



LOOP

BUILDING CIRCULARLY



ACADEMY 04

2023 JUNE 26 – 30

ROYAL DANISH ACADEMY

INTRODUCTION

The workshop at the Royal Danish Academy has been the 4th workshop and culmination of the Erasmus+ project “Social and Environmental Impact Academy for Architects (SEIAA)”. The research center CINARK – Center for Industrialised Architecture at the Royal Danish Academy (DK) facilitated a five-day workshop in Copenhagen in cooperation with the University of Liechtenstein (LI), Bergen School of Architecture (NO) and Hasselt University (BE).

The academic framework of the workshop has been linked to the topic “ecology of tectonics” that is fundamental to the work executed in our research center:

“The physical properties and the lifespan of building materials are to a large extent dependent on the way in which they are designed and built into constructions and subsequently maintained. In a recycling perspective, the design and assembly principles of the constructions become even more important, as they should preferably be able to be disassembled. It points to tectonic strategies – ecology of tectonics – that considers not only the life cycle of building materials, but also the lifespan of the constructions so that buildings are designed for circular economy. The ecology of tectonics holds an understanding that buildings consist of parts that as a whole form part of a wider context of nature-based and cultural systems.

At best, this understanding will contribute to a new ethical dimension within tectonic practice and in architecture in general, which acknowledges the correlation between the materials used, the ecosystems they are part of, and the resources we share seen in a global perspective”.

TWO LOOP CIRCULAR DESIGN

As in the previous workshops, students worked in groups mixed across the four universities. Together they explored and defined circular design strategies through hands-on 1:1 experiments, combining functionality, aesthetics and circularity. They could explore questions, such as: What does it mean to build circularly? What characterizes the beauty of circular and tectonic solutions?

As an outcome, they provided material evidence of how two loops of circularity could function in the built environment. The findings have been brought together and materialised into five multipurpose podiums, that demonstrated five strategies of how a random assortment of materials could be translated in a multipurpose podium.

How do we need to think and build in a circular economy? To achieve a meaningful low-impact circular economy in construction, architecture must become proficient at using, reusing and recycling materials so architectural design must be designed for reuse. To practice with such open-ended, adaptable, and reversible qualities, in our workshop we worked with two loops of circularity: At the Architecture School workshops we received two random containers filled with demolition materials from a reuse-material-supplier. The task was to build a multipurpose podium that would be Designed-for-Disassembly. On the lawn next to the workshops, we re-assembled and recalibrated the construction ready for it be placed on the waterfront. Here the design was re-worked and adapted to its surroundings.



UNLOADING THE WASTE CONTAINER. Photo: Cornelia Faisst
RECOGNISING WASTE AS A RESSOURCE. Photo: Cornelia Faisst

HOW WE WORK

Five intercultural groups of four architecture students dealt with the environmental impacts that arise through the design and the use of our built environment. Using hands-on methods, we perceived limitations as challenges for our creativity. We searched for beauty in reduction, by focusing on the elemental purposes of architecture. Instead of adding new designs to an increasing pile of waste, we thought about strategies to make better use of the existing.

Neither the teachers nor the students knew the materials in advance, and this is the key pedagogical point of the workshop. In a circular economy the available materials are design-drivers and as such the architectural design can only be loosely planned. The workshop then became a study of creative flexibility where the students adapted their designs in accordance and in dialogue with the materials and techniques available.

THEORY AND PRACTISE

Often the Circular Economy is presented by scholars, practitioners, and politicians as a solution to the climate crisis. The Circular Economy is seen as a decoupling of economic growth from the over-consumption of scarce resources. This arguably is a paradox as growth and increasing material consumption are an interdependent phenomenon. As such the reality of Circular Economy is not as clear-cut as one could hope for. In the workshop we intercept material and products deemed no longer useable on their journey to be decommissioned, cut-up and burned or otherwise discarded. The unfortunate reality is that a lot of these materials will continue to be discarded after our workshop as the task of taking responsibility for the waste of building industry is logistically not feasible. But by presenting this enormous waste for the students – while showing them the design potential that lies in recycling – we hope that the students will leave this workshop with a realistic

image of the waste problem in construction while enabling them to push for a better practice where the Circular Economy and re-/upcycling are natural parts of the design.

