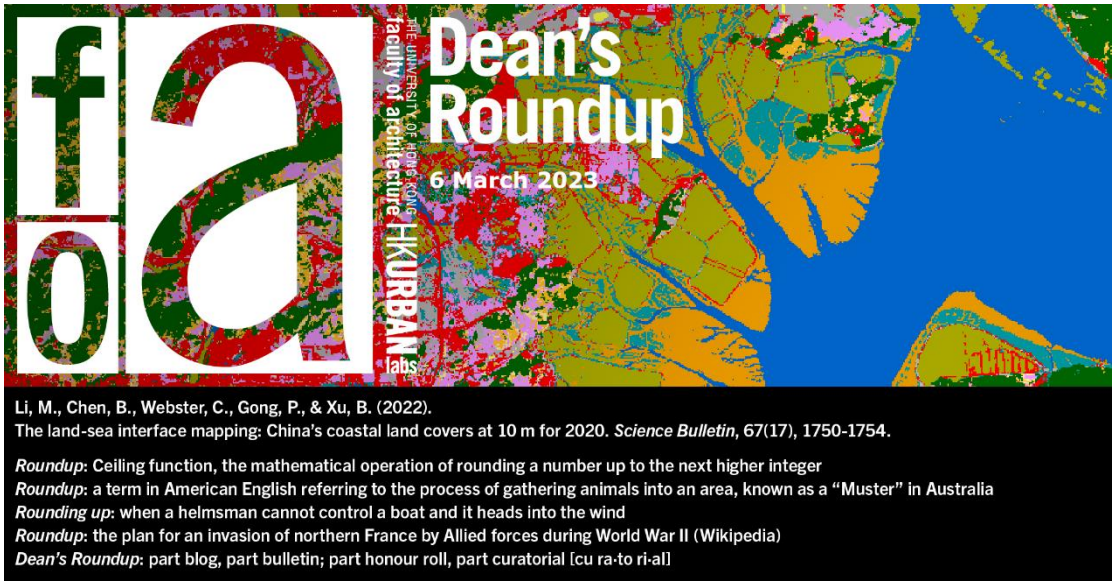


Scale and Majesty

Regular readers will note that the issue of *scale* crops up a lot in DRup blogs. It crops up even more in the research reported in the main section of DRup. All built environment scholars and professionals grapple with issues of spatial scale as part of their craft. That's why it is rewarding to sometimes step back and ask questions in a new way, using scale as an analytical construct. This time, I want to share a simple insight I had recently when considering how different kinds of building performance scale with height, width and length. It concerns the sense of awe and majesty commonly experienced when walking into a monumental building such as a cathedral, temple, mosque, concert hall, mausoleum, or palace.

This thought experiment starts with the proposition that humans are not very good at imagining, visualising or understanding non-linear trends. This inability has been long studied and taught, especially in business schools when considering compound interest and the unimaginable results of re-investing profits.

Another illustration is a story that in one version has a king offering a reward to a subject who has performed some selfless act. 'How would you like to be rewarded?' the king asks. The reward method requested seems overly modest to the king, but the king agrees anyway, no doubt marvelling at the humility of this noble subject. All that is demanded is payment in grains of rice, starting with one single grain placed on a chess board on the first day, then doubling to two grains on the adjacent chess board square on the second day, doubling to 4 on the next square the next day, 8, 16, 32, 64 and so on until the board is full of rice grains. The king had been willing to offer so much more and he accepts, perhaps with a quizzical smile.

If 1kg of rice is worth 12 HKD, then after 7 days and 7 squares, the payment is worth just 0.044 HKD. Not a lot. Bad deal for the subject, good for the king? Even by day and square 15, the rice reward is only worth 11.4 HKD. But by day and square 30, it has compounded to 377,366 HKD. And there are 64 squares on a chess board! The humble citizen is about to become unimaginably wealthy. By day and square 36 his reward is 23.9M HKD and by square 54, with 6 'doublings' left to go, the reward is 5.22 x 10^{11} kg of rice, more than the entire global rice production today and heavier than all the gold that has ever been mined.[1] The process of compounding is literally beyond the ability of the human mind to track.

Humans seem to have evolved with a naturally linear process of projecting trends. The things we have habitually counted typically follow an additive process. I cover half an acre a day bringing in my harvest and I have 5 acres. Adding up the days leads me to conclude that harvesting will take me 10 days. Even when our daily sums are multiplicative, they tend to be linear. If I invite my neighbour to help, offering my labour on his harvest in return, then I can cover 2x half an acre a day. I add up, multiplying each day's labour by a constant of 2, and estimate that my harvest will be done in 5 days.

Examples of non-linear, compounding counting are difficult to think of in the primitive economies that governed the evolution of the human brain. Rolling a snowball down a hill is one but is hardly an important evolutionary influence on the human brain.

How does this relate to scale and the majestic qualities of buildings? Here's my second, and main, proposition. I think it's a novel insight, so if you pass it on or use it, please cite DRup. If the insight is ancient and well documented, please let me have references. Here it is: building sections and plans scale up by a factor of 2. In other words, as the length and height of a cathedral's façade

[1] Maths courtesy of https://www.mathscareers.org.uk/the-rice-and-chessboard-legend/

doubles, the façade's area will quadruple. Area increases as a function of height and length, by the power of 2. But building volume, as a function of the one-dimensional measurements of height, length and width, scales by a power of 3. Double all three dimensions (H,L,W) and volume increases 8-fold. Experiences that take in the transition between 2D and 3D scaling catch us by surprise. They are experiences as discontinuities, not natural progressions. They may cause us to gasp.

My third proposition, therefore, is that this explains the typical reaction when entering a cathedral. Imagine: you walk along the outside of one of the 130-metre side elevations of Notre Dame Cathedral in Paris. You are impressed by the majestic one-dimensional scale of the building's length. Then you look up and your impression of grandeur is shockingly multiplied by the power of 2 as each one-dimensional ten metres of stone you pass becomes 100 square metres of stone in the 2D façade rising above you. The 130-metre length is combined with the 64-metre height *multiplicatively* to create a towering wall above you, built of 8,320 square metres of Lutetian Limestone. Then you turn the corner and your experience continues along the curved apse, the majestic impression still coming from a two-dimensional stimulus (although the curve may give some hint of a volumetric stimulus). Then around the corner again, and another 130m of 2D architecture. You turn the remaining corner, coming to the impressive front façade. Along this, you stop and you enter.

You stand in awe at the indescribable massiveness of the interior. You have abruptly moved from a mental image of the scale of the building that is constructed and perceived in two dimensions, to one that is three dimensional.

You are now experiencing volume, not just area.

And the quantity of sensory inputs, perhaps conceived of as units of majesty, has moved from 8,320 square metres at most, during your walk around the building (you only experience one façade at a time on a close walk), to 400,000 cubic metres. Your mind simply does not allow you to naturally scale-up by an order of magnitude from the quantity of experienced surface, to the quantity of experienced volume.

The thought experiment has many more practical implications for architecture and architecture education. For example, how do we teach students to extrapolate from the scale models they use to hone their design skills? Structural properties in buildings may generally be assumed to scale to the power of 2. That's because the strength of a column to support superstructure is a function of its cross-section, which is a 2D quantity. If you want to support a larger 3D superstructure, you have to increase the area of the column's 2D section.

Energy performance, on the other hand, may generally be expected to scale by the power of 3, since it is a function of volume. Costs, in all buildings but cathedrals, probably also scale to the power of 3. Add an extra 10 metres to the length of your design and the costs are likely to rise by a factor of 1000. You were an artist in the 1990s, commissioned to build a statue of Saddam Hussein,

standing on a monumental marble plinth (it happened to a friend of mine). Saddam got back personally, wanting the plinth extended in length by 10 metres. It takes 100 marble blocks to construct one 10-metre long course. Total number of blocks for the additional projection of ego: 1 million.

Our bamboo-bending architect colleague Kristof Crolla tells me that the architectural performance property of *deflection* scales to the power of 4. A doubling of the length of a span with the same section results in a 16-fold deflection. Without due attention to this law of physics, a 1:1 version of the scale model designed in a studio would resemble a spoonful of spaghetti.

The solidness of Saddam's plinth and the experienced void of Maurice de Sully's Notre Dame are volumetric quantities. The genius of the medieval cathedral is that in terms of built materials, the void is all majestic benefit and no cost (ignoring the cost of the flying buttresses that support the sheer walls). Saddam's plinth as a volume is mostly costs and only partially benefit. To be precise, in terms of marble blocks you can see as a fraction of those used in construction, it is 5% benefit. 95% of the blocks are unseen. Between solid and void lie 'in-between dimensions'. Building costs and energy costs scale to the power of 3 if a building is solidly filled with building materials, as with the plinth, and solidly filled with energy. In principle, the building costs of an empty cathedral should scale to the power of 2 because there are no building materials in the void. I am sure architectural theorists must have explored the idea of the medieval cathedral as two-dimensional architecture. If a building is loosely filled with floor-plates, rooms and circulation infrastructure, then costs may geometrically scale to something less than 3 and more than 2. Mathematicians call this a fractal dimension. Put simply it is a dimension that describes the degree of space filling, be it between 1D and 2D, or 2D and 3D. A façade made of perforated blocks fills 2D space less than fully and its costs will therefore scale by less than the power of 2. It has a fractal dimension of between 1 and 2.

How do we teach students to hone their art of scale model building in a way that appreciates the all-important scaling of performance? Experiential learning that takes students from the desk-top 3D printer or analogue paper model, to a factory and thence to a building site is one answer. FoA is about to launch an exciting new master's degree programme based on experiential scaling-up. Doing more teaching and learning *in-silico* is another answer. Computer simulations can help us accurately compute and then visualise non-linear scaling properties of the objects we are making and studying, be they compounding interest of complexly engineered statistical real estate investment vehicles or a bamboo cathedral.

Thanks to all those mentioned below for the massive amount of work and great achievements.

Chris Webster
Dean, FoA

Faculty of Architecture

1. New colleagues

- A warm welcome to the following colleagues, who joined our Faculty since January 2023:

	Dr Creighton Paul Connolly Assistant Professor Department of Urban Planning and Design Creighton obtained his PhD in Human Geography from the University of Manchester (2016), an MA in Geography from the Memorial University of Newfoundland (Canada) and a BA(hons) in Geography from the University of British Columbia. Trained as an urban political ecologist, he examines processes of urban and environmental governance, planning and development in his work, focusing on the Southeast Asian region. Prior to joining DUPAD, Creighton held faculty positions in the School of Graduate Studies at Lingnan University (2021-22), and the University of Lincoln, UK (2018-21). He also worked as a postdoctoral fellow at the Asia Research Institute, National University of Singapore (2016-18).
	Dr Tongping Hao Post-doctoral Fellow Department of Urban Planning and Design Tongping is a certified planner in China, a BEAM professional, and a LEED & WELL accredited professional. She completed her PhD degree at DUPAD recently. Prior to her graduation, Tongping was already a green building engineer in Hong Kong and consulted sustainable design projects in the Greater Bay Area, collaborating with international design companies, developers, and government institutes. Her research expertise lies in urban simulation at the neighbourhood and street scales, design optimisation and urban data analytics. She is working on research projects about modelling urban microclimate, optimising heat-resilient design, and investigating human behaviour under thermal variations. She has developed a simulation-based design optimisation framework and utilised machine learning algorithms to enhance the integration of digital technologies in support of design practice.

