timber supports

a woody interpretation of open building
for an ethno- ecological era

growingreciprocity

Thematic research report MSc Architecture TU Delft

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"The trees which you planted as a child have long since grown too heavy; you do not deceive them. But the winds ... but the spaces ... Raise no monument."

Rainer Maria Rilke (1923)

Abstract

This research explores and interprets the methodology of Open Building through the integration of timber as a main structural material for the support in contemporary urban contexts. Initially described by John Habraken, Open Building aims to balance top-down scalable housing production with bottom-up user control over their living spaces, distinguishing the tissue (urbanism), support and infill (architecture). Historically implemented by the use of static materials, mainly concrete, Open-Building manifests itself as a clear contrast between support structure and its infill and -natural- context. Although timber has been used as a structural material since the birth of our civilizations the new possibilities of this material on the larger scale is differs greatly from the original context in which open-building has been developed from and as a response to contemporary paradigms and innovations in the architectural and urban field which besides social qualities focuses on ecological responsibility, circularity, sustainability and more extended adaptability.

Case studies of contemporary timber (open) buildings highlight how timber can transform the open building framework enabling openness - adaptability, flexibility and user control - not merely in the infill but also in the support system itself. Besides the lightweightness and reconfigurability increased by the use of 1D, 2D or 3D components or units timber and its natural materiality thematically harmonizes the methodology's levels further when compared to the conventional division in static and dynamic levels of open building implemented in practice. Although the hierarchy of the methodology is key to creating openness, allowing support to be - more - adaptable and reconfigurable, the departure from fixed morphologies emphasizes dynamic dependencies rather than static hierarchies. Besides several crucial challenges deriving from the use of timber for the support system (e.g. deterioration, acoustics, stability and foundation), this re-interpretation of OB might put more pressure on communities, innovation and the creative use of dependencies on the larger scale within the levels of the OP methodology - tissue and support - to achieve openness, scalability and circularity. Finally, when it comes to this new approach, thematic design within open buildings should be reconsidered as more conventional 'styles' influenced by the OB methodology seem to derive from historic (post-war) materialism and paradigms which differ to a great extent from the contemporary.

Keywords:
Architecture, Timber, Open Building, Supports, Adaptability, Flexibility, User Agency, Circularity, Bio-based, Ethno-ecology, Urban Density

Vocabulary

openness (of a built environment)
agency and ability of a community or individual to appropriate and adapt their spaces.

dynamic structure, space and systems
adaptable structure and space due to the use of lightweight and/or de-and-remountable components and systems and independencies

static structure, space and systems
non or barely adaptable structure or space due to the use of fixed and/or heavy components and building systems or dependencies

ethno-ecological paradigms
contemporary focus both social as ecological aspects in contrast to post war/modern paradigms which mainly focused on human (social) aspects of the built environment.

levels of open building:

tissue
the - urban - fabric of the environment in which an open building is placed.

support
a building level distinguished in open building methodology which refers to the building which serves the community as a whole. Often describes as a "base building"

infill
a building level distinguished in open building methodology and describes by habraken as the "detachable unit. This refers mainly to interiors and systems which can easily be adapted over time. The infill is situated within the support as the individual is situated within the community.

1. Introduction

As the Dutch housing crisis continues and the need for sustainable urban densification becomes more prominent, the demand for large scale industrial and circular building production increases.[1] Although wood has been a major resource for building as one of the oldest and most used in history, the material timber made a revival due to the aim for a more circular built environment and the development of new materials, techniques, products and systems. When it comes to the creation of living spaces, new innovations and production methods result in mass produced timber products, elements and units (e.g. standardized stackable housing units and engineered/mass timber) which allow for large-scale fast production off-site and easy assembly on-site. [2] These industrial top-down approaches - to answer to the quantitative demand of dwelling spaces - are by governments and professionals in the built-environment often described as one of the solutions to both the housing- and sustainability-crisis.[3]

The question of housing, however, is not limited to the qualitative demand of sustainable dwelling spaces at a certain time. Within architectural and philosophical discourse authorship and appropriation of individuals and community within its environment are widely explored and advocated for, emphasizing the importance of reciprocity between the human individuals, non-humans and their environments. An understanding of not merely being in the world, but becoming-with the world around us increasingly dominates ontology, a reciprocal process which creates belonging and connectivity with our local cultural and ecological context, and each other. Whereas mass production and standardization focuses on the quantity of spaces, the user's agency of the (built) environment manifests itself mainly through bottom up processes contributing to the qualitative creation of places. Besides, might this reciprocal relationship with the broader environment approaches sustainability beyond mere pragmatic solutions - avoiding individualism and anthropocentrism - connecting humans and more-than-humans intertwining culture with nature into a more holistic milieu. [4]

Open building, an influential methodology introduced by John Habraken (1961), seems to integrate these two top-down and bottom-up processes by conceptualizing different levels of architecture in which housing and the housing process should be approached. In his early work Habraken described reciprocity with our environment when it comes to housing as the natural relationship of inhabitants with their habitat.[5] In the methodology of open building (OB) the -urban- tissue, support and infill are distinguished. When creating an OB, within an urban tissue a support is placed - a 'base building' for and in control of the community. This support, or base building, on its turn has an infill - by and in control of the individuals - or households - making part of that community - allowing for appropriation and adaptability within the support (building). Therefore OB links physical levels - the building's support and infill - to social levels - community and individuals - aiming to create architecture which reciprocates with a diverse and dynamic socio-cultural context. This approach is further developed since his first book De Dragers en de Mensen (Supports: an alternative to mass housing), not in the last place by members of the SAR (Stichting Architecten Research). Habrakens influence also became visible in the magazine Forum, of which he has been an editor, with the concept of the OB resonating with the Forumgroep's concept of the Reciprocity of Form and other participation projects. OB methodology influencing and taking shape in the architecture of the (Forumgroep) structuralist - like Bakema and Hertzberger - and participation projects like in t buildings 'designed' by Lucien Kroll. [6,7] In the more contemporary Dutch context the group behind OpenBuilding.co, a collaboration of architects, builds upon this heritage by implementing its principles in more contemporary architectural projects.[8]

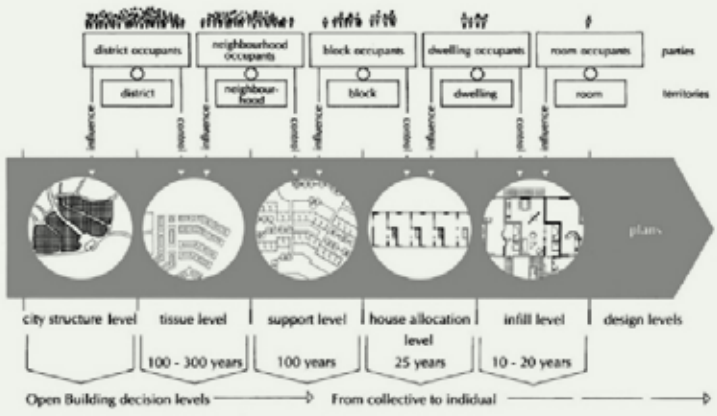


fig.1.1 levels of open building, Habraken (1961)

1.
Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. "De woningbouw betaalbaar en duurzaam versnellen: Programma conceptuele bouw en industriële productie." Rapport| Rijksoverheid. nl.

2.
Van der Lugt, Pablo. Tomorrow's Timber: Towards the next building revolution. MaterialDistrict, 2020.

3.
Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. "De woningbouw betaalbaar en duurzaam versnellen: Programma conceptuele bouw en industriële productie." Rapport| Rijksoverheid. nl.

4.
Brief philosophical review Reciprocating with our more-than-human and cultural environments requires, as Bergson suggests in Creative Evolution (1907), an openness to life's continuous becoming. In architecture, this calls for designs attuned to temporal and ecological flux rather than static form. Merleau-Ponty's Phenomenology of Perception (1945) reminds us that space is lived and embodied—architecture thus becomes an extension of sensory reciprocity. Heidegger's The Question Concerning Technology (1954) warns of enframing that reduces dwelling to resource, urging instead a revealing that lets beings and materials show themselves. Deleuze's Difference and Repetition (1968) and Haraway's Staying with the Trouble (2016) inspire architectural practices of becoming and sympoietic co-formation, where design emerges through collaborative and ecological entanglements. Finally, Stiegler's Technics and Time (1994) calls for a caring technics: technologies of making that cultivate rather than dominate. Together, these perspectives invite a bottom-up, participatory architectural technicity—one that reweaves human and nonhuman relations through situated invention, ethical responsiveness, and shared transformation.

5.
Habraken, N. J. (1961). De dragers en de mensen: het einde van de massawoningbouw. Stichting Architecten Research. However the earlier works of Habrakendoes not directly specify the word "open building" and seems to be coined first by Age van Randen.is widely accepted as the work at the foundation of the concept of open building.

6.
Cuperus, Y. (2001). An introduction to open building. In Proceedings of the 9th Annual Conference of the International Group for Lean Construction.

7.
Habraken, N. J., Bosma, K., Van Hoogstraten, D., Vos, M.,. (2000) Housing for the Millions: John Habraken and the SAR (1960-2000). Nai

Lucien Kroll -MéMé

La Mémé (Maison Médicale), Louvain-la-Neuve — Designed by Lucien Kroll in the early 1970s, this project is a built manifesto of N. John Habraken's Open Building ideas. Instead of a fixed architectural form, La Mémé invited users—students, doctors, and residents—to participate in shaping their environment. Its adaptable, irregular design celebrates diversity, user agency, and the rejection of top-down modernist control.

