

BACK TO THE FUTURE!  
THE NEXT 50 YEARS

# BOOK OF ABSTRACTS

**The 51st International Conference of  
Architectural Science Association (ANZAScA)**

29 November - 2 December 2017  
Victoria University of Wellington, New Zealand

MARC AUREL SCHNABEL (Ed.)

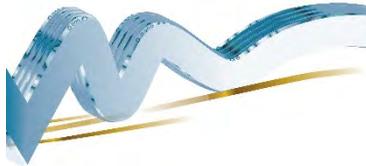


# **Back to the Future: The Next 50 Years**

*51<sup>st</sup> International Conference of the Architectural Science Association  
(ANZAScA)*

## **Book of Abstracts**

Edited by  
Marc Aurel Schnabel



# Back to the Future: The Next 50 Years

51<sup>st</sup> International Conference of the Architectural Science Association (ANZAScA)

Hosted by School of Architecture, Victoria University of Wellington

29 November – 2 December 2017



Edited by Marc Aurel Schnabel

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# Foreword

The Architectural Science Association (ASA), formerly known as the *Australian and New Zealand Architectural Science Association (ANZAScA)*, is an international organisation, the objective of which is to promote architectural science, theory and practice primarily about teaching and research in institutions of higher education.

In 2017, ASA embarks into the future – again. 54 years ago, Prof Henry (Jack) Cowan, Mr Derrick Kendrick and other architectural science academics held the first meeting to start the formation of the association. Since then, nearly every year, the ASA is holding an annual international conference, drawing on not only architectural scientists but also researchers and practitioners outside tertiary educational institutions. Papers discuss cutting-edge research across Architectural Science as well as areas dealing with architectural (science) education, digital design, historic preservation of buildings, landscape architecture and urban design. The annual conferences draw top academics, researchers and practitioners from all continents around the world. Standing on the shoulders of our work of the past 50 years, the 51<sup>st</sup> instalment of the conference explores avenues that will have the significant impact on in the development of Architectural Science in the next 50 years. Hence, it is timely to ask, *What are the future trajectories in our field?, What are the visionary researchers and practices that will influence our built environment over the next 50 years?,* and more importantly, *Do we now have a better-built environment, more responsible architecture, and more environmentally sustainable design, than we did 50 years ago?* The theme of this 51<sup>st</sup> International Conference of the Architectural Science Association (ANZAScA) is, therefore: “Back to the Future: The Next 50 Years”. This publication presents 79 accepted papers presented at the Conference, hosted by the School of Architecture, Victoria University of Wellington, Wellington, New Zealand, 29 November – 2 December

2017. Details of the Conference are currently at [www.asa2017.victoria.ac.nz](http://www.asa2017.victoria.ac.nz), and each paper is archived at ASA's website: [www.anzasca.net](http://www.anzasca.net).

Each paper in these proceedings has undergone a rigorous peer review process. Following the call for abstracts in March 2017, a total of 193 abstracts were submitted for review. Each abstract was blind peer reviewed by two members of our International Scientific Committee, made up of 82 experts from ten countries, across four continents. Of these, 159 abstracts were accepted for development into a full paper. Following this, 141 full papers were submitted, each of which was again blind peer reviewed by two to three members of our International Scientific Committee. Based on the reviewers' recommendations, 85 papers were accepted for presentation at the conference, and 79 are included in this publication.

On behalf of the Organising Committee, I would like to sincerely thank all of the people who have contributed to realising this Conference. Thanks go to all the authors for working hard on the papers and presentations. I am very grateful to members of the International Scientific Committee for their rigorous reviews, without which we would not have been able to maintain and improve the quality of the papers. I am deeply grateful for those who have worked behind the scenes: from the School of Architecture, particularly Shuva Chowdhury, who went several extra lengths, Yingyi Zhang, and Selena Shaw; my colleagues at the Office of Faculty of Architecture and Design, various people around Victoria University of Wellington, and members of ASA Exco, in particular Guy Marriage, who came up with the conference theme. We hope that the papers presented in this publication reflect on the theme and the role that Architectural Science has played and will continue to play for the betterment of our built environment.

*Marc Aurel Schnabel, Wellington, 2017*

# CONFERENCE THEME

In celebrating the 51st International Conference of Architectural Science Association (ANZAScA), we look forward into the future and seek the presentation of visionary research and practice that will influence our built environment over the next 50 years. Standing on the shoulders of our work of the past 50 years, the conference explores avenues that will have the great impact on in the development of Architectural Science. The theme calls for relevant ideas from a variety of domains reflecting and speculating on future trajectories of architectural science to reveal possible phenomena, factors and forces that will influence these trajectories with an exploratory perspective.

The 51<sup>st</sup> International Conference of the Architectural Science Association (ANZAScA) is hosted by the School of Architecture, Victoria University of Wellington, New Zealand. We cordially have been inviting architectural science and design researchers, educators, design professionals, stakeholders, and students to present their critical thoughts, discuss new ideas, and engage in our debate:

## **“Back to the Future: The Next 50 Years”**

The Conference Proceedings are grouped into nine chapters:

- Vision (trajectories, speculations & phenomena)
- Theory (philosophy, methodology, culture & society, history)
- Context (landscape, urban design, heritage)
- Design (buildings, details, (digital) design)
- Simulation (calibration & validation, virtual, augmented & mixed environments, climate change)
- Architectural Science (environmental quality, well-being, health)
- Modes of production (construction technology, productivity, BIM, CIM, robotics, innovative technology, automation)
- Practice, Education & Profession (building code, professionalism, development, safety, pedagogy)
- Culture (culture, indigenous, tradition)

Contributions of the above groupings of research-areas have been sought to cover relevant content relating to architectural science of the disciplines of architecture, engineering, building science, design, urban- & landscape design, computer science, philosophy, psychology, mathematics, humanities, and other relevant disciplines, who can contribute to the discussion. Researchers and doctoral students have been invited to submit research papers and critical essays and to attend the conference to widen our discussion about the future trajectories of architectural science.

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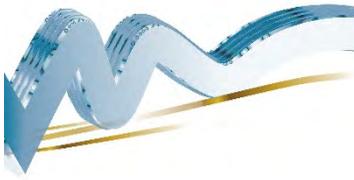
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## Keynotes

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## **Diving into Potential**

*Architecture taking Care and Responsibility for our Living System and the Future*

Jerome Partington

*Sustainability Manager  
Jasmax Design, Auckland, NZ*

**Abstract:** A brief dive into Jasmax' s sustainability journey, to reflect on the evolution of our sustainable design vision from green buildings to regenerative development. By embracing the unique potential of bountiful Aotearoa NZ, Jasmax has learnt to challenge ourselves to be better and do our best as we encourage others to do the same. Jerome describes Jaasmax' Auckland Office roots; the high-performance Green Star + NABERSNZ Certified NZI Centre, projects that provided the foundation to embrace and pilot the international Living Building Challenge for Tuhoē's Te Kura Whare, now the first Living Certified project outside the USA, and how this inspiration and client collaboration became the impetus for both Ara's Kahukura, engineering and architecture school, and the new flagship living education centre in Auckland – project proof, that challenges all of us to look deep for our own potential and the value of consciously working together for the health of our living system.

# Towards a Digital Building Culture

Russell Loveridge

*Managing Director Senior*

*Swiss National Centre of Competence in Research (NCCR) in Digital  
Fabrication, Zurich, CFH*

**Abstract:** Digital tools and numerically controlled fabrication processes are already redefining manufacturing in many industrial sectors. However, architecture and construction is the single largest industrial sector focused on production, and yet it is also one of the most resistant to the adoption of new technology. Initiated in 2014, the Swiss National Centre of Competence in Research (NCCR) Digital Fabrication aims to foster a revolution in construction through the seamless combination of digital technologies with material and physical building processes. Researchers across academic disciplines collaborate to develop ground-breaking technologies while concurrently remaining aware of the issues of economy, ecology, societal impact and the very important role that architecture plays in defining place and culture. This keynote presentation will highlight research being undertaken within the NCCR Digital Fabrication and will discuss the innovative and collaborative approaches needed to tackle such programmatic, economic, and social challenges of digitally augmenting the construction of our built environment.

# Stories of Resilience

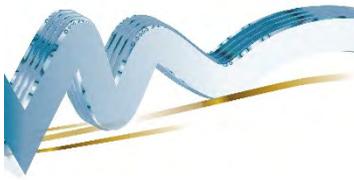
Anica Landreneau

*Principal and Director of Sustainable Design  
HOK, Washington DC, USA*

**Abstract:** An exploration of projects past, present and future that are designed to adapt to shifts in climate while transforming the economic, social, cultural and urban fabric of the cities we live in. Case Studies include: Pearl Harbor, HI; Los Angeles, CA; Houston, TX; Washington, DC; Cartagena, Colombia; and Jeddah and Riyadh, Saudi Arabia

# Culture

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# **'Primitive Attitudes' and Traditional Practices**

## *Looking Back For Sustainable Solutions to Future Flood Disasters*

Shenuka de Sylva, Brenda Vale and Robert Vale

*Victoria University of Wellington, New Zealand*

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**Abstract:** Global warming, even with a 2°C rise in temperature as per the Paris agreement, will mean more flooding events, as warmer air holding more moisture leads to greater rainfall. Human settlements have grown up by water, whether sea or river, as this gives access for trading. Such settlements in both the developed and developing world will have to learn to cope with more and greater flood events. Many poor communities are already forced to live on flood prone land that those with more money avoid. The global increase in flood disasters related to natural hazards, and the massive economic costs of these, gives the opportunity for a deeper interrogation of the issue. This paper summarises the link between global warming and flooding and then uses two empirical case studies of vernacular communities to contrast their ways of living with flooding with western attitudes of trying to avoid it. As it becomes more obvious that rapid urbanisation and the vast infrastructure developments that support urban lifestyles play a major role in these disasters, there is no better time to look back in time and beyond westernised worldviews for future solutions that are favourable to both people and environment.

**Keywords:** Floods; traditional practices; living with inundation; learning from the vernacular.

# Reclaiming Heritage by Retelling 'The Thing' in Virtual Reality

*Decoding Walled City of Lahore*

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**Abstract:** The focus of this work is on representing the surrounding of Masjid Wazir Khan in Lahore. It is explored how the computational tools and translations can promote a participatory process to build up a digital archive. The concern for abandoned spaces in heritage sites is examined by observing user interaction with heritage displays through different media. The paper presents two stages of a digital heritage work. Providing the details of an exhibition, the initial stage informs the reader about the background of the project. Explaining the necessity of the shift from analog interaction tested in the exhibition to the digital, the paper elaborates on the deployed workflow. Primarily, the front façade of Masjid Wazir Khan and the square at its entrance are visually surveyed by photography. Secondly, the photographic survey is used to build a 3D virtual model of the site by using a photogrammetry 3D modelling software. Thirdly, the 3D model is imported into an immersive virtual reality system through which users are teleported to the site in Lahore. The paper demonstrates the qualitative findings of the deployed digital workflow that links the heritage context to distant users, providing technical details of the deployed modelling process.

**Keywords:** Photogrammetry; digital heritage; user experience; virtual reality; Walled City Lahore.

# Between Architecture and Construction

## *A Site of Integrated Learning*

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**Abstract:** In 1994 the School of Architecture and Construction at Unitec Institute of Technology received its first intake for a new Bachelor of Architecture programme. The co-location of this architecture degree within a school that contained construction programmes (Bachelors of Building and Quantity Surveying) was seen to be of collaborative benefit. However, within three years, this new theoretically beneficial formulation had split. Contemporaneously, the University of Newcastle, Australia had adopted a one hundred per cent Problem Based Learning (PBL) model to facilitate stronger relationships for learning with the local profession and construction industry that ran for 10 years. Recently Unitec MARCP students engaged in an integrated design and technology studio project for a comparatively short period of six weeks. In a contemporary education world where collaboration and cross-disciplinarity are the language of currency this examination of the processes of growth and decay in these three events at Unitec and Newcastle provide insights into the potentials and pitfalls of such constructions. This paper will discuss upon these events to draw out issues that might illuminate future attempts to develop integrated learning practices for architecture and construction.