	Dr Chun Wing Vanessa Lo Assistant Lecturer Department of Urban Planning and Design Dr Lo obtained her PhD degree at the University of Sheffield. Her research interests include housing studies, policy, ageing, intergenerational issues, urban governance and placemaking. At DUPAD, she teaches courses for the Common Core Curriculum, BA(Urban Studies) and Master of Housing Management programmes.
	Dr Qingyao Qiao Post-doctoral Fellow Faculty of Architecture Qingyao completed his PhD degree at The University of Manchester, where he also worked as a research associate. Prior to that, he received his Master's degree in Civil Engineering from Shenzhen University in 2018. His research interests include building energy consumption prediction, machine learning application, feature engineering and data mining, agent-based modelling, project safety control measure, and occupational health and safety. He is a researcher at the Healthy High Density Cities Lab, working on projects concerning built environment and infectious disease modelling under the supervision of Dean Chris Webster, Dr Chinmoy Sarkar and Dr Eric Schuldenfrei.

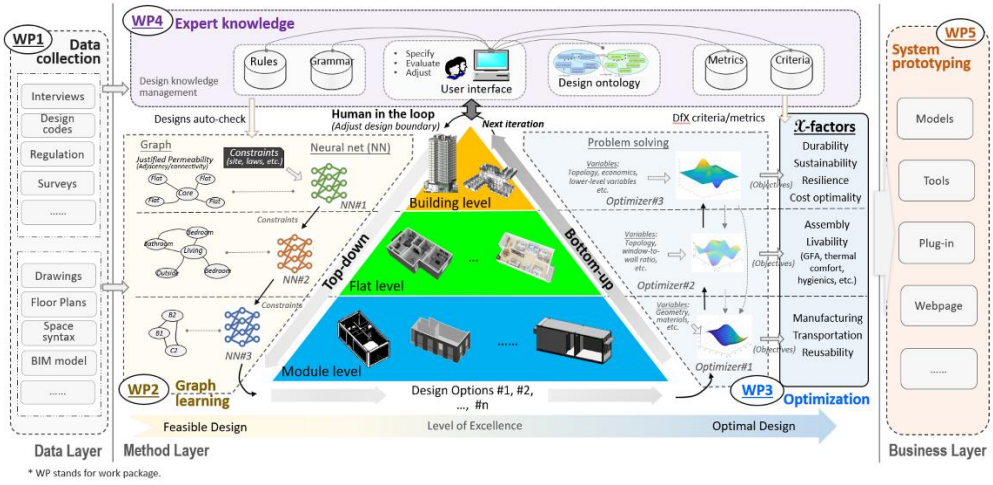
2. Dr Weifeng Li (Associate Dean in Research Postgraduate Studies)

- represented the Faculty to attend the CEDARS Non-academic Induction Programme – High Table Dinner, organised for first-year students on Saturday, 25 February 2023, at Loke Yew Hall.

  The Dinner was part of the CEDARS Non-academic Induction Programme for new students to learn from distinguished community leaders on the ideal of a university and the social responsibilities of university students.

3. RGC CRF 2022/23

- An iLab research team led by Professor Wilson Lu has been awarded the Hong Kong Research Grant Council (RGC) Collaborative Research Fund (CRF) in its 2022/23 exercise. Generative design, design for manufacturing and assembly (DfMA) and Design for Excellence (DfX) are all popular topics. This is perhaps the world's first 'generative design for excellence' research project! In this project, iLab researchers adopt a combination of generative design, DfMA and DfX, along with many innovative methodological approaches such as Graph Learning (or machine learning with graphs), Generative Adversarial Network, heuristic optimization, and so on.



Funding Scheme: Research Grant Council (RGC) Collaborative Research Fund (CRF)

Funding Year: 2022/23

Project Title: Generative DfX in high-rise modular building: An expert-augmented cascade graph learning and optimisation approach

Project Coordinator (PC): Professor Wilson Lu (REC)

Co-Principal-Investigators (Co-PI): Professor Chris Webster (FoA), Dr Kristof Crolla (ARC), Dr Frank Xue (REC) and Dr Junjie Chen (REC)

Project Start Date: 1 April 2023

Project Duration: 36 months

Funded Amount from RGC (without including on-cost): HK$5.31m

Project Summary/Abstract: *High-rise modular building (HRMB) is highly advocated to address the housing crisis in high-density cities around the world. In line with this advocacy is the principle of design for*

excellence (DfX) that is vigorously explored to unlock the full potential of modular building. DfX encompasses 'excellence' criteria such as functionality, ease of manufacture and assembly, logistics, buildability, sustainability, and cost, which require multidisciplinary domain knowledge that is beyond the capability of any single designer. Computer-aided generative design seems to provide a promising strategy to handle the multifaceted knowledge requirement.

This project aims to develop a computer-aided, designer-oriented generative DfX methodology for HRMB. We employ graph learning in a top-down manner to generate a rough building (floor plan), then flat design, and finally detailed module design. It then leverages advanced heuristic algorithms to optimise the generated design options from the bottom up, i.e., from module to flat and ultimately to building (floor plan). The process will be augmented by design knowledge and includes human experts in the loop.

We will pilot the research in Hong Kong's HRMBs, a rich context for considering DfX in relation to factors including user groups, available construction technologies, manufacturing capacity, logistics, and site conditions. The research will deepen our understanding of HRMB design by considering a wide range of excellence criteria, and may open up a new design paradigm through which humans and machines collaborate to deliver design value.

Highlights of the research project:

1. Extending DfMA to DfX to consider more challenging and mysterious eXcellence factors;
2. Deploying graph learning (or machine learning with graphs) in generative design, as much of our design and construction knowledge is represented as graphs;
3. Using Generative Adversarial Network (GAN) instead of prevailing algorithms (e.g., auto-encoder, Shaper_GA) to more effectively generate design options;
4. Respecting expert knowledge, be it explicit or tacit, e.g., to solve the local and global optimum problem and the 'curse of high dimensionality' from DfMA to DfX;
5. Organising the computational challenges in a cascade fashion – it is a typical 'divide and conquer' arrangement.

Department of Architecture

1. Spring 2023 Discussion Series – Kau Yi Chau Artificial Islands

   This talk series is organised for the Department's academic collaboration with the Civil Engineering and Development Department (CEDD) and the Planning Department (PlanD) of the HKSAR Government. Speakers are invited to share the latest studies on the Kau Yi Chau artificial islands in Hong Kong's central waters.

   Dates: 17, 24 February and 3 March 2023 (Fridays)
   Time: 4:00 pm - 5:30 pm
   Venue: Room 730, 7/F, Knowles Building
   Featured speakers: Stephanie Chan, Pakin Cheung, Jaime Pong, Amy Wu, William Yeung

Talk 1 on Friday, 17 February 2023:

Speaker: Pakin Cheung (CEDD)
Topic: *Shaping of artificial islands–between art and science*

Speaker: Jaime Pong (CEDD)
Topic: *Urban forestry and biodiversity*

Talk 2 on Friday, 24 February 2023:

Speakers: Amy Wu (PlanD) and Jaime Pong (CEDD)
Topic: *Urban and landscape design concepts and framework*

Speaker: William Yeung (CEDD)
Topic: *Smart, green, resilient and carbon neutrality*

Talk 3 on Friday, 3 March 2023:

Speaker: Amy Wu (PlanD)
Topic: Strategies for planning and design of active mobility

Speaker: Stephanie Chan (PlanD)
T*opic: Planning for 15-minute neighbourhoods*

This talk series is an internal event open to **FoA members and students**. Every talk is followed by a Q&A session with the audience.

Upon the speakers' request, recordings are not allowed for the talk series.

More information: https://www.arch.hku.hk/event_/kau-yi-chau-artificial-islands/

2. Spring 2023 Public Lecture Series – Moving Bodies

(i) Featured speaker: Shingo Masuda 増田信吾
Topic: *Is It Truly Necessary?*
Date: 10 February 2023
Time: 6:30pm – 8:00pm
Venue: Room 419, 4/F, Knowles Building

***Abstract**: We only see value in designing structures that have a fundamental impact on a place. The key to accessing that value can be found hiding along the boundaries where different territories collide, in elements such as windows, foundations, and eaves, and within the subtle phenomena that tend to be overlooked. By turning our sights outward and simultaneously focusing our attention on details, we challenge ourselves to reconsider what is truly necessary.*

More information: https://www.arch.hku.hk/event_/shingo-masuda/

Biography: *Shingo Masuda (b. 1982) founded joint practice Shingo Masuda + Katsuhisa Otsubo with Katsuhisa Otsubo (b. 1983) in 2007, after they both graduated from the Musashino Art University. Masuda was the Baird Visiting Critic at Cornell University in 2015, a specially appointed associate professor at Meiji University from 2019-2022, and has been a lecturer at Musashino Art University from 2010 onwards. He was lecturer at several other universities, including Tokyo Institute of Technology in 2019-2020 and Tokyo National University of Fine Arts and Music in 2018-2019. Masuda and Otsubo were winners of the AR Emerging Architecture Award (2014) and 32nd Yoshioka Prize (2016). They were selected to be part of the team for the Japanese Pavilion of the Venice Biennale 2016, where they received a special mention. They also exhibited at the 2017 Chicago Architecture Biennial. Their solo exhibition, entitled 'Shingo Masuda + Katsuhisa Otsubo: Is It Truly Necessary?', was held at TOTO GALLERY·MA in 2020. Their first monograph,* Adaptation Shingo Masuda + Katsuhisa Otsubo*, was published by TOTO Publishing in 2020.*

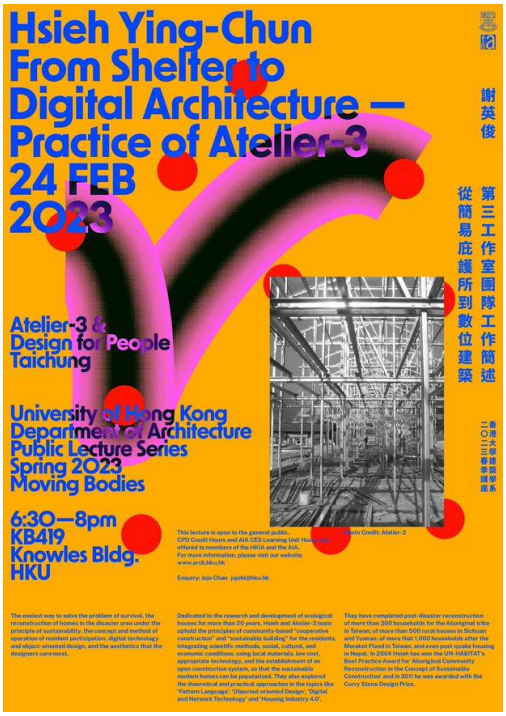
(ii) Featured speaker: Hsieh Ying Chun 謝英俊

Topic: *From Shelter to Digital Architecture – Practice of Atelier-3*
第三工作室團隊工作簡述／從簡易庇護所到數位建築

Date: 24 February 2023
Time: 6:30pm – 8:00pm
Venue: Room 419, 4/F, Knowles Building

Abstract: *The easiest way to solve the problem of survival: the reconstruction of homes in the disaster area under the principle of sustainability, the concept and method of operation of resident participation, digital technology and object-oriented design, and the aesthetics that the designers care most.*

More information: https://www.arch.hku.hk/event_/hsieh-ying-chun/



Biography: *Dedicated to the research and development of ecological houses for more than 20 years, Hsieh Ying Chun and the Atelier-3 team uphold the principles of community-based 'cooperative construction' and 'sustainable building' for the residents, integrating scientific methods, social, cultural, and economic conditions, using local materials at low cost, appropriate technology, and the establishment of an open construction system, so that the sustainable modern homes can be popularised. They also explored the theoretical and practical approaches in topics like 'Pattern Language', 'Object-oriented Design', 'Digital and Network Technology' and 'Housing Industry 4.0'. They have completed post-disaster reconstruction of more than 300 households for the Aboriginal tribe in Taiwan; more than 500 rural houses in Sichuan and Yunnan; more than 1,000 households after the Morakot Flood in Taiwan, and even post-quake housing in Nepal. Hsieh won the UN-HABITAT's Best Practice Award for 'Aboriginal Community Reconstruction in the Concept of Sustainable Construction' in 2004 and the Curry Stone Design Prize in 2011.*

3. ‘Backpack Housing’ Exhibition

Dates: 20 January to 13 February 2023
Venue: S314, 3/F, Staunton (Block A), PMQ

Design:
Donn Holohan

Project Team:
Leung Lok Yan (Project Leader)
Kevin Lin
Chan Ching Yin
Partners:
Urban Ecologies Design Lab
Habitat for Humanity
Bank of China Hong Kong
Chinachem Group

Description*: Mongkok contains almost no unused space. Programmes shift and disparate activities overlap – transforming from day to night and from week to week, mediated by temporal structures of ductwork, neon, shopfront screens and market stalls. However, at the scale of a district, there are unforeseen redundancies. As apartment and office blocks are rapidly decommissioned, demolished and rebuilt, they also lie empty while ownership disputes are settled and building permits are obtained. The result is a significant building vacancy rate – despite urgent demand.*

These spaces, located across the city, are the site for Backpack Housing. A reconfigurable kit of parts, this system provides a framework through which these spaces can be occupied temporarily – plugging into existing and remaining infrastructure and providing shelter for some of Hong Kong's most vulnerable residents. Each system is crafted for one person within a particular space, moving with them as they move from transitional to more certain housing. At its most complete, each Backpack provides a safe, private and well-appointed shelter, which can be reconfigured as loose furniture, partitioning systems, or storage if and when required. This exhibition sees the prototypical system redeployed and adapted to the residential exhibition space at PMQ – bringing with it traces of its past occupancy.