In Denmark today there are many stakeholders pushing for Circular Economy in construction and many examples are already built. Buildings based on reuse and recycling are not uncommon anymore and this is a positive development. However, there are equally many examples of Circular construction that cannot participate in a Circular Economy in the future simply because the focus is on reuse and recycling here-and-now and little consideration has been given to reuse at the buildings' end-of-life. An example of this is the reuse of brick in Denmark. Many buildings are being built with reused bricks but for that to happen the bricks must have been laid originally with weak limestone mortar. That was the case before the 1960s and as such many brick constructions can be reused. Since then, the brick industry has used strong cement-based mortar meaning that the bricks cannot be taken apart in the future for further reuse. The Circular Economy in practice is filled with this kind of example of One-Loop-Design.



FOCUS AREAS OF THE WORKSHOP REGARDING THE 17 SDGS.

CIRCULAR STRATEGIES TOWARDS SUSTAINABLE DEVELOPMENT

The Circular Economy is placed within the 12th Sustainable Development Goal of the United Nations entitled 'Responsible Consumption and Production'. It directly addresses overconsumption within the field of construction and the crisis of increasing scarcity of raw materials. It aims to mitigate unnecessary use of finite and renewable resources but focuses on the potential of reuse and re-/upcycling of waste materials from demolition sites. It opens the door to novel approaches in design where material awareness and the impact of material use are key in architectural design. Similarly, the 13th Sustainable Development Goal of 'Climate Action' is also addressed by the Circular Economy. The most sustainable material is arguably any material we do not use. Such a strategy both mitigates new material use and unnecessary processing. Production of building materials is responsible for up to 40% of CO2 emission and thus hindering material consumption addresses scarcity and Global Warming Potentials.

WORKSHOP DIARY



DAY 1

ARRIVAL DAY

The workshop began with a self-presentation where each participant introduced themselves through a prepared task. The task had been sent in advance and invited everyone to define their relation to the topic of circular building through answering three questions: 1. How do you define circular thinking and making? 2. Have you worked with it in one of your previous projects? and 3. How do you live in a circular way in your everyday life? The task gave the chance for us to quickly see the experiences and interests of all the participants. We then walked into the center of the city to enjoy pizza alongside one of the canals.



DAY 2

INPUT DAY

The day started with an introduction to the department of CINARK and a tour of the RDA campus. Associate Professor Pelle Munch-Petersen gave a lecture on The Material of the Circular Economy. The two containers that had been delivered with waste materials were then emptied into the workshop's courtyard and we began sorting the material. Amongst some 300 year old timber beams, there were also many lightweight timber panels used for temporarily sealing fasades with plastic sheeting during construction, more than 20 selfstanding shelving units, metal railings, thin timber sections and various other artefacts. We shared a dinner in the canteen so we had the possibility to talk across the groups and plan further.



DAY 3

INPUT DAY

Christian Vittrup a civil-engineer working with the production of upcycled materials at the design and manufacturer company Again, introduced the processes and history of the products that they have developed into the marketplace. The challenges of scale, testing and certification, and the balance in using certain materials for furniture, interior or exterior dependent on the risk profile was discussed alongside the barriers to entry for new products dependent on regulation. In the afternoon we continued to explore and develop the first version of the Circular Social Podiums and shared dinner again in the canteen.



DAY 4

GROUP WORK DAY

We cycled to an exhibition settlement entitled 'Living Places' that the rooflight manufacture Velux showcases sustainable building methods in a series of case study houses, gardens and greenhouses. This was followed by a tour and lecture at Lendager Architects who have based their practise on upcycling materials and reuse at varying scales. After cycling back to the campus Teaching Assistant Professor, Ph.D. Astrid Mody gave us a lecture on Prototyping that gave us methodological frameworks, based on natural, social sciences or the arts that we could use to position our experimentation within the academic field. We returned to the workshops and continued to make iterations of the Circular Social Podiums for the rest of the day. The students had the opportunity to explore the city independently during the evening.



