



Overarching Editorial

Making (A)mends - Restorative strategies, responses and pedagogies in architecture and the built environment

Raúl Castaño-Rosa

Tampere University School of Architecture
raul.castanodelarosa@tuni.fi

Iida Kalakoski

Tampere University School of Architecture
iida.kalakoski@tuni.fi

Mario Kolkwitz

Tampere University School of Architecture
mario.kolkwitz@tuni.fi

Mari-Sohvi Miettinen

Tampere University School of Architecture
mari-sohvi.miettinen@tuni.fi

Sofie Pelsmakers

Tampere University School of Architecture
sofie.pelsmakers@tuni.fi

Making (A)Mends

In October 2022, the 14th ATUT symposium Making (A)mends was held at the Tampere School of Architecture. Making (A)mends plays on the word 'mend' and to 'amend'; to mend in the sense of repairing or restoring something, but also in the sense of redeveloping and putting something back together. 'Amending' is about improving, changing, adapting, and putting ourselves on a new path.

At the time of the conference, we had just come out of a two-year COVID pandemic of lockdowns and little face to face contact. It made visible the positive impact we have on each other and that we need each other as fellow human beings, but it also became visible – when we slowed down and gave back the city to nature – how nature and non-humans were able to take up that space. For a short time, we could glimpse a different kind of planet.

Yet climate records continue to be broken around the world: hottest temperatures, longest heatwaves, worst droughts ever recorded; extreme and record flooding and rainfall. And we are guilty of contributing to this: architecture and built environment projects continue to exploit, disrupt and damage the planet.

We also witnessed war and conflict, and this showed how we are deeply interconnected as humans to each other but also to our environment. It shows that a better, more sustainable, inclusive and restorative world is not possible without peace.

Fixing the climate, biodiversity and security crises we face as a society are extraordinarily complex and challenging tasks. Research has shown that radical transformations of our physical, political, organisational, social and value structures are needed to respond to – and prepare for – these crises and to restore the past damage that our activities and (in)activities in the built environment have inflicted. Architecture and urban planning have a fundamental role to play in this, given the long 'lock-in' of the urban plans and spaces and places we are part of designing and their potential (negative and positive) impacts over time with the associated local and global (in)justices they create.

This special issue provides several different perspectives on 'Making (A)mends' to address how we can and must be part of the solution and raises at times uncomfortable questions about our own role, responsibility and values as architects and urban planners, how we got here, and how we can make (a)mends, urgently.

Contributions in this Special Issue

Around 60 abstracts were received in response to the call for oral and verbal presentations. These underwent a rigorous double-blind peer review process, and 50 abstracts were accepted for presentations. From these, 24 papers were received for a rigorous double-blind peer review process which led to the publication of 18 papers in this special issue (Table 1), structured along four themes: resilience (4 papers), restore & repair (3 papers), revalue and reform (6 papers), and reflect and re-educate (5 papers).

Table 1. The 18 papers published in this special issue ordered by theme.

Paper title	Authors	Theme	Keywords	Pages
Housing design quality in Finland: Room for improvement	Lehtinen et al.	Resilience	housing, quality, resilience, resident, daylight, circulation, furnishability, spatial connections	18–40
Building Management Systems in residential buildings: their role in energy and indoor climate resilience	Castaño-Rosa et al. (1a)	Resilience	building management system, home energy management system, resilience, affordability, inclusivity	41–62
Rewilding the built environment: a resilient response to different crises	Castaño-Rosa et al. (1b)	Resilience, Restore & Repair	built environment, resilience, sustainability, green infrastructure, re-wilding, greening	63–87
Finnish mid-rise timber apartment buildings: Architectural, structural, and constructional features	Tuure et al.	Resilience	timber, timber apartment buildings, mid-rise, architectural features, structural system, construction method, Finland	88–119
Re-evaluating the Aaltos' Pre-war Housing: a field study of the home environment in a case study	Rugbjerg et al.	Restore & Repair	Aino and Alvar Aalto, Environment, Housing, Modern Architecture, Field Studies	120–146
Architectural Design from Upcycled Formwork Wood: Perspectives on New Physical and Aesthetic Qualities of Salvaged Formwork Wood, Computer Vision and Algorithm-Assisted Façade Design	Nicolas & Filz	Restore & Repair	Formwork wood; Computer Vision; Upcycle; Timber Façade, Sustainability, Architecture.	147–177
Buildings as Objects: Competing Values of Built Heritage in Urban Renewal	Kalakoski & Kuitunen	Restore & Repair	city renewal, city planning, cityscape, architectural preservation, interpretation, canonization	178–194
Research Education for Architecture Students – Case Study of an Academic Reading Circle	Vartola	Reflect & Re-educate	online architectural education, architectural pedagogy, architectural research, reading circle, online group work	195–213

