instead of privileging them in their raw form, have married the materials with both old and new production procedures. Selected examples – Eberswalde Technical School Library (Eberswalde, Germany, 1999), the Museum der Kulturen (Basel, Switzerland, 2010), and Beijing National Stadium “Bird’s Nest” (Beijing, 2008) – while having aesthetic value and contributing to a high level of contemporary semi-synthetic design, raise the question of whether architectural skins, as

¹³ Leatherbarrow and Mostafavi, *Surface Architecture*, 210.

¹⁴ Ibid.

an entity, are shifting to become more artificial in both material and meaning.¹⁵

Figure 6 (L): Eberswalde Technical School Library – Eberswalde, Germany, 1999

Figure 7 (R): Museum der Kulturen – Basel, Switzerland, 2010

Figure 8: Beijing National Stadium, "Bird's Nest" – Beijing, China, 2008

¹⁵ The projects mentioned have used artificial façade materials in the sense of their being either man-made or aesthetically manipulated through the application of inorganic coatings or additives, as opposed to naturally sourced, 'pure' materials.

PART II: **DECAY**

Figure 9: Decaying birch log section, with bark still intact

REPAIR vs. REPLACEMENT

Goffi's comparative distinction between preservation 'as is' and restoration 'as was' and the values embedded in the act of cyclical re-making can be viewed in parallel with some architects' and conservationists' reconsideration of selective, sequential replacement as a more viable and valuable form of architectural rejuvenation. Building and material conservation are currently facing the dilemma of whether to remedy the existing building stock through complete demolition and the making-new of compromised structures and building components, or through a more gradual repurposing and adaptive reuse of the base elements. Garth Rockcastle¹⁶ is a strong proponent of conservation design through replacement, for reasons of material and environmental sustainability and for a shift in cultural understandings of exclusive authorship to celebrate buildings' embodied social and material histories.

Rockcastle celebrates the virtues of selective and contextually sensitive acts of replacement by imagining existing buildings and their materials at the absolute molecular scale, in which everything is omnipresent and omni-temporal, and can never be created from new, only physically remade, recycled, reassembled, reconfigured, or renewed.¹⁷ Gradual changes to any component of a building over time, as compared to an immediate and entire

¹⁶ Rockcastle, architect and professor at the University of Maryland, was Professor and Dean of the University of Minnesota, Department of Architecture (1978-2004), and Dean of the University of Maryland School of Architecture, Planning and Preservation (2004-2010). He is a founding principal of the Minneapolis-based practice, MSR Design (Meyer, Scherer, & Rockcastle, Ltd.), and was guest editor for *Places* Journal, Issue 20.1, "Re-Placing", in 2008.

¹⁷ Garth Rockcastle, "Why Re-Place?" *Places* 20, no. 1 (2008): 4.

erasure of it altogether, reveal its history and allow the multiplicity of hands and authors to contribute to a more informed and collaborative design process. The collaboration needed between people, materials, and the built architectural fabric to accomplish this form of conservational replacement necessitate designers to think and practice in ways that are more environmentally aware, more enlightened about heritage, and more concerned with a deeper understanding of the importance of working with each other.¹⁸

Replacement and the remaking of things, on both a short term scale (quick fixes to a building after a sudden natural disaster) and long term (calculated, planned, and researched protection of components of heritage buildings and monuments), can be considered a valuable form of creative liberation, wherein rich material, building, and site histories give narrative fuel for more imaginative explorations of form and design expression. Additions, interventions, and componential replacements can become a form of architectural reveal to celebrate the past and highlight the histories and values of the existing outer layer of buildings, and everything that lives within.

¹⁸ Rockcastle, "Why Re-Place?" 5.

WEATHERING

The process of weathering, from an objective consideration, is typically regarded as an element of physical loss – of value, of material, and of strength. Object maintenance, through any combination of remaking, restoring, and replacing, has become an undesirable trait of buildings' post-construction life cycles, consequently resulting in the development of materials significantly more resistant to staining, discolouration, erosion, cracks, rust, and dust. Weathering, however, is also objectively unavoidable. The effects of time on a weathered building or constituent material may physically warp or destroy its initial layer of protective coating, but these outcomes can concurrently add to the ever-present metamorphosis of a building's character, narrative, and materiality.

Leatherbarrow and Mostafavi, in *On Weathering*, consider the process of weathering as a vehicle for its architectural merits, asserting that it is perhaps not only a problem to be solved or a fact to be neglected and avoided. Rather, weathering can and should be embraced as an inevitable occurrence recognized and utilized for the uncertainties of its manifestation¹⁹ and for the freedoms of unpredictability and aesthetic invention resulting from its actions.

Erosion and other physical depletions of a building's surface materials through subtractive weathering subsequently expose regenerated surfaces

¹⁹ Leatherbarrow and Mostafavi, *On Weathering*, 16.

of the same material from within. This acts simultaneously as the erasure of one surface directly catalyzing the revelation of a newer other.²⁰ Cycles of re-exposition of 'fresh' material surfaces to the outside environment represent, in essence, a self-contained interpretation of Goffi's notion of cyclical re-making of buildings as a whole. As a microcosm for ritual or necessitated reconstructions of larger architectural assemblies, material regeneration-through-degeneration highlights the relationship between past, present, and future of the material in question, and the values of its embodied history.

Additive weathering, comparatively, can be viewed as a historical record of a building's site and environment – a component of architecture which can greatly influence a building's core design, both spatially and materially. Stains, patinas, and biological accumulations can all constitute elements of additive weathering. All matter – and materials – exist in the continuum of time, in which the patina of wear adds the enriching experience of time to the materials of construction.²¹ Patina, a time-bound 'growth of skin' that covers the new surface with an accumulation that represents the tension between a work of art and the conditions of its location,²² can assume a variety of forms, depending on the shapes and traits of its base materials.

²⁰ Leatherbarrow and Mostafavi, *On Weathering*, 64.

²¹ Pallasmaa, Juhani, *The Eyes of the Skin: Architecture and the Senses* (West Sussex: Wiley-Academy, 2005), 31.

²² Leatherbarrow and Mostafavi, *On Weathering*, 69.

Buildings that have aged are often prized and romanticized for their mellowed brickwork, moss-covered stone, and seasoned timber.²³ The addition of sedimentary build-up, while contributing aesthetically to a building's aged character, can also benefit its surface cladding by providing a supernumerary layer of protection from environmental stressors. The concept of additive weathering embodies Leatherbarrow and Mostafavi's adage that "Finishing ends construction; weathering constructs finishes."²⁴

Material weathering is the primary mark of the passage of time. As a building's external surfaces age, all of its stains, erosions, and surface faults embody the notion of material sacrifice, adding character to the building and allowing it to 'breathe' and exist sempiternally through time and history.

Figure 10: Weathered clapboard siding

²³ Leatherbarrow and Mostafavi, *On Weathering*, 6.

²⁴ Leatherbarrow and Mostafavi, *On Weathering*, 5.

MAINTENANCE & CARE

Alongside weathering and material decay lie the necessary acts of maintenance and care. Bolstered in present day discussions by the shift toward sustainable design practice and environmental sensitivity of material usage and waste, anthropologist Shannon Mattern asserts that maintenance of the material world has become a topic of focus – a timely subject, but in no ways a new one.²⁵

Architectural maintenance at the building scale involves a wide spectrum of professional knowledge and expertise that includes preservation, material science, and building codes.^{26 27} As maintenance of existing buildings and materials becomes increasingly prevalent in modern day architectural practice, the value of knowledge and appreciation toward environmentally sensible materials, either alone or in combination with sophisticated sustainable technologies, has come to the forefront of design thinking.

The ethos and affect of maintenance, herein encompassing the values of preserving material histories both physical and metaphorical, has led to an increased discussion of the merits of ‘care’ by anthropologists, sociologists, and designers alike. From a combined anthropological and sociological perspective, political scientist Joan Tronto and the late American civil rights

²⁵ Mattern, Shannon. “Maintenance and Care: A working guide to the repair of rust, dust, cracks, and corrupted code in our cities, our homes, and our social relations.” *Places* (November 2, 2018): 2.

²⁶ Mattern, “Maintenance and Care,” 7.

²⁷ Mattern quotes Hilary Sample, MOS Architects principal and Columbia University Associate Professor, for this list of expertise relating specifically to labour industries involved in maintaining buildings. The list also includes development, (social and economic) policy, and insurance law.

activist Berenice Fisher have each defined 'care' for the built and natural environment as a whole performative entity encompassing "everything that we do to maintain, continue, and repair 'our world' so that we can live in it as well as possible".²⁸ Furthering this notion, philosopher and sociologist Maria Puig de la Bellacasa advocates for the merits of caring and maintaining the material world because we, as a society, "care for things not because they produce value, but because they already have value".²⁹

Materials, as matter to be cared for and maintained, can be viewed as things to be learned from over time, whether through physical repair and replacement, or through readings of their storied influences through time. Occasionally, learning from the materials can be achieved through acceptance of curated decay³⁰ (see: *Weathering*), to allow the natural environment to expose the materials' histories and actively engage the imagination.

