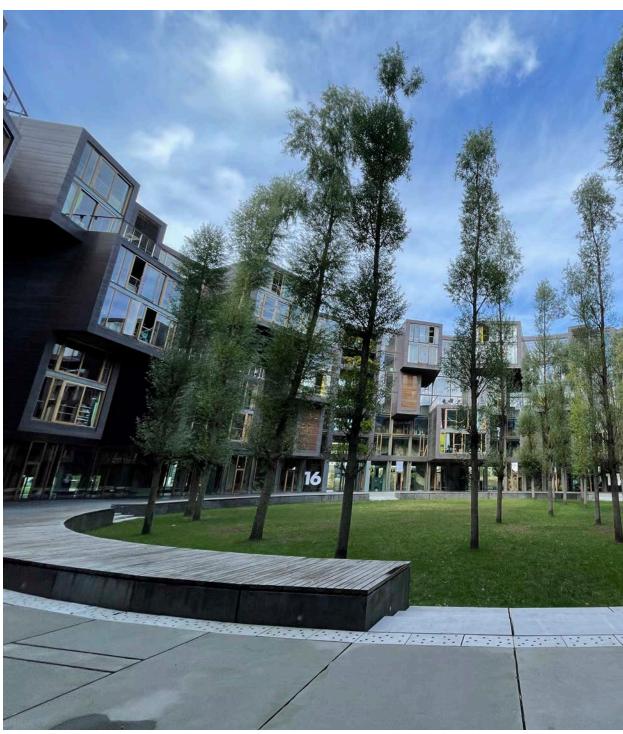# SCAN | DESIGN 2022

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CH 1 Introduction

Kasper Guldager, Home.Earth
Cradle to Cradle, Circular Economy, Dough-nut Economics

Lasse Lind, 3XN/GXN
Green Innovation in Architecture, Recycling, and Upcycling

CH 2 People + Social Foundation

2.1 How Do You Measure Living Well?
Gitte Andersen
Smart m2 and Community Design; Work, Play, Life, Learn

2.2 Housing First + Equitable Living
Mette Margrethe Elf
Shared Senior living and integrating homeless

2.3

Community Informed Design
Kåre Stokholm Poulsgaard, GXN
Architecture and Anthropology

CH 3 People + Planet

3.1 Can We Make Architecture Care About People?
Søren Nielsen Vandkunsten
Re-beauty and Circular Aesthetics

3.2 Do Plants Matter?
Matt Ritter and Jen Yost
Botany Professors at Cal Poly SLO: Plants and Architecture

CH 4 Planet + Technology

4.1 Why Do We Need to Change How We Design?
Dan Pham, Home.Earth
Carbon Transparency and Impact Tools

4.2 What Technologies Help Us Upcycle Our Materials?
Ann-Britt and Henry Glogau, GXN
Urban Metabolism and Upcycling,

4.3 How Do We Give Our Materials a Second Life?
Magnus Sølvhøj, Lendager Architects
Circular Materials and New Possibilities

4.4 Should Architecture Be Portable?
Mads Møller, Arcgency
Circular Architecture on the Move

4.5 Alternative + Research Focused Design Process
Lasse Lind, 3XN/GXN
Design Methodology and Second Brief
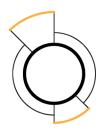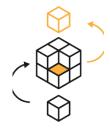
Contents

01

Introduction

Planetary Boundaries

Our planet can only sustain our current way of life temporarily, we must radically change our lifestyles in order to conform to the planetary boundary. This measure is quantified by a number of planets it would take to sustain a given condition worldwide.

Adaptive Reuse

History is apparent in the built environment, structures can tell the story of our past, present, and future. Often times, structures outgrow their prior use and must be adapted to fit a new purpose.

Design for Disassembly

Using modern building techniques, materials, and fasteners, we can deconstruct our buildings at the end of its lifecycle to be reused.

Communal Living

Buildings can function as micro society's, creating bonds between neighbors through interaction, amenities, or programs. Applications of communal living can foster urban belonging and a sense of connection to a group.

Upcycling
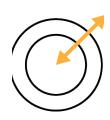
Mirroring natural processes that occur in an ecosystem, opportunities for reusing materials beyond their original implementation can give a new life and new meaning to the elements within and surrounding a building.

Modular Architecture

A building method that aims to streamline the construction process by creating building elements off-site. Once on-site the modules are fastened together. Modular architecture frequently reduces cost and construction speed in a controlled and safe fabrication environment.

Themes

Doughnut Economics

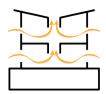A model for structuring an economy that takes into account both the planetary boundary, and the social foundation of a society. Existing within this 'doughnut' ring stimulates tangible and effective solutions to the ongoing climate crisis.

Housing First

Housing first prioritizes housing as the solution to the un-housed population. Given a functioning home and supportive community, reintegration into society becomes much easier.

Sustainable Systems

Sustainable systems aim to reduce the carbon footprint of a building by leveraging climate analysis and environmental conditions. The optimization of systems within a building create thermal, lighting, and acoustical comfort for the users.
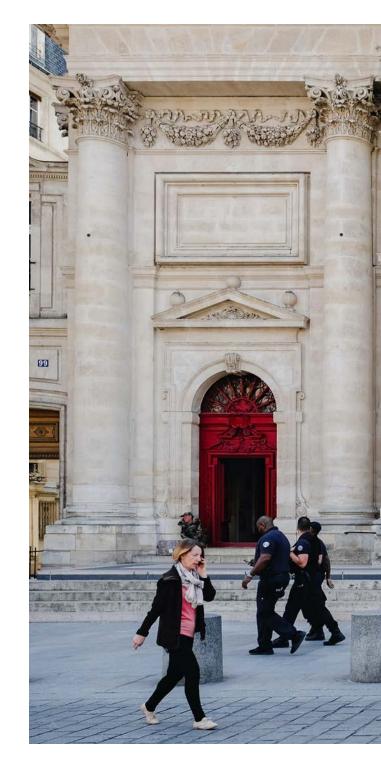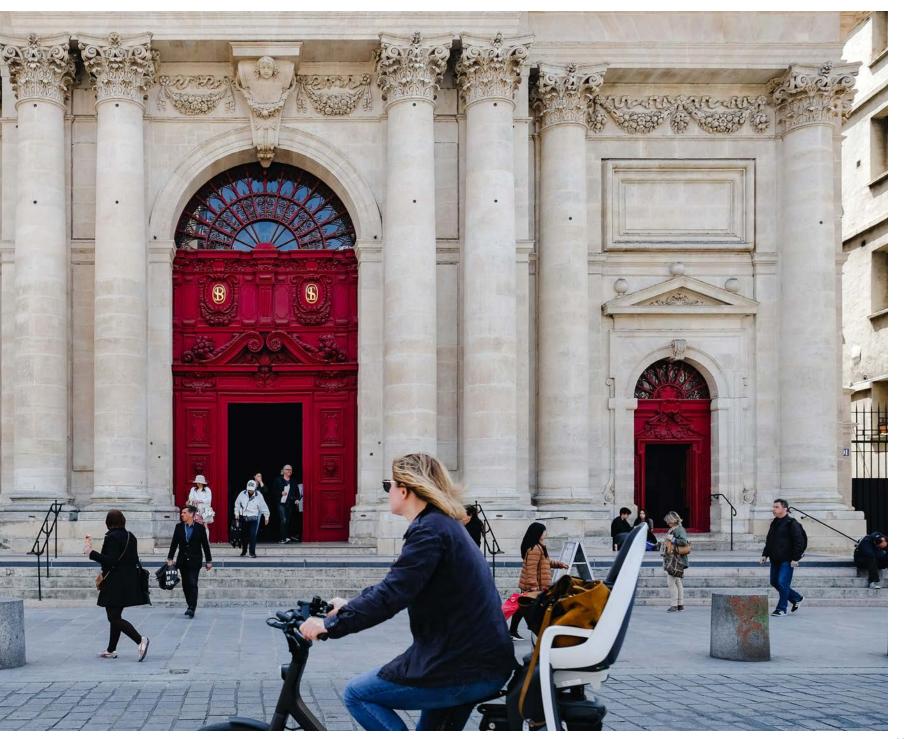
Connection to Nature

Connection to the outdoor environment can manifest itself in many different ways. Interaction with green space and natural retreats can foster sustainable practices and promote human health and happiness.

The urban fabric is rapidly evolving.

Migration into the world's major cities around the globe continues to grow. The United Nations predicts that 68% of the world's population will live in urban areas by 2050, a 13% jump from today's 55%. By 2050 approximately 2.5 billion people will need to find housing in our cities where housing availability is already scarce. Our challenge is to find ways to accommodate ever more people in our cities while improving living condions and dramatically reducing our carbon emissions.

What does it mean to build sustainability?

The green rating systems we use to measure buildings are "relative sustainability" metrics, comparing new sustainable building practices against existing ones. What we need are **absolute sustainability** metrics that measure our environmental impacts against what the biosphere can sustain.

To achieve a shift of this magnitude we'll need to charge our understanding of both sustainability and socioeconomic structures. Kate Raworth from the Doughnut Economics Action Lab has proposed a new economic model that considers the limits of the biosphere and the societal changes needed to live within these limits into a concept called the **planetary boundaries** framework.

What are planetary boundaries?

Planetary Boundaries is a term developed by the Stockholm Resilience Center to describe nine measurable thresholds under which human life can continue to thrive. If the categories are pushed beyond the boundary of operable limits, the destruction to the biosphere would be beyond repair. We have been operating outside the boundary of four categories leading to climate change, loss of biodiversity, land-system change, and disruption of biogeochemical flows.