**Keywords:** Pedagogy; integration; design; technology.

# A Visual Consultation Method for Understanding Spatial Use in Remote Aboriginal Housing

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**Abstract:** Appropriate housing within remote Aboriginal communities is a chronic issue. With government funded, public housing projects aiming to procure maximum housing units for minimum cost, in the shortest period, cultural aspects of housing provision are often neglected. Insufficient and ineffective consultation is a significant factor in the deficiencies found in the procurement of public housing situated in remote Aboriginal communities. The paper proposes that addressing spatial use patterns through community consultation in housing has the potential to enhance housing quality. Due to the time and the expense associated, individual client consultation in current procurement strategies is limited, at best, generally resulting in housing which inhibits social function and cultural expression. This paper reports on a visual consultation method to overcome the economic and time restitution of typical housing procurement in remote Aboriginal communities. The paper presents “The House Game” an interactive consultation method that facilitates the understanding of spatial use patterns. The paper demonstrates how these patterns can be used for post-occupancy evaluation and the formulation of architectural briefs for appropriate housing.

**Keywords:** Visual consultation method; spatial use patterns; remote aboriginal housing.

# Developing Culturally Appropriate Spatial Standards for Dwellings in New Zealand

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**Abstract:** Crowding is a pressing issue in New Zealand residential housing. Over the next thirty years, our population is expected to grow to 6 million, up from its current 4.6 million. With this, it becomes increasingly important to provide guidance to designers on how to best design spaces so our burgeoning population can thrive. Crowding in New Zealand is particularly a problem when multi-generational families increase loads on internal amenities, with homes often stretched to accommodate more than they were designed for. Spatial standards have been introduced in New Zealand that help to mitigate the issue, but do little to address the unique spatial needs of our culturally diverse population. This paper assumes the need for a universal standard to guide building in this country, and asks: How can New Zealand determine a spatial standard for minimum dwelling size that considers the needs of our culturally diverse population? It examines existing spatial standards, assessing how they address the spatial requirements of various cultures, and, a set of design guidelines that articulate spatial relationships for culturally sensitive dwellings. This paper outlines an approach for amalgamating these documents, making recommendations for the development of a universal standard appropriate for New Zealand.

**Keywords:** Housing; standards; appropriateness; culture.

## Context

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# The Impacts of Social and Physical Context on Neighbourhood Satisfaction in the Suburbs

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**Abstract:** Neighbourhood satisfaction is a key contributor to psychological wellbeing and sustainable community. This paper asks whether physical built environment characteristics or social factors have the greater impacts on satisfaction with residential suburban neighbourhoods. Quantitative analyses via a survey of 247 residents living in three Australian suburbs were conducted. First, Pearson correlations was used to investigate the relationship between perceived neighbourhood satisfaction and a number of independent social and physical neighbourhood design variables. The results showed that neighbourhood satisfaction is strongly associated with physical design characteristics, even allowing for the interaction of sociodemographic variables. Hierarchical multiple regression was then conducted to examine the extent to which five groups of physical characteristics impacted neighbourhood satisfaction: (1) street layout, (2) pedestrian environment, (3) neighbourhood connectivity, (4) public space provision, and (5) dwelling form when socioeconomic factors are controlled for. Physical built environment characteristics such as provision of open spaces, street type and trees coverage were more significant predictors of residents' satisfaction than socio-demographic factors (income, length of residency and number of household members). This indicates that well designed neighbourhoods can be more attractive for residents. The findings also suggest that satisfaction associated with the social and physical needs of residents can be critical influences that planners and decision makers need to consider when designing for sustainable communities in contemporary suburban contexts.

**Keywords:** Satisfaction, Physical environment, Neighbourhood, Sustainability, Socio-demographic factors, Suburbs.

## Looking Ahead

### *Investigating performance Art with Schoolchildren as a Catalyst for Urban Redesign*

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**Abstract:** This paper describes the background to a recent and ongoing research project into the effect of performance art on environmental learning among a group of 8-10-year-old inner-city schoolchildren who participated in an environmentally-focused process theatre performance during a recent Fringe Festival in Auckland, New Zealand. As part of this investigation, a student researcher is carrying out a simple co-design process with the schoolchildren, towards making the Auckland cityscape more child-friendly through urban redesign. Focus groups with the schoolchildren have been conducted and interviews with some key stakeholders (e.g. parents, teacher), as well as analysing school work completed by the children. Early findings indicate that the children revelled in taking part in the whole performance experience, especially due to meeting and talking with adults during the performances. They also have clear, yet naïve, ideas for improving their city, which indicates their interest and concern for it. This included them raising issues such as traffic, dirty and building-dominated appearance, homeless people and the need for alternative housing and transport. However, while many children claimed the experience has changed their behaviour, they were less clear on the specifics of this and further analysis is planned.

**Keywords:** schoolchildren; performance art; urban design; environmental education

# Agricultural By-products for the Production of Building Insulation in New Zealand

## *A first Look*

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**Abstract:** New Zealand's increasing population and economic growth is boosting the need for more buildings, and consequently more building materials. Increasing manufacture of building materials leads to the production of greenhouse gases as well as the depletion of finite natural resources. Approaches that reduce the environmental impact of construction can help achieve long term sustainability. One approach is the use of natural or recycled materials. Some agricultural by-products have characteristics similar to materials already used to manufacture insulation and could be an alternative bio-based solution. Rigorous analysis of the viability of this alternative is needed before such materials can be considered. This paper presents a literature-based study of technical research and opportunities evident in the New Zealand market.

**Keywords:** Insulation; bio-based material; feasibility; agricultural by-products.

# Reverberations

## *Architectural Practice through the Lens of Multiscale Dynamical Fractal Systems Theory*

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**Abstract:** The postmodernist emphasis on context encourages us to pursue understandings of the communities within which buildings exist as a central component of the discourse of architectural practice. However, significant challenges to this approach exist, since the contexts in question subtend a wide range of spatial and temporal scales, and are driven by self-referential dynamical systems that are centred on the psychologies of agents who perform complementary and overlapping roles as building-dwellers and community-dwellers. This work addresses this epistemic gap by exploring the causal relations between object and context through the introduction of the concept of building-as-community. Specifically, this entails a radical rejection of the dichotomy between buildings and communities, arguing that together they form a complex system that can be explored from the ontological perspectives of dynamical systems theory and fractal geometry; the spatiotemporal patterns thus elucidated can helpfully inform aspects of architectural science. For example, the interactions within (and without) a building can be understood as a microcosm of the interactions between the building and its embedding community, suggesting a shift in emphasis towards a unified, congruous framework for understanding both buildings and communities as interrelated phenomena operating on non-coextensive but nonetheless overlapping and intertwined spatiotemporal scales.

**Keywords:** Dynamics; community; multiscale.

# Identifying a Model Urban Precinct

## *Impact Of Built Mass for Thermally Comfortable Living in Tropics*

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**Abstract:** The Research investigates the behaviour of tropical micro-climates in urban precincts, affected by building masses; focusing in to a commercial zone in Colombo Central Business District. The tendency of growth in developing countries contributes by blocking wind path ways and cycling the solar rays of reflection resulting Urban Heat Islands. Three case study areas with similar urban microclimates and activity patterns were selected for the investigation. The building mass, aspect ratio, height / width ratio, air temperature, sky view factor (SVF), velocity of the wind and relative humidity are considered as basic attributes. Measured data were analysed by the software RayMan-Pro to provide Physiological Equivalent Temperature (PET) with a conceptual and suggestive attribute in a model urban precinct, for better thermal satisfaction levels. The qualitative changes of each precinct have been identified by onsite climate surveys; while thermal Indices behave according to Interrelationships in micro climates. The results demonstrate the urban precincts with dense building mass are having a higher air temperature levels in addition to PET behaviour, wind and shadings by SVF cannot participate positively when considered separately, but altogether make healthier micro climatic conditions with the best level of building mass composition in urban precincts in tropics.

**Keywords:** Urban microclimate; sky view factor; urban precincts; albedo.

# What Makes A City 'Biophilic'?

## *Observations and Experiences from the Wellington Nature Map Project*

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**Abstract:** Despite clear benefits of maintaining human relationships with nature, people increasingly live in urban settings and spend high proportions of time indoors. Both of these trends are increasing globally. This means it is vital to ensure that future cities are designed, created and managed to enable meaningful human / nature connections. Cities that are examples of urban environments where human / nature relationships are innately encouraged and are part of residents' daily experiences have been termed 'biophilic cities'. Wellington, New Zealand is one of a select few cities internationally that has been identified as a biophilic city. In order to test the validity of that claim, this research set out to use GIS mapping to determine specific areas, sites and buildings that could be identified as being biophilic within Wellington. In order to do this, a unique biophilic cities framework was devised where 30 unique characteristics of biophilic cities were identified and used to map Wellington. Results from this mapping research are examined. Key findings include that when several identified aspects of biophilic design are nearby in urban settings, experiencing these through time while moving through a city enhances the positive effects of these elements.

**Keywords:** Biophilic design; urban design; urban nature; mapping.

# Coastal Retreat

## *Future Implications for Architecture in New Zealand's Coastal Hazard Zones*

Chris Murphy

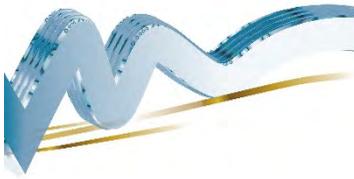
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**Abstract:** Climate adaptation strategies evident in New Zealand local authority planning schemes suggest an awareness of coastal hazard issues caused by global warming and subsequent sea level rise. Coastal land identified as hazardous has limits on new residential development. Alterations to existing buildings are required to be within specific floor level heights and constructed of materials that lend themselves for removal. The emphasis is, however, on managing the impending hazard, rather than reducing or removing the risk. Limits on local authority powers and the fee simple entitlement of ownership mean the ability to order removal of buildings is limited to dangerous health and safety issues of immediate concern. Planned building retreat or removal in the face of future uncertainty is not possible without the cooperation of the landowner, a challenging scenario given the high cost and desirability of coastal land. This paper will overview key literature surrounding climate change adaptation policy as it relates to coastal hazards and sea-level rise. It will evaluate and compare the coastal hazard adaptation policies of two district schemes within New Zealand and suggest future strategies around the concept of “managed retreat” that may serve to minimise the potential damage to buildings (and their owners) living within hazardous coastal zones.

**Keywords:** Environmental policy; adaptation; local government.

# Simulation

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# Speculations on the Representation of Architecture in Virtual Reality

*How can we (continue to) simulate the unseen?*

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**Abstract:** This paper discusses the present and future possibilities of representation models of architecture in new media such as virtual reality, seen in the broader context of tradition, perception, and neurology. Through comparative studies of real and virtual scenarios using eye tracking, the paper discusses if the constantly evolving toolset for architectural representation has in itself changed the core values of architecture, or if it is rather the level of skilful application of technology that can inflict on architecture and its quality. It is easy to contemplate virtual reality as an extension to the visual field of perception. However, this should not necessarily imply an acceptance of the dominance of vision over the other senses, and the much-criticized retinal architecture with its inherent loss of plasticity. Recent neurology studies indicate that 3D representation models in virtual reality are less demanding on the brain's working memory than 3D models seen on flat two-dimensional screens. This paper suggests that virtual reality representational architectural models can, if used correctly, significantly improve the imaginative role of architectural representation.