image © Lucien Kroll

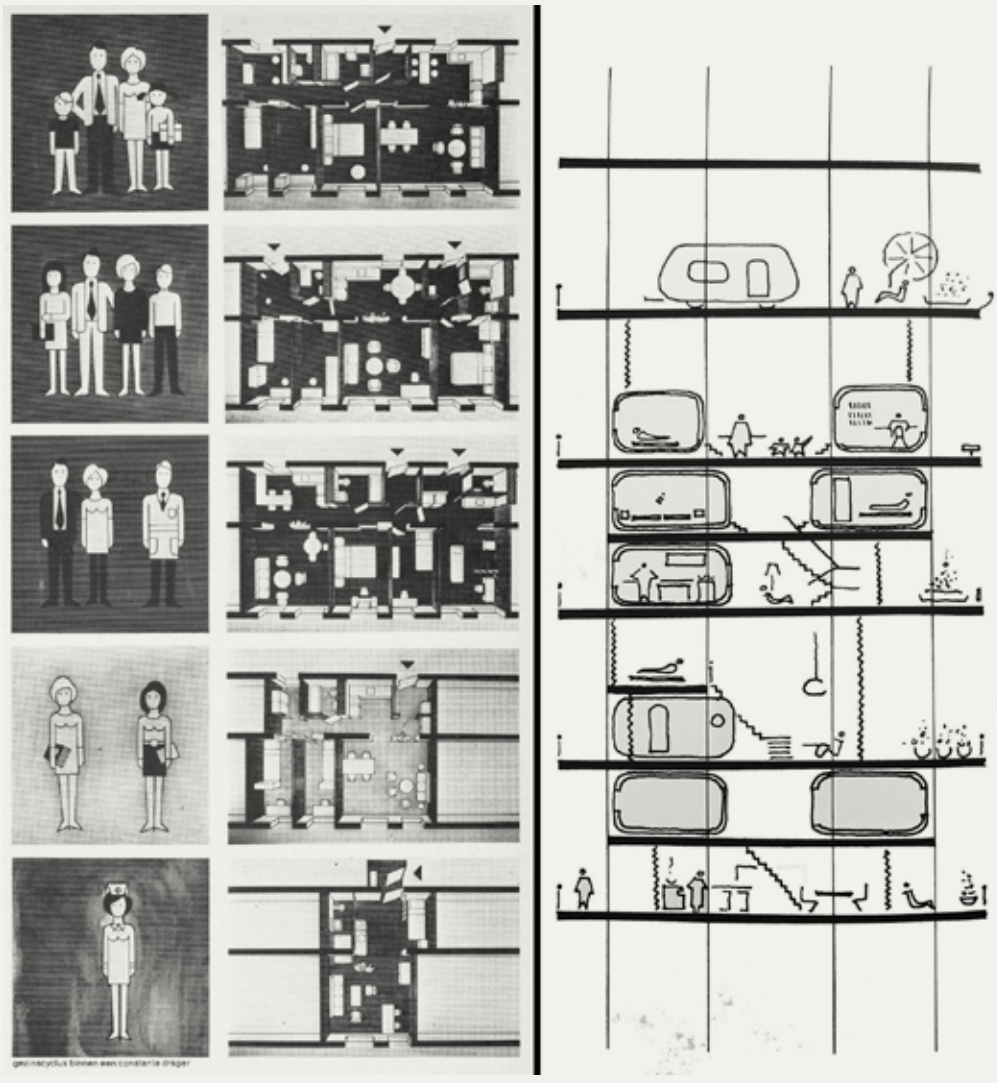


Image by John Habraken examplifing the principle of open building.

Left: unique and changing infills for and by a diverse demographic

Right: infill placed within a support which serves the community

image from:
Grondslagen voor de bouw van dragers en defabricage van dragerwoningen" ("Foundations for the construction of supports and their manufacture"), 1963.

Coalbrookdale bridge
Thomas Farnolls Pritchard, Severn River 1779

This first major bridge constructed from cast iron shows how innovation begins by echoing tradition. Though made of iron, its form and structure imitates timber construction. This reveals both continuity and transition—old methods shaping new materials. Yet, true progress lies in reinterpreting iron on its own terms, using its unique strengths rather than copying wood.

How do we reinterpret the traditional interpretation of open building within the context of innovated contemporary timber materialism?

Top-up
Frantzen et al, , Amsterdam, 2020

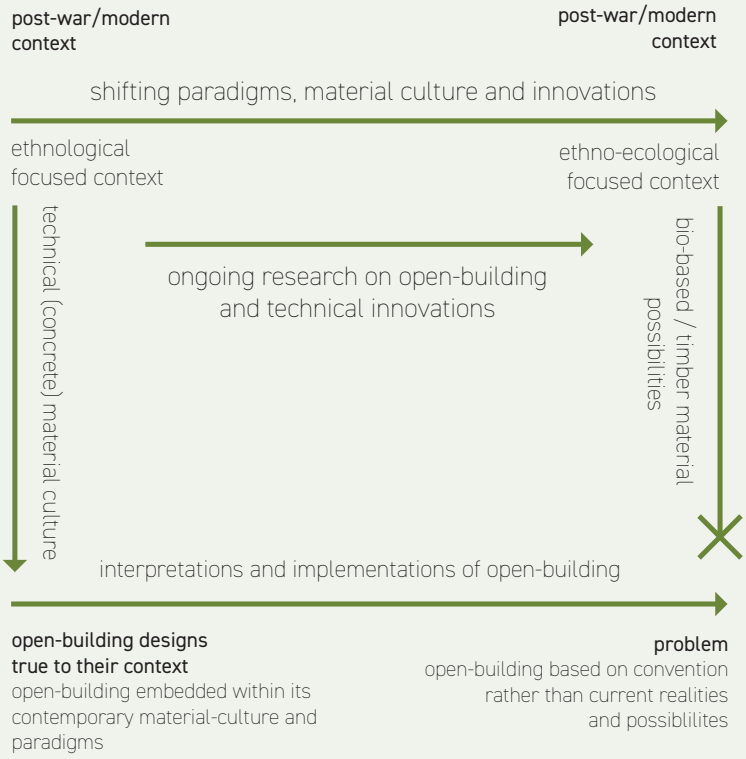
The Top-up building by Frantzen et. al is designed (and praised for) following the open-building principles while incorporating timber in the design. However, as it uses a concrete element (UC-20) based building method, using timber columns instead - how true is this design to the materiality of timber and the role this material might play within open-building?

2. Problem statement

A new material innovations and paradigms demands to revisit the methods by which they are used.

Open Building proposes an interesting concept with many interpretations and architectural implementations following this approach, however, the methodology derives from a different context with different paradigms and technologies than our current. Although Habraken deliberately aimed to create a universal concept - not referring to actual examples of buildings, styles and types in his early work - the concept of OB has been developed in a time in which the focuses mainly on ethnological aspects of a specific environment using technical materials as brick, steel - and perhaps most importantly; concrete - to create a long lasting support system on a new plot. In the contemporary architectural landscape paradigms shifted towards broader concerns and parallel to this new knowledge and innovations - particularly those addressing sustainability and circularity - shape the current. While the adaptability inherent in open building methodologies aligns with sustainable building strategies, contemporary discourse extends this to a broader framework of circularity. Moreover, the scope of current architectural practices has moved beyond a mere ethnological focus to also incorporate an ecological scope when aiming for sustainability, cohesion and justice.

A notable shift in the contemporary application of open building lies in advancements in material technology, particularly on a structural level through the development of engineered timber products such as mass timber. These innovations allow the support system of a - large scale - open building to be constructed using timber, instead of merely the infill. The use of timber aligns with the goals of a circular built environment, offering (mainly) bio-based and lightweight properties that position it as a promising material in addressing contemporary architectural challenges. This transition proposes a significant new trajectory for open building, wherein timber plays a central role.



3. Research methodology

Exploring and discussing timber supports within open building.

This research seeks to contextualize, explore and re-imagine the concept of OB within contemporary architectural paradigms, focusing in particular on the use of timber for the structural system of the OB support. By interpreting OB methodology through these new materialistic possibilities, the study aims to reconcile the top-down design approach - centered on the creation of spaces for larger communities - with the bottom-up processes shaped by the agency of individuals and localized communities while incorporating contemporary paradigms. The main questions we aim to answer here will therefore be; how can the use of timber support systems contribute to creating an open building? And, how might the concept of open building be reinterpreted within the light of contemporary timber building construction?

On one hand this research will explore the opportunities and challenges timber construction brings to the implementation of the OB methodology within contemporary contexts. On the other side, this research will create a critical position towards interpretations and implementations in relation to the current context - using historical and contemporary research and examples. Aiming to extract a well-founded re-interpretation of OB fitting the current context in particular in the light of contemporary timber construction of urban housing. As open building is a vast concept with many aspects and interpretations it will be challenging to avoid simplifications and generalizations when. However, a more zoomed out view on OB - and the influence of the use of timber within this methodology - could bring a more general oversight on this methodology and the opportunities and challenges this new materiality brings within the current context. This might also be helpful for further exploration and research. In order to do so the following chapters will guide this process:

Open building framework for a qualitative assessment and further exploration:

What are the main criteria of open building and how do they relate to the current context?

Case study assessment of contemporary timber (open) buildings:

How is (timber) open building being implemented within the current context?
What are the challenges and opportunities using timber support systems in creating an open building?

Discussion:

How do timber support systems relate to the interpretation and implementation of the open building methodology?
And, how might we interpret open building in the current context using contemporary possibilities for timber support systems?

Elaboration and conclusion:

How might we re-interpret the concept of supports - and its relation to the OB other building levels; the tissue and support - in the methodology of open building using timber in the contemporary context?

4. Framework

Criteria of contemporary open building

The methodology of OB will function as a framework for this research describing important criteria, the levels and criteria. To set out a universal framework we will focus on the works of Habraken, de SAR, Frans van der Werf and the more recent organization Openbuilding.co to point out the general criteria while incorporating the more contemporary field to discuss or update these criteria according to the current context. The concept of OB functions as a framework for further assessment, discussion and elaboration of this research.

As described three levels are distinguished within this methodology, the tissue (urban fabric), support (base building) and infill (detachable units). Beyond the - physical - building scales which are represented by this distinction, do these levels also indicate agency on different societal scales. In general the concept of OB describes a method where - in a tissue - a support is placed, for and in control of a community -, which on its turn has an infill - in control and for an individual (or household). Independence is a major aspect to following the methodology in a successful manner, so to say, changes in the infill - by individuals - should not demand changes of the support of the building. (diagram 3.1)

Besides these levels several criteria can be distinguished deriving the methodology of OB. As this research focuses on timber support systems some criteria might be more affected by the - shift in - materialization. In the next section these criteria will be outlined. Throughout the rest of the paper a reference will be made to openness, a term which in this context will mainly apply to spatial adaptability, flexibility in design, separation of systems and user agency while the others mainly focus on making a strong, circulair and scalable design. Needless to say, these criteria should not be considered as separate elements to achieve openness as they are intertwined and dependent on each other to achieve openness through these specific aspects.