4. Su Chang

- has published the following article in the Experiments & Processes section of the *Landscape Architecture Frontiers* journal:

  Su, C. (2022). Houses Like Water: Observations and Reflections on House Types of Kat O Fishing Village in Hong Kong. *Landscape Architecture Frontiers*, *10*(3): 86–93.
  https://journal.hep.com.cn/laf/EN/10.15302/J-LAF-1-050047

This paper is featured on the cover of the journal

Abstract: *Liquid Homes: Building, Living and Other Stories of Hong Kong Fishing Villages is a research, curatorial, and design collaboration that explores the culture of Tanka people and their fluid state of living and building, presenting stories from a long overdue reading of the other Hong Kong. This essay, as an ongoing work, intends to reflect on our recent observations of the houses in Kat O fishing village by documenting the self-built additions in relation to the surrounding topography and water environment. These findings evoke an understanding of houses as „amphibious creatures" of hybrid qualities riding on the seams between land and water, and denote the notion of homes as „fluid entities"—physical yet elusive, subject to the floating identity of the community. The research intends to offer an ethnographic reading of Hong Kong coastal settlements and their building typologies, rethink building materialities by their temporal qualities and beyond the physical matter, imagine a renewed reading on the dialectical relation between the built and the natural, and propose new ways to design sustainable architecture through the landscape.*

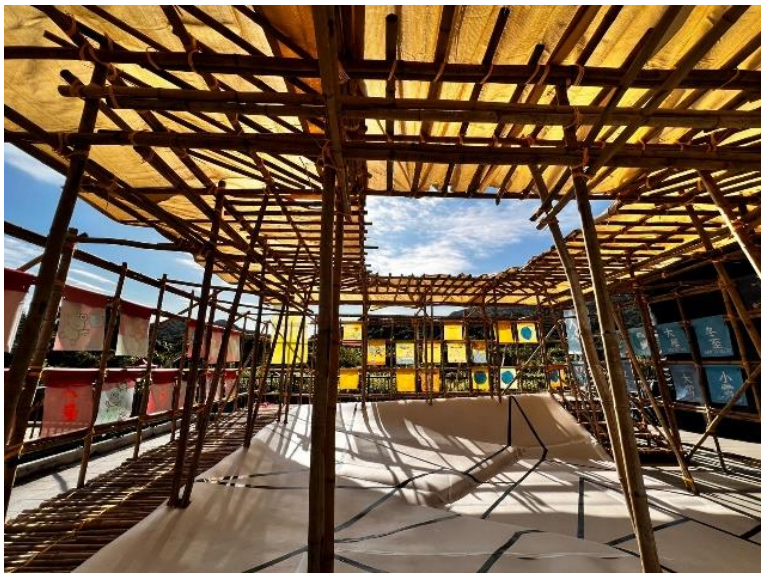
This work previously received funding from the Design Trust, and is supported by the HKU Teaching Development and Language

Enhancement Grant (TDLEG) for Undergraduate Research. It is a spin-off project led by BA(AS) Year 4 students Tam Wing Huen Raven, Hon Ming Rou, Zhu Yalan Julia, and Ma Ho Ching Issac. An exhibition of the research process was held at RNH Space in 2022.

5. Ar Wallace Chang

- is the architect of the Lai Chi Wo Children Play Theatre [Children Theatre Workshop + Art Tech Performance], a countryside cultural innovation project proposed by Zuni Icosahedran and funded by the Countryside Conservation Funding Scheme. The project comprises a Play Theatre and a Bamboo Playground set up in Lai Chi Wo, one of the oldest, largest and best-preserved rural settlements in Hong Kong.

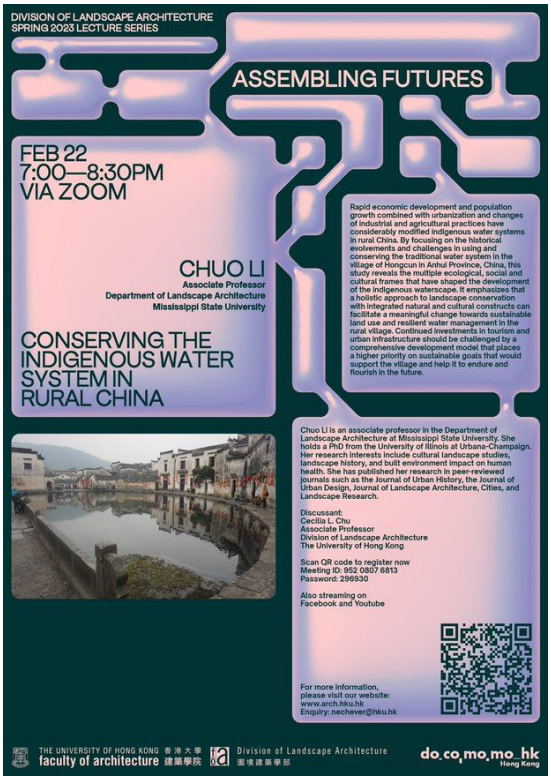
  The Bamboo Playground, which transforms traditional bamboo scaffolding structure with innovative design, is built for children to play and learn together. With the theme of the traditional Chinese 24 solar terms and the AR application featuring the 'Four Mascots', children can learn traditional rural knowledge through play.



Division of Landscape Architecture

1. Spring 2023 Public Lecture Series – ASSEMBLING FUTURES

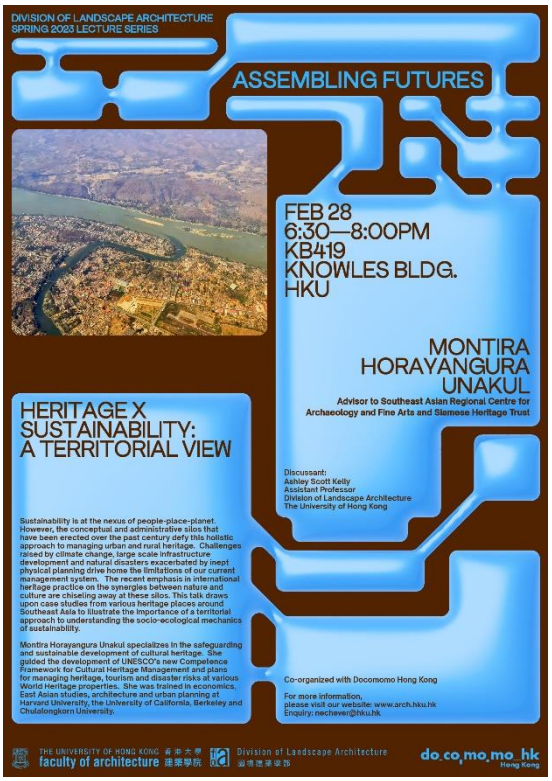
   (i) Featured speaker: Chuo Li, Department of Landscape Architecture, Mississippi State University
   Discussant: Cecilia Chu
   Topic: Conserving the Indigenous Water System in Rural China
   Date: 22 February 2023
   Time: 7:00pm – 8:30pm
   Mode: Zoom



Abstract: *Rapid economic development and population growth combined with urbanization and changes of industrial and agricultural practices have considerably modified indigenous water systems in rural China. By focusing on the historical evolvements and challenges in using and conserving the traditional water system in the village of Hongcun in Anhui Province, China, this study reveals the multiple ecological, social and cultural frames that have shaped the development of the indigenous waterscape. It emphasizes that a holistic approach to landscape conservation with integrated natural and cultural constructs can facilitate a meaningful change towards sustainable land use and resilient water management in the rural village. Continued investments in tourism and urban infrastructure should be challenged by a comprehensive development model that places a higher priority on sustainable goals that would support the village and help it to endure and flourish in the future.*

Biography: *Chuo Li is an associate professor in the Department of Landscape Architecture at Mississippi State University. She holds a PhD from the University of Illinois at Urbana-Champaign. Her research interests include cultural landscape studies, landscape history, and built environment's impact on human health. She has published research in peer-reviewed journals such as the* Journal of Urban History*,* Journal of Urban Design*,* Journal of Landscape Architecture*,* Cities*, and* Landscape Research*.*

(ii) Featured speaker: Montira Horayangura Unakul, Southeast Asian Regional Centre for Archaeology and Fine Arts, and Siamese Heritage Trust
Discussant: Ashley Scott Kelly
Topic: Heritage x Sustainability: A Territorial View
Date: 28 February 2023
Time: 6:30pm – 8:00pm
Venue: Room 419, 4/F, Knowles Building, HKU



Abstract*: Sustainability is at the nexus of people-place-planet. However, the conceptual and administrative silos that have been erected over the past century defy this holistic approach to managing urban and rural heritage. Challenges raised by climate change, large-scale infrastructure development and natural disasters exacerbated by inept physical planning drive home the limitations of our current management system. The recent emphasis in international heritage practice on the synergies between nature and culture are chiselling away at these silos. This talk draws upon case studies from various heritage places around Southeast Asia to illustrate the importance of a territorial approach to understanding the socio-ecological mechanics of sustainability.*

Biography: *Montira Horayangura Unakul specialises in safeguarding the sustainable development of cultural heritage. She guided the development of UNESCO's new Competence Framework for Cultural Heritage Management and the plans for managing heritage, tourism and disaster risks at various World Heritage properties. She was trained in economics, East Asian studies, architecture and urban planning at Harvard University, the University of California, Berkeley and Chulalongkorn University.*

(iii) Featured speaker: Maan Barua, Department of Geography, The University of Cambridge
Discussants: Sony Devabhaktuni and Natalia Echeverri
Topic: Infrastructure in a Minor Key
Date: 2 March 2023
Time: 6:30pm – 8:00pm
Mode: Zoom

Abstract*: Infrastructure is a pivotal concept in reading the assembly, function and politics of urban life. Whilst scholarship on infrastructure has exploded in the interpretative social sciences, much of this work remains resolutely humanist, tethered to notions of design, planning and assembly. What might looking at animal-infrastructure assemblages do for developing an ecology of infrastructure that does not take infrastructural form or constitution for granted? How might relations between macaques and infrastructure enable us to rethink the material politics of urban life? Drawing on fieldwork in Delhi, India, this talk first shows how arboreal geographies of macaques and itinerant practices of electricians purloining electricity give rise to infrastructural form in ways*

completely unanticipated in the electric grid's inaugural assembly. The talk then turns to what the speaker calls 'infrapolitics' – activities that subtend political life – and how claims to infrastructures are made by summoning various other-than-human agents, be they macaques or spectral beings. The talk then turns to how relations between people and macaques themselves become infrastructural, subtending economic practices at the margins of urban life. Together, these strands articulate what the speaker calls a minor ecology of infrastructure, which posits a different grammar for understanding infrastructural formations than more familiar idioms of informality, planning design and assembly.

