Re-inventing vernacular knowledge systems for log timber buildings in contemporary regenerative construction

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ABSTRACT: Log timber houses have been a dominant building tradition in Scandinavia with perspective on the past 1000 years. In the last century however this wooden mass wall construction technique and its embedded traditional knowledge has been marginalized, and to a large extent outcompeted by modern insulated framework and concrete construction. A heritage of knowing, building and dwelling has been left behind without advocacy or coherent assessment, for what reason the sustainable qualities of the log timber building is not measured or developed according to the contemporary norms of construction. There are great potentials in vernacular knowledge systems and adapting traditional log timber techniques for future sustainable construction.

KEYWORDS: Log timber technique, vernacular timber building, traditional knowledge, sustainable building, regenerative buildings

1. INTRODUCTION

This paper presents the theoretical foundation and approach in an ongoing research project aiming to review the Swedish vernacular heritage of log timber buildings and investigate how traditional techniques and knowledge systems may contribute to contemporary regenerative building/housing. The anticipated results are firstly a catalogue of traditional practices for adapted use in regenerative building today; and secondly a coherent methodology to measure and assess the reinforcing impact on climate and biodiversity of adapted traditional log timber building knowledge. We will point out relevant perspectives and possible understandings of traditional craft knowledge and dwellings that can be used in the transformation into a thriving future.
The anticipated results include a catalogue of good practices with clarifications and assessments of what is required to bring the use of log timber techniques into modern building construction practice.

Today humanity faces a manmade climate crisis of proportions hard to grasp [1]. The United Nations Secretary-General, António Guterres, stated in his speech for the Leaders Forum at Columbia University in December 2020 that "Our planet is broken. Humanity is waging war on nature. This is suicidal." [2]. Humanity has to reduce our emissions of carbon dioxide by 50% by 2050 [3]. This means that we today have to *choose* a "low energy path" even though we still have fossil energy supplies. This notion of a need to return to frugality is setting the agenda for how we need to transform the building sector into something that has a holistically positive impact contributing to the reduction of greenhouse gases in the atmosphere. Here, the skills from the past, adapted for a low-energy society, have an important role to play in sharing experience of performing under conditions of scarcity and simultaneously treading lightly on our Earth. These are all skills we need to relearn to both adapt to and mitigate the multitude of crises we are currently facing.

2. CLIMATE CRISES AND THE BUILDING INDUSTRY

The content of carbon dioxide (CO_2) in the atmosphere should not exceed 350 ppm if we want the planet to stay in the stable area of the Holocene [4, 5]. The Holocene is the geological era when life, as we know it, has developed and thrived on Earth. The Planetary Boundaries is a theory which points out a number of areas where human impact on Earth is so massive that it is changing its natural systems.

The global monthly mean amount of CO_2 in the atmosphere in December 2020, when Guterres made the statement above, was 414.49 ppm of CO_2 [6]. Although the idea of planetary boundaries has been criticized [7] it still illustrates the magnitude of the human challenge.

The UN Environment Programme was launched two weeks after Guterres' speech. Its 2019 *Global Status Report for Buildings and Construction* stated that the sector is one of the largest global contributors of greenhouse gases, emitting 39% of total global energy-related CO_2 emissions [8, 9].

3. REGENERATIVE PARADIGM

The challenges are today so great that it will not be enough to improve the systems we have or to just limit our use of resources [10]. Humanity needs to create systems that do not just reduce the impact of our actions. The actions themselves need to, in every aspect, generate positive spinoffs. Every building activity needs to be a positive force that generates

higher storage of CO_2, creates habitats and living conditions that promote biodiversity and empower local societies, and strengthens relations between citizens [11].

The history of sustainability has been described by dividing it into two paradigms [12]. The first was defined in the report *Our Common Future* by the UN initiative: "meets the needs of the present without compromising the ability of future generations to meet their own needs" [13]. The second paradigm developed as a business tool in the private building sector to meet societal demands emanating from the consequences of the destruction of ecosystems and the effects of climate change. For business this offers a combination of opportunities and risks [12]. Both of these paradigms are criticized because they are incapable of changing the existing system. They just reduce the impact of the system that created the crises in the first place [14]. Incentives for radical change and innovation is therefore missing. The shift to a regenerative paradigm requires a changed worldview from today's "expansionist worldview rooted in a mechanistic metaphor" [10, 15] to one focusing on relational approaches and identifying humans as "an integral part of nature and partners in the process of co-creation and co-evolution" (Fig.1). A worldview that acknowledge the interdependency and interconnectedness of all things is becoming more common today [16, 17]. The key elements of the Regenerative Sustainability concept are according to du Plessis and Brandon [16]:

- Uphold relationships, not just life-supporting but also life enhancing conditions.
- Respond and adapt to, and evolve with, change while avoiding threats to life-supporting and life enhancing capacity of global and local socio-ecological systems.
- Humans are a part of and must treat socio-ecological systems with a spirit of fellowship and mutuality. Therefore, we have a responsibility for the consequences we inflict on the system.
- Decision-making is a reflective process that needs to question whether the proposed values uphold the values of the ecological worldview, not just measure against predetermined criteria and indicators.
- Initiatives should not be goal-driven, but rather systems that can adapt to changing circumstances, new knowledge, and surprises; learning from experience to build adaptive capacity, resilience and the ability to regenerate themselves.

A broader theoretical context for sustainability needs to be formulated with the focus on reinforcing life-supporting systems [12]. In the regenerative paradigm, *place* is the primary basis in every action [18]. It is recognized that only when people "discover how a project can become truly meaningful" [19],

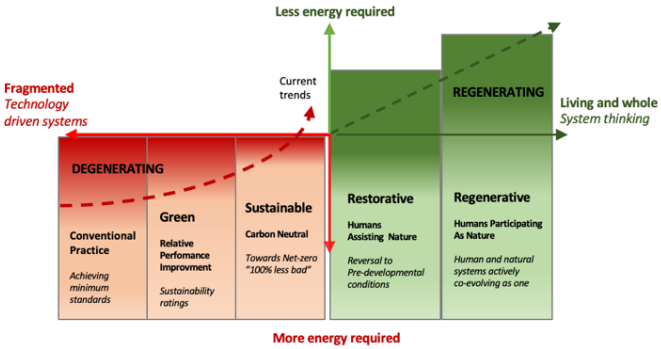

Figure 1: Illustration of different approaches to sustainability. Developed from Reed, 2007; Craft. et al., 2017 [14, 44].

only then will it "connect people back to the spirit of place in a way that they are vitalized by it and become intrinsically motivated to care for it" [20], so that long-term commitment, care and sustainability can be created.

This is the opposite to green design where "the tick-in-the-box system" decides the rate of sustainability [18]. In a regenerative design perspective, it is important to evaluate the building continuously over time and within its context. As Camrass describes it, "…regeneration is not simply "achieved" rather continues to be achieved." Therefore over time it also has the ability to strengthen [21]. In regenerative systems-thinking, the designed interventions create self-renewing systems and the necessary conditions for sustained positive development [19]. Therefore, for the pillars of social, ecological, and economical sustainability, the inclusion of history and time connected to *place* is essential. This also brings up the question of how longer time frames could be formulated within industry and research that would support an understanding of complex, cross-disciplinary issues [21]. Regenerative futures build on the concepts of regenerative design, sustainability, and development but bring in futures concepts to deepen the regenerative sustainability approaches further (Table 1).

Camrass argues, similar to Du Plessis and Reed, that "Conventional approaches to sustainability that seek to mitigate or neutralise harm are insufficient to address the accrued ecological and social debts of human activity" [12, 14, 21]. Camrass adds to the former concepts of regenerative thinking with futures thinking which she argues "…has the potential to facilitate a departure from a "business as usual" approach to sustainability practice." [21]. For this, we need to step outside the existing norms of behaviour and collectively embrace the regenerative capacity of human activity. With Du Plessis' argument Camrass empathises that traditional knowledge systems are vital to the regeneration of societies and adds that regenerative thinking is not new and we need to embrace historical wisdom to succeed.

Table 1. Summary of Regenerative future, adapted from Camrass 2020 [21].

	Regenerative futures
Goals	*- Net positive, social, cultural, and ecological outcomes* *- Interactive adaptability – ongoing co- evolution of a community* *- A pathway to transformation -alignment between vision and reality*
Roots and background	*- Futures studies, anticipatory action learning, social sciences, regenerative design, regenerative development, regenerative sustainability*
Views of reality	*-Reinforcing loops between internal and external realities* *- Multi layered and incorporating the empirical, the unconscious and the mythological*
Views of time	*-Emphasises the past (weight), present (push) and future (pull)*
Features	*- Environmental scanning* *- Narrative(s) of place constructed using historical, current, local, and regional contextual factors* *- Process of deep questioning leads to emergence of the category of the future* *- Collective mapping of alternative futures and decision-making about desirable futures* *- Layered – an emphasis on worldviews and myths that underlie possible, probable, and preferred futures. Works within epistemological context of participants* *- System-based – considers the interconnectedness within and between economic, ecological, and social systems at various scales* *- Deep time*
Measurement	*- Collaboratively developed* *- Alternative measurements* *- Redress of previously accumulated ecological debt* *- Focus on transformative impact rather than output*

Also “heritage as a rich source for the future” is pointed out by Bussey [22]. Additionally, Camrass states that “transitioning “back” to such views challenges deeply entrenched patterns and repositions humans as embedded within the broader way of life” [21].