Transformation of Architectural Design-Research Pedagogy. Guidelines for the design of an experimental master's course based on disorienting dilemmas	Rubio Hernández et al.	Reflect & Re-educate	transformation, architectural design studio, research through design, constructivist pedagogies, disorienting dilemmas	214–238
(A)mending Architecture Education in the Climate Emergency through Inclusivity and Collaboration	Nisonen et al.	Reflect & Re-educate	architecture education, values, climate emergency, sustainability, design studio, educational reform, teaching, critical thinking, collaborative learning	239–264
Choose your tools wisely Using dialogical architectural pedagogies for sustainable world	Nawratek	Reflect & Re-educate	pedagogy, architecture, design, education, radical inclusivity, narrative	265–283
Teaching with wood: reconciling future architects with the forest	Camilli & Brown	Reflect & Re-educate	timber, architecture education, design-build, sustainability, grounded theory	284–297
Unravelling the public procurement networks of architectural services in Finland as pathways of transformative innovations and tacit knowledge	Kuo & Filz	Revalue & Reform	Finnish public procurement, architectural services, Buyer-supplier network, clustering, data visualization, innovation and knowledge transfer, sector transformation	298–330
Extending the Extension A Study into the Synthesis of Spatiality and Embodied Carbon in Future Alterations of Suburban Dublin.	Conlon-Dooley	Revalue & Reform	drawing, sustainability, embodied carbon	331–347
Drawing Cages The Settings of Mediating Actors in the Case of Low2No	Lindgren	Revalue & Reform	actor-network theory, architectural drawings, urban planning, urban design, Low2No.	348–367
Om att uppfinna hjulet på nytt: kvarteret som byggsten för staden	Parkatti	Revalue & Reform	kvarter, stadsliv, urban design, urbanitet (stadsmässighet)	368–389

Material flows from buildings A comparison of patterns in two Finnish cities	Kolkwitz & Huuhka	Revalue & Reform	circular economy, comparative research, building stock dynamics, building stock dynamics, material flow analysis, sustainable cities	390–419
Assessing the Carbon Impacts of Five Apartment Buildings with Different Timber Frames: A Finnish Study	Westerholm	Revalue & Reform	Multi-story timber buildings, life cycle assessment, decarbonization potential, climate change mitigation, industrial timber construction, sustainable construction	420–444

Each of the four themes are described below with a brief introduction to the theme, and how the published papers relate to it, followed by key findings, connections and where to next. Despite the categorisation under four themes and dominating focus on the Finnish context, the studies published under this special issue show a great level of diversity. This reveals both the vastness and complexity of often deeply rooted systemic flaws in the construction industry that are to be overcome in order to achieve a truly sustainable built environment. The thematic overlaps and connections between the different publications further highlights the need to approach each of the conference themes not isolated from each other but holistically both within this field of research and the greater context. Some research papers do exactly that and are referred to across the themes.

In all the four articles under the Resilience theme, design is emphasised as a decisive moment in the sustainable development and creation of our built environment.

Resilience

Resilience in the built environment involves the creation and provision of built environments that enable (urban) systems and its inhabitants to overcome the impacts of any disruptions such as climate change, the pandemic and other crises, while adapting to them during the process. This includes material (e.g., physical) systems, non-material systems (such as legislation) and community characteristics (i.e., culture, values). Building resilience also implies the combination of top-down and bottom-up approaches where effective and just policies at the macro-level (e.g. city planning) facilitate the implementation of different solutions at the micro-level (e.g. housing, building) through clear and inclusive communication and collaboration amongst different stakeholders / actors at the meso-level (e.g. in the neighbourhood).

Housing and the way we live play a key role in resilience promotion. However, society and housing provision is under increasing pressure to accommodate societal changes, e.g., an aging population, an increasing number of single person households, increased working from home, climate change, the green transition, and the covid-19 pandemic. *Lehtinen et al.* stress the pivotal role of housing design quality to support flexibility in the residential building stock and prevent it from premature obsolescence while supporting the resilience of individuals, households and society. They illustrate the value of mixed-methods to investigate housing quality factors and highlight that there is much room for improvement in the quality of the design of the Finnish housing stock to ensure long-term resilience, with focus on the design of circulation areas, better daylighting through reduced depth of plan and careful balcony design.

Related to housing design quality, the connection to green spaces is one key characteristic to promote resilience in housing and the urban built environment in general. *Castaño-Rosa et al. 1b* systematically review and discuss the wide range of societal benefits of green spaces and the need to understand the key conditions and design considerations that have been proven effective while avoiding unintended consequences (e.g., eco-gentrification, displacement due to land value increase).

