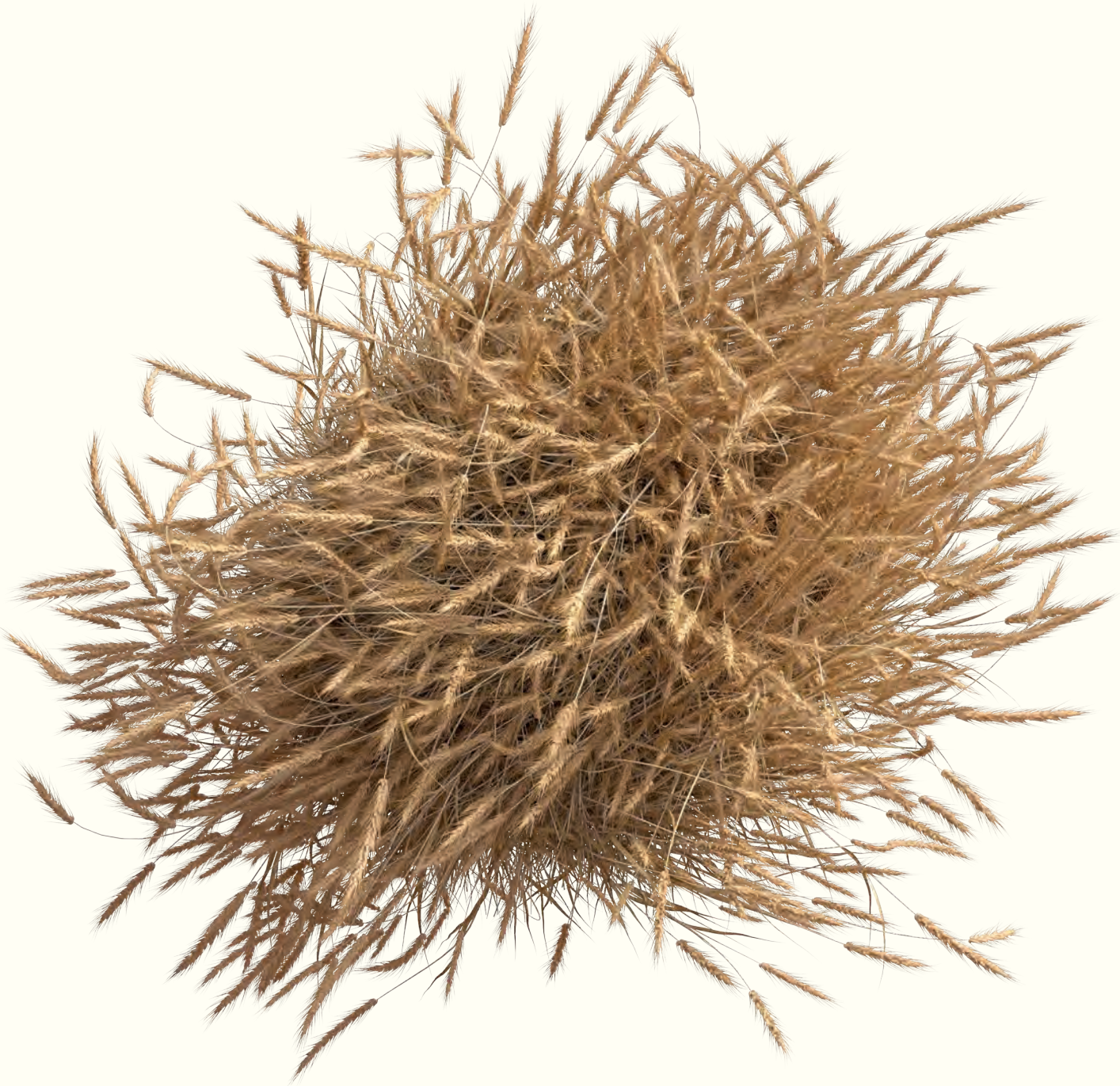
Rolling out our sketching paper

Changing Our Footprint



Henning Larsen

Introduction

Changing Our Footprint

The construction industry is accountable for 40% of global emissions; a painful truth that fuels our drive and responsibility to change.

‘Changing Our Footprint’ presents this journey through questions, concepts, projects, and materials – optimistic alternatives explored along our way.

This is an unconventional architecture exhibition. An effort to address the construction industry’s outsized environmental footprint, the exhibition embraces the responsibility for change by presenting a hopeful and optimistic path forward.

Sharing some of our explorative journeys of learning and curiosity, ‘Changing our Footprint’ sheds light on the meaningful concepts, possibilities, and potentials ahead.

“As a studio we are experienced but we are always on a continuous journey to develop, and this exhibition is an acceleration of this development. It’s a readiness to change. We still have much to learn, and unlearn, as we reshape our industry’s outsized environmental impact and just facing up to this can be anxiety-provoking. But it also holds a wealth of opportunities, and has led us to embark upon the explorative and collaborative journey of changing our footprint.”
— Louis Becker, Global Design Principal of Henning Larsen

The concepts, projects, models, and materials exhibited represent our scalable steps, as we progress towards a desirable future through research, testing and continuous learning. Celebrating the use of biogenic resources, including wood, straw, eelgrass, and mycelium as well as reused and upcycled matrials, the exhibition looks broadly at alternatives to conventional practice. Ranging from decarbonization and 3D printing, to transformations and design for disassembly, the topics presented showcase our efforts within innovation and our steadfast commitment to push the boundaries of design.

With the theme of ‘rolling out the sketching paper’, the nature of the work exhibited does not necessarily offer final and definitive answers but rather, boldly asks the difficult questions required to better our ways and create significant positive change.

Through 2023, the exhibition was first shown at Aedes Architecture Forum in Berlin, then making its way to AIT Arkitektur Salon in Hamburg. More recently, it was re-curated for the Gallery Stairs in the Danish Architecture Center in Copenhagen.

About Henning Larsen

Founded in 1959 by Danish architect Henning Larsen, whose legacy of creativity and learning we carry today, we navigate the complex connections that bind together our built environment, ecological systems, and societies at large.

As an experienced studio with a global presence, balancing hands-on capabilities with artistic sensitivity is at the core of our design approach. With that, is an unending call for adaptability and responsiveness. We are driven by curiosity and the conviction that influence can only be justified by relevance.

Designing our collective tomorrow is a task we approach with care. We strive to be advocates and enablers of sustainable change, committing ourselves to the contextual needs of today as well as those of tomorrow. To us, this means continuously seeking to push the boundaries of design by asking difficult questions, not shying away from challenges, and weighing the scope of our impact.

Working across architecture, landscape, and urbanism, we must maintain acute attention to detail whilst never losing sight of the bigger picture. It is this that enables us to manifest lasting change as we co-create, innovate, and cultivate desirable futures through design.

Content

Foreword

Katharina Benjamin, founder of the digital architecture magazine Kontextur, gave the following speech at our exhibition opening in Aedes Architecture Forum.

I would like to express my sincere gratitude to Henning Larsen, Copenhagen and our host the Aedes gallery who have invited us all here for a much-needed dialogue around CHANGING OUR FOOTPRINT in architecture.

I guess, as you may have heard – already, in recent years the climate crisis, has become the most urgent topic in our macrocosms and microcosms as well as in our minds and media. However, the understanding of how big a role the planning and building sector plays in this has only slowly found its way into the conversation. Construction, operation and demolition of building structures is at the root of 40% of the global CO2 emissions. Let this sink in.

Although research on sustainable construction and materials has been around for a long time, it hasn't influenced the professional and academic field properly and deeply enough yet. Up until recently, it was rather laughed at, as far as I remember. So, it's time to talk about a net-zero building industry – realistically.

Maybe it's daring to ask, but could this even be an opportunity for architecture to reinvent and reposition itself? Away from the blandness of "anything goes" and the quick industry fixes such as green roofs and façades as well as cheap foam insulation and unhealthy materials. Could this difficult situation even lead towards an exploring architecture of CARE and REPAIR, deeply embedded in a social discourse within our society?

For years, no day goes by without hearing and reading about climate tipping points, extreme weather conditions, the non-achievability of the 1.5 degree goal, but also the profits of Big Oil as well as frauds and cover-ups by corporations and states as they avoid climate accountability.

This is why I ask myself everyday personally and professionally: is there really still hope and how can we even cope going forward? Where is the path? What has to be prioritized? How radical should we be?

What would be the highest common denominator? Is sustainability still more than a green-washed marketing stunt? Can we bundle interests for the common good? And what are the blindspots in our own rather academic discourse?

In 2017 climate scientist Hans Joachim Schellnhuber said: "The decisive decade is 2020–2030. This is when the global phase out of coal must take place, the combustion engine must disappear, and cement must be replaced as a building material (...). This means nothing less than the complete reinvention of modernity."

Now we are already in the fourth year of this decisive decade and a global pandemic, a war, inflation, a cost-of living crisis and grueling bureaucracy have limited our scope of action and diverted the attention to immediate problems and direct risks.

Long gone seem the times where the School Strike for Climate by Fridays for Future brought hundreds of thousands onto the streets, peacefully.

Today we witness forms of resistance that are far more radical.

These sentiments can also be noticed in the field of architecture education. In the last two weeks, students at my Alma Mater have occupied the Bauhaus-University Weimar and have explained their actions as follows:

"We are students at the Bauhaus University who no longer want to accept the prevailing conditions. We slide from one crisis to the next: climate catastrophe, covid, nursing shortage, energy crisis, poverty... All of this is produced by the capitalist economy that cannot exist without colonialism, racism, wealth inequality and patriarchy. If we want to overcome the crisis, we must criticize, question and overcome the social conditions ourselves. There are no easy solutions. We need to talk."

