Critical Practices

A new research format aimed at bridging and nurturing research across academia and practice

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Publication date:
2022

Document Version
Publisher's PDF, also known as Version of record

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A NEW RESEARCH FORMAT AIMED AT BRIDGING AND NURTURING RESEARCH ACROSS ACADEMIA AND PRACTICE

AALBORG UNIVERSITET
STRUCTURES & ARCHITECTURE

ICSA
5th International Conference
on Structures and Architecture
2022
6-8 July Aalborg, Denmark

The new experimental research format Critical Practices was launched at the 5th International Conference on Structures and Architecture, ICSA2022 held at The Department of Architecture, Design, and Media Technology at Aalborg University, Denmark in order to stimulate further cohesiveness across the theory and practice of structures and architecture.

Photo credits: 'Neigbourhood Reusestation' by Lendager Group © Rasmus Hjortshøj / Coast

PREFACE

The call for Critical Practices launched at ICSA2022 is a new experimental research format, intended to bridge research in academia and research in practice. This has been done by inviting authors to submit physical prototypes as research output for peer review in combination with short reflection papers. For a design to be prototypical, it must contain a germ that makes it present also to future generations. Hence, the notion of prototype motivates an ecological discussion of how knowledge and matter can be sustained through design.

Consequently, the call for submission to this new experimental research format has been for demonstration of progress into the practice of the synergy of structures and architecture across the architectural scales. As a result of this initiative and call, we received an impressive number of 30 Critical Practice submissions from internationally acknowledged practitioners and scholars for peer review. From these 30 submissions, 15 were finally accepted for publication, presentation, and exhibition at the conference. At the conference, the exhibition of the prototypes was accompanied by oral presentations of the prototypes in a chaired session followed by a panel discussion and award ceremony on 6 July 2022 in the main auditorium at CREATE, Department of Architecture, Design, and Media Technology at Aalborg University.

The 15 prototypes ranged in scale from details in façade systems, over innovations in spatial gestures and structural configurations of building typologies, to explorations of novel principles for viable urban infrastructures and large-scale developments. We are excited to be able to present them to you in this booklet, which contains statements from the panel members and an abstract presentation of each of the 15 prototypes. In this matter, the booklet serves to spur further debate and initiatives in bridging research across academia and practice following the conference, as an invitation to continued debate and progress into the intersection of research and practice.

Introducing the booklet, we want to express our sincere gratitude to all authors, reviewers, panel members, and to colleagues, workshop staff and our dedicated and talented students in the Critical practices Exhibition Team at the Department at CREATE, Aalborg University for all your efforts in joining this experiment. Likewise, we are grateful to the support of Realdania & Dreyers Foundation without which the initiative would not have been possible.

Paulo Cruz & Marie Frier Hvejsel (Chairs of ICSA2022)

PROTOTYPES AS AN EXPERIMENT

LEANING FROM THE PROCESS

Process pictures from the setting up of the prototypes in the exhibition at ICSA2022. Many of the prototypes were assembled for the first time at the conference, hence, making the exhibition itself a live workshop for prototypes experiments.

PROTOTYPE?

For a design to be ‘prototypical’, it must contain a germ that makes it present also to future generations.

To facilitate discussion about how to develop the new experimental research format prior to and at ICSA2022, a panel consisting of leading researchers and practitioners have generously agreed to take part and develop the experiment. The panel members were:

ISAK WORRE FOGED
The Royal Danish Academy / Pasold Foged Architects,
Denmark (Session & Panel Chair)

LOUISE FIIL HANSEN
Design Director & Partner, SLA, Denmark

NIKLAS NOLSØE
Business Development Director, Lendager, Denmark

KÅRE STOKHOLM POULSGAARD
Head of Innovation, GXN, Denmark

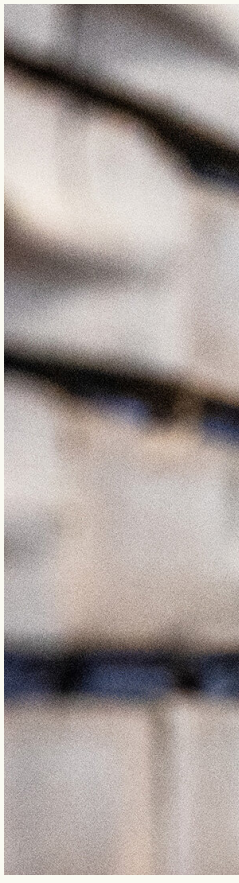
FRANK JENSEN
Owner & Chairman, Søren Jensen Engineers, Denmark

To exemplify directions for potential authors in this new experimental category 'Critical Practices', the panel members have contributed with a series of perspectives on the notion of 'prototype'. These perspectives were intended as means to initiate the discussion of the role of the prototype in bridging research in academia and research in practice prior to the conference. The panel members were asked for a statement and an example from their own practice / research:

ISAK WORRE FOGED

The Royal Danish Academy /
Pasold Foged Architects, Denmark
(Session & Panel Chair)

'This new hybrid research format is a potential to initiate a fundamental and necessary discussion about the application of the prototype as explorative practice across investigation, test, and communication. It raises critical questions about how we can understand the prototype as part of the value chain that we are investigating in the intersection of research and practice, and how can we share the knowledge produced by the prototype?'