Furthermore, smart technologies such as Building Management Systems (BMS) have recently gained increased popularity as an effective solution to optimise residential building performance. However, from a scoping literature review, *Castaño-Rosa et al. 1a* indicate that applying BMS in dwellings has the potential to improve preparedness for future shocks if design flaws, such as a sole focus on technical parameters and the overall negligence of social and human factors, can be overcome.

The aforementioned articles showcase the relevance of design considerations that promote resilience in the built environment for and through its users. *Tuure et al.* discuss the design of wooden residential buildings to increase the usage of timber as a renewable construction material and carbon storage and in general, to utilise the material's positive properties for the Finnish housing stock and society. They provide key insights to improve the efficiency in material application and to streamline the construction process of multi-storey timber structures whose legal utilisation in housing was made possible in the recently enacted Finnish Land Use and Building Act from 2018.

In all the four articles under the Resilience theme, design is emphasised as a decisive moment in the sustainable development and creation of our built environment. Including different stakeholders from housing designers to users and urban planners to construction companies does not only support planning but also our research.

Key findings and recommendations

While access to natural light in apartments is known to support residents' well-being, *Lehtinen et al.*, through an objective daylight analysis, show that there is still room for improvement. For instance, balconies are designed in a way that often obstruct the main window in a typical Finnish studio apartment which in consequence, reduces the indoor living quality. Identifying the interlinkage between daylight, furnishability, and circulation areas is among the key findings of their study and reveals a general lack in adaptability of the urban housing stock in addition to its negative impacts on residents' well-being. As a result, housing designers need to consider room depth and balcony placements and their impact on daylight quality as well as non-obstructively placed areas for circulation and furniture.

Castaño-Rosa et al. 1b provide four key considerations to promote resilience in the built environment through the implementation of green spaces, which need to be designed in such a way that they (1) support biodiversity, (2) are interconnected with the context, (3) accessible and (4) appealing for citizens to protect and appreciate them. Ultimately, democratic, participatory approaches where all community's members are part of the co-development process are essential, as well as collaboration between private and public actors to ensure that functions, ecological process, and wildlife habitat quality are protected by effective policies (see *Castaño-Rosa et al. 1a*, *Castaño-Rosa et al. 1b*, *Tuure et al.*).

Castaño-Rosa et al. 1a showcase a significant potential of smart energy systems and technology in the residential sector to support energy efficiency, indoor climate control, and healthcare. Smart home appliances may improve preparedness to prevent or mitigate the severity of the impacts of shocks such as extreme-weather periods and help to quickly readjust after. However, *Castaño-Rosa et al. 1a* argue that a human-centred approach is needed in the design and implementation phase to include key aspects of adaptability, flexibility, equity, and inclusivity.

Stakeholders in design and manufacturing process are also addressed in *Tuure et al.*, who state the need of including wood product suppliers in the early design stage, to support the design of structural elements based on manufacturers' knowledge about the limitations of different materials. Engaging the wood product supplier during the early stages is often challenging since tendering processes are typically conducted at a later stage. Thus, enhancing the standardisation of building components and their thicknesses can further streamline the design process. In general, *Tuure et al.* stress the importance of understanding how the material properties of wooden products dictate their most efficient areas of application. According to the authors, this knowledge helps to create a wooden building stock resilient towards premature obsolescence inflicted by errors in construction or design.

Future research

Future research should move from theoretical to empirical stage, for instance, *Lehtinen et al.* concentrated on simplified assumptions of the amount of daylight, where further research on the impact of the window design on the heat gains, heat losses, views to outside, different balcony locations, and indoor comfort circumstances should be conducted, not just theoretically but also in practice. Similarly, further study of the physical and visual connections and qualities between the apartment, neighbourhood, and the shared and transitional spaces is needed. This is also highlighted by *Castaño-Rosa et al. 1b* where further research is needed to test and adapt the proposed green infrastructure resilience considerations in different contexts, specifically those with different climatic, cultural, and built environment characteristics (e.g., no studies were included in Africa, Australia, South America).

As stated by *Castaño-Rosa et al. 1a*, political changes are needed too (macro-scale); future practices in the field and practical policy decisions must strengthen technological systems design with the end user (human-centred design and control approach) instead of solely focusing on the final product in order to promote a more resilient residential sector. *Tuure et al.* showcase how legislative changes at the macro-scale too would allow the use of novel construction techniques. Their applications would greatly benefit from unifying building control service practices related to the interpretation of construction solutions for wooden apartment buildings, overcoming traditional biases and educating the public about the safety, sustainability, and aesthetic appeal of timber constructions. Furthermore, it is important to highlight that, although timber is a renewable resource with a positive carbon handprint, it is crucial to thoughtfully evaluate the environmental impact of timber construction, considering the environmental impact related to over exploitation (ecological footprint).