DAY 5

GROUP WORK DAY

We began the day on the waterfront outside the Architecture Museum at Søren Kirkegaards Plads with a tour and introduction of one of the three pavilions built to demonstrate technologies that will enable a reduction in emissions by at least 25%. The architect Uffe Leth explained how the research at CINARK had led to collaborations between small actors within the Thatch industry to develop prefabricated Thatch panels. Professor Anne Beim gave a lecture on Biogen and circular approaches. Discussions led to the importance of good tectonic competence in order to find simpler solutions to applying biogen materials and in dismantling structures. A critical aspect of the work of CINARK has been in relation to fire treatments on natural materials, and the testing of clay application to gain an equivalent B rating on thatch was shared. In the afternoon the structures were dismantled then relocated from the workshop and the square to the waterfront. On rebuilding it was possible to make adjustments and further iterations of the podiums, both in the built sense, but also in the positioning to site and the water.



DAY 6

PRESENTATION DAY

The day began with an introduction to the documentation format of the booklet for the students to prepare finished material to summarise their proposals in this booklet. There was also time to make changes to the social podiums ready for the presentation in the afternoon.

Jørn Kiesslinger a partner at Lendager Architects joined the group as an external guest for discussion of the 5 podiums. Members of the public who were passing by also stopped to listen to the presentations. We shared a final dinner in the H15 Eatery to celebrate the end of this part of the program.

DESIGN 01

HIERARCHY IN CIRCULARITY



IN THE CONTEXT. Photo: Mads Christian Hvidberg

INE GRAJCHEN

MADS CHRISTIAN HVIDBERG

MANTAO AMADEUS JAKOBS

MARIA WENYUE JESSEN AAS

During the analysis on the first day, we were all immediately intrigued by a large metal element. We made the decision to utilise it as our foundational base. This choice sparked a deliberation about our subsequent design direction. Once we had a comprehensive understanding of the available materials and the properties of the chosen steel base, we opted to establish a connection between a lightweight wooden structure and the imposing steel framework to achieve a striking contrast. This decision prompted us to delve deeper into the possibilities. By strategically placing wooden panels within the gaps of the steel structure, we created inviting seating areas. These panels were fashioned from repurposed shelves and seamlessly connected using salvaged components from dismantled frames.

The approach aimed to minimise wood modifications and reduce the number of cuts. The existing openings in the metal served as connection points for the new structure. The connection between the two elements was achieved using the screws from the disassembled frames.

“It becomes a part of the architectural language that the wood never aligns in joints but instead offsets from one another.”

MADS CHRISTIAN HVIDBERG





In hindsight, it would have been better to use bolts, as it would have facilitated the disassembly of the structure. By utilizing the strong and stable metal frame as a foundation, a solid base was provided for the wooden elements. Simultaneously, the light nature of the wood created a sense of airiness and spaciousness within the structure.

The project is based on a heavy steel base, a horizontally ribbed object. Steel production has significant CO2 emissions, so it is crucial for us to become proficient in reusing this material. To reuse the steel and maintain the weight of this object while highlighting its importance in our design, we chose to incorporate a lighter structure that would subordinate itself to the steel object. A clear hierarchy in the architecture becomes essential in conveying our approach to sustainability.

The wooden frames used to create the lighter structure are redeployed in the lengths they come in. It becomes an architectural expression that the wood never aligns in joints but instead offsets from one another. This is also done to exemplify that the wood could have had completely different lengths and still be usable.



The project is located along the canal at Holmen, positioned with the water on one side and a larger building on the other. As a human, one experiences a grand scale from the large building to the infinity of the water. Our project aims to complement this scale by supporting the horizontal features of the context and incorporating an angled roof that meets the water, signifying the transition from building, to quay, to the water.

