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Nordic Architecture of Regionalism: Digital Wood in Multi-storey Buildings

Introduction

Wood as an archetype material is of particular interest in the discourse of regionalism, as it is not newly invented, and its application has existed in high-rise and long-span wood structures since when wood was crafted with manual tools. The prepared wood or timber has been used for expression, structure, and construction of buildings. The inherent characteristic of timber and its link to the past makes it relevant to the current regionalism theme in architecture. “In the long history of architecture, wood plays an almost continuously dominant role as a building material. Buildings that still stand today showcase intricate construction systems made from posts and beams.” (Correa, et al., 2019, p. 63) Many mass and tall timber buildings were designed with lasting, durable details which have survived over thousands of years, within a varied ecological aesthetic and sympathy with context, while extending aspects of traditional, vernacular, and regional architecture.

Nordic countries have a rich history of using timber as a primary building material, with traditional vernacular architecture showcasing the beauty and functionality of wood construction. Wood appears not only in single family houses, but also in relatively high-rise structures, known as Stave churches, for instance, Heddal Stave Church (1250 CE) in Notodden, Norway, (Fig. 01) which is the largest stave church in Norway.

In the contemporary era, there are more reasons to build taller wooden buildings. “The resurgence of timber as a large-scale construction material has come about because of both social and technological reasons”, and for the most important reasons to be economic and efficient. (Svilans, et al., 2019, p. 95) Specifically, to say, solid timber has many advantages over modern conventional structural materials, in a way that it “requires less energy than concrete or steel for its production.” (Gordon, 2003) “As a renewable resource with a negative carbon footprint and low embodied energy, timber is central in the discourse on carbon-neutral, energy- and resource-efficient construction.” (Bucklin, et al., 2018, p. 425)



Fig. 01. Heddal Stave Church, Notodden, the largest stave church in Norway

Source: Micha L. Rieser; in the Norwegian Directorate for Cultural Heritage database.

The discourse of architectural scale plays a crucial role in envisioning timber high-rises. In early-modernism, timber has been associated with low-rise and mid-rise structures due to perceived limitations in its load-bearing capabilities. However, advancements in engineering, computational design, and manufacturing technologies have challenged this notion. Through the integration of engineered wood products such as cross-laminated timber (CLT), glulam, and laminated veneer lumber (LVL), architects and engineers are pushing the boundaries of what is possible in terms of height and scale. One magnificent effort is the Mjøstårnet building in Brumunddal, Norway, known as the Wood Hotel, which is officially the world's tallest wooden building, and it contains a hotel, apartments, offices, restaurant, common areas and a swimming facility. (Fig. 02)



Fig. 02. Mjøstårnet at its opening in March 2019.
Source: Nina Rundsvveen (Published in Wikipedia)

As the use of timber in high-rise construction gains attraction in Nordic countries, the problem of scale has emerged as a significant challenge. While timber offers numerous advantages, including sustainability and aesthetics, its application in tall buildings introduces complexities related to structural integrity, fire safety, and building regulations. This essay explores the problem of scale in timber high-rises in Nordic countries, delving into the key issues and potential solutions that architects and engineers are grappling with.

Due to the scale of these universal edifices, they have larger environmental and visual impact. Normally single-family houses in the urban fabrics have only a direct visual relationship with its immediate vicinity, whereas taller buildings have potentially visual impact with many places far and wide in the city within its form. Therefore, it is of the utmost importance to bring about a change in how taller buildings would be revolutionized. Mass wood construction could not only satisfy the need with regards to density and sustainability, but it should also contribute to a more regionally valued built environment.

Methods

The research is conducted upon the previous paper by the author named ‘Rethinking of Critical Regionalism in High-rise Buildings’, herein specifically within wood high-rises in Nordic countries. We would like to know whether these potential places might stand as a reference of regional architecture for other parts of Europe or elsewhere. This paper presents a qualitative assessment of multi-storey timber buildings through the lens of computational regionalism, struggling to reconcile the tensions of conflicting forces of localization and globalization, for instance, local craftsmanship versus standard pre-fabrication, and to introduce a computational approach at the intersection of vernacular and digitalization.