²⁸ Mattern, "Maintenance and Care," 10.

²⁹ Ibid.

³⁰ Mattern, "Maintenance and Care," 13.

PART III: **RE-IMAGINATIONS**

Figure 11: Oak bark fragment

VERNACULAR CLADDING

Wood has been used for centuries as a construction material, serving a dual purpose as both an element of a buildings' structure and skin. Particularly in the eastern Canadian Maritime regions, a variety of hard and soft woods can be found in the vernacular residential architecture built before 1900.³¹ In large part, these coastal dwellings are of timber frame construction and are clad with the simplest of materials – namely wooden shingles and, occasionally, clapboard.³²

In some cases, the wall cavity between the structural timbers and exterior sheathing may have been packed with a variety of filler materials such as mud and clay, wood and mortar, sawdust, seaweed, straw, birch bark, or stone rubble.³³ Presumably conceived either as a form of structural reinforcement to back up the wall's stability, or as a preliminary layer of interstitial thermal mass insulation, these materials found within the vernacular houses' wall cavities were influential toward the buildings' resistance to the moisture-saturated, windy weather conditions of the Eastern provinces.

The damp and wind-driven seasonal weather patterns of the Canadian coast did not hinder the nineteenth and twentieth century construction methods

³¹ Peter Ennals and Deryck Holdsworth, "Vernacular Architecture and the Cultural Landscape of the Maritime Provinces – A Reconnaissance." *Acadiensis* 10, no. 2 (1981): 86.

³² Ennals and Holdsworth, "Vernacular Architecture," 88.

³³ Ennals and Holdsworth, "Vernacular Architecture," 91.

and materials, shown quite prominently today through the surviving vernacular buildings' retention of their original board and batten wood siding.³⁴ Applied vertically, this traditional arrangement and construction technique of wooden cladding members has seen a resurgence over the past six decades alongside the increased popularity and standardization of rainscreen building technology. Inherently positioned proud of the sheathing surface through the use of horizontal furring strips attached to the stick frame structure, the vertical siding naturally creates and protects the air space within the wall assembly that is paramount to the drainage, moisture, and temperature control of the rainscreen principle.³⁵ (*For further reading, see Appendix A*)

Figure 12: Typical timber rainscreen detail

35 Ibid.

CASE STUDY

TILTING (Newfoundland, Canada)

Robert Mellin, a Newfoundland architect, scholar, and Associate Professor at McGill University, has been a leading historian on the social, cultural, and architectural histories of vernacular fishing villages in his home province, and has written extensively on heritage conservation and preservation of its vernacular building stock. He has focused two of his books and several journal articles on the small fishing village of Tilting, located on Fogo Island northeast of Newfoundland's main island.

Figure 13: Tilting vernacular architecture displays wood-clad standalone outbuildings, with similarly clad fishing village houses and public buildings in the background

Through its vernacular buildings, settlement patterns, and dominance of farming, agriculture, animal husbandry, and fishing, Tilting provides one of the strongest extant demonstrations of the Irish influence on Newfoundland's landscape, architecture, and material culture.³⁶ The small houses, community halls, and outbuildings associated with the traditional family-based inshore fishery date from as far back as the late nineteenth century, and are one of the best known collections of this fishing village's vernacular architecture in the province of Newfoundland and Labrador.³⁷ There has been considerable effort by the Tilting community toward preserving and restoring these remaining structures, since they have essentially disappeared throughout the rest of the province.³⁸

The small outbuildings, propped up on tentative wooden support connections across the irregular coastal topography, are at a particular risk of destruction and disappearance. If left alone, the older houses and outbuildings that fall into disrepair without any permanent ties to the ground eventually disappear without leaving any traces or memories on the landscape.³⁹ The practices of recycling, re-making, and transforming the architecture of these outbuildings lies at the crux of Tilting's characteristic architectural and material cultures. The attitudes toward in-the-moment conservation in the village hinge on buildings' traits of elasticity, fragility,

³⁶ Robert Mellin, "Conservation in Tilting, Newfoundland: Rugged Landscape, Strong People, Fragile Architecture." *APT Bulletin* 37, no. 2/3 (2006): 13.

³⁷ Ibid.

³⁸ Tilting has received both provincial and federal heritage designations. In June 2003, it became Newfoundland & Labrador's first registered heritage district on account of its buildings' and landscapes' preservation of the inshore fishery culture.

³⁹ Mellin, "Conservation in Tilting," 14.

consistency in the use and transformation of natural materials, and celebratory acceptance of the constraints of irregular terrain.⁴⁰

Figure 14: A small Tilting outbuilding that has been blown over and damaged by strong coastal winds

Root cellars and cabbage houses, examples of subterranean outbuildings in Tilting, are used for storing vegetables and are individually representative of two defining characteristics of the village's approach to sustainable, living-off-the-land design strategies. The root cellars are built down into the ground and covered with shingles made from birch bark, used for its renowned resistance to moisture penetration, and covered with a thick layer of sod.⁴¹ Both of these cladding materials are naturally sourced and untreated, which allows them to be easily re-sourced and replaced in the event of damage or decay.

⁴⁰ Mellin, "Conservation in Tilting," 15.

⁴¹ Ibid.

Tilting's cabbage houses demonstrate the town's traditional practice of recycling almost anything. The small storage shelters are fashioned from repurposed row punts – small fishing boats that can be found in high abundance in the Fogo Island area. Also reused and recycled are the sills, beams, and cladding boards of old houses used in construction of new homes; wood from old pallets and packing crates for furniture; and entire relocated pieces of old houses and their additions re-imagined as standalone outbuildings.⁴²

Figure 15: Mellin's drawings of Tilting root cellars and cabbage houses, showing their subterranean siting and the repurposing of row punts

⁴² Ibid.

Over the recent decades, questions of revitalization through a plan to boost Tilting's tourism and economy have raised some issues regarding the extant building stock in the village. With respect to preservation of Tilting's architectural character, Mellin states:

"... [it] is one of the most important considerations, and the plain and austere character of Tilting's architecture should inform the approach to restoration work. Tilting's buildings are being repaired in an informal setting without the customary control over results that comes from using paid consultants, contractors, and project managers. In this setting it is sometimes difficult to convince participants to pay attention to the original detailing. New or "improved" details may be proposed, such as a projecting eave or painted wooden corner boards. In Tilting some fishing stages had these details and others did not, and often the main issue is no longer saving structures from demolition but saving structures from the character change that results from inappropriately 'improved' detailing." ⁴³

Hand-in-hand with the benefits of Tilting's proposed Heritage-Conservation and Development Plan are questions and issues surrounding costs, monetary and of time and labour, related to technical deficiencies of the village architecture. The main focus of these concerns is the need to

⁴³ Mellin, "Conservation in Tilting," 19.

implement a new exterior cladding system that can better withstand long winters and severe environmental conditions of the coastal maritime region, while maintaining the material and architectural culture of Tilting itself. In the recent past, buildings were painted with high-gloss, oil-based paint which trapped moisture behind the paint, causing flaking, peeling, and necessary reparative repainting on an average of four year intervals.⁴⁴ Additionally, the trapped moisture accelerated the decay and rot of the substratum of wooden cladding components, adding to the time, cost, and efforts of wholly unnecessary repair and replacement. Taking cues from earlier, more natural exterior protective coatings, the sides and backs of houses and the entirety of the village's outbuildings are painted with either red ochre, a ferrous clay earth pigment, or a combination of ochre and cod liver oil.⁴⁵ As a more permeable alternative, the ochre coating would prevent moisture rot and not compromise the longevity of the cladding behind it. Architects, engineers, and building scientists involved in the Development Plan for Tilting recommended the use of latex primers and paints to coat the wooden cladding members of a ventilated rainscreen assembly, prizing the latex paints for their similarities to ochre stains with regard to moisture flow, and its increased UV protection.⁴⁶

The desire to preserve material and architectural culture in Tilting with a consistency of detailing, materials, architectural elements and paint colours, encompasses a broader question of historical integrity and reverence of tradition from both the design and community lenses. The need for

⁴⁴ Mellin, "Conservation in Tilting," 20.

⁴⁵ Ibid.

⁴⁶ Ibid.

constant maintenance demonstrates the fragility of construction in Tilting⁴⁷, but such is a necessary sacrifice in order to save the history and lessons learned from a village that sits as a testament to the values of time, and as a still-shot of an increasingly fleeting way of life.