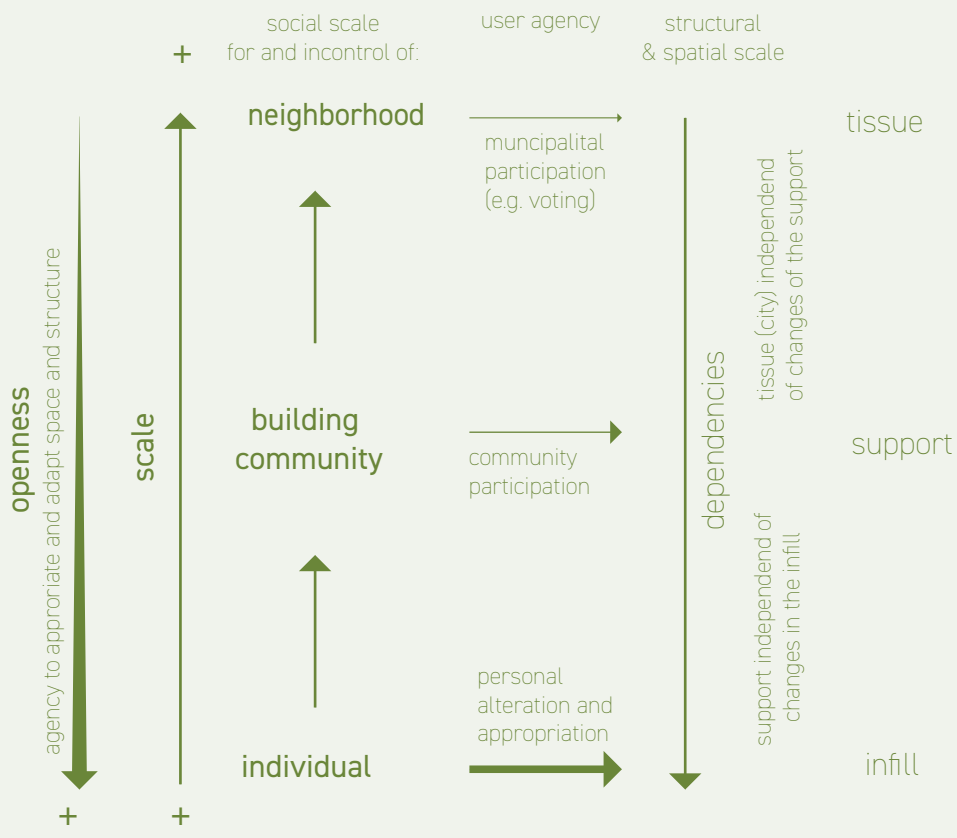
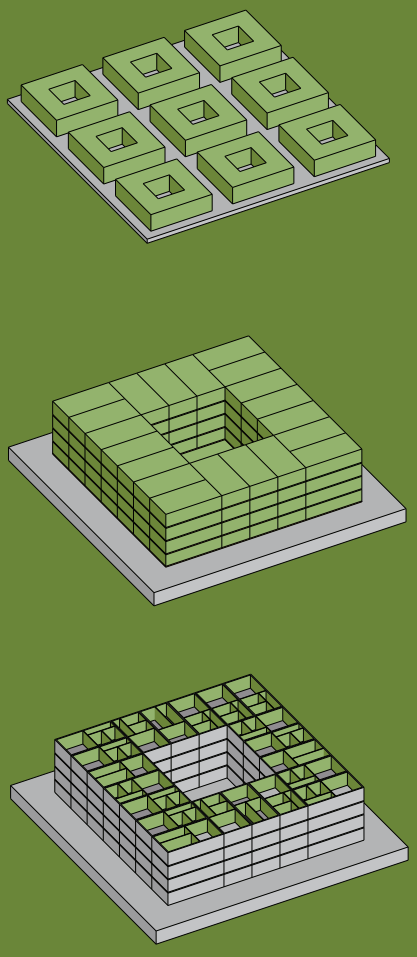


Diagram 4.1
Distinguished building levels in Open Building and hierarchy between these levels



Flexibility in design

The capacity of a support to accommodate spatial changes in its infill by a diverse community of users, is the core principle of OB. This concerns the adaptability between and within private - and communal/public - spaces, allowing them to evolve over time in response to varying needs. Throughout a building's lifespan, the occupants and their ways of using spaces will inevitably change—sometimes in predictable ways, and other times unexpectedly. On a micro level, households' use of a space changes due to factors like changing family compositions, evolving lifestyles, and personal preferences. For example, the recent surge in remote work, catalyzed by the COVID-19 pandemic, underscored the need for flexible living spaces.[8] In the Netherlands, demographic trends highlight the growing demand for adaptability. Urbanization, an aging population, and the rise in single-person households require varied compositions and sizes of private spaces, alongside a greater emphasis on public and communal areas.

Although, in OB, spatial adaptability has been approached more commonly within the boundaries of the support, more contemporary research emphasizes the importance of adaptability on a larger scale, focussing on a longer timeframe. In order for cities to become more resilient, spatial adaptability should even be considered on a neighbourhood or larger scale, to future changes for example due to - foreseen or unforeseen - aspects like innovations in mobility or a changing climate which demand or allow a more optimal reconfiguration of the urban tissue.[9]

These dynamics illustrate the multifaceted need for spatial adaptivity. On one hand, individuals might want to reconfigure their living spaces within existing boundaries. Conversely, broader changes, such as shifts in household composition or societal trends, might require more profound adjustments, such as rethinking the boundaries between private and communal spaces. Even public spaces and their interplay with private ones may need reimagining to address evolving usage patterns. While some changes—like demographic shifts—can be anticipated, others emerge unexpectedly. Thus, the ability to adapt spatial configurations becomes essential to meet the complex, evolving demands of society.

User control

Whereas adaptability focuses primarily on the technical aspects and possibilities of future change, the aspect of user control focuses on levels of agency of the future users. Habraken and the SAR describe a support involves that over which the community has control.[10] The detachable units (or: infill) is that area over which the individual decides. To explore the openness of a building as proposed within the OB methodology the degree of agency and a clear division in control is important to assess. On the scale of the dwelling unit these are more direct than on the scale of the support system of which the community should have a degree of control through participation of the individuals of this group.

Flexibility in design

This criteria, although a more specific aspect, is related to the adaptability of the building and when assessing and discussing the system we will explore the freedom to allow for a large freedom in design options made possible by this. On an infill level this means that individuals have a large amount of design freedom to alter their spaces to their needs and wishes due to changes of households of preferences. On a support level, this criteria focuses on that the timber system underlying in the "base building" is able to be (re)configured into a large variety of designs due to different temporal, cultural and ecological contexts.

Separation of Systems

Although overlap is imminent, the criteria of adaptability focuses mainly on the spatial variations of layout possible, the idea of separated systems is important to make this technically feasible. Being able to separate systems does not only apply to systems being dry-mounted and or places 'in situ' , the hierarchy in the building methodology is important to make systems separable. This notion resonates strongly with Steward Brands Shearing Layers, which focuses on adaptability and maintenance in the future extending the building's - and its materials - lifespan.[11] When approaching this from an open building point of view the hierarchy of these layers should align with the social lyers of OB (community and individual), which grasps back to the criteria of user agency.

Durability of Structure

Due to the hierarchy of the levels, the support is placed in the tissue and the infill in the support, there is a clear division in timespan - the support and therefore the structural system of the support - should therefore focus on having a longer lifespan in its particular location than the infill, as the infill should allow for the more frequent changes as discussed earlier. Besides design, materiality, maintenance having influence on this criteria, durability will be assessed to explore other factors that can contribute to the resilience of the structure.

8.
Buitelaar, E., Bastiaanssen, J., Hilbers, H., t Hoen, M., Husby, T., Christian, L., van der Staak, M., Snellen, D. and Weterings, A., 2021. Thuiswerken en de gevolgen voor wonen, werken en mobiliteit: Op zoek naar trends, trendbreuken en kansen als gevolg van corona.

9.
Krishnan, S., Yonca, A.N. and Comes, T., 2023. RISE-UP: Resilience in Urban Planning for Climate Uncertainty.

10.
Habraken, N. J., Boekholt, J. T., Dinjens, P. J. M., Thijssen, A. P., Wiewel, W., & Gibbons, S. (1986). Variations: the systematic design of supports. Laboratory of Architecture and Planning at MIT.

11.
OpenBuilding.co. (2021). Manifesto OpenBuilding.co (2021). www.openbuilding.co. Retrieved 1-12-2024 from https://www.openbuilding.co/Manifesto

Contextual responsiveness

Habraken describes the importance of designing the support building as an integrated part of its context. On the one hand a support is building respecting and making use of its contextual realities, climate, orientation and the tissue when designed within a specific location, on the other hand the support responds to its dynamic context on a micro scale, to the diverse community with changing demands and wishes. Whereas in the early works related to OB the focus on the context had a mere ethnological focus, approaching the tissue mainly as a cultural context, contemporary focus - also in OB - has shifted incorporating the natural context even in the urban fabric. Therefore within this paper we will assess the context from an ethno-ecological perspective.

Integral design thematic

Although open buildings distinguish different levels of design and process (tissue, support and infill) and advocate for the separation of these elements on a social and technical scale, the importance of a theme in which these become a whole is stated as crucial to create coherence and aesthetics. According to Habraken this is the one of the most important design questions, which on a more philosophical level describes the coherence of a community and its strong relation to the individuals of this community and its location. Frans van der Werf, approaching OB more from an urbanistic point of view, describes the whole - the infill and the support within a tissue as "the small gestures within the big gesture" (het kleine gebaar in het grote gebaar) and emphasizes the importance of thematic designing.[12] The statement could be made that within open buildings, the tissue, support and infill should, despite their separative organisation, conceptually (or aesthetically) follow an overarching theme or concept.

Scalability

As open building proposes - stated by Habraken as - "an alternative to mass produced housing", it should be able to answer to the quantitative demand of dwelling living spaces.[13] Whereas timber can be used in many ways and forms, this assessment will explore and discuss different building systems, aiming to make statements about these systems in relation to the openness. We will assess and discuss the effectiveness of production and assembly of the support systems in a general way, to eventually highlight systems which besides allowing for change through more user controlled agency, also can be implemented effectively on a larger scale to provide these dwelling spaces in the first place. This aspect is highly influenced by innovations and the availability of resources.

Circularity

The potentially longer lifespan of a building due to the possibility of future adaptability makes circularity a main feature of the methodology of OB. In the contemporary paradigm the topic of circularity becomes more prominent, this criteria will be assessed more deeply and other aspects of circularity will be explored. In the assessment we will focus on how timber proposes opportunities and challenges when it comes to designing a circular support and an open building in general.

12.
Werf, F. v. D. (1993). Open ontwerpen. Rotterdam: Uitgeverij 10

13..
Habraken, N. J. "De Dragers en de Mensen, Stichting Architecten Research." Amsterdam, original Scheltema & Holkema 1985 (1961).

5. Case studies

Qualitative assessment of contemporary timber (open) buildings for further exploration and discussion.

The cases which will be assessed aim to show a variety of projects - using timber structural building systems - with expressed emphasis on either OB and/or one of the major key criteria. As OB focuses on residential building but also aims for adaptability within functions office and industrial buildings (e.g. lofts have been a major inspiration for OB support design) projects and their systems beyond dwelling will be explored as well. The same accounts for projects not specifically profiling as open buildings might shine new light on this concept when moving from technical materials for constructing towards timber (large scale) structural systems of supports. Using these different cases the criteria of OB and their relation between tissue, support and infill are assessed according to the framework outlined in the previous chapter.

The case study-assessment is outlined the appendix. Assessing the cases several topics emerge which seem to play a significant role in creating an open-building using timber, outlined in figure 5.1. To gain a better understanding of the implications of using a timber support system in relation to the general concept of OB within the current context these topics will be discussed by using, besides the cases, supporting literature on open-building and timber architecture for discussion.