Our project creates a shelter-like spaciousness that invites people to stay. It achieves this by considering the human scale and recognising heights, both the seating height and roof height. The space created is open, but the orientation of the columns encourages people to position themselves with their gaze towards the water and the building at their back. Having the building at their back will create a sense of security while staying there. This project is built with a specific context and use in mind. But the sustainability and architectural approach could easily be translated to other places and functions.



“A clear hierarchy in the architecture becomes essential in conveying our approach to sustainability.”

MADS CHRISTIAN HVIDBERG



IN THE PROCESS. Photo: Mads Christian Hvidberg

DESIGN 02

OFFICE LANDSCAPE



MULTIFUNCTIONAL FURNITURE. Photo: Cornelia Faisst

STEFANY VELASQUEZ SARRIA

LENA WINDEREN

SANDER PANIS

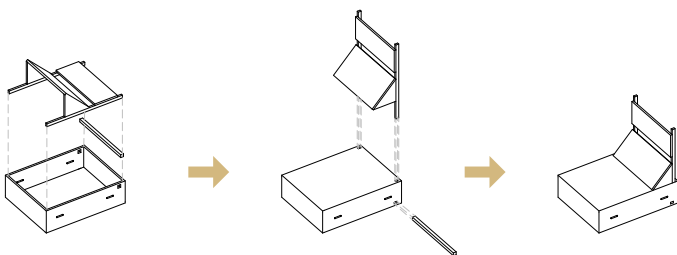
IRIS DENISOV

Our project presents a design concept that repurposes discarded wooden cabinets into a unique seating podium, creating a landscape of functionality and interaction. By rotating and modifying the cabinets, we create an arrangement with multiple levels and versatile seating options. These repurposed cabinets serve as multifunctional elements, providing seating, reclining, and creative spaces for indoor use. On sunny days, they can also be placed outside, expanding their usability and inviting people to enjoy the outdoors. Sustainability and mobility are key considerations, as the cabinets can be easily disassembled and relocated using a box system. This flexibility allows the seating podium to be adapted to different indoor and outdoor environments. By repurposing these cabinets, we embrace creative reuse, challenge the concept of waste, and create an engaging space that showcases the beauty of repurposed materials.

“With only one
thing you can do
everything you
want.”

STEPANY VELASQUEZ SARRIA





Through our exploration, we discovered that making small adjustments to the cabinets allowed us to create a versatile modular system that capitalised on their abundance. We recognized the inherent mobility and transformative potential of file cabinets, prompting us to emphasize these properties in our design. This led us to envision a dynamic and ever-evolving landscape.

The concept revolves around the idea of a forever changing (office) landscape, where the cabinets serve as the building blocks of an adaptable environment. By incorporating movable and transformational elements, we enable users to rearrange the layout according to their needs and preferences. This flexibility ensures that the space remains dynamic and can be continually reimagined to accommodate evolving social dynamics and creativity. By harnessing the logic of the file cabinets' moveable and transformational properties, we have created a landscape that can be changed individually. The modular system allows for seamless reconfiguration, enabling a sense of empowerment and ownership for users as they shape their work environment. This forward-thinking approach not only maximizes the functionality of the cabinets but also promotes a sense of creativity, collaboration, and adaptability.



We started our process by looking at what materials we were given and were drawn in many different directions regarding what to use and what situation we wanted to create. We began sketching out some different ideas, but the moment we went out to look and feel the materials again we found the file cabinets to be the most intriguing. They are in good shape and are made from with sturdy materials and design-solutions, but for some reason they have been sent to die, en masse. An entire office-landscape in a pile. So why are they not loved anymore, and how can some simple gestures make us love them again? Do we need to alter their shape and use them in a new way? Or does the relationship we have to the material hinder us from loving them as they only remind us of what they were created for?



“How can things
transform both
functionally and
structurally?”

LENA WINDEREN



END RESULT OF THE CABINET MODULES. Photo: Sander Panis

DESIGN 03

ENTANGLED



FINAL RESULT. Photo: Sophie Feichtmair

SOPHIE FEICHTMAIR

PETTER FINSAETHER BOLSTAD

KRISTIN CUHRA

ISA LEEMANS

In the spirit of our workshop, we tried to make a social structure that was not only from leftover material, but also built in a way that allows the material to function well into the third loop of use. In the planning phase we fell in love with the 300-year-old timber beam. We wanted to use its weathered aesthetics and solidity to support something softer and more elegant that could provide some kind of shelter.