The built environment is responsible for about half the energy used on the planet and claims vast amounts of physical resources. Therefore, it is vital that the designers of the built environment become stewards of the earth and work to reform design and construction strategies to build within planetary boundaries.
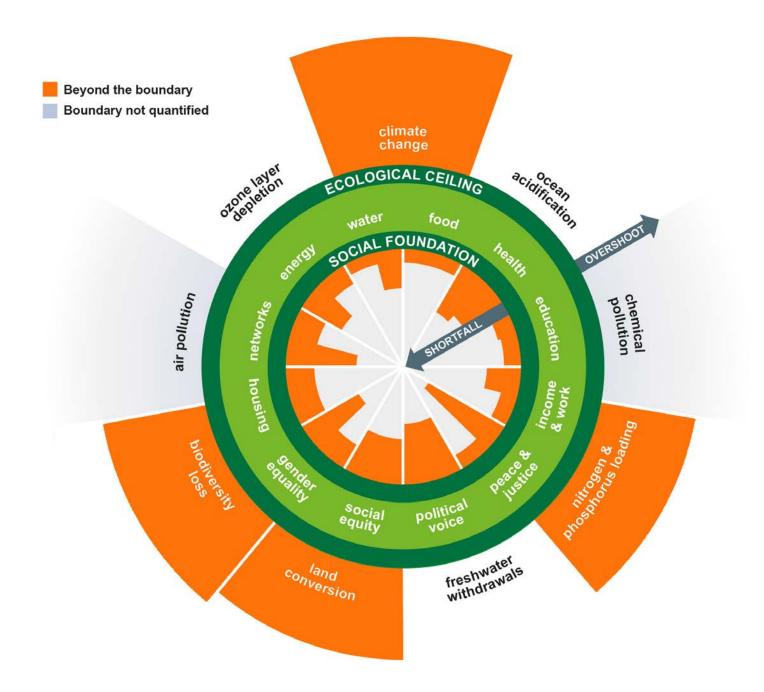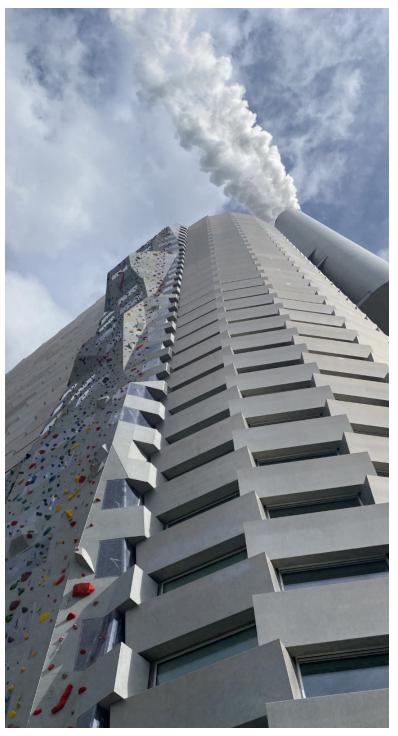
Fig.1 Kate Raworth "Doughnut Economics" 2017

"The Doughnut consists of two concentric rings: a social foundation, to ensure that no one is left falling short on life's essentials, and an ecological ceiling, to ensure that humanity does not collectively overshoot the planetary boundaries that protect Earth's life-supporting systems. Between these two sets of boundaries lies a doughnut-shaped space that is both ecologically safe and socially just: a space in which humanity can thrive."
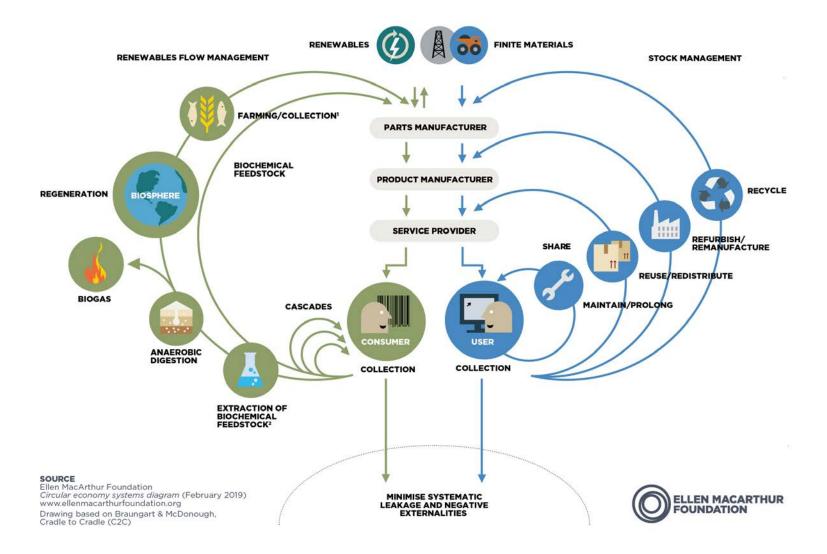
-Doughnut Economics Action Lab
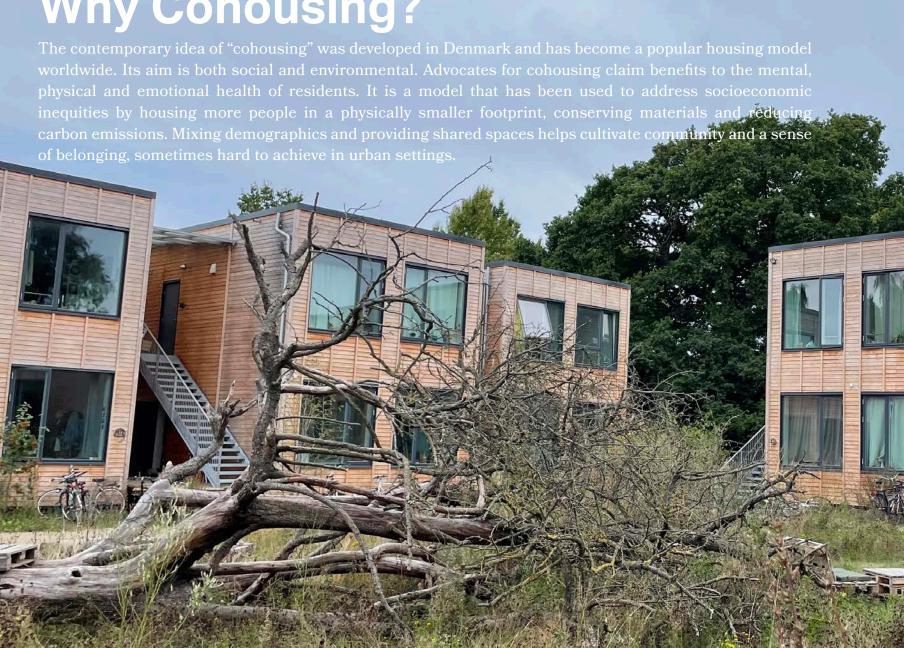
Cradle-to-Cradle

A methodology that has emerged to address destructive building practices is Cradle-to-Cradle (C2C), developed by William McDonough and Michael Braungart. C2C is a design strategy modeled on the regenerative nature of the circle of life. The guiding principle requires that all materials and products be designed and fabricated to either be re-used, recycled or upcycled into new materials, or biodegrade to become fuel or food for other biological or technical cycles. This contrasts with the current design process which McDonough and Braungart term 'cradle-to-death,' where resources are viewed as limitless and are either burned or put in landfills at the end of their useful life. Strategies like upcycling and designing for disassembly allow the lifespan of building elements to be greatly expanded, materials kept in circulation, and reduce the need for fabrication using raw materials.

The goal of this studio is to use the C2C methodology to develop design concepts for mixed-use, mixed-income, and mixed-generational cohousing that doesn't exceed the planetary boundary framework, creating homes that are "**people and planet positive**."

RENEWABLES   FINITE MATERIALS

RENEWABLES FLOW MANAGEMENT   STOCK MANAGEMENT

FARMING/COLLECTION[1]

PARTS MANUFACTURER

BIOCHEMICAL
FEEDSTOCK

PRODUCT MANUFACTURER

RECYCLE

REGENERATION   BIOSPHERE

SERVICE PROVIDER

REFURBISH/
REMANUFACTURE

SHARE

REUSE/REDISTRIBUTE

BIOGAS

CASCADES   MAINTAIN/PROLONG

CONSUMER   USER

ANAEROBIC
DIGESTION

COLLECTION   COLLECTION

EXTRACTION OF
BIOCHEMICAL
FEEDSTOCK[2]

MINIMISE SYSTEMATIC
LEAKAGE AND NEGATIVE
EXTERNALITIES

Why Cohousing?

The contemporary idea of "cohousing" was developed in Denmark and has become a popular housing model worldwide. Its aim is both social and environmental. Advocates for cohousing claim benefits to the mental, physical and emotional health of residents. It is a model that has been used to address socioeconomic inequities by housing more people in a physically smaller footprint, conserving materials and reducing carbon emissions. Mixing demographics and providing shared spaces helps cultivate community and a sense of belonging, sometimes hard to achieve in urban settings.

Our Studio

This studio worked under the guidance of Kasper Guldager Jensen, co-founder of the Danish property developer Home. Earth, and Lasse Lind, director of GXN, the research and sustainability arm of the Danish architecture studio 3XN Architects. Both firms are working on green innovation in design, exploring upcycling and design for disassembly, and applying Doughnut Economics as a framework for the development of new housing in Denmark and beyond.