Figure 16: A house on Kelly's Island, Newfoundland, bought and restored by Tilting expatriates, demonstrates the townspeople's pride and expertise of craft, and the value of their community's heritage. This house restoration won a Southcott Award from the Newfoundland Historic Trust in 2005.⁴⁸

⁴⁷ Ibid.

⁴⁸ Mellin, "Conservation in Tilting", 18.

NEW METHODS, OLD MATERIALS

Advancements in material science and building envelope design have resulted in an increased amount of new builds and adaptive reuse projects implementing organic materials as exterior rainscreen assemblies. More reliable barriers (thermal, vapour, moisture, and air) in new construction and conservational renovations and rehabilitations on existing buildings have given cladding materials increased opportunity to be used in their natural, organic states. Ameliorations to the internal layers of the wall and rainscreen assemblies have relieved the cladding material layer of many of its previous ancillary environmentally protective qualities, aside from being a physical shield from precipitation. This new, focused role of the cladding layer has given it an increased level of design expression, providing architects the freedom to experiment with a broader selection of visual, textural, and atmospheric qualities in their buildings' skins.

CASE STUDY

GHOST LAB #4 (Nova Scotia, Canada)

Brian MacKay-Lyons, in tandem with his firm MacKay-Lyons Sweetapple and with the assistance of groups of students at the Dalhousie University School of Architecture and abroad, ran the Ghost Architectural Laboratory, a series of exploratory design-build educational projects, between 1994 and 2011.⁴⁹ The participants learned from MacKay-Lyons as they built temporary structures on the architect's property on an acreage of farmland in Lower Kingsburg, north of Halifax. The Ghost Lab produced small buildings that celebrated inventive craftsmanship and frugal pragmatism typical of traditional Nova Scotian vernacular construction during the seventeenth century French settlement of the East Coast of Canada. MacKay-Lyons and the participants in the Ghost Lab projects analyzed Maritime vernacular craft and materials thoroughly, before beginning any construction.⁵⁰ As such, all twelve Ghost Lab projects integrated Nova Scotian vernacular techniques, while also adapting them to contemporary building conventions. The semi-temporary pavilions on the Nova Scotia site primarily served as teaching tools and as landscape markers, subsequently testing and revealing the relationships between their structure to their cladding materials, their overall effects on the natural landscape, their creation of shelter, and the notions of permeability and powers of nature.

⁴⁹ The twelve Ghost Lab buildings, both existing and demolished, are comprised of a mix of small open-air pavilions and enclosed residential cabins for the participants, of which the latter are the only buildings still standing today.

⁵⁰ Brian MacKay-Lyons, *Ghost: Building an architectural vision* (New York: Princeton Architectural Press, 2008), 2.

Figure 17: Ghost Lab projects 1-12. Pavilions 1-5 were either dismantled or destroyed, while Cabins 6-12 were constructed as permanent fixtures on the Nova Scotia coast.

'Ghost 4', erected in July 2002, was an elongated structure that extruded into a single gateway to the sea.⁵¹ The rigid wooden structural framework followed dimensions and spatial layout dictated by the foundation ruins of two ancient Acadian and German settlement barns on the site, splitting it into nine structural bays. The central bay was completely un-clad, bridging the land to the water through the built form and embodying a physical and experiential threshold to and from the sea. The remaining eight bays of the building, symmetrically arranged four per side, were wrapped with long horizontal planks of wood "alternated and interlocked" in varying degrees of vertical density.⁵² This staggered slicing and puncturing of planar voids into the cladding layer accentuated the horizontality of the Ghost structure,

⁵¹ MacKay-Lyons, *Ghost*, 87.

⁵² Ibid.

the sweeping views across the undulating farmland and ocean horizon, and the planned impermanence of its cladding's protective elemental qualities.

Ghost 4's singular usage of wood for its structure and cladding, specifically untreated planks of various dimensions of construction lumber, illustrates its appreciation and respect for the vernacular systems of structure and construction. The reflected duality of built form to void was largely indistinguishable within the structure alone, and was only distinctly revealed through the spacing and density of the pavilion's wood cladding. Each of its two built volumes opened toward starkly opposing landscape conditions. One half of the pavilion's cladding heavily fragmented and disrupted its transparency toward solid ground to provide open and expansive viewing priority to the sea, while its counterpart did precisely the opposite. Only the central bay, through its absence of cladding, acknowledged the wet and dry sites' harmony with each other, augmenting the human experience.

Figure 18: Ghost 4 pavilion, 2002

CASE STUDY

SCHULZENDORF PRIMARY SCHOOL (Brandenburg, Germany)

In Schulzendorf, Germany, a small municipality in Brandenburg southwest of Berlin, a conversion and extension of Schulzendorf Primary School was undertaken by Berlin-based firm Zanderroth Architekten in 2007. Their main design objective, through a proposed extension to the existing school – instead of constructing another free-standing building – was to create a single, harmonized, closed volume encompassing both old and new.⁵³ To create a “jointless shell around the existing building and the two [new] annexes”, the firm decided to construct a second layer, a curtain façade, of exterior cladding suspended away from the existing precast concrete walls, composed of woven willow reeds and branches on a steel frame.

Figure 19: Schulzendorf Primary School woven reed rainscreen

⁵³ Zanderroth Architekten. "Il26: Conversion and Extension of Schulzendorf Primary School; Illgenstrasse 26, Schulzendorf, Brandenburg." Ru43 - Projekte – Zanderrotharchitekten. <http://www.zanderroth.de/en/projekte/il26/info> (accessed January 02, 2019).

The separation of the willow reeds from the mineral wool-insulated surface of the concrete wall employs the ventilated cavity principle of a typical rainscreen assembly, protecting the additive layer of fibrous insulation and the aged concrete itself from water damage and other detrimental effects of the environment. The reeds, having been peeled and subsequently protected with a fire retardant coating, act as an additional layer of defense for the newly invigorated wall assembly. As a material that, when decayed, can easily be re-sourced and replaced without the expenditure of large amounts of energy, manufacturing cost or carbon emission, the willow reeds exemplify the push toward more sustainable material selections and environmentally sensitive design practices.

Figure 20: Schulzendorf rainscreen plan detail

CASE STUDY

MISANO - HEKIKAI SHINKIN BANK (Nagoya City, Japan)

Japanese architects, builders, and craftsmen have been constructing and cladding buildings with wood for centuries, using it for everything from structure to cladding to furniture to interior ornamentation. Kengo Kuma, renowned for his use of wood as intricate structural and decorative components, recently completed a project in 2017 in Nagoya City, the Misono branch of the Hekikai Shinkin Bank. Accoya wood⁵⁴ has been used as a secondary cladding skin on top of the glazed curtain wall spanning the bank's entire seven stories. As a slender, diagonally oriented louver system, the thin lines of wood act primarily as a sun shading device for the building, which sits at the corner of a busy intersection.⁵⁵

As a rainscreen system, the Accoya wood slats do not function in the typical all-encompassing environmental barrier fashion of more 'complete' cladding assemblies, but they do somewhat represent a modern re-imagining of vernacular plank siding. Though more widely spaced and oriented against the building on their shorter cross-section, the louver planks do protect the inner layers of the wall (in this case, the glass) from

⁵⁴ Accoya is a brand of modified timber with heightened rot resistance and increased dimensional stability from a scientific process of acetylation, essentially soaking softwood in a form of vinegar (acetic anhydride). The acid alters the wood cells' behaviour and prevents them from being able to absorb water. <https://www.accoya.com/blog/acetylation-what-is-it-and-and-what-is-acetylated-wood/>

⁵⁵ Designboom.com. "Kengo Kuma's Wooden Cladding Emulates the Effects of a Japanese Forest." Designboom | Architecture & Design Magazine. July 06, 2018. <https://www.designboom.com/architecture/kengo-kuma-accoya-wood-cladding-toki-shinkin-bank-misono-branch-07-06-2018/>. (accessed January 03, 2019).

some of the direct exposures to the elements. If manipulated further, possibly by a slight increase in rotation and a more dense application pattern, the slats could function as a semi-permeable double rainscreen layer which, through its scientifically enhanced performance benefits, could withstand the tests of time better than its more natural predecessors.

Figure 21: Accoya wood louvres on the Misano branch of Hekikai Shinkin Bank

Wood, in both its natural and engineered states, remains a sacrificial building material and, when used in any rainscreen assembly, must still embrace the sacrificial nature of the building skin. Advances have been made, and will continue to be investigated toward the creation of more durable materials and more reliable layered assemblies to be utilized in wall construction, but the sacrificial value of these outer materials to protect the integrity of what lies beyond the surface must not be lost or forgotten.