**Keywords:** virtual reality; representation; perception; neurology.

# A Workflow of Data Integrating and Parametric Modelling in Urban Design Regulation

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**Abstract:** This paper presents a computer-aided workflow that supports data integration and parametric modelling in urban design regulation. The recent urban regulations are criticised regarding the inefficient data exchange, ungearing across two-dimensional provisions and three-dimensional constructions, as well as unpredictable development results. Although various attempts have been made to utilise parametric design instruments in urban scale, most of them are only for modelling fast. This paper proposes a parametric methodology on algorithm platforms to offer a rational workflow for urban design regulating. The workflow includes three phases: (1) data integrating, (2) form-based regulation modelling, and (3) object-oriented regulation modelling. Rhinoceros 3DTM, Grasshopper 3DTM, and related plug-ins are employed as modelling and data analysing instruments. The proposed workflow is examined and evaluated through experimenting with real-world contexts. This paper further demonstrates that parametric methodologies provide a high-quality contribution to decision-making and urban regulating in next 50 years.

**Keywords:** Data integrating; parametric modelling; workflow; urban design regulation.

# How important is Insulation in the Modern Office Building?

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**Abstract:** Adding insulation limits the rate at which heat is transferred between the internal and external environments. Consequently, there is an expectation that the presence of insulation will reduce energy consumption as less heating and cooling will be required. For internal dominated buildings located in certain climates, an excessive amount of insulation may prevent heat loss through the wall, increasing the energy required to cool the building. Real New Zealand office building calibrated energy models are used to explore how the energy use of a building interacts with load densities, climate and insulation level. It is found that the internal load level has a significant impact on the overall energy consumption, in all the explored New Zealand climates. An increase in cooling energy requirements was observed to occur in heating dominated buildings with a low load level and patterns of use.

**Keywords:** Insulation; building simulation; heat trapping; energy saving

# Generating Urban Codes for Neighbourhoods

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**Abstract:** This research has developed a participatory methodology to generate urban codes to achieve the desired configuration for neighbourhoods in New Zealand. Urban codes are the qualities inherent in the built environment which have either evolved by themselves or have been guided by rules and regulations. The work develops a novel decision-making platform that brings together city level and local neighbourhood data to aid participatory urban design decisions. This platform offers stakeholder collaboration and engagement in complex urban design decision-making processes. The research develops a configurational design method by employing virtual instruments to generate building forms. The research methodology establishes a middle approach between top-down and bottom-up urban design methods where the generated urban forms can be visualised in an online platform for stakeholders to get real-time feedback. In particular, it explores an alternative urban design process as an algorithmic knowledge-based system for neighbourhood design.

**Keywords:** Urban codes; algorithmic urban design; decision-making platform; investigation rules; virtual instruments.

# Acoustic Design for an Auditorium Project

## *Using Building Performance Simulation to Enhance Architectural Quality*

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**Abstract:** This paper reports a consultancy work for an auditorium project. The consultancy work considers four important acoustic design issues for auditoria: volume and seats; control of reverberation time (RT); diffusion of sound; elimination of defects. Odeon 5.0 was used to simulate the reverberation time and sound propagation and diffusion. Case studies were used to discuss the simulation results and to propose design guidelines. For a small auditorium, the design recommendation is about how to minimize sound absorption and to achieve sufficient reverberation. Sound defects were found in the stage outlet and rear walls. The design recommendations based on the consultancy work helped architects improve their design and enhance architectural quality.

**Keywords:** Architectural acoustics; building performance simulation; auditorium; design quality.

# Optimization of Complex Fenestration Systems using an Artificial Neural Network

*Considering Energy and Daylighting Performance of Office Buildings*

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**Abstract:** The use of artificial neural networks (ANNs) in building performance problems has been widely studied by different authors in the last years. ANNs can decrease the computational time when the building design is complex due to high number of variables. In this research, an ANN was developed in Python and used to optimize an office space with exterior and fixed complex fenestration systems and dimmed luminaries in three different climates of Chile considering variables such as window-to-wall ratio, solar heat gain coefficient, U-value of windows, shading device, walls' thermal resistance and insulation position. The office performance metrics considered in the objective function of optimization process are total energy consumption (sum of lighting, heating and cooling energy consumption) and two visual comfort criteria, spatial daylight autonomy (sDA) and annual sunlight exposure (ASE). A total of 5,400 lighting simulations and 12,800 energy simulations were performed to train the ANN. The simulations were carried out using mkSchedule, a tool that integrates energy and lighting simulations. The results show the capability of the ANN to be incorporated to an optimization process of office buildings based on energy performance and visual comfort metrics.

**Keywords:** Complex fenestration systems; artificial neural network; energy performance; visual comfort; optimization.

# House Retrofits and Comfort Measures to Reduce Heat Stress and Carbon in a Warmer Future

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**Abstract:** Australia has one of the highest carbon emissions per person for buildings in the world. Record-breaking summer temperatures were experienced in 2017. So there is an urgent need for designers to reduce carbon emissions and temperatures to ensure the health and comfort of occupants in existing buildings. This paper reports on research on climate change modelling, thermal simulations of retrofits for the main three representative Australian house types as well as for a ‘cool retreat’, and an alternative comfort approach. The results indicate that the most cost-effective single carbon reducing retrofits are partial house air conditioning, ceiling insulation, external wall cavity insulation, and an optimal level of sealing the house. Then they depend on the type of house e.g. insulation under timber-floored houses and an internal brick wall for concrete-floored houses. The most cost-optimal carbon savings of combinations of retrofits across all house types were those with do-it-yourself (DIY) simple payback periods of between 5 and 8 years. Measures to reduce heat stress and cooling energy include bulk ceiling and roof insulation with added roof foil, external wall cavity insulation, a parasol roof and ceiling fans as well as occupants adopting a Standard Effective Temperature (SET\*) comfort approach.

**Keywords:** House retrofits; carbon emissions; cool retreats; standard effective temperature (SET\*)

# A Virtual Reality Experiment to Investigate Optimum High-Density Apartment Parameters

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**Abstract:** The current study uses Virtual Reality (VR) to experimentally investigate how room shape and volume affect perception of space and perceived size to identify optimal design for densified urban apartments. Optimal parameters are defined as (1) room shape that produces the largest increase in perceived space with the smallest increase of objective space (2) rooms that produce high perceived spaciousness and livability ratings. Participants experienced a series of virtual rooms of different shapes and volumes, and were asked to scale a cubed reference room to match the size of the target room. While room shape determined the accuracy of the spatial perception it is suggested that the optimum parameters of ceiling height and room width affect perceived spaciousness and liveability. Defining optimum parameters of room height, width and shape are foundational to providing strategies in apartment design to produce optimum perceived spaciousness and liveability. This research aims to firstly, develop a new method for studying optimal architectural design parameters, and secondly study the relationship between perceived space, shape and volume to form optimum parameters. Future research can then build on these parameters and introduce more complex parameters to produce defensible architectural strategies for optimizing high-density design.

**Keywords:** Occupant wellbeing, virtual reality, perception of space, densification.

# Building Performance Modelling

## *Parametric Study of Energy Optimization for Office Retrofit in the Tropics*

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**Abstract:** Buildings are accounted for approximately 40% of global energy consumption and one-third of global greenhouse gas (GHG) emissions. A significant proportion of energy utilization is due to the spread of heating, ventilating, and air conditioning (HVAC) installations in response to the growing demands for better thermal comfort of the built environment. While the proportion of energy consumption of buildings is an issue, architects have not seriously considered to innovate new solutions to tackle the problem particularly existing office building which is centrally airconditioned and consumed substantial amount of energy. Only few has been research to improve its performance to save energy that can be used as bench mark for post occupancy evaluation for existing buildings. To elucidate this issue, this paper is a result of a case study using building performance simulation tool to optimized energy for an actual office retrofit project in the tropics. Its objectives are to explore an energy optimization strategy using building performance simulation tool (IESVE) and to improve existing office building envelop for utmost energy efficiency. The result revealed that using parametric methodology through building performance simulation tool, an office building has the potential to achieve 26.8 % energy savings.

**Keywords:** Building Performance Modelling; building envelop; energy efficiency; office building retrofit.

# Less and More in Aotearoa New Zealand

## *More Houses and Less CO<sub>2</sub> Emissions*

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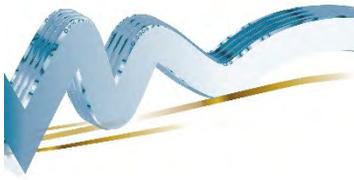
**Abstract:** This paper outlines the case for further research into an expanded use of bio-based materials for housing construction in Aotearoa New Zealand. Not only are large numbers of houses required to address ongoing shortages, but there is also an urgent need to address climate change. The embodied CO<sub>2</sub> emissions of the materials used to construct the future housing stock are, therefore, critical and warrant further investigation. Bio-based materials have very low CO<sub>2</sub> emissions, and some of those grown in Aotearoa New Zealand, are currently underutilised. Over 40 percent of straw, a byproduct of grain production, is currently burned in the field but it has the potential to be used on the scale necessary to satisfy current and future housing needs. Engagement with grain growers and researchers is necessary in order to further the research, as is gaining an understanding of overseas developments in prefabricated straw construction. Public perception is also important. Seventy years ago and facing a similar housing crisis, an attempt was made to introduce an alternative construction method, soil cement, into mainstream building practice. The reasons for Terracrete's forward-thinking but ultimately unsuccessful venture are considered when speculating on a contemporary response using an uncommon material.

**Keywords:** Bio-based; housing; straw; embodied energy.



# Theory

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# **Boler's Pedagogy of Discomfort**

## *Examining a Turn of the Century Idea for Contemporary Architectural Education*

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**Abstract:** Within the architectural design studio we have the opportunity to employ Boler's (1999) Pedagogy of Discomfort in two dimensions; both to disrupt students' ways of seeing and also their habits of making – the way they execute design as a practice. By challenging students to work with theoretical ideas and methods of creation beyond those they are comfortable with, a transformation in their understanding of the role of architecture and how it operates within the world can result. This paper will reflect on two design studios recently conducted at the University of Melbourne that sought to broaden students' perceptions of architecture's potential to influence perceptions, discourses and behaviours. Furthermore, to enable them to recognise their own capacity to challenge convention and, by extension, their own agency to demonstrate leadership within the built environment. This paper will reframe Boler's pedagogy of discomfort through Markauskaite and Goodyear's (2016) more recent theory of epistemic fluency to establish the enduring relevance of Boler's pedagogical approach for contemporary architectural education.

**Keywords:** Epistemic fluency; research through design; architectural citizenship; design leadership.

# Exploration of Indoor Tracking Systems as an Architectural Research Tool for the Study on the Housing for the Elderly

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**Abstract:** With the increasing elderly population, there is a heightened demand for knowledge about housing that best fits their needs, particularly in the event of increased impairment. More specifically, greater understanding is required of those with limited mobility and reduced spatial usage. This research examines the use of indoor tracking systems as an architectural research tool, to investigate the spatial use of the elderly in their private house. Data on equipment performance specifications, cost and operability was gathered through a literature review, through a review of technical specifications and eliciting further information by emails to the suppliers and finally the physical testing of one system. This data was subjected to a comparative analysis. The research found that there were a complex set of requirements for accurate recording of spatial use, which are derived from housing setting, research design and the required scale of movement to detect. The systems that meet all requirements for tracking the elderly indoors are scarce. Improvements to currently available indoor tracking systems would enhance the potential for using them as part of user focused architectural research and provide a more precise and effective knowledge for the design of housing for the dependent elderly.

**Keywords:** Architectural research methods; Indoor tracking devices; spatial use; housing for the highly-dependent elderly.