Restore & Repair

While the symposium and call for papers intended to provide a fruitful starting point for considering existing buildings and their preservation as part of a response to a more sustainable built environment, there are only three papers in this special issue explicitly dealing with this theme. However, the restoration and repairing theme also intended to go beyond circular construction and the physical repair of existing structures, and to also unfold where restorative action is needed in society through, for example, democratic processes, care for nature and non-humans (biophilia, topophilia), and restoring health and well-being of all living-forms and the planet, as closely connected to the theme of resilience. More specifically, the call for papers asked for contributions around how we can create resilience while also simultaneously restoring past damage(s); what new regional, city and building typologies and different models of living, working and learning and ownership and management might be more restorative and adaptive to changing conditions and what re-thinking and re-imagination is required across and with different sections of society and with other disciplines. Looking at the theme of restore and repair more broadly, other papers in this special issue also fit in this theme (e.g. *Castano et al (1b)*, *Conlon-Dooley and Kolkwitz & Huuhka*), but were described elsewhere.

The three articles in this theme focus on values of the built environment and how they evolve over time. These values are connected to living standards, architectural heritage, and ageing of building materials. Two of the articles look at the existing building stock from today's perspective. Firstly, *Rugbjerg et al* discuss the indoor quality of Alvar Aalto's residential buildings from the perspective of the present sustainability discourse. Using today's values to examine buildings from the past is an emerging approach in architecture in search for a better understanding of how past buildings work and why they are valued in order to learn lessons for the future, e.g. for a more sustainable usage of the limited global material and energy resources.

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Kalakoski & Kuitunen study the planning process of the Northern railyard in Tampere and conceptualise the interplay between the experts' and participants' interpretations about the role of architectural heritage of the site in urban renewal. The research questions the established status of architectural and visual examination at the core of the evaluation of the city and its built heritage.

Finally, *Nicolas & Filz* explore the aesthetics, ageing, and material performance of reclaimed formwork wood in buildings' facades, highlighting that "the surface color changes with time, giving a new perception of beauty." By doing so, the authors shed light on the underutilised potential of byproducts from construction processes and hence, expand the conference theme from a mere building-to-building approach in reuse.

The idea of new standards and thinking about beauty, performance, usability and participation is indeed the overarching theme and novelty of this theme as part of the special issue. This special issue also highlights that we need to expand our understanding and acceptance of different qualities of existing materials as resources.

Key findings

The research by *Nicolas & Filz* proposes to consider wood formwork as a material with new qualities, instead of being a waste material. Finding new uses for wood formwork could help to conserve natural resources, reduce the amount of waste sent to landfill and decrease the environmental impact of the construction industry. To make use of this source of material, the research provides methods to evaluate the material's behaviour, performance and its overall aesthetics changing over time. Based on weathering tests and predictive simulations, the authors developed an algorithm-assisted design process which supports the application of reclaimed wood formwork according to the material properties which were found to differ at times significantly from those of untreated timber.

At a larger scale, the study by *Kalakoski & Kuitunen* suggest that the aesthetically biased interpretations of urban heritage still dominate the expert discourse where urban planning experts in Finland are claimed to emphasise the material and object-like nature of built heritage. The authors state that the expert-led reports and investigations are problematic because they focus on the material and instrumental dimensions of the built environment.

Finally, through analysing Alvar Aalto's Terassitalo (the terraced house) in Kauttua, (1937-38), and three other housing projects in Sunila, Kotka (1937) *Rugbjerg et al.* identify five qualities that can be ascribed to current notions of sustainable architecture that are still relevant today as we strive to learn lessons for housing design today and in the future. The identified characteristics are orientation, vegetation, empowerment, passive strategies, and thermal enjoyment.

Future research

In their research, the authors provide a series of recommendations for future research; for example, *Nicolas & Filz* advocate a more streamlined process of identifying the surface material properties of the reclaimed timber boards by employing machine learning for it to also become replicable in different contexts. The methodologies and test environment developed and adjusted for the research on upcycled wood formwork can be used and developed for different structures and materials to provide innovative approaches to re-use and upcycle construction materials. The authors further emphasise the need to extend the level of detail in which weather resistance, mechanical properties and surface properties are studied. More data from tests and prototypes can be expected to further support the knowledge of the boards' best application in real-life conditions.

