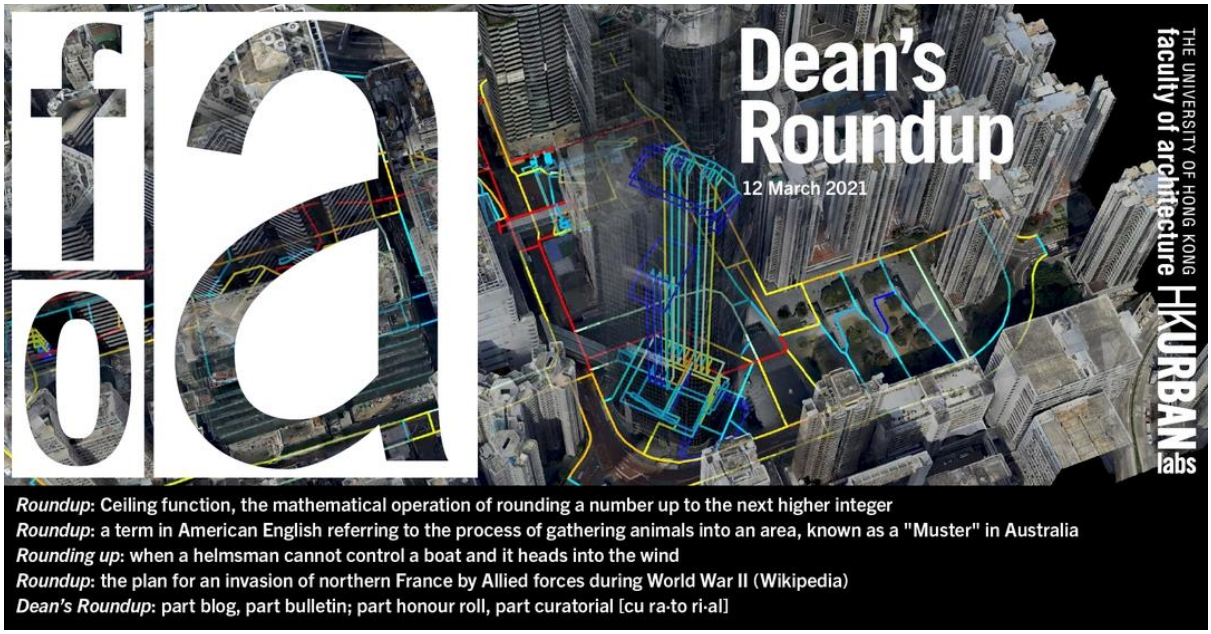


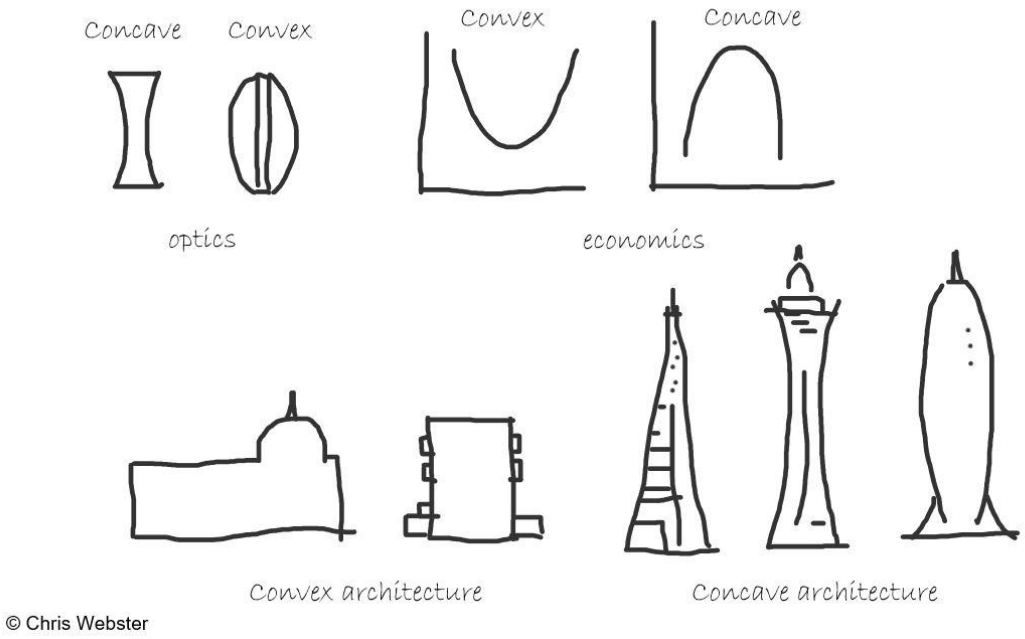
Concave architecture

Our colleague Eike Schling has successfully squatted a small corner of the Knowles Building public open space. On it, he and his students have constructed a 1:1 prototype cladding structure (to continue a recent DRup theme). If you look at the explanatory notes and images displayed next to it (reproduced below), you will notice that Eike has rendered it into the corner of a new piece of real estate acquired by FoA not far away from the squatted corner. In the image, it forms a concave corner of a room that is likely to become an architectural research lab. Nice.

But as you see from the rendering, if we instead used a more conventional corner we could squeeze one, possibly two more desks into the room! It made me think of a discussion I indulged in a few years ago about skyline shapes and function. The speculation arose from a HK-inspired question of building economics: in a space-scarce location, what would induce a developer to do anything other than design to the maximum envelope? Or put another way, what value has historically been imputed

to architecture that is anything less or more than the rectangular extrusion of the building footprint?

Since I'm an urban theorist, I will call architecture that is less than the rectangular envelope defined by legal or structural footprint, *concave architecture,* and designs that 'bulge' out of that envelope, *convex architecture*. The legal or structural (two alternatives) 3D envelope, we will call the *convex hull* of the design, after the mathematical idea of a convex hull, defined as a surface created by joining the outermost set of a 3D point-cloud in a way that permits no concavities. Of course, *convex* is *concave* viewed the other way around and the terms as used in economics, describe the converse view, to confuse matters (which is resolved by referring to either *convex-up* or *convex-down*). The concave economics graph below is *concave down* and the convex curve can be described as *concave up*. Concave architecture, in my speculative theory, is therefore that which includes a cavity within the legal or structural convex hull (at a scale above small architectural detail).



In the skyline blog, and a more recent commentary on a FoA Buddhist architecture conference, I noted casually and with no pretence at rigour, that religious architecture tends to extrude. Weaving this into my theory, we could say that the medieval church tower was extruded at the cruciform junction of the nave and transept. Technically this was probably convex architecture at first, with early designers finding ways of opening up the internal space to the heavens to inspire awe and worship. Over time, the whole nave (the long hall of the church) became the