Our site, situated in the Amager Øst neighborhood, currently hosts a kindergarten and an industrial maker's space. Our objective is to develop a mixed-use cohousing development that is people and planet positive.

The following pages distill concepts and ideas from our site visits and the lectures presented to us during our two-week trip to Copenhagen in September 2022. All experts in their fields, the speakers provided insights into many dimensions of creating affordable, socially and environmentally sustainable housing in Denmark. These expert presentations formed the knowledge base for our studio and guided our research, our ethnographic interviews, and the site analysis for our project.
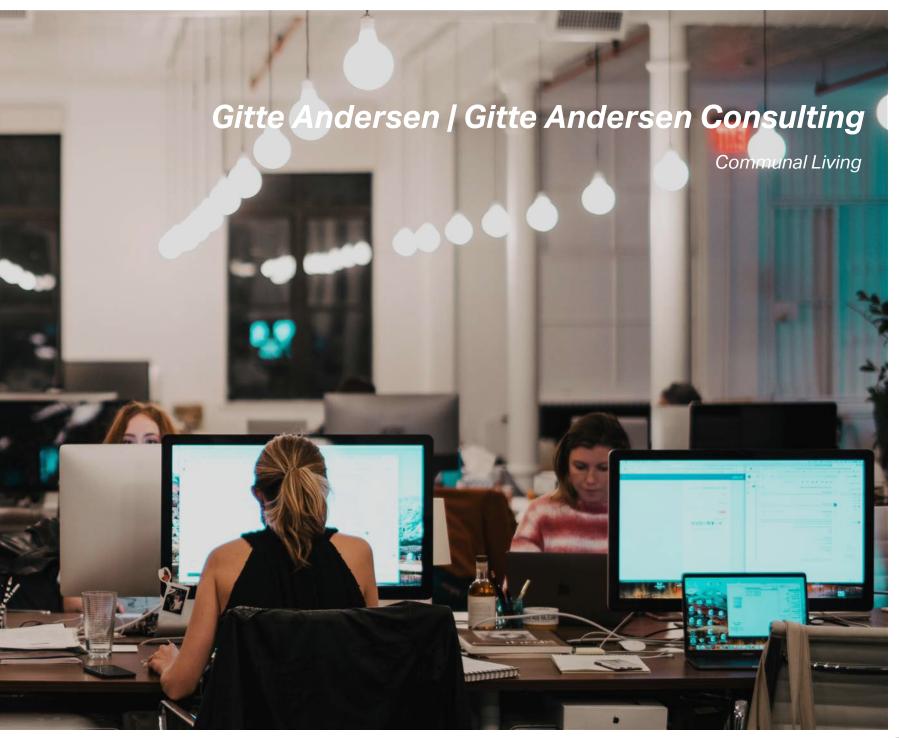
This studio would not have been possible without the generous support of the Scan Design Foundation, the inspiration of Kasper and Lasse, and the guidance of our studio professor, Rob Peña.

02

People + Social Foundation

2.1

How do you measure living well?

Gitte Andersen | Gitte Andersen Consulting
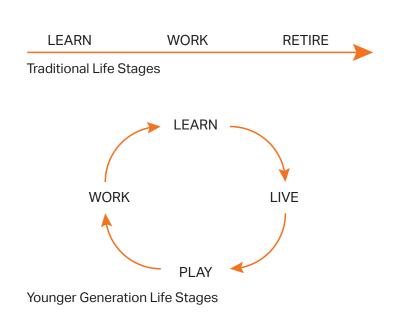
Communal Living

The younger generation perceives the workplace differently.

Research indicates that compared to previous generations' perception of work, younger generations place greater value on a lifestyle that balances work with life, learning, and play. This new perception is driven by purpose, technology, sustainability, experience, innovation, and the importance of meaningful work.

59% of the world says their physical, emotional, mental, and spiritual needs are not fully met.

We are social creatures who place high value in engaging with our communities, finding joy in our work, and investing our time in meaningful activities. The more these needs are met the greater our joy, energy, engagement, productivity, and life satisfaction.

LEARN   WORK   RETIRE

Traditional Life Stages

LEARN

LIVE

PLAY

WORK

Younger Generation Life Stages

How do we address feelings of lonliness through shared spaces?

As a result of the COVID19 pandemic, we've discovered a new kind of work-life balance where the timelines of our workdays are more fluid and our work happens at home, in public places in our neighborhoods, the office or at school. Many of us work in greater solitude and this can lead to a sense of isolation and loneliness. With many businesses continuing to operate under a virtual or hybrid model, an individual's environment outside of the office is increasingly important. Gitte Andersen's analysis demonstrates the value of well curated workspaces.
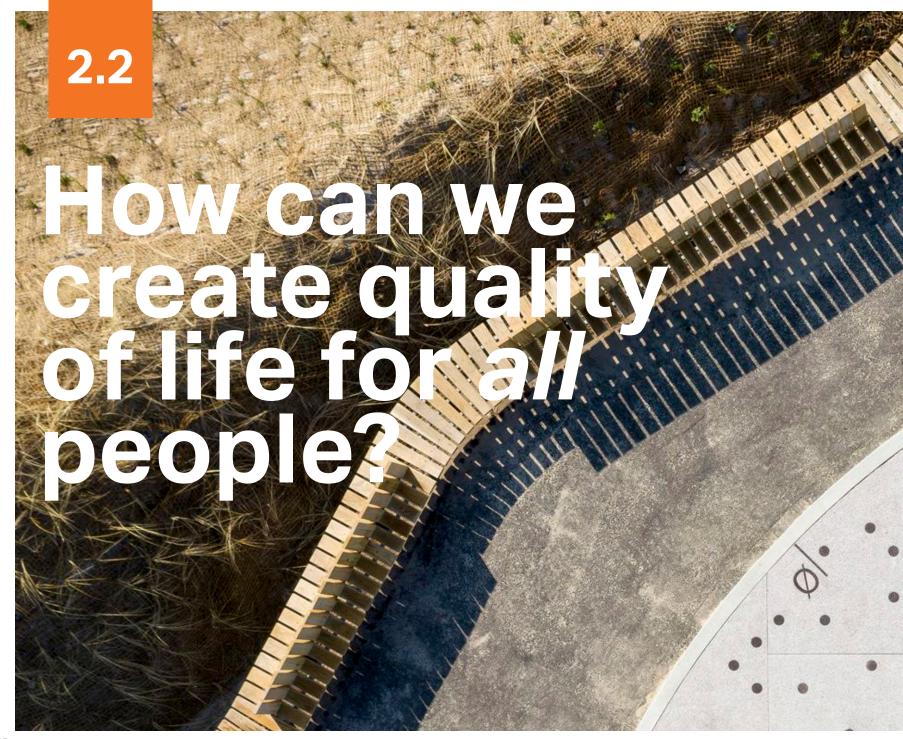
At home, designers should provide a balance between **personal space** and **public places** that address our needs for community, collaboration, and a healthy work-life balance.
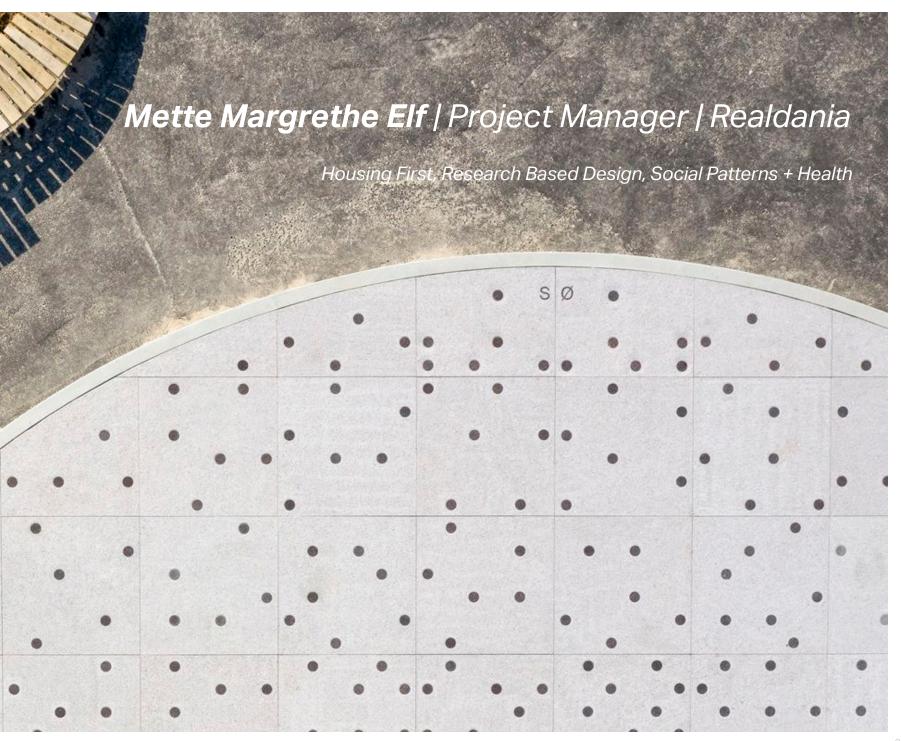
These places don't always need to be built. In every neighborhood there are underutilized spaces in the neighborhood. Many spaces indoors and outdoors are used for just a few hours per week. Schools and universities have spaces that go unused outside of instructional hours that could be used for community gatherings and events.