Biography: *Maan Barua's research is on the economies, ontologies and politics of the living and material world. His most recent work examines how cities are governed by regulating nonhuman life. Maan's forthcoming book* Lively Cities: Reconfiguring Urban Ecology *will be published by Minnesota University Press in May 2023. He is the PI for an ERC Horizon 2020 Starting Grant on Urban Ecologies and is a Senior Lecturer at the Department of Geography, The University of Cambridge.*

About 'Assembling Futures': *The DLA Spring 2023 Public Lecture Series 'Assembling Futures' brings together distinguished academics and professionals in the fields of landscape architecture and heritage conservation to discuss recent works concerning environmental futures. Although landscape and heritage practices have long engaged with the regeneration of existing environments for future use, the precise relationships between such works and the future remain underexamined. Lectures in this series explore landscape architecture and heritage conservation as future-making practices that condition how future environments are managed, valued and imagined. By attending to how different projects reassemble the relationships between human and non-human agents and evolving socio-material engagements across different scales, the series encourages critical reflections on the competing visions of building future worlds in the face of growing uncertainty and unfolding environment crises. This lecture is co-organised by the Division of Landscape Architecture at HKU, Docomomo Hong Kong, and the Built Heritage Research Collaborative, one of the HKUrbanLabs at HKU Faculty of Architecture. It is free and open to the public.*

2. Dr Chao Ren

   - has been invited by the United Nations Environment Programme to participate in the 7th Global Environment Outlook (GEO-7) First Global Author's Meeting to be held at the United Nations Conference Centre (UNCC) in Bangkok, Thailand, on 13-17 March 2023.

3. Ms Wren Wanying Liang (MLA 2022)

    - won the Gold Award of 2022 Asian Design Award, for her MLA thesis project titled ‘Landscape as an early intervention: Redesigning the neighborhood park to reduce the tragedy of being homeless in Hong Kong’, supervised by Dr Bin Jiang.

4. Ms Minhui Lu (MLA 2022)

    - won First Prize (Top Prize) of 2022 YuanYe International Awards and Gold Award of 2022 Asian Design Award, for her MLA thesis project titled ‘From E-waste to E-restoration: Using landscape architecture to promote electronic pollution treatment and ecological sustainability in Guiyu Town, Guangdong, China’, supervised by Dr Bin Jiang.

Department of Real Estate and Construction

1. Dr Llewellyn Tang

   - was invited to present his research on ‘AutoCDE: An A.I. Driven Smart Asset Platform with Digital Twin Technology that Changes the Construction and Engineering Industry’ for the Digital Roads of the Future of the University of Cambridge on 13 January 2023. This research talk demonstrated the development strategy and process of the adoption of ISO 19650 to support the creation of an A.I.-driven smart asset platform with digital twin technology that decarbonises the construction and engineering industry. It illustrated that the use of an international standardised approach is central to supporting the creation of digital twins for better carbon management.

Llewellyn was also invited to present on the topic for the Cambridge Centre for Smart Infrastructure and Construction Research Talk on 18 January 2023. The talk is available on YouTube.

2. Research Brown Bag Seminar

- Dr Carol Hon, Senior Lecturer at the School of Architecture and Built Environment of Queensland University of Technology, was invited to present her research on 'Managing Psychosocial Hazards for Better Mental Health of the Australian Construction Workers' at the Department on 18 January 2023. The seminar examined the relationships between psychosocial hazards and mental health outcomes in the Australian construction industry. She explained the methodology, results, and conclusions from the three phases of her research that had been completed so far (a meta-analysis; qualitative interviews; and a Bayesian Network model), and shared the next steps for the project.

  About the Speaker:

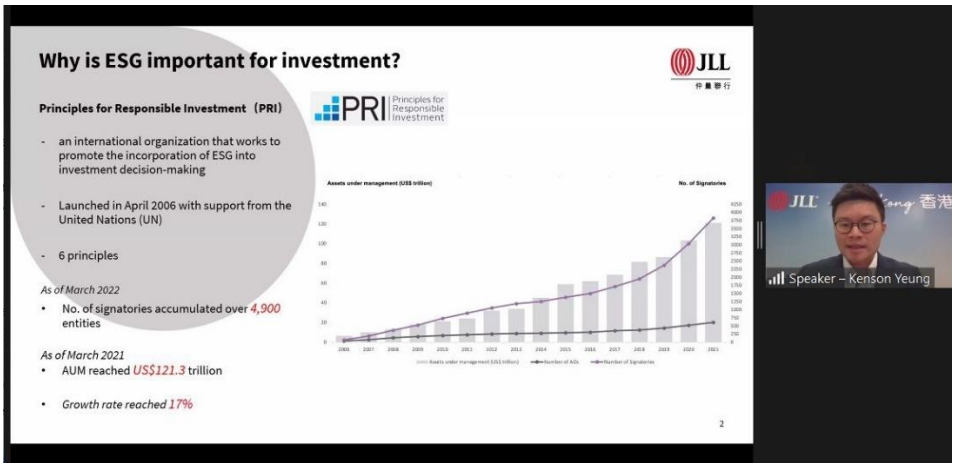
  Dr Carol Hon is a Senior Lecturer at the School of Architecture and Built Environment, Queensland University of Technology (QUT). She obtained her Bachelor's degree from the University of Hong Kong, and her MPhil and PhD degrees from the Hong Kong Polytechnic University. She is passionate about reducing construction accidents and improving health and safety. Her research with the Centre for Work Health and Safety of the New South Wales Government contributes to developing an innovative training programme to reduce electrical risks for young construction workers in Australia. She received a prestigious Australian Research Council (ARC) Discovery for Early Career Researcher Award (DECRA) for the project titled 'Improving Mental Health and Safety in the Construction Industry'. Before joining academia, Carol practised in the industry as a quantity surveyor.

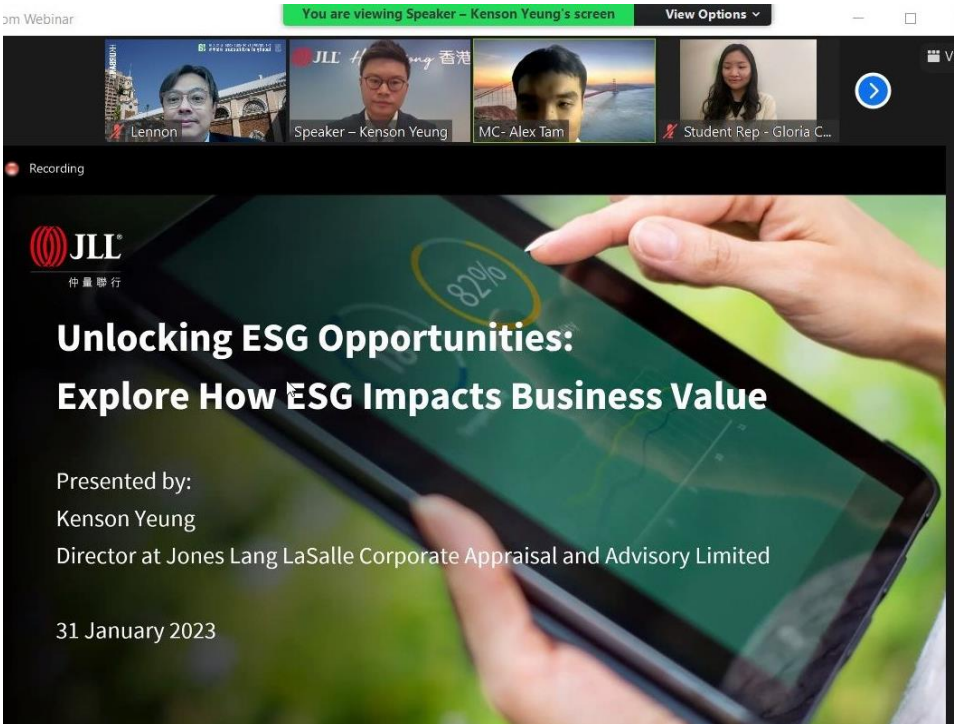
  Abstract: *Many construction workers have poor mental health conditions. In Australia, construction workers died by suicide six times more than they were killed by accidents in construction sites. While there are many factors leading to suicide, a prolonged exposure to*

psychosocial hazards in the workplace adversely affects the mental health of the construction workforce. Research on psychosocial hazards in the construction industry has been limited. To fill this gap, the Australian Research Council funded a project to better manage psychosocial hazards to improve the mental health of Australian construction workers. This presentation highlights key findings of the project from the meta-analysis to interviews and Bayesian Network Model. It provides recommendations for managing psychosocial hazards and reducing their impacts on the mental health of construction workers.

3. ESG Webinar

- Mr Kenson Yeung, Director of Jones Lang LaSalle Corporate Appraisal and Advisory Limited, was invited to share his views on how ESG impacts business value in a webinar co-organised by the HKU Real Estate Society, a student association of our Master of Science in Real Estate [MSc(RE)] programme, and the Hong Kong Institute of Surveyors, on 31 January 2023.





4. Ar Kasing Yu

   - was interviewed by RTHK's documentary programme 'Hong Kong United', in the episode of '漫遊築覺——高街的歷史建築' [Strolling through Historic Buildings on High Street], in which he introduced how architectural projects were skilfully designed to overcome the difficulties of building on slopes and make proper use of space. He also discussed how community development and historic building conservation can go hand in hand.

     The interview came out on 2 February 2023 and is available online: https://www.rthk.hk/tv/dtt32/programme/hkunited/episode/854665

5. Dr Michael Wang

- has been ranked 19th in the latest Real Estate Academic Leadership (REAL) author rankings for 2018-22. The rankings highlight the scholars who have made the greatest contributions to real estate knowledge as measured by publication output across the top three real estate journals: *Journal of Real Estate Finance and Economics* (JREFE), *Journal of Real Estate Research* (JRER), and *Real Estate Economics* (REE).

Table 1. The REAL author rankings for 2018–2022.

Rank	Previous Rank	Author	Publications
1	1	Michael J. Seiler	20
2	3	Zhenguo Lin	14
3	4	David C. Ling	12
4	4	Eli Beracha	11
	6	Geoffrey K. Turnbull	11
	9	Julia Freybote	11
	2	William G. Hardin III	11
8	7	Alex M. van de Minne	10
	7	Zifeng Feng	10
10	9	David M. Harrison	9
	17	Marc K. Francke	9
12	NR	Bing Zhu	8
	9	Brent W. Ambrose	8
	9	David M. Geltner	8
	17	Eva Steiner	8
	17	Seow-Eng Ong	8
	9	Tingyu Zhou	8
	NR	Walter D'Lima	8
19	17	Abdullah Yavas	7
	NR	Chongyu Wang	7
	NR	David H. Downs	7
	17	Jia Xie	7
	25	Joseph T.L. Ooi	7
	NR	K. W. Chau	7
	9	Moussa Diop	7
26	25	Alan Tidwell	6
	25	Benjamin Scheick	6
	9	Bennie D. Waller	6
	25	Henry J. Munneke	6
	NR	Jackson T. Anderson	6
	25	Jeffrey P. Cohen	6
	NR	Jianfu Shen	6
	NR	Jonathan A. Wiley	6
	NR	Kimberly F. Luchtenberg	6
	25	Lingxiao Li	6
	9	Milena T. Petrova	6
	NR	Piet Eichholtz	6
	25	Stanimira Milcheva	6
	NR	Steffen P. Sebastian	6
	NR	Susan M. Wachter	6
	25	Tien Foo Sing	6
	17	Yingchun Liu	6

Notes: The ranking is based on the number of publications in JREFE, JRER, or REE. Publications are defined as works that are published, forthcoming, and accepted but unassigned artides as of 9/1/22. A previous ranking of "NR" signifies that the author was not ranked in the 2017–2021 rankings. In addition, there are 16 authors with five publications, 35 authors with four publications, 53 authors with three publications, 144 authors with two publications, and 722 authors with one publication.