MATERIALITY

To better understand the full meaning and design possibilities of any given architectural material, one must consider and evaluate its properties of materiality, relating to the human *experience* of it through its growth, treatment, construction, and built lifespan. These non-physical traits of materials are what communicate their stories, embedded within and created through their architectural making.

Marco Frascari, the late Italian architect, professor, and scholar of theories of architectural representation, references materials' anagogic sense as its most freeing quality most receptive to change and variation. According to Frascari, drawings and materials can be evaluated through four senses: the *literal* sense teaches what happened; the *allegorical* what you believe; the *moral* what you should do; and the *anagogic* where you are going.⁵⁶ Representing uncertainties in a material's future, coupled with an open-minded curiosity of undetermined outcomes, the anagogical sense demonstrates an immaterial reality beyond the material's physical conditions.^{57,58} Imagination in the perception of materials (i.e. their materiality) relates to the abstract *human experience* of architecture, in contrast to the physical, scientific construction viability of technological assemblies and constituent parts. To successfully understand the complete

⁵⁶ Marco Frascari, *Eleven Exercises in the Art of Architectural Drawing: Slow Food for the Architect's Imagination* (New York: Routledge, 2011), 59.

⁵⁷ Ibid.

⁵⁸ Frascari writes that anagogy occurs when the connection between (physical) materiality and (sensual, experiential, abstract) immateriality, and perceptible and imperceptible, are in a suspension of time.

architectural meaning of façades and buildings' cladding materials, the anagogical, emotional aspects of materials should be considered as a storytelling element to uncover cues from their past and to inform possible eventualities of their future.

While Frascari's definition and theoretical siting of anagogy stands as a framework for the analysis of drawings and materials, it should be noted that he has projected architectural connotations of physicality and space onto a historical guideline for interpreting Biblical texts. Medieval scholar Bonnie Howe cites and translates a poem from the Middle Ages that explains the *Quadrige* – the four ways to interpret the Bible:

*"Littera gesta docet, quid creda allegoria,
Moralis quid agas, quo tendas anagogia.*

The letter shows us what god and our fathers did;

The allegory shows us where our faith is hid;

The moral meaning gives us the rules of daily life;

The anagogy shows us where we end our strife."⁵⁹

The *Quadrige* shares, essentially, the same interpretations Frascari's reading of the four senses of evaluation – the *littera* (literal) describes events and actions of the past; the *allegoria* (allegorical) reveals things that are hidden

⁵⁹ Bonnie Howe, *Because You Bear This Name: Conceptual Metaphor And the Moral Meaning of 1 Peter* (Leiden: Brill, 2006)

(faith and/or beliefs); the *moralis* (moral) sets rules for conduct in the present; and *anagogia* (anagogical) deals with events or consequences of the future.

Juhani Pallasmaa argues that storytelling through avenues of materiality and time begin to be lost in buildings of the present technological age – machine-made materials, glass, metals, synthetic plastics – usually deliberately aimed at ageless perfection. They hide their material histories and do not incorporate the dimension of time, or the unavoidable and mentally significant process of aging.⁶⁰ Natural materials, through their expressions of their age and histories, translate actions of human making and use into experiential qualities, markings, and non-visual sensory stimuli. Telling stories through wear, metamorphoses, and contextual adaptation, natural materials allow humans to be directly involved, either as spectator or actor, in their deteriorations, restorations, and transformations.

Citing the writings of American therapist Gotthard Booth, Pallasmaa supposes that this human-material connection is a key combatant to deteriorating effects of the human psyche. Booth states that we, humans, have a mental need to grasp that we are rooted in the continuity of time, and in the man-made world it is the task of architecture to facilitate this experience.⁶¹ As we see, feel, smell, and hear buildings and materials age and decay, we are faced with the prospects of mortality and in turn, gain a

⁶⁰ Pallasmaa, *Eyes of the Skin*, 31.

⁶¹ Pallasmaa, *Eyes of the Skin*, 32.

strengthened re-appreciation of the values of conservation, preservation, and rejuvenation of life.

Storytelling, re: Frascari, can be considered as a duality of linear versus chaotic time, personified by the ancient Greeks as two etymologic characters, *Chronos* and *Kairos*. Chronos, the quantitative time, is more straightforward, chronological, and referential to history; Kairos is qualitative, therefore mercurial, unpredictable, and less tangible, hinging on chance, opportunity, and synchronicity.⁶² This analogy, when projected onto buildings and materials, encourages an adaptive, elastic attitude toward form, re-making, and replacement. Buildings, and their materials, should respond the requests of their own epoch, but should concurrently be able to adapt to requests that cannot be anticipated or even imagined.⁶³ Natural disasters, pests, or even unconventional coating treatments should be embraced and welcomed as *Kairos* elements of materials' constantly evolving narratives.

University of Aberdeen's professor of anthropology, Tim Ingold, has written about the 'riddle of materials' and their constant shifts in meaning and interpretation when acted upon by human beings. He states that materials, unlike objects, do not exist as static entities with definitively categorized diagnostic attributes; rather, they exist as substances-in-becoming that are constantly modulating through time, forever overtaking and transforming the meanings and physical forms assigned to them periodically in their

⁶² Frascari, *Eleven Exercises*, 69.

⁶³ Ibid.

pasts.⁶⁴ These subtle shifts of a continuously evolving material narrative are what prevent materials, over extended periods of time, from being separated into definite, permanent categories. To accurately and completely describe any material's materiality, one must observe and engage with what is physically present, uncover the stories of its past, and glean insight into sympathetic human-inflicted transformations to enhance its future. This process, Ingold states, gives the material a voice and allows it to tell – and write – its own story.⁶⁵

Design theorist David Pye proposes that materiality lies in the qualities of a material, and makes a distinction between its properties and qualities. Properties are objective and scientifically measurable aspects of the material, while qualities are subjective – ideas in people's heads, shaped by their experiences with and around the material, which are then projected onto it.⁶⁶

The position proposed here is that the materiality of *things* (buildings, materials, and their fragments) encapsulates all that is not physically quantifiable through data, measurements, and calculation. Rather, materiality lies in its qualitative characteristics: what is learned about it through its making, re-purposing, and transforming.

⁶⁴ Tim Ingold, *Making: Anthropology, Archaeology, Art and Architecture* (London: Routledge, 2013), 31.

⁶⁵ Ibid.

⁶⁶ Ingold, *Making*, 29.

PART IV: **EXPLORATIONS**

Figure 22: Digitally milled tree slice siding for the "Corbel-Bacon Cabin", seen in the workshop warehouse of *HANNAH Architecture & Design* at Cornell University, Ithaca, NY

WHAT SHOULD CLADDING 'SAY'?

Façades of architecture are tasked with communicating narratively selective, sometimes falsified versions of the histories of the things – buildings, or people – wrapped within them. In referencing the humanistic assumption in the realm of Western architecture that the façade of a building should speak to and about its insides, Rem Koolhaas brings up the notion of an 'honest' façade in *Delirious New York: A Retroactive Manifesto for Manhattan*.⁶⁷ The fact that buildings have both an interior and an exterior, and the subsequent act of separating the two both in form and in meaning, is framed in a critical discussion of the New York City skyscraper but can be considered against a large variety of building types, programs, and sizes, and further distilled as the manifestation of a severance of the façade from the building's habitable space(s).

Treating Koolhaas' distinction of the exterior-interior relationship of the skyscraper as a macroscopic metaphor of a building's cladding materials, one can envision the same layers and boundaries of the larger 'building' within the single layer of the material façade itself. When examined at this enhanced scale, the façade surface does in fact differ from the thicker façade material. Both components – the surface which responds to the exterior environment, and the material which supports said surface – carry their individual stories, histories, behaviours, and physical properties. The aging and physical detriment of the cladding's surface layer directly influences the

⁶⁷ Rem Koolhaas, *Delirious New York: A Retroactive Manifesto for Manhattan* (Rotterdam: 010 Publishers, 1994), 100.

'life' of the supporting material, whose integrity concurrently affects the stability and longevity of the surface that protects it. This cycle of action and reaction, in theory, only hits a finite limit once the overall material passes its natural inflection point: when the surface deteriorates *into* the support, or, when the support is worn down to no longer be viable.

Cladding materials, especially in their 'natural' or non-synthetic forms, can bring an element of genuineness to the character of the architecture. Occasionally, environmental forces can expose the natural material's performative limitations which act as valuable reveals of the material's ever-changing narratives and give insight to how their pasts can influence their futures.

METHODOLOGY

The design explorations proposed herein are framed to consider wood (a natural material) and its narrative qualities of materiality as a parallel counterpart to engineered cladding materials altered to deter the markings and evocatively meaningful influences of time. To reiterate, the two guiding questions posed at the beginning of this thesis were:

- How can wood in its natural state, with its inevitable degradations and imperfections, celebrate these changes as an unveiling of its embodied character and history?; and
- How can these marks, traces, and transformations be used to further inform details and designs of the rainscreen as a communicator of material narratives?