When I started studying architecture in Weimar in 2010 this would have been unthinkable. We were rather a-political, well-behaved, conformist. We talked about form, beauty and aesthetics, but we were not reflecting on content, canon and concrete. We learned about male-architects from male professors. We concealed our social class and yet we did not know that without financial backup and at best an architecture office run by the family, build-ing an independent architecture career would become super tough, often not rewarding and sometimes just not livable. Especially with children. A further and pressing problem, we just did not receive any education on sustainable construction fit for middle- and northern European climate and standards. If we ever heard the term "sustainability" at all – it was only in connection to de-signing building projects in the Global South, where thermal transmittance could easily be ignored, couldn't it?

This was not just my personal and singular Weimar-experience, we have educated generations of architects and keep educating more, who are not fit for the tasks they are facing today.

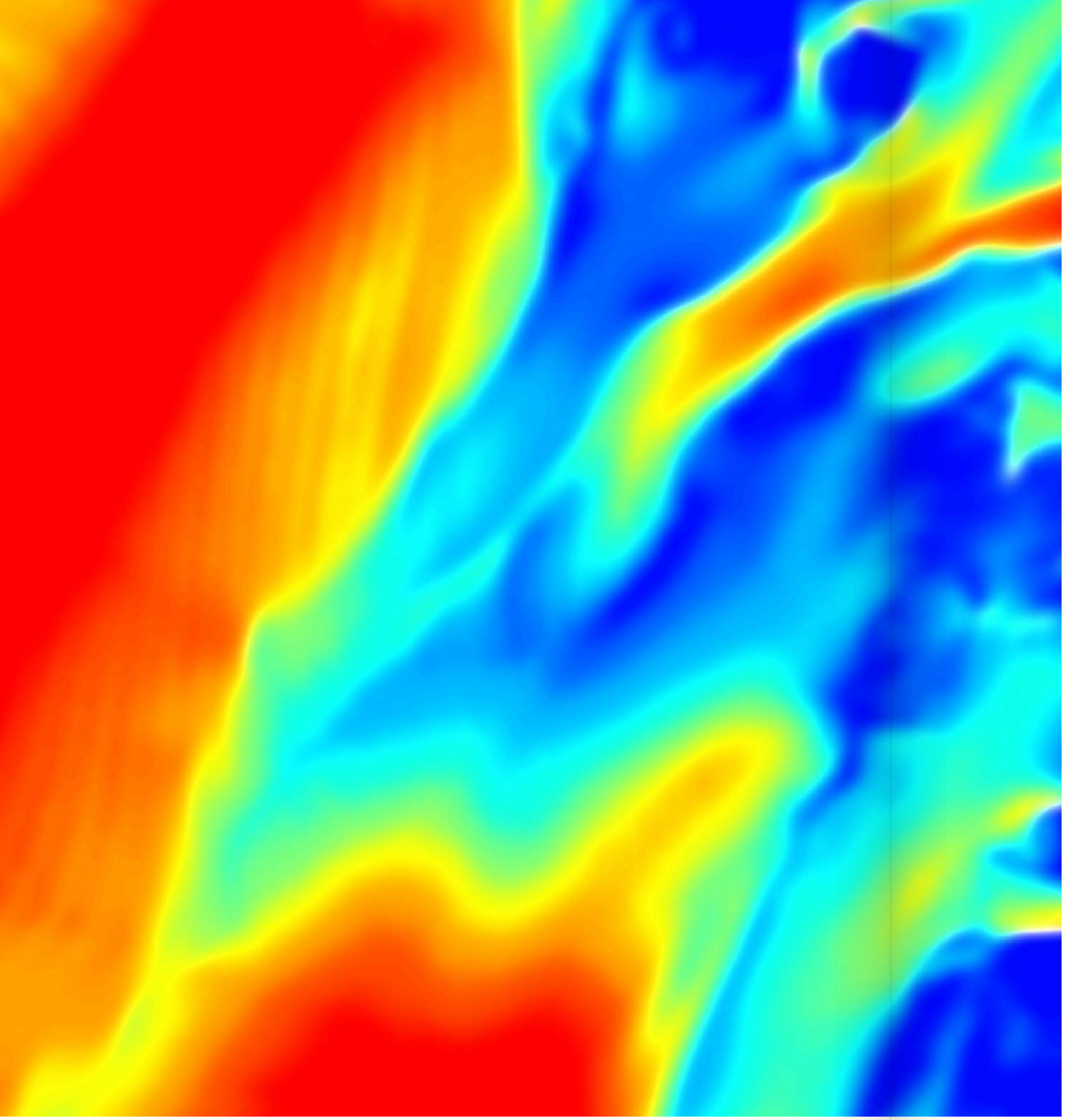
Countdown 2030 a group of practicing architects based in Basel told us recently: "We felt unable to cope with the new questions as reliable knowledge and awareness considering truly sustainable construction techniques are still largely missing within the field of architecture and different approaches are still heavily debated."

And this is why we should be more than thankful to Henning Larson for sharing their research and explorations, their pressing questions and methodology, their failures and progresses, their small steps and their big leaps so openly with us. And putting it up for debate. So let's start the work, let's build a common, reliable and tested knowledge basis for sustainable construction that we can teach and build on. It is needed, desperately, so we can change our footprint.

Thank you.

Decarbonization

With a staggering 40% of global emissions currently associated with the construction industry, reducing our carbon footprint has never been more important.



Innovation

Tirelessly learning by doing.

The nature of knowledge – much like the nature of architecture – is that it is forever building upon itself, evolving the way we consider and interact with the world. Research, innovation, and optimization are therefore key drivers in our strategy. They allow us to question habitual thinking and enable us to create truly novel solutions that embody great potential, both in their relevance today and in their promise to the future.

Integral to this path of progress and learning, are experimentation, prototyping, failure, and above all, the willingness to embrace uncertainty.

"Our aim is to support new ways of thinking and working. We insist on interdisciplinary expertise, design excellence, and a readiness to challenge the status quo with curiosity and compassion."
— Jakob Strømann-Andersen, Director of Innovation and Sustainability, Partner

Unboxing Carbon

How much do we really know about our carbon footprint?

The last decade has seen a wellspring of vocabulary around sustainability emerge and gain prominence. But though we seem to have gained the language, do we have the literacy? How much do we know about the carbon footprint of our designs?

And how can we trim that footprint in the design process?

40% of global emissions are associated with the construction industry; with pre-construction phases accounting for a staggering 11% of them. Referred to as upfront carbon, these phases include extraction, production, and transportation of materials.

To put this into perspective, the climate change impacts from the production of construction materials are about 3 times higher than the impacts from the aviation sector.

Uncomfortable as the numbers may be, they also reveal the potential our industry has of being at the forefront of real and tangible change. Over the last few years, we have developed ‘Unboxing Carbon’, a course and open-sourced catalog providing the knowledge and tools to evaluate building materials based on their upfront carbon, or environmental impact pre-construction.

The measure of emissions that relate to raw material extraction, transport, and manufacturing, upfront carbon refers to the emissions associated with products before any architecture even happens. You might ask why we focus our attention on emissions associated with the pre-construction phases, when a project’s environmental footprint goes far beyond the environmental impact of its materials and some materials are built to last longer than others. You’re asking a very good question.

The latest IPCC reports show that if we are to limit temperature increase to 1.5ºC, we must act now. By 2030, emissions must be reduced by 43% compared to 2019! And so, calculating environmental impact across the lifetime of a building or project would mean turning a blind eye towards its environmental impact today.

We’ve chosen to listen to science.

Urban Decarb

Bringing carbon into focus on the urban scale.

No question that the carbon footprint of building components and materials has come into greater focus in recent years. However, buildings cannot be examined in isolation. As of now, the immense impact of embodied carbon on an urban scale - that is the emissions associated with the entire life cycle of material components in our cities - is too often overlooked. To take on this challenge, our team of architects, urbanists, and computational designers have developed Urban Decarb.

A tool for integrating carbon knowledge of urban components in early design stages of urbanism projects, Urban Decarb marks a significant step in operationalizing embodied carbon as a design parameter on the urban scale. Based on synchronized datasets associated with a project's geographic context, the tool helps visualize the carbon impact of different scenarios as they are being modeled.

"Currently, there isn't a way of looking at embodied carbon holistically in the field of urbanism, because the data sources are so siloed. Urban Decarb tackles that by integrating the data and making it accessible in early concept phases. It looks at structural systems and façades as well as roads, parking, and landscaping, and helps designers make informed decisions toward decarbonization."
— Nielsine Otto, Architect and Urbanist

"This is part of our ambition of exploring different parameters holistically within the urban scale. Embodied carbon is just the start, but we can't stop there. Our impact cannot be reduced to a carbon footprint."
— Mariusz Hermansdorfer, Head of Computational Design

Central to informing the carbon impact and savings relating to various design choices, Urban Decarb was prototyped for our competition proposal for the 102-acre transformation of Odense's once-industrial Inner Harbor. With the ambition of generating impact through scalability, we cannot wait to implement the tool in some of our larger urban redevelopment projects.

One such project is the 520-acre development of Toronto's Downsview area, (roughly the same size as the city's downtown). Currently divided by roads, rail lines, and a former airport, the project reimagines and redefines the entire district as a well-connected, green, and resilient home for a flourishing community.

Downsview

Location:
Toronto, Canada

Typology:
Masterplan

Size:
520 acres

Status:
In progress, to be completed in 2050

Client:
Northcrest Developments, Canada Lands Company

Services:
Architecture, Masterplanning, Urban Design

Team:
KPMB, SLA, Ramboll, Transsolar Engineering, Urban Strategies

Earthshot

Let’s talk about net zero.

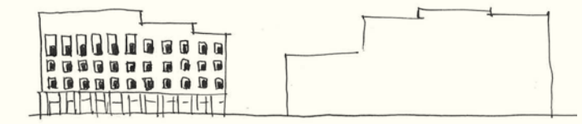
Every discipline has its before and after moments. Whether major paradigm shifts or technological advancements, progress rather organically distances us from the ways of the past. But progress is not momentary, and the categories titled ‘before’ and ‘after’ are relational rather than fixed. Simultaneously propelled toward tomorrow and restrained by yesterday, we navigate a world in motion.