# Facilitating Transformative Experiences

## *Case Studies for School Design*

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**Abstract:** Our rapidly changing world, current environmental crisis and calls for regenerative approaches to development evidences the need for change. To achieve sustainable change a transformation in the way we understand and conduct relationships in and with the world is required. The environment is not something at arm's length, but rather a complex system, of which built, natural, and social systems, among others, are all part. As a profession architecture must have approaches that are reflexive, responsive, longitudinal and inclusive. This paper draws together two illustrative case studies to demonstrate such approaches. These case studies underscore the potential to facilitate continued transformation within approaches to the design of space and the discipline of architecture. The two workshops discussed in this paper enabled architects, teachers, policy-makers and others, to look at their own roles within the broader systems that shape the built environment of schools. Transformative learning is taken as a theoretical model through which to reflect on the two case studies. Transformative learning experiences are those that are most likely to prompt, support and sustain change in worldview and behaviour. They can be catalyst events that are uncommon, unusual or uncomfortable, and challenge assumptions and beliefs. This paper focuses on three aspects that modified the participants' ability to engage more or less fully in the workshops as a transformative event. These aspects are discussed here as key factors which those seeking to develop events to help provoke change could use to guide workshop development and reflection. These three aspects are the role of unfamiliar context as provocation; agency as capacity and ability to change, and making connections to the everyday. These three aspects are discussed for their potential to contribute to transformation as part of the continuing development of the architecture profession.

**Keywords:** Workshop design; transformative learning; professional development.

# “Back” to the Future

## *Parametric in an Ancient Treatise on Architecture*

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**Abstract:** Ancient treatises on architecture in India form a knowledge system which is intertwined with historical architecture in a complex manner. The content cloaks issues in architectural issues with philosophy, religion and other contextual references which leads to some practitioners’ contention that the treatise is “religious mumbo-jumbo” while others attempt to employ it as a technical construction manual. This paper submits that the treatise is primarily about architectural theory and practice and its focus is design processes for different building types set out in the form of textual guidelines detailing the stages involved in the generation of the built form. This finds resonance in parametric design viewed as a set of instructions establishing relationship between objects controlled by variables which renders the treatise relevant to contemporary architecture in general and computation design process in particular. The utility of the treatise is enhanced in conservation efforts, especially reconstruction of ruined historical buildings, and post-colonial scholarship in indigenous knowledge systems. Also, by premising correlation with contemporary processes in computation design, this paper informs their historical location and contributes towards their place as integral to design systems. It is premised that by going “back” in history in the form of an ancient treatise, the future, envisioned as parametric design, is informed.

**Keywords:** Parametric design process, historical treatise on architecture in India, Samranganasutradhara.

# Gateway Pavilion

## *Returning to Conventional Practice*

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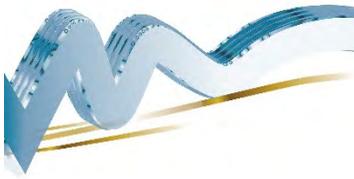
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**Abstract:** The design and production of architecture is being heavily influenced by software, both positively and negatively. On the one side, it can be seen to provide new design opportunities while on the other it can create unexpected constraints. It is attractive and easy to generate complex digital forms however to realise it may seem overwhelming. This is reflected in architects constantly developing complex digital forms but they are seldom translated into production. Articles suggest students can work with digital software without much consideration of tolerance for manufacturing, however project and material realities say otherwise. When an appropriate workflow is applied, the making process is not as complicated as many are led to believe. The Gateway Pavilion on Waiheke Island reveals pedagogical requirements to teach students essential skills to produce complex designs with a practical build process. This paper is a case study reviewing the alternate route taken when digital fabrication is no longer an option.

**Keywords:** Prototyping; design-build; pedagogy.

# Design

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# Improvisations in Polyrhythmic Spatiality

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**Abstract:** This paper outlines creative practice ‘research through design’ project work wherein musical improvisation on the digital drum kit forms the methodological basis for an examination of the “Y-Condition” between music and architecture as applied to design process. Through the mass generation of drum data and the translation into the spatial domain using parametric digital design tools, spatialization of a corpus of polyrhythmic drumming in a solo context is enabled. This process enables novel models of musical analysis and representation, and also provides opportunities for a post-Xenakian integrated ‘musico-spatial design’ creative practice to emerge.

**Keywords:** Music and Architecture, Design Research, improvisation, parametric digital design, design process

# Settlement

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**Abstract:** In the early 1970s Michael Payne had a national reputation from housing design experience in Hong Kong and the Osaka Expo 70 project. Payne's previous work and Quaker background led to appointment as architect for a new Quaker community in Whanganui. His design for an intentional community of friends was informed by international experience in housing design and travel, including to foundational Danish co-housing communities soon after they were established. The Quaker Settlement was built over twenty five years and now consists of 17 houses around a number of unique common facilities. They are consistent in design, yet individual. They are an early example of New Zealand low energy, solar, and environmentally sustainable design. Importantly they have been socially sustainable in operation for over 40 years. The Quaker Settlement is an important built exemplar of Payne's vision and legacy that remains highly relevant today. Cohousing is once again a focus in New Zealand, however groups and architects are struggling to realise projects, or articulate the integrated architectural and social means necessary to create them. This paper revisits the project to determine contexts of its production, to document key characteristics for future reference, and to distil its enduring relevance.

**Keywords:** Context; Landscape; Urban design; Heritage.

# Sharing Space and Older New Zealanders

## *Preferences for the Conversion of Existing Houses*

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**Abstract:** Given the slow rate of adding new houses to the existing stock in New Zealand and the fact 80% of older households fall into the small categories, it is essential to find effective design solutions for redeveloping existing houses to achieve a better quality of life for the elderly. Two New Zealand housing types were redesigned to New Zealand Lifemark standards. Three design proposals were produced for each type with various degrees of sharing. To discover how potential users felt about degrees of sharing in the proposed designs, these were presented to people aged 55-85 years using an online questionnaire. Participants were asked to comment on the six schemes and proposals for the redesign of the section and outdoor space. The main focus of the survey was to investigate the features liked by respondents in each scheme. This study shows that conversion of the selected houses to accommodate ageing in place is possible. Findings from this study also show having a spare multi-purpose room and private deck are the features most favoured by the respondents. Size and sunlight are also important factors in housing design, and smaller, and potentially easier to heat and maintain units, are less liked than larger ones.

**Keywords:** Ageing in place; refurbishment; lifetime homes; shared spaces.

# Estimating the Floor Area of a House Knowing its Number of Rooms and how these are named

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**Abstract:** Globally, statistics are used to investigate the condition of housing as an indicator of quality of life. Among these house size is an important parameter for showing the quality of housing, although measuring the floor area of a house is both time consuming and expensive, and would be very difficult for big census samples. Information about the overall floor area of a house is also used in life cycle analysis and energy and lighting simulation tools. A floor plan study of New Zealand houses was undertaken as part of a larger project. In total, 287 published plans of New Zealand houses of various ages with differing numbers of rooms were selected and analyzed in AutoCAD to find room and whole house areas. Data about the average floor area for each room type for all houses were gathered in an Excel spreadsheet and transferred to SPSS for further analysis. This showed that the size and combination of rooms of NZ houses follow a specific pattern. Using the results, a tool was developed for estimating the floor area of a house based on its number of different types of room. This study showed that with careful analysis of the floor plans of examples from an existing national housing stock, it is possible to find patterns for the size and types of rooms and use such information for predicting the floor area of similar house types.

**Keywords:** House size; room standard; room type; New Zealand.

# Bedroom and Room Standards and Large Housing in New Zealand

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**Abstract:** In most developed countries censuses and crowding indices measure house size in terms of number rooms or bedrooms, even though the average house size varies in different countries. According to Statistics New Zealand and studies by BRANZ, recently New Zealand houses have changed both in terms of overall floor area and types of rooms. A floor plan study of 287 New Zealand houses revealed new houses have many specialized rooms and normal room types (sleeping bedrooms, living rooms) are bigger. Though bathrooms/laundries are never counted as habitable rooms, some in new houses are exceed the size of a bedroom in a 3-bedroom New Zealand state house. The study also shows the floor area of a 3 bedroom house in New Zealand varies from 79-225m<sup>2</sup>, thereby questioning whether using number of bedrooms could be underestimating house size in New Zealand and other developed countries. This paper uses evidence to propose that censuses and crowding indices need more complicated tools for predicting house size and discusses the form these might take.

**Keywords:** Room standard; New Zealand; large housing; crowding index

# Advancing Collaboration between Students of Architecture and Engineering

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**Abstract:** Following on from the Canterbury Earthquakes Royal Commission recommendations 163 and 185, various methods are underway to start improving dialogue and collaboration between architecture students and engineering students in New Zealand. This includes work at all three architecture schools in New Zealand, the inclusion of an architect in residence at Canterbury University's School of Engineering, and most importantly, the Arch-Eng-Build workshops held annually by the Cement and Concrete Association, the Building Research Association and others. The Arch-Eng-Build workshops are small scale and focused on a select group of talented students from each discipline and have been expanded to include building management students as well. As admirable as the Arch-Eng-Build workshops are, the aims need to be expanded to a wider audience, i.e. all students of architecture and engineering. This paper explores the way forward for the NZ tertiary education system and makes proposals for further vital collaboration and integration between the professions.

**Keywords:** Collaboration; education; architecture; engineering.

# Biological Systems

## *Outcomes in Architectural Design Studios*

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**Abstract:** This conference paper is the second of two papers that discuss the outcomes of a long-term pedagogical research project into the integration of interdisciplinary design-research, and making practices into the content of second-year architecture studios. This paper focuses on one studio involved in the design of biological systems. The studio introduced students to the socio-cultural and bioethical dilemmas that arise when using living organisms as a design material. Students were required to create a biological system using traditional design materials and *Physarum Polycephalum*, a harmless, yellow single-celled organism capable of solving complex mazes and which grows up to 30cm in length. Through the design, prototyping, and testing of these systems students are encouraged to learn through practice, developing their projects iteratively while being critical of the implications of their actions. Through a discussion of the studio aims, structure, project examples, and outcomes, this paper outlines an initial approach to teaching biological design within a studio context. Along with the paper on Responsive Systems these works highlight the importance of critical engagement with materials and processes and of opening up future architectural pedagogy to new fields of exploration.

**Keywords:** Architectural education, critical design, biological systems, making

# Explore a Combination of Materials in Building Sustainable Construction Practices

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**Abstract:** The construction sector is associated with significant environmental impacts, being a major consumer of raw materials and energy, and generating a lot of pollution. Therefore, it is essential for the industry to move towards more sustainable construction practices. The selection of building materials is a relevant factor in sustainability, nevertheless, it seems that the industry is more focused on other aspects, such as speed of construction and cost reduction, rather than careful choice of materials. Research through the life cycle assessment methodology has identified that all stages of construction introduce environmental, social and economic impacts. Within the theme of sustainability, there are some important concepts that can also be applied to construction, such as recycling, which is converting waste materials into raw materials to produce new products, and reusing, which uses materials or products again without going through industrial processes and transformations. Sustainable materials must have all the benefits of a conventional product and still have a sustainable performance. Two of these natural materials, bamboo and cork, are alternative construction materials, and when used together, produce new elements for building construction that can be used on sustainable constructive systems. This research proposal introduces the concept of using those materials during the construction phase.