Kalakoski & Kuitunen argue that the built heritage discourse in Finland led by experts often clashes with the public perception that looks at cities as spaces of interaction and the product of different user groups' interests. The authors suggest that narrow interpretations can cause damage to both, the planning process, and the built environment. Therefore, it is important to question the over-emphasis of the expert gaze in the planning processes and evaluation of the built heritage. Further research needs to investigate this discrepancy to gain a better understanding and to raise awareness for its risks in urban development.

In addition to studying the living comfort of apartments designed by Aino and Alvar Aalto, *Rugbjerg et al* suggest further research to investigate the technical aspects such as calculated and measured energy consumption based on the building layouts as well as the influence of solar gains and shading. More qualitative evidence needs to be collected about residence satisfaction and how building alterations have changed the expectations of comfort. Further comparing the case studies from *Rugbjerg et al* with similar housing projects from both the 1930s and today, could help "to fully understand the successful, and transferable sustainable housing design principles to the present day".

(A)mending architecture in the era of climate crisis calls for connection with nature and its complex ecologies, accepting the polyphony of human and more-than-human voices, and understanding architecture as a form of care towards the environment – both built and unbuilt.

Reflect and re-educate

The current environmental crisis is a crisis of climate, nature and biodiversity, as well as a humanitarian one. It is also a crisis of education. And like all fields of education, architecture balances between transmitting the well-proven practices and approved knowledge, while encouraging the new generation to challenge the status quo and conventions that have proven to be unsustainable. Although nowadays considered an academic field of study, the main aim of architecture education is to produce practicing designers. Due to its strong link to practice, as pointed out by *Nisonen et al.*, architecture education is heavily based on imitation of real-life design problems and hierarchical master-apprentice culture. As this tradition has proven to be effective in socialising the student to the designer identity, *Nisonen et al* point out that it may hinder the creation of inclusive, holistic and low-hierarchy learning environments that are essential in facing the current crisis.

As such, education in the field of built environment too, is in an urgent need for change. In the 14th ATUT symposium as well as in this special issue, scholars and educators were invited to share their views and experiences and to reflect on our field of research and practice, and how to re-educate the architects to face the challenges in times of this multi-faceted crisis. What are the implications and challenges of new situations and values for what, and how, we teach and learn? What approaches have been shown to be successful? And, just as importantly, what do we need to unlearn? The teaching related research presented in this special issue shows the creativity of educators and the variety of tools they utilise to integrate sustainability and restorative principles in built environment education.

Key findings

The traditional literature review by *Nisonen et al.* maps interdisciplinary scholarly debates on sustainable education with a focus on values and culture. Although the amount of research on teaching methods and pedagogies is increasing, there is only a limited amount of such research that concentrates on the values and cultures prevailing in architecture education, and what their connection is to unsustainable professional practices. The Modernist principles of architecture that also influence education (i.e. how we teach and what we teach) is a significant contributor to the climate emergency, as they justify the separation of humans and nature, and lead to the oppression of nature and vulnerable communities for profit. Probing discussions from various fields such as social sciences, environmental education and ecofeminism, *Nisonen et al.* propose an

educational transition towards a holistic worldview, that highlights the interconnectedness of all life. As a practical implementation for these values, the design studio, a typical setting for architecture education, should transit towards a platform of low hierarchies, dialogue and critical thinking.

Nawratek also dives into the deeply embedded structures of exclusion in architecture education in the paper “Choose your tools wisely”, referring to The Carrier bag Theory of Fiction by Ursula K. Le Guin (2019). Instead of considering the human being as a conquering species with a spear as their first tool, Le Guin proposes that the earliest tool of humans must have been a carrier bag, symbolising the un-linear narrative of human origins, a continuous process and multiple voices. The built environment too should be considered as a constant state of becoming and growing through increasing complexity. *Nawratek* positions Radical Inclusivity, rooted in philosophy by Mikhail Bakhtin, as a framework for more inclusive architectural practice and pedagogy. As an application for these values, a design studio using polyphony and dialogic approaches and involving non-humans is unfolded.

The holistic attitude towards the environment can also be seen in the way architects perceive materials, as presented by *Camilli & Brown*. Their paper, exploring a novel pedagogical framework in teaching timber architecture, reaching beyond the conventional conception of wood as a sustainable material that has a great potential in cutting down carbon emissions in construction. Instead of seeing timber as something passive to be exploited, it should be seen as a living entity with a complex ecology, that influences the design of buildings. *Camilli & Brown* posit that thinking ecologically is not only about the sustainability of a single material, but comprehending the complexity of an ecological system. The pedagogical framework presented in the paper encourages the students to think about wood in a more complex way, but the hands-on approach and direct contact with the material also helps to demystify the students’ (mis)conceptions about sustainability.