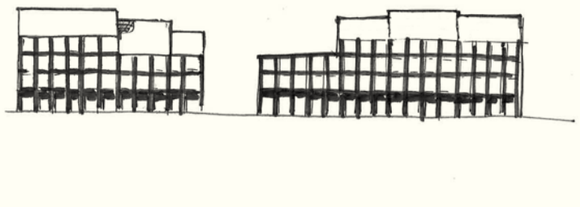
The actionable carbon knowledge we have gained within the last few years alone highlights this motion clearly. But with limited time and a long way to go in decarbonizing our industry, it takes an ‘Earth Shot’ project to mark the way forward.

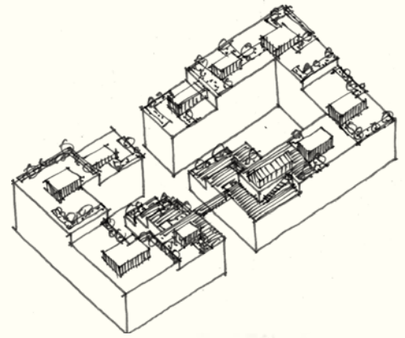
NREP is a leading developer in the Nordics that is seeking to push the real estate market by unfolding three lighthouse projects. These projects wish to demonstrate that a carbon neutral goal is attainable across typologies. One of the three, our Earthshot is a residential project that employs biogenic materials. Offering open-source solutions, the project aims to support the path toward a decarbonized construction industry.

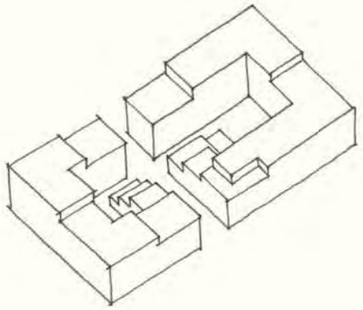
The significance of the number zero when it comes to carbon cannot be overstated. When adapting a workflow, it means a detailed embrace of numbers to support and inform our design ambitions.

“Being brutally honest with carbon data at every step of the design process means seeing all the elements as they come together and not overlooking anything, from the carbon-heavy aspects of the project to its smallest details. This really allows you to reflect on how we, like most of our industry peers, have essentially been working blindfolded for years, never fully understanding the extent of our impact. Incorporating this data is like finally lifting that veil.”
— Troels Dam Madsen, Associate Design Director









Earthshot

Location:
Nordhavn, Denmark

Typology:
Residential

Size:
13,000 m²

Status:
Ongoing, expected completion 2025

Client:
NREP

Services:
Architecture, Innovation

Team:
Søren Jensen

Biogenic Materials

As climate change continues to affect the planet, it is becoming increasingly important to reconsider the materials of our craft. Wood and other renewable bio-based materials offer great alternatives.

Wood

If materials could speak...

Trees absorb carbon dioxide throughout their lifetime and release it in decay, timber construction can help to reduce the amount of carbon dioxide in the atmosphere by prolonging the carbon cycle. This means mindfully considering the many individual scales at which we interact with wood, from tree trunks and bark to cross-laminated timber, woodchips, fibers, and even paper.

With circularity and ‘cascading use’ as clear priorities, we must extend the material life cycle of wood and draw out its capacities for carbon storage. Timber is also far lighter than other building materials and is thus much easier to transport. Compared to concrete, it requires up to 5 times fewer transportation carriers!

Believe it or not, timber construction will not burn, break, or rot, and thankfully, when selecting certified wood, sustainable forestry is guaranteed.

World of Volvo

What does it take to carry out an ambition?

The undertaking of architecture and construction is messy. A multitude of stakeholders and partnerships are involved in realizing any project. More often than not, this translates into a continuous push and pull of all parties weighing in on the design and process.

From budget cuts to material choices, from social impact to upholding a concept, challenges are built into any project and present themselves along the way. No surprise then, that it takes a seriously daring team to drive innovative and ambitious design. It takes a partnership of bold change-makers committed to challenging the status quo and just cannot be taken for granted.

World of Volvo, a 20,500 m2 experience center in Gothenburg, was unfolded in what can only be defined as such a partnership. Enabling an ambitious design that was undertaken through an uncompromising process, this is also a partnership that showcases a necessary change in our industry, that is the openness toward timber in large-scale construction.

“Up until recently, people weren’t open to working with timber so we’re usually up against clients and collaborators who won’t dare to use it. There are clients and engineers that need to be convinced but also within our own organization that needed time. We are also on this path of change so it’s just amazing that we could make this happen, from the initial sketches that were all free form and then had to be rationalized to now seeing it unfold.”
— Fabia Baumann, Structural Design Engineer

“This really was not a cookie-cutter process. We had a great relationship with our clients who were ambitious throughout, but it also took engineers who were creative and willing to be bold.”
— Filip Lyders Francati, Lead Design Architect

Designed around the Swedish concept of ‘Allemansrätten’, denoting a fundamental right to nature or ‘the freedom to roam’, World of Volvo will offer an open invitation to the public.

The building uses a timber structure to embody the regional landscape in both form and mat-eriality. The main structure, made of glulam, forms three tree trunk-like columns arranged in a mathematical pattern. Fanning out to carry the entire load of the roof, the columns envelope visitors in a forest-like canopy.

The expansive round structure is surrounded by a thriving Swedish landscape that extends onto an accessible roof, inviting the public to actively engage and explore the grounds.

World of Volvo

Location:
Gothenburg, Sweden

Typology:
Cultural

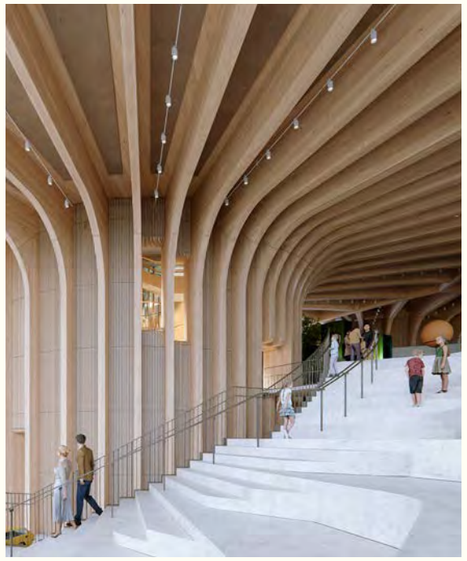
Size:
20,500 m²

Status:
Completed 2023

Client:
AB Volvo and Volvo Cars

Services:
Architecture, Landscape Architecture, Interiors

Team:
Avarn, Andersson & Hultmark, BRA bygg - BRA mark and BRA Teknik, Brion Ventilation, Cedås Akustik, Confire, Fredblad, Vinergi, Inhouse tech, Lindner Scandinavia, Nord ström Kelly Arkitekter, Optima Engineering, Prefab syd, Wieha



Ørestad Church

Being is an intrinsically spatial experience.

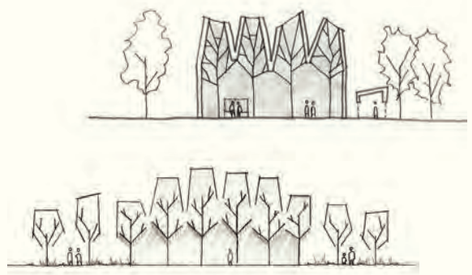
From kinship to housing, from relationships to recreational activities and well-being, our lives take place within the materiality of our spatial surroundings. For better or worse, they offer the backdrop to an endless range of individual and collective experiences. Working with responsibility over the built environment, we are no strangers to thinking through the influence that physical surroundings can have on societies and cultures.

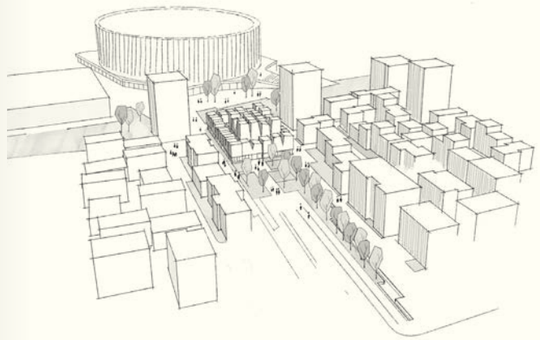
Designing the first new build church in Copenhagen in over 30 years, demanded that we rethink the typology. Exploring local perceptions of churches and the ways in which people of diverse backgrounds look to modern spirituality informed our design and ambition. This meant crafting an invitation and meeting place that would accommodate all of the neighborhood's residents and not just its church-goers.

"We found that for many, entering a church is a barrier. Instead, people tend to look to nature for pensive and spiritual experiences. This encouraged us to create a flexible, and inclusive gathering space that was inspired by clearings in the forest and the light that filters through the trees. Wood was central to this, acting as a symbolic carrier for both social and cultural values."
— Nina la Cour Sell,
Lead Design Architect

With timber as the primary material in the design and the façade shingles made entirely of tree scraps, a planet-minded material choice is harnessed to embody both familiarity and warmth in a sensory experience.

All the while, the church design also supports a new architectural expression and a modern outlook on the future of inclusive community spaces.





Ørestad Church

Location:
Copenhagen, Denmark

Typology:
Cultural

Size:
2,100 m²

Status:
In progress, to be completed in 2026

Client:
Parish of Islands Brygge

Services:
Architecture,
Landscape Architecture

Team:
Ramboll, Platant

Straw

What if the future were built of straw?

Straw in construction is not a new phenomenon. As a building material, straw has lent itself to architecture for centuries if not millennia, with early evidence of it being utilized as far back as the Paleolithic Era.

Straw is the agricultural residue of harvesting cereal crops and makes up about half of their yield. It is thus extremely widespread and abundant with the annual global production of wheat straw reaching 529 million tonnes and that of rice straw ranging between 800 to 1,000 million tonnes per year. Despite its abundance, much of this agricultural byproduct goes to waste and is usually abandoned or burned. In Europe alone, 144 million tonnes of wheat straw go to waste each year.