The guiding principles of sacrifice, cyclical regenerations, and the celebration of curated decay carry through all of the following design exercises. The following material, photographic, and representational studies will attempt to uncover and compose narratives of materiality through detailed analyses and translations of wood as, a) a standalone natural material, and b) the key component in the assembly of a naturally-faced architectural cladding system.

The outcomes of the three studies – thermal modification, celebrations of weathering, and the interplay between technical detailing and the art of façade tectonics – will be analysed and combined, to culminate in a speculative drawing that aims to answer the thesis' guiding questions, ultimately proposing a new, informed way of considering the temporality, decay and possible re-imaginings of a wooden rainscreen.

MATERIAL STORIES

The narratives that shape experiential materiality can evoke many emotions, historical insights, and speculations linked to their existences along the continuous spectrum of time. These stories, primarily rooted in the physical marks and traces in and on the material body, can also be influenced and altered by its ever-changing environmental conditions. Everything from the quality of light, strength of wind, temperature, and external material adjacencies can affect the communication of the material's story and, in turn, how it is perceived by the experiencer. Furthermore, these stories are not static, and are always in a state of flux determined by the material's physical being, and by the individual mindset of its interpreter.

Italo Calvino, in an excerpt from chapter eight of his novel *Invisible Cities*, recounts the material story of a square of either ebony or maple wood inlaid in a chessboard, as follows:

"Kublai had arrived at the extreme operation: the definitive conquest, of which the empire's multiform treasures were only illusory envelopes; it was reduced to a square of planed wood.

Then Marco Polo spoke: "Your chessboard, sire, is inlaid with two woods: ebony and maple. The square on which your enlightened gaze is fixed was cut from the ring of a trunk that grew in a year of drought: you see how its fibers are arranged? Here a barely hinted knot can be made out: a bud tried to burgeon on a premature spring day, but the night's frost forced it to desist." [...] "Here is a thicker pore: perhaps it was a larvum's nest; not a woodworm, because, once born, it would have begun to dig, but a caterpillar that gnawed the leaves and was the cause of the tree's being chosen for chopping down . . . This edge was scored by the wood carver with his gouge so that it would adhere to the next square, more protruding. . . ."

The quantity of things that could be read in a little piece of smooth and empty wood overwhelmed Kublai; Polo was already talking about ebony forests, about rafts laden with logs that come down the rivers, of docks, of women at the windows. . . ."⁶⁸

⁶⁸ Italo Calvino, *Invisible Cities*, trans. William Weaver (New York: Harcourt Brace Jovanovich, 1974), 131-2.

Through his meticulous description of the wooden square's minutia, Calvino – through the voice of Marco Polo – succeeds in conveying not only the most thorough physical description of the wood itself, but also in attaching characters, actions, environmental conditions and their combined consequences onto and into the material, giving it life, character, and a sense of purpose. In this story, the wood acts as a window into the outside world, revealing sensory qualities of the seasons, introducing characters that would have acted on or with the tree during its life, and detailing the carver's actions while crafting the chessboard to which it owes its current form of existence.

The combination of pragmatic and emotional analyses of the wood's physical properties opens avenues of greater discovery and imagination into its existence in the present, and frames speculations and aspirations for the unknown of its future.

TORREFACTION

The material modification process of torrefaction, a thermochemical treatment for wood and other biomass materials, has been used as a method of protection against rot, flammability, and insect infestation since the early 19th century. Typically carried out in temperatures between 200 – 320°C (392 – 608°F), and ideally without any added oxygen, the wood is essentially baked for a minimum of three or four hours. The low oxygen content in the torrefaction environment greatly reduces the chances of combustion as the wood is heated and baked through. This high-heat baking process draws out any remaining water present within the wood itself, as well as partially decomposing and releasing its biopolymers: cellulose, hemicellulose, and lignin.

The expulsion of these biopolymers from the wood throughout the torrefaction process eliminates all biological activity in the resultant torrefied pieces, reducing the risk of flammability and flame spread, and stops any actions of rot or decay. The end result, torrefied wood, is much dryer, darker, and more brittle than its untreated counterpart. Perhaps most significant toward its potential role as a cladding material are the hydrophobic properties it gains during the torrefaction process, which allows it to repel water and other precipitates more successfully than untreated wood.

The consequence of semi-destructuralization through the breakdown of the wood's internal fibres is the sacrifice of the torrefaction process; namely, torrefied wood gains protective qualities against environmental stressors and natural decay but loses a large amount of its linear strength and structural viability.

Figure 23: Torrefaction process photos (Poplar, Maple, Red Oak, White Oak)

Figure 24: Torrefied poplar-clad garage, "FS Shed", Reverse Architecture, 2017-present
Belmont, MA, USA

Figure 25: Torrefied wood (photo from Colloquium III, February 12, 2019)
(L-R): Red Cedar, Pine, Ash, Maple, Poplar, Red Oak, White Oak, Birch

'The Materiality of Thermal Modification'

Torrefaction, objectively, alters the appearance and visual perception of the wood it treats by darkening its colour throughout, and slightly compressing its dimension perpendicular to its grain direction. However, within these objective changes lie all of the experiential transformations and sensory augmentations that combine to create the narrative of the material as it is thermally modified.

'Cooked' in a standard kitchen oven, the selected woods emitted varying levels of fragrance and smoke over the course of the three-hour baking period, making the room – and by extension, the entire house – smell like a rustic cottage or woodland log cabin. Wafting for days throughout the adjacent rooms, the olfactory stimulus lingered in the kitchen and around the oven for over two weeks after the day of production. The smell, an unexpected yet comforting mix of a campfire and slightly caramelized sugars, transplanted a rural, outdoor aura into the walls of a characteristically opposite suburban home.

The smoke that escaped from the oven when the torrefaction was complete, itself a marriage of the senses of sight and smell, left a blanket haze across the kitchen ceiling. For hours after the baking ended, the smoke preserved the memory of the 'raw' woods, a particulate conglomeration of all matter that was expelled through this act of thermal modification.

FAULTS & TRANSLATIONS

The following photographic exercise starts to document wood-clad buildings in the neighbourhoods, documenting observed instances of weathering, surface faults, and abnormalities in three typical cladding typologies: clapboard, tongue-in-groove siding, and cedar shingles. Sketches of each building's cladding attempt to extract only that which is 'imperfect' in the materials, to exhibit the effects of time and weathering on their surfaces. By isolating what could be perceived as defects or impurities, the sketches call attention to the progressive cycles of life experienced by the materials, and highlight areas of the cladding that could undergo cyclical narrative 'resets' to extend their existence through the sequence of linear time. Perhaps, these imperfections and signs of age can be reimagined as a methodical design strategy, to emphasize their detailing and placement on a façade as a curated showcase of material weathering.

Three properties in Old Ottawa South and three in The Glebe were selected for this exercise. None of the houses are entirely clad with wood; it is primarily used as accent cladding on dormers or bay window protrusions. The garages, however, have been fully clad in wood boards. All of the board siding has been painted, and exist today with varying levels of wear. The cedar shingles on the house at 5 Howick Place have been painted, while those on 19 Seneca Street have been left in their natural untreated state.

Figure 26: Map, Old Ottawa South

Figure 27: Map, The Glebe

Accompanying each photograph and sketch is a short observational musing, speculating on the possible causes of the woods' weathering and how they arrived at their current states.

Figure 28: 5 Howick Place, photo and sketch

5 Howick Place

The dark blue-painted cedar shingles on the upper bay window are west-facing, meaning they are more likely to face heavier wind speeds throughout the year. The shingles, presumably when installed, cover each other at inconsistent widths of overlap, and the resulting pushing from underneath has caused some of the more irregularly placed ones to start splitting.

The paint is also peeling or flaking off, but interestingly only on the lowest two rows – where the paint has disappeared, the grain lines and grooves of the shingles have now been exposed, possibly creating many more channels for water runoff. The two weathered rows seem to flare out at a wider angle from the vertical surface of the brick veneer under and behind them, perhaps this has affected their exposure to direct sunlight and more impact from precipitation?

Figure 29: 19 Seneca Street, photo and sketch

19 Seneca Street

The cedar is showing signs of bending, but only the shingles mounted on the south facing façade – could they have cupped in the rain and be flattening as they dry in the sunlight?

Their knots and splits seem to be 'breathing', releasing the water trapped inside them through the cold, long winter. A few of them have accumulated dark stains and discolorations, complementing the patchwork of redder heartwood, greener sapwood, and the brown outlines of knots.