height of earlier towers, through more sophisticated building techniques. Although there are churches without towers, the towers continued to rise even higher, however, capturing space from the sky to bring inside and making landmarks visible for miles around. So let's call a religious tower *convex* architecture, not concave. The 12th century church spire turned into the 19th church steeple and both were extensions to, not cavities within, the convex hull of the building structure. The 1930s Chrysler Building appropriated the spire to top a 20th

century cathedral, with attendant spiritual significance. It's spire, like those on most tall buildings, is not so much lost space as a cheeky extension: gaining a few extra metres in the architect's height credentials; a hat for the building; centre-piece for a viewing platform; and a lightening conductor (the tallest building in a city is also an experiment with atmospheric physics).

Spherical towers, on the other hand, are clearly *concave architecture*, reducing useable space compared to the convex hull. Spherical towers are associated with fortification and the loss of space is compensated by the strength of structure in battles. The compensatory logic is not so obvious for religious building, which is presumably why you find fewer round towers than square, in church buildings. The round minarets of Ottoman mosques are convex architecture, extruded like the church spire, to visually and audibly communicate with worshippers living in surrounding communities.

The most common skyline in modern capitalist cities is the full extruded rectangle. Commercial real estate investment is a method of storing value and the more floor space from the footprint, the more value stored. However, the trail-blazing tallest building in any particular phase of capital expansion, tends to have distinct concavity. This is ironic in that the tallest designs at the height of a building boom might surely be expected to max out on value created. But the tallest buildings nearly always come immediately before an economic bust or in the year or two after and are the most extravagant extremes of loose money capitalised into land and buildings. They tend to be designed during the final 'winner's curse' phase of a liquidity boom. So loose was money at the peaks of the 20th century's boom-bust cycles in 1910 (Singer Building, NYC), 1929 (Empire State Building, NYC), 1973 (Sears Tower, Chicago), 1997 (Petronas Towers, KL), 2008 (Burj Khalifa, Dubai), that skyscrapers could easily waste vast amounts of useable floor-space in world-beating concavities. At times such as these, use value is not the main object of real estate investment; this is the time of maxing out on speculative value, which can be far detached from use value. Architecturally, this detachment becomes concavity.