We increasingly recognised the interesting opportunities to weave the thin planks. At first more as a backrest/cladding/facade, but our fascination led us into exploring its structural capabilities as well.

“Let the
material
decide.”

PETTER FINSAETHER BOLSTAD



PROTOTYPING. Photo: Isa Leemans



We began working with the wooden beam as a bench. We wanted to create an angle that was comfortable to lean on and invited people to sit longer and relax. By providing proper support for people this also provided the structural starting point of the arched shelter. The woven arch came out of our exploration of the material capabilities of the thin wooden planks. Weaving is a very old technique which fits well in our circular story because it is easy to build and to dismantle. For this part, it was important to work as much as possible with the capabilities of the material itself. We let the full length of the planks decide the width of the woven frame as they interlaced diagonally in a weave. We tied them together in the intersections, this allowed the whole construction to contract and expand as an accordion. When it was fully contracted it was much stiffer and stronger. We used this ability for moving it and later we extended it on the bench into an arch. Extending the arch was a very exciting event. It revealed many places that should be further supported when forming the arch. This was done with the help of the other groups and some responsive tectonic thinking. In the end it became a combination of weaving additional rows of planks at the ends and in the middle whilst using wooden sticks to bind it together with some screws and rope.



The whole process began with a vague idea and was purely inspired by the found material. The building and forming to finally disassembling and moving it led to trying and failing more than once. It was about figuring out how the material functions and what characterises it. We had to make decisions, stick to them or begin again. Always in mind with the goal to build in a circular manner. Creating not only a space for our needs, but also thinking about the environment and future generations.



“Let’s find out,
it’s about
trial-and-error.”

SOPHIE FEICHTMAIR



IDEA SKETCHING. Photo: Isa Leemans

DESIGN 04

IN-TENSION



JOINTS. Photo: Mustafa Karaaslan

MUSTAFA KARAASLAN
VIDA TRULSDOTTER BOOGH
HÉLÈNE SIMONIS
ESBEN LINDHE

The point of departure was choosing the materials and letting different structures appear from them. One principal of circular building is to rework existing materials as little as possible, preferably not at all. This avoids using more energy than necessary on yet another process of reuse. We attempted this by setting principals for ourself to not cut any of our material and only use our own bodies as tools. The method for choosing materials was an intuitive attraction to the repetitive and rigid character of the steel structures, which at the same time had a lightness to them with them being hollow and painted in light gray and white, making the surface just a bit uneven.

After agreeing on the rules we had set for ourselves; no cutting, using our bodies as tools; simply reacting to the chosen steel structures, the consequence was to assemble structures according to the principles of pressure and tension. Here the A-frame emerged. By leaning the gray structures towards each other we could lock them in place by sliding the white pieces in between the gaps of the gray ones. The weight of the steel also kept everything in place.

“Playful rigidity
in the assembled
structure.”

