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Investigations on Cultural Ecology of Industrial Timber Construction – *through tectonic understanding of new wood materials*

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ABSTRACT: It is expected that the plastic and flexible qualities of the new wood materials is relevant for our time and the paper will explore this assumption. Questions towards different aspects of new timber constructions and wood materials will be presented in order to discuss its cultural ecology and everyday tectonic. I.e. what is the relevance of new timber constructions? The development of timber construction through time will be discussed through the concept of metabolism.

The paper will present will present experimental reflections where a material practice will analyse and develop the themes of the paper.

The aim is to consider recent developments in architecture from a historical perspective. A confrontation with Gottfried Semper metabolic theory provides the methodological tools with which the more recent theories can be studied. This will create a theoretical foundation for the research of materials.

1 INTRODUCTION

This article is written in the very beginning of an industrial PhD project about the tectonic possibilities of wood materials in industrial building systems. The industrial PhD is in cooperation between Center for Industrial Architecture (CINARK) at the Royal Academy of fine Art School of Architecture (KADK) and Danish Fire technical Institute (DBI). The project is investigating the field between traditional crafted wooden architecture (e.g. log-houses) and architecture created with new technologies (e.g. Cross Laminated Timber, CLT).

Being in an early state of the research project, the aim of this article is to open a general discussion and point out relevant questions regarding the PhD project.

When writing the application for my PhD project I started a screening of the broader literature in the field, where Andrea Deplazes, “Constructing Architecture” became central in pointing out the possibilities, themes, questions and problems in timber constructions. One thing that puzzled me was his seemingly sharp distinction between nature/technology and culture, when he describes the culture as the biggest barrier for the implementations of technologies in the building industry: he states, “the shaping criteria of the new technologies intrinsic to the system appear only after overcoming permanent cultural images (stereotypes)” (Deplazes, 2013)

Investigating cultural ecology of industrial timber construction will be done through this statement; what is the relationship between the permanent cultural images Deplaze writes about and cultural ecology? Is permanent cultural images part of a cultural ecology?

New timber structures is a part of a future everyday tectonic since it becomes economically competitive to other construction materials, getting acknowledged for it’s environmental benefits and its ability to shape large uninterrupted spaces for flexible programs and institutions.

2 APPROACH

First I will briefly describe the development in the fabrication of timber construction before seeking back in my former production and relate my work “Gitterværk” to this current discussion in an attempt to open up the discussion for theory, subjective observation and experimental practise equally.

Then questions, problems and paradoxes will be analysed from the two main conceptual constructions:

1. Cultural ecology: a meta-concept – an order – world order
2. Material turn: theoretical discourse – a direction of concept

3 FABRICATING TIMBER CONSTRUCTION

Technology is of great importance in developing and fabricating current timber construction. Technology as a term is unifying the art of bringing forth – the fabrication - and the knowledge of fabrication.

Tectonics is derived from the Greek word *teuton* meaning carpenter or builder, and is rooted in the fabrication of timber construction.

Christoph Schindler writes an architectural periodization model on the history of timber building dividing it into three phases:

1) The wooden phase where the machine replaces human hands using hand-tool technology, with the carpenter as the “*archi tecton*”, the head builder, building log or half-timbered constructions. Traditional rules governing the material and its natural dimensions and typical solutions for details guided the carpenter. He worked with the natural growth pattern of the wood adapting the design of the building to fit as necessary.