4. TRADITIONAL LOG TIMBER BUILDINGS

Traditional log timber buildings have been the dominant way of building for most households in the forested parts of Scandinavia for the past 1000 years. Archaeological sources indicate that the log timber house was introduced in Scandinavia about AD 900-1000 [23-26]. The technique has since then been adapted to various building categories and types of settlements [27-29]. The log timber technique is not a particular expression of folklore. For instance it was incorporated in the church’s building program already in the 13th century when the parish organization and cathedral chapters were established and empowered in society [30-31]. Andrine Nilsen has investigated Swedish urban settlements in early modern time and argues that the wooden building was crucial for all urban development until the 19th century [29].

The log timber technique was adapted and developed in diverse forms and functions also according to the variety of natural resources, social structures, and economies [28]. In the southern parts of Scandinavia, the half-timber technique was common due to the properties of oak as a main timber resource. Deforestation resulted in innovative combinations of solid timber and timber frames [28, 33]. The southern farmsteads added different functions in rows under one roof. The solid insulated log timber construction was mainly used in the dwelling area and the lighter constructions for the economic functions of the household. The building became a modular system where different materials and construction techniques were combined. The wooden elements were often traded, produced elsewhere, and erected on site [32]. In forested areas and predominantly in the northern parts of Scandinavia, the household’s functions were often catered for by separate buildings. The techniques and materials were adapted to the building’s function, status, lifecycle and maintenance. Reuse and mobility were extensive as these smaller log timber buildings could be disassembled and re-erected.

Today, the corner timber house is mainly produced in a few categories, like the winter sports cabin or summer cottage. The design emphasises some visual memes like the visible logs, salient and repetitive traces from hewing, and the projecting ends of the logs at the corner joints.

Finn Werne conceptualized the end of this long and diverse building tradition as a “knowledge paradox” [34]. In the end of the 19th and beginning of the 20th centuries, log timber buildings were looked on as historical artefacts and the subjects for emerging academic fields like ethnology, history of arts, and architecture. Concurrently, the log timber building was actually the dominant building technique, not only measured in numbers of existing buildings, but actually in the way that the majority of houses were still built. The establishment of new academic subjects like Ethnology contributed to the documentation of traditional buildings but also to the discourses of vernacularity, historicity and heritagization of traditional buildings, transforming a resource and a

living building tradition into something obsolete in contemporary society.

5. TRADITIONAL KNOWLEDGE SYSTEMS

A tradition is a cultural phenomenon that is transmitted from one generation to another, and developed and sustained by each generation for the future. A tradition may be recognized as cultural heritage by a community, group, or individuals [35]. A tradition may be associated with a particular tangible heritage like the log timber building, but any material culture subsumes the intangible heritage of which it is a product [36]. However, the emerging discourse on safeguarding traditional craftsmanship as an element of intangible cultural heritage may also be counteracting the creativity and adaptive capacity of the tradition, i.e. the very drivers of a sustainable living tradition [37].

The tradition is enmeshed in a complex knowledge system that extends beyond the modern concepts of tangible and intangible cultural heritage. In this project, we approach the traditional knowledge system of log timber building from three perspectives:

1. The variety of craft skills
2. The collaborative production processes
3. Building programs for diversity in dwellings.

Traditional craft skills looks at both general skills that recur in log timber building and also the particular skills that are required for the various categories of buildings, particular forms or uses of timber, tree species, and tools. Throughout history, the associated skills have had a diversity in advancements and transmitted both among professionals and commoners. However, a core feature is how to fit irregular timber into a construction. The energy input in transforming the forest tree into a log timber building is low and feasible even with hand tools. The horizontal logs are grooved underneath and each side is scribed and the unique profile of one log is transferred to another. The technique is commonly used for raw timber as a structure of horizontal logs is compressed by its own weight and thus deals with hygroscopic deformations. To select the logs for each position and foresee the compression in terms of openings and trusses is a vital part of the craftsmanship. A comprehensive research question is: what constitutes a traditional skill, and when is a tradition broken or diluted into something essentially different? What is situated in time and space and what is possible to transfer, develop and upscale?