Hence a very non-architect question comes to mind, wondering whether we should design Eike's concave corner into FoA's new suite of labs on Knowles Building upper ground floor. Is it worth the loss of two desks' space? The answer is simple, of course. If the design adds more prestige, kudos, self-promotional, stylistic and sophistication value than it takes away from use value, then Eike has it.

The more testing question, which we should equip our students to answer thoughtfully in many alternative ways, might be: '*how much* concavity can we afford?'. There is probably an empirical answer to this and an interesting PhD topic. If we took the total of 1450 buildings over 150m high that can currently be found in the top 5 cities for numbers of tall buildings (Hong Kong, Shenzhen, NYC, Dubai and Shanghai, in that order[1]), and measured the concavity of each, defined as volume subtracted from 3D convex hull, what would be the average, range and distribution of the concavities? The average % of useable volume given up in pursuit of distinctive design?

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[1] *'Number of 150m+ Completed Buildings - The Skyscraper Center'. Skyscrapercenter.com. Accessed March 2021*

Back to Eike's squatting. I have long been a student of informal housing – ever since reading architect John Turner as an undergraduate. I once made a survey of squatted infringements of public open space in contrasting neighbourhood types in Cairo, Egypt. When space or income is scarce, architecture turns convex. Families on the ground and first floors of Cairo's 1950s municipal style housing estates, like their cousins in the city's vast informal squatter suburbs, took every opportunity to capture outside space to use privately, building illegal two-floor extensions, or enclosing small underused spaces with fences. A bit like HK architects capturing space by extruded window casements (while there was still a loophole in building regulations).

So, perhaps we can make a general rule: concave architecture is the luxury of the rich and convex architecture, a solution of the poor. We are space poor in HKU. Perhaps Eike can turn his corner architecture piece inside-out.

Congratulations to those of FoA's prolifically productive researchers and teachers mentioned below. As much as I enjoy writing DRup blogs, the greater enjoyment comes from reading the accomplishments of colleagues.

Chris Webster
March 2021

Faculty of Architecture

1. E-birthday card to alumni

- A birthday card has been sent daily via email to our alumni who were born on the day starting from 1 March 2021.

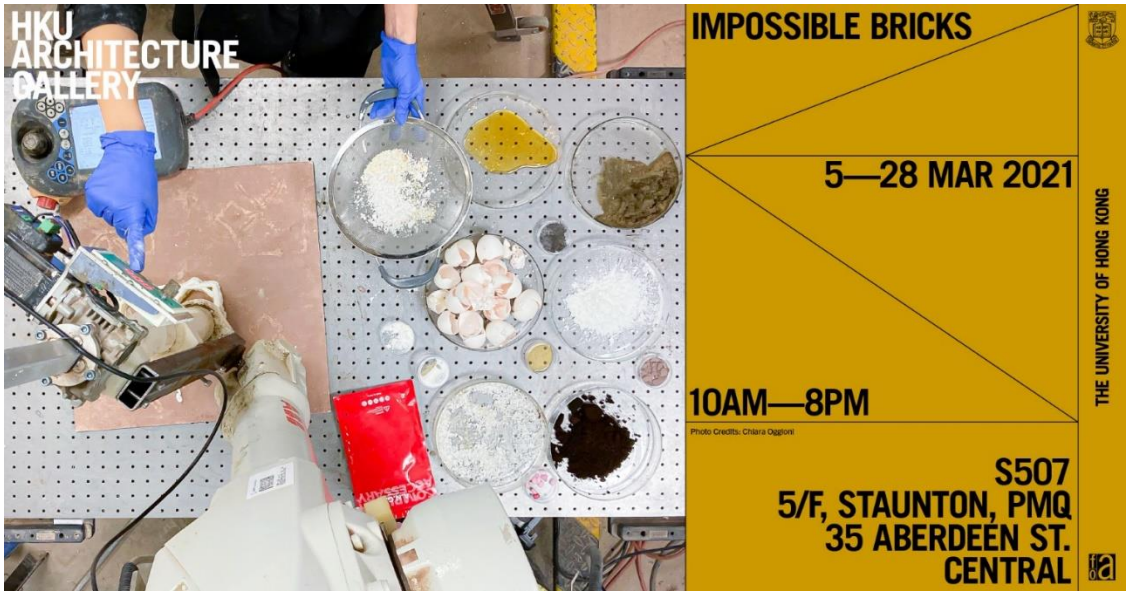
Selected news and public events organised by our Faculty and Departments would be sent along with this card to promote our initiatives to alumni. Colleagues are welcome to submit their ongoing and upcoming events to Janice Leung of the Faculty Office, at jan.leung@hku.hk.