In this regard, a groundwork should be established “on the fertile overlap of critical regionalism and digital process” as it is named the ‘computational regionalism’ realm, to find potentially sophisticated and adaptive structural solutions for hyper-complex geometries in which these new complex surface geometries might be interpreted regionally, and how they might be translated in terms of conveying meanings. We believe that automated performance-based contemporary solutions might constitute a new ‘digital vernacular’. (Connolly, 2015, p. 8) To fulfil this purpose, it is important to “translate the strategies of regional responses that were applied in the past to be adapted to today’s high-rise buildings; in other words, make it critically regionalist.” (Zahiri, et al., 2017, p. 13) This could be also formulated in the context of critical regionalism¹ to setup a synthesis of the vernacular with modernism when it comes to wood as the most primitive material as well as modern one. In the following sections, the paper investigates three aspects of Nordic regionalism; place, culture, and tectonics. And then it discusses the potential of digital wood to bound these three aspects in the design and construction processes of high-rise timber buildings.

¹ Critical regionalism, as a resistance medium strives to counter the placelessness and lack of identity of the International Style

Place

The reason we specify ‘place’, and consequently shrink our investigation in only Nordic countries, arises from the loss of regional identity in architecture, or what is to say the issue of ‘placelessness’.

“The problem of place-making is critical when it comes to high-rise constructions [which] tend to become disjunctive in this regard, although one may still relate such works to existing topographic features or, alternatively, to other high-rise structures.” (Frampton, 2006, p. 382)

By defining the ‘place’, the recollection of traditional wood techniques then become abstracted values from cultural traditions – what we call it ‘added values’ – resulting in an architecture that celebrates humanist and creative interpretation based on vernacular technology and regional tendencies. This approach biases the idea of an anti-human machine aesthetic, and instead, embraces place and human context in design.

“The way a society thrives as a cultural identity is directly related to their built environments, and vice versa.” (Connolly, 2015, p. 29) The place is strongly connected to the definition of identity, but it should not be over-looked at very far before this concept actually becomes deadly, like in Nazi Germany with “its national romanticism [which] relied on misinterpretations or distortion of Nordic legend.” (Canizaro, 2006, p. 25)

Another issue yet is that this retrospective conceptualization of the place should contain the increasing movement of immigrant people in the age of globalization. Defining the place inherently shrinks the room for diverging. Especially Scandinavians who have been at peace for at least half a century, who are an affluent and tolerant nation. So, one thing is the conserving effect that this has on the architecture of such low-populated countries.

Nordic countries are rich in the discourse of regionalism. For example, Kenneth Frampton’s essay “Towards a Critical Regionalism from 1983 has been particularly important, as it seemed to hold up the Nordic countries as examples of a locally rooted architecture.” (Frampton, 2006) Frampton advocates for an architecture that “rejects centrist ideals and promotes regional design independence as a reflection of that area’s character.” (Frampton, 2007, p. 327) In this regard, the Norwegian architectural theorist, “Christian Norberg-Schulz, particularly in his later works, gives to the idea of Genius Loci², has had far-reaching consequences. . . in Norway.” (Frampton, 2006) Genius Loci is the “Latin description for ‘spirit of a place.’ The idea has existed for centuries in various aspects with a morphing definition.” (Connolly, 2015, p. 11)

To envision the multi-storey timber utopia outside the mainstream of a universal template, it seems practical to deploy a site-specific approach to the design of timber multi-storey buildings, rather than adaptation to a placeless global template.

² Latin description for ‘spirit of a place’

By looking from this regionalism framework, it would be easier to develop a site-specific solution to the problem of place-making in Nordic countries.