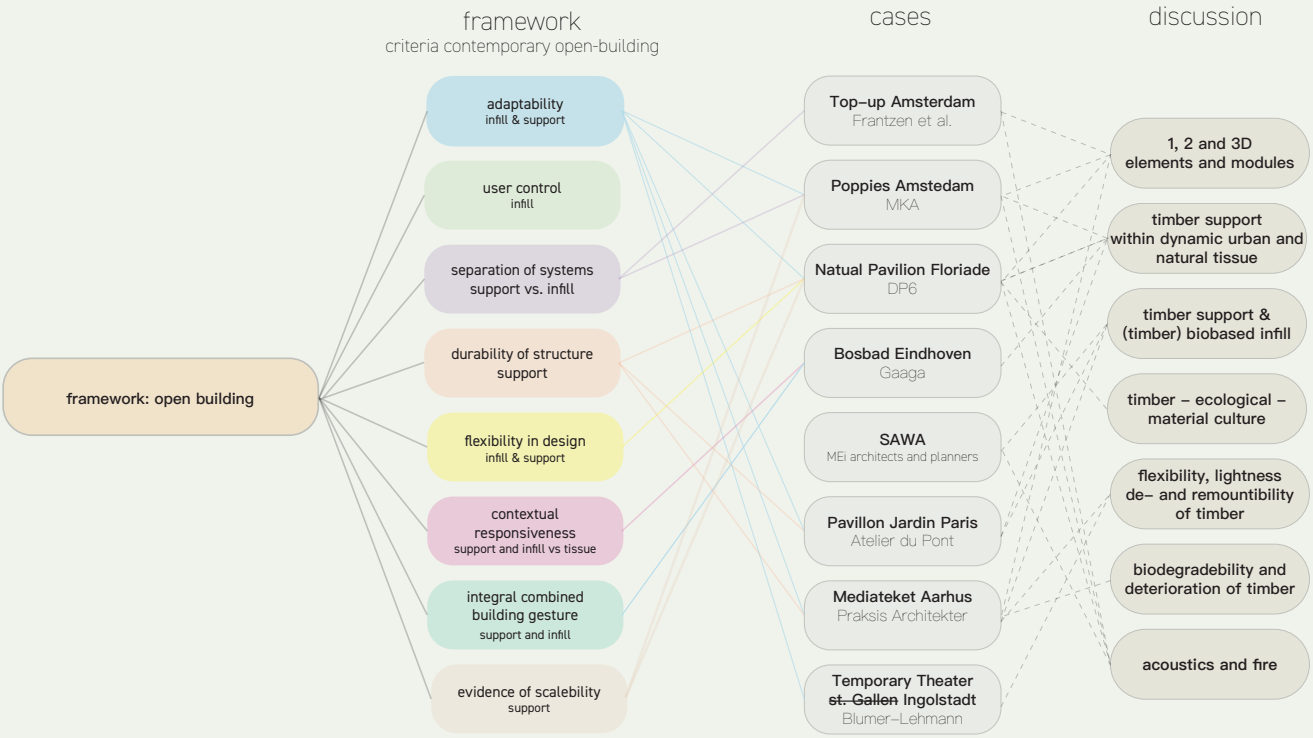


Diagram 5.1
topics for discussion on timber supports in open building followed from case study assessment (full assessment in appendix)

14.
Frantzen, T. (2020) Open Building NOW! lecture by Tom Frantzen, OpenBuilding.co

15.
Marc Koehler Associates, (2021) Robin Wood: Timber City Block, Built Around a Tiny Forest,.

16.
"Innovaties - the Natural Pavilion." (2022.) The Natural Pavilion.

6. Discussion
on timber in contemporary open building

The case study assessment explored the influence of timber and how the material - being used for the support system - can bring opportunities and challenges to creating an open building. Besides this, these cases give an overview on how to achieve openness when following the OB methodology in the current context. In this section we will discuss these findings to deepen an understanding of the influence of this - new - material for the concept of the support and the OB methodology as such. At first we will explore these through several topics, related to this shift in materiality, discussing the findings of the case studies. Alongside this, we will gasp back to earlier research and implementation of OB, in this way we aim to understand where a departure takes place from earlier interpretation, therefore gaining a better understanding on the influence timber support systems might - have in interpreting this methodology in a contemporary context.

De- / remountability and reconfigurability of 1D, 2D and 3D timber elements and units flexibilization of the support.

The timber support systems of the assessed case studies almost all consist of de-and-remountable 1D or 2D elements, in some systems forming a (pre-assembled) 3D unit. By exploring overlap and discrepancies in the different systems used, these features will be explored in relation to the OB criteria and levels.

For the structural system making up the support in Top-Up, the statement could be made that in this particular example the system is in fact a concrete construction - UC20 with a central core - made hybrid by swapping the concrete column for timber - glulam - columns. According to the architect the timber has mainly been used for its lightness and demountability when dismantling the entire building. In this example the timber does not seem to contribute much to the openness of the building when compared to concrete the system is conventionally constructed of and is mainly used for its circularity benefits. [14] The lightweightness of the timber has been used to contribute to the support being able to build upon the existing structure - therefore the statement could be made that the lightweightness in combination with the demountability of the timber contributes to the support system being more flexible to fill in different tissues instead of merely the infill of the support itself.

The Natural Pavilion seems to show an interesting approach to this, going a step further. Instead of being designed for mere disassembly, the 3D building units making up the structure seem to be designed for reconfiguration, contributing to flexibility in design making the support itself more adaptable to future alteration. Although the structures designed with the housing units of Poppies and Robin woods by Superlofts / Superwoods (MKA) can also be reassembled can merely be stacked allowing for less flexibility in design and spatial adaptability, in contrast to the more open units of the Natural Pavilion.[16] The possibility to cantilever and design freedom of the HoutKern method (timber support system of the Natural Pavilion) however, seems to derive from the steel connections and braces, which does not benefit circularity or fully align with the concept of the timber support system. Interesting to notice is that Circlewood, the joined team developed the HoutKern method further, moving more towards off-site produced rectangular units using mass timber (instead of the sawn fully bio-based local timber used in the pavilion), in order to achieve more scalability due to industrial production and fast assembly, compromising the flexibility of design, spatial adaptability and circularity of material usage. [16]

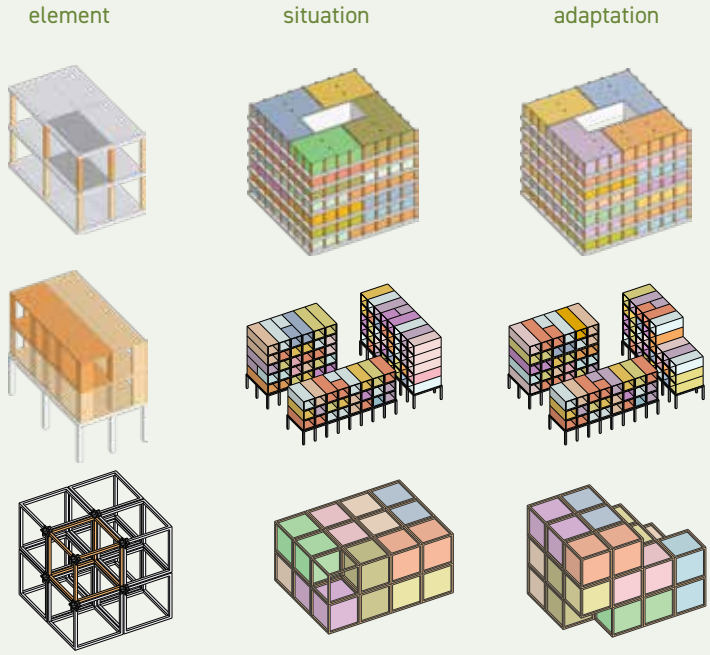
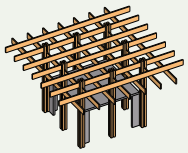


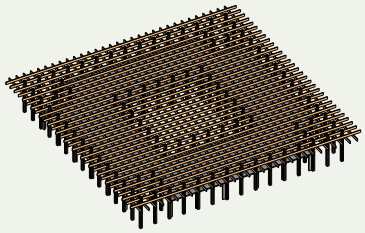
fig. 6.1

Openness of different timber construction elements. A departure from merely internal adaptability of the infill in the support towards morphological adaptability of the support within the tissue

The reconfigurability also seems to play an interesting part in the design of the Mediateket, the architect states that it is designed so it can be reconfigured over time. The level - support or infill - this structure should be categorized in is less clear, however it is the infill of the glass and concrete structure that incorporates a load bearing structure, circulation and communal spaces of the library. When we compare this to the design of Pavillon de Jardin in Paris we might see a comparable support system - made primarily from clustered 1D elements. This structure however, is not designed for future alteration, this also seems to be hard as it is made up from much larger components and due to the structure not being encompassed by another casco (it forms the roof and facade) the although separation of systems in OB is mainly described interdependence of a structure.[17] Not only on a technical level the lightweightness of timber suits the openness of the building, as can be seen in the Mediateket several alterations can be done by the users (community) of the building due to the mere possibility to carry the elements.[18] When it comes to the load bearing structure however, responsibilities and dependencies make it difficult, and perhaps undesirably, to alter the structure. The combination between the separation of systems and therefore dependencies - on the scale of the support - user agency increases, allowing for great flexibility and adaptivity in the future, not only for the infill but also the support system itself.

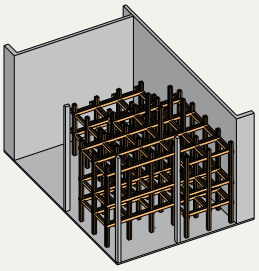


clustered column and beam structure encompassing a stabilizing concrete internal structure



a barely adaptive structure due to the dependecies of the structure for the infill

clustered column and beam structure encompassed by technical (concrete) external structure. Timber structure function as a dynamic system between support and infill.



a highly adaptable structure due to the indepenancy of protective roof and facade systems.

The lightweightness and de-and-remountability of the timber elements contributes to this as it can make the support system more approachable for alteration on a smaller social level (communities). In many of the cases explored the material timber is used in the support system as a load bearing structure which is de-and-remountable, the light(weight)ness of the material makes it able to create a high degree of adaptability and agency within the support system. In contrast to more traditional cases these features show a shift in principle, in which adaptivity does not only apply to the infill of a building but to the support system itself. Whereas small 1D and 2D elements allow for more adaptability and flexibility and user agency, the 3D units on the other site allow for clear reconfigurability of units, where the morphology is mainly created by stacking the units. Creating 3D units off site might result in more scalability due to fast assembly on-site, in the examples these units seem to be more defined for a particular function and for a large part "filled-in" which compromises the building's *openness*.