Department of Architecture

1. Lidia Ratoi

   - is exhibiting her architectural prototypes transformed from food waste and biological matter, through the use of digital technology:

     Impossible Bricks



Waste management is a pressing worldwide issue that occurs in both developed and underdeveloped countries. Like many big cities, food waste is one of the largest sources of solid waste in Hong Kong. In the same way that we have developed ‘impossible food’ to satisfy consumption, in order to be more careful towards our environment, animals and our own bodies, the next step is to create impossible architecture. What if the act of consumption becomes the act of construction?

Throughout history, architecture and nature have been inseparable, and technology has been the medium for bridging the two. While the general construction industry uses state-of-the-art technology such as 3D printers, Robotic Arms, and Mini Robots, at the HKU Robotic Fabrication Laboratory, we are researching ways to seamlessly integrate natural materials with building technology. Using natural materials that we are currently wasting, we can create a new face for the rapid urbanisation of cities we inhabit.

‘Impossible Bricks’ proposes the sustainable use of food waste to maximise reuse of local resources. The project uses digital technology to transform biological matter into bricks, tiles, modules, or other architectural prototypes, suggesting a provocative alternative to wasteful consumption by revaluing food waste for ‘impossible’ construction.

Date:	**5 March (Friday) – 28 March (Sunday) 2021**
Time:	**10am-8pm**
Venue:	**S507, 5/F, Staunton (Block A), PMQ,** **35 Aberdeen Street, Central, Hong Kong**

Weekend Workshops

***Image Recycling* – Haotian Zhang, Tianying Li** (14 March, 2pm-4pm)
***Intimate Plastic* – Tianying Li, Lidia Ratoi, Su Chang** (21 March, 10am-6pm)
***Wear a Waste* – Lidia Ratoi, Chiara Oggioni, Yi Sun** (28 March, 10am-6pm)

Details of the workshops are to be announced on the Instagram account *impossible.bricks*.

Leading researcher: Lidia Ratoi
Curatorial work and workshops: Lidia Ratoi, Li Tianying, Chiara Oggioni, Su Chang, Sun Yi, Zhang Haotian

Acknowledgements:
Hong Sum Ho Angus (photography and material research); Chan Chun Hei Jason and Fan Ka Mak Moses (digital design); Chan Osten, Cheung Wing See Kyo, Chick Kar Yi Priscilla, Zhu Yalan Julia (material research)

For further enquiries, please contact Isabel Wong at isabel.wong@hku.hk.

Division of Landscape Architecture

1. Dr Bin Chen

   - has received the Association of American Geographers (AAG) Early Career Award in Remote Sensing in 2021.

     The Award recognises post-doctoral scientists and early career academics in Geography and related disciplines, who are poised to make outstanding contributions to the field of remote sensing and to the geographic community through their remote sensing research, teaching and outreach.

Centre of Urban Studies and Urban Planning

1. Dr Kyungmin Nam and Dean Webster

   - co-authored a paper which has been accepted for presentation at the 24th Annual Conference on Global Economic Analysis on 23-25 June 2021.

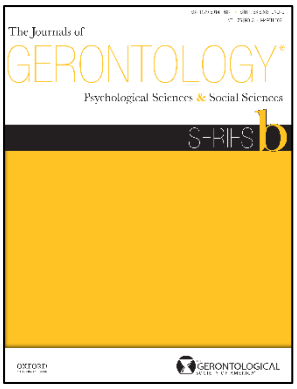
   - have received the Wallace E. Tyner Award for their research paper:

     Bonnie Wang, **Kyungmin Nam**, **Chris Webster**, Niven Winchester (2020). Impacts of China's emissions trading scheme on the national and Hong Kong economies: a dynamic computable general equilibrium analysis. Frontiers in Environmental Science, 8:599231.
     DOI: http://dx.doi.org/10.3389/fenvs.2020.599231

2. Professor Rebecca Chiu, Dr Derrick Ho and Dean Webster

   - have published a co-authored paper:

     Shiyu Lu, Yuqi Liu, Yingqi Guo, **Hung Chak Ho**, Yimeng Song, Wei Cheng, Cheryl Chui, On Fung Chan, **Chris Webster**, **Rebecca Lai Har Chiu**, Terry Y. S. Lum (2021). 'Neighborhood built environment and late-life depression: a multilevel path analysis in a Chinese society', The Journals of Gerontology: Series B, gbab037. DOI: https://doi.org/10.1093/geronb/gbab037.