"Straw is a fast-growing biomass, an agricultural by-product that stores CO2. It's a goldmine as a sustainable building resource."
— Peter Tegner Matz,
Senior Constructing Architect

Like other biobased materials, straw has a part in the natural carbon cycle in which carbon circulates endlessly between land, sea, and sky, absorbing and storing the element throughout its lifetime and releasing it in decay. Employing straw in design means prolonging the storage phase of this cycle and using the built environment to reduce the emissions of greenhouse gases released into the earth's atmosphere.

When upcycled and adopted as a construction material, straw is not only a scalable solution for carbon sequestration and waste management but also a great alternative to producing new materials.

It is a well-insulated, well-ventilated, fire-safe, easily assembled, easily disassembled, and reusable material. Adapted to meet today's needs and requirements, straw bale construction is a viable alternative to conventional practice and a scalable means of prioritizing both people and the planet.

Sundby School

What if we reframe the mundane to celebrate local heritage?

With global urban populations on an incline and our cities expanding, rural communities are often weakened, reducing in size and resources; at times even losing touch with their local sense of place. Can architecture lend itself to reshaping these trends?

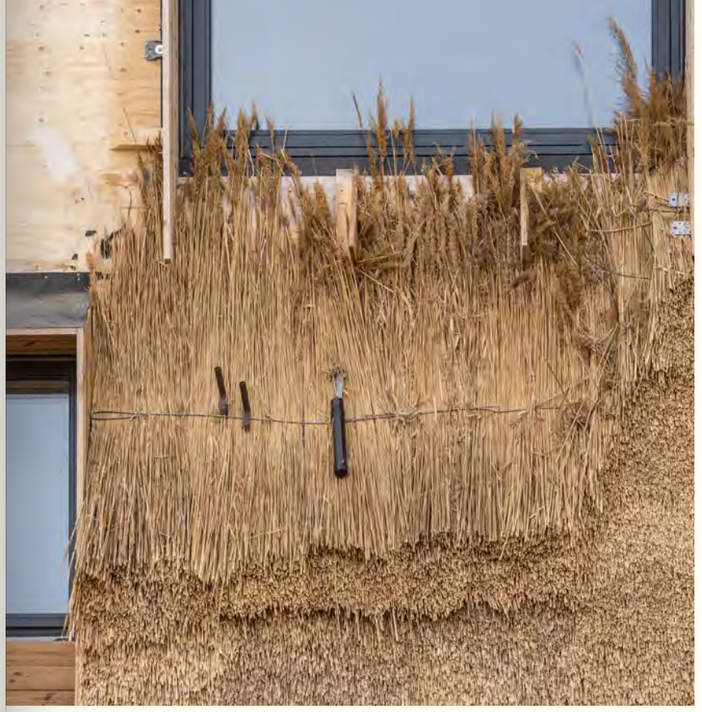
Located in the rural region of Loland-Falster, the Danish town of Sundby has seen a general decline in recent years. From number of inhabitants to income and education, the area is facing significant challenges that locals say are resulting in a decreased sense of pride and ownership for residents. Peeling back these contextual layers, it became evident that Sundby Primary School would have to do more than offer amodern learning environment. Our design had to convey confidence in the future of the town and offer the community something to enjoy and take pride in.

With this ambition, we turned to one of the area's defining qualities: its predominantly horizontal landscape and surrounding fields. Working within scenery that is most often taken for granted, we set out to offer a new perspective on the otherwise mundane, one that captures and emphasizes the poetic subtleties of the landscape. Straw was the obvious choice.

"Straw is found in abundance in the area and has been used traditionally in local architecture, in the unique feature of thatched façades. Introducing this element in our design, we were able to reference local heritage and mirror the school's surroundings, with the aim of uplifting both."
— Per Ebbe Hansson, Lead Design Architect and Head of Learning

"The focus on straw is echoed on varying scales in the project. It's spotlighted in the façade, but we've also created an invitation for the children and wider community to take to the roof, where they can look out over a landscape that would otherwise be undervalued or ignored."
– Eva Ravnborg, Country Market Director Denmark

Working within this intersection of landscape and learning, we've been truly humbled by the local response to the project, showing that impact can go far beyond the boundaries of the site.



Sundby School

Location:
Sundby, Denmark

Typology:
Educational

Size:
7,000 m²

Status:
Under construction, expected completion 2023

Client:
Guldborgsund Municipality

Services:
Architecture

Team:
SKALA Architects, BO-HUS, ETN Arkiteketer, Autens, and MOE

Feldballe School

Making architecture out of agriculture.

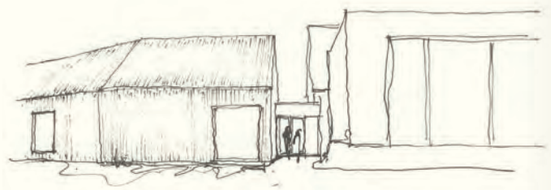
Truthfully, the real victims of the climate crisis are demographics that have contributed least to the problem. Of them, are the increasingly and inspiringly vocal young generation; a generation that is coming of age with the weight of an incredible existential burden and the sense that its future is in question.

In our 250 m2 extension of Feldballe School, one of our key aims was to convey the message to young people that they, like the planet they are to inherit, are a priority. To do so, we chose upcycled straw as the primary material.

Though small in scale, Feldballe School exemplifies the exciting potential that arises when accountability is embraced as a catalyst for design and an uncompromising material strategy is adopted.

With its pioneering panel system of compressed straw, a roof made solely of timber, and a ventilation system made of seagrass, the Feldballe school extension is built almost entirely of bio-based materials.

These are materials that sequester rather than emit CO2. They are also totally free of toxic chemicals, fire-safe, and once assembled, offer both efficient insulation and – according to our reliable young sources – a great indoor climate.



Feldballe School Extension

Location:
Rønde, Denmark

Typology:
Educational

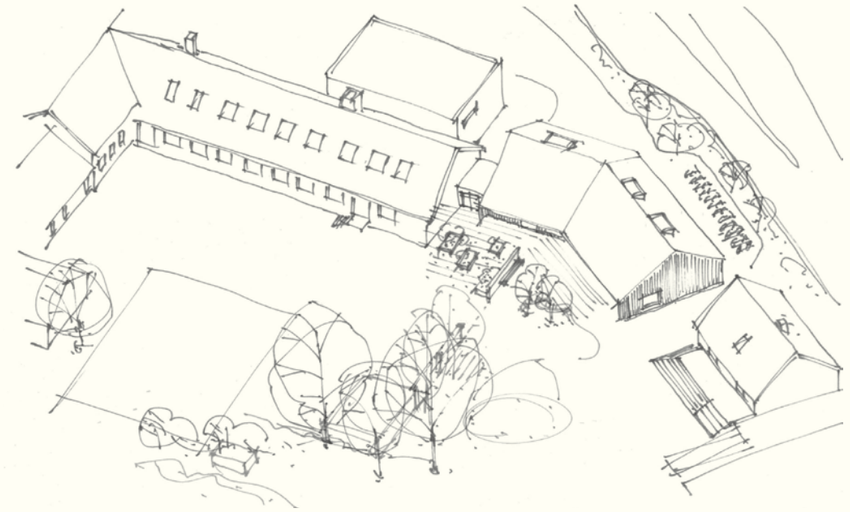
Size:
250 m²

Status:
Completed 2022

Client:
Feldballe Friskole & Børnehus

Services:
Architecture

Team:
Realdania, EcoCocon



Eelgrass

Have we been looking for materials in the wrong places?

The use of eelgrass in construction dates back to the 1600s, when settlers of the Danish Island of Læsø would forge thick roof-thatching for their, today, renowned ‘seaweed houses’ – a technique unseen anywhere else in Denmark, or the world for that matter. The tradition was abandoned due to changing construction demands in the 20th century, and as a result eelgrass as a building material was mostly forgotten about, until rather recently.

A fast-growing carbon-binding sea plant, eelgrass naturally washes ashore in large quantities – making it an abundant and renewable resource.

“Eelgrass is a resource that reproduces efficiently. In architecture, it is something of a miracle material that can be used for ventilation, insulation and acoustics while sequestering large amounts of CO2.”
— Magnus Reffs Kramhøft,
Lead Design Architect

Eelgrass has many inherent qualities as a modern building material: it provides excellent acoustic and thermal comfort, effective humidity regulation, long-term durability, high fire-resistance and low susceptibility to mold and bacteria due to its naturally high content of mineral salts. Such solutions can be found in Søuld’s acoustic panels and NOTECH’s passive ventilation system, which was used in our extension of Feldballe School.

Mycelium

Could an ancient organism be key to constructing a more sustainable future?

Fungi are of the most widespread organisms on Earth, yet we rarely see or consider their presence in its entirety.

Whether foraging mushrooms in the forest, getting rid of mold, or employing yeast-enabled processes in preparing food or medicine, most of our encounters with fungi are only at the tip of the iceberg – with the literal mushroom growing above ground.

Mycelium is the branchlike root system of fungi, growing to span many kilometers in soils and substrates. Among nature's oldest recycling organisms, it has undergone billions of years of evolution.

With the ability to grow on various bio-based materials such as fabric, sawdust or coffee grounds, mycelium can transform organic waste such as agricultural residue into a broad range of building materials, including, amongst others, insulation, hard boards, and even structural elements.

Mycelium-based products contain no toxins and are fully biodegradable after use. The result is a zero-waste cycle in which nutrients are circulated back into the biosphere.

"Mycelium embodies a potential for aesthetically competitive, biobased, scalable, and CO2-sequestering products."
— Magnus Reffs Kramhøft, Lead Design Architect

In collaboration with Naturpladen, a local Danish manufacturer, we are currently exploring the potential of mycelium in decarbonizing acoustic panels – a product that conventionally uses plastic and cement as binding agents resulting in a heavy carbon cost.