A **gap analysis** is a method to identify specific unmet needs of a group of people and was used in this studio to create a framework for our project. A gap analysis compares current conditions against desired outcomes. Our objective was to understand how people in three demographic groups rank aspects of the livability of their current community. Then they were asked to rank these same elements in a future or ideal state. The area between the current and future state is the "gap," and this gap analysis aims to address these needs through informed design decisions that improve on current conditions in the home and neighborhood.

Living well means having basic needs met.

- Younger generations plac a high value on work-life balance

- When people's needs are met, they respond positively to their environment

- Find underutilized local spaces and apply them to new uses to enhance community

- A gap analysis helps designers make better informed decisions with community input

How can we create quality of life for *all* people?

__Mette Margrethe Elf__ | Project Manager | Realdania

Housing First, Research Based Design, Social Patterns + Health

Integrating Outlying Demographics

The built environment should be structured to accommodate all members of society including vulnerable individuals who may not be capable of providing quality housing for themselves. This is precisely the goal of Realdania, a philanthropic organization whose mission is to **"create quality of life for all people in the built environment."**

The key word is **'all' people**. Realdania pays special attention to community members that are easily overlooked or misrepresented. They fund programs targeted at researching what "quality of living" means for these overlooked community members and how best to provide it. Realdania's "Youth in Homelessness" project led by Mette Margrethe Elf is aimed at addressing the quality of living for young people experiencing homelessness.

Housing First: Stability and Identity

Mette presented Realdania's **Housing First** initiative; a program aimed at addressing the issue of homelessness in younger age groups. Housing First starts by placing young adults into affordable housing from the start, along with the social support services.

A study by Realdania and Videncentret Bolius, 'Danes in the Built Environment 2018' shows that having a **stable home** has a direct influence on a person's **quality of life**. The first step is providing people homes. But to achieve long-term successful outcomes these individuals need a pathway to reintegrate into society.

Age: 18-28

Youth make up **one third** of the **homeless population** in Denmark

33%

Age: 29-100

66%

95%

The **mortality rate** for **homeless youth** is between **14 and 20 times higher**

5%

"How can the physical framework of a building increase the livability of the people that are there?"

- Mette Margrethe Elf

Part of the Housing First process is to allow young people to practice their participation within the community at their own pace. It is key for young people to choose how much or how little they involve themselves in social situations, and they should have a variety of interactions available to them.

Your own company

Having the means to relax, cook, and practice hobbies in a private space is essential for young people coming out of homelessness. A living space should provide for all basic daily needs, most importantly to be alone. It should also be a space that can be decorated and personalized.

To be together, separately

Living in community with other residents without the need to interact is an excellent way for vulnerable young people to begin sharing experiences with those around them. Whether they are doing laundry at the same time or eating in a communal space, these interactions can make it easier to meet others.

Being practical together

Having opportunities to work together to achieve a common goal has social as well as practical benefits. Not just for young people coming out of homelessness but also for less social individuals. Shared indoor and outdoor facilities for cleaning and maintenance are excellent opportunities for this.

To meet spontaneously

Make the most of highly trafficked areas where residents are most likely to come across each other such as common walkways, entrances, edge zones, and communal areas. Design these areas for spontaneous interactions, places to linger or spark a conversation between neighbors on their way to wash clothes. These interactions feel natural and promote healthy social exchanges.

To meet in a group

Being a part of a group can foster a sense of belonging; spaces we create should encourage this. Regardless of background, residents participating in group activities can build networks and help individuals find access to resources they might not have. Providing a variety of indoor and outdoor meeting spaces is essential.

Design Values

The 'Youth in Homelessness' program is aimed at individuals age 18-29 years. Young adults comprise a third of the homeless population in Denmark and experience mortality rates which are 14-20 times higher than those in other age groups. This effort is guided by four Design values.
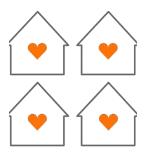
#1 Payability

People experiencing homelessness are not financially stable. Guaranteeing **a fixed rent of 3000-3200 DKK ($400-$430 USD)** provides stability and an opportunity to find pathways out of homelessness. However, affordability should not compromise privacy. Shared living has not proven to help vulnerable individuals.
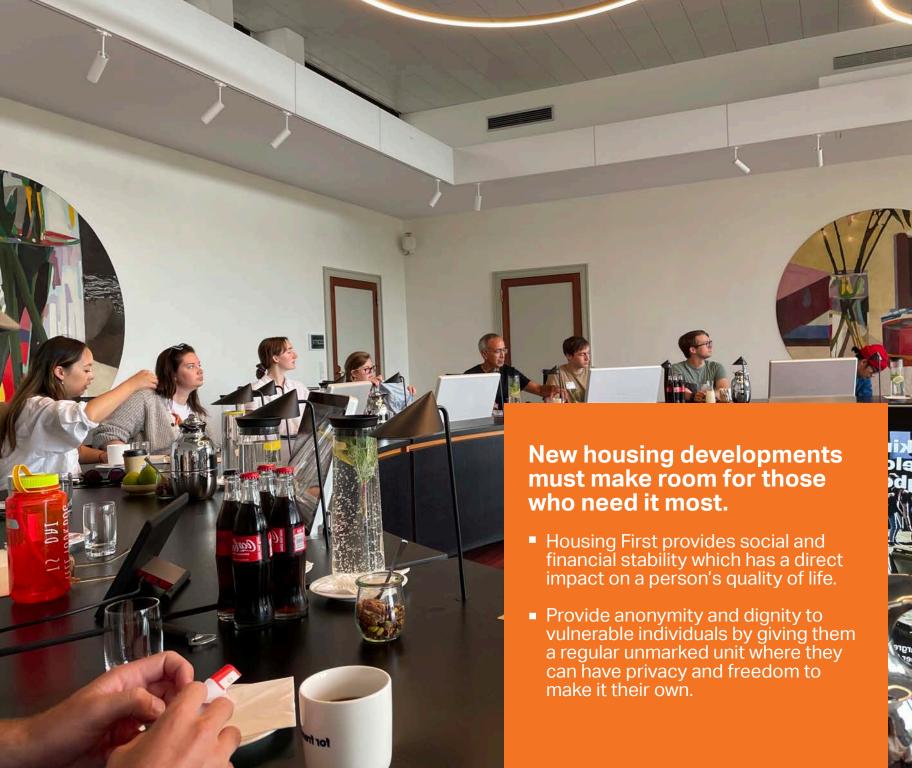
#2 Equal Housing Environment

Realdania suggests that **approximately 10% to 15% of the units in an 'ordinary' housing development to be used for housing homeless youths.** This assures privacy, dignity and tranquility. The units should be evenly distributed and shifted after the departure of the occupant to avoid being labeled as a 'homeless unit'

#3 Housing with quality

Homeless housing is often stigmatized and located in older buildings, robbing users of their dignity. As a principle, **housing first homes should appear modern and have the characteristics of a domestic setting for young people.** These homes should also be independent and allow the person living there to make it their own. Pre-furnished units can feel institutional; allow residents to bring their own furnishings.

#4 Community - a natural option
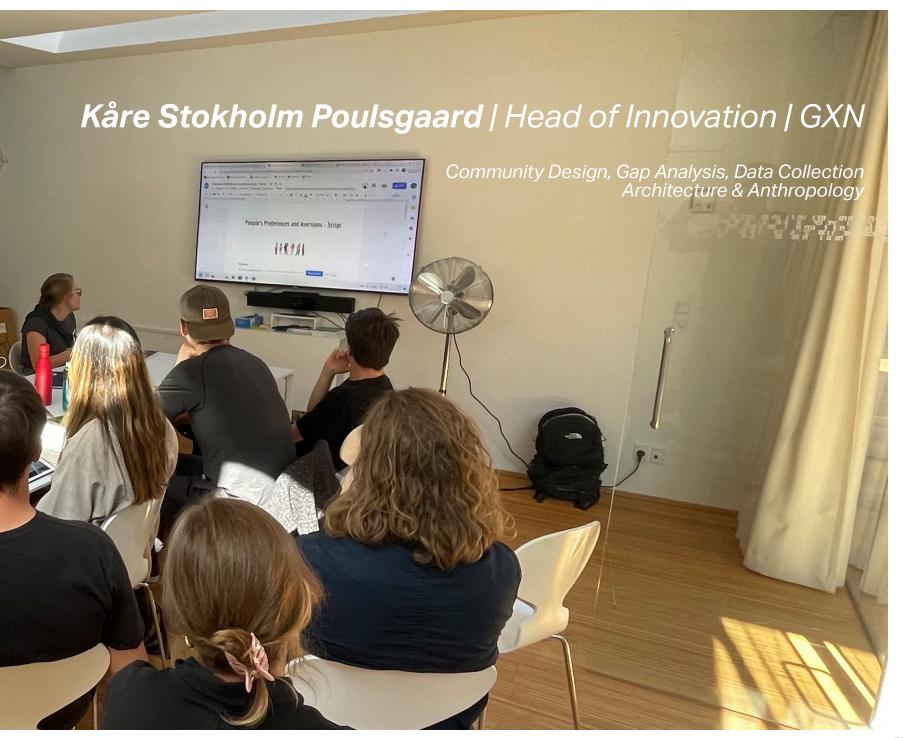
It is essential that these young people are able to join the community a their own pace. **The housing environment must create opportunities for scalable social interaction.** The architecture should allow for spontaneous and natural interactions and includes places and platforms from which one might observe social spaces and gauge their willingness to interact from a distance.

New housing developments must make room for those who need it most.

- Housing First provides social and financial stability which has a direct impact on a person's quality of life.