Abstract:

Objective: *Neighbourhood built environments (BEs) are increasingly recognised as being associated with late-life depression. However, their pathways are still understudied. This study investigates the mediating effects of physical, social activities (PA & SA) and functional ability (FA) in the relationships between BEs and late-life depression.*

Method: *We conducted a cross-sectional analysis with data from 2,081 community-dwellers aged 65 years and above in Hong Kong in 2014. Two road-network-based service area buffers (200- and 500-metre buffers) adjusted by terrain and slope from participants' residences were created to define the scope of neighbourhoods. BEs comprised population density in District Council Constituency Areas (DCCAs), urban greenness, land use diversity, and neighbourhood facilities within 200- and 500-metre buffers. Multilevel path analysis models were used.*

Results: *More urban greenness within both buffers and more commercial facilities within a 500-metre buffer were directly associated with fewer depressive symptoms. SA mediated the relationship between the number of community facilities and depressive symptoms within a 200-metre buffer. Neighbourhood urban greenness and the number of commercial facilities had indirect associations on depressive symptoms within a 500-metre buffer, which were mediated by FA.*

Conclusion: *Our findings have implications for the ecological model of aging. The mediating effects of SA and FA underscore the importance of promoting active social lifestyles and maintaining FA for older adults' mental health in high-density cities. Policy implications on how to build age-friendly communities are discussed.*

iLab

1. iLab researchers have the following papers accepted for publication:

   (i) **Chen, J. J., Lu, W. S.**, and **Xue, F.** (2021). 'Looking beneath the surface': a visual-physical feature hybrid approach for unattended gauging of construction waste composition. Journal of Environmental Management. Forthcoming. Article no.112233.

Abstract: *There are various scenarios challenging human experts to judge the interior of something based on limited surface information. Likewise, at waste disposal facilities around the world, human inspectors are often challenged to gauge the composition of waste bulks to determine admissibility and chargeable levy. Manual approaches are laborious, hazardous, and prone to carelessness and fatigue, making unattended gauging of construction waste composition using simple surface information highly desired. This research attempts to contribute to automated waste composition gauging by harnessing a valuable dataset from Hong Kong. Firstly, visual features, called visual inert probability (VIP),*

characterising inert and non-inert materials are extracted from 1,127 photos of waste bulks using a fine-tuned convolutional neural network (CNN). Then, these visual features together with easy-to-obtain physical features (e.g., weight and depth) are fed to a tailor-made support vector machine (SVM) model to determine waste composition as measured by the proportions of inert and non-inert materials. The visual-physical feature hybrid model achieved a waste composition gauging accuracy of 94% in the experiments. This high performance implies that the model, with proper adaption and integration, could replace human inspectors to smooth the operation of the waste disposal facilities.

(ii) **Wang, J.** and **Lu, W. S.** (2021). A deployment framework for BIM localization. Engineering, Construction and Architectural Management. Forthcoming.

Abstract:

Purpose *– Over the past two decades, building information modeling (BIM) has been promoted as one of the most disruptive innovations across the global architecture, engineering, and construction (AEC) community. Nevertheless, despite its widely propagated benefits, BIM adoption in various localities is not progressing excitingly. BIM as an innovation developed from a presumed, general context may not fit well with the specific regulatory, social, and cultural settings of a locality. This study aims to tackle the lukewarm local BIM adoption by developing a deployment framework for BIM localisation.*

Design/Methodology/Approach *– Drawing upon the diffusion of innovation theory, a longitudinal case study is designed and conducted by engaging closely with a top cost consultancy company in Hong Kong for 41 months.*