Figure 30: 24 Seneca Street, photo and sketch

24 Seneca Street

Decades of winters' freezes and thaws have changed the wood boards on this garage, especially since the cladding extends completely down to the ground; see how the lowest two have started to peel? The salt and snow have stripped their paint away, breaking off in flakes, its face now bare to the chill and wet of spring. Here and there, they show signs of rot, softened by the water that snuck through exposed pores. Corners and edges are starting to splinter, fraying out its fibres that bend, contract, and curl.

Circles of rust have marked the paint, dotting the boards where the nail heads have been exposed. They sometimes skip a board or two, but the patterns show us where the new ones will appear.

Figure 31: 102 Second Avenue, photo and sketch

102 Second Avenue

The most noticeably weathered of all the houses studied, the wood board siding on 102 Second Ave has the most consistent distribution of peeled paint, scratches, and long horizontal cracks on all three facades visible from the street. It appears, however, that the bulk of the surface weathering has not penetrated into the wood itself to compromise it organically, because most of the visible faults are the large patches missing paint. The few cracks observed running lengthwise along some of the boards on the east and west facades have not completely split through the boards, but are merely surface imperfections.

While the main transformation to the exposed wood has been discoloration and staining (presumably from water), the boards abutting the windows on the front façade have started warping, and are splitting apart from both each other, and the window trim. This has opened gaps between the cladding components and raises the risk of water and pest penetration into the rainscreen cavity.

Figure 32: 110 Second Avenue, photo and sketch

110 Second Avenue

The clapboards enveloping the small upper-floor protrusion show significant weathering along their bottom edges, particularly when they meet at the corner. The paint appears to have been chipped off the boards' edges a long time ago, since the areas of unpainted wood have greyed significantly after being exposed to the heat, rain, wind, and snow.

Deep gouges and cracks have also been take out of the boards near the window frames, possibly due to expansions or contractions of the window through different seasons, or maybe from insect infestation burrowed into the crevices between the horizontal clapboard and vertical window trim.

There seems to be no discernable warping of the boards' profiles along their lengths – only chips, cracks, and discolorations along their bottom edges.

Figure 33: 455 Sunnyside Avenue, photo and sketch

455 Sunnyside Avenue

The wood on this garage has not faced as much weathering of its paint coating as its neighbourhood counterparts. The main issue here has been lengthwise cupping and twisting, which has created long openings at the seams between the boards, along both their horizontal and vertical edges.

The north façade (the side of the garage) appears to have been pecked or clawed at by an animal trying to get something that was hidden in a crack between two warped boards. The hole that was created has yet to be filled in, leaving the possibility open for further pests to eat away at the compromised material.

As the boards have been twisting, expanding, and contracting through the effects of seasonal shifts and subpar moisture mediation, splits have appeared at some of the fastening points. The holes around the nails at both the ends and middles of the boards have begun to split them lengthwise.

DRAWING THE DETAILS

The drawing typology of the Detail Section, as it pertains to wall assemblies and cladding connections, has become a valuable learning and visualization tool for understanding the methods and materials of building envelope construction. The standardization of drawing conventions has highlighted the precision and prescriptive qualities of the rainscreen, framing it as a 'kit of parts' sometimes lacking the interpretive lens of materiality. The Detail has its merits, particularly that it shows all of the objects and quantitative conditions that are otherwise hidden, from an exterior perspective, to the naked eye – fasteners, barriers, and air spaces. These drawings, however, are typically intended as a construction document, and therefore present the cladding as a 'perfect' entity in its objectively pristine state. This restriction gives the cladding no representational opportunity to express its potential deformations or elements of its material character as it will inevitably exist over time.

The following exercise is a study in re-visualizing, through the act of drawing, the tactility and qualities of materiality that are lost in the sterilization of the typical Detail Section. Surface characteristics of the wood – bark textures, cracks, grain lines, and knots – are emphasized in the charcoal sketches as elements of the cladding's outward presentation to be celebrated and embraced, not erased or forgotten.

Figure 34: Detail Sections and interpretive façade materiality sketches (T-B): Clapboard siding, Drop channel siding, Split log siding with bark

RECTO | VERSO

The final drawing, done on mylar, takes full advantage of the sheet's semi-transparency to examine, explore, and communicate the double-sided narrative of wood as natural material cladding. Taking the form of a Recto/Verso drawing, the 'two sides of the story' are presented as equal yet complementary faces existing on both sides of a two dimensional plane of representation. Combining the technical and theoretical, the digital and hand-drawn, and objective notes with subjective narratives, this drawing attempts to mediate the middle-ground between the *engineered* and the *natural*, to maintain that one cannot fully exist without the other.

The Recto side, drawn digitally, displays the precisely measured components of an objectively viable rainscreen assembly, complete with dimensions, notations, and the sequenced layers of construction. All of these elements are drawn in an idealized state, without any faults, and with minimal to no tolerance for shifting, compromise, or decay. The Recto drawing strips the actual cladding layer of any material connotation, showing its pieces simply as a static skin that will remain unaltered and unaffected by any abnormal environmental influences.

The Verso side, drawn by hand, conveys everything subjective about wood as cladding material and its influences from, and on, its life in time. Technical notations are hereby replaced with narrative anecdotes, to exhibit how initially perfect, untouched material surfaces are altered by the effects

of weather and weathering, manipulating their shape and potentially instigating movement. These altered forms and potential breadths of affected movement are drawn (identically, yet inversed) as sectional representations of the weathered, transformed materials. Decay, maintenance, removal, and the need for replacement are explicitly stated, and are treated as a beneficial opportunity for experimentation. A variety of weathering and transformative reactions of the wood rainscreen are explored through this drawing. They are methodically arranged to suggest a sectional interpretation of a façade that has been designed to celebrate material changes and to present its ever-changing story.

Adding to the notion of materiality on the Verso side, some of the lines and markings have been drawn with homemade ink distilled from wine and a form of protective growths from oak trees.⁶⁹ These galls, used in the ink preparation for their tannic properties, were originally created by the tree to protect itself against wasp larvae planted in its trunk and branches. The tree, in a feat of self-preservation, underwent acts of sacrifice, regeneration, and material replacement, consequently birthing a new version of itself into the world. This connection between wood as the material being drawn, and wood as a component of its physical representation, enhances the material narrative and interplay between both the drawing and the cladding system being explored.

⁶⁹ This ink was made in the *Daedalic Exercises* workshop [ARCN5302W], as a didactic study and learning-through-making of an assigned Medieval manuscript. The ink itself was one of hundreds of recipes compiled from artisans in the north of Italy and across France from the 1380s – 1411, transcribed into its manuscript form by French Royal court official Jean Le Begue in Paris, in 1431. The complete recipe, in its original Latin and its English translation, can be found in Appendix C.

Figure 35: Recto | Verso – preliminary sketch of 'Recto' side

Figure 36: Recto | Verso drawing, 'Recto' side

Figure 37: Recto | Verso drawing, 'Verso' side

Figure 38: Recto | Verso drawing, 'Verso' side zoom 1

Figure 39: Recto | Verso drawing, 'Verso' side zoom 2

Figure 40: Recto | Verso drawing, 'Verso' side zoom 3

Figure 41: Recto | Verso drawing, 'Verso' side zoom 4

Figure 42: Recto | Verso drawing, 'Verso' side zoom 5

Figure 43: Recto | Verso drawing, 'Verso' side zoom 6

DESIGN REFLECTION

In retrospective reflection of the concepts supported by this body of research and shown through the material and representational exercises, there lies the critical question of, "So What?" How does this thesis, and all of the ideas and arguments within it, assert itself in the 'real', built world and the physical *making* of architecture?

The sacrifice of materials has been framed, thus far, as a beneficial aspect of architectural and experiential narrative. Going forward, one can speculate that natural materials and their sacrifices, in combination with technological construction advancements, can make buildings 'better' on the outside without compromising their 'insides'.

Torrefaction, as a scientific process and as a material exploration, has proven fruitful toward avenues of design expression. Its performative benefits and narrative substance, as detailed previously, indicate that torrefied woods could and should become a more widely used cladding material. The primary factors supporting its increased use are the material's longevity and built-in environmental protection. When coupled with its aesthetic and sensory qualities, such as the richness of colour and exudence of scent, torrefied wood proves itself to be a very valuable, natural material resource well suited to both building science and architectural design. The resurgence of a centuries-old material treatment technique, also contributes to this thesis' concept of linear-cyclical time sequencing.

Figure 44: Recto | Verso drawing, 'Verso' side, Torrefaction

Speculations on a 'Double Skin Rainscreen'

The cyclical-linear time relationship can also be applied to buildings as a complete entity, considered insofar that the details (of connection, and of sequenced material assembly) exist on the cyclical plane, constantly being maintained, refurbished, and restored, while the building as a whole – the result and by-product of these cycles of repair and re-making, travels steadily along the path of linear time.