'Acoustic Tile': The project 'Acoustic Tiles' is developed through a series of physical and computational prototyping stages, which enable speculative design processes paired with a rigorous experimental procedure of testing and documenting advancements. As a design research methodology, the prototype in this work is understood as a vehicle for exploration, testing and communication, and an enabler for addressing questions and answers that cross disciplinary borders.

Photo credits: / IW Foged

LOUISE FIIL HANSEN

Design Director & Partner, SLA, Denmark

'Using prototypes when working with the grown environment is different than when working with the built environment. In SLA, we deal with urban ecosystems that are inherently uncontrollable: Instead of fixed control, we envision the development of our urban projects in symbiosis with natural growth, social interactions, climate change, etc. Our prototyping is therefore to study natural processes together with our biologists and social behavior with our anthropologists with the goal of coining conceptual ideas about how to spatially transform the classical challenges of the city such as pollution, social segregation, biodiversity loss and climate crisis and turn these challenges into possibilities for improved livability. To us, prototyping means creating the starting conditions from where our cities will grow.'

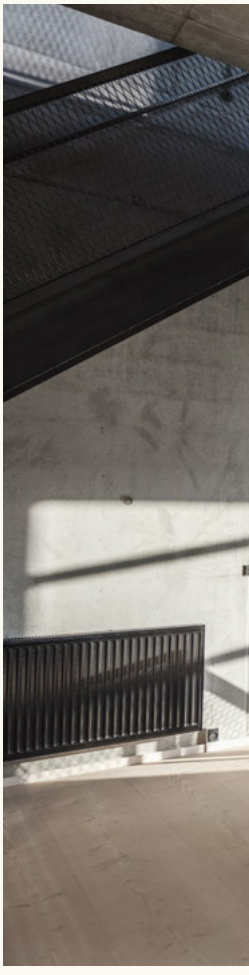
Photo credits: SLA

‘Skt Kjelds Square & Bryggervangen’: As the city’s largest and most radical climate adaptation project to date, Skt Kjelds Square & Bryggervangen is the prototype for how Copenhagen will address and mitigate the challenges of cloudbursts and climate change in the future – while transforming these urban challenges into a public realm that is more social, more green, more biodiverse, and much more livable than before. As such, the project acts as a prototype and as a beacon for how to turn climate challenges into livability potentials – for Copenhagen as well as the rest of the world.

ANDERS LENDAGER

Founder & CEO, Lendager Group, Denmark

'The idea of prototyping is fundamental to us in breaking new ground towards a sustainable building industry; in principle our entire practice is built upon prototyping. But the notion of prototype must necessarily be questioned and framed critically. In our practice we do a whole series of 'mock ups', what you might usually identify as prototypes. However, these mock ups are not in themselves prototypes. The prototype occurs when the process results in a solution characterized by a conceptual quality that makes it recyclable'.



'Upcycle Studios': 60% of the materials in Upcycle Studios in Ørestaden, Copenhagen, are upcycled. This has resulted in a CO2 saving of 45%. The windows come from an energy renovation, the concrete aggregate from the Copenhagen Metro, and the wood is waste wood from Dinesen. Before the innovations were ready to be implemented in the building substantial testing was needed. Numerous mock ups of the glass façade, of experiments with sustainable ways of preparing the wood, and for getting the right concrete mix testing where done in the lab and on site in conjunction with mock ups of the spatial development of the studio-dwelling as a new architectural typology. As a series of parallel investigations, these mock ups together form the prototypical quality of 'Upcycle Studios'.

Photo credits: 'Upcycle Studios' by Lendager Group
© Rasmus Hjortshøj / Coast.

KÅRE STOKHOLM POULSGAARD

Head of Innovation, GXN, Denmark

"The prototype allows us to integrate research and design through collaborative production of conceptual, digital and physical artefacts. This relates to new forms of practice as much as it relates to materials and objects. The prototype is good to think and collaborate with. It is a tool for experimentation and integration of varied ideas and expertise in order to think outside the established bounds of architecture, which is increasingly necessary to solve contemporary challenges from within design practice.

Photo credits: GXN

'The Circle House Demonstrator' is a 1:1 prototype and exhibition space showcasing circular design and construction at scale across the building's layers, materials and products. The aim of the Circle House project is to develop and disseminate know-how about circularity in the Danish construction sector by building 60 fully circular housing units. To that end, its architecture is not designed by a single firm, but by four architecture offices with input from more than 60 partners across the built environment. The Circle House Demonstrator prototype, then, is as much a forum for circular and collaborative design as it is a physical building. The partners' deep and varied expertise were integrated through collaborative design of the prototype and knowledge gained throughout this process was shared between a large number of individual companies. For full list of partners in Circle House project see: https://gxn.3xn.com/project/circle-house.

FRANK JENSEN

Owner & Chairman, Søren Jensen Engineers, Denmark

'In an engineering sense the prototype rests on the threshold of the hypothetical construct and the realisation of the construct. Today the hypothetical – the hypotheses of the engineered performance of a building, a building part or a connection is largely virtual. The prototype for our practice is a logical next step towards the realisation. A bridging point and talking point between the virtual and physical. A bridging point in terms of validation of the expected performance through testing and sensors, and a talking point on aesthetics, constructability and realisation techniques. As our practice probes ever deeper into the decarbonisation of our projects we find that prototyping becomes increasingly valuable as a tool for managing risks, expectations and not least a catalyst for novel ideas and concepts.'