**Keywords:** Bamboo, cork, construction, modular, sustainability.

# Stripping Back Kitchen Joinery

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**Abstract:** At the beginning of the 21st Century, new kitchen joinery was typically constructed of panels. The panels were fabricated of medium density fibreboard, using waste from the timber industry, and finished in melamine. The panel product does not patina well, has a short life and requires disposal in land-fill because of its toxicity, but a large industry promotes and supports these 'box' system kitchens. As the world comes to terms with excessive consumption, unsustainable production systems and pollution, this kitchen joinery industry is an anomaly. The joinery design is 'unacceptable' for a sustainable world. In the context of the evolution of kitchen joinery in New Zealand and internationally, this paper proposes a new kitchen joinery system. Named Good Bones, the design does not have a 'box' carcass. It uses just drawers for storage, minimal robust materials and environmentally friendly finishes which can be user applied. The flexible assembly allows for design adaption to suit houses of different eras, personalization by consecutive owners, adaption to suit new appliances and possible relocation.

Two prototype installations in Wellington, New Zealand are presented and reviewed. Users and joiners provide feed-back, both on the design and possible implications for the current kitchen joinery industry.

**Keywords:** Kitchen joinery; sustainable design; design innovation.

# Design that Builds Industry Skill and Capacity

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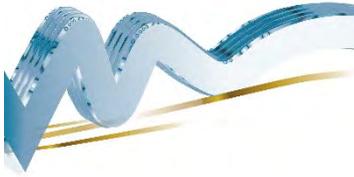
**Abstract:** This paper explores the potential for innovative architectural design to build industry skill and capacity, and support resilient regional economies. It is a result from a final-year student Advanced Design Research (ADR) project at the University of Tasmania's (UTas) School of Architecture and Design that focussed on the University's \$300m Northern Transformation program (NTP). The students followed a mixed methods approach to seek to understand the potential for collaborative building design processes to develop Tasmanian industry, and through their findings, support those active in overseeing the building program maintain the conditions for this to occur. By the process's end, the team was able to generate and present a cohesive document, outlining aspects of innovation and capacity building through design as well as providing 15 guidelines for the potential implementation of innovation. This paper sets out the team's methodology and the five major themes and fifteen guidelines for improving the likelihood of successful design and construction innovation are presented and discussed.

**Keywords:** Design; innovation; research; industry.



## **Modes of Production**

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# Enabling Automated Compliance Audit of Architectural Designs

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**Abstract:** A rapid uptake of Building Information Modelling (BIM) by architects in recent years has enabled improved collaboration and better information sharing among project stakeholders. BIM will continue to have a positive impact on the quality improvement of the built environments and the overall productivity boost in the industry. One activity that has not fully benefited from this collaborative approach is the compliant design process whereby certain design aspects must be audited for compliance with some normative standards or requirement specifications. A challenge to automate this laborious and error-prone conventional manual process has been attributed to the inability of machines to readily process legal knowledge that is conveyed in natural language texts. There have been a number of approaches suggested by researchers towards enabling an automated compliant design process, each has its advantages and also drawbacks. This paper introduces emerging open standards LegalDocML and LegalRuleML for exchanging legal knowledge and describes an automated compliance audit framework that treats both the building design data and the normative information as independent input components to be processed. The framework incorporates a human guidance element to facilitate the audit process. Lastly, a case study highlighting common compliant architectural design problems is used to illustrate the approach.

**Keywords:** Building information modelling; compliance audit; legal knowledge; process modelling

# Information Visualization for Multivariate Schematic Design

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**Abstract:** While BIM modelling continues to become the most pervasive software in the AEC industry, we must address the fact that it remains little more than method for collecting direct inputs about the creation of building elements. As a profession, we ought to strive to integrate how we evaluate our building designs in meaningful ways early on the design process (when it can most readily affect our decision making). This paper will describe a series of visualization methods developed as part of tools designed to work with Autodesk Revit and Dynamo to integrate analytical information into the schematic design process. Each tool tested a myriad of methods for mapping and delivering information often including, two-dimensional heat mapping, three-dimensional(voxel) mapping, and other methods for mapping data sets with even more dimensions, often as a user navigates into a model, data increases its density (just-in-time). More dimensions of data types can be mapped by using clustering algorithms to constrain and find zones where relationships between different data types are located to better understand the underlying relationships.

**Keywords:** BIM; design software; visualization; design process.

# Towards the Development of Pre-Occupancy Evaluation Framework in New Zealand

## *A Literature Review on Limitations to Green Building Rating Systems*

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**Abstract:** Green rated buildings have come to attract people's attention, although there is a diffused scepticism on whether their performance will comply with design expectations throughout the building's life. This paper provides a literature review on limitations of the rating system. According to previous studies, barriers to facilitate certification schemes are still present in many countries. Some of the main reasons are related to i) high costs, ii) insufficient knowledge about certification, and iii) time-consuming procedures. Inexperienced clients have difficulties in understanding the assessment process, as third-party organizations do not have a suitable system to show guidelines and approaches for a client, such as Pre-Occupancy Evaluation. To date, researchers have conducted some studies on Post-Occupancy Evaluation in order to show the effectiveness of certified buildings. However, no attention has been paid to Pre-Occupancy Evaluation by the rating tool based on a customer's self-assessment which enables clients to estimate costs, a rating level (or total point) and implementation time in advance, selecting suitable options in the building information and requirements of each credit. This paper shows that identifying existing obstacles is essential to further develop and improve rating systems so as to be more acceptable in New Zealand. This preliminary investigation will also inform future studies on the development of the Pre-Occupancy Evaluation framework for New Zealand.

**Keywords:** Green Building Rating Systems; certification process; barriers; pre-occupancy evaluation; Green Star NZ.

# Thick and Thin

## *The Future for Walls as Solid Masses or Delicate Layers*

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**Abstract:** While houses built from engineered timber products such as cross-laminated timber are an excellent structural construction solution, the mass house construction market in New Zealand still sticks with more traditional construction methods centred around individual sticks of timber. These traditional methods are however still reliant on timber sizes that are relatively weighty and volumetrically large, in relation to more advanced cladding systems such as cars or planes, where thin skins of cladding are carefully wrapped over a lightweight but structurally rigorous framework. This paper examines current and future walls, including possible structural solutions such as the stressed skin matrix and monocoque construction methods that are widely used in vehicles. Comparisons are made with other technologies where recent advances in large-scale 3D printing have created entire houses fabricated from liquidised amorphous substances. Can they be reliably considered as practical building systems for the future? Recent advances in 3D printing are multiplying, including the ability to sinter solids directly from sand, being explored as a possible future for building “off-shore” constructions. The paper draws upon advances being worked in freeform 3D printing and real-life building projects as well as examining the future of student-led research into digitally-led building construction systems.

**Keywords:** 3D-printing; structure; stressed-skin; wall.

# Potential for Prefabrication to Enhance the New Zealand Construction Industry

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**Abstract:** The New Zealand construction industry finds it increasingly difficult to meet the growing demand for housing. There is increased demand over the whole country but particularly in Auckland, where some 30,000 new homes are needed in the very near future. New Zealand's population is growing at a rate that will see it rise to some 6 million by 2068. To meet demand, the construction industry will need to produce housing more efficiently than it has been doing to date. This paper investigates the potential for increased use of prefabrication techniques to address these challenges. Prefabrication is well understood to be faster, more energy efficient, cleaner and safer than traditional construction methods. The uptake of prefabrication methods in New Zealand was around 32 percent of all new houses in 2013, which lies somewhere between 90 percent uptake in Sweden and around three percent in Australia; two countries with which New Zealand is often compared. The paper discusses the current needs of the construction industry and, after reviewing the potential benefits of prefabrication, speculates over how these methods could help address the current crisis of housing supply in New Zealand.

**Keywords:** Prefabrication; housing crisis; benefits and disadvantages.

# Barriers and Strategies to Streamline an Efficient BIM Workflow within the New Zealand Construction Industry

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**Abstract:** This paper will be demonstrating a research framework on the need to boost the productivity and efficiency of design-to-manufacture within the New Zealand construction industry. We outline and address how the implementation of BIM can be an effective approach to streamline the flow of information through design-to-manufacture for the construction sector. However, there are also many issues which surround the application of BIM that also affects its value. Many users within the design-to-manufacture supply chain mostly are unable to utilise BIM to its full capabilities. The research aims to propose an effective strategy for which information of a BIM project can transition seamlessly throughout a design-to-fabrication workflow. This improvement is to reduce conflict, minimise data loss and allow for a smoother transition and handling throughout the design and construction process. The research is to be delivered through six key stages. Currently, this research is in the initial stages of stage 2. Therefore this paper will address the outcome of stage 1. The stages are as follows: (1) Recognise and identify barriers; (2) Data collection; (3) Result analysis; (4) Formulate recommendations; (5) Pilot implementation; and (6) Project review. While this research project is currently ongoing, this paper intends to provide awareness for those involved in the New Zealand construction industry.

**Keywords:** Building Information Modelling; design-for-manufacture-and-assembly; lean; productivity.

# A Possible Future for Building Codes

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**Abstract:** Building designers prepare project specifications in part to demonstrate building Code compliance. Checking the specification for compliance is done manually, and is not easy to do well. This paper proposes a method in which specifications and building Codes could be developed to facilitate compliance checking, including automated Code checking which, to date, has evidently not considered the specification. This method entails embedding the building Code in the local national master specification systems (NMSS). Building information modelling (BIM) has a major part to play – use of a BIM-compliant NMSS could support automated compliance checking. The paper uses the Australian ABCB National Construction Code (NCC) and the UK's RIBA Enterprises NBS Create BIM-ready NMSS to illustrate the proposals, as good examples of a single national Code and a BIM-specification respectively.

**Keywords:** Specifications; building Codes; BIM.

# An Intelligent System for Actuating Windows of Naturally Ventilated Residential Houses

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**Abstract:** In New Zealand's (NZ) mild climatic conditions, most residential houses are ventilated naturally, mainly by opening windows. However, maintaining the indoor thermal comfort characteristics of a house by modulating natural ventilation is particularly challenging, as the solution is not explicit. Determining a solution requires a technique that adjusts openable window area while encapsulating the complexity, dynamics, and nonlinearity associated with the natural ventilation driving forces and building thermal behaviour. This work examined the feasibility of predicting the air temperature time-series of an occupied naturally ventilated house by an Artificial Neural Network (ANN) model. It was found that the ANN technique could be used to predict the occupied space indoor air temperature time-series of the naturally ventilated house and that this can be used as part of an intelligent window control strategy for naturally ventilated residential houses.

**Keywords:** Natural ventilation; thermal comfort; artificial neural network; residential house.

## Timber 4.0

### *A Computer-Vision Approach for Visual Grading Low-Grade Plantation Hardwood*

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**Abstract:** The objective of this study was to develop a proof-of-concept for using low-cost, off-the-shelf RGB-D computer vision techniques to assess grading and defect features in low-grade plantation hardwood. It is framed within a wider research project that proposes the integration this data within a Cyber-Physical System allowing real-time design and material feedback within a computational design and fabrication workflow.

**Keywords:** Computer vision; plantation timber; digital fabrication; computational design.

# Timber Frame Construction for a Circular Materials Economy

## *Alternative Framing Methods and Post-Use Certification*

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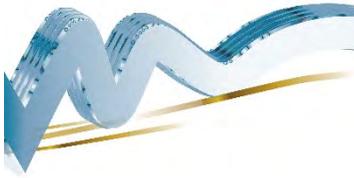
**Abstract:** The building and construction sector in New Zealand consumes more than 50% of all raw materials while simultaneously generating more than half of all waste sent to landfill. These unprecedented levels of consumption are set to continue as demand for residential housing continues to grow rapidly. This research suggests that building construction methodologies and compliance infrastructure could be established that would enable the widespread reuse and recycling of building materials. Design experimentation shows that an efficient, flexible and affordable reusable wall system can be fabricated using a range of commonly available construction materials. Practices for the post-use certification and strength testing of materials are proposed to validate widespread adoption of material reuse in the construction industry. Visual strength grading of recycled timber is highlighted as a critical factor for enabling the widespread and affordable reuse of this material.