Pavillon de Jardin, Paris © Charly Broyez

Mediateket, Aarhus © Metsa Group

Figure 6.2
Overlapping material and structures can take different positions within the hierarchy of a building. *The border between support and infill seems to blur using adaptable (lightweight and reconfigurable) timber products.*

17.
Alexi, M. (2025) "The Pavillon Jardins in Paris by Atelier du Pont." Detail.De.

18..
Metsä Group.(2021) Mediateket is a fascinating combination of steel, concrete and Kerto LVL .

19.
Bijlsma, L, Maaskant, M and Schreurs, E. (2001) Towards a Pluriform Maxihouse Diagoon Housing (1969-1970) by Herman Hertzberger. Evolving Housing (1969-1972) by Van den Broek and Bakema, OASE Journal

20.
Platje, R (2021) Open Building NOW! 2 Lecture Robert Platje, OpenBuilding.co

21.
Frantzen, T. (2020) Open Building NOW! Lecture by Tom Frantzen, OpenBuilding.co

22.
Stevelink, E. Bergsma, Open Building NOW! 2. (2021) Case study lecture by GAAGA, OpenBuilding.co

22.
Marc Koehler Associates, (2021) Poppies.

23.
Hug, M (2024) Theater St. Gallen | Timber Structure for Temporary Theatre." n.d. Blumer Lehmann.

24..
Metsä Group.(2021) Mediateket is a fascinating combination of steel, concrete and Kerto LVL .

25.
Alexi, M. (2025) "The Pavillon Jardins in Paris by Atelier du Pont." Detail.De

Concrete "static" support which is appropriated and adapted through a dynamic infill

images
top 1: by Frans van der Werf
Support system of Molenvliet, van der Werf
bottom 2 &3: by antoine van leeuwen
Diagoonwoning Hertzberger
concrete static structure as a support of a dynamic infill.

Departure from the traditional static support

Support as a detachable unit of the tissue compatibility between infill, support and tissue

In many of the early examples of praised buildings which work with a support and infill combination the use of concrete seems undeniable. The past - post-war reconstructive - context and the influence of modernism seemed to make concrete "the obvious" material for construction of larger housing projects in the years of the introduction of OB. This seemed to result in projects by Hertzberger's Diagoonwoningen, the Groeiwoningen designed by Van de Broek en Bakema, Lucien Kroll's Le Même and Frans van der Werf's Molenvliet, where a morphological static concrete casco is situated which is filled in by more adaptable and flexible lightweight systems allowing for user agency. Although these projects relate to OB in different ways, they promote participation and allow great freedom for expansion of the home outside of the structure's morphology and appearance. The appearance of the building as a whole seems to be defined by this contrast of the static determined and the dynamic "to be" determined infill.

In general the statement could be made that the adaptability and flexibility of the support structure itself becomes a design strategy in contemporary timber building, as structures are built up from more easily - lightweight - de-and-remountable elements and units. Although we might conclude that this is a strategy mainly for circularity and scalability reasons, when focusing on openness we might state that the support system itself becomes more adaptable in its tissue due to its possibility from reconfiguration or reassembly in another tissue. Whereas in earlier interpretations of OB the infill consists of (reconfigurable) units detachable from the static support, due to this new materiality the support seems to consist of (reconfigurable) units detachable from the tissue.

Dynamic timber support structures due to the use of - contemporary - timber products and systems.

The temporary theater in St. Gallen by Blumer Lehman has been relocated to Ingolstadt. The lightweight and thermal properties contribute to the efficiency of this relocation in which the "support" structure manifests itselft as a detatchable unit of the tissue.

© blumer-lehmann

The "Houtkern methode" used to construct the Natural Pavilion conists of 3D units constructed from 1D elements result in a high degree of demountability and remountability. The project reveals the a dynamic support system which is besides detatchable from the tissue, reconfigurable in its or different locations

© daria scagliola

Since the early OB research compatibility has been described as crucial to harmonize support and infill. One of the major design tools described by the SAR is the 20 - 10 cm tartan grid which organizes building components and spaces using a standardized modular system. In the Netherlands, this 30 cm grid was integral to the development of NEN (2883) standards related to modular coordination, which later got replaced by NEN 6000. This system facilitates dimensional coordination, ensuring compatibility and flexibility in construction.

In the current context we could also approach compatibility on a different level. As buildings - and therefore their support systems - are also designed for dis- and-reassembly and reconfiguration in changing tissues the statement could be made that compatibility between these levels, the support and the tissue, becomes more prominent. Methods and systems which allow for a lot of freedom in design and adaptability might be helpful to create this compatibility, just as designing the support according to systems like the tartan grid, as a method to create openness through compatibility between the support and infill.

Challenges for Timber Open Building

Acoustics, Deterioration, Foundation and Stability

Besides the opportunities described in the earlier sections, the use of timber for the support system might bring several challenges, in particular for the construction of multi-story urban housing projects. In this research the case study assessment gives us great insight in the technical and social issues which come when aiming for adaptivity, agency and flexibility

Acoustics in timber structures vs. openness

One of the major challenges, and clearly an issue which had to be dealt with in some of the assessed projects, are the acoustics in timber structures, especially for housing projects. As discussed the lightweightness of timber brings many opportunities for other criteria, this same feature brings an issue here, therefore often concrete is poured to create mass for sound installation. This however creates issues with OB criteria like the separation of systems and circularity and the idea of the timber support as such.

To allow for this separation of systems and maintaining circularity of material use the approach in SAWA building shows that, instead of pouring concrete, using sand or gravel to create this mass, systems are still detachable in a future stadium allowing for more openness in the building. [20] A second case, which shows an interesting way of dealing with the acoustics in relation to the separation of systems is the Top-up building. In the spirit of OB, the architects did not want to install all the MEP within the apartments beforehand, allowing for a lot of user agency and flexibility in design, something which was not the case in the SAWA building.[20] The floor system seems important when aiming to achieve openness. User agency in this manner, did not only include user's freedom for spatial adaptability in the apartment, this same freedom came with the responsibility of applying the right - provided - sound insulation to create comfort for the other individuals of the building's community.

To avoid sound transfer, adding weight does not seem to be the only way to achieve better acoustics. In the case of the 3D modules used in some of the cases (e.g. Houtkern and Superwoods) In this way the separation between elements in a system creates openness while achieving. An important note to make here is that by avoiding sound transfer through detachment instead of adding weight, lightweightness of the timber system is maintained and contributes to the complete adaptability and flexibility of the whole support system as discussed in the previous sections. To achieve openness the hierarchy of the floor system seems an important factor and user agency should be considered in the hierarchy in which these systems are separable.

Deterioration of timber

Timber, being a bio-based material instead of a technical one, might bring challenges to the criteria of durability and therefore also circularity of the structure as such. In many of the examples shown in the assessment, the support structure is therefore not exposed. In most of the cases (Poppies, Top-up. Bosbad and the Temporary theater) the structure is cladded with technical material or a more durable timber. [21,22,23,24] The separation of these systems are important to allow for adaptability, flexibility in design and user agency , therefore openness. User agency on an individual scale however - when it comes to the facade - can be considered challenging when the support system is dependent on this material - and therefore on the individual users - to keep its durability.

In the case of the Mediateket, deterioration does not seem to be a major challenge from the timber support system, as the structure is encompassed by another structure. The roof - and facade - protecting the support system from weathering allows for an independence, creating more flexibility in design and adaptation, as the roof is independent of this internal structure. Although Pavillon Jardin uses a comparable system - as discussed earlier - , the encompassing structure (facade and roof) is dependent on the load-bearing structure of the timber support system. In this example the deterioration of the - exposed - timber system is taken into account in its morphology, creating a cantilever in the roof protecting its facade from weathering. This however makes the support system less flexible and adaptable as it is dependent on this morphology.

As deterioration of the timber is a challenge, the support system should probably be protected, it is important on what level this dependency provides. If the dependency derives from a larger, more permanent scale, like the tissue or the morphology of the support, more openness might be possible on the infill (or even the support) of the building, as it is not dependent on this level for its durability.

26.
Platje, R (2021) Open Building NOW! 2 Lecture Robert Platje, OpenBuilding.co

Stability of the support

Using timber seems to bring a challenge to the stability of the structure. In many of the explored cases, technical materials compromise a fully timber system to achieve a stable structure. The same could be said for the foundation.

Most cases assessed use stiff cores to create stability in the structure, in the assessed cases here these cores made from 2D elements are in these cases all constructed from concrete. Robert Platje (Mei architects and Planners), describes that their choice for a concrete core was a practical one. When it comes to high-rise buildings like the SAWA building, the use of CLT (the most obvious mass timber choice) for stiffness would become so thick that it would not be efficient to use in the building. However, as Platje describes in mid-rise buildings using CLT for the material of the stiffening core would be more feasible.[26] The temporary Theater constructed by Blumer-Lehmann does use CLT for vertical stiffness, although not in the core but in the encompassing structure. This however compromises its openness as it does not allow adaptation, flexibility in design and user agency when it comes to the facade, being physically completely closed off. Creating an encompassing structure however creates a more open floor plan which suits many different functions, like in this case a theater with large spaces. [27]

The Natural Pavilion uses steel to create stiffness - being a technical material - this material comprises circularity at least in a certain manner. The lightweightness and de-and-remountability of this system, the steel contributes to, does serve the reconfiguration and therefore openness of the support system. [28]

Foundation of the support

It also seems challenging to use timber for the foundation, most buildings in the assessed cases are built upon a concrete structure. Minimizing the use of technical materials seems the most used consideration when aiming for circularity and scalability. The lightness of timber contributes to this as a less material intense foundation is needed, on the other hand, scalability compromises as the foundation increases parallel to the height of a building.

Most of the explored cases use a more conventional concrete foundation although less material is used due to the lighter construction. In the Top-up building however, the construction of a new foundation is avoided by using an existing structure in the tissue.26 The Natural Pavilion tries to use technical materials in a different way. In this example timber is being used to create the foundation, by using untreated tree trunks, deterioration of these wooden foundations however is avoided by using technical materials - in this case recycled plastic and (95%) recycled concrete - at depth where groundwater levels change and deterioration might take place. [29]

Constructing the foundation for a timber support system is challenging as deterioration of timber in the soil can take place, compromising the durability of the whole building. Minimalizing technical materials seems the main principle in the cases used, the lightweightness of timber contributes to using a less material intense foundation. One strategy might be finding foundational features in the tissue compatibility is important. Another method could be to use (reused) technical materials only in precise locations to avoid deterioration.

27.
Hug, M (2024) Theater St. Gallen | Timber Structure for Temporary Theatre." n.d. Blumer Lehmann.

28.
Frantzen, T. (2020) Open Building NOW! Lecture by Tom Frantzen, OpenBuilding.co

29.
"Innovaties - the Natural Pavilion." 2022. The Natural Pavilion. March 9, 2022.