Findings *– The findings refuted the 'one-size-fits-for-all' view to use a standardised BIM for international users. Rather, an organisation needs to undergo a series of localisation works to integrate global BIM in its specific local context. The deployment framework outlines the BIM dimensions (i.e., Technology, Process, and Protocol) and the mechanisms (i.e., Configuration, Coupling, and Reinterpretation) of BIM localisation that go through the three 'A's (i.e., Analysis, Adaption, and Assimilation) process under a firm's network and contextual factors.*

Originality/value *– This study improves our understanding of sluggish BIM adoption by attributing it to the gap between general BIM development and the local, unique BIM use context. By proposing the deployment framework, the study also offers a handy tool for prospective executives to localise BIM and harness its power in their respective organisations and localities.*

2. iLab researchers have published the following papers:

(i) **Guo, H.** and **Lu, W. S.** (2021). The inverse U-shaped relationship between corporate social responsibility and competitiveness: evidence from Chinese international construction companies. Journal of Cleaner Production, 295, 126374. DOI: https://doi.org/10.1016/j.jclepro.2021.126374.

Abstract: *The relationship between corporate social responsibility (CSR) and its material implications is a classic inquiry with tremendous academic and practical values. In recent years, the inquiry has shifted to the CSR-competitiveness link by viewing competitiveness as a more comprehensive construct that is able to capture more sustainable business success than traditional financial performance. This paper argued an inverse U-shaped relationship between CSR and competitiveness considering the complex interaction between both benefits and costs of CSR. Focusing on Chinese international construction companies (CICCs), it empirically tests the curvilinear relationship between the two constructs. By undertaking a panel data regression on 55 CICCs and 473 observations from 2010 to 2019, the inverse U-shaped relationship between CSR and competitiveness is confirmed: CICCs' competitiveness will increase at first with their CSR engagement but will decline from a threshold level where CSR costs begin to gain priority. This study opens up a new avenue through which business executives and policymakers are inspired to wisely manage social responsibility resources and pursue a balance where the business and society should strike.*

(ii) **Lu, W. S., Yuan, L.,** and **Xue, F.** (2021). Investigating the bulk density of construction waste: a big data-driven approach. Resources, Conservation & Recycling, 169, 105480. DOI: https://doi.org/10.1016/j.resconrec.2021.105480.

Abstract: *Construction waste contains inert (e.g., construction debris, rubble, earth, bitumen, and concrete) and non-inert materials (e.g., bamboo, plastics, wood, paper, and vegetation), while it is often a combination of the two when it is generated at source. The bulk density of construction waste is the yardstick information for many subsequent waste management efforts. One feasible way to derive the bulk density information is to segregate the mixture of inert and non-inert substances and examine their compositions, but clearly, this is an onerous task. This paper reports a data-driven approach to obtain the bulk densities of inert and non-inert construction waste by analysing a big dataset of 4.9 million loads of construction waste in Hong Kong in the years 2017 to 2019. It is discovered that the means of bulk density are 336 kg/m^3 for non-inert waste, 528 kg/m^3 for mixed waste, and 991 kg/m^3 for inert waste, and their coefficients of variation are 69%, 43%, and 29%, respectively. The research not only proved our heuristic rules concerning the bulk densities of the three generic types of construction waste, but also articulated, for the first time, their converged means and ranges. The findings can be used in adjusting the admission criteria as adopted in the governmental waste management facilities. Future research is recommended to further narrow down the bulk density ranges to provide more accurate references for construction waste management.*

(iii) **Lu, W. S., Bao, Z. K., Lee, W. M. W., Chi, B.** and **Wang, J. Y.** (2020). An analytical framework of 'zero waste construction site': two case studies of Shenzhen, China. Waste Management, 121, 343-353.
DOI: https://doi.org/10.1016/j.wasman.2020.12.029.

Abstract: *Around the global construction industry, there is an emerging trend to pursue a 'zero-waste' goal at the site level, but little is known about it. This paper aims to shed insights on the waste management concept of 'zero waste*

construction site' by delineating its meaning, system boundary, assessment period, and operation strategies, which are further formulated in an analytical framework. Owing to the nascent nature of the concept, we adopted a qualitative approach including archival study, a series of semi-structured interviews, and two in-depth case studies in Shenzhen, China to sketch the analytical framework. Meanwhile, an analogy between 'zero waste construction site' and 'net zero building' is continuously made to fine-tune and finalise the framework. This research demonstrates that the zero-waste goal is challenging but achievable on individual construction sites. The system boundary to examine the zero-waste goal is contingent on the project scope, be it a new construction, renovation, or demolition project. The assessment period is dependent on the duration of the construction project. However, it would be too costly, if not entirely impossible, to achieve a 'zero waste construction site' by treating it as a closed system. Rather, one needs to consider open, off-site strategies, e.g., engaging third-party recycling services, reusing recycled materials in subsequent projects, or trading it in to a recycled material market. The analytical framework can be utilised to scrutinise existing construction waste management practices. In the long term, the research will contribute positively to a 'zero waste' society.