**Keywords:** Material Reuse, closed loop design, cradle to cradle, sustainability.



## **Practice, Education & Profession**

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# **BIM is Easier Said than Done**

## *Calibrating Architectural Education in New Zealand to the Opportunities of BIM*

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**Abstract:** Creating, manipulating, sharing and appraising building information through digital 3D models is one of the most extensive paradigm shifts to have occurred in contemporary architectural practice. Despite the promise of BIM, documented instances of its success and endorsement by governments, the architectural profession has been slow to assimilate BIM into practice. This paper will argue that the nature of the virtual building challenges the architectural designer to reconsider attitudes towards representation and literal engagement with the digital model. In response to this, this paper examines the expectations of the AEC industry regarding BIM and questions the preparation of architectural graduates to meet this challenge. The paper reports on a focus group of recent graduates that confirm the current lack of exposure to BIM in schools. An approach to addressing this deficiency in the design studio is offered and a way forward for the profession to take its place in the future with BIM. It should be noted that the views reflected in this paper is that of the author only and does not necessarily represent the views of Studio of Pacific Architecture.

**Keywords:** BIM; architectural education; virtual building; design studio.

# Dry Under the Floor

## *Development of NZ House Sub Floor Ventilation Requirements*

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**Abstract:** This paper traces the development of sub-floor (crawl space) ventilation from early New Zealand uses of suspended floors to the first formal requirements through to the modern day. This includes council by-laws, nationally developed standards and most recently the New Zealand Building Code. Although sub-floor ventilation was being provided from the earliest European housing, the first minimum gap between floor joist of 100 mm was suggested in 1912 but the first local Government by-law recommend was in 1920 when the One Tree Hill Roads Board required 150 mm space. Although the New Zealand State Forest Service's 1924 "Building Conference Relating to the Use of Timber in Building-Construction" suggested a minimum ground clearance of 300 mm with ventilators of 1 in<sup>2</sup> per ft<sup>2</sup> of floor area (0.7%), it was not until 1944 when NZSS 95 Part IX required ½in<sup>2</sup> per ft<sup>2</sup> (0.35%) that a ventilator requirement was incorporated in local government by-laws. This requirement has continued to the present day (2017), although in 1999 the minimum ground clearance or crawl space was increased to 450 mm. Recent BRANZ research has confirmed these ventilation requirements as being reasonable, although the results may also contribute to a more science based set of requirements.

**Keywords:** Moisture; timber; dry rot; suspended floor.

# Looking Back To A Job Well Done?

## *Measuring Success in the Integration of Teaching and Learning across Multiple Modes of Delivery*

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**Abstract:** Thirty years ago, in 2017 we embraced a strategy to integrate all modes of teaching delivery in the School of Built Environment at Curtin University. We knew there would be significant challenges to teaching and learning practices. Back then, face-to-face and online teaching were considered discrete and separate practices; however, this was not reflected in the learning experience of students, predominantly the original digital natives, for whom new technologies had become a necessary part of their lives. The purpose behind integrating learning modes, in addition to embracing improved digital technologies, was to improve the teaching and learning experiences by recognising successes in both face-to-face and online practices, and adapting to suit all modes. All stakeholders had to participate, engage and commit to adapting teaching and learning practices to the new digital environments. This paper addresses what was a complex problem from the point of view of the different stakeholders— institutions, staff and students. The similarities and gaps in the support provided are discussed with the aim to identify alternative ways of supporting success in teaching and learning. This paper discusses the support offered in transitioning into the digital age and implementing an integrated strategy of delivery. In 2017 when this project was initiated, it had already become clear that the stage was set for further research on this topic. Since 2017 the work discussed in this paper was used to build the limited data available to develop tools that could be employed to measure the success of this strategy.

**Keywords:** Pedagogical practice; education experience; digital environments.

# Embodied Energy of the Common Wood Fired Brick

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**Abstract:** With calls for environmentally conscious building design and construction on the increase across East Africa, the need to better appreciate the environmental credentials of commonly used materials has become a priority. Lack of in-depth studies of Embodied Energy (EE) and Green House Gas (GHG) emissions related to the construction industry can be attributed to a variety of factors, most notably, the ad hoc nature of the industry in the region. Of interest for this study is the EE of the most commonly used material for domestic construction, the wood fired brick. Manufactured close to sources of heavy clays or laterite soils, these bricks are fired on site in traditional scove kilns, making use of wood fuel to bake the bricks. Regarded as a cheap material and used in virtually all construction, little is known of their structural integrity, embodied energy values or the emissions stemming from the manufacturing process. Through an investigation of a selection of kilns in the central region of Uganda, the manufacturing process of the bricks was tracked and documented, making use of the inputs-outputs method to determine the EE of the final brick product. The findings of this study suggest relatively high Embodied Energy value for these bricks with a value of 4.26MJ/kg. While burning wood in this case could be considered carbon neutral, the broader impact from Green House Gas emissions as a result of this method of brick manufacture still needs to be explored. This also raises concerns for the potential growth in materials to support the growing demand for housing over the next few decades.

**Keywords:** East Africa; embodied energy; scove kilns; wood fired brick

# Design and Build an Organisation to Deliver

## *Learning from a Project Management Studio*

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**Abstract:** Successful inter-professional collaboration in a built environment project takes personal leadership and interpersonal capacity, professional competencies that are not explicitly addressed in the current architectural curriculum. This paper presents an action research exploring the pathway of educating these traits through a project management studio. Students were challenged by a large group size from which to design and live out an organisational structure to deliver a debate. The results highlight two themes: perceived ambiguity and workload, and intragroup conflict as trigger of double-loop learning.

**Keywords:** Project management studio, ambiguity, organisational structure, collaboration.

# Space Syntax in Design Curriculum

## *Opportunities And Challenges*

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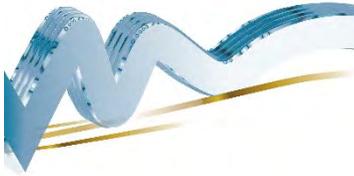
**Abstract:** Space syntax is a prominent theory for understanding some key aspects of the built environment and people's behaviour within it. Hence, familiarity with the theory would be an advantage for the designers to analyse, learn from and improve the exiting design as well as to create a more responsible built environment in future. However, the theory of space syntax has not yet been adequately integrated into the curriculum of many design schools. This paper presents an analysis of opportunities and challenges of the application of space syntax in the undergraduate architectural design curriculum. The goal of this paper is to anticipate these challenges and support a curriculum planning strategy for the matter. For this purpose, this paper first provides a brief review of previous studies and efforts to integrate space syntax into the design pedagogy. Then, it pursues a qualitative approach to identify different aspects of the relevance of space syntax within the design pedagogy. At the end, the paper presents our approach to address the considerations arisen in the literature review and introduces some of the steps planned for familiarising architectural design students at the University of South Australia.

**Keywords:** Space syntax; design pedagogy; design curriculum.



## Vision

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# Regenerative Development

*What is it, How does it Support Innovation in the Built Environment  
and how can it Lead to a Sustainable and Thriving Future*

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**Abstract:** There has been a call from many areas of research and practice for a different approach to sustainable development in the built environment. This has occurred because of the evidence that the social and ecological indicators that underpin our civilisation are being eroded; that is, we are failing at our current approach to sustainability. Led by thinkers in the built environment the call has gone out for approaches that facilitate built environment outcomes that move beyond marginal improvements and shift our focus towards creating vitality and net benefit. That is, projects that begin to heal the damage done in the past and create vital relationships that lead to resilience, as well as adaptive and thriving outcomes. It is argued that regenerative development is a process that can facilitate this type of approach to contributive development. This paper will present the frameworks used to support the application of regenerative development thinking to three projects in Victoria, Australia. While these are long-term projects that will be in development over 15 years, what is presented here is their initial conceptual design processes which aim to increase the potential for regenerative outcomes. The projects were informed by the LENSES framework, the Living Building Challenge, the Regenesis frameworks and Biophilic design principles. Each project has an ecological baseline that was collected as part of the project so as to measure the benefits post construction and occupation.

**Keywords:** Regenerative development; built environment innovation; eco-city; ecological worldview.

# Whither Design Theory and Methods?

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**Abstract:** This position paper briefly introduces design theory and design methods, presents changes that have occurred on the last 50 years prior to examining the changes that are likely to take place over the next 50 years in designing and in building. It examines potential changes in our knowledge about the cognitive behaviour of designers, users, users' social behaviour, user-building interactions, user emotions, design tools that learn and adapt, buildings that learn and adapt, buildings as part of a social ecology, and three new types of interfaces: brain-computer interfaces, user-building interfaces and brain-building interfaces. Each of these is assessed for their potential effect on design theories and design methods. The conclusion is that very few, if any, of these will require modifications to design theories but that new design methods will need to be developed.

**Keywords:** Design theory; design methods

# Sensory Pleasure of Interiority

## *Finding Transdisciplinary Research Language for Complex Indoor Environment Quality*

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**Abstract:** While indoor environment quality (IEQ) measurement is an established process, it omits the sensory pleasure of interior environments, possibly due to perceived subjectivity in the context of objective productivity. Given the significant commercial interior renovation industry, the developing evidence linking sensory pleasure to thermal comfort, the known complexity of indoor habitation, and the growth of large data set analysis, there exists an opportunity to expand the scope of IEQ appraisal. Drawing on the interior architecture discipline and its holistic 'interiority', this speculative paper presents a high-level content analysis of selected texts and identifies candidate sensory quality variables for future use in environment quality measurement. The intention of this process is to translate across the interior architecture and architectural science disciplines by quantising interior architecture perspectives into measurable variables. These broader candidate variables would likely be more inclusive of the lived experience and agency of occupants of interior spaces and offers extended complex indoor environment quality data collection for future use in advanced statistics.

**Keywords:** interior design; interior architecture; indoor environment quality; methodology.

# Apartment Assessment Platform

## *A Model for Capturing and Comparing Apartment Designs*

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**Abstract:** Since 2002, multi residential developments proposals are assessed under the State Environmental Policy No 65 (SEPP 65) which measures apartment design quality according to nine design principles. The introduction of the SEPP 65 has improved the quality of apartment designs, however, it has also introduced the challenge of collecting data and analysis for assessment. Current analysis tools predominantly assess environmental conditionals and provide analysis results without mechanisms to store the analytical data in a structured hierarchical format. This paper explores a framework for capturing apartment designs and associated analytical data in a structured format, allowing a method for documenting and presenting design analysis in an efficient manner. An initial case study demonstrates the capture of metrics across a range of spatial and environmental analytics which can be tailored to meet the SEPP 65 objectives. In addition, the framework allows comparative analysis between apartments, providing a methodology for Architects and developers to build an intelligence within their portfolio of designs. Through the structured storage of design plans and analytics, fundamental design questions about layout, room sizes, daylight, sunlight, natural ventilation and privacy can be assessed as historical data sets that can provide insights into the success of designs over time.

**Keywords:** Data, BIM, Analysis, Apartment Design, Parametric Design

# Always New Performance Based Design

## *Ise Shrines as a Model for Future Architecture*

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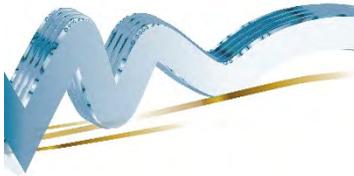
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**Abstract:** In Japan, a radical experiment has been going on for more than one thousand years: wooden structures are built and dismantled every twenty years in an ongoing renewal process without a known beginning or end. We will look into the Ise shrines not as buildings but as genetic sequences or generative lines of code. As living organisms that change through time, that... emerge, age, decay, emerge... living organisms that have an exact understanding of their importance and impact in a much wider system. A renewable system carefully planned for long term resilience. A large widespread system that expands through all Japan. A system that has a long term strategy that resists becoming part of other global systems. A system that trades short term benefits for long term security. A system that changes and adapts through the years sometimes trying to be forgotten, sometimes trying to be embraced by the population. Ise in its humble scale and lack of ornamentation is as relevant for our future as it was thirteen hundred years ago.