- Provide anonymity and dignity to vulnerable individuals by giving them a regular unmarked unit where they can have privacy and freedom to make it their own.

2.3

Community Informed Design

Kåre Stokholm Poulsgaard | *Head of Innovation* | *GXN*

Community Design, Gap Analysis, Data Collection
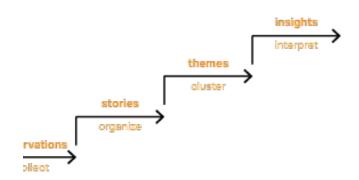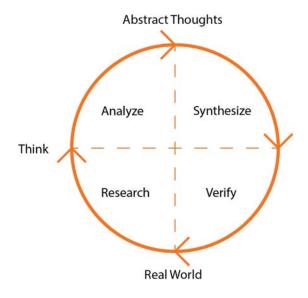*Architecture & Anthropology*
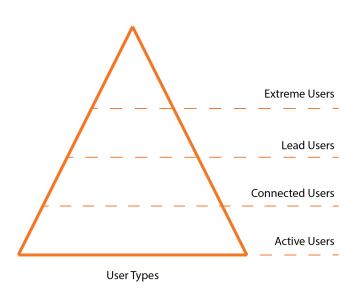
"What makes sense to people and their world?"

When preparing stakeholder interviews, we should be clear about the information we're seeking. We're interested in knowing not only what people want and need in the places they live, but also the reasons why. Instead of asking only what a person's favorite room in their house is, we should follow-up with questions about the characteristics of these places. This process of inquiry is about digging incrementally deeper into the attributes of the spaces and places people are drawn toward or that they dislike or avoid. This ethnographic method is aimed at understanding **how people sense and experience the world.**

It's important to understand as deeply as possible the communities we're designing for. Kåre described how methods from anthropological research can be used to ascertain the **preferences and aversions** of a project's stakeholders, both the residents and the people in the neighborhood. **Interrogating the problem and the place** are vital components of the design process.

Architecture doesn't stop after the building is built.

Abstract Thoughts

Analyze   Synthesize

Think

Research   Verify

Real World

Extreme Users

Lead Users

Connected Users

Active Users

User Types

Interpreting the needs of potential users is the first step in the design process and involves a kind of interrogation of the problem and the place. Through a process of analysis and synthesis of information, processing abstract thoughts into real world applications, inferences can be made to develop informed design solutions.

Generating knowledge in an imperical way

Kåre suggest that people engage a project at different levels, from "active" to "extreme" users. Each stakeholder has a different level of engagement and investment in the project. While there are more "active users" that regularly inhabit the place, their level of investment is lower than the smaller number of "extreme users" who call this home and have a long-term investment in the place. Understanding this diversity in use and investment should inform our design decisions.

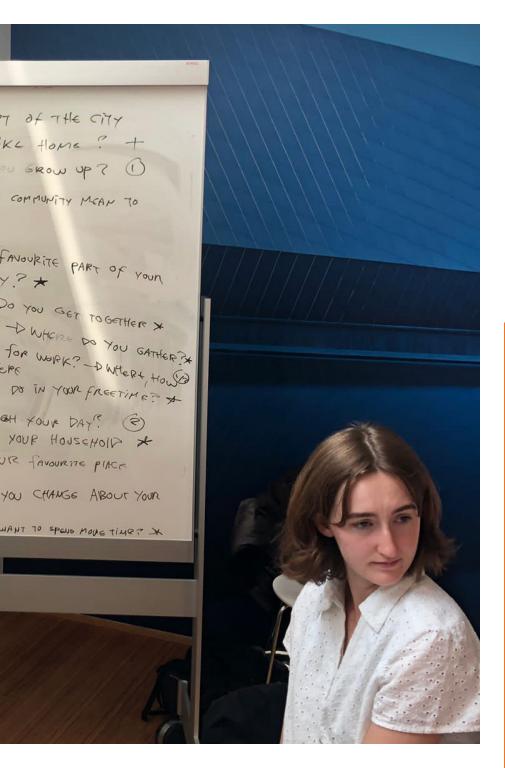## Consider the different types of users

Writing an interview guide:

- Start broad + soft
- Start by putting at ease the person you're interviewing; introduce yourself
- Downplay your knowledge to make them feel comfortable
- Develop grand tour questions
- Make it concrete
- Ask why

The ethnographic interview:

- Keep it friendly
- Ask lots of questions
- Identify contradictions and comparisons
- Mix in your own observations
- Record the conversation

Architecture should respond to the community
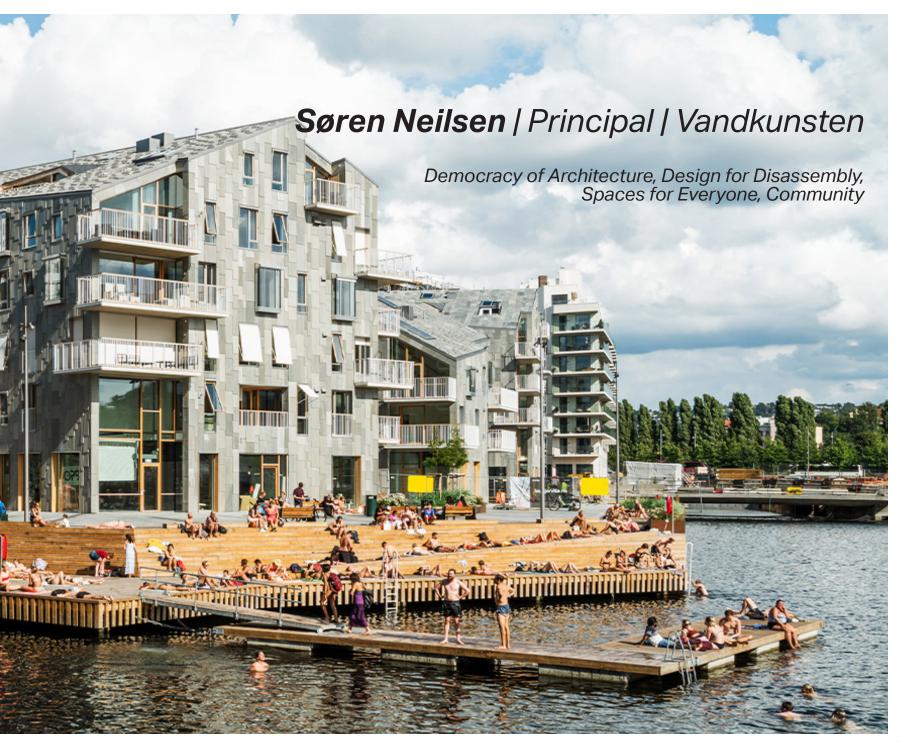
- Ask "why" questions to draw-out design conclusions

- It is a process of turning abstract thoughts into real world applications

- Interpreting the needs of potential users is the first step in the design process and includes interrogating both the site and the people

- Understanding the diversity of people who will interact with the designed spaces helps develop design conclusions

03

People +
Planet

3.1

Can we make architecture care about people?

Søren Neilsen | *Principal* | *Vandkunsten*

Democracy of Architecture, Design for Disassembly,
Spaces for Everyone, Community

Encourage shared amenities.

Architecture should support the health and well-being of the entire community by creating humane and engaging housing for people of all economic levels to share. A healthy society doesn't segregate economic classes of people.

Vankunsten has found that multifamily housing with 20 to 30 units creates the right balance of neighborly interaction and personal privacy. It allows residents to know everyone and it supports serendipitous interactions among neighbors. Spaces that are just large enough to support the congregation of a handful of people encourages the idea of community.

It's also important how a building meets the ground and touches the sky. Buildings with sheltering pitched roofs signals architecture that is domestic and secure. Søren suggests that designers should "lose control in a controlled way," and to "allow for the random and accidental."

How can we accommodate for future uses of our building?

Buildings shouldn't be intended to be disassembled but designed and built with the knowledge that those materials will be used again down the road. What are our buildings' second, third, and fourth lives? How can we accommodate for future uses of our buildings? A well-ordered structural grid makes this easier. By designing the structure on a robust grid, you facilitate changes to the uses of a buildings over time. Concrete construction makes it impossible to change anything. If a building's structure has a good relationship to its site, the building is more likely to "learn" and adapt to new uses.

Architecture *must* care for, and reflect society at all scales.

- Creating spaces that appreciate culture are both functional and beautiful.

- Funtional but robust spaces are key to designing for a changing future.

- Technincal reversability makes for building systems that can be disassembled and resued at the end of a buildings life.

Do Plants Matter?

Matt Ritter & Jenn Yost | *Professors, Botanists*

Urban Ecology, Biophilic Design, Connection to Nature

Plants are good for people and for the planet.

Nature is the source of our good lives. The paper-thin biosphere wrapping our planet delivers everything we need to survive aboard our planetary spaceship. In addition to beauty and sensory delight, trees and plants provide invaluable ecosystem services including oxygen, energy, and clean water. Nature should be both our guide and our measure for sustainable design.

Nature is also our first and last line of defense against climate change and toward sustainability.

Urban ecology is about synergistic relationships between the built and natural environments. Trees and plants can provide seasonal solar shading, habitat for birds and mammals, and stormwater management. Urban ecology is key to addressing climate change, allowing us to operate our lives on incoming solar radiation, and helping to store and sequester carbon.

Are trees always the answer?