Considering this thesis' assertions, an architect could potentially design a rainscreen physically composed of a single material in a multiplicity of layers, allowing the exterior-most skin to weather, decay, and dematerialize completely over its embodied lifetime, thereby exposing a protected, 'fresh', rebirthed material from underneath. As the rainscreen enters its next cycle of life, the newly exposed material of its composition will begin to write its own story, echoing but not copying that which preceded it.

The following rainscreen detail combines horizontal wood siding (the inner cladding layer) and vertical board siding on the exterior. The interplay and 90-degree rotation of cladding members allows for built-in furring supports for a necessary 19mm air cavity between the two layers of wood – battens at the seams of the horizontal boards provide structure for the outer layer in double-skin assembly, and act as aesthetic accent once exposed. The decay of parts, or all, of the outer cladding layer staggers the cyclical narrative returns with the unpredictable exposure of the second skin.

Figure 45: Recto | Verso drawing study, 'Double Skin Rainscreen'

Speculations on a 'Thick Board Rainscreen'

Could cladding boards, alternatively, be specified at greater thickness to allow for this ritual routine of removal, in anticipation of narrative prolongation equally at the hands of man *and* of nature? Considering that the generally accepted lifespan of a building sits between 40-50 years, the life cycle of typical 25mm wide solid wood siding boards can be analyzed along the same timeline. If said board can be projected to weather and dematerialize at x amount over 50 years, reinstating a wider cladding board in its place would benefit the big-picture narrative of the material, and contribute to a less destructive amount of material use over multiple building cycles. The wider board could potentially decay at the same rate, losing the same physical amount of material mass. However, the increased width would allow the board to either remain in place, untouched, through a second life cycle of the building, or to be repurposed as cladding on a new building, equally as viable as a freshly hewn siding board, but without the need to source and process new material stock. Again, the cycles of the rainscreen material progress through time, constantly adding to its expanding narrative within.

Figure 46: Recto | Verso drawing study, 'Thick Board Rainscreen'

Could the act of re-making and regenerating a wood rainscreen in fact be as simple as shaving or slicing away the weathered face of the boards? Would this gradual removal of physical material prolong the life – both physical and narrative – of the material itself? Or would it falsify the authenticity and strip away the importance of this continuation of time?

It is this dual condition, and partnered yet binary relationship of influence that has framed the direction of this research and speculation. How can we, as architects, design rainscreens *for* material aging, while also allowing material aging to *inform* our designs? Who or what, in the end, shapes this quintessential face of architecture?

Each of the aforementioned speculative rainscreen proposals could be used in a range of building types across an array of climates, and in either urban or rural zones. The material(s) themselves are not site-specific; rather, the environments to which they are exposed and the sites they exist in will effectively influence, shape, and – to a certain degree – dictate the narratives that they follow.

The woods' responses and adaptations to these external conditions will never be identical from place to place, nor from board to board or shingle to shingle. Each piece will react differently, for they are merely pawns in the uncertain playing field of life, bound only by time and space.

Figure 47: Final Defense layout, April 18, 2019

CONCLUSION

The Sacrificial Layer has attempted to examine an alternate method of consideration for the use and valuing of wood as a natural cladding material, and to envision its existence in the architectural world as only a fraction of its extended temporal lifetime.

The decision to take a speculative approach of observational analysis and representational discovery through drawing stemmed from the time limitations inherent in thesis research process as imposed on the real-world scope that physical material testing would necessitate. To have adequately tested and observed any tangible or quantifiable material changes on elements of wood cladding (weathering, replacements, and the need for maintenance) would require years, if not decades, of environmental stress on the materials.

That being said, since much of architectural detailing in preparation for its components' aging is inherently speculative in nature, this thesis occupies a suitable and appropriate role in the discourse surrounding the intersections of architectural theory and building science technology. It is my hope that, through this body of research and design speculation, the importance of material narratives and the acceptance of the 'imperfect' can claim its well-deserved seat at the table of architectural-conservation practice.

APPENDIX A

RAINSCREEN SCIENTIFIC PRINCIPLES

Cladding, as the intermediary architectural surface boundary between exterior and interior spaces, serves its primary function of protecting the structure and insulation within a wall assembly from the impact of nature and its elements. Preventing the exposure of the inner wall layers to the intrusive and destructive properties of moisture became a point of great interest to Canadian engineers and building scientists in the early 1960's.

In reference to the initial concept of a rainscreen seen nearly two decades earlier in a 1946 paper by C.H. Johansson entitled "The Influence of Moisture on the Heat Conductance for Brick", scientists and engineers at the National Research Council of Canada (NRCC) conducted years of material and mathematical testing, experiments, and analysis to determine a method of design and construction that would ensure constant and reliable moisture management within a wall cavity.⁷⁰ The extents of their research confirmed a widely observed shortfall of their popularized, present-day 'face seal' cladding treatment technique, wherein the surface coating on a wall must be created 'perfect' and remain so for its entire lifetime. If this face seal system were to, expectedly, inherit cracks or imperfections – even on the microscopic level – after being affected by the nature of construction activities, the aging of the sealants or coating itself under temperature

⁷⁰ Dale D. Kerr and Kenneth Labs, "The rain screen wall," *Progressive Architecture* 71, no. 7 (Aug 1990): 47+, accessed November 11, 2018, http://link.galegroup.com/apps/doc/A9276683/AONE?u=ocul_carleton&sid=AONE&xid=6523df10.

cycling or ultraviolet radiation, and the differential movement or settling of building components over time, water would pass through the damaged shield of the wall surface and penetrate into the cavity it was meant to protect.⁷¹

The NRC's studies and subsequent recommendations to designers and professionals in the building and construction industry proposed a formalized cladding system that would not substantially increase neither the cost nor complexities of the construction process.⁷² G. Kirby Garden's 1963 article in the NRC's Division of Building Research's *Canadian Building Digest* 40, "Rain Penetration and Its Control", laid out the concepts, methods, and materials involved in the new form of cladding arrangement, and popularized the term 'open rainscreen' and the overarching rainscreen principle.⁷³

The success of this new rainscreen principle hinged on the standardization of a three-layered weather control system within the design of the wall cavity: two layers of material (sheathing and cladding) separated by an air space. This air space, sandwiched between a sealed, airtight inner sheathing face and a vented cladding layer, minimizes the air pressure differential (APD) that exists across the outer building wall assembly. Mediation and equalization of the air pressure through the wall cavity works to drive out any moisture trapped within the air space through the vents and openings

⁷¹ Ibid.

⁷² Ibid.

⁷³ Ibid.

in the cladding layer. Typical construction details of modern day rainscreen assemblies call for an air space between $\frac{3}{4}$ " (19mm) to 1.5" (38.1mm) wide.⁷⁴

The Institute for Research in Construction, a branch of NRC, conducted rain penetration tests on four full-scale wood-frame wall specimens with windows. Test parameters included type of cladding used for the first line of defence, and size of cavity and type of sheathing membrane used in the second line of defence. The windows were installed in flashed and drained rough openings, and sealed on the exterior. Water penetration was measured both with and without static and dynamic pressure differences across the specimens, and with several degrees of defect in the sealant, typical of those defects observed in the field.

The first three specimens were clad with 12-mm cement board with synthetic stucco finish, and installed over:

- 12-mm cement board furring strips over asphalt-impregnated paper over oriented strand board (OSB), providing a 12-mm deep cavity;
- asphalt-impregnated paper over OSB, where the space between the cement board and the paper provided the cavity; and
- 3-mm plastic furring strips over asphalt-impregnated paper over OSB, providing a 3-mm deep cavity.

⁷⁴ Ibid.

Figure 48: IRC rainscreen specimens 1-3

The fourth specimen was clad with 25-mm expanded polystyrene (EPS) with a synthetic stucco finish, and installed over a continuous layer of 3-mm plastic furring over asphalt-impregnated paper over OSB. All specimens, including the one without a furred cavity, effectively drained a considerable amount of water that entered around and through the windows. However, a large amount of water was absorbed and retained in the cement board cladding in specimens 1, 2 and 3.⁷⁵

Figure 49: IRC rainscreen specimen 4

⁷⁵ W. C. Brown, G. A. Chown, G. F. Poirier, and M. Z. Rousseau, "Designing Exterior Walls According to the Rainscreen Principle," *NRC-IRC Construction Technology Update No. 34* (December 1999): 6.

In academic and industry terminology, this form of rainscreen wall assembly is referenced differently in North America than in Europe. The 'open rainscreen' label in North America clearly implies the necessary apertures and ventilation in the cladding, however the European term, 'two-stage weather-tightening', more plainly spells out the layered construction mechanism involved in the drainage and moisture control steps.