2) The industrial phase where the machine guides the work piece and tool using machine-tool technology, managing rationalisation of the production process. The components were hence standardised which called for a homogenisation of the material. Wood in its natural state was broken down and glued together again in order to eliminate its anisotropy and inhomogeneity in its growth patterns. This led to new conditions for timber building: The standard dimensional lumber known as “two-by-fours” gave rise to balloon frame construction. Rationalisation guided the details which was nailed joints with planks covered both sides of the frames hiding the tectonic that was previously evident in the construction. (maybe also mention Modular building systems and plywood panels)

3) The digital phase where the machine also takes charge of the variable control of information using information-tool technology. (Kaufmann, 2012)

Andrea Deplazes states that the growing interest in new timber construction technologies seems to support the view that, for the first time in the history of architecture a trend appears, which points towards a category of filigree construction and away from solid timber construction. (Deplazes, 2013)

As described earlier, Semper sought the explanation for the transmission or translation of characteristic forms of one material in to another material and Vitruvius asserted that the forms of columns and entablature of the Greek temple emerged from or imitated timber. Semper and Vitruvius were describing translation of timber in to stone – from filigree to solid – the translation we see in current construction moves the opposite direction from solid concrete to wood filigree.

3.1 *Filigree and solid constructions*

There are two parallel movements. One being, that the building constructions in general has a tendency (according to Deplazes) to move away from solid concrete construction toward the light wood construction. The other being wood moving the opposite direction from being filigree in frame construction to be solid homogeneous panel constructions.

New technologies in timber constructions change the tectonic properties of the wood materials from being light filigree (layered, weaved, stacked) into being solid and homogeneous. New

technologies enhance the strength and rationalisation of the wood materials in engineered wood material like CLT (cross laminated timber), laminated strand lumber (LSL), parallel strand lumber (PSL), laminated veneer lumber (LVL) and nail or dowel-laminated timber. CLT, a very popular building material, is a solid homogeneous material best known for its ability to construct the ‘ply-scrapers’ – tall wooden houses (10-15 floors) being built in the last 5 years.

4 EXPERIMENTAL REFLECTION

Prior to this study I have investigated (among other subjects) the relationship between filigree and solid construction in a wooden screen wall – “Gitterværk”.

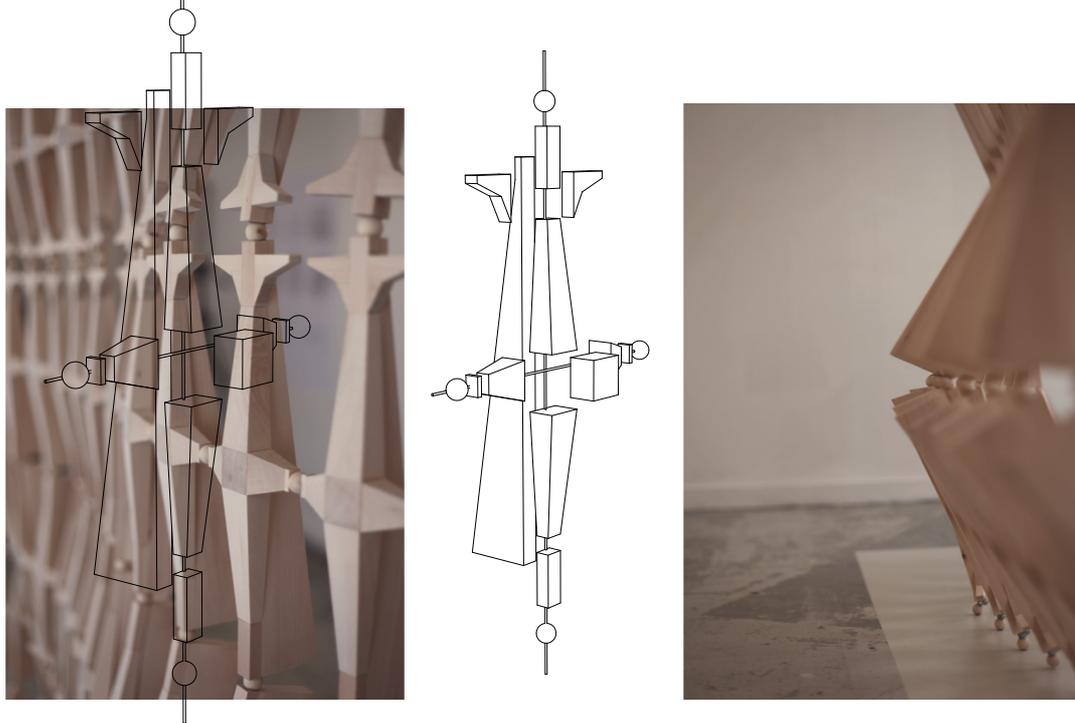


Figure 1. “Gitterværk” by author

According to Gottfried Semper the main purposes of tectonics are: (Semper et al., 2004)