Equally, transformation as a restorative practice is an important shift in architecture. *Rubio Hernandez et al.* explore its potential in architecture education. While transformation is the subject of heritage and conservation courses, reutilisation is increasingly part of more general design courses. The paper merges a literature review on the concept of transformation as a research-by-design strategy, and a critical review of a pilot course utilising transformation as a theoretical framework, as well as a practical learning tool. Based on their findings, *Rubio Hernandez et al.* propose that the concept of transformative pedagogy can contribute to the discipline of sustainable architecture, as it nurtures new generations of architects to address the complex and interconnected challenges of creating sustainable built environments.

Finally, the paper by *Vartola* presents a pedagogical experiment: an introductory online research course that applied Tyson Seburn’s role-based Academic Reading Circle groupwork model to a master’s level course on architectural research. The aim of the course was to support the researcher skills and researcher identity among architectural professionals, and to increase their understanding on the rich methodological opportunities in the field of architectural research. The study explains the pedagogical setup and implementation of Academic Reading Circle model and discusses possibilities for further development, based on teacher’s as well as students’ experiences.

Future research

The papers by *Nisonen et al.* and *Nawratek* call out for a wider shift in the value base that architecture education is based on: a practitioner with a holistic understanding on the interconnectedness of things within ecosystems and

society; and as a critical thinker with a comprehension of the built environment as a process of constant becoming. (A)mending architecture in the era of climate crisis calls for connection with nature and its complex ecologies, accepting the polyphony of human and more-than-human voices, and understanding architecture as a form of care towards the environment – both built and unbuilt. The practical teaching implementations presented in educational papers of this journal show this shift is already happening in academia with a diversity of approaches. As put by *Nawratek*: “It is, however, a daunting perspective to do things differently, get rid of the spear and use the carrier bag instead. It is complicated and painstaking work, all that weaving in and out of the fabric of the world, creating new bonds, negotiating, and mending, caring for and repairing what is torn and damaged. On the other hand, we are already doing it by constantly questioning what we do and how. Echoing the words of bell hooks, our classrooms and design studios can become the academy’s most radical space of possibility.”

As we go on exploring the depths of the carrier bag, further research is needed on how this value shift is permanently established as a part of architecture and built environment education, in terms of curriculum content but also teaching methods and pedagogies used, learning environments and teacher skills, as well as national and international objectives of the field’s education. Despite the existing hierarchies and conventions, academia is known to be a haven for exploring novel approaches. A question remains, how these new conceptions find their way to the construction industry and societal stakeholders that ultimately are fundamental in delivering a restorative world.

The revalue and reform theme asks the question whether we could achieve a resilient, restorative, diverse, inclusive and equal sustainable built environment with the current mindset and values that has made us complicit.

Revalue and reform

Our current development of the built environment has been exploitative, extractive and unequal. The revalue and reform theme asks the question whether we could achieve a resilient, restorative, diverse, inclusive and equal sustainable built environment with the current mindset and values that has made us complicit. The six papers in this section accept, argue for and explore what new values, reforms, and ways of ‘seeing’ and working are needed to achieve a sustainable built environment. Several other papers in this special issue also fit in this theme but were discussed elsewhere (e.g. *Nisonen et al*, *Nawratek*, *Castano et al (1b)*).

Three papers cover the carbon impact of materials. *Conlon-Dooley* investigates the homeowners’ motivations and value-systems and the associated embodied carbon emissions of transformations and alterations of suburban houses in Dublin. The ICE database was used, providing simplified estimations of embodied carbon. By applying this mixed method approach, the author sheds light on the negative carbon consequences of building alterations that aim to improve the living conditions within the case studies. It is crucial to understand the impacts of the homeowner’s and architects’ decisions on the environment in order to reframe and re-value design decisions which can positively empower discussions at the early design stages. This requires also a value-system change in architecture by architects and other stakeholders (e.g. planners, local authorities).

Westerholm put the Finnish Ministry of Environment’s Life Cycle Assessment (LCA) requirements and database to the test, comparing the LCA results of five recently constructed residential multi-story timber buildings with a conventional concrete building and current climate goals. In doing so *Westerholm* highlights that the design of what we consider to be low carbon timber buildings need a rethink to ensure climate goals are met.