'A decade of pavilions': An annual 5x5 relay run has for Søren Jensen become an annual prototyping and proving ground for new insights and capabilities. Over the last decade we have explored form-finding, off-site manufacturing, computer aided manufacturing, 3D-printing, topology optimisation, parametric design, biological materials and many other evolving technologies. Besides the demonstration in-house capabilities and interests the many pavilions and not least their assembly and disassembly have given valuable insights that have found their way into actual buildings and provided the Søren Jensen team with numerous team building hours.

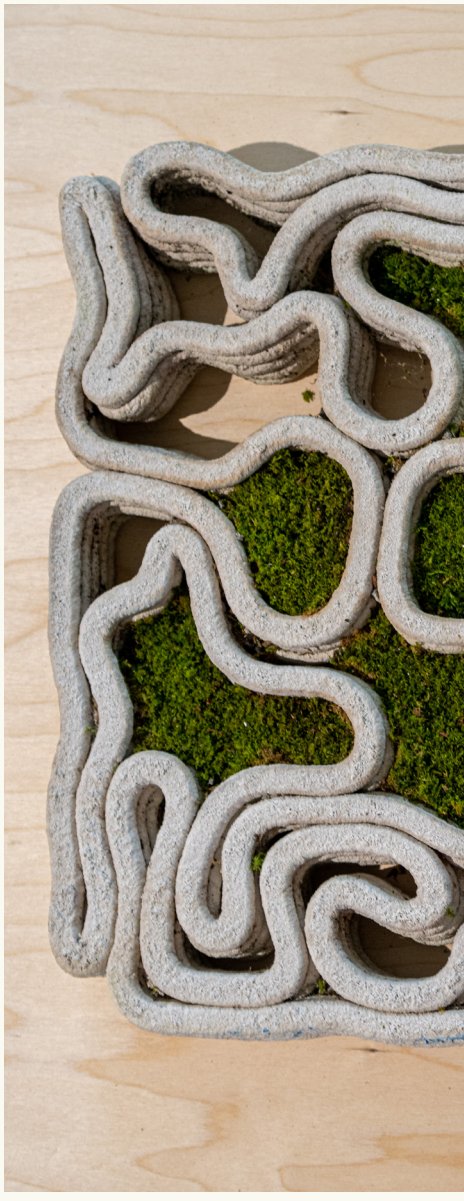
PROTOTYPES

THE EXPERIMENT IN PICTURES

01
PROBIOTIC STRUCTURES

R.P. Beckett, S.P.Nair & Incremental3D
The Bartlett School of Architecture, UCL
United Kingdom

This critical practice submission describes the design approach developed towards creating a probiotic architectural prototype which serves as a microbiodiversity enhancing intervention for urban environments. The materials used are designed to be embedded with and support the growth of beneficial microorganisms offering an interface for healthy microbial exposures and entanglements between the human and the building. The research explores a novel multi layered, robotic extrusion approach on to curved surfaces to create spatial building elements viable as an industrial process.




3D PRINT LAB
Multi-Storey Rammed Earth Construction

02

MULTI-STOREY RAMMED EARTH CONSTRUCTION

J. Jeppesen, N. Brix, J. Johansson & L. K. Nielsen

Kea – Copenhagen School of Design and Technology & Egen vinding og datter

Denmark

Reducing the use of concrete and other CO2-heavy building materials in construction by reintroducing the use of clay soil structures, could lead to a considerable reduction in the construction industry's current CO2 emissions. For such a development to take place, however, it requires the development of new methods that enables us to construct multi-storey buildings in clay soil. We have historical examples of multi-storey buildings with a load bearing system of rammed earth, but despite the fact, that we are experiencing a great interest and development of the fieldtoday, we still miss examples of newly erected multi-storey buildings, where the load bearing stucture is made from non-stabilized rammed earth. Therefore, with this project, we want to investigate whether rammed earth construction can be used to build multi-storey buildings in an urban Danish context.

03

CAST & PLACE: *A CAST ALUMINUM PAVILION DEFINED BY CLAY*

E.M. Segal, L. Ramsburg, J. Draper, S. Thompson, P. Draper, B. Lindsay, M. Dowd & A.A.H. Cheng

Hofstra University, Princeton University, Rensselaer Polytechnic Institute, Entuitive & Knippers Helbig
United States & Germany