- 1/ The frame with the corresponding filling
- 2/ The lattice, a complicated frame
- 3/ The supports
- 4/ The structure, an integration of the supports with the frame

I will try to describe “Gitterværk” from these main purposes in order to relate it to and qualify it in a tectonic discussion:

1/ The frame of “Gitterværk” is of an internal character. The outer frame is the floor and ceiling and the lattice can be seen either as pure filling or pure framing.

2/ The lattice of “Gitterværk” relates to its qualities as a frame or as pure framing. It consists of limb-sized elements repeated horizontally and vertically connected with ball joints. Each element is glued together from 12 individual wood pieces in order to achieve its particular shape (could have been shaped from one piece of wood using CNC milling techniques).

3/ The support of “Gitterværk” is a grid of wires connecting and carrying the wooden structure from the ceiling. It runs parallel to and is built in the wooden structure. The connection and integration of the connecting and carrying system of the lattice is done through hollow canals in the wooden elements connected with ball joints in order to make it flexible and bendable. The wood is re-enforced with wire. This relationship between the outer form and an inner supporting system relates to the relationship between a concrete form and its re-enforcement.

4/ The structure of “Gitterværk” is of a repetitive endless nature since its frame is comprised from the walls, floor and ceiling of the room where it stands. It has a complete dependency with the ceiling from where it hangs, a close relationship with the floor where it rests and a secondary relationship to the walls that surrounds it.

“Gitterværk” is a complex construction with several logics and intentions. The reflections above should not be read as conclusive but hopefully opening towards the following discussion.

5 CONCEPTUAL CONSTRUCTIONS

The following section will describe two conceptual constructions describing some main positions and bring forth thinkers who is pointing at and writing about these.

Cultural ecology: a meta-concept – an order or world order

Material turn: a theoretical discourse – a direction of concepts

5.1 *Cultural ecology*

David Leatherbarrow writes in his contribution to “Towards an Ecology of Tectonics” about the conceptual construction “Cultural Ecology”, on the ecological implications on architecture due to the global ecological crisis. He notes that the problem is complex and that the ecological concepts derived from research in the natural sciences need to be augmented by cultural understanding if ecology is to have a significant role in architecture. Also the selection, treatment and assembly of materials, together with the configuration and qualification of settings, can be evidences of ecological order, if cultural norms guide the orientations and involvements that define the design. Albeit necessary for the progress of modern science, the presupposition of nature as a system congenial to reason is still a conjecture, one not assumed by earlier scientists and questioned by some contemporary thinkers. A second premise of the modern view of ecology is the radical dissimilarity between the human and natural worlds. That, too, is a notion that needs to be questioned. Arguments for cultural ecology posit not only correspondences between these two spheres, but their shared basic premises. (Beim et al., 2014)

“The word (red. ecology) comes from the Greek *oikos*, meaning “household,” “home,” or “place to live.” Thus, ecology deals with the organism and its environment. “Eco as *oikos* + ology as *logos* would have meant something like “discourse on home life”, had the term been used.” (Beim et al., 2014)

Ecology as a “place to live” dealing with “organism and its environment” directs the understanding of the concept towards the immediate. Hence the concepts relevance and everyday will be coupled with the aspects of everyday tectonics and relevant construction types.

Aiming for an investigation of relevant construction types – the everyday tectonics - based on the idea of a pragmatic relevant construction type being applicable in situations where it is needed, and a cultural relevant construction type being relatable to qualities of our society. Hence relevance is seen as applicability but also as the construction/material that is able to mirror our time. E.g. a flexible or mouldable material can be seen as having a cultural relevance since it has qualities, which our society desires or defines itself by.