Collaborative production processes concern local stakeholders' collaborations to make houses from locally accessible resources. The knowledge system involves a territorial knowledge of where to access materials for building, the processing in local sawmills and joineries for instance, and the collaboration between professional labour and the consumer's own labour in kind to reduce the costs. The traditional knowledge systems for log timber buildings often manage time with long horizons, where for instance a particular stand of trees or stock of local materials is designated for a particular project. Furthermore, the materials and skills for maintenance are commonly also integrated into the production processes. This research seeks to identify general features of smart specialisations, schemes of production processes, networks and business models that could be adapted and established today.

Building programs for diversity in dwellings look at the ability to adapt buildings for a large variety of preferences in terms of homes and livelihoods. The traditional knowledge system of log timber building includes examples of flexible uses over the course of a day, a year and a life. The possibility to adapt to various conditions and levels of energy consumption are commonly integrated into the building program. The research questions concern historic forms of dwellings that could be transferred into a modern building program adding dwellings for a more diverse range of livelihoods in society today. What production exists for generational housing, diverse partnership living, seasonal uses, multifunctional spaces for a whole life course, and shifts between the household's economic functions and dwelling spaces do we find?

6. LIFE CYCLE PERSPECTIVES

The project aims to assess traditional building practices from a life cycle perspective. Tools such as Environmental Management Systems and Life Cycle Analysis (LCA) have evolved to measure the eco-efficiency of the building sector today [38]. For the Swedish context, it will be mandatory from 1 Jan 2022 to produce an LCA on all newly constructed buildings [39] focusing on their carbon dioxide (CO_2) emissions. This follows the trends in neighbouring countries such as Norway that have similar legislation [40]. Although it is important to have the lifecycle perspective on construction activity, these green assessment tools have been criticised for missing out on the core regenerative principle of adapting the building to the place where the building is erected. They also seldom take social and cultural aspects into consideration [19, 41] nor do they include the purpose and meaning of the building. LCA systems are developed and used in the context of the existing paradigm of how to construct a building. An LCA is often based on existing databases with generic data for existing construction products. This creates advantages for "products'' and existing building systems even if they are not associated with holistically positive impacts. If an LCA is attributional, as required in the upcoming Swedish building regulations [39], the LCA is limited to the planned new building as an entity separate from its context or the place where it will be constructed [42-

43], and does not take into account what will be removed, such as forest or existing buildings. Therefore, the results from such an LCA could be misleading since there is almost always an already existing value that is either enhanced or reduced by a new construction project. If we look at how the concept of LCA is used today in relation to the concept of regenerative design, it is clear that they are not supporting each other.

If we instead used the life cycle perspective to examine and analyse existing buildings to understand how they were built, and how materials in structures can be maintained, repaired, and upgraded so that they can last for 200-300 years or more, then the life cycle perspective can be used to stimulate change instead of supporting current systems of constructing buildings which are not compatible with a sustainable future.

7. A CATALOGUE OF ADAPTED TRADITIONAL PRACTICES

This research aims to develop a catalogue of traditional craft practices that offer methods and develop relevant tools to achieve a certain design goal depending on what is offered in any given situation AND place.

By using the qualities and functions called for in the regenerative paradigm to describe examples of good practices and procedures in traditional crafts today, we can develop a catalogue of practices that is useful for designers, architects, engineers and professionals in planning and construction (Table 2).

Table 2. Examples of how traditional craft can activate regeneration.

A Regenerative paradigm require	*Traditional crafts can offer*
Eco-centric worldview	*A diversity of worldviews*
Notion of place	*Notion of place*
Cultural awareness	*Awareness of local culture*
Social awareness	*Awareness of local social structures and norms*
Local materials	*Contact with local materials producers. Methods for turning them into building materials.*
Local workforce	*Network for local workforce*
Low-processed materials	*Low-processed materials*
Human scale	*Human scale*
Co-creating, transdisciplinary process	*Co-creating, transdisciplinary process*
Limit extraction of natural resources	*Reduce the impact from local material extraction*
A sense of belonging	*Belonging to local community through making and materials*
Use already existing building stock	*Knowledge in traditional building methods and materials*
Meaning	*Directly meaningful for local actors and users*

8. CONCLUSION

This paper has outlined a regenerative paradigm on sustainable building and developed a research approach to survey and adapt traditional log timber building practices for future sustainable building practices. The approach involves a broad investigation of the traditional knowledge system comprising craftsmanship but also collaborative production processes and building programs for diversity in dwellings. The inventory of traditional practices is assessed in a life cycle perspective and developed for regenerative construction today. The outcome is a catalogue of adapted traditional practices that can be used in future sustainable design, buildings and dwellings.

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