Not all urban forests and gardens are created equally. Urban plant life is often more abundant in neighborhoods with greater affluence and availability of resources, able to host and nurture a variety of trees and plants. Trees and plants require water and upkeep to reach maturation. Regularly watering and tending younger trees is essential to prevent early death. In neighborhoods with less resources and home ownership, such demands can often be secondary and result in plant life failing to thrive.
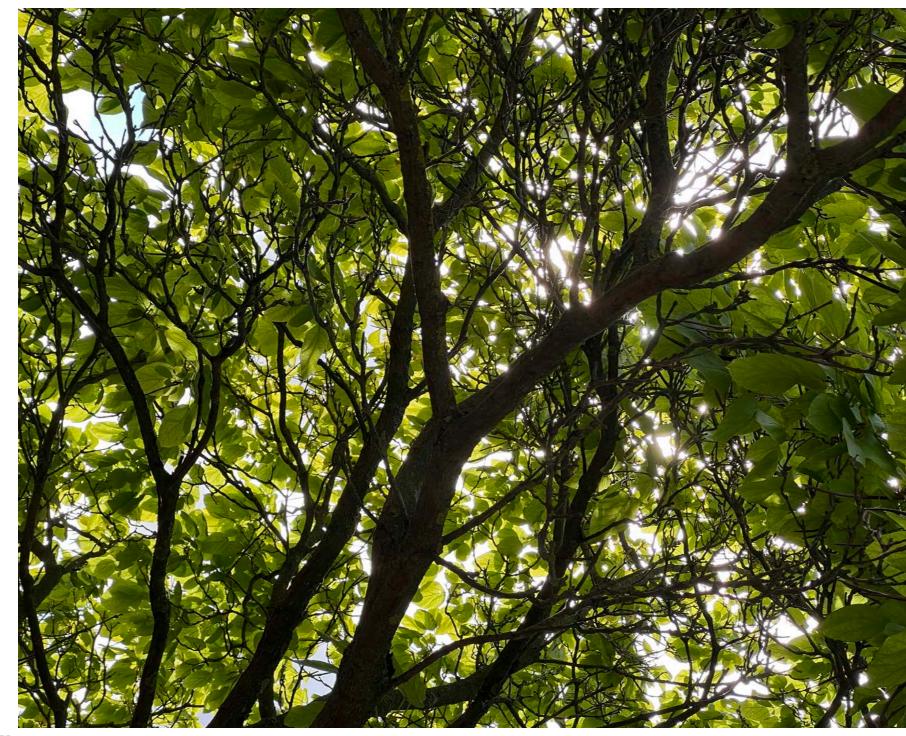
While **trees store carbon temporarily**, they don't sequester atmospheric carbon forever. Eventually decay will occur and the carbon stored will be released back into the atmosphere. But in the coming critical decades we can capture and store more carbon than we emit, and we can store some of the captured carbon in more urban trees and in the buildings, furniture and products made from them.

As it is in life, so it is in ecology: **diversity is key to survival.** The more diverse and varied the species of plants in an ecosystem, the more likely it is to endure and thrive in challenging conditions. Matt and Jenn pointed out numerous immigrant species of trees and plants throughout Copenhagen that have adapted and now thrive in their environment. These new residents add to the diversity and resilience of their ecosystems.

Matt and Jenn introduced us to their web-based plant identification tool, "SelecTree," an illustrated guide for identifying the species of a tree through a process of elimination. This tool helps designers identify the trees that thrive in a particular setting, and to select trees and plants that will thrive in similar circumstances in a proposed design.

The more diverse an ecology is, the more resilient it becomes.
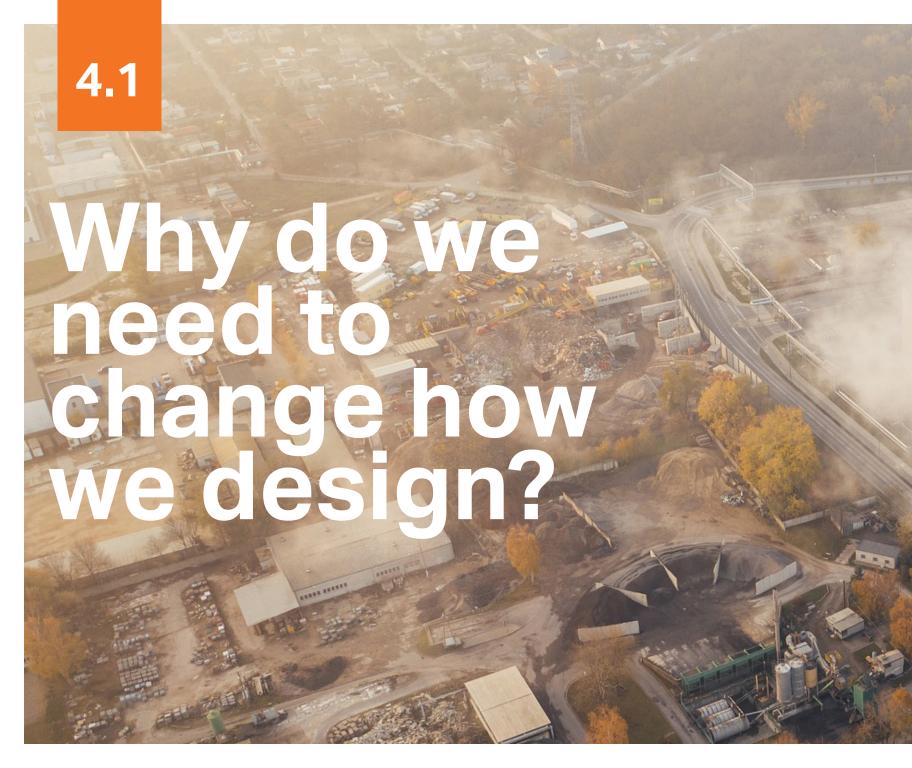
Plants matter.

- No sustainability without plant life.

- Healthy ecology requires active maintenence and resources.

- No such thing as too much diversity in ecology.

- Trees are a method of near-term carbon capture.

04

Planet +
Technology

4.1

Why do we need to change how we design?

Dan Pham | *Co-Founder Sustainability | Home.Earth*

*Computational Design, Data Collection,
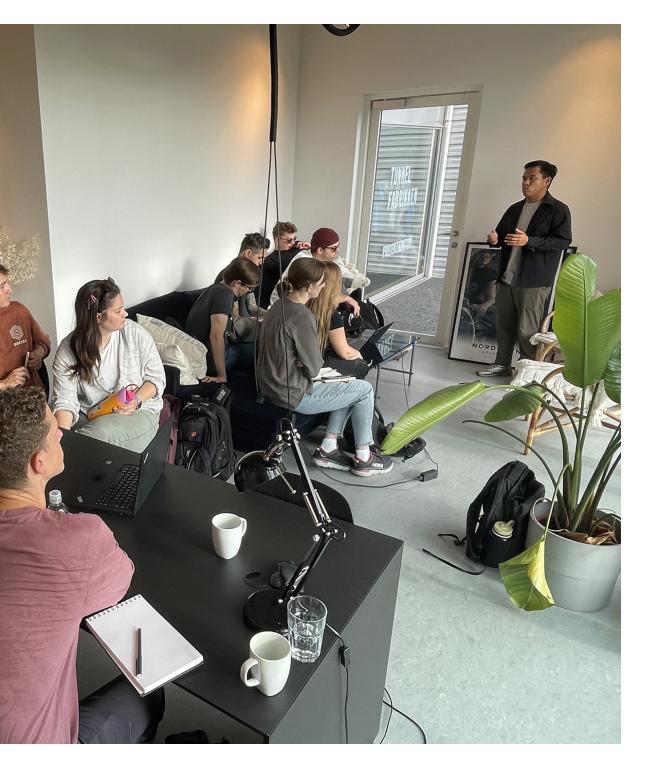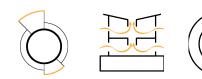Sustainable Systems. Doughnut Econmoics, Planetary Boundries*

Students arriving at Home.Earth via bike.

Home.Earth becomes a classroom for the day, through lecture and dialouge students gain a better understanding of real estate and living within our planetary boundries.

From relative to absolute: living within the planetary boundry.

Operational and embodied carbon emissions from the built environment have increased dramatically over the past 40 years. The planetary systems that support life as we know it are nearing a critical threshold. While we're moving faster, our current efforts to reduce our carbon emissions are still way too slow and will not get us where we need to be quickly enough to stave off catastrophic climate change. These current efforts, measured against historic trends, can be termed as **"relative sustainability."** Instead, we must achieve **absolute sustainability,** a scenario for human activity that recognizes 1.5 degrees C of warming as the limit to avoid catastrophic climate change. By reframing the sustainability conversation from relative to absolute, both the gravity and the impact of this issue might be realized.

How would you use your 'carbon budget?

Applying Kate Raworth's concept of doughnut economics and planetary boundaries, we can develop the framework for designing a truly sustainable world. Achieving sustainability on a global scale is daunting and complicated, and the changes necessary must be shared equitably among carbon emitters worldwide.

If we can establish how much human generated carbon dioxide the biosphere is capable of absorbing in order to stop any more increase in atmospheric CO_2, and divide this among the people on the planet, we arrive at each person's allocation of emissions or their **"carbon budget."** Assigning a portion of this budget for each person's habitation, we can establish a household carbon budget that we must design within. This includes both the operational carbon for power and the embodied carbon in a building's materials. Size, energy efficiency and material selection are the critical dimensions in meeting this budget. Thermal comfort, fresh air, access to daylight and nature, beauty and livability are the qualitative dimensions of this design challenge.