(iv) **Xue, F., Wu, L,** and **Lu, W. S.** (2020). Semantic enrichment of building and city information models: a ten-year review. Advanced Engineering Informatics, 47, 101245. DOI: https://doi.org/10.1016/j.aei.2020.101245.

Abstract: *Building Information Models (BIMs) and City Information Models (CIMs) have flourished in building and urban studies independently over the past decade. Semantic enrichment is an indispensable process that adds new semantics such as geometric, non-geometric, and topological information into existing BIMs or CIMs to enable multidisciplinary applications in fields such as construction management, geoinformatics, and urban planning. These two paths are now coming to a juncture for integration and juxtaposition. However, a critical review of the semantic enrichment of BIM and CIM is missing in the literature. This research aims to probe into semantic enrichment by comparing its similarities and differences between BIM and CIM over a ten-year time span. The research methods include establishing a uniform conceptual model, and sourcing and analysing 44 pertinent cases in the literature. The findings plot the terminologies, methods, scopes, and trends for the semantic enrichment approaches in the two domains. With the increasing availability of data sources, algorithms, and computing power, they cross the border to enter each other's domain. Future research will likely gain new momentums from the demands of value-added applications, development of remote sensing devices, intelligent data processing algorithms, interoperability between BIM and CIM software platforms, and emerging technologies such as big data analytics.*

(v) **Laovisutthichai, V., Lu, W. S.**, and **Bao, Z. K.** (2020). Design for construction waste minimization: guidelines and practice. Architectural Engineering and Design Management. DOI: https://doi.org/10.1080/17452007.2020.1862043.

Abstract: *Design for Construction Waste Minimisation (DfCWM) advocates the proactive minimisation of potential construction waste from the design or earlier stage. Numerous DfCWM practices have been recommended, but they are*

hitherto in a piecemeal fashion without an integrative guideline to enable designers to consider DfCWM in a systematic manner. Their practice examples and application results have also been rarely investigated. This study aims to amalgamate DfCWM recommendations, develop practicable guidelines, and implement in real-world settings. It adopts a design thinking method to develop the guidelines from literature, brainstorming, action research, case study, and most importantly, dynamic iteration thereof. The results affirm the impact of DfCWM on not only preventing construction waste generation effectively but reducing the construction cost without jeopardising the design. However, its implementation is not merely a simple linear process and requires coordination from all stakeholders. For practitioners, this research also provides the DfCWM guidelines to be a design companion, encouraging deliberation of an entire building and material life cycle with special consideration given to waste minimisation. Further studies are suggested for two areas: (a) modelling DfCWM into a multi-criteria optimisation problem, and (b) integrating it with other design for excellence considerations.

(vi) **Xue, F., Wu, L.,** & **Lu, W.** (2021). Two-layer adaptive blockchain-based supervision model for off-site modular housing production. Computers in Industry. In press, article no. 103437.

Abstract: *By manufacturing housing products off-site and assembling on-site, modular construction can significantly improve the housing supply efficiency, particularly for high-density cities. However, off-site modular housing production (OMHP) supervision is currently problematic. The production parties are reluctant to provide detailed private data; even worse, the submitted operation records can be easily fabricated, tampered with, or hard to trace the responsibility. This study develops an innovative Two-layer Adaptive Blockchain-based Supervision (TABS) model for OMHP. The first layer includes the adaptive private sidechains of participants. The second layer is the main blockchain for communication and 'trading' among all participants. Benefitted from the unique adaptive two-layer structure, TABS can avoid tampering with operation records by the main blockchain and drive the participants to publish their operation records promptly without privacy leaks. A system prototype was also developed to evaluate the performance of the TABS model. The results indicated that the TABS model could enhance privacy and reduce storage costs at an acceptable latency level. This study's findings can pave the avenue for a tamper-proof and privacy-preserving supervision mechanism in the architecture, engineering, and construction industry.*

(vii) Chen, K., & **Xue, F.** (2020). The renaissance of augmented reality in construction: history, present status and future directions. Smart and Sustainable Built Environment. In press. DOI: https://doi.org/10.1108/SASBE-08-2020-0124.