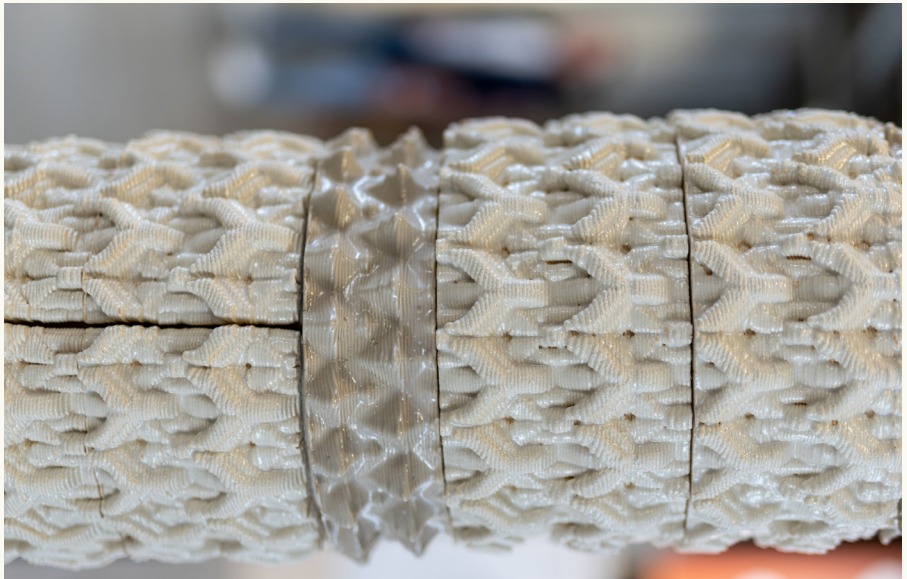
Cast & Place was an experimental design-build pavilion featuring aluminum panels that were cast into the patterns that emerged from the natural process of clay cracking. Onsite trays of clay flanked the structure to demonstrate the process used to fabricate the panels. Upcycled aluminum was intended to be a central feature of the pavilion, but moving from the competition proposal to the built work revealed the complexities of upcycling within the project's constraints. Clay, as reliable pattern finder in a novel fabrication method and register of on-site activity, came to define the as-built pavilion.

04

TEXTILE COLUMN: *DRAWING AND WEAVING WITH 3D PRINTED CLAY*

S. Pain, N. Bartov, E.P. Choo & J. Young
Royal Danish Academy
Denmark

Textile columns are a series of 3D printed ceramic clad structures that are prototypes for ornamental,fire-resistant cladding systems for structural steel. These pieces offers a critical practice against the state of the art by reimagining architectural ceramics in the digital age using Semperian metaphors of textile and dressing as design principles. The approach is illustrative of an alternative to the complex computational design methods that dominate the field with greater focus on architectural theory and analogue thinking. The aim of these prototype is to question how we design using paste-based additive manufacturing technologies from an architectural perspective and explore 3D printed clay for its ornamental and fire-resistant qualities. These columns question the relationship between the ornamented and the bearing in the digital age.



05

THATCHED FACADES FOR A SUSTAINABLE FUTURE: *CO2 NEUTRAL FIRE-RETARDANTS FOR VERTICAL THATCHED SURFACES*

A. Beim & H. Ejstrup
CINARK – Center for Industrialized Architecture & Royal Danish Academy
Denmark

This project is a practise-oriented research collaboration between stakeholders, industry and academia, which sets out to investigate, how material choices and radical tectonic solutions can be drivers for sustainable change in design, industry and legislation. Fire safety as a part of the design solution is central when building with bio-based materials. As a point of departure, the project aims to develop new standards for co2-neutral bio-based materials in façade constructions as well as generating new combinations of materials, surface treatments, and construction solutions. The focus of the project is to develop and test new sustainable solutions for thatched vertical constructions. It aims to both have an environmentally low impact, have as 'close-to-standard' fire retardant properties and to be industrial scalable. Initially the project was described as a three stages investigation starting with 1) a mapping of existing knowledge in historic and modern construction in Denmark and northern Europe, 2) a development, design and built-up of a thatched construction and 3) a comparative fire test of the constructions.

06
CURVED OAK PROTOTYPES

N. M. Larsen & A. K. Aagaard
Aarhus School of Architecture
Denmark

This research challenges current linear processing methods for standardised timber and seeks to extend the scope of tree species and wood types used in an architectural context. A method is proposed where crooked sawlogs are digitised, analysed, and registered in a database. The database then serves as the basis for specific design solutions where curved materials can be advantageous. Through prototypes, the research describes a bespoke design and fabrication method that utilises natural irregularities of the wood and suggests how these natural shapes can be beneficial for specific construction types. Using a broader range of wood resources in architecture can increase carbon sequestration while supporting biodiversity in plantation forests.