SCALE DOWN — **SCALE DOWN**

FOOD

TRANSPORTATION

HOUSING

TIE CARBON BUDGET TO CONSUMPTION

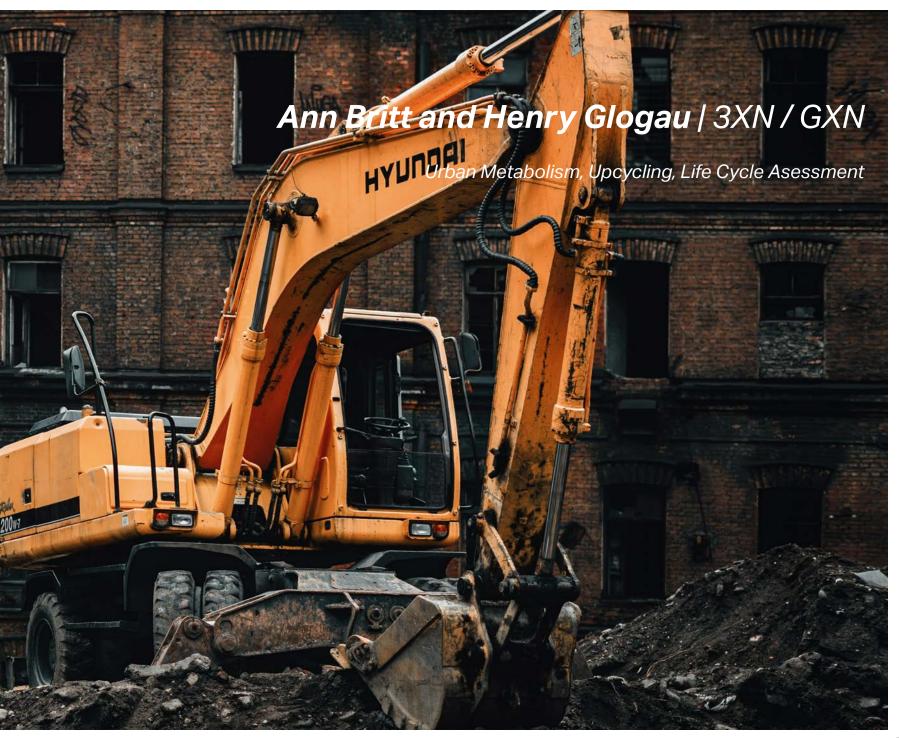DOWNSIZE CARBON CAPACTIY SCOPE FROM PLANET TO PERSON

How much space do we truly need to live in order to minimize carbon footprint?

Well established green-building strategies are employed throughout the design process. However, early conceptual design guidance on size, massing, primary structure, materials, insulation, and environmental systems choices comes from the Carbon Tool developed by Home.Earth. Testing these early concepts, the tool makes high-level calculations of energy use, embodied carbon, and life-cycle carbon impacts, and calculates a value of CO2 per square meter. Dividing this estimate by the number of occupants, the housing component of an individual's 'housing carbon budget' is estimated. With "home economics" in order, food and transportation choices are the next critical choices for a responsible planetary citizen.

The bioshpere cannot absorb the current rate of human generated carbon.

- Changing our focus from relative to abosolute sustainability allows for real conversations about long term viability.

- Living small means less carbon usage per resident + the greater carbon efficiency of a building.

- Life Cycle Assessments can help us understand the total enviornmental impact of construction materials.

- By using carbon-consumption analysis tools early in design we can create more carbon efficient buildings.

4.2

What technologies help us upcycle materials?

Ann Britt and Henry Glogau | 3XN / GXN

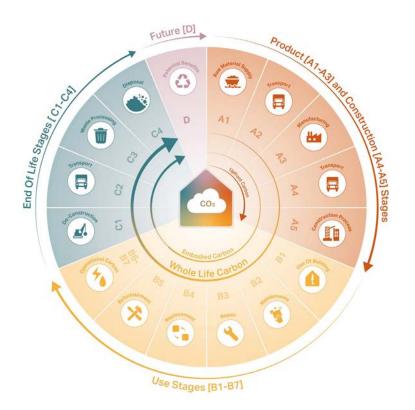Urban Metabolism, Upcycling, Life Cycle Asessment

How can we use existing buildings to make new ones?

Current practice for material production, building construction and demolition follow a linear flow from extraction to waste. **Urban metabolism** is the idea that flows of energy and resources used in a city should be monitored and directed so that these resources stay in circulation and are used multiple times in other places and process rather than thrown away at the end of their first use, creating a regenerative, self-sustaining system. Applying urban metabolism to construction, architects can create a more sustainable built environment by championing the transition from a l**inear to a circular flow of materials**. Urban metabolism is aimed at a more sustainable future where materials, information, people, and buildings exist in a cyclical ecosystem, accounting for all impacts of the built environment on the natural environment.

How do you know what is in a building?

One of the best ways to understand what went into a building and what will be salvageable for a future project is a **life cycle analysis**. A life cycle analysis accounts for all the materials and their upstream impacts, and the energy used during a building's lifetime. It accounts for the total carbon impact of a building, and it identifies what materials can be re-used or re-purposed at the end of a building's useful life. This includes every element of the building's creation, from the extraction, transportation, manufacture, construction, use and final disassembly of everything that went into the building. Traditional life cycle analysis is done by on-site pre-demolition analysis of the materials that are recoverable or salvageable for the construction of a new building. New tools allow for a more comprehensive analysis of the total carbon impacts of a building and an accounting of the parts and pieces so that they can find uses in a circular urban metabolism.

In a **fully circular flow of materials**, the extraction and disposal phases of a material's life cycle would be skipped as no new materials would be thrown away and therefore no new materials would need to be mined or harvested, keeping all materials in circulation.

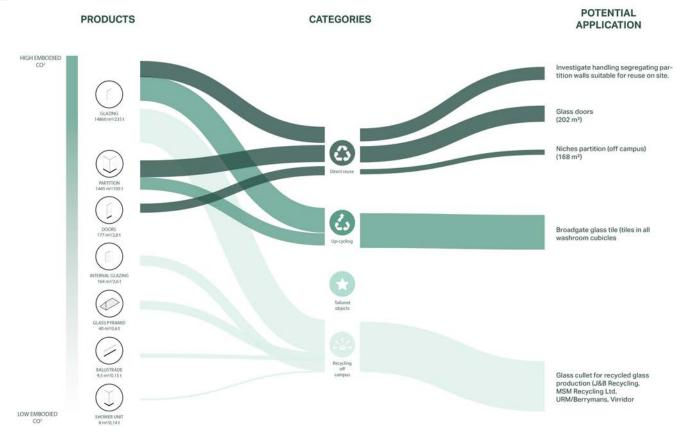Life Cycle Diagram from Ann and Henry's presentation

Another dimension of life cycle assessment is to identify building elements and materials that can be upcycled rather than recycled or discarded. Upcycling is the idea that we can **create new products out of used materials and assemblies** that may have had no functional similarity to their original form. If a chair's full life cycle assessment is undertaken, a designer does not necessarily have to recycle the chair as another chair. The legs could become metal for a door handle or supports for a shelving unit. When scaled up, these principles can be applied to the parts and pieces of a building. For example, a glass door could turn into glass tile for a bathroom, or sprinkler piping into bike racks. Upcycling is just one more way of closing resource loops in an urban metabolism.

"Urban upcycling is about creating the material solutions of tomorrow with the waste of today"

Glass Recycling
Flow diagram

Urban metabolism and upcycling
graph shown by Ann and Henry in their
presentation. Shows the many way different
ways urban metabolism can take place on
different materials in a building.

Upcycled sprinkler pipes made into bike racks from Ann and Henry

View of the water from 3XN's office, an adaptive reuse project of a former boat house.

A life cycle analysis with a focus on reuse and upcycling could reduce our footprint on earth.

- The site has buildings on it with salvageable materials that could be upcycled or reused.

- In a perfect urban metabolism no materials would be wasted and instead put to new uses.

- Life-Cycle-Assessments and upcycling could help turn the movement of materials in a city from a linear to a circular flow

How do we give our materials a second life?

Magnus Sølvhøj | *Project Director* | *Lendager Architects*

Upcycling, Design for Disassembly,
Sustainable Systems, Doughnut Econmoics, Planetary Boundries

How do you cultivate a design culture and clientele around upcycling?

Lendager is an architecture firm that focuses on **sustainability, design for disassembly, and upcycling**. They do extensive material research and field investigations for the urban ore of salvaged and reclaimed assemblies that are the bones and building blocks of the buildings they design, saving their clients' money while building a more sustainable future.

An example of their research and urban mining work was an effort to make hard plastic roof shingles from old Carlsberg bottles. When this material proved unsuitable for this purpose, they found a way to make components of chairs from this material.
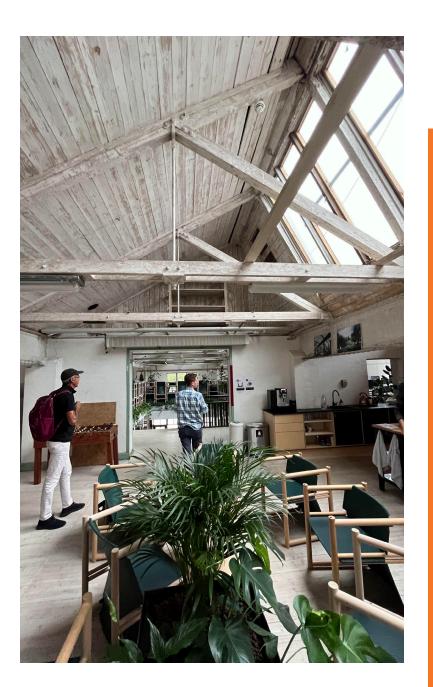
How do you assess existing materials for reuse?