The natural materiality of timber within contemporary ethno-ecological paradigms: *A departure from mere technical - ethnological era*

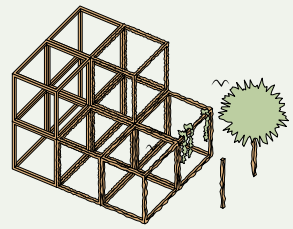
Besides the adaptability and flexibility of timber deriving from its material properties and contemporary innovations as discussed in the previous chapter, the way timber is being perceived in our environment seems to influence the particular way it is being used in contemporary OB.

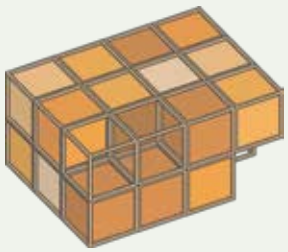
The case of the Natural Pavilion is an interesting example to start this discussion. In contrast to the examples of the post-war architecture in which the support and the infill show clear contrast in its architecture, the building by DP6 shows a different approach. The natural material of timber, in combination with the bio-based infill placed within this base structure by many different participants seems to work as a patchwork with an underlying theme. Opposite to the examples of the static support systems made from technical materials the architectural theme does not seems to be based in the contrast between the materialistic appearance, but seem to create a "gesamtkunstwerk" where a - bio-based - timber frame is filled in with other bio-based materials as a patchwork, therefore sharing the same theme and natural appearance while still maintaining a clear support and infill division. The division from support to infill seems therefore to be softer, a gradual transition from less to more dynamic instead of a contrast between static (not flexible and adaptable) monolithic to dynamic (flexible and adaptable) elements.

Another way the Natural Pavilion uses the natural material of timber - or wood - can be visible in how it connects to its natural environment. Just as it connects with its infill through this natural appearance, it connects with its natural environment through this 'ecological material culture'. This can also be stated for the design of Bosbad, designed by Gaaga, although a large part of the support system is made from technical materials - concrete and steel. Timber - or wood, as tree trunks in their natural appearance are used form a gradual transition form the natural - biological - outside context to the cultural technical inside the building. In a sense the building opens up to the natural environment breaking with the sharp contrast between nature and culture, the core of the building however remains highly technical in its materialization.

The Natural Pavilion - DP6 & Ciclewood © daria scagliola

Bosbad Eindhoven - Gaaga © gaaga

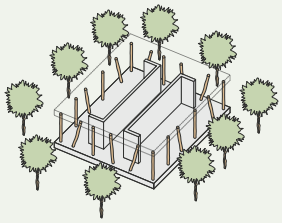


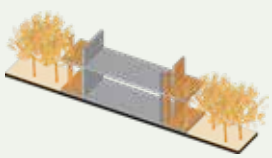


support vs tissue
direct materialist relationship

support vs infill
a biosbased "gesammtkunstwerk"

fig. 6.3
role of natural materiality of timber in relation to building levels in the Natural Pavilion





support vs Tissue
transitional relationship

tissue vs. support vs. infill
transition from ecological (biobased) exterior to cultural (technical) interior

fig. 6.4
role of natural materiality of timber in relation to building levels in Bosbad

Themes and styles in open-building

Material driven form and aesthetics, a shift from contrasting to harmonizing open-building levels.

We discussed that in the post-war/modern architectural paradigm the infill and support levels often show and contrast due to the static, heavy, monolithic and technical nature of the support and the light, dynamic and element based nature of the infill. As described through comparing early examples and literature to the more contemporary cases of timber building the argument is made that this contrast strongly derives from the context' paradigms and material culture, which shifted over time. The theme of contrasting building levels in architectural projects like those of Hertzberger, Bakema in architectural styles of those times not in the last place structuralism. Lucien Kroll however does not seem to with this contrast as such, although it is hard to describe his architecture as a style, the appearance of the buildings derive mainly from its evolving alterations of patchwork and extensions, however, even his projects couldn't be liberated from the underlying static - concrete - support structure.

The concept of a more dynamic support has already been explored and advocated in early open-building discourse. In his doctorate work "Flexibility in Supports" Robert Oxman, a student of Habraken and contributor to the SAR explored sub-types of OB supports in which not only the infill but the support of an open-building itself can be altered over time exploring potential sub-types of the support; Site and Services, House Shell, Core House, Expandable Dwelling Unit, Habitable but Unfinished Dwelling. Without going deeper into these sub-types itself Oxman makes the statement that the fundamental principle of open-building, aiming for adaptability for and by its users across time, can be improved on a larger scale by thinking of the support system as a dynamic layer of the building itself. This would improve adaptability on a larger scale and longer timeframe as the morphology of the building can change due to expansion, reduction and reconfigurability. Although the material of timber is not discussed in his work, Oxman concludes that innovations towards more lightweight, de-and-remountable and reconfigurable building materials elements, and systems would make the flexibility of the support more feasible.

Although the hierarchy of dependencies and temporalities between the building levels is crucial to propose a clear framework to improve and preserve future adaptability we might argue if the static - dynamic divide between the building levels is a quality of the methodology or actually a result of the context it derives from. Without giving a value judgment of the different themes and therefor deriving styles in architecture, we might argue that the materialistic realities in the - and perhaps post-war and post-modern fashion - had great influence on the early architectural styles inspired by the writings of Habraken en the SAR resulting in this theme of contrasting support and infill. In the current context however we might argue if this thematic contains the same significance. Considering the new material culture and the paradigm shift from merely ethological to ethno-ecological contextual responsiveness (response-ability) and circularity, we might state that the support in OB as a dynamic element in open-building became more feasible and perhaps more desired in the current context. A more flexible support might extend open-building's focus on dynamic households to building for dynamic communities within a dynamic ecological and urban context.

30.
Oxman, R.M. (1978) Flexibility in supports: an analysis of the effect of selected physical design variables upon the flexibility of support type housing systems.

6. Elaboration & Conclusion

Reinterpretation of open building in the context of timber and contemporary paradigms.

By researching the influence of timber support on interpreting the methodology of OB within the current context we aimed to get a better understanding in bringing together scalable - circular - timber construction and openness in the current context. This fits in the larger objective to unite the demand for the quantity of space - understood as a top-down, industrial process - and the quantity of space - as a more bottom-up reciprocal relation with our environment. Contemporary paradigms of circularity and a more ethno-ecological scope are putting more emphasis on adaptability and flexibility, aiming for more resilience of not only buildings but also on the urban scale.

We stated that new innovations in timber construction, improve the ability to construct the support system of an OB out of timber. This influenced several of the criteria of OB and shines a different light on the way we could interpret the building levels and methodology as such. Especially when compared to historical implementations of this methodology, new paradigms and innovations catalyze a departure from this context and open up new possibilities. Challenges however should be taken into account as different problems creating openness in a scalable and circular fashion.

Timber supports

Contemporary demands for a more sustainable circular built environment, incorporating ecological besides mere ethnological significance - catalyses by the innovations in timber building construction - has great influence on how the support of a building is - and might be - built and understood. In contrast to the static (mainly concrete based) support in earlier examples of open-building, timber improved the adaptability of the support itself. This shift has a great influences the framework of open-building as besides the infill level of OB the support is can be considered dynamic within this new context as well.

As the support structure occupies a higher level in the hierarchy and provides more dependencies than the infill, the various systems(e.g. foundation, load-bearing members and roof) should be considered part of the support and are interdependent. Therefore, although a dynamic support could extend the qualities of open-building as it improves adaptability on larger scale and longer timeframe it would add a level of complexity to the framework of open-building compared to the clear static (support) - dynamic (infill) divide. Because each system relies on another, separating them and constructing them more independently could be a strategy to enable greater freedom within the overall design. This approach encourages viewing the support as a dynamic and separable system, while recognizing dependences on the support. This concept also relates to the challenges of intrinsic timber construction, where factors such as fire safety, acoustics, stability, and material degradation demand different configurations and structural strategies - therefore architectural themes, styles and aesthetics - than those found in constructions primarily based on technical materials, particularly concrete.

The technical innovations that make the support more flexible and adaptable can also be examined from a social perspective—one inherent to OB. As the support is conceived as being shaped for - and perhaps by and under control of - the community, increasing its openness shifts greater responsibility and creative power to that community. This enables residents not only to modify their private spaces individually but also to collectively adapt parts of the communal structure. However, this hierarchical openness introduces new challenges: clear boundaries must be defined regarding what is and is not possible; who has agency to do what where? And when is negotiation needed and between whom? Consequently, the emphasis shifts toward participation and collective responsibility, ensuring that the community's agency in shaping its environment is both empowered and guided.

Timber support and its relation to the infill

In building which incorporate the open-building methodology wood has always been a major resource which could be used for the infill, due to it's material properties and being embedded in craft based, bottom-up, practice. Individual households used timber to appropriate and adapt the spaces in which they have agency without the help of large industries. Therefor we might state that the openness of timber has manifested itself on this level open building.

The contemporary reality that timber can be used more widely and effectively to achieve scalability has the result that timber can be used for both the infill as the support of a building. Although the hierarchy between the building levels has to be maintained due to the infill being dependent on - and more temporary than - the support, the sharp contrast between the support and infill seems to dissolve as the static versus dynamic divide shifts to a from less to more dynamic hierarchy. Besides are these levels within OB harmonized in an materialistic aesthetic sense when using timber for the infill as the support, something which was less feasible in earlier implementations of open-building due to the lack of presence of the engineered contemporary timber products.

Whereas the SAR used the tartan grid to achieve compatibility between the different levels (support and infill) through overlapping organization, using timber for both the support and infill seems to contribute to achieving this through its overlapping materiality of wood. In the explored cases in this research the overlap of the same material is in some examples even manifested in the type of systems used for both an infill as a support. Compatibility therefore might not only be looked for *between* building systems through organization the tools like the tartan-grid, but even *within* systems focusing more on technical compatibility and modularity on different levels of scale. Besides, when taking material properties into account when designing a building different materials come with different aesthetics.

Timber support vs tissue

As argues in the previous sections, designing the support from a more lightweight, demountable and reconfigurable material - made possible by contemporary timber building techniques - makes the support more dynamic in nature. Therefore might need to reinterpret the support within the tissue. Instead of a static "solid" in the tissue we might state it should be considered another dynamic level in OB. Needless to say the support could never be as dynamic as the infill as it occupies a higher level in the hierarchy, its higher permanence and interdependencies. However, we might state that timber supports might be considered an *infill of the tissue*, which is dynamic on a larger scale and longer time frame than the *infill of the support*.