07

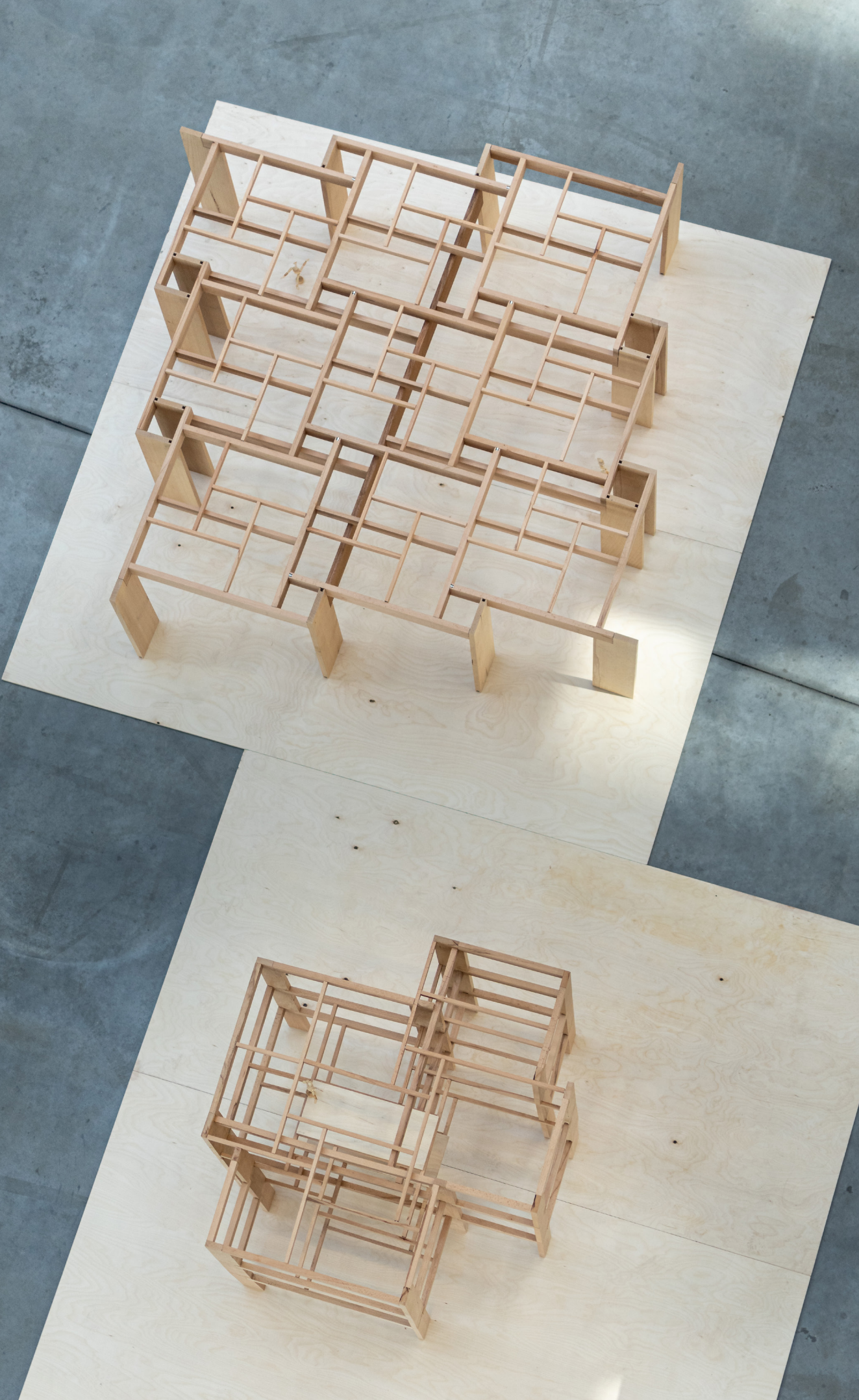
ADAPTIVE REFLECTIVE ENVIRONMENTS

I.W. Foged & M.H. Sørensen

Pasold Foged Architects, Royal Danish Academy & CCO Architects

Denmark

This project investigates and proposes a more versatile and adaptive approach to architectural daylighting in schools. Findings are based on experimental prototyping studies, daylight simulation studies and interview studies. The conclusions form a critical position to the current focus on high daylight quantities, where instead the ability to configure a specific light environment should have high priority in creating qualitative learning environments.



08

MULTI-LAYER PLANAR RECIPROCAL FRAMES:

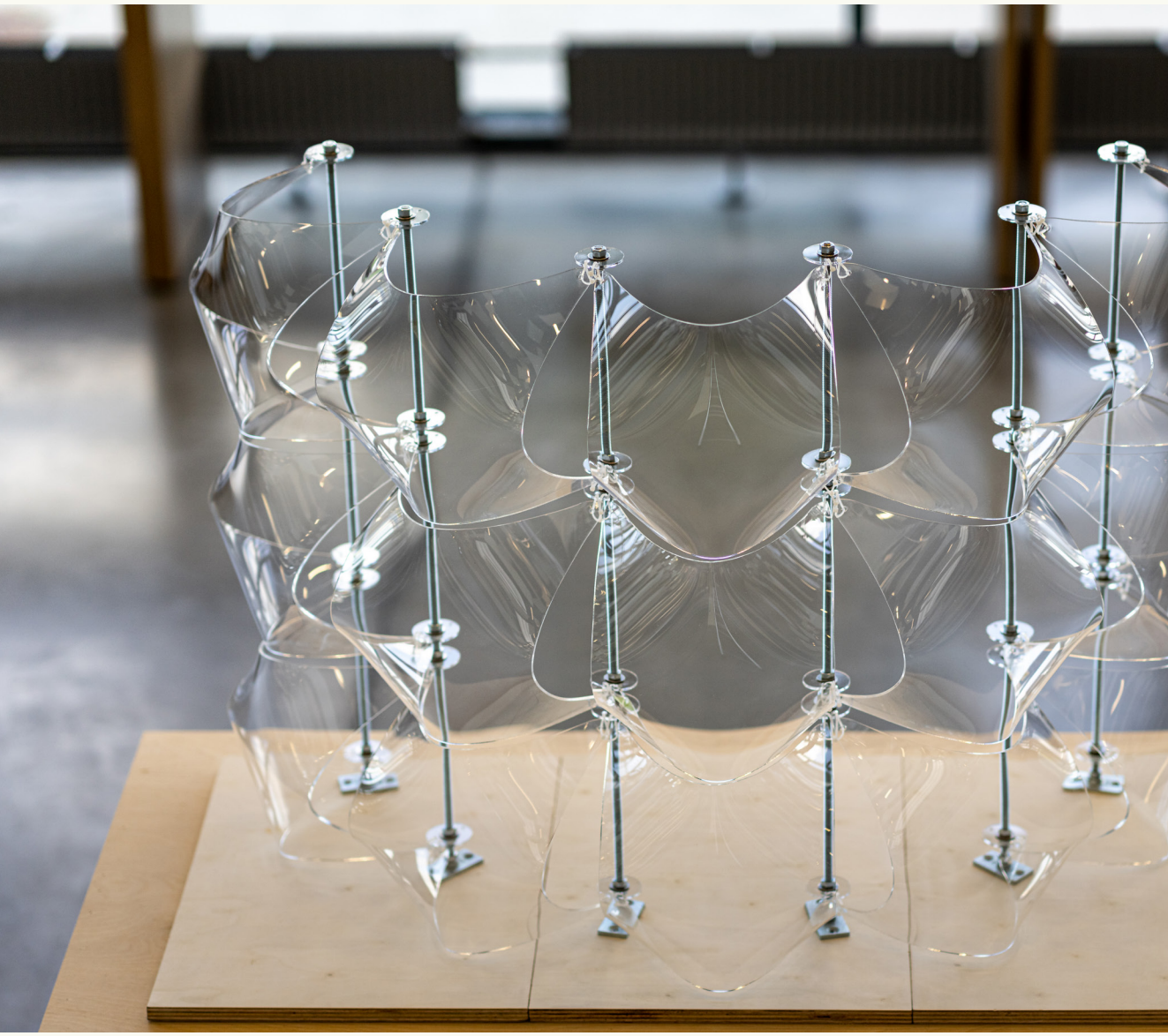
A STRUCTURE PROTOTYPE FOR FLOOR AND ROOF SYSTEMS

M. Dunn

SAUL School of Architecture
Ireland

This proposal centres on developing a structure prototype using planar Reciprocal Frame (RF) structures that can be adpated to a variety of floors and flat roofs for different building programmes. RF's use of short members to create long spans, the simplicity of the joint where two members meet and finally the repeating pattern the system creates are developed in two models, scale 1:10. The prototype is modular, flexible, extendable and guarantees frequent and regular void spaces which lend themselves to lightwells and service voids. It can be made from a kit-ofparts suitable for pre-fabrication and rapid assembly.

Also, by assembling RF frames one layer atop another, the need for temporary supports during construction is negated. This RF protype addresses efficiency in the use of building materials and the potential re-configuration of buildings and their elements as per the circular economy.



09

REUSE AND MISUSE WITH HEAT FORMED ACRYLIC

A. Chao, E.M. Segal, L. Ramsburg & P. Draper
University at Buffalo, Hofstra University, Princeton University & Entuitive
United States

The Acrylic Pixel is a modular system of aggregated heat slumped acrylic panels. The work builds on previous research into utilizing heat to form acrylic shell structures. The recent events surrounding the Covid-19 pandemic have also reframed our initial interests in material production and waste as acrylic barriers have become intertwined within the everyday physical and social landscape. This paper presents a prototype that critiques and subverts the typical use of acrylic by warping, distorting, and manipulating light and vision through the panels. The modular system can be assembled in a variety of ways as a public installation. The prototype is a catalyst to encourage viewers to look and engage in dialogue around the material, social, and cultural aspects of our relationship to acrylic.