Made from recycled wood and this upcycled plastic, these chairs, placed throughout Lendager's office, are stackable and designed to be completely disassembled. Research at Lendager has led to more material solutions:

- **Upsound** wave panels for sound absorption made from plastic bottles.
- **Upconstruction** recycled concrete displaces 45% of the new concrete in their projects.
- **Upwood** acoustic panels made from wooden window frames.

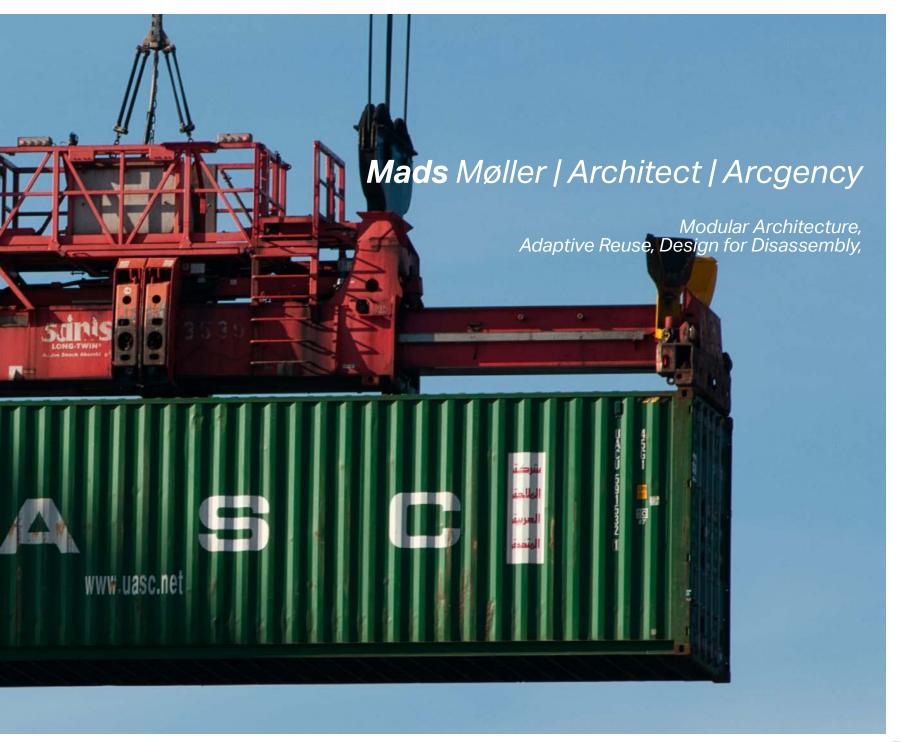## How do you design for disassembly?

The Resource Rows multi-family project uses these materials along with re-purposed bricks from abandoned buildings for the new building's façade. Lendager was able to save as much as 29% CO2 by upcycling 10% of all the building materials in this project.

Building materials must be resused to ensure the planet's resources don't run out.

- Lendager consistently finds ways to resuse found materials and develop something new.

- They consider upcycling materials for every project, resuing existing concrete, wood, and brick already found on site or sourced nearby.

- For the site we can document available materials that are already there and create a material bank.

- Find if there are other materials nearby that can be repurposed or resued.

- Determine the viability of the current building on site and see if it can stay, should be reused for materials, or something else

Should Architecture Be Portable?

Mads *Møller | Architect | Arcgency*

*Modular Architecture,
Adaptive Reuse, Design for Disassembly,*

Adapt, Change

What happens to a building when its use is no longer relevant, or the previous use no longer suits the community and its intentions? There may still be value in the building that can be used elsewhere. Dynamic rearrangement of the building blocks of our cities supports the evolution of ever-changing communities.

The Stack projects illustrate Arcgency's framework for **flexibility in the built environment**. The permanence of fixed architecture restricts **versatility** for future uses. Stack I and II are portable offices that occupy a site for a limited time. 90% of their materials come from recycled sources and are designed for disassembly so they can be returned to circulation. Shipping containers are the primary module, facilitating both **portability and temporality**.

Pick-up/Drop-off

Design for disassembly is another factor that makes transport possible. Strategic use of the connection points that lock and unlock facilitate future reuse. The Stacks have found their newest site in Nordhavn. In a proof-of-concept demonstration, they were disassembled, carried overnight on the backs of large trucks, then reassembled in just a few days.

Building codes can restrict and impede **innovation and sustainable design**. The Stacks projects faced many approval obstacles on their way to realization. One example is a code requirement for a concrete foundation system which isn't necessary for these structures and runs counter to the flexible and temporal purpose of this system. Arcgency, along with Statens Kunstfond, are putting forward examples that challenge outdated requirements and regulations to re-write codes and break trail for new opportunities and experiments in nomadic, versatile, and more sustainable buildings.

Stack II new site in Nordhavnen

Reuse and **repurposing** available urban ore can lower the cost of construction, reduce embodied energy, and keep materials in circulation and out of landfills. Modern cities are dynamic places with ever changing needs. Designing with modules allow for flexible configuration of space over time that can evolve and adapt to changing needs. **Flexibility, modularity,** and **disassembly** allows for addition or reduction of space, movement, and seamless evolution in the fabric of the city.

The combinations are endless!

Architecture should be versatile.

- Reimagine flexibility of the built environment to become more adaptive.

- Building with modular design allows maximum configurations.

- Accommodate unknown future uses and make room for structures to change shape over time.

Iterative and Research-Based Design.

Lasse Lind | *Principal at 3XN/GXN*

Design Methodology, Project Planning/Iterative Design,
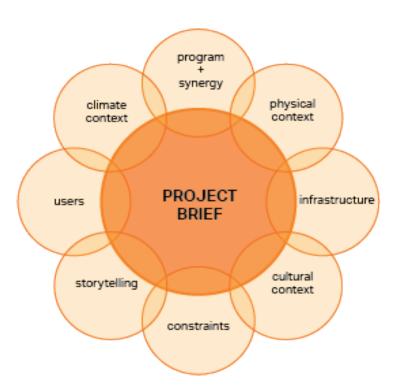*Sustainable Systems, Urban Belonging*

Iterative and Research-Based Design.

Design firms approach project analysis with a variety of tools and methods. Lasse Lind shared several best practice methods employed at 3XN/GXN.

The project brief must paint a clear and comprehensive picture of the physical, cultural and climate contexts of the place. **Storytelling** can be an effective way to develop the program in collaboration with the client to understand the scope of the project and gain a full picture of anything that might affect or be affected by the design. The research and **dialogue with the client** should seek synergistic relationships, two-for-one opportunities for design integration. **Interroation** of the **site** and the **program** should seek to identify factors that either support or constrain the project. The design team should seek understanding of the **lived experiences** of the project's inhabitants, along with their **preferences** and **aversions**.
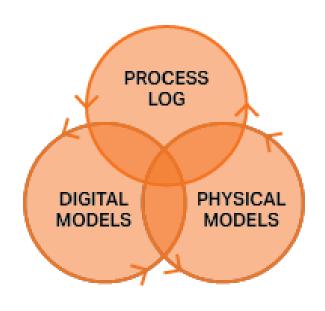
"How can we create diverse experiences for the different user groups?"

Tools used to explore, test, and illustrate design alternatives include:

Digital models that provide realistic 3-D information to test concepts with the design team and clients. These can be extremely useful towards the end of the project timeline for project refinement and approvals.

Process logs are useful throughout the entire project and provide a sort of essential transparency to the project process and development. They're a method to share knowledge and allow others to understand how and why design decisions are being made.

Physical models offer the most tangible illustration of a design alternative. As a design tool they can lead to serendipitous surprises, **unexpected possibilities** for the form and organization of the project. They facilitate quiet reflection and analysis not just on the form, but on the building's relationship to the context.

PROCESS LOG

DIGITAL MODELS

PHYSICAL MODELS

Lasse illustrated elements of this design methodology in their design process for the Sydney Fish Market. A comprehensive project brief was developed collaboratively with the client. The design emerged organically through development of the project narrative, iterative development and testing of design concepts that were illustrated and documented in digital and physical models.
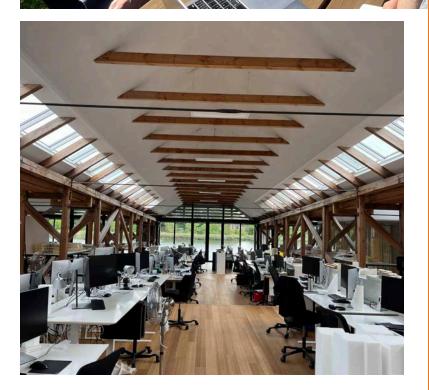
A thorough design process is key to a sustainable, efficient and successful project.

Kåre and Gitte shared methods to collect data and conduct interviews aimed at understanding the **preferences** and **aversions** of project stakeholders.

One method is called a **gap analysis**. Project stakeholders are asked how they live and the conditions of their current homes and neighborhoods. They're asked to identify what works well and what doesn't, and the things that are missing or could be improved in their homes and neighborhoods. The difference between what a project stakeholder has and what they'd like to have in their homes and neighborhoods is the "gap."

Research based design is central to well-thought-out projects.

Synthesis, reflection and analysis are key to a project's success.

Planning ahead allows for a more efficient use of space, reducing the overall cost of the project and increasing the quality of the space.

It is important to design for what the users actually use and require rather than what the designer or even the client thinks they want.