Therefore, a resistance medium is therefore necessary to counter the placelessness and lack of identity of homogenized timber processes. The result should manifest a shift from placeless mass-production to place-driven products to solve complex design problems.

Material Culture

Wood has been an integral part of Nordic people culture for centuries, serving as a versatile and sustainable material for various applications. From furniture and tools to housing and infrastructure, wood has played a crucial role in shaping their civilization. However, as small nordic societies have evolved and scaled up, the problem of scale in wood culture has emerged as a significant challenge. There are complexities and considerations associated with scaling up wood culture, addressing issues such as sustainability, resource management, and technological advancements.

Scandinavians, from the builders of Viking ships to the Stave churches and farmstead, nearly a millennium, used wood as the dominant material of construction. Wood culture survived over centuries with minimum changes in architectural results. The woodwork has been momentum in progression because Scandinavia was overall a much more agriculturally oriented society than the rest of Europe. The daily life occurred on farmsteads that were often in isolated communities with less contact to the outside. (Fig. 03)



Fig. 03. Eiktunet, Gjøvik, Norway. Langloft from Øvre Gjøvik (left), and the barn from Søndre Breiskallen (right)

Source: Author

Wood is extensively machinable, brought by the opportunity to create innovative and aesthetic appealing forms. Digital fabrication facilitates enormous capacity to rethink wood's setup and its associated traditional processes to reconcile the "tensions between traditional craft-based knowledge and the need to externalize and re-implement tacit material knowledge, a complex, which Achim Menges referred to as 'material culture'". (Kilian, 2017, pp. 211-212)

Technological advancements play a vital role in addressing the problem of scale in wood culture. Traditional woodworking techniques and tools may not be sufficient to meet the demands of large-scale production. Advancements in timber processing, such as computer-aided design and manufacturing (CAD/CAM), robotic automation, and digital fabrication, have revolutionized the efficiency and precision

of wood production. These technologies enable the optimization of timber utilization, reduce waste, and improve the overall productivity of wood culture. Embracing and integrating these technological advancements is essential for the successful scaling up of wood-based industries.

However, one of the primary concerns when scaling up wood culture is the sustainability of timber resources. As demand for wood products increases, there is a risk of overexploitation and deforestation, leading to ecological imbalances and habitat loss. Sustainable forestry practices, such as selective logging, reforestation, and responsible sourcing, are essential to ensure the long-term viability of wood culture. Collaboration between industry stakeholders, policymakers, and environmental organizations is crucial in developing and implementing strategies that balance the utilization of wood resources with the preservation and regeneration of forests.

Furthermore, the perception and cultural acceptance of wood in large-scale applications also need to be addressed. In Nordic countries, wood is not only associated with smaller-scale, so promoting the use of wood in larger-scale applications requires less education, awareness, and showcasing successful examples of wooden structures. Demonstrating the aesthetic, functional, and sustainable qualities of wood in high-rise examples across the peninsula can shift cultural attitudes and encourage the adoption of wood culture at scale.

Vernacular Tectonics

Nordic countries have a rich history of using timber as a primary building material, with traditional vernacular architecture showcasing the beauty and functionality of wood construction. However, as the demand for larger and more complex structures grows, the problem of scale arises in the context of vernacular timber tectonics. Scaling up traditional timber construction methods to meet the requirements of modern buildings presents challenges related to structural integrity with certain level of local practicing of wood.

The strength of regional wood craft techniques and methods for construction reacts with natural phenomena of its direct environment. “Tectonics is based on a thorough knowledge of the nature of materials, stemming from local traditions, which are reinterpreted so as to be applicable in the late modern globalized world.” (Holst, 2019, p. 72) This constitutes a systematic setup in wood’s application for spatial makeup in the development of the Nordic urban environment.