10

DOUBLE CURVED STRESSED SKIN STRUCTURES FOR ARCHITECTURE

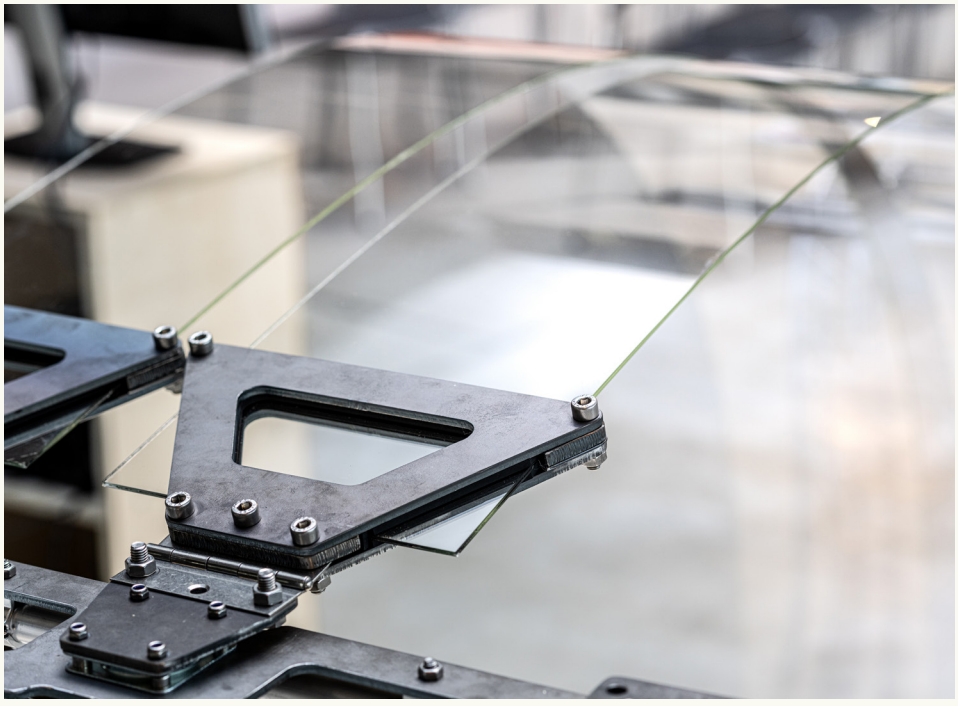
A. MeyBoom & D. Correa

University of British Columbia & University of Waterloo
Canada

Advanced parametric tools and fabrication equipment give us the ability to design and build novel geometries. In the structural system showcased here, these advanced approaches are combined with the traditional 'stressed skin' structure and the material wood to create a structurally efficient and architecturally useful construction.

The stressed skin wood structure is a historically known form of wood construction used to make double curved surfaces. Stressed skin structures have primarily been used in engineering applications of moving objects such as boats, planes and spaceships because of the necessity for curved lightweight, strong and aerodynamic shapes.The double curvature is achieved by the same mechanism that was used by the Eames elephant: since plywood bends only in one direction then one direction of curvature is used as the first direction of curvature and the second direction of curvature is provided by the 'tabs' which allow localized bending in the secondary direction.

This prototype aims to be a proof of concept that demonstrates the ability of the stressed skin wood structure to deal with double curvature while exhibiting its great design flexibility. It demonstrates an adaptive architectural system with unique potential for wood.



11

KINETIC THIN GLASS BUILDING ENVELOPE

H.M. Mulder

SDU University of Southern Denmark
Denmark

Kinetic building envelopes might be employed to support building operation in a wider spectrum of weather conditions. Traditionally, in such envelopes, extensive supplemental mechanisation is applied to move discrete components. This affects the aesthetics, maintainability and durability of envelopes. This submission presents a prototype of dynamic thin glass, that is actuated along the edge, and by twisting glass strips, explores new kinetic tectonics. A process of thinking through prototyping allows the maker and those examining the work to develop new ideas about transparent kinetic systems, and their role in future facades.

13

PROTOTYPING COLLECTIVE GESTURES: *REWORKING THE WAY AND THE WORK OF ARCHITECTURE*

M. F. Hvejsel, W. Ahues, M. Stumpf & M. Wyller
Aalborg University, David Chipperfield Architects & WHP
Denmark & Germany

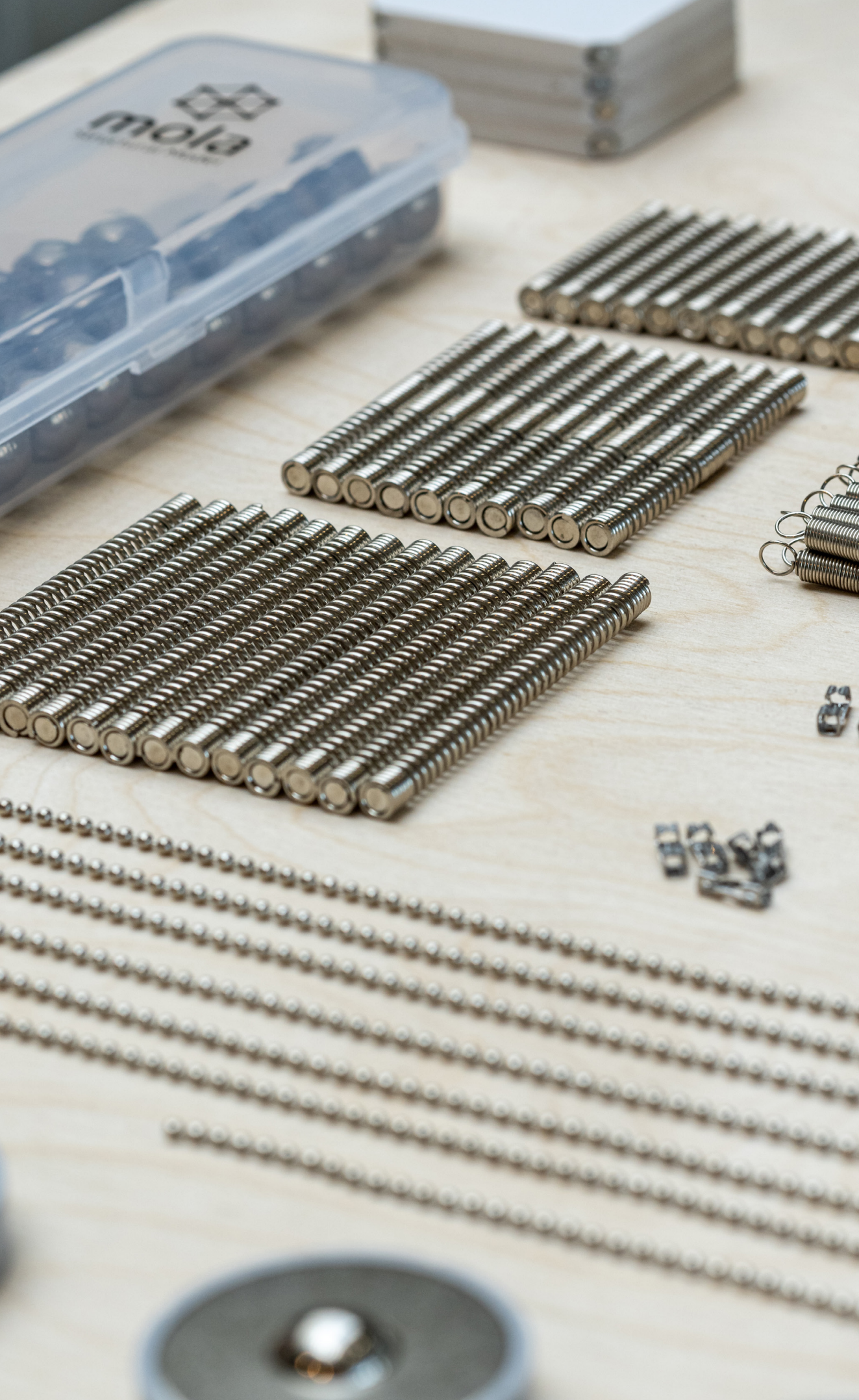
Progress towards a viable development of the built environment entails a series of interdisciplinary challenges that needs to be addressed collectively. In architectural practice, these challenges necessarily call for a reworking of our ways of working (how and with whom do we collaborate?) as well as the work of architecture itself (how and with what do we built?). With this 'Critical Practice' submission, the prototype itself provides a view into how this necessary rework takes shape in the practice of David Chipperfield Architects: As the managing board created a space for transformation within the office opening a potential for Wiebke Ahues to develop a team with focus on integral and participative design processes, 'collective practice' began to take shape. By mapping out the interdisciplinary knowledge gathered in and of the prototype as a product of teamwork, we discuss its critical potential towards gradual change of the confining conditions of 'usual practice'. The prototype in question, developed as a competition entry for Hufelandstraße in Munich, exemplifies how the individual competencies of each team member can be activated collectively in reworking the resourcefulness of the entire body of architectural construction.