Transformation

The most sustainable buildings are ones that are already built. At its core, sustainability is about extending the longevity of what we already have, moving away from linear economic models to circular ones. Within architecture, this translates into transformations, renovations, retrofits, and the like. These processes significantly reduce carbon emissions, by up to 70% compared to conventional new construction.

But within a sector that is often rather conservative in its ways, this requires a shift in mindset from everyone along the supply chain. Working with the ‘already built’ introduces challenges that are both practical and systemic, but nonetheless, these are challenges that must be met.

Rebus

How do we rethink the current limitations of renovation projects?

REBUS (Renovating Buildings Sustainably), is an extensive research project and strategic partnership spanning many stakeholders, from housing associations and contractors to consultants and research institutions. The project resulted in an adaptive and innovative solution, adding value to an overwhelmingly widespread and underperforming typology – that of 1960-70s social housing blocks.

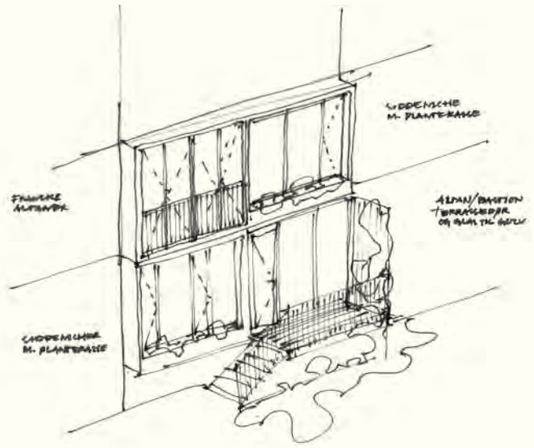
Renovating the existing housing stock is by far the least carbon-intensive construction solution available. The renovation process uses 30% fewer resources and post-renovation, buildings will consume 50% less energy. But even when we push for seemingly simple, cost-effective, and low-carbon solutions, we cannot lose sight of users, authorities, associations, and the like.

"Doing renovations within this typology demands that we acknowledge the social, political, and physical infrastructures that are at play within our built environment. And if we are to implement realistic sustainable solutions they just have to work together with these systems, both literally and figuratively."
— Martin Vraa Nielsen,
Lead Sustainability Consultant

REBUS prefabricated panels can be quickly and easily mounted on the existing building facades and do not require residents to move out of their homes, as is usually the case. Utilizing the existing infrastructure, the solution maintains the existing fire, vapor, and acoustic barriers.

It minimizes interior work and construction time while significantly improving the building's energy consumption, indoor climate, daylight, and architectural quality.

The modular panel system is configurable to best suit the different lifestyles and needs of residents, increasing their involvement and offering a sense of ownership and influence on the building design.



Rebus - Renovation Buldings Sustainably

Location:
Denmark

Typology:
Residential

Size:
-

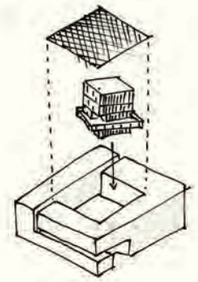
Status:
Completed 2021

Client:
Innovation Fund Denmark, Realdania, Grundejernes Investeringsfond

Services:
Architecture, Digital & Innovation, Façade Engineering

Team:
Technological Institute Denmark, Enemærke & Petersen, Technical University of Denmark, BUILD, Himmerland Boligforening, Frederikshavn Boligforening, COWI, Saint Gobain

Uppsala Town Hall



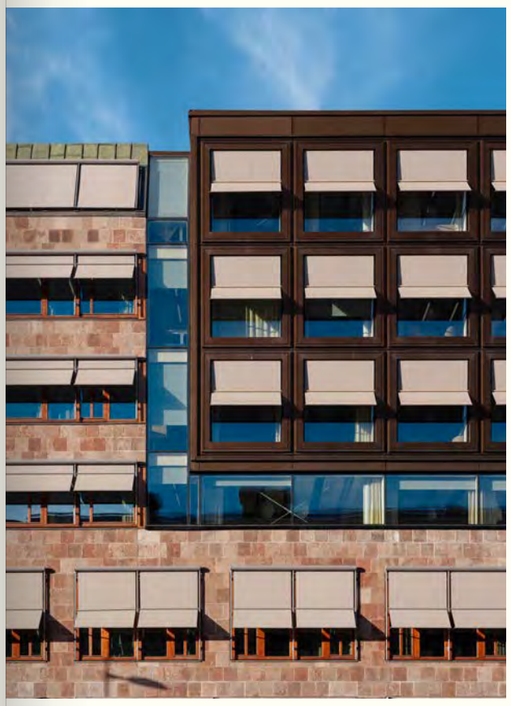
New designs on old square meters.

Like every project, a transformation calls for a deep dive into context to fully unfold the geographical and cultural conditions. But, in addition, it is also likely to include an exploration into the work of others, investigating the past through the built.

The transformation of Uppsala Town Hall embodies this spirit proudly. Totaling 25,000 m2, just over half of the project is newly built. The project extends the existing architecture, that is the half-completed late modernist design of the brothers Erik and Tore Ahlsén.

"It was really like going on an exploratory journey of discovery and unraveling the past like a mystery that you're trying to follow or solve. It's a totally different mindset than designing from new, but at the same time, it can produce really exciting and unexpected results. It pushes and challenges the design process because you have the old architecture playing an active role, like another voice at the discussion table."
— Per Ebbe Hansson, Lead Design Architect

Another unique aspect of this transformation project was the attention to acoustics and their essential, but often underappreciated role in how architecture is experienced. Together with Ph.D. researcher and acoustic engineer, Finnur Pind, a digital tool was developed to explore this intangible presence. Using virtual reality technology, the tool simulates the sound experience of spaces based on their material and spatial qualities incorporating considerations of reverberation, speech clarity, and acoustic comfort toward an acoustically informed design.



Uppsala Town Hall

Location:
Uppsala, Sweden

Typology:
Civic, Cultural

Size:
25,000 m²

Status:
Completed 2021

Client:
Uppsala Municipality

Services:
Architecture,
Digital & Innovation

Team:
SLA, Tyréns

Reused Bricks

Giving old materials new life. Pre-industrialization, the material components of buildings that were deemed unusable would be removed and taken to the next construction site. But as demolition costs dropped over time, particularly in proportion to labor, the once careful approach to deconstruction disappeared.

It may be time for a comeback.

Did you know that 1m² of new bricks embodies the same amount of carbon as 60m² of reused bricks?

The emissions saved during production are essential to rethinking the carbon footprint of construction processes. With reused bricks, the production phases are significantly minimized and demand only harvesting from existing buildings, transportation, and cleaning, before the bricks become ready for their next life.

A simple solution and impactful no-brainer, old bricks now have new life in many of our projects.

Frederiksbjerg School

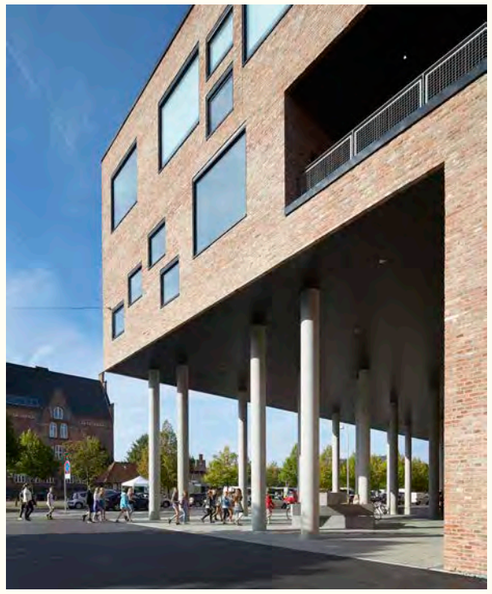
Can we bring the soul of the old into the new?

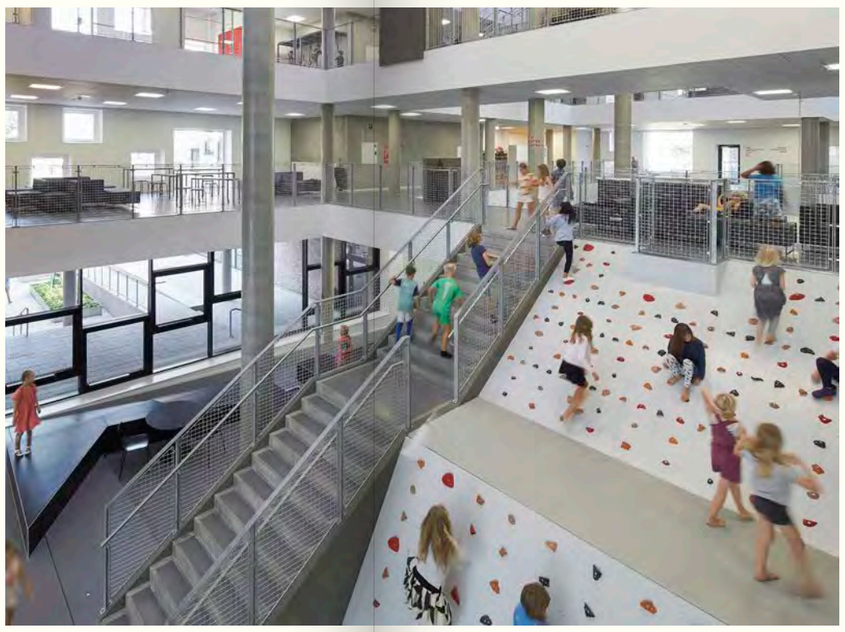
The past and the present unite in the new-built Frederiksbjerg School in Aarhus, Denmark. The façades are made from reused bricks of which a large part stem from historical buildings in the area.

Some of the oldest bricks used to form the regional hospital of Aarhus, which was built in the 1880s. Others stem from a former school, which was built in 1953.