**Keywords:** Ephemeral architecture; system; generative architecture; permanence.

# Architecture Science

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# Relationship between Indoor and Outdoor Fluorescent Biological Aerosol Particles

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**Abstract:** This study aims to characterize the ratios of bioaerosol levels in a meeting room to outdoor levels and ii) to investigate the impact of two factors, air-conditioning and mechanical ventilation (ACMV) operation status and human occupancy, on time-resolved relationship between indoor and outdoor bioaerosols. Using an ultraviolet-light induced fluorescence (UV-LIF) technique, we measured number concentrations of total aerosol particulate matter (tPM) and fluorescent biological aerosol particles (bioPM) (1.0-3.0  $\mu\text{m}$  and 3.0-5.0  $\mu\text{m}$  diameter) in an office and outdoors, sampling with 1-min resolution. The air-conditioning and mechanical ventilation (ACMV) system equipped with high-grade filters was effective in controlling both tPM and bioPM indoors. As expected, removal efficiencies were found to be size dependent. One human subject walking on the carpet was found to be a strong contributor to bioPM, resulting in 2-3 times higher concentration than that outdoors. Compared to the times when the room is vacant, the biological proportion of total airborne particles increased by an order of magnitude during the light walking period. Consequently, indoor-to-outdoor ratios depend on the ACMV operating conditions and on human activities. This pilot study provides preliminary data concerning the bioPM levels in an indoor environment equipped with an ACMV system. Ongoing investigations using this approach promise to improve our understanding of the processes that influence indoor bioaerosol levels and the effectiveness of control alternatives.

**Keywords:** Bioaerosol; real time; indoor-to-outdoor ratio; human occupancy.

# Ventilation for Reduced Heat Stress in Apartments

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**Abstract:** The increase in building code requirements of modern buildings are correlated with increased overheating, particularly in apartment buildings. This research addresses the comparative performance of the Australian apartment stock with international heat wave regulations, six apartment buildings were performance modelled based on the extremes of the 2009 Victorian heatwave that began on the 27 January with daytime temperatures topping 43°C across 3 days, with night-time minimums of above 25°C. All 6 apartments failed the four international summer comfort standards that were reviewed. The worst performing apartment underwent further investigation. Retrofit strategies were tested to determine the most effective method for reducing overheating. As found in the literature, improved ventilation is often the most effective retrofit method. Further investigation revealed that ventilation opportunities are significantly restricted by the Australian NCC window protection requirements that restrict window openings, reducing typical ventilation area from a window from 50% to 20%. This has a significant impact on the ability to use natural ventilation for reducing of overheating in apartments.

**Keywords:** climate change; heatwave; comfort; apartments.

# The Influence of Indoor Environmental Quality in Schools

## *A Systematic Literature Review*

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**Abstract:** The impact of IEQ (daylight, temperature, acoustics and indoor air quality) in school settings is a subject of concern for many scholars and parents and teachers. This review has appraised the breadth of studies that have examined the influence of IEQ on learning performance and health in schools. Using the replicable search processes of a systematic literature adopted from medical research practice, one hundred and fifty relevant articles were retrieved from four search databases (Science direct, Scopus, PubMed and Google Scholar). Analysis of these articles has revealed that the impact on students' health and comfort of each individual IEQ variable is significant. This, in some studies has been shown to influence learning performance. However, while these variables are interlinked in building design they are not studied together in health and learning performance studies. An evidence-based method is proposed for investigating what relative contributory effect these four variables have on learning performance. As these IEQ variables individually have a very significant effect on student performance, this study has the potential to guide important changes in the design and refurbishment of new and existing school buildings. If successful, it could support educational quality and effectiveness of teaching and learning.

**Keywords:** Daylighting; temperature; acoustics; indoor air quality

# Biomimicry as Innovation

## *A Systematic Review*

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**Abstract:** Systematic literature reviews originated in biomedical science. They are methods to systematically identify, select and critically appraise evidence. They form the foundation of the process reported here which has investigated whether there is any evidence in the literature showing that biomimicry might be a generalizable principle that could assist designers to improve the thermal performance of buildings. In its defining papers biomimetic design is argued to be an applied science that derives inspiration from the natural world and opens avenues for technological/sustainable design and innovation. It suggests that study of nature can reveal more sustainable solutions in terms of efficient processes, functions, systems and materials. For example, thermal adaptation of natural organisms to extreme conditions takes place through behavioural, morphological and physiological mechanisms. However, the literature review has revealed that there is no publication outlining a systematised procedure to attribute thermal issues to corresponding natural adaptation strategies applied by specific organisms. Biomimetic design concepts often seem to be written about with very specific examples which seem more to be about the metaphorical use of one-off examples of nature-inspired design than about a general approach to the mining of biological information systems for design inspiration.

**Keywords:** Biomimicry; natural adaptation mechanisms; biological samples; energy efficiency.

# End of Life Care in an Australian Hospital

## *The Role of the Built Environment in End of Life Nursing*

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**Abstract:** Healthcare design is a growing field of research with recent studies revealing the impact the built environment has on occupants' health and well-being. In a qualitative mixed methods case study, data was collected from a spatial evaluation and focus group interview with nursing staff from the Royal Adelaide Hospital Emergency Extended Care Unit in Adelaide, South Australia. Seven design elements were identified as central to the design of end of life spaces in a hospital context. Participants prioritised facilities for family and visitors and home-like components and furnishings above the other design elements. The results of the study suggest that for nursing staff the built environment needs to support both patients and visitors at end of life. This paper discusses the observed spatial qualities and reports the design elements identified by nursing staff as important in end of life spaces in an Emergency Department. The outcomes from this research are useful for designers, as well as nursing staff, in order to develop a deeper understanding of the impact of the built environment on qualitative experiences.

**Keywords:** End of life space; nursing; case study; hospital design.

# The Impact of Thermal Comfort Criteria on Energy Consumption of Residential Buildings

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**Abstract:** In Australia, the current Nationwide House Energy Rating Scheme adopts a variation of the ASHRAE 55-2013 adaptive thermal comfort method with a criterion of 90% acceptability. It has been debated that such a high acceptability requirement may be too strict for residential buildings, and a criterion of 80% or even 70% acceptability may be adequate. This study evaluates the impact of thermal comfort criteria on space cooling energy requirement in three typical climates (Melbourne-heating dominated, Sydney-balanced heating and cooling, Darwin-cooling dominated) in Australia through building simulation. The results show that under both current and future climates (assuming a global warming temperature of 2°C), the decrease from 90% to 70% in the acceptability has minor or no impact on housing cooling energy consumption in Melbourne and Sydney. However, it may have significant impact on space cooling energy consumption in Darwin (saving more than 40%). It was found that for high-set lightweight houses in Darwin, easing the acceptability limits will increase energy star rating by 3.6 stars and 1.6 stars under current and future climates respectively. It was also found that for both current and future climates easing the acceptability limits from 90% to 80% has greater impact than reducing from 80% to 70%.

**Keywords:** Adaptive thermal comfort; acceptability limit; cooling load; future climate change.

# Example of Medical Information on Asbestos

## *Transdisciplinary Research in Architectural Science*

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**Abstract:** In recent years, there has been an increase in discussion of the role transdisciplinary research can play in many fields of study, opening the questions of its definition, similarities and differences with other seemingly similar approaches. This paper discusses the importance of the transdisciplinary research using the example of integration of medical and architectural information when evaluating building materials. Specific focus is on the impact building materials present for human health, which is one area of study which cannot belong solely in architecture or health sciences, and consequently requires some collaboration or integration between these disciplines. It is proposed that transdisciplinary research offers a significant platform for study of health impacts of building materials but also for research in architectural science in general. This paper examines a range of studies related to human health impacts from one building material, asbestos, observing the key patterns in the used research strategies. Based on this analysis, it is possible to identify and recommend an effective transdisciplinary approach. The core value of this paper is that it contributes to development of new research practices which can foster more effective development in architectural science.

**Keywords:** Transdisciplinary research; toxicity; building materials; asbestos.

# Fisherman Settlement and Housing Innovation based on Bioclimatic Design in Surabaya

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**Abstract:** Fisherman settlements at the eastern coast of Surabaya are characterized by densely populated areas, some substandard houses and poor infrastructure conditions. Since some houses are crowded and substandard, innovation of the settlement and houses become very important. The innovation, as the process of introducing new idea should be directed to create more healthy and comfortable settlement, with adequate infrastructure, at least for the next 50 years. The aim of research was to find an innovative design of fisherman settlement and houses based on bioclimatic design. The bioclimatic design was chosen, since this was based on the strategy to give comfort to the house dwellers, bearing in mind the climatic conditions of the coastal environment and climate change in the future. Together those, improvement in the sanitation and infrastructure will create healthier fisherman settlement. The method used in the research surveyed in the crowded settlement and houses, to indicate the inadequate settlement and house design, which made the conditions uncomfortable to the dwellers. Mapping of the settlement's infrastructure and sanitation was done, to indicate the improvement required. The result of the research shows that the innovation of the settlement and houses based on bioclimatic design was acceptable to the fishermen, if the innovation was matched to their activities.

**Keywords:** Bioclimatic design; fishermen settlement; houses; innovation

# Soundscapes in Public Libraries

## *A Case Study*

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**Abstract:** This study investigates the acoustic conditions of reading spaces in a public library in Melbourne. An acoustics performance survey for library users was developed to evaluate library use, sound environment and noise, and a face-to-face survey was conducted in the library. The library users described their sound environment as 'pleasant', 'appropriate' and 'calm'. The respondents of two reading rooms expressed a high level of satisfaction with sound environment and a neutral perception of noise, neither noisy nor quiet. Three main sources of noise, namely, 'footsteps', 'people' and 'chair dragging' were also found in the reading spaces. Interestingly, it was found that noise from lift, windows and doors opening, traffic and construction noise and noise from birds outside the building, resulted in the difference between user perceptions of noise between two reading rooms. It could be interpreted that this result was related to the library space layout, building design and building services. It is recommended that the link between architectural characteristics and space use pattern and acoustic performance be examined in public library buildings.

**Keywords:** Soundscape; acoustics; public libraries.

# A Review of IAQ Standards and Guidelines for Australian and New Zealand School Classrooms

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**Abstract:** Information on indoor environmental conditions in Australian and New Zealand school classrooms is limited. The indoor environments in schools are less studied compared to other building types such as offices. Limited data and scientific studies on measurements of school environments, particularly on thermal conditions and indoor air quality (IAQ) are available. Moreover, majority of the studies have been conducted in the northern mid-latitudes. This lack of knowledge poses a big concern considering that children, unlike adults, are much more vulnerable, and are expected to perform work that is not optional and would almost always be new to them. This paper reports on the findings of a literature review that explores thermal comfort, particularly indoor air quality and ventilation requirements for Australia and New Zealand school classrooms. The objectives of the review are to identify national and international standards and guidelines associated with the provision of thermal environments and indoor air quality in educational facilities, to examine current knowledge on the relationship between indoor conditions and educational outcomes and identify findings of applicable indoor environmental quality (IEQ) research.