These flexible or mouldable qualities are in Denmark especially recognizable on programmatic levels. In institutions like libraries or other cultural and/or public programs, multifunctionality, flexible programmes and open spaces are key-qualities combining activities like working, reading, coffee drinking, music listening, theatre watching, communal services (passport-renewal, tax counselling etc.), lecture attending etc. (see DOK1 in Århus or BLOX in Copenhagen). Combining these activities requires clever architectural plan solutions and the will to compromise in order to gain. E.g. compromise on the ability for contemplation in space and mind, lacking quiet focused rooms, to obtain a new cultural city space rich on diversity and interconnections between activities (web). It creates a network of equal spaces with floating programmes.

There seems to be a cultural image of wood being natural and relating to “the good life”. I claim that the moment you chop the tree the wood becomes artificial. Or maybe even before – the cultivated tree is a product of culture and hence an artificial construction.

5.2 Material turn

Wood has undergone a conceptual slide from being solely a raw (little processed) material into also being a designed building material including a range of materials from raw materials, to artificial produced composites. In humanities they talk about a ‘material turn’:

“A new generation of scholars claims that postmodernism has remained too modern; “deconstruction” of binaries for instance is criticized for still assuming the old epistemic foundation. This has led to several “turns”, that is, attempts to write nature, bodies, and things into the humanities. The performative turn focuses on doing art instead of reflecting upon artistic end products; the affective turn focuses on the bodily aspects of artists and viewers; the material turn focuses on the agency of artistic material itself. The material turn has been called a paradigm shift in the humanities as it encompasses the former two, and focuses on what has been made most passive: matter.” (“The Material Turn in the Humanities,” n.d.)

In architecture the concept of “material turn” is well known as translation of materials. This section will focus on material translations as a theoretical discourse and juxtapose the concepts: metabolism (Semper), political ecology (Bennett) and material turn (Latour).

The aim is to consider recent developments in architecture from a historical perspective. A confrontation with Gottfried Semper metabolic theory provides the methodological tools with which the more recent theories can be studied. This will create a theoretical foundation for the research of materials.

The word metabolism refers to the exchange of materials in nature. Semper sought the explanation for the transmission or translation of characteristic forms of one material in to another material. Vitruvius asserted in his "Ten Books" that the forms of columns and entablature of the Greek temple emerged from or imitated timber.

Dr. Ákos Moravánszky from ETH Zürich writes about imitation and metabolism. “Imitation” is derived from the Greek word *mimesis*, which is a basic theoretical principle in the creation of art. Dr. Ákos Moravánszky notes that the old thesis of mimesis as an object of art is too often reduced to the representation of reality in painting or sculpture, although it is omnipresent in architecture. The original types are in the process of transforming imitation artefacts of art.

“For Semper however metabolism was a principle of the objects memory capacity, a cultural significance that exceeds the value of their everyday utility by far. The meaning of "material" as a subject was important to him to stress the need for artistic editing. He pointed out that the narrative material, "the material to be treated" is to be reshaped itself as a destiny of an individual, increased monumentalizes to contact us as expressions of general human beautiful and large.

The concept of metabolism makes in art and architecture visible something that is otherwise hard to explain: the alchemical transformation between materiality and immateriality”. (“Forschungsprojekt — Stoffwechsel. Die dargestellte Wirklichkeit der Architektur — Titularprofessur für Architekturtheorie Dr. Ákos Moravánszky — Institut gta — ETH Zürich,” n.d.)

The role of wood in construction has changed through the last 5-10 years from solely being a low-tech carpentry task into also being a multifaceted pre-fabricated building industry using digital manufacturing and planning tools. A timber construction has gone from being only lightweight filigree constructions in small building structures to also being solid constructions in large multi-story structures.