The mix of sources meant that not all bricks matched perfectly, requiring bricklayers to rinse and evaluate the half million bricks almost individually. Up close, this gives the facades a patchwork appearance; chalky whites and deep reds standing out in the weathered tan canvas. From afar, it dissolves into its surroundings. It's as if it has been there forever.

It takes more for the bricklayers to work with the reused brick because of the stone's variety in shape and color. But the extra effort increases by far the value of the building, and the façade appears warm and glowing.





Frederiksbjerg School

Location:
Aarhus, Denmark

Typology:
Educational

Size:
15,000 m²

Status:
Completed 2016

Client:
Municipality of Aarhus

Services:
Architecture, Graphic, Interior & Lighting Design

Team:
GPP Architects, Møller & Grønborg, Niras, Hoffmann

Concrete

Can we reimagine our reliance on concrete? Concrete is a staple of architecture and construction. From structural elements to the infrastructure on which our modern lives depend, concrete is basically everywhere. Versatile and durable, its influence on our built environment just cannot be overstated.

Accounting for 8% of global greenhouse gas emissions, the production of concrete also has a considerable environmental impact. The production of cement, the key ingredient in concrete, is not only a major source of emissions but also necessitates mining of raw materials, resulting in habitat destruction and water pollution.

In spite of these, concrete continues to dominate our industry. It is used twice as much in construction as all other building materials combined and is second only to water as the most consumed material in the world.

“As of now, concrete is not disappearing from the construction industry. So, we need to find better ways to use it while reducing its environmental impact in the short and long term.”
— Jakob Strømann-Andersen,
Director Innovation and Sustainability, Partner

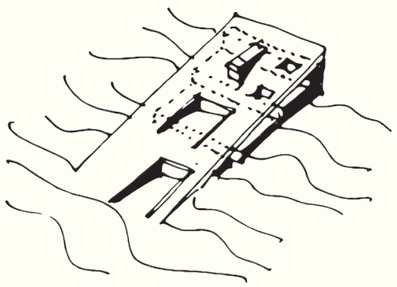
Moesgaard Museum

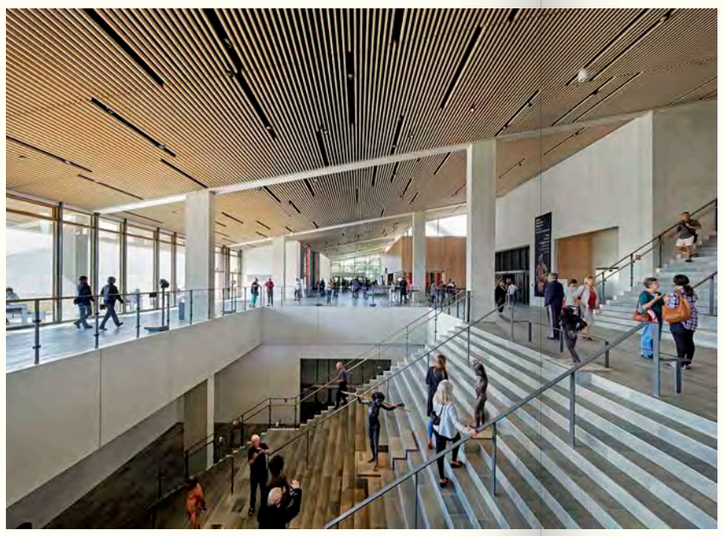
Time for concrete change

Today it is clear that the construction industry's use of concrete demands review but just less than a decade ago, things were perceived very differently.

Our design of Moesgaard Museum, a 16,000 m2 cultural institution, was constructed almost entirely out of concrete, 9,500 cubic meters of it, to be exact. Completed in 2014, the project was even awarded for its use of cast-in-place concrete!

Estimated at 300 kg of CO2e per cubic meter, Moesgaard Museum reaches an astounding footprint of 2,850 tonnes of CO2e. While this is a design of which we are proud for its simple architectural gesture and contribution to social life, we also know that this is a design of the past. Moesgaard boasts design choices that we simply would not make today.





Moesgaard Museum

Location:
Aarhus, Denmark

Typology:
Cultural

Size:
16,000 m²

Status:
Completed 2014

Client:
Moesgaard Museum

Services:
Architecture, Graphic, Interior & Lighting Design

Team:
Kristine Jensen, COWI, D-K2, MT Højgaard and Lindpro, LIW Planning

Seratech

What if we could harness cement production for carbon capture?

As technology propels us forward, material scientists and engineers are developing solutions for reducing the environmental footprint of materials. Seratech's zero-carbon cement, developed by Ph.D. students at Imperial College London, is one of these inspiring advancements.

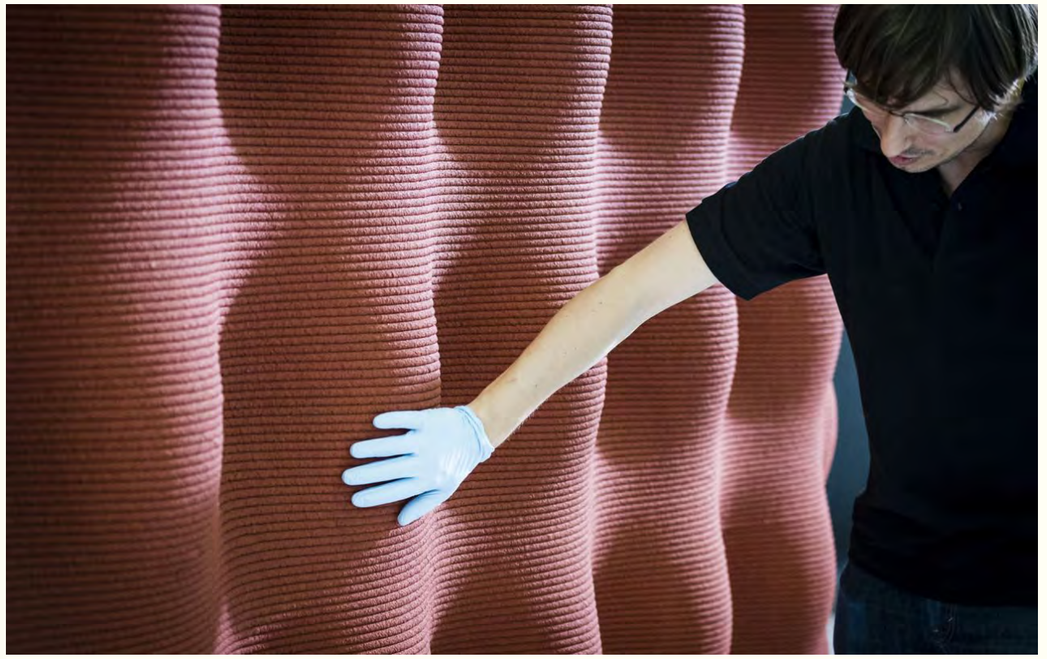
Capturing waste CO2 directly from industrial sources through a chemical process, Seratech's innovation yields a cement additive that can replace the amount of portland cement in the concrete mix by up to 40%. The carbon capture associated with producing the additive means the concrete products achieve a zero-carbon footprint.

Seratech's aim is for humanity to be able to continue building robust cities and infrastructure, but without the climate cost of traditional cement mixes.

3D Printing

Additive manufacturing and 3D printing are moving fast. Continuously being optimized, they mark great potential within the future of architecture, and computational design. Enabling the printing of complex, custom-designed shapes and alteration of material mixtures, they offers ways of rethinking conventional practice.

By printing only what is structurally necessary rather than using formwork, 3D printing concrete generates great material savings while also reducing the production of waste compared to conventional methods. It also offers more geometric freedom, moving away from standardized elements and the creative limitations of straight lines, creating new textures and articulations.



N3XTCON Rowhouses

A new visual language.

N3XTCON is a collaborative project spanning manufacturers, researchers, developers, and designers with the ambition of bringing 3D concrete printing to an industrial scale, creating new possibilities for future construction.

As a demonstrator project, we've been exploring the very conventional and extremely widespread rowhouse typology, pushing its boundaries with the architectural opportunities offered by 3D-printed concrete. When completed, this will be Denmark's first two story 3D-printed project of this scale and a viable low-carbon alternative to current industry norms.

"Throughout history, there have been turning points where new construction processes would change how architects work and think. I believe that robotics and 3D printing are going to do the same. They really could be of the more influential things to enter our practice. They open unexplored design realms and give ways of challenging standards and conventions, ultimately creating a new visual language."
— Troels Dam Madsen,
Associate Design Director

Acknowledging the standard qualities of the rowhouse typology while challenging its classic structure, the design features a gentle indent gesture created by the self-stabilizing curved walls. This feature, inherent to the logic of 3D printing, results in a new experience of the home and a more distinct sense of privacy for residents.

N3XTCON Rowhouses

Location:
Nærheden, Denmark

Client:
FB Gruppen

Typology:
Residential

Services:
Architecture, Innovation

Size:
500 m²

Team:
Cobod International, FB Gruppen, ARFY, 3DCP Group

Status:
In progress, expected completion 2025

A hybrid 3DCP slab

Nerdy influence makes a lasting contribution.