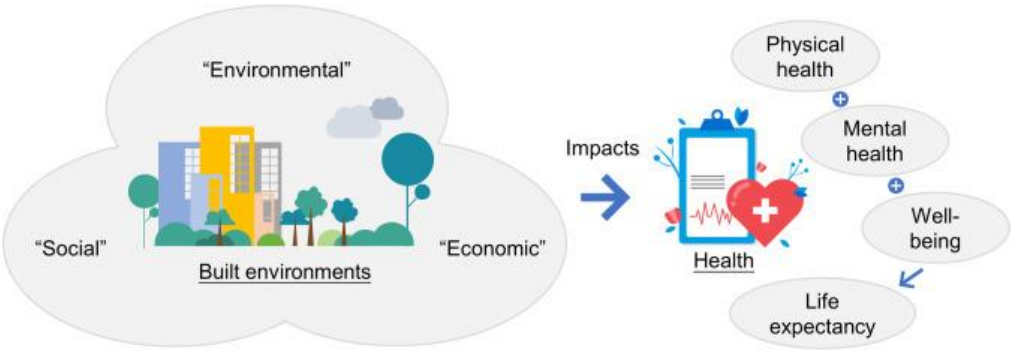
Future Urbanity & Sustainable Environment (FUSE) Lab

1. Dr Binley Chen

   - has published the following paper:

     Chen, B.* (2023). Coincided disparity between housing price and health outcome. ***The Lancet Regional Health – Europe***, *27*, 100593. https://doi.org/10.1016/j.lanepe.2023.100593

     Abstract: *A global consensus has been increasingly acknowledged that the built environment, including man-made or modified structures, surfaces, facilities, and landscapes, influences human health and wellbeing (Fig. 1). Housing price, as a monetary metric to reflect the quality of the built environment regarding properties' structural and socioeconomic attributes, locations, and neighboring amenities, is highly associated with physical and mental health from research findings in recent studies. These results unveil the underlying concerns of coincided disparities between the built environment and human health; worrisomely, this trend is expected to exacerbate along with rapid urbanization. The United Nations 2030 Agenda for Sustainable Development has highlighted the aspiration of making cities and human settlements inclusive, safe, resilient, and sustainable in the 11th Sustainable Development Goal. The current challenge is how to promote social, environmental, and economic prosperities while mitigating associated disparities (with the goal of leaving no one behind).*

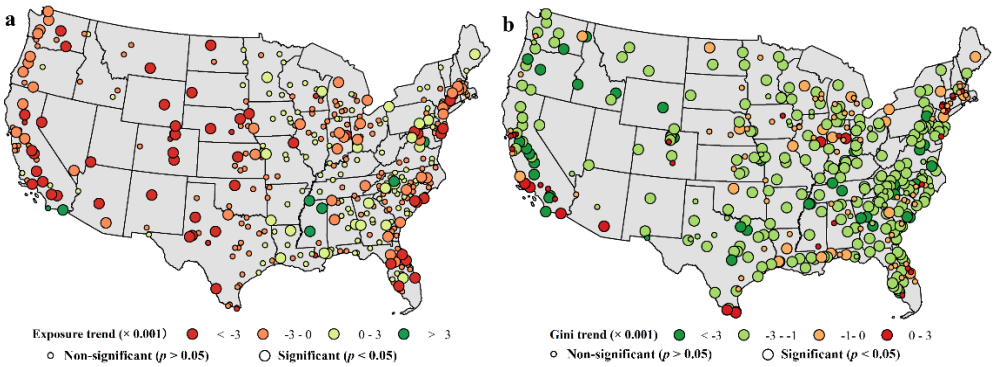


2. Dr Shengbiao Wu (PDF, DLA), Ms Wenbo Yu (PhD student, DLA) and Dr Binley Chen

   - have published the following paper:

Wu, S., Yu, W., Chen, B.* (2023). Observed inequality in thermal comfort exposure and its multifaceted associations with greenspace in United States cities. ***Landscape and Urban Planning***, *233*, 104701. https://doi.org/10.1016/j.landurbplan.2023.104701

Abstract: *Increasing exposure to heat stress threatens the health and well-being of urban residents. However, existing studies on measuring human thermal comfort exposure remain uncertain without considering fine-scale human-heat interaction and its long-term dynamics. To inform this issue, we proposed a population-weighted exposure assessment framework with the integration of high-resolution land surface temperature and population data to evaluate human exposure to thermal comfort and the associated inequality across 398 major cities over 2000–2020 in the United States, and further explored the multifaceted associations between greenspace and thermal comfort. Results show that 199 United States cities (50.00 %) experience severe heat stress (i.e., thermal comfort exposure <0.44) and 99 of which (24.87 %) are unevenly exposed to heat stress (i.e., Gini index of thermal comfort exposure >0.36). Temporal analysis from 2000 to 2020 reveals that human exposure to thermal comfort decreases by a mean magnitude of −0.00081 yr−1, and the associated inequality level decreases by a mean magnitude of −0.00153 yr−1. By linking urban greenspace and heat exposure, we find that greenspace has multifaceted associations with heat stress, with a highly positive correlation between greenspace and thermal comfort (i.e., comfort regulation by physical cooling effect) and a coincided exposure inequality between greenspace and thermal comfort. This study offers an alternative framework to characterize fine-scale human exposure to thermal comfort across space and time, provides observational evidence of thermal comfort exposure inequality in the United States cities, and highlights the need for prioritizing greening policies and actions to mitigate heat stress and exposure disparity.*



Healthy High Density Cities Lab

1. Dr Chinmoy Sarkar

   - delivered a presentation entitled 'Towards *Longevity-Ready* Cities: Built and Social Environmental Determinants of Healthy Longevity', in the capacity of the inaugural NAM-HKU Fellow in Global Health Leadership, on 17 February 2023 via Zoom.

Co-hosted by the U.S. National Academy of Medicine (NAM) and the HKU School of Public Health, the seminar featured Dr Sarkar's project conducted as a part of his fellowship. Dr Sarkar talked about the built and social environmental determinants of healthy longevity, including existing scientific evidence and future directions towards achieving the goal of longevity-ready cities. The presentation was followed by a panel discussion, featuring Mr Paul Irving (University of Southern California Leonard Davis School of Gerontology; Milken Institute), Dr John W. Rowe (Columbia University), and Dean Chris Webster.

iLab

1. The Chinese Research Institute of Construction Management (CRIOCM) 27th (2022) International Symposium on Advancement of Construction Management and Real Estate

   - This time, the two-day CRIOCM annual conference was held online from The Chinese University of Hong Kong (CUHK) on 5-6 December 2023, with the theme of 'Construction Management and Real Estate in the Post-Pandemic Age: Building Smart and Resilient Cities for Healthy Living'. After a vigorous peer review, the conference had finally accepted more than 170 papers from 14 countries and regions, with more than 620 scholars presenting their research or attending the conference.

     CRIOCM 2022 featured the following keynote speakers:

     Professor Bo Huang (CUHK)
     Professor Liyin Shen (Zhejiang University City College)
     Professor Geoffrey Shen (HKPolyU)
     Professor Wei Pan (HKU)
     Professor Chimay Anumba (Florida University)
     Professor Xiangyu Wang (Curtin University)
     Professor Chris Webster (HKU)
     Professor Ming Xu (Tsinghua University)
     Professor Haibo Zhang (Nanjing University)

   - Professor Wilson Lu, in the capacity of CRIOCM President, delivered an opening speech at the conference on 5 December 2022.

   - Dr Frank Xue chaired Parallel Session 8B at the conference on 5 December 2022.

   - The following iLab members presented their works at the conference:

     Mr Benjamin Kwaku Ababio (HKU-PS, HKPFS, PhD Student, REC)
     Dr Binley Chen
     Dr Junjie Chen (RAP, REC)
     Mr Yonglin Fu (RA, REC)
     Mr Frank Ato Ghansah (PhD Student, REC)
     Ms Dong Liang (PhD student, REC)
     Professor Wilson Lu
     Mr Yipeng Pan (RA, REC)
     Ms Jiajia Wang (PhD student, REC)
     Dr Frank Xue
     Ms Qianyun Zhou (RA, REC)

- Among them, Yonglin, Junjie, Yipeng and Professor Lu won the **CRIOCM 2022 Best Paper Award**, for the following paper:

  Fu, Y., **Chen, J.**, **Pan, Y** & **Lu, W.** (2022). An integrated visualization framework to enhance human-robot collaboration in facility management. The CRIOCM 2022 International Symposium on Advancement of Construction Management and Real Estate, Hong Kong, China, 5-6 December 2022. Proceedings in press.

- Benjamin, Frank and Professor Lu won a **Merit Paper Award** for the following paper:

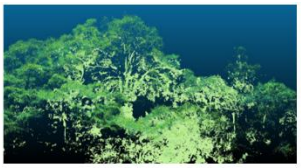
  Ababio, B., **Xue, F.**, & **Lu, W.** (2022). Enhancing Circular Procurement in the Construction Sector: A Conceptual Framework for Stakeholder Collaboration. The CRIOCM 2022 International Symposium on Advancement of Construction Management and Real Estate, Hong Kong, China, 5-6 December 2022. Proceedings in press.

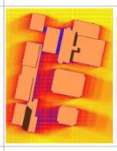
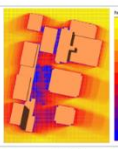
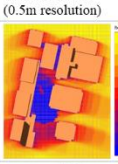
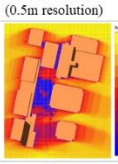
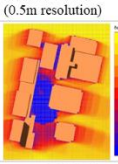
- Dr Frank Xue and Ms Dong Liang presented the following paper at the conference:

  Liang, D. & **Xue, F.** (2022). A SWOT Analysis for Applications of 4D Point Clouds (4DPC) in Construction. The CRIOCM 2022 International Symposium on Advancement of Construction Management and Real Estate, Hong Kong, China, 5-6 December 2022. Proceedings in press.

- Ms Qianyun Zhou, Ms Jiajia Wang, Dr Binley Chen and Dr Frank Xue presented the following paper at the conference:

  Zhou, Q., **Wang, J., Chen, B.,** & **Xue, F.** (2022). Precise Urban Green Volume-enabled Building and Environment Simulation: Sub-Meter Voxel Modeling of Airborne and Hand-held 3D Scans of Urban Trees. The CRIOCM 2022 International Symposium on Advancement of Construction Management and Real Estate, Hong Kong, China, 5-6 December 2022. Proceedings in press.



	No greenery model	Over-simplified greenery model	The airborne scanned greenery model (0.5m resolution)	The handheld scanned greenery model (0.5m resolution)	The multi-source greenery model (0.5m resolution)
Simulation Visualization					
Green Volume/m3	--	3200	1841	3022.25	4863.25
Total Radiation/h	596.63	579.71	561.46	576.24	560.38
Time/s	40s	70s	75s	90s	95s

- Professor Lu announced the next President of CRIOCM at the closing ceremony of the conference, following the completion of his three-year presidency from 2019 to 2022.