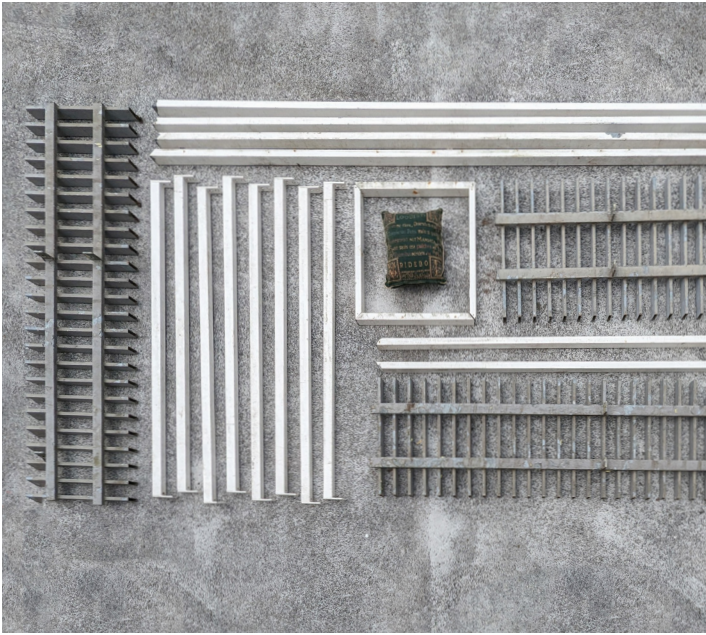
MUSTAFA KARAASLAN



COLLAGE OF POSSIBLE USES. Photo: H el ene Simonis & Mustafa Karaaslan



When it came to the form of the assembled structure, we tried out different settings and layers of the material we chose. First assembling the structures in a line looking like two 'A's next to each other. But with the strict and see-through characteristics of the materials we thought it would be simple to create an enclosed space, with a clearer center. This would invite people to gather and explore the space. A visible heavy and rigid structure that gives a secure feeling and therefore invites you to put your weight on it. Whether sitting, laying or climbing. At the end of the process we found a structure that aimed to be honest towards the users and therefore invites them to play and discover it with their bodies.



Through these days we found a system that has been generous enough to let us experiment. We found that with the materials and the principle of pressure and tension, the structure can be set up and taken apart without anything other than the material and our bodies being involved. It could also be restructured into other constellations by following this system. This means that it can be adapted to different sites, which could potentially extend its life. Steel lives a long time and when the structure has completed its goal in one place, it can potentially move on to a new place, just like people.

It is also interesting to reflect on the life the materials had before they became this construction. At the time of writing, this is uncertain. What did they do in their youth? Were there more of them, and if so where are the rest? And is it okay for them to live on in this new constellation?



“The intention
is to be part
of the context,
not be the
context”

HÉLÈNE SIMONIS



FLEXIBLE ASSEMBLY. Photo: Mustafa Karaaslan

DESIGN 05

WEAVING WASTE



TESTING NEW SITTING OPPORTUNITIES. Photo: Cornelia Faisst

ERIK OLOFGÖRS
TONE FIRING
GULNARA BOSKOV
HANNES HERZOG

Together we explore and define circular design strategies through hands-on 1:1 experiments, which aim to combine functionality, aesthetics and circularity.

Our aim was to make a podium; a place for gathering, sitting, standing on, in a human scale. Following inputs on circular design and making, we realised that the output will occur in a different process than that we are used to. The order changes - the starting point becomes the material, and the material decides the design. We started with looking at the pallet; what is already here, what potential lies in the materials we are given? So we began working directly at with the wooden frame elements. We felt these would enable us to make a structure that could be movable and possible to dismantle.

“Instead of
letting it crack
anywhere,
we are
controlling
the crack”



FRAMEWORK. Photo: Gulnara Boskov



The school is on the waterfront, across the harbour from the Opera. Each morning we started the working day with swim and we wanted to develop our project from this, to create a place for dwelling or interacting with the water. It could be a semi-private and semi-enclosed space where one could feel more comfortable changing, and catching a breath after uniting with the ocean. A place to reset.

Although broad variety of materials were available, we decided to mainly use wooden elements. We found a number of 2"4 wooden frames, timber beams that had been used for 300 years, thin planks and a steel frame as a grounding. Only a few screws at selected places were needed.

Previous experience in steaming and bending wood sparked the idea of weaving wooden planks due to their dimensions. We tested the wood's bending capacity by soaking it in salt water for a day. Initially, we encountered cracking issues when attempting sharp ninety-degree corners. However, we developed a new technique that allowed us to control the cracking and this enabled us to weave corners successfully.



This weaving technique also addressed both the aesthetic and functional aspects, providing options for transparency, privacy, and adapting to the windy environment on site.