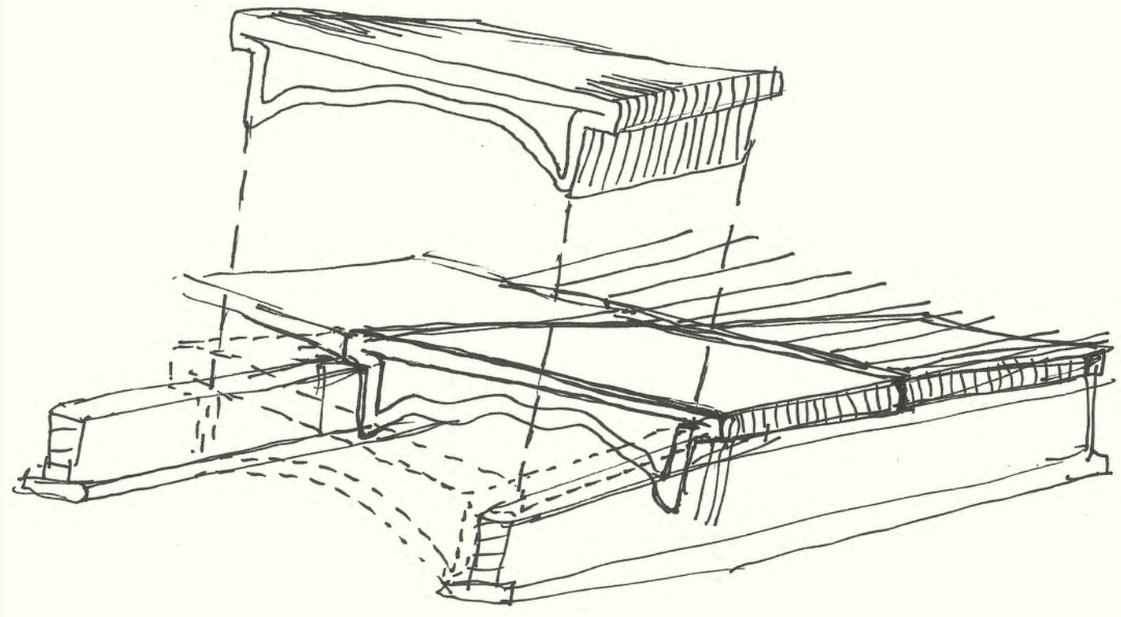
Over the years, we have had the great pleasure of investing in new knowledge by welcoming nine industrial Ph.D. candidates to our team. We couldn't be prouder of this nerdy bunch and value the perspectives they bring with them as they inform and better our design processes, infusing them with academic rigor and possibility.

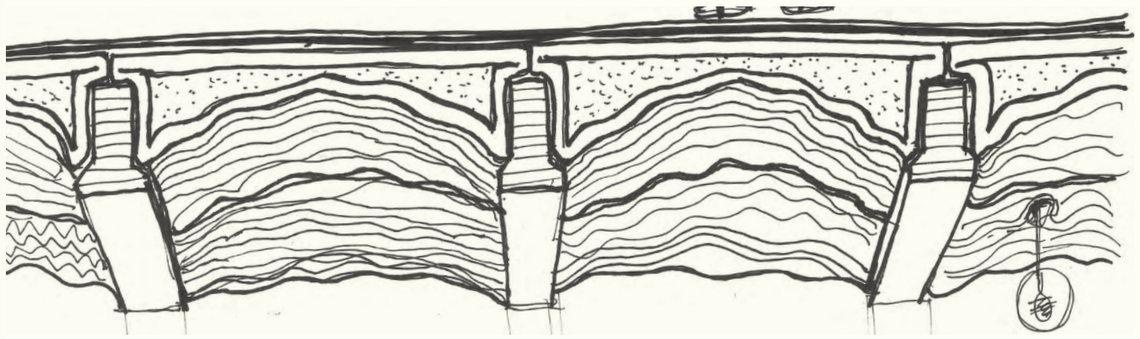
Of our fantastic academics is Katie Heywood, who is carving out room for new knowledge and responsive approaches in additive manufacturing. She combines knowledge of structural limitations with the environmental impacts of 3D-printed concrete, getting to know the intricacies of the material and process with a critical eye on their footprint.

"Because I'm working with concrete, it is so important to maintain that not everything should be printed. If that's not kept in check then it just can't be a sustainable solution. My hope is to use this research to influence the design process and to ensure that the way we 3D print at Henning Larsen, will in fact be sustainable."
— Katie Heywood, Architect and Industrial Ph.D. Candidate

Katie has developed a 3D-printed structural element, a slab that is reimagined as a hybrid timber-concrete structure, seeking to harness the natural properties of the materials. Utilizing new digital fabrication methods and computational form finding, it creates a 3D concrete printed vault.

The design follows three main targets in its development: lower embodied carbon, better material recovery, and smarter use of building materials. Secondary to these targets are equal ease-of-use to current slabs, scalability, and meeting building regulations.





Ecosystems

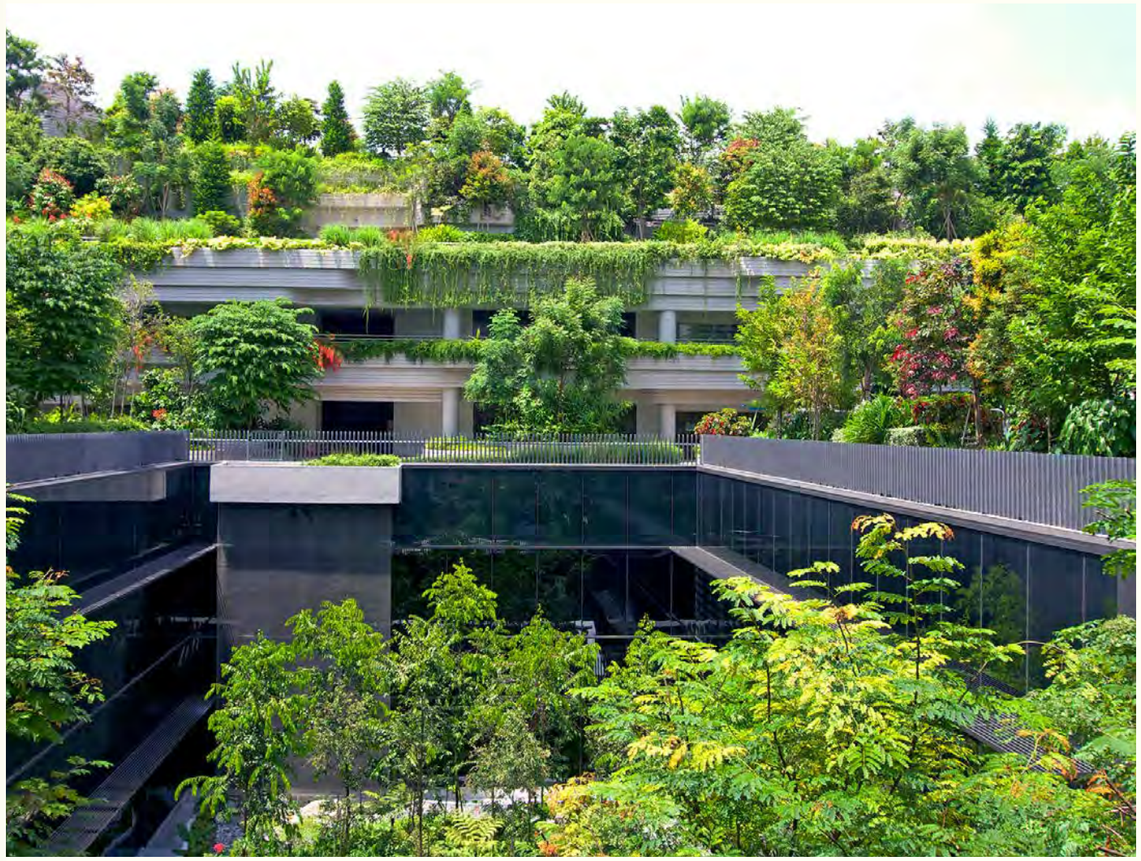
Ecosystems of every scale are vital to our survival, providing us with the air we breathe, the water we drink, and the food we eat. They regulate the climate and purify the air while clearly demonstrating the interconnectedness that characterizes our planet.

Kampung Admiralty

What if landscape and architecture were one?

“Kampung is a Malay word meaning village and offers a reference to the local context predating Singapore’s rapid urban development. Recreating the connection to nature and strong community spirit that characterized that time, Kampung Admiralty is an integrated public development that combines public facilities and services on a site that was once an empty lot and car park.”
— Agnes Chain, Senior Landscape Architect

While maximizing land use and improving microclimate conditions, water-sensitive urban design is implemented to form a truly thriving multi-tiered landscape. Acting as a backdrop for cross-generational community life, the design centers around the needs of the area’s aging population. With 1.2 acres of self-irrigating landscape covered by 730 trees of 58 different species, over 80 thousand shrubs of 66 different species, an intricate terraced water filtration network, and 24/7 public access - Kampung Admiralty can only be defined as a thriving ecosystem, serving both people and wildlife.



Kampung Admiralty

Location:
Singapore

Typology:
Mixed Use

Size:
8,980 m²

Status:
Completed 2017

Client:
Housing and Development Board (HDB)

Services:
Landscape Architecture, Sustainable Planting, Stormwater Irrigation Management, Community Consultation

Team:
Ramboll Studio Dreiseitl, WOHA Architects

Green Façade

Biodiversity is the priority.

As we actively rethink our impact on the planet, we must, amongst other things, ensure that our built environment does not lend itself to current rates of biodiversity loss but rather works against them to achieve net gain. We must broaden the audience for whom we design to include plant and animal species and the intricate ecosystems on which they depend.

Taking advantage of vertical spaces in Copenhagen's Nordø, we implement an innovative green façade that pushes beyond conventions. Integrated as a structural element (rather than mounted on the exterior), the green façade can be implemented in a wide range of typologies, offering a unique symbiosis between nature and architecture as a living building element.

This façade system can be implemented in a wide range of typologies. It is watered primarily with rainwater collected in tanks that can collect up to 7,500 liters of water, offering a hydraulic buffer and ensuring robustness during dry periods.

By putting urban nature and biodiversity first, the system is also expected to reduce street noise by 15% and cool the street environment by reducing the urban heat island effect.

Green Façade

Location:
Copenhagen, Denmark

Typology:
Façade Innovation

Size:
260 m²

Status:
In progress, to be completed summer 2023

Client:
Danish Ministry of Environment / Eco-innovation MUD

Services:
Innovation, Design, Construction Technology

Team:
BG Byggros, Kompromet

Urban Development

Rapid urbanization is demanding that our cities be in a constant state of development. By 2050, 70% of the world's population will reside in cities.