An important part of this rethink may lie in *Kolkwitz & Huuhka’s* research, who investigate building stocks as valuable urban mines of material and spatial resources. Their reuse and adaptation can substitute for new construction and

virgin material extraction which mitigates resource exploitation and reduces the initial carbon spike caused by construction. *Kolkwitz & Huuhka* use Material Flow Analysis of two Finnish cities over a nearly 20-year period to understand how construction and demolition are enabled and driven by a series of factors conditions and how they influence the urban development. *Kolkwitz & Huuhka* also highlight the need for a holistic circular economy approach including a focus on social issues, well-being and biodiversity in re-valuing our built environment practices and that this must be done with a multitude of different actors.

Lindgren's research and that of *Kuo & Filz* focus on these different actors. *Lindgren's* research specifically focuses on human aspects of an ambitious low carbon case study in Helsinki, Finland, using Actor Network Theory to understand how different stakeholders influenced decision-making over a nearly 10-year period from inception to completion of the case study. Of importance, as was in *Conlon-Dooley's* work, were the drawings and other documents (e.g. building permits) to gain a full understanding of the design and decision-making processes. *Kuo & Filz* further investigated collaborative networks in procurement to understand how innovations and ambitious goals and knowledge and actions can be met in the real-world. They use Finland, which has been ranked top in the EU for progressive procurement policy, as a case to study procurement networks. However, *Kuo & Filz's* research highlights the lack of research in architecture on this topic.

Finally, *Parkatti* draws the focus on the level of the city structure. *Parkatti's* article examines closed blocks as basic units of the city and discusses the block, more explicitly the closed block, as its own unit in the urban environment and how blocks as such take place and are given place in the urban environment and its development. *Parkatti* managed to capture many interesting dimensions of the diversity of what a neighborhood is. A block is, in addition to an urban unit and architectural component, also a thought and a social, material and affective environment. *Parkatti* suggests that defining and redefining such traditional components of urban planning, may offer urban spaces that become widely understood and accepted. However, this does not mean that the tradition of perimeter blocks should be respected dogmatically.

Key findings

Conlon-Dooley, like *Lehtinen et al* in Finland, found that connection to outside and to nature and particularly access to good sunlight and daylight was a crucial aspect for homeowners in Dublin. Improving these aspects was a main driver for home alterations which, however, further contributed to the negative embodied carbon impact of the altered dwellings. Related to this but to multi-story residential buildings in Finland, *Westerholm* observed that while timber construction significantly reduces embodied carbon emissions and total carbon emissions compared to a concrete structure, overall current timber-based construction methods are still insufficient to achieve current climate goals and that further development of multi-story timber buildings is still necessary. This is because a significant proportion of timber buildings have other carbon intensive materials, especially intermediate floors and walls. *Westerholm's* critical stance towards multi-storey timber construction creates a complementary contribution to *Tuure et al.* (discussed in Resilience theme) in which the sustainability of wood in construction is perceived as a given. The guest editors also note that carbon sequestration can become a perverse incentive and can lead to unintended consequences where the inefficient and inappropriate use of timber products can be specified as a means to achieve carbon neutrality (or claim to create a carbon positive building) just to offset carbon emissions, reducing the availability of wood products in other buildings.

Part of this necessary rethink is also understanding the patterns and mechanisms of urban development as related to material flows as part of *Kolkwitz & Huuhka's* research. They found that the age at which buildings get demolished varies significantly depending on a series of factors like their location, building type and size which often, was smaller compared to new buildings. *Kolkwitz & Huuhka* argue that part of the solution to reduce the urban embodied carbon footprint from construction lies in utilising existing buildings, which connects to Conlon-Dooley's work on transformations of homes as part of circular economy principles. *Kolkwitz & Huuhka's* Material Flow Analysis method aims to link building flows (construction, demolition) with resultant material consequences (e.g. demand for materials and disposal of demolition waste) and highlight the lack of reliable data but also a certain disconnection between building and material flows. This gets explained by different typologies using different materials (e.g. low rise residential in timber construction versus concrete in multi-story) and demolition of warehouses versus offices which results in qualitatively and quantitatively different outflows of materials.

Lindgren's research highlights how misalignment between systemic and concrete objectives led to the final building design not meeting the original competition goals. Lindgren argues that setting out a more detailed plan and framework early on would have helped protect the initial design stage values but that sufficient time has to be allowed for this. Too much freedom to develop and innovate, paradoxically led to business-as-usual approaches. Related to this, *Kuo & Filz* highlight that current networks are held by top companies which may stifle innovation and stepping out of the status quo. They also advocate that engineers, architects, contractors and researchers need a "better understanding of the environment in which our creative solutions need to be accepted, adopted, and eventually thrive, in addition to merely considering the solutions themselves", linking back to the role we can play in influencing collaborations and policymaking through our expert knowledge to ensure innovative ideas make it to the real-world. Finally, *Parkatti* argues that there is something timeless and universal in the closed urban blocks, and these qualities should be examined, analysed and applied to contemporary city planning.