2. Mr Sou-han Chen (RA, REC)

   - presented the following paper at the 19th International Conference on Computing in Civil and Building Engineering (ICCCBE) 2022, in Cape Town, South Africa, on 26-28 October 2022:

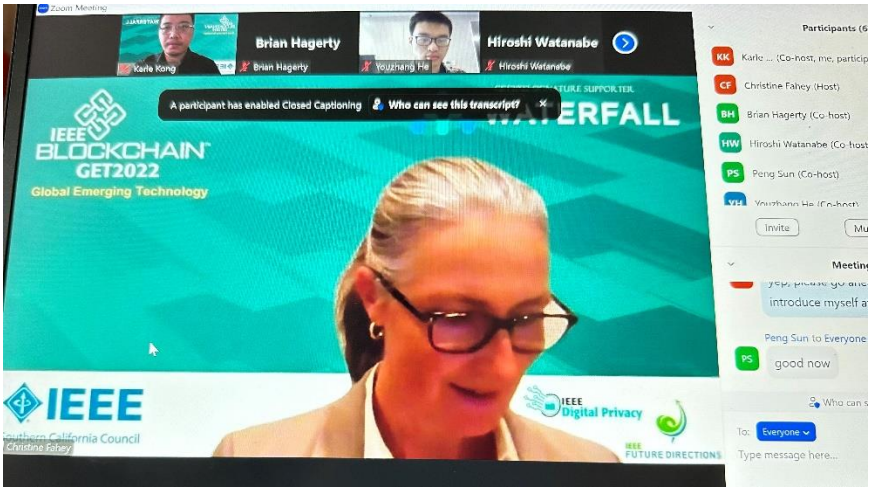
     Chen, S.-H., & **Xue, F.** (2022). Interactive BIM-based VR: A case study of doors. The 19th International Conference on Computing in Civil and Building Engineering (ICCCBE) 2022, Cape Town, South Africa, 26-28 October 2022. Proceedings in press.

Sou-han Chen presenting at ICCCBE 2022

3. iLab Researchers

   - Dr Frank Xue, Mr Kong Lingming (PhD student, REC), Mr Chen Chen (RA, REC), Mr Rui Zhao, Mr Zhe Chen, Mr Liupengfei Wu (PhD student, REC), Miss Zhongze Yang (PhD student, REC) and Professor Wilson Lu presented the following paper at the 2022 IEEE 1st Global Emerging Technology (GET) Blockchain Forum, on 7-11 November 2022:

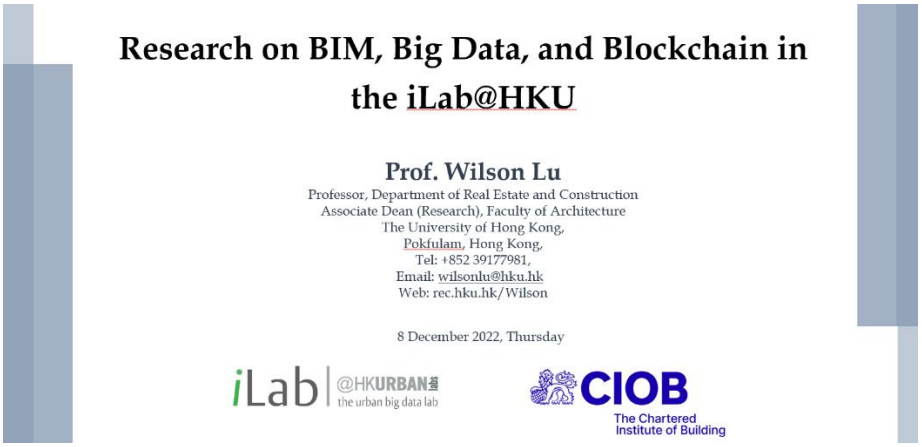
     Kong, L., **Chen, C., Zhao, R.**, **Chen, Z.**, **Wu, L.**, **Yang, Z.**, Li, X., **Lu, W.**, & **Xue, F.** (2022). When permissioned blockchain meets IoT oracles: An on-chain quality assurance system for off-shore modular construction manufacture. 2022 IEEE 1st Global Emerging Technology (GET) Blockchain Forum, virtual conference, 7-11 November 2022. Proceedings in press.



4. Professor Wilson Lu

- gave a talk on ‘Cross-border Construction Waste Material Trading to Achieve a Low Carbon, Circular Greater Bay Area (GBA), China’ at the International Conference on Cultural Landscape Protection and Urban-Rural Sustainable Development, organised by Suzhou University on 4 December 2022.

- chaired and presented about BIM, big data and blockchain research at the Chartered Institute of Building (CIOB) (HK Chapter) webinar ‘Data is the New … Rebar’ on 8 December 2022. He also moderated the Q&A session with Mr Jordan Kostelac of JLL (Asia).



- received a Certificate of Appreciation from the Hong Kong Construction Industry Council (CIC) in recognition of his support and contributions to the assessment panels of the CIC BIM Certification and Accreditation Schemes (BIMCAS). Professor Lu is a long-time member of the CIC BIM Managers and has helped to assess countless applicants who applied to the BIMCAS over the years.

- was invited by the CIC to be a Member of Advisory Panel for Master Class on AI in Construction, and attended a preparation meeting with the CIC on 1 December 2022.

- gave a talk on ‘Journal Paper Writing and Frontier of Smart Construction Research’ to North China University of Technology (NCUT) on 21 November 2022.

- has been invited to join the International Advisory Board of the Sardinia 2023 – 19th International Symposium on Waste Management and Sustainable Landfilling, to be held in Cagliari, Italy, on 9-13 October 2023.

- has been appointed as (Deputy) Editor of *Engineering, Construction and Architectural Management* (ECAM), a journal of Emerald Publishing with an Impact Factor of 3.850 in 2021.

5. Dr Frank Xue

- gave a public lecture titled 'Low-cost Digital Twins of Built Assets: Automatic Creation of Photo-realistic OpenBIM by Integrating Ubiquitous Augmented Reality and 2D CAD Drawings' on Innovations in OpenBIM and OpenGIS (the HKABAEIMA Training Class 51) on 12 October 2022.

- presented on 'Multi-user Internet Narrative Environment of HKU (MineHKU) for Smart City Courses and Virtual Campus Events' (Co-Is: Professor Anthony Yeh and Dr Isabelle Chan) at The 3rd HKU Teaching and Learning Festival 2022, on 8 November 2022.

(Note: this HKU block-world metaverse model is freely available for HKU teachers and students. You are welcome to approach Frank for a copy of the model.)

- gave a talk titled 'Digital Twinning Buildings and Cities with 3D Point Clouds: A Semantics Perspective' at the 2022 Leica Geosystems Hong Kong Seminar – Are You Ready for an Autonomous Future?, held at Sheraton Hotel in Tsim Sha Tsui on 25 November 2022.

- joined the Editorial Board of *Frontiers of Engineering Management*, co-published by China Higher Education Press and Springer, as a Special Corresponding Expert.

- received a grant of RMB 100,000 from the Guangdong Natural Science Fund – General Programme 2023, to support his research project titled 'From 3D Real Scene to 3D Semantics: Reconstruction of Semantic Volumetric Building Models Using 3D Skeletons in Urban Point Clouds', for a period of 24 months commencing from January 2023.

6. Dr Junjie Chen

   - won the HKU Teaching Development Grant (TDG) with his proposal titled ‘MetaClass: Metaverse and Robotics-enabled Curriculum and Pedagogical Innovations to Promote Construction Engineering and Management Knowledge Teaching and Learning’, for an amount of HK$230,040. The project aims to improve construction engineering and management (CEM) knowledge T&L performance via curriculum and pedagogical innovations enabled by metaverse and robotics. There are four specific objectives:

     (i) To explore the difficulties of CEM knowledge T&L;
     (ii) To develop a set of CEM knowledge T&L modules using robotics and metaverse;
     (iii) To implement the modules in real-life T&L and assess their effects; and
     (iv) To explore advanced technologies-based curriculum and pedagogical innovations to promote students’ learning of CEM knowledge

7. CIC Chairman Visit

   - Ir Thomas Ho, Chairman of Hong Kong Construction Industry Council (CIC), Professor Ada Fung, Chairperson of CIC’s Committee on BIM, together with a group of CIC members, visited iLab on 7 December 2022, to explore advanced construction technologies and cutting-edge construction management research. The three-hour visit started with the Welcome Remarks by Dean Webster, followed by a sharing session on iLab’s research findings in construction management and technologies, presented by Professor Wilson Lu. After that, there was a follow up discussion and photo-taking session before the CIC delegates toured iLab.

From left: Professor Chris Webster, Ir Thomas Ho, Mr Alex Ho

Professor Wilson Lu

Round-table discussion among the guests and speakers

Closing ceremony and award presentation

8. Professor Wilson Lu and iLab researchers

- have published the following papers:

(i) **Ghansah, F. A.** & **Lu, W. S.** (2023). Major opportunities of digital twins for smart buildings: A scientometric and content analysis. *Smart and Sustainable Built Environment*. https://doi.org/10.1108/SASBE-09-2022-0192

Purpose *– Digital twins provide enormous opportunities for smart buildings. However, an up-to-date intellectual landscape to*

understand and identify the major opportunities of digital twins for smart buildings is still not enough. This study, therefore, performs an up-to-date comprehensive literature review to identify the major opportunities of digital twins for smart buildings.

Design/methodology/approach *– Scientometric and content analysis are utilised to comprehensively evaluate the intellectual landscape of the general knowledge of digital twins for smart buildings.*

Findings *– The study uncovered 24 opportunities that were further categorised into four major opportunities: efficient building performance (smart "building" environment), efficient building process (smart construction site environment), information efficiency and effective user interactions. The study further identified the limitations of the existing studies and made recommendations for future research in the methodology adopted and the research domain. Five research domains were considered for future research, namely "real-time data acquisition, processing and storage", "security and privacy issues", "standardised and domain modelling", "collaboration between the building industry and the digital twin developers" and "skilled workforce to enable a seamless transition from theory to practice".*

Practical implications *– All stakeholders, including practitioners, policymakers and researchers in the field of "architecture, engineering, construction and operations" (AECO), may benefit from the findings of this study by gaining an in-depth understanding of the opportunities of digital twins and their implementation in smart buildings in the AECO industry. The limitations and the possible research directions may serve as guidelines for streamlining the practical adoption and implementation of digital twins for smart buildings.*

Originality/value *– This study adopted scientometric and content analysis to comprehensively assess the intellectual landscape of relevant literature and identify four major opportunities of digital twins for smart building, to which scholars have given limited attention. Finally, a research direction framework is presented to address the identified limitations of existing studies and help envision the ideal state of digital twins for smart buildings.*

(ii) **Yang, Z. Z.** & **Lu, W. S.** (2022). Facility layout design for modular construction manufacturing: A comparison based on simulation and optimization. *Automation in Construction, 147*, 104713. https://doi.org/10.1016/j.autcon.2022.104713

Abstract: *With modular construction reviving around the world, a significant portion of on-site works is now mass-produced as modules in factories, shifting Modular Construction Manufacturing (MCM) from*

a traditional oxymoron to an upfront challenge for project or production managers. Nevertheless, little is known about such MCM in a factory, e.g., the production line layout. This paper identifies the optimal Facility Layout Design (FLD) for MCM in a factory by simulating and optimizing a real-life case. Firstly, the workflows and schedules of MCM are collected and re-engineered into nine categories. Then, data is collected and implemented to five candidate FLDs for simulation and optimization. The results show that 'cellular layout' has the most output and 'product layout' is the most economical selection in the case factory. This research sheds light on the uncharted area of MCM. It also calls for more studies to examine Industry 4.0 advances in transforming the traditional construction industry.