Expanding continuously to accommodating their fast growing populations, adapting our urban environments asks that we approach cities as consequential spaces for creating impactful change.

Aarhus Rewater

Can we use architecture to foreground the invisible?

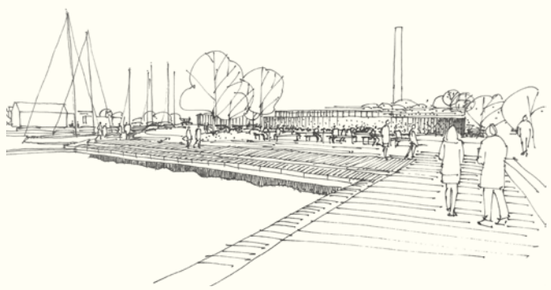
From power lines and plumbing to waste management, water treatment, and data centers, our modern lives depend on the functionality of many essential systems that are most often tucked away and hidden from view. Whether underground or distanced from the urban landscape, these invisible infrastructures are taken for granted at best.

But now, as it becomes discerningly clear that we must change our ways, it is essential that we rethink these relationships and actively engage with our collective influence. We must proactively make the invisible visible.

For the design of Aarhus ReWater, a large water treatment facility, combining a technical function with social life became central to our vision. Rather than a closed industrial site, we saw this as an opportunity to craft a new landscape typology that combines nature and industry and offers a unique sense of ownership to the public.

"Not only did we have to learn a lot about these hidden systems, we also had to design the invitation for others to learn about them too."
— *Marie Attrup Scheel, Landscape Architect*

Working innovatively on Aarhus Rewater, we incorporated Sandworm, a modeling program that uses an augmented reality sandbox to model and scan complex topographies, allowing designers to transfer manipulated landscapes into a 3D model and vice versa.



Aarhus ReWater

Location:
Aarhus, Denmark

Typology:
Waterfront Masterplan, Operational, Landscape

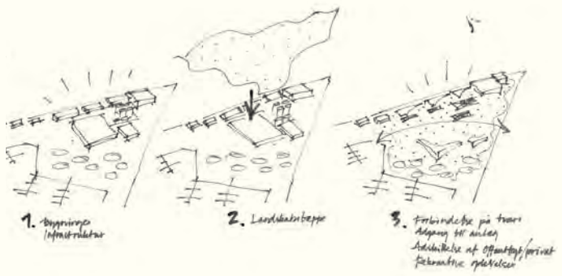
Size:
40,600 m²

Status:
In progress, expected completion 2028

Client:
AarhusVand

Services:
Architecture, Landscape, Architecture, Master Planning, Urban Design

Team:
Klinges Tegnestue, Topotek 1, Eva Koch



Fælledby

Can we harness urban development to tackle past mistakes?

On the outskirts of Copenhagen, buried underneath a layer of struggling soil, lies a former junkyard to be developed into a new residential neighborhood. Though overgrown, the area was home to limited plant and animal species, with hazardous materials hidden underground.

In breaking ground and assessing the soil, these materials were found to be polluting the area as rainwater would seep through the layers of rubble.

“Fælledby demanded that we incorporate surface solutions for water retention and flow. The result is a design for a community and nature-centered neighborhood, 40% of which will be dedicated to landscaping.

The area will offer itself to diverse species while redirecting over 100 million liters of polluted water every year.”
— Michael Tillegreen Dagø, Project Manager

However, as the site had not been built upon or developed prior, we have faced opposition amongst Copenhageners who are concerned about losing nature to city expansion, fearful of development, and protective over the green spaces they can access. The best we can do is deliver a design that contributes for the better but with urban development being a present-day necessity, we find ourselves navigating a very literal complex ground.

Fælledby

Location:
Copenhagen, Denmark

Typology:
Masterplan

Size:
219,000 m²

Status:
Broken ground in 2021, expected completion in 2031

Client:
By&Havn

Services:
Architecture, Landscape Architecture, Masterplanning, Urban Design

Team:
MOE

Design for Disassembly

Architecture is not forever. Built projects have an end of life at which point their components and materials are disposed of, most often ending up in landfills. At present, construction waste accounts for half of the world's solid waste, 90% of which comes from demolition. By 2025 this is predicted to reach 1.1 billion tons annually.

Design for disassembly means accepting account-ability for these alarming numbers and designing proactively and practically to change them.

Restaurant Rummel

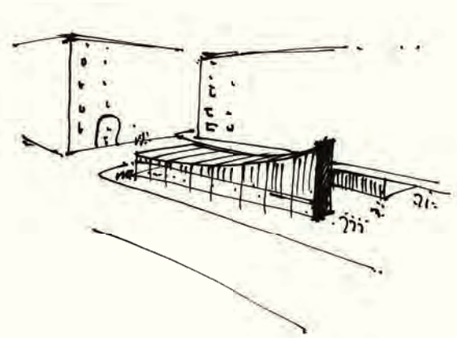
What if temporality were adopted into design?

Design for disassembly means ensuring that building components can be reused and have a healthy second life. Embraced as a key design driver, design for disassembly was central to our design of the small but striking Rummel, a 500 m2 restaurant nestled in the streets of Stockholm.

With a burnt wood exterior and glulam frames, the timber structure is designed as a double frame structure, with changing angles and heights from one end of the building to the other.

“Disassembly becomes part of the language of Rummel in that the way parts are mounted and bolted together is made visible, making it easy to understand how the building is constructed. This also makes it easy to dismantle so that parts can easily be inspected, removed, or replaced when necessary, without cutting through the cladding.”
— Peter Tegner Matz,
Project Manager and Constructing Architect

In this way, the temporality of the building components is accounted for and incorporated into the design. Rummel’s design for disassembly enables flexible usages and a prolonged life cycle of its parts; all the while conveying that everything – including our built environment – is in a constant state of becoming.



Restaurant Rummel

Location:
Stockholm, Sweden

Typology:
Restaurant

Size:
500 m²

Status:
Completed

Client:
Humlegården

Services:
Architecture

Team:
PQ Projektledningi,
Hillstatik, Serneke

Fritz Hansen Pavilion

Mindfully ensuring that each component could be repurposed, leaving not traces on site, and above all, creating no waste in the process.

Designing the Fritz Hansen Pavilion demanded that we embrace the temporality of the pavilion typology. The pavilion's design is deliberately simple – a shell-like, transparent structure, letting daylight and nature in.

In line with circular design principles, the pavilion's entire structure is designed to be disassembled and reused in the future reconstruction of Fritz Hansen's Headquarters.

Hybrid Structures

The construction industry's outsized environmental impact can no longer be ignored. Standards must change, and business as usual needs correcting.

That said, our industry – an industry that is heavily influenced by slow-moving social, political, and economic systems – is rather difficult to alter.
The reality is, that with an abundance of stakeholders and decision-makers holding different interests and agendas, progress and innovation are often compromised in favor of more conventional, low-risk, and cost-efficient methods, despite their impact on our planet.

As a result, progress often takes form in paths of compromise, opening new opportunities that work together with long-standing frameworks.

Hybrid-timber construction, combining wood with other materials such as steel and concrete, offers solutions that steadily propel our industry toward more responsible design choices.

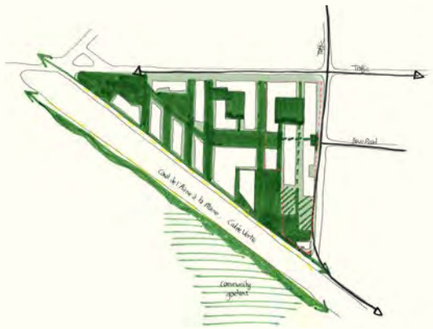
Neoma Business School

A hybrid way forward.

In a former industrial, partially abandoned site overlooking the channel in Reims, our 26,000 m2 hybrid design for the new campus of NEOMA Business School is planned to break ground in spring of this year.

Incorporating an array of timber elements including the wood-frame façade, wood cladding, and wooden structural elements, the design centers around the health and well-being of students and staff, while also reducing the emissions associated with construction, use, and maintenance of the building.

The new campus will open toward the canal and parks that surround it, offering itself to student life that is nestled within a stirring green landscape.



NEOMA Business School

Location:
Reims, France

Typology:
Higher Education

Size:
26,000 m²

Status:
In progress, expected completion in 2025

Client:
NEOMA Business School

Services:
Architecture,
Landscape Architecture

Team:
Patriarche, Egis, Elioth, Etamine, Acoustb, Creafactory

Havelwerke

Comprising of twelve new buildings and a vibrant public realm, Spandau's 82,570 m2 mixed-use urban development of Havelwerke is planned as an innovation hub, a new home for forward-thinking companies and initiatives. With hybrid structures throughout, the project demonstrates a clear departure from conventions and welcomed progress in hybrid construction within the commercial typology.

Concrete ground floors offer flexibility, while all timber beams and columns in the upper floors support the feel of a unique working environment. And with composite structural systems combining the two materials, both concrete and timber are utilized to their strengths.

Havelwerke I & II

Location:
Spandau, Germany

Typology:
Mixed Use

Size:
82,570 m²

Status:
In progress, expected completion in 2025

Client:
Signa

Services:
Architecture,
Urban Design

Team:
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Concluding Words

A journey towards a new paradigm

As an experienced studio with a global presence, we embrace the responsibility of being in a continuous state of movement - bettering ourselves and our ways to meet the needs of both people and the planet. This has led us to embark upon the explorative and collaborative journey of changing our footprint.

While we can’t have all the answers now, we are ready to ask some difficult questions. Join us as we walk this path.

The projects, materials, and learnings in this booklet, represent our steps as we progress toward a new paradigm. But changing one’s footprint is a ceaseless endeavor and one that must be executed in collaboration with others.

We hope you will share your impressions and thoughts with us.

#changingourfootprint

Thank you for reading.
Thank you for collaborating.

Henning
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