Further research

Many of the papers in this sub-theme not only highlight the need for further research, but also of developing the research methods and data analysis methods themselves further. For example, *Conlon-Dooley* highlighted the value of observational drawing and as part of understanding and communicating different values to homeowners, and more research is required into this area how this can be fully exploited to that extent.

Different tools also need exploring in terms of what to use for embodied carbon calculations – as expressed by *Westerholm*, though the value of swift and simplified calculations as undertaken by Conlon-Dooley also show the value and use for different purposes. *Westerholm* also highlights that further development of multi-story timber buildings is still necessary as is research into their actual performance and their potential in meeting urgent climate mitigation goals. Especially intermediate walls and floors and insulation materials hold a large decarbonisation potential. *Westerholm* highlights it is important to reform existing regulations and to develop structural solutions that can achieve fire safety and good acoustics while meeting climate mitigation goals. *Westerholm* highlights that this involves a multitude of stakeholders, beyond architects and engineers but also policymakers, clients and manufacturers and suppliers.

The importance of not only involving stakeholders but also ensuring productive collaboration and meaningful decision-making was highlighted in *Lindgren's* and *Kuo & Filz's* research; further research is needed to test different ways of doing

this, as well as further investigation into the research methods and data analysis. Furthermore, *Kolkwitz & Huuhka* highlight the lack of material and environmental indicators for buildings and that a circular approach requires reduction of outflows (demolition waste) and that spatial and functional adaptation are part of a circular economy approach, prioritising not building and utilising existing available space. And this requires a reframing and revaluing of current practices by a multitude of different stakeholders to bring about this change.

To make (a)mends, it is not enough to communicate architecture's impact on the planet but also to propose, communicate, test and validate new strategies and solutions across different scales.

Summary

This special issue collected a great diversity of papers asking important questions and giving some partial answers. The majority of papers highlighted that a green transition or radical transformation cannot be achieved by architects alone but together with a multitude of different stakeholders. However, more research is required into how interdisciplinary collaboration can be achieved in reality to support climate goals. Several papers did not simply conclude about the importance of this collaborative necessity, but took it as starting point and made the subject of collaboration in and of itself as a research enquiry (e.g. *Lindgren* and *Kuo & Filz*); more of this work and development of research and data analysis methods are required.

We also need to look at impacts more holistically, so not just embodied carbon but also operational carbon, health and well-being, impact on biodiversity etc. Architectural researchers need to join forces with other experts to create new understandings and bring architectural knowledge to these topics of enquiry and key findings back into architecture. This special issue further highlights contradictory aspects of sustainability such as the negative carbon impact of home alterations to improve quality of life (*Conlon-Dooley*) as well as the often-overlooked negative environmental impact associated with timber construction due to high amount of non-timber products and materials still being used (*Westerholm*). Understanding these constraints is of great importance to support the decision-making towards holistically sustainable approaches.

Also unknown is ultimately when we theorise of what may bring about change and how this can be upscaled with urgency and in which contexts this may hold true. For example, using new pedagogical methods and curriculum content: will this be reflected in a different architecture being created in reality? How do we know that what we propose will actually work in reality? Several contributions in this special issue studied building projects and large-scale developments retrospectively (e.g. *Conlon-Dooley*, *Kolkwitz & Huuhka*, *Lindgren*, *Rugbjerg et al.*, *Tuure et al.*) and hence, stand as a kind of quality control of real-world built examples. Their contributions highlight the importance for architects and other stakeholders in planning to return to site and critically evaluate their work's impact. The findings from these assessments need to be utilised in improving the quality of future projects and research is not only needed to collect evidence but also to disseminate across all areas of architectural research and practice.

Not all papers expressed the same urgency for radical change; while acknowledging a radical value system change is needed, conclusions did not always follow through in then offering radical solutions that could help bring about this value system change or this radical transformation that is so urgent and necessary. This suggests that also in the area of architectural research, much is to be done for us to step up our own awareness of the scale and urgency of the task ahead, and our role within this. This will also require architectural research to undergo a radical but necessary value-system change and requires researchers to being able to critically assess and allocate their own work in the broader sustainability discourse.

To make (a)mends, it is not enough to communicate architecture's impact on the planet but also to propose, communicate, test and validate new strategies and solutions across different scales. This requires a system-change and value-system change not only in the architecture profession, but also in architectural research itself.

Making (A)mends special issue guest editors,

Sofie Pelsmakers

Mari-Sohvi Miettinen

Raúl Castaño-Rosa

Mario Kolkwitz

Iida Kalakoski