Wood has been the main building material for ancient Nord men, not only in ship crafting, but also in their homes. “Norwegian vernacular wood architecture is characterized by stave and log³ construction.” (Adamic, 2016, p. 126) Wood has a long precedent in Nordic log houses; what they call lafting, an efficient technique passed down through first-hand practices, (Fig. 04 (a)) which has been forsaken under the shadow of mass timber production. Many timber projects are in combination with steel connections or fasteners, which may be geometrically interlocked, but extensively rely on complex secondary material. “While these hybrid materials have opened new markets such as multi-storey housing, separating the component materials

³ Nor. stav og laft

of such products is not economically feasible, and the reduction of carbon emissions from timber are largely negated by the high emissions of secondary materials.” (Hegger, et al., 2006) (Bucklin, et al., 2018, p. 425) (Fig. 04 (b)) This complexity could be solved through rethinking of such vernacular techniques and translate them to novel interlocking joinery system by the possibilities that robotic fabrication could bring forward. Unlike in mass timber construction which is bound to capabilities of the machines, which favor 90° or 180° angle joints, the digitalized spatial pocketing plane could favor non-orthogonal morphologies. (Fig. 04 (c))

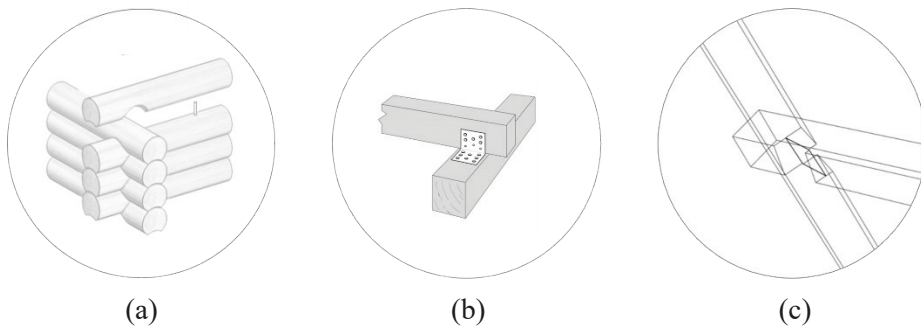


Fig. 04. (a) Vernacular log joint (b) Timber beam connection via steel plates and fasteners (c) Interlocking non-planar joinery

Source: Author

The existence of traditional wood works played on the basic attraction to architectural influences. Vernacular tectonics could be formulated in the context of digital regionalism to setup a synthesis of the vernacular with modernism when it comes to wood as the most primitive material as well as modern one. At the level of vernacular, these influences have existed as a pragmatic decision to address locally established problems, with specific techniques, what is understood as reflection practice.

Discussion: Digital Wood

By ‘digital wood’, herein, we mean the processed wood acquiring digital fabrication and production, brought up by the question that how digital wood can reconcile wood construction with increasing use of globalized prefabricated products towards added-value complex products, without becoming “a strain of ‘meta-wood’ that transcends the sentimental kitsch of the vernacular . . . where it engages in dialogue with the divergent and emergent field lines. As a meta-wood system depicting regional independence, ‘place’ is created within the physicality of the wood phenomena.” (Connolly, 2015, p. 164) Placelessness will be the result of machinist approaches towards universal architecture, leading to mechanically air-conditioned timber buildings, whose wood surfaces do not reflect any climatic justifications. This box is a monoculture global template that reduces things to universal civilization. It is often momentum in creativity and unable to address contemporary issues regarding the local values.

“Similar to the Arts & Crafts movement that happened as a reaction to the Industrial Revolution, now in contemporary design the tradition of craftsmanship is clearly gaining increasing value and appreciation in today’s reality of the technological world as these reflect the traditions of a people’s identity. Just as the individuals involved around promoting the Arts & Crafts as an alternative to the monotony of a machine-aesthetic.” (Connolly, 2015, pp. 33-34)

There has been a culture-specific trend which is gaining strength universally and one could foresee a renewed interest in Nordic architecture, where there is a response to this universal movement which calls for a back-to-basics approach to the local practice of wood. Touching upon the phenomenological discourse of the Finnish theorist, Juhani Pallasmaa, carved wood has had certain levels of haptic qualities in the long history of Nordic wood crafting. For instance, “The wood carver understands how to whittle with the grain rather than across it” (Connolly, 2015, p. 36), something that has not been respected by digital machines. We often see the fuzzy edges are left on many wood machine operators. One important feature with wood is the experience of the quality of the material in a populist era which emphasizes more on images and makes people unresponsive to other senses. But the experience of wooden buildings on a tactile level is also important.