(iii) **Zheng, L.**, **Lu, W. S.**, **Wu, L.**, & **Zhou, Q. Y.** (2022). A review of integration between BIM and CFD for building outdoor environment simulation. *Building and Environment, 228*, 109862. https://doi.org/10.1016/j.buildenv.2022.109862

Abstract: *Numerous studies have demonstrated that the climate of cities and human settlements can affect building performance and human comfort. Historically, ambient data were collected through on-site measurements or simulations using physical models. Nowadays, with the advancement of data-based techniques and computing resources, especially Building Information Modeling (BIM) used to address the requirement for building data and numerical simulation with Computational Fluid Dynamics (CFD) used to assess building outdoor environments have increased in popularity. This paper presents a review of publications on this topic till 2022. The reviewed publications are categorized into different sections according to the following characteristics: general BIM-CFD integration process, building design optimization, and integration process optimization. In addition, the reviewed publications are categorized by the BIM design parameters, CFD simulation equations, building locations, BIM software, and BIM-CFD integration approach under consideration. This review discusses current research trends and major research issues in detail and presents future perspectives. The results show that from the early to late stages of the BIM-CFD integrated environmental studies, the BIM parameters considered were shifted from 3D to nD (e.g., energy). Meanwhile, CFD models and new technologies were chosen more carefully to meet the needs of different building scenario simulations. Although the current dynamic data transfer and synchronization capabilities between BIM and CFD need to be improved and rely heavily on the development of efficient Application Programming Interfaces (API), both BIM and CFD still play an indispensable role in building design practice.*

(iv) **Ababio, B. K.**, & **Lu, W. S.** (2023). Barriers and enablers of circular economy in construction: A multi-system perspective towards the development of a practical framework. *Construction Management and Economics, 41*(1), 3-21. https://doi.org/10.1080/01446193.2022.2135750

Abstract: *The growing environmental concerns and threat of resource scarcity have heightened interest in the Circular Economy (CE) concept over the last decade. Nonetheless, implementation of CE practice within the built environment has taken a slower pace in comparison with other industries. A clear understanding of systemic and multilevel aspects of CE, especially in relation to barriers that hinder practical implementation, appears to be lacking within the sector. In context of this, the study aims to examine the existing body of knowledge to elucidate, from a systemic perspective, CE barriers across various levels in construction. To achieve this purpose, a scientometric analysis is used to examine 581 bibliometric-searched filtered articles on CE implementation barriers in construction. Key issues, drivers and potential resolutions are explained using content analysis of specific pre-determined articles. The study finds that critical system levels of CE implementation (micro, meso, and macro levels) are interrelated, however, barriers and drivers at each individual level may differ. Additionally, this paper categorizes key barriers to implementing CE-aligned strategies into five main themes, namely definition and theory misconception, political and legislative, social and cultural, financial and economic, and technological barriers. Based on these, four cross-cutting enablers are established to drive the transition from a linear to a circular economy in construction. The findings of this study highlight deficiencies and challenges in current research while providing a path for future studies. The study provides a convenient point of reference for practitioners, policy makers, and research and development (R&D) institutions on CE implementation within the industry. The study also promotes public awareness and aids the AEC sector develop its intellectual capital to overcome CE barriers.*

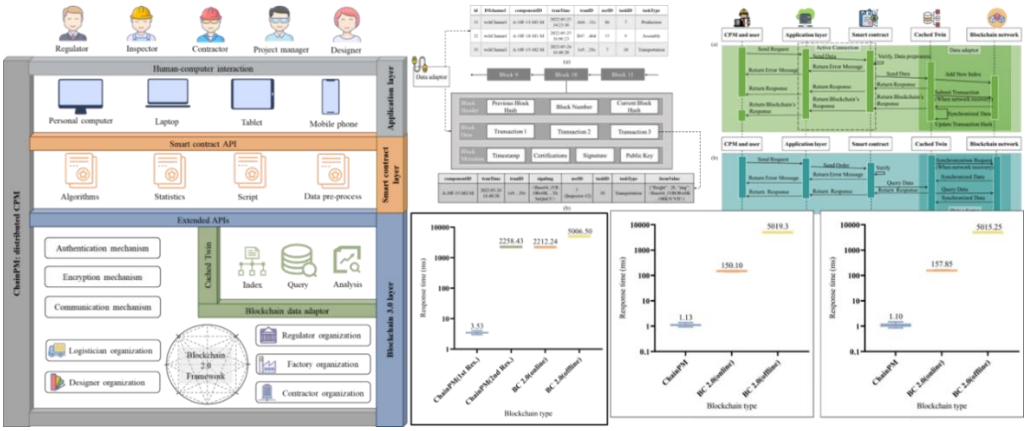
9. Mr Rui Zhao (MPhil student, REC), Mr Zhe Chen (PhD student, REC) & Dr Frank Xue

- have published the following paper:

Zhao, R., **Chen, Z.**, & **Xue, F.** (2023). A blockchain 3.0 paradigm for digital twins in construction project management. *Automation in Construction*, *145*, 104645. https://doi.org/10.1016/j.autcon.2022.104645

Abstract: *Construction project management (CPM) is inherently complex and distributed, while digital twin and blockchain are recognized as promising solutions for information-reliant CPM. By learning from the lessons of Blockchain 1.0 and 2.0 paradigms in the literature, such as slow synchronization and failed offline functions, this paper proposes ChainPM as a Blockchain 3.0 paradigm. ChainPM extends Blockchain 2.0 with innovative indexing, query, and analysis function sets for key CPM data. Experimental results from a pilot study of a modular construction project showed that the information synchronization latency was reduced by 99.2% to 99.8%, and query and analytical functions*

worked equally well without network connections. ChainPM contributes to a novel trend of Blockchain 3.0 paradigms for CPM digital twins, emphasizing indexing key CPM data, combinatorial query, digital authorship, and fast response without downgrading the 'single source of truth.' For practitioners, ChainPM addresses key barriers of Internet reliance and information delay to CPM digital twins.

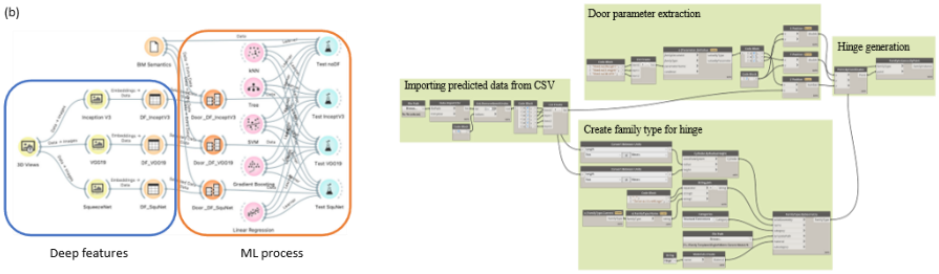


10. Mr Sou-han Chen (RA, REC) and Dr Frank Xue

- have published the following paper:

Chen, S.-H., & **Xue, F.** (2023). Automatic BIM detailing using deep features of 3D views. *Automation in Construction, 148*, 104780. https://doi.org/10.1016/j.autcon.2022.104780

Abstract: *Building information modeling (BIM) detailing, the process of adding the level of graphical and non-graphical details, is required in many BIM stages and applications; however, manual BIM detailing is a resource-intensive and costly process. This study proposes an automatic BIM detailing method based on deep features (DFs) of BIM 3D views in three steps. First, a BIM's 3D view and semantics were extracted automatically. Then, machine learning (ML) algorithms learned the DFs to predict the target BIM's invisible details. Finally, the details were automatically added to BIM by a Dynamo program. A case study of motion-bearing component detailing for 86 doors through three DFs and five ML algorithms revealed that DFs improved the automatic detailing results comprehensively (29 out of 32 scenarios) and significantly. This paper's contribution includes an effective, novel approach for automatic BIM detailing as well as quantified experimental evidence about the effectiveness of DFs for BIM applications.*



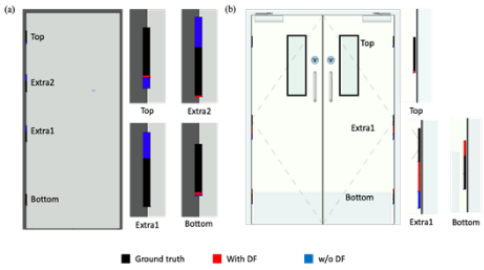


Table 8
Deep feature's improvement matrix under different ML algorithm.

ML algorithm	Classification prediction tasks			Regression prediction tasks				Sub total
	Quantity	Depth	Radius	Top	Bottom	$Extra_1$	$Extra_2$	
KNN	✓	✓	✓	✓	✓	✓	✓	7
Tree	✓	✓	✓	×	✓	✓	×	5
XGBoost	✓	✓	✓	×	✓	✓	✓	6
LR	N/A	N/A	N/A	✓	✓	✓	✓	4
SVM	✓	✓	✓	✓	✓	✓	✓	7
Sub total	4	4	4	3	5	5	4	

"✓" indicates the result is improved compared to w/o DF; "N/A" indicates not applicable.

Ronald Coase Centre for Property Rights Research

1. Professor Lawrence Lai, Professor Stephen Davies, Mr Nixon Leung and Mr Vincent Chan (PhD students)

   - have published the following paper:

   Lai, L. W. C., **Davies, S. N. G.**, Lau, P. L. K., **Leung, N. T. H.**, **Chan, V. N. H.**, & Chua, M. H. Y. (2023). "Ring up for an appointment": Empirical & oral evidence of commercial & other freedoms in the heyday of the City. *Cities*, *135*, 104232. https://doi.org/10.1016/j.cities.2023.104232

   Abstract: *Informed by economic concepts of product competition, this paper uses publicly available and accurate business information on establishment names and addresses obtained from the* Yellow Pages *of the contemporary Hong Kong telephone book and census socio-economic data backed by oral testimonies, to dispel the myth that the "Kowloon Walled City" was an incarcerated ghetto. The use of this imagery in the title for this City as a built up, politically sensitive zone levelled to the ground to make way for a public Chinese garden shortly before Hong Kong was returned to China, is treated as a form of 'product differentiation' in the academic research marketplace. As a contribution to planning theory, the paper uses the City as a show case of how academic branding, through descriptors, creates images of places and offers a countervailing image. Technically, it demonstrates the immense archival value of telephone directories and business chronicles apart from census data as sources of socially significant data for urban studies and informed re-interpretation of subjective imageries of an urban place.*