14

PHYSICAL MODEL:
GOIAN-CERVEIRA FOOTBRIDGE OVER THE MIÑO RIVER, SPAIN - PORTUGAL

M.S. de Oliveira, A.B. Larena, J.G. Mateo & J.B. Larena
Mola Structural Model, Technical University of Madrid & Bernabeu Ingenieros
Brazil & Spain

This critical practice presents the experience of physical model development during the design phase of an innovative structure. It shows synergy between design and physical models, that improves the understanding of the structure behavior. As a complement to this critical practice, the research paper: "Design process: Goian-Cerveira footbridge over the Miño River, Spain-Portugal" presents the design process and configuration of this innovative structure. The construction of physical models allows to understand the structural scheme and to test different configurations. Mola Structural Model was used as a design tool through an online collaboration between Spain and Brazil. Mola is an interactive physical model that simulates structures behavior. The model consists of a set of modular pieces connected through magnets. It provides a sensory experience, simulating the behavior of the footbridge in a tactile and visual way. Physical models contribute to improve the understanding of structures, actively assisting the design process.


mola


Re:Shuffle
CLT

15
RE:SHUFFLE

L. Mangliár & M. Hudert
Aarhus University
Denmark

Increasing the use of timber can help to reduce the environmental impact of the building construction sector. Preconditions for this are short routes of transport and certified sustainable forest management. For a truly sustainable use of timber, it is equally important to extend the service life of wooden components as much as possible, for example by unlocking new material sources such as waste wood. The research project Re:Shuffle investigates computational workflows and construction methods that enable practitioners to design and realize structurally sound and aesthetically appealing buildings and building components with reclaimed and surplus timber elements.

16

LAS ARADAS MEMORIAL:
ENGAGING IN POPULAR BUILDING TECHNIQUES

H. Fallon & T. Montulet

KU Leuven & UCLouvain
Belgium

The prototype developed for the Las Aradas Memorial represents and questions ways of assembling through popular buildings techniques. It looks into the question of tradition and context, and how studying or inviting the vernacular can create a strong sense of identity while creating feasible and ready-to-build constructions. The project that commemorates ca. 600 victims of the Salvadoran civil war (1980-1992) is currently under construction in the region of Chalatenango, northern El Salvador. The prototype can therefore be read as a post- and pre-construction site testing ground for the design team. The fragments of the commemoration project depict a cut-out of the general design (1/50), and four 1/10 models, representing the fireplace, the existing monument, the memorial bearing the names and a column of the roof structure.

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Kasper Brogaard

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PHOTOS

Per Bille

THANKS

We want to express our sincere gratitude to all authors, reviewers, panel members, and to colleagues, workshop staff and to our dedicated and talented students in the Critical Practices exhibition team for all your efforts in joining this experiment. Likewise, we are grateful to the support of Realdania and Dreyers Foundation without which the initiative would not have been possible.

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