**Keywords:** Indoor air quality (IAQ); indoor environmental quality (ieq); school classrooms.

# Public Engagement in Urban Microclimate Research

## *An Overview of a Citizen Science Project*

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**Abstract:** The term “citizen science” broadly describes public engagement in scientific research in collaboration with professional scientists. This paper discusses the application of citizen science in microclimatic research for a project recently funded by the Australian federal government. The aim of the project is to engage local communities across Australia in urban microclimate research and empower the public in adopting various mitigation actions. The different steps involved in the project, ranging from engaging councils and citizens, selection of precincts and measurement locations according to the strategic priorities of each council, designing instrumentation and cost-effective method of gathering high quality data are discussed. The main challenges anticipated in implementing the project at large spatial and temporal scale and how those challenges will be addressed are also explored.

**Keywords:** Citizen Science; urban microclimate; temperature; mitigation strategies.

# Field Study of Auckland Housing Winter Indoor Health Conditions Associated with Insulation, Heating and Energy

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**Abstract:** Common problems of winter indoor micro-climatic conditions of Auckland houses are low air temperature and high relative humidity. Winter indoor air temperature and relative humidity are mainly impacted by house design with different insulation in their envelopes, different space heating methods and how much energy is used for space heating. The three Auckland houses, with different insulation and glazing in their envelopes and different space heating methods (temporary heating and central heating), were selected for field studies of winter indoor microclimatic conditions. According to the field study data and energy data, the study identifies differences in indoor thermal and health conditions of local houses with different R-value building envelopes, investigates what type of space heating is suitable and how much space heating energy is needed to achieve the guidelines for indoor thermal comfort and healthy conditions for a local lightweight timber frame construction house with sufficient insulation and double glazed windows. To compare and identify differences of energy consumption between the house using central heating and the local houses using different temporary space heating, this study randomly collected the energy data of 131 Auckland sample houses using different temporary heating methods, with or without sufficient insulation and double glazed windows.

**Keywords:** Housing Energy; Indoor health; insulation; space heating.

# Thermal Comfort Analyses of Elementary School Students in the Tropical Region

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**Abstract:** This study aimed to analyse the thermal comfort level of students in primary school classrooms in the tropical region with the case studies done in Makassar, Indonesia. The data collection was done through a survey in the six selected primary schools in Makassar. The study involved 1,111 students from 33 classrooms. The recorded data includes personal data and the thermal environments, i.e. air temperature, air humidity, mean radiant temperature (MRT), and airflow velocity. At the same time, students were asked to fill out questionnaires asking their comfort level perceived at the time of measurements. The results showed that Temperatures range from 28.33oC in the morning (8:00 am) to 34.29oC in the afternoon (2:20 pm). Air humidity ranges from 53% to 89% with an average of 68%. Students experienced relatively stagnant airflow conditions characterised by a minimum 0m/s, an average 0.1m/s, and a maximum 1.45m/s of air velocity. The elementary school students are quite tolerant to high temperatures. Even though only a small percentage of respondents (28%) feel neutral in comparison with respondents who feel warm and hot (43%), 86% of them accepted these conditions. However, more than 72% of respondents preferred to decrease the air temperature in the classrooms.

**Keywords:** Air temperature; elementary schools; neutral temperature; thermal comfort.

# Moisture Production and Extraction in New Zealand Homes

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**Abstract:** The effect of moisture in New Zealand homes is a topic which has been studied intensely, yet problems still arise from excess moisture. The effects that moisture can have in homes is well documented; however very few studies exists on sources of moisture created by occupants. Typically, studies have focused on removing moisture after its production, rather than focusing on its source. This paper examines both the moisture produced in bathrooms in New Zealand homes and the effectiveness of extraction fans found in these bathrooms. A literature review was conducted on the amount of moisture produced in bathrooms and the common factors that make extraction fans ineffective. From this, a survey was conducted and experiments performed to measure the amount of moisture produced in a typical New Zealand home and the effectiveness of commercially available fan and duct systems. The main findings from this study were that commercially available ventilation systems for removing moisture from homes are performing well below the requirements of the New Zealand building code.

**Keywords:** Ventilation; moisture; bathroom; extraction fans.

# Responsive Systems and Electronic Spatial Interfaces

## *Outcomes in Architectural Design Studios*

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**Abstract:** This conference paper is the first of two papers that discuss the outcomes of a long-term pedagogical research project into the integration of interdisciplinary design-research, and making practices into the content of second-year architecture studios. This paper focuses specifically upon one studio involved in the design of responsive systems and electronic spatial interfaces. The studio introduces students to technologies associated with “The Internet of Things” and encourages them to consider how their use in design might impact a range of different social and spatial systems. Through the design, prototyping, and testing of these systems students are encouraged to learn through practice, developing their projects iteratively while being critical of the implications of their actions. Through a discussion of the studio aims, structure, project examples, and outcomes, this paper outlines an initial approach to the teaching of programming and electronics within a design studio context. Along with the paper on Biological Systems these works highlight the importance of critical engagement with materials and processes and of opening up future architectural pedagogy to new fields of exploration.

**Keywords:** Architectural education, critical design, responsive systems, spatial computing

# **A Comprehensive Review of Literature on the Importance of Windowscapes**

## *Evaluation and Suggestion for Improvement of New Zealand Building Code*

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**Abstract:** Rapid intensification of Auckland has made our visual awareness of the outdoor environment (windowscapes) more confined and restricted. The recent changes of Auckland's windowscapes have made the shortcomings of New Zealand Building Code more apparent. This paper aims to demonstrate the importance of windowscapes in urban dwellers' life and to suggest some changes to current building code to provide healthier and liveable indoor environments. Hence, evidence from the literature on the impact of views on building occupants' wellbeing will be first reviewed. Then, New Zealand Code Clause (G7 Natural light) and its Acceptable Solution will be critically analysed to identify areas that require improvement. Our literature review indicates that private views are more relevant for health and wellbeing than building and planning legislation in New Zealand currently considers them to be. Hence, this paper suggests that windowscapes should become an essential part of future building codes and standards. This paper concludes that providing strict requirements regarding windowscapes is essential to building a healthier indoor environment.

**Keywords:** Windowscapes; building code clause G7 and acceptable solution; health and well-being; visual awareness of the outdoor environment.

# A Pilot Study of Design Evaluation of Three Memory Support Residential Facilities in Victoria

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**Abstract:** There are over 400,000 persons with dementia in Australia. This figure is projected to increase by 90% to more than 760,000 in the next 20 years and exceed 1.1 million by 2056. Due to the significant increase in the number of people with dementia, the demand for memory support residential facilities is expected to increase. People with dementia are vulnerable to environmental impacts, so the design of such facilities has a significant impact on the quality of life and well-being of the residents. In this pilot study, three memory support facilities in Victoria are selected for evaluation: Rathdowne Place in Carlton, Peninsula Grange in Mornington and Campbell Place in Glen Waverley. Through design analysis and fieldwork observation, the aim of this study is to identify key factors of the built environment for residents with dementia, compare building layouts and provide design recommendations.

**Keywords:** Design for dementia; memory support facilities; residential care; design evaluation

# Outdoor Wind Environment Study of High-rise Residential Buildings in Urban Areas

## *A Literature Review*

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**Abstract:** As wind environment is one of the key elements in the sustainable and environmental design, there is a need to study local wind environments of modern cities. In urban areas, especially when the density of city is increasing, the influence from buildings to wind environment is becoming higher and higher. This paper presents a literature review for outdoor wind environment study of high-rise residential buildings in urban areas. First, the previous wind environment research is reviewed. It not only helps to understand the fundamentals of interaction of how wind flows around objects such as buildings on the earth's surface, but also present the gap between the formal study and the nowadays contemporary residential buildings in urban areas. Second, as there are two methods of wind tunnel and computational fluid dynamics (CFD) for simulating the wind environment, this paper focuses in summarizing the existing CFD tools and setting up the fundamentals for developing future workflow. Third, the evaluation criteria of wind environment from different standards is compared. In the end, a possible framework to evaluate wind environment is discussed. The literature review is intended to highlight the limitations of previous research of novel high-rise residential buildings and current adaptation analysis methods. In particular, for the hot-summer and cold-winter climate, and with the development of architecture, novel forms and arrangements of residential buildings have been developed, wind environment design strategy response to this kind of climate and forms is insufficient. The review helps to set up the fundamentals for our following research to explore the optimization of outdoor wind environment of residential buildings in urban areas by establishing early-stage design principles.

**Keywords:** Wind environment; high-rise residential building; CFD; design principles

# Implications for the Design of Rental Housing for the Elderly that Improves their Quality of Life

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**Abstract:** As the population ages, the demand for suitable rental housing will increase. Suitable housing means housing that can accommodate those impairments that typically correspond with ageing. This paper explores the quality of life (QoL) requirements of the elderly with high-care needs who live in rental housing. It identifies important design considerations through a qualitative case study of three elderly people who need assistance and are living in local-authority rental housing in New Zealand. The themes of QoL were identified from the literature and related to the larger themes of; 1. Activities and independence, 2. Sense of control, 3. Privacy, 4. Relationships, 5. Quality of care and 6. Other. The survey consisted of a detailed documentation of the physical environment, followed by interviews with and full-day observations of the residents and their caregivers. The study finds that the design of housing that improves their QoL requires solutions to accommodate the various conflicting needs for their QoL which include those derived from the diversity in user's preferences and impairments. In the design of rental housing, there is greater need for additional or reorganized space to accommodate caregivers and visitors; maintain residents' independence, privacy and other aspects important for their QoL.

**Keywords:** Elderly; quality of life; rental housing; qualitative method.

# The Role of HVAC filter in Building Operation and Maintenance

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**Abstract:** The filter in Heating Ventilation and Air Conditioning (HVAC) system is the first line of defence to maintain a healthy indoor environment from airborne particle pollutants. The work focuses on the analysis of indoor/outdoor airborne particulate matter (PM) concentrations and materials accumulated on HVAC filters. We used optical particle counters/sizers to monitor the PM number concentrations in five indoor environments and one outdoor location. The filter samples from the corresponding HVAC systems were collected after monitoring period for biological contents analysis. Results from the mass balance model showed that the indoor/outdoor (I/O) particle ratios generally decreased with higher filter grades, indicating the filter effectiveness in removing PM from the outdoor and recirculating air. The total accumulated amounts of biological contents also suggested the similar trends. The pressure drops across the filters, however, provided some limiting factors for pursuing the highest filter efficiency in typical building operation. The results showed that the benefits of using higher quality filters will gradually decrease or even off-set by the increasing pressures drops that directly translated to the energy consumptions, highlighting the importance to obtain a balance between these design and operating conditions. In addition, we observed that the different indoor conditions such as occupancy level and the function of the indoor environment are highly associated with the amount of deposited biological contents on the filters.

**Keywords:** HVAC filter, indoor air quality, particulate matters, bioaerosols

# Architectural Technology

## *The Technology of Architecture*

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**Abstract:** Architectural Technology is a relatively new discipline and relates to the anatomy and physiology of buildings and of their production and performance. The practice of Architectural Technology is underpinned by the application of science, engineering and technology and is closely aligned to industry. Architecture Technology is also set within an industry that is under capitalised, resource intensive, risk averse and litigious. Industry is now recognising the value of the discipline of Architectural Technology as critical in the digital age given its focus on empirically based design. Digitalisation of design and construction through Building Information Modelling, relates to production, performance, environmental sustainability, economic efficiency and effectiveness. BIM enables simulation, standardisation, systemisation, and optimisation in design and construction. One example of the relevancy of the discipline is how the skills of Architectural Technology align with those necessary for BIM and this hopefully create greater recognition of the discipline in the future. To improve the recognition of the discipline beyond the UK, this paper presents the educational and professional standards for Architectural Technology. The argument is made that concurrent industry interests in Building Information Modelling and in the profession, is an opportunity for both the expansion of the discipline and greater BIM adoption.

**Keywords:** Architectural technology, architecture, technologist, BIM.

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