For the Europeans, the rainscreen consists of a dual staged system, the first of which is the outer cladding layer which physically blocks or directs water entry into the wall cavity, and the second is the actual air space, which controls air leakage throughout the wall assembly and is necessary to prevent rain penetration.⁷⁶ While both terms are valid, and expressly represent the same building science innovation, perhaps the European naming convention more successfully illustrates the concept in practice.

⁷⁶ Kerr and Labs, "The rain screen wall".

APPENDIX B

INVISIBLE CITIES, "Chapter 8" excerpt, Italo Calvino, 1972 (Italy)

(Translated to English by William Weaver, 1974)

From the foot of the Great Khan's throne a majolica pavement extended. Marco Polo, mute informant, spread out on it the samples of the wares he had brought back from his journeys to the ends of the empire: a helmet, a seashell, a coconut, a fan. Arranging the objects in a certain order on the black and white tiles, and occasionally shifting them with studied moves, the ambassador tried to depict for the monarch's eyes the vicissitudes of his travels, the conditions of the empire, the prerogatives of the distant provincial seats.

Kublai was a keen chess player; following Marco's movements, he observed that certain pieces implied or excluded the vicinity of other pieces and were shifted along certain lines. Ignoring the objects' variety of form, he could grasp the system of arranging one with respect to the others on the majolica floor. He thought: "If each city is like a game of chess, the day when I have learned the rules, I shall finally possess my empire, even if I shall never succeed in knowing all the cities it contains."

Actually, it was useless for Marco's speeches to employ all this bric-a-brac: a chessboard would have sufficed, with its specific pieces. To each piece, in turn, they could give an appropriate meaning: a knight could stand for a real horseman, or for a procession of coaches, an army on the march, an equestrian monument: a queen could be a lady looking down from her balcony, a fountain, a church with a pointed dome, a quince tree.

Returning from his last mission, Marco Polo found the Khan awaiting him, seated at a chessboard. With a gesture he invited the Venetian to sit opposite him and describe, with the help only of the chessmen, the cities he had visited. Marco did not lose heart. The Great Khan's chessmen were huge pieces of polished ivory: arranging on the board looming rooks and sulky

knights, assembling swarms of pawns, drawing straight or oblique avenues like a queen's progress, Marco recreated the perspectives and the spaces of black and white cities on moonlit nights.

Contemplating these essential landscapes, Kublai reflected on the invisible order that sustains cities, on the rules that decreed how they rise, take shape and prosper, adapting themselves to the seasons, and then how they sadden and fall in ruins. At times he thought he was on the verge of discovering a coherent, harmonious system underlying the infinite deformities and discords, but no model could stand up to the comparison with the game of chess. Perhaps, instead of racking one's brain to suggest with the ivory pieces' scant help visions which were anyway destined to oblivion, it would suffice to play a game according to the rules, and to consider each successive state of the board as one of the countless forms that the system of forms assembles and destroys.

Now Kublai Khan no longer had to send Marco Polo on distant expeditions: he kept him playing endless games of chess. Knowledge of the empire was hidden in the pattern drawn by the angular shifts of the knight, by the diagonal passages opened by the bishop's incursions, by the lumbering, cautious tread of the king and the humble pawn, by the inexorable ups and downs of every game.

The Great Khan tried to concentrate on the game: but now it was the game's purpose that eluded him. Each game ends in a gain or a loss: but of what? What were the true stakes? At checkmate, beneath the foot of the king, knocked aside by the winner's hand, a black or a white square remains. By disembodiment his conquests to reduce them to the essential, Kublai had arrived at the extreme operation: the definitive conquest, of which the empire's multiform treasures were only illusory envelopes. It was reduced to a square of planed wood: nothingness. . . .

[. . .]

. . . The Great Khan tried to concentrate on the game: but now it was the game's reason that eluded him. The end of every game is a gain or a loss: but of what? What were the real stakes? At checkmate, beneath the foot of the king, knocked aside by the winner's hand, nothingness remains: a black square, or a white one. By disembodiment his conquests to reduce them to the essential, Kublai had arrived at the extreme operation: the definitive conquest, of which the empire's multiform treasures were only illusory envelopes; it was reduced to a square of planed wood.

Then Marco Polo spoke: "Your chessboard, sire, is inlaid with two woods: ebony and maple. The square on which your enlightened gaze is fixed was cut from the ring of a trunk that grew in a year of drought: you see how its fibers are arranged? Here a barely hinted knot can be made out: a bud tried to burgeon on a premature spring day, but the night's frost forced it to desist."

Until then the Great Khan had not realized that the foreigner knew how to express himself fluently in his language, but it was not this fluency that amazed him.

"Here is a thicker pore: perhaps it was a larvum's nest; not a woodworm, because, once born, it would have begun to dig, but a caterpillar that gnawed the leaves and was the cause of the tree's being chosen for chopping down . . . This edge was scored by the wood carver with his gouge so that it would adhere to the next square, more protruding. . . ."

The quantity of things that could be read in a little piece of smooth and empty wood overwhelmed Kublai; Polo was already talking about ebony forests, about rafts laden with logs that come down the rivers, of docks, of women at the windows. . . .

APPENDIX C

RECIPE FOR INK – *Experimenta 118. de coloribus: praemittitur tabula ordine alphabetico digesta de vocabulis synonymis et aequivocis [...]*, compiled by Jean Le Begue, 1431 (Italy)

English translation: Merrifield, Mary Philadelphia. *Original Treatises: Dating from the XIIth to XVIIIth Centuries on the Arts of Painting, in Oil, Miniature, Mosaic, and on Glass: of Gilding, Dyeing, and the Preparation of Colours and Artificial Gems; Preceded by a General Introduction; with Translations, Prefaces, and Notes, Volumes 1 & 2.* London: John Murray, Albemarle Street, 1849.

47. Ad faciendum optimum attramentum pro scribendo, precipue libros.—

Recipe bocales ^{oz}iiii optimi vini vermigii vel albi, et libram i. galle modicum fracte, que ponatur in dicto vino, et stet in ipso per duodecim dies, et agitur omni die cum baculo, ultima vero die colletur bene subtiliter per colatorium tele lineae; postea ponatur in vase mundo ad ignem, et callefiat usque dum quasi bulliat; diende deponatur ab igne, et cum refrigeratum sit, taliter quod sit tepidum, ponatur in ipso onzie ^{oz}iiii gummi arabici bene lucidi et clari, et agitur cum baculo; diende ponatur libra $\frac{1}{2}$ vitrioli romani, et semper misceatur cum baculo, donec bene incorporentur omnia simul, et infrigidetur et usui servetur. Et nota quod attramentum factum cum vino est bonum ad scribendum libros scienciarum, que cum de ipso scripti sunt libri, non cadunt littere, neque quasi raddi possunt, nec expelli de carta, de papiro. Set si scripti sunt de attramento, seu incausto, facto de aqua, non est sic, que bene radi possunt leviter, et accidere potest quod littere de ipso scripte caduce sint.

- Bocales ^{oz}iiii vini, vela que, vel per medietatem de utroque.
- Lipra i. gallarum, de onziis xii. pro lipra.
- Onzie ^{oz}iiii gummi arabici.
- Onzie vi. vitrioli romani.

Et qui caperet gallas, gummam, et vitriolum, quodlibet ad equale, videlicet totidem de uno quotidem de alio, ad pondus, ad huc bonum esset, videlicet ut onzie vi. de quolibet, quod satis esset pro dictis libris ^{oz}iiii vini, seu aque, vel aque et vini, ut supra.

47. To make good ink for writing, particularly for books. Take 4 bottles of good wine, white or red, and 1 lb. of galls, slightly bruised, which must be put into the wine, and allowed to stand in it for 12 days, and be stirred every day with a stick. The twelfth day it must be strained through a strainer of fine linen, and must be poured into a clean jar, and put on the fire to get hot, until it almost boils. Then remove it from the fire, and when it has cooled so as only to be tepid, put into it 4 oz. of gum-arabic, which must be very bright and clear, and stir it with a stick, then add ½ lb. of Roman vitriol, and stir it continually with the stick, until all things are well incorporated together, and let it cool and keep it for use. And note, that ink made with wine is good for writing books upon the sciences, because, when books are written with it, the letters do not fade, and can hardly be scraped out or discharged from parchment or paper. But if they are written with ink made with water, it is not so, for they can easily be scraped out, and it may happen that the letters written with it will fade.

- 4 bottles of wine, or water, or half of each.
- 1 pound of galls of xij, oz. to the pound.
- 4 oz. of gum arabic.
- 6 oz. of Roman vitriol.

And if you took equal parts of each, galls, gum, and vitriol, as much of one as of the other, by weight, it would still be good; as, for instance, 6 oz. of each, which would be sufficient for the said 4 lbs. of wine or water, or of wine and water mixed as before.

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