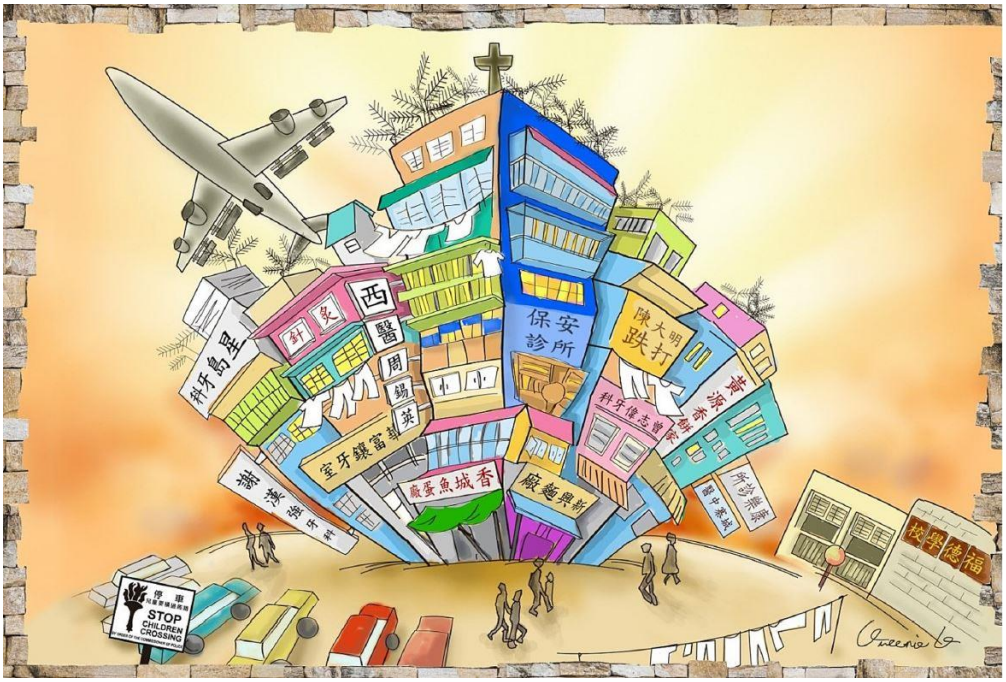


Image: Queenie Lo

2. Professor KW Chau, Professor Stephen Davies, Professor Lawrence Lai and Dr Lennon Choy

- have published the following paper:

Chau, K. W., **Davies, S. N. G.**, **Lai, L. W. C.**, & **Lennon, H. T. C.** (2023). Museums for ex situ tangible heritage conservation: A neo-institutional analytical and empirical economic analysis. *Land Use Policy*, *127*, 106561. https://doi.org/10.1016/j.landusepol.2023.106561

Abstract: *As a first attempt to position the role of museums in land use planning, this paper modifies a neo-institutional economic perspective to canvass the economic advantages of a museum as a form of real property in a community. It explains that a museum, outdoor or indoor, as a derived demand for real property because selected ex situ heritage items need space to concentrate. Such concentration not only reduces the transaction costs of searching for users but also accumulates value by being positioned at a fixed location, as in the case of a heritage building as in situ heritage, so that it may even become a new heritage site (if not also a heritage building) over a period of time. This is demonstrated by the case of London Bus Museum, which stands in sharp contrast to a hidden private collection of retired buses in Hong Kong. An empirical test of the effects on values of neighbouring property of a cattle depot/slaughter house reused as an art museum was conducted to shed light on the economic advantages of a museum. This paper expands the understanding of curating to encompass the formation of a museum and the gaining of heritage value for the museum itself. Some land use implications are discussed, particularly that museums should be purpose-built rather than being accommodated in heritage buildings.*

Urban Environments and Human Health Lab

1. Dr Bin Jiang, Ms Lan Luo (PhD candidate), Ms Xueming Liu (PhD candidate), Ms Wren Wanying Liang (MLA 2022) and Ms Siqi Wang (MLA 2020)

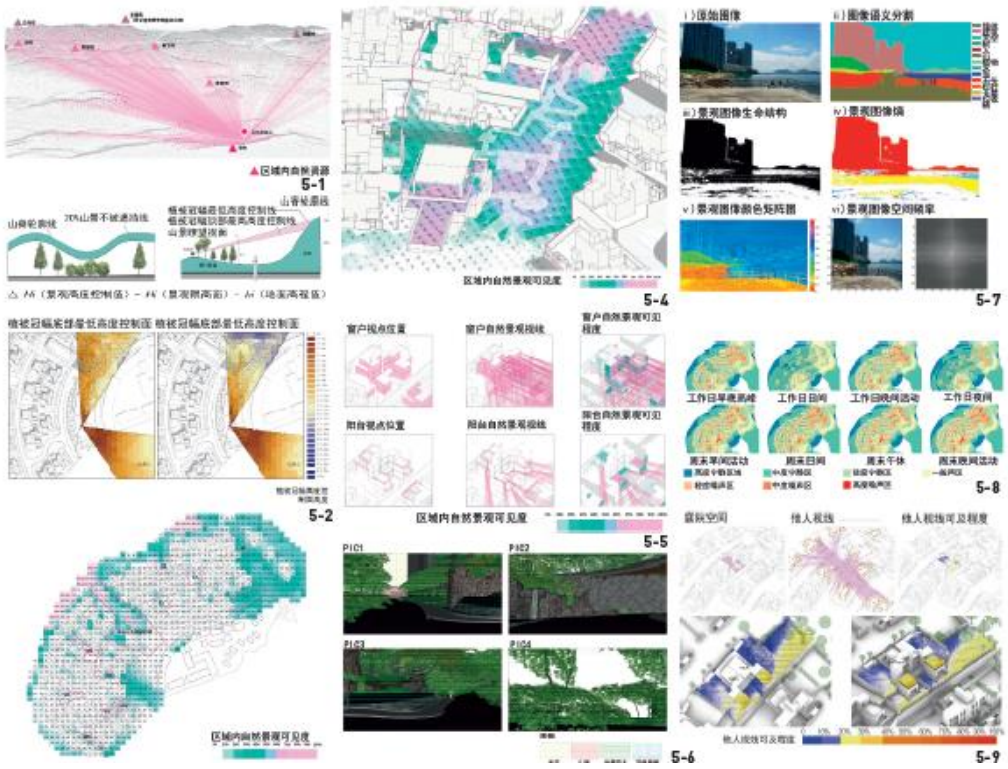
   - have published the following paper in a top Chinese journal:

     Jiang, B.*, **Luo, L.**, **Liu, X.**, **Liang, W.**, **Wang, S.** (2023). Healthy Landscape and Healthy Residential Landscape: Theoretical Framework and Digital Evaluation System (健康景觀及健康社區景觀：理論框架與數位評價系統), *Chinese Landscape Architecture, 39*(2):13-19. http://www.jchla.com/ch/reader/view_abstract.aspx?file_no=20230202&flag=1

     Abstract: *The multidimensional health crisis has been sparked by wide and rapid urbanization. A healthy community environment can help residents maintain good mental, physical, and social health from upstream, so as to prevent and reduce the occurrence of mental and physical diseases. At present, at the level of theoretical research, the systematic theoretical framework and related impact mechanisms of residential landscape have not been fully established; at the level of methodological research, a systematic evaluation toolkit for healthy community landscapes has not been formed. This study is an initial effort to address these problems. First, this study develops a systematic landscape-health theoretical framework through analysis and synthesis of theoretical and empirical literature in related fields. The framework includes 10 theoretical pathways for landscapes to promote mental health, physical health, and social health. Based on this framework, with an awareness of landscape conditions of urban communities in China and availability of digital techniques, the digital evaluation system of healthy community landscape is proposed. This study will provide a strong support for the development of healthy landscape and healthy residential landscape in China.*

     To the research team's best knowledge, this article could be the first study that presented a theoretical framework and digital evaluation system to guide design practice of healthy community landscapes.

     Note: Ms Liang and Ms Wang are Research Assistants of Urban Environments and Human Health Lab.



2. Ms Wren Wanying Liang (MLA 2022) and Dr Bin Jiang

   - have published the following paper:

     Liang, W., & **Jiang, B.*** (2022). Where is my home: The redesign of urban park landscape as an early social intervention for the homeless population. *Time + Architecture, 187*(5). https://timearchi.tongji.edu.cn/CN/news/news119.shtml

何以为家

城市中草药公园景观作为露宿者的早期社会干预

Where Is My Home

The Redesign of Urban Park Landscape as an Early Social Intervention for the Homeless Population

摘要 香港露宿者数量逐年增加，但社会所提供的物质资源只关注到无家可归的表象，无法真正帮助人们脱困。早期介入和能够提升自我能力的社会支持是减少露宿悲剧的关键措施。文章考察现有社会资源，梳理出其中缺失的关键因素——过渡性的工作、额外收入、日常健康保健等，进而从景观角度提出早期社会介入措施——草药种植计划。从种植到加工与售卖中草药、凉茶、手工作品，围绕中草药种植展开的一系列活动，提供了不同种类和难度的工作，人们从中获得的自我价值提升和经济收入为脱离露宿生活奠定了基础。

关键词 露宿者；早期干预；参与式景观；收入；尊严

ABSTRACT The population of homeless in Hong Kong is increasing year by year, but the material resources provided by the society only focus on the superficial phenomenon of homelessness, ignoring the core predicament: weakened social ties and lack of social support. This article examines existing social resources to tease out the missing factors—transitional jobs, additional income, basic health care, meeting basic needs, and stable camper sites—in an attempt to develop early interventions from a landscape perspective: herbal growing plans to help people get ready to escape homelessness.

KEY WORDS Homelessness; Early intervention; Participant Landscape; Income; Dignity

中图分类号：P901; TU986.5; C912.6

文献标识码：A

文章编号：1005-684X(2022)05-0058-08

Note: Ms Liang is a recent MLA graduate, and she was advised by Dr Bin Jiang on this project. She is currently a Research Assistant of the Urban Environments and Human Health Lab.

3. Dr Bin Jiang

- has published the following paper:

  Wu, X., Lu, Y., & **Jiang, B.** (2023). Built environment factors moderate pandemic fatigue in social distance during the COVID-19 pandemic: A nationwide longitudinal study in the United States. *Landscape and Urban Planning (IF=8.119)*, *233*, 104690, ISSN 0169-2046. https://doi.org/10.1016/j.landurbplan.2023.104690

  Abstract: *Non-pharmaceutical interventions (NPIs) remain some of the most effective measures for coping with the ever-changing coronavirus disease 2019 (COVID-19) pandemic. Pandemic fatigue, which manifests as the declined willingness to follow the recommended protective behaviors (e.g., keeping social distance policies, wearing masks), has commanded increasing attention from researchers and policymakers after the prolonged NPIs and COVID-19 worldwide. However, long-term changes in pandemic fatigue are not well understood, especially amidst the ever-changing pandemic landscape. Built environment factors have been shown to positively affect mental and physical health, but it is still unclear whether built environments can moderate pandemic fatigue. In this study, we used Google mobility data to investigate longitudinal trends of pandemic fatigue in social distance since the onset of NPIs enforcement in the United States. The results indicated that pandemic fatigue continuously worsened over nearly two years of NPIs implementation, and a sharp increase occurred after the vaccination program began. Additionally, we detected a significant moderation effect of greenspace and urbanicity levels on pandemic fatigue. People living in areas with high levels of greenness or urbanicity experienced lower*

levels of pandemic fatigue. These findings not only shed new light on the effects of greenness and urbanicity on COVID-19 pandemic fatigue, but also provide evidence for developing more tailored and effective strategies to cope with pandemic fatigue.

- has delivered the following keynote speech/plenary talk/lectures:

  (i) a keynote speech entitled 'Urban Environments & Mental Health: Theoretical and Emprirical Studies', at the 15th International Conference of Environment and Behavior Research hosted by the Architectural Society of China in Beijing, on 19 November 2022.

  (ii) a plentary talk on 'Impacts of Green Spaces on Public Health: Recent Studies' at the Cross-generation and Inherit Experiences on Landscape and Human Health: Teaching, Research, and Innovation Technology International Hybrid Conference, organised by Tunghai University in Taiwan, on 13 December 2022.

(iii) a lecture titled ‘An invisible but critical pathway: Urban nature and mental health’, for the Tsinghua University School of Architecture course ‘Urban and Rural Ecological and Environmental Planning’, in November 2022.

(iv) a lecture titled ‘An invisible but critical pathway: Urban nature and mental health’, for the School of Architecture, Harbin Institute of Technology, on 17 November 2022.

(v) a lecture on ‘Urban landscape to promote health and wellbeing: Theory and practice’, at the Design Education and the Future of Living Environment – Hong Kong, Macao and Taiwan Special Academic Exchange Week, organised by the School of Architecture and Planning, Hunan University, on 9 December 2022.