In the realm of architecture and construction, the disconnection between haptic methods of tectonics and digital methods in timber construction has become an increasingly prevalent concern. Haptic methods refer to the tactile and sensory aspects of craftsmanship, where skilled artisans work directly with materials, engaging in a physical dialogue with the building process. On the other hand, digital methods encompass the use of computer-aided design (CAD) tools, computational algorithms, and robotic fabrication techniques to optimize construction processes. While both approaches have their merits, the growing divide between them raises questions about the impact on timber construction and the quality of architectural experiences.

A holistic approach to timber construction would entail leveraging the precision and efficiency of digital methods while retaining the human touch and craftsmanship that haptic methods offer. Embracing a hybrid approach, where digital tools are used to optimize design and fabrication processes, but with an understanding and respect for the materiality and sensory qualities of timber, can lead to more enriching architectural experiences.

Furthermore, collaboration and knowledge exchange between digital experts and craftsmen are essential. Bridging the gap between these disciplines can foster a deeper understanding of the material’s behavior and its potential within a digital framework. By fostering interdisciplinary dialogue and embracing a balanced approach, architects and builders can ensure that the benefits of both haptic and digital methods are maximized.

Conclusion

Due to the long history of regional woodwork in Nordic countries, it would be arguably difficult to challenge the pre-conceived notions and to make a radical change in the language of wood architecture. The Nordic architectural configuration of volume depends greatly on its specific location and climate. The translation of this configuration into high-rise is difficult, especially when climate varies significantly with height, and each storey cuts across multiple climate zones.

The problem of scale in timber high-rises in Nordic countries presents multifaceted challenges that extend beyond structural considerations. The complex phenomenological aspect is related with the tactile quality of wood; as a natural material, has distinct sensory qualities that set it apart from more conventional construction materials like concrete or steel.

Addressing these challenges requires collaboration, innovation, and a holistic approach. By addressing the problem of scale in timber high-rises, Nordic countries can continue to lead the way in sustainable and innovative construction practices, shaping a future where tall timber buildings become a viable and environmentally responsible option.

We shall employ a site-specific approach to the design of multi-storey buildings, rather than adaptation to a global template. By regarding multi-storey buildings as an adaptive organism, there is an opportunity to develop a site-specific solution to the problem of place-making in Nordic countries. Thereby, generative design and optimization strategies in the initial phase of design lead to tremendous amounts of saving energy pertaining to material and energy.

Creating a sustainable built environment shall comply with regional justifications. The goal should establish a regionalist framework of tall timber buildings, where for example, a high-rise building in a Nordic city functions more or less the same as in Chinese wooden towers in terms of energy efficiency and other contributed climatic factors but feels part of a local vernacular culture and response. This requires a deep understanding of historical vernacular vertical forms (e.g., comparing stave churches versus pagodas as references for tall buildings).

Integrative regional design becomes critical for timber high-rises, due to their enormous heights and scales, which require the most advanced wood technologies and have a greater impact on Nordic urbans and even global context. In parallel with the popularity of wood in the high-rise construction sector, there is this interest to discuss the topic also in scientific literature. While most of the scientific literatures on high-rise wood construction have investigated the general concepts of energy, structural, or environmental problems, the present paper focuses on a specific regional scope. This means an expanded view of knowledge in the discourse of the regional architecture of tall timber buildings, which can significantly contribute to a greater and better exploitation of the potential of timber construction in Nordic countries and elsewhere.

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