Technological developments in building systems and semi-finished products have replaced most of what was formerly considered as for the tectonic fundamentals of timber constructions.

In other words has wood undergone a conceptual slide from being solely a natural (little processed) material into also being a designed building material including a range of materials from natural to artificial produced composites.

The theory of metabolism is concerned with the active role of materials. Jane Bennett writes about the idea of matter as passive stuff, as raw, brute, or inert as a dominant modern thought - a habit of parsing the world into dull matter (it, things) and vibrant life (us, beings), and states that the quarantines of matter and life encourage us to ignore the vitality of matter and the lively powers of material formations. Her ambition is to make a vital materiality start take shape, again. Again, since a version of this idea already found expression in childhood experiences of a world populated by animate things rather than passive objects, and try to re-invoke this sense, to

awaken what Henri Bergson described as “a latent belief in the spontaneity of nature.” Her political project of is, to encourage more intelligent and sustainable engagements with vibrant matter and lively things. Putting a guiding question: “How would political responses to public problems change were we to take seriously the vitality of (nonhuman) bodies?” She states an aspiration to articulate a vibrant materiality that runs alongside and inside humans to see how analyses of political events might change if we gave the force of things more due. This describes what Bennett calls a political ecology of things. (Bennett, 2010)

How does this relate to the current state of wood constructions? In the introduction to this paper I quoted Andrea Deplazes: “the shaping criteria of the new technologies intrinsic to the system appear only after overcoming permanent cultural images (stereotypes).” (Deplazes, 2013). Is the stereotype the right problem?

As I read it Deplazes thinks, that cultural perceptions of a material are stopping the implementation of the technological development of the materials in the building culture. Can we separate the possibilities of technology from the images from of culture? Does Deplazes regard technology as a ‘sort of nature’ and in doing so re-establish a simplified opposition between technology/nature and culture? A way to address this could be to start the discussion/investigation in between the oppositions.

His seemingly sharp distinction between nature/technology and culture can be questioned by the theories of the active role of material. They brake down the binary opposing of nature and culture, describing it more like a web than a polar line.

“The relationship between labour or production and raw materials is in delicate flux, shaped by economics, politics, technology, and by culture. If materials are rarely used in their raw form, where is the line between what we perceive as ‘natural’ and manmade?” (Goodwin et al., 2014)

6. SUMMERISING REFLECTIONS

Today there is a competition among builders and architects on who can design and build the tallest wooden structure, which hopefully eventually can contribute to the development of new ways of building with wood also in more ordinary building projects.

The technological and prestigious race is in some ways making us blind for the great variety of properties and structural principles of the timber structures. It is possible to build high-rise wooden structures using CLT elements and the way we build with CLT is similar to the way we build with pre-cast concrete elements. Only difference is that you have to cover up the wooden walls with plaster to resist fire and reinforce the slabs to improve the acoustics. The wood is no longer visible, purely structural, and some of its qualities, like in-door climate moisture regulating, acoustic (for the room it is facing), haptic/sensory, visual, smell, airtight but moist-diffusible (when using CLT you don’t need to use a moist barrier) is not being used, seen or sensed. Is it possible for wooden building elements to play a multifunctional role in for example constituting the interior faces of the rooms?

Is there any better way to use the material? When do we need the strength of CLT panels and when can we use other and maybe smarter building systems?

Compared to other structural materials wood is a lightweight material and can be used for building on top of other buildings and places where lightweight is required and is able to play an important role in retrofitting and densifying of our cities. In that sense it has a concrete relevance to one important task of our society and building industry and hence a cultural ecology. In other words, the lightness of the wood makes it ecological in a cultural sense and in a climatic sense.

It is expected that the plastic and flexible qualities of new wood materials is relevant for our time and I claim that relevance is the key quality for a cultural ecology. Is the relevance of the plastic and flexible qualities concrete or only theoretical? What is the everyday relevance of these wood materials and the constructions in which they are parts of? How is it concrete? Is concrete opposed to theoretical?

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