This consideration might open the door for a building to not only be resilient to the changes of its individual occupants but also be more resilient to changes of the community as a whole and changes in the tissue. In the introduction we described how the way we use cities changes as both its community and ecology evolves - not only the way we use our private spaces changes over time on a short timeframe As open-building compatibility between the support and infill has been a major aspect. One can state that in the current context, not in the last part due to the need for circularity, compatibility of a support system with different urban tissues could be a new focus point. This might mean that the focus changes from creating a base building as a fixed morphological object customized to its specific location, towards creating a building (system) which is compatible with a changing or different locations. In this sense the support might be configured for a specific place in a specific time, but reconfigured for a in changing times and locations. Whereas the SAR introduced methods to create compatibility with multiple fill-ins, perhaps a system or method should be explored to create compatibility with multiple or changing tissues.

Another element to consider - when the support is more dynamic within its tissue is that perhaps the support might therefore not be understood as an all encompassing building for the community, but be considered a configuration of different systems that support flexibility and adaptivity. Using the tissue to create independencies of certain elements the support provides (e.g. roofs, load-bearing structures and foundations) uses the separation of systems on a larger scale so more openness (flexibility in design, adaptability and user agency) is provided to the rest of the system while meeting circularity by reusing existing structures. As the support becomes mode dynamic due to the use of contemporary timber products and systems, the way it can adapt to changes in the tissue increases. Therefore when designing an open building in timber it is perhaps more important to explore the more permanent or more temporal aspects of the tissue it is places in, to understand which aspects of the support should be more or less dynamic and therefor open for change in the future.

At last,since the post-war era in which open-building emerged a shift has taken place on how we consider the tissue. Whereas before we interpret the tissue as primarily an urban built-environment for the large community of the city, contemporary paradigms aim to incorporate the natural-environment and its ecology as well in order to create a more sustainable and holistic environment. This departure from a mere cultural-social view on the city to incorporating natural-biological aspects as well seems to align with the departure from a technical-cultural material culture to a bio-based materialism which comes with timber construction. In contrast to the static support made from technical materials (concrete-steel) in historical examples of OB practice, the dynamic support made from biological-resources does not contrast but relates to the dynamic natural environment of our tissue. Therefore, similar to the harmonization between the support and the infill as described in the previous section we see a harmonization between the support and natural and dynamic aspects of our tissue which became more prominent in contemporary paradigms.

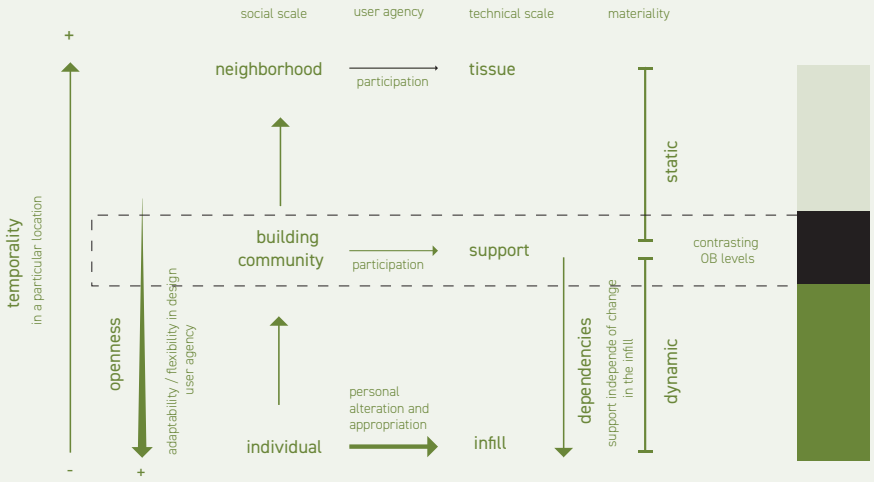


Diagram 7.1

Post-war/-modern interpretation and implementation of Open Building without the use of timber on the support level.

Using technical and static materials for the support creates a sharp contrast between the building levels.
A static (often concrete) support results in a fixed morphology with hard boundaries. Which in its materialism and dynamism barely
This contrast seemed to be a

Conclusion on overall interpretation of the OB methodology

In conclusion we might state that using contemporary timber materiality to design and construct the support of an open-building has major influence on how we might - and perhaps should - interpret the concept of open building within contemporary paradigms and urban contexts. As described the sharp contrast between the tissue, support and infill seems to fade when using the natural resource of wood and constructing the support from contemporary (dynamic) timber products and systems. As a support becomes more dynamic and the materialization connects - instead of contrasts - with its infill and the natural environment, the architecture deriving from it seems to be able to harmonize individual (infill) and community (support) - and the cultural and natural urban environment (tissue).

The hierarchy - of dependencies and temporalities - between the different scales (tissue-support-infill) and aligning these with social scales (community and individuals) however, seems to be just as, or perhaps even more - valuable within this context. In contrast to when the support is considered static this might put more emphasis on this hierarchy. A more dynamic support might add a complexity to how we approach open- building; as the infill is dependent on the support changes in the support have influence on the infill.

The idea of the support as a static *open-form* which can be filled in with different dynamic systems seems to lose its significance under the influence of contemporary timber construction and limit the aim of the methodology - to improve adaptability and agency by communities - to the small scale (apartments and individual households). Considering the timber support as an *open-system* which also can be adopted over time , while taking the hierarchy inherent to open-building into account, adaptability and agency on a larger scale and longer timeframe might be improved, which not merely consider changes in the infill (individual household) but also answer to the evolving communities and ecologies within urban context, establishing an even more resilient and inclusive built environment.

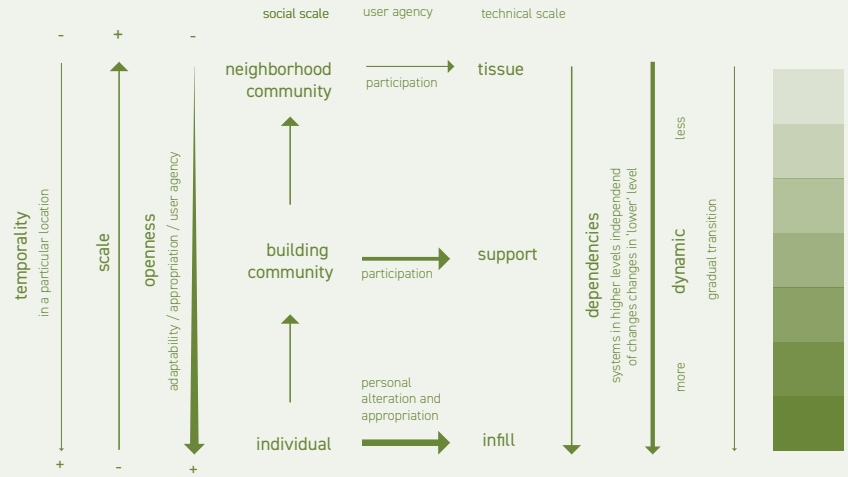


Diagram 7.2

Reinterpretation of the Open Building methodology through the use of timber for the support level.

Using timber seems to break with the sharp contrast between the building levels of OB. The natural material and its and dynamic properties (lightweightness and reconfigurabiliuty) of contemporary timber products bridge or even harmonize the dynamic infill and the natural environment.

7. Acknowledgments & further research

Limited framework - more extensive research of timber open-building
Due to the limited framework of this document several topics and criteria important to the success of creating openness in the build environment and in particular using the methodology of open building have not been touched upon. As this research mainly focused on the material and technical aspects of timber within the OB approach topics like social organization - agency and negotiation - and economical and legal probability should be explored more to make statements on the broader influence and feasibility of the use of timber creating open buildings within the contemporary context. A more extensive framework and broader study selection could contribute to a deeper understanding of this the relation between these topic.

Reconsider the relevance of open building within current paradigms and material culture.
This research argues if the distinction between the building levels (tissue, infill and support) are still relevant considering new paradigms and material culture. The distinction between these building levels seem to be inherent to the open-building methodology. Therefore one might question if a reinterpretation of open building is a valuable approach. Perhaps a completely different approach, apart from open-building might be more valuable as some of the OB core principles are reconsidered or even rejected when assessing them within this new context.

Exploring the influence of timber architecture on other methodologies aiming for openness in the urban built environment.
This document merely focuses on open-building as introduced by John Habraken, which is merely one methodology to achieve openness within the built environment. However agency and ability to adapt and appropriate space and structure can be achieved in many different manners. Besides has open building developed and reinterpreted within last decennia. These different approaches might be explored further to achieve a wider and deeper understanding of how openness can be achieved within contemporary urban environment using timber.

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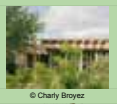
appendix

overview case study assessment of contemporary timber (open) buildings.

	Natural pavilion DP6 architectuurstudio / Cricklewood	**Poppies** MKA	**Top up** Frantzen et. al	**Bosbad** Gaaga	**~~St. Gallen~~ Ingoldstad Theater** Blumer-Lehmann	**Mediateket Aarhus** Praksis Arkitekter	**Pavilion Jardins** Atelier du Pont	**Sawa** MEI architects and planners
								
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	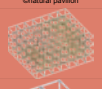							
				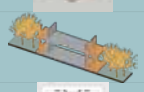			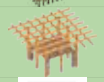	
								