To ensure simple assembly and circular thinking, we minimized the use of additional screws and manipulation of the material. Our design involved a wooden frame on a steel foundation, with the rescued logs placed on top without any joining so that their own weight is the anchoring force.

When moving the podium from the workshop to the waterfront, it proved simple to dismantle, transport, and reconstruct the podium. The design was adapted to the new environment by shifting placement of openings or windows within the structure.

The bench consisted of stacked timber logs, showcasing visible iron elements as ornaments. By preserving the material's origin and avoiding extensive modification, we gave new life to old materials, creating a social waterfront dwelling for passersby.



“Reusing
materials
enhances their
value, turning
forgotten
elements
into renewed
treasures.”

GULNARA BOSKOV

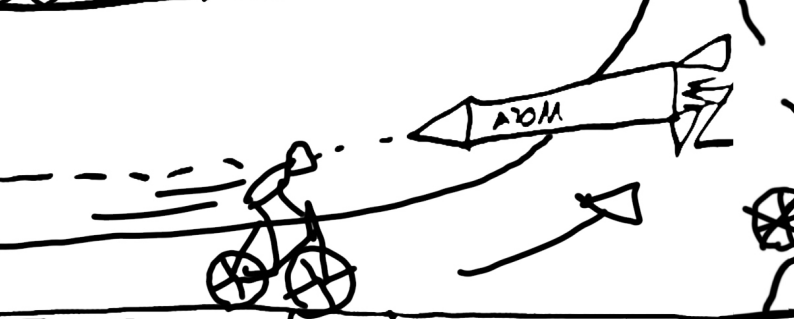
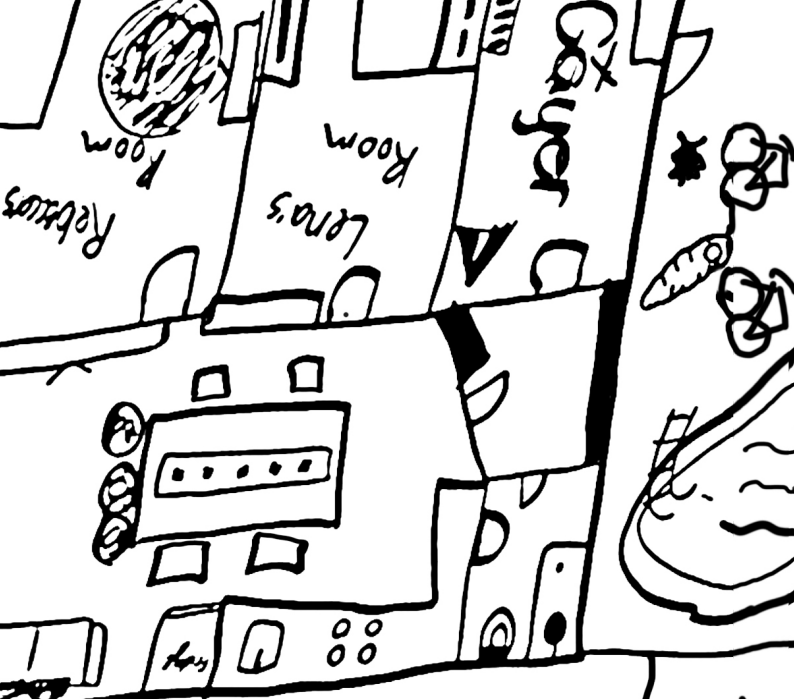


MATERIALS COMING TOGETHER. Photo: Tone Firing

DESIGNING FOR AN OPEN- ENDED FUTURE

Design for disassembly is key. Making sure that the architectural composition can be taken apart and be reused introduces a humility into the design process where beauty exists partially in recognition that the future is unknown. Materials will then be available for use in the future in a manner we cannot predict and design for now. The possibility for many loops thus, is the focus.

Now, after the workshop some of the podium materials will be used by others, some will be taken apart and reused by others and some will be discarded and burned or otherwise meet their end-of-life. That is the nature of Circular Economy in the present day. The hope is that by realising this as a potential for design, more architects will begin to base their designs on what is already there and for many alternative futures.



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