Support construction method	**houtkern methode:**3D sawn timber modules + CLT Slab Temporary - post and beam / slab modules	**Superwoods:**3D mass timber modules Load bearing walls with openings	**UC20 hybrid - table construction:** Hybrid 1d mass timber & 2D concrete elements	Hybrid timber (engineered and trunk-wood) , concrete prefab H/V slabs and columns and steel columns	De-and-remountable Casco .1 and 2D elements"Mass timber (CLT) pre-manufactured building elements	**metsa LVL S-beam & Q Panel:Clustered 1D Post and Beam within concerete Casco**	**Glulam timber 1D elements Timber open frame around concrete stabilizing structure**	High Rise timber building Fully CLT floors and columns No concrete on floors Concrete core(gravel for mass and openness) Stimulation of diversity No load bearing walls
stiffness (vertical / horizontal)	Steel shoring and CLT slabs	Concrete core & CLT slabs	concrete core	concrete 2D elements	Encompassing: Large pre-manufactured CLT components.	2D Q panels	concrete internal structure	Concrete core
foundation & plinth	wood + steel. Steel is used where groundwater levels change to avoid deterioration and wood could for a part of the foundation	concrete plinth (superlofts)	existing concrete plinth	concrete slab	Need for new foundation in new location	n/a	concrete base core	No dry connections - not demountable
summary of openness	Timber modules although showing their division create biobased support - fill-in architecture with large focus on reconfiguration and the natural environment.	Stacking of lightweight timber units, fast assembly and industrial production Housing units (private) vs added structures	Timber used in concrete (UC20) construction method creating a solid although made for disassembly)	Concrete OB - breaks with the hard boundary of a solid transitioning to the natural environment through the use of wood	Casco timber building proven to be relocated to create casco in different locations.	Clustered timber post and beam creates load bearing support system within casco protecting it from deterioration . More user control	Clustered timber post and beam creates casco with technical core for (e.g.) stiffness. Gradual transition from technical (concrete cultural interior) to ecological. (wood ecological exterior)	post (glulam) and slab (CLT) + concrete stabilizing core
Adaptability	Highly adaptable, both infill and support created as an open grid. Timber support system out of reconfigurable units from 1D elements	Both infill and support are adaptable to a certain extend	only infill is adaptable	minor reconfigurations possible. Adaptability within the units possible - not optimal. Due to shafts and columns	Adaptability is found in the tissue. Location can change over time. Building itself not adaptable apart from decoration anf furnishing	Highly adaptable structure due to avoidance of dependancies (roof / facade)	Potentially within the system but due to dependancies not adaptable.	high density urban area
Can spaces within the building be reconfigured for different uses over time without major structural alterations?	grid structure creates clear units which can be filled in, smaller and bigger spaces can be created. . Besides, units are interchangeably used for in- and exterior.	The housing units can created spaces by dividing (1/2) or multiplying units. Openings in the mass timber walls create connecting. Hard to create larger open spaces and interchange between interior and exterior.	Yes spaces can be reconfigured. Column to column - wall to wall. Not clear units - makes division legally more difficult	Due to division (volumes) and concrete exterior wall slabs reconfiguration only possible within an apartment of with the one besides.	limited to theater function or similar	Yes due to open floorplan	n/a	due to an open floor plan post and slab construction. No loadbearing walls
Does the design anticipate future changes in technology, use, or demographics?	Reconfiguration asks for new design in different location. Now made for office, other configuration possible but needed when updating.	system does allow for adaptability but limited by housing as units.	yes large open spaces and separate systems make different use possible. Dividing in plots is however difficult due to the need of "structural units"	possible reconfiguration of and between spaces within the support. Due to avoidance of fixed vertical 2D elements	n/a	highit adaptable within the encompassing structure for other purposes or in other encompassing structures which protect from weathering	n/a	Yes, internally: Open floor plan allows for reconfiguarion and division of spaces within the structure
User Control	N/A Clear division in support and infill on a technical level. The division in support and infill is not made on a social level, so user agency is n/a in this case.	Interior appropriable in open floorplan.	Interior appropriable in open floorplan. Several rules for appropropriation for accoustics	personal control within spaces, participation in courtyard	n/a	n/a	n/a	Technically possible due to open floorplan. However fixed in VVE
To what extent can individuals personalize or modify their spaces to meet their needs?	Due to the vapour open , biobased infills - clear rules are set for the infill of the facade, allowing for multiple infills by individuals (in this case providers of biobased products) reducing the need for oversight for moisture protection.	user can modify spaces. Facade is on support level.	Interior appropriable in open floorplan. Several rules for appropropriation for accoustics	Modification is highly possible although not taking in account from the beginning.	Function is a theater and this program is fixed in the support. Perhabs could it take similar functions but therefore limited	n/a	n/a	Technically possible due to open floorplan. However fixed in VVE
Are there mechanisms for user participation in decision-making?	Collaboration between multiple actors making up support and infill system. Large focus on showcasing not actual appropriation due to demands and wishes	participation in public spaces like coffee bar and courtyard	architects worked closely together with inhabitant and other architects for unique interior spaces in the infill	Participation in courtyard	n/a	n/a	large open floorplan and several appropriable spaces on the ground floor	n/a
Separation of Systems	highly / easily separable and accessible	Separating housing modules contributes to separating systems for acoustics	Highly and easily separable and accessible in the infill	n/a	n/a	n/a	n/a	Largely separable due to dry mounting and accessible systems
Are building systems (e.g., plumbing, electrical, partitions) independent from the main structure, allowing for easy upgrades or replacement?	Separated visible (technical) systems. Reduced by vapour open building and natural ventilation	yes due to separate modules with separate system,connecting to main infrastructure.	yes due to separate modules with separate system,connecting to main infrastructure.	Shafts run through apartments. Instead of individually connecting to main infrastructure in the support	n/a	n/a	n/a	Access to systems in floor. Gravel on top of CLT (instead of concrete) allows for access to systems by users in the floor.
Are elements separated for acoustics	yes due to separate modules	Separating housing modules contributes to separating systems for acoustics	raised floors with acoustic decoupling on concrete floors	n/a	n/a	n/a	n/a	gravel for acoustic can be adapted over time
Are elements separated for fire	Yes Duplicator bio based panels	Compartimented between housing modules	Highly durable due to the use of concrete non-exposed glulam timber columns	Different materials used for support structure. Steel and concrete are durable	n/a	n/a	n/a	n/a
Durability of Support Structure	The durability derives from the adaptability and reconfiguration of the timber elements. Due to the exposure of the material the structure is less durable.	High durability due to unexposed engineered timber units and possible reconfiguration	Highly durable due to the use of concrete non-exposed glulam timber columns	Different materials used for support structure. Steel and concrete are durable	durable due to protected timber casco and possible relocation	High durability of the interal (concrete glass) structure and unexposed timber (infill/support)	Exposed timber is coated and protected by overhanging roof system	Exposed cladding
Is the primary structure designed for long-term use, using durable materials and configurations that accommodate changing infill over time?	Primary structure consists of reconfigurable elements - sawn douglas fir - exposed. Designed for possible other use in other site and configuration	Primary structure consists of reconfigurable CLT housing units	n/a	No reconfigurability	yes ,use of CLT elements and protected from weathering. Made to relocate after use	n/a	n/a	Fully timber accept from core to reduce material use (to thick) - no concrete in floors
Is the durability of the timber considered in the design to avoid deterrigation	In current configuration timber is exposed. No treatment or cantilevers	n/a	n/a	Timber is used in exposed form while technical material is used internally, might cause problems for durability	yes due to protective cladding	n/a	n/a	Exposed cladding might deteriorate
Is the durability of the support structure also considered in another situation or configuration	yes considered in other configurations	n/a	load bearing structure designed for disassembly - complete disassembly / no reconfiguration	n/a	Yes, made for dis-and-reassebly. Cladded with technical material to protect from deterioration	n/a	n/a	n/a
Flexibility in Design	Due to reconfiguration of the timber modules with steel knots	Flexible through stacking, load bearing walls and direction of the units less freedom	Flexible infill, fixed support	limited	limited	Timber system is highly flexible due to reconfigurable mainly 1D elements.	limited	Fix and repair store
Does the base building (support) allow for diverse layouts or configurations of infill?	the support as a whole can be reconfigured with the cube units as the smallest unit	Configuration of division of spaces horizontally and vertically. partially limited to more modules. Premade openings for future adaptability but not complete open.	Yes, horizontally due to open floor plan	n/a	n/a	n/a	n/a	(Fixed and described in VVE)
				n/a	n/a	n/a	n/a	
				n/a	n/a	n/a	n/a	
Contextual Responsiveness (support vs tissue)	temporal , connection to ecology but new plot in "greenfield", using local timber, putting ecological entities in and upon the units making them part of support system	support is reconfigurable in essence.	Fixed on top of existing structure	Fixed in tissue, response through use of materials and transitions	Temporal therefore it can respond (be located in) different tissues	n/a	n/a	Align core values of project with Community (integration)
Does the building integrate well with its surrounding environment, respecting cultural, social, and urban contexts?	The infill is a showcase of biobased and upcycled materials. Relating to its cultural context in this sense. It is an open framework filled in by different actors (representing materials. This way it represents the diversity.			n/a	cultural function	n/a	n/a	n/a
Does the building integrate well with its surrounding environment, respecting ecological context	Due to incorporating "bio" elements like a (roof) garden and pond within the main structure (in units) it relates the support structure not only to the infill but also to the tissue. It uses local sawn timber to show a direct connection to it environment.			The structure opens towards its surroundings. In structural openness and materiality it connects in a gradual transition to its surroundings	not designed for particular contexts. Enclosed	n/a	n/a	openings for birds in facade and raised garden planned
Combined gesture of total (support + infill)	Biobased infill and support creates overarching theme representing both	Gesture derives from the support. Units are not visible, due to overall clear border is made.	support decides gesture - infill by individual or participation does not seem to be in place	Has a clear division and transition between "cultural/technical interior and natural/biological exterior	Enclosed fixed program. Support and infill not highly distinquised	n/a	n/a	Timber support + infill (cladding)
do the support and infill relate to each other in its aesthetics / appearance	yes, string relation through it "biobased character" the sawn timber structure relates to this and creates a diorama effect	n/a			n/a	n/a	n/a	Full timber support and exterior create combined gesturre
		n/a			n/a	n/a	n/a	n/a
does the building represent the community (support) and the individuals (infill) in its design	socially not divided in this project. Technically a clear division visible between infill and support, although a complete character	communal spaces on (technical / concrete) plinth - added to units due to cores	communal spaces on (technical / concrete) plinth - added to units due to cores		n/a	n/a	n/a	n/a
Evidence of scalability	HoutKern methode is scaling up and used in different designs for low environmental impact and fast configuration, although in a slightly different system in which the system uses non-exposed mass timber :"transport : flatpak Elements : 1D and 2D (assembly) Vapour open"	Super woods is a system which has been used in many more buildings of MKA "transport : module on truck Elements :2D elements (production) Vapour closed"	Quick building process for the support due to conventional UC20 concrete building system,	using timber for construction to create a connection with the natural environment - for aesthetic reasons on exterior. Rest is concrete or steel	due to automized manufacturing (CNC) CLT elements. Not scalable for other purposes.	Standardized building elemenrs + Transport: flatpack Elements: 1D and 2D elements (assembly)	transport: flatpack Elements: 1D and 2D elements (assembly)	High-rise support for vertical scalability of the building . Manufacturing use of semi-standardized timber products
Circularity	Aiming for circularity seems to focus on the use of mainly biobased - and reclaimed materials. The support system in created from local untreated timber reducing chemicals / adhesives and transportation. 95% is biobased / recycled. Local sawn timber is used. CLT in interior slabs.95% is biobased / recycled. Local sawn timber is used. CLT in interior slabs	Full timber units - CLT - although on concrete plinth / foundation	UC20 is a dry connection system therefore reusable. Use of timber improves circularity. Reuse of existing structure for foundation and concrete pinth	Circularity through the use of timber in some structural elements. However fixed concrete and technical materials like steel compromize circularirty	due to possible recolation of the structure and use of timber (CLT)	Circularity due to the use of de-and-remountable standardized LVL elements. Glued elements compomize the biobased nature of timber but improve durability	Circularity due to the use of de-and-remountable standardized glulam lements. Glued elements compomize the biobased nature of timber but improve durability	Circularity due to the use of de-and-remountable standardized glulam lements. Glued elements compomize the biobased nature of timber but improve durability

**citations of used finding in main text*