Abstract:

Purpose*: Augmented Reality (AR) has become one of the most promising technologies in construction since it can seamlessly connect the physical construction environment and virtual contents. In view of the recent research*

efforts, this study attempts to summarise the latest research achievements and inform future development of AR in construction.

***Design/methodology/approach**: The review was conducted in three steps. First, a keyword search was adopted, and 546 papers were found from Scopus and Web of Science. Secondly, each paper was screened based on the selection criteria, and a final set of 69 papers was obtained. Thirdly, specific AR applications and the associated technical details were extracted from the 69 papers for further analysis.*

***Findings**: The review shows that: (1) design assessment, process monitoring, and maintenance management and operation were the most frequently cited AR applications in the design, construction, and operation stages, respectively; (2) information browser and tangible interaction were more frequently adopted than collaborative interaction and hybrid interaction; and (3) AR has been integrated with BIM, computer vision, and cloud computing for enhanced functions.*

***Originality/value**: The contributions of this study to the body of knowledge are twofold. First, this study extends the understanding of AR applications in the construction setting. Second, this study identifies possible improvements in the design and development of AR systems in order to leverage their benefits to construction.*

(viii) Li, C. Z., Chen, Z., **Xue, F.**, Kong, X. T.R., Xiao, B., Lai, X., & Zhao, Y. (2021). A blockchain-and IoT-based smart product-service system for the sustainability of prefabricated housing construction. Journal of Cleaner Production, 286, 125391. ISSN 0959-6526. DOI: https://doi.org/10.1016/j.jclepro.2020.125391.

***Abstract:** Prefabricated housing construction (PHC) will be widely recognised as a contributor to consumption reduction and sustainability enhancement if inherent drawbacks (e.g., fragmented management, poor connectivity) can be addressed efficiently. The promotion of advanced information and communication technologies (ICT) has triggered the evolvement of smart product-service systems (SPSS), where a smart connected product (SCP) acts as a critical role in the interconnection of physical components and specialised services for value co-creation. Hence, it is promising to realise the positive improvement of PHC based on an SPSS approach, especially during the challenging post-COVID-19 pandemic era. We developed an intelligent platform based on service-oriented manners with practical case demonstration for interactive innovation of PHC shareholders, among which prefabricated components (PC) have been defined as the SCP in PHC, and a platform-enabled approach has also been adopted in the way of SPSS. Furthermore, distributed security technology viz. blockchain along with inclusive ICT (e.g., Internet-of-Things (IoT), Cyber-Physical System (CPS), and Building Information Modelling (BIM)) are employed jointly to spark new modes of smart construction. Meanwhile, valuable exploration and open research directions are expected to facilitate the PHC supply chain to become more resilient in sustainability.*

3. Professor Wilson Lu, Dr Frank Xue, Dr Junjie Chen, Miss Wendy Lee and Mr Lanny Yuan

- paid a site visit to the Tseung Kwan O construction waste off-site sorting facility and met with colleagues from the Environmental Protection Department (EPD), Civil Engineering and Development Department (CEDD), and the facility on 1 February 2021.

Meeting at TKO construction waste off-site sorting facility

4. Professor Wilson Lu

- met on 5 February 2021 with Mr Cameron McKenzie, CEO, and Miss Li, representative of ASPIRE, an Australian company specialised in circular economy and working with Hong Kong stakeholders such as CLP and Gammon Construction to enable waste management in Hong Kong. Later, on 19 February, Mr McKenzie demonstrated an online platform that facilitated waste sharing.

- delivered a keynote speech titled 'Smart technologies for resilient industrialised construction under the "new normal" of the COVID-19 era' at the International Forum on 'Cooperation and Opportunity on Industrialized Construction under the Belt and Road Initiative' on 27 February 2021, at Hong Kong PolyU.

- served as External Examiner at the PhD examinations of the following institutes:

  - The University of Newcastle, Australia (in December 2020)
  - The University of Malaya, Malaysia (in February 2021)
  - Israel Institute of Technology, Israel (in March 2021)

5. Dr Frank Xue

- won a Type-B RPg place entitled 'Blockchain 4.0-based Building Information Modeling (B4BIM)' from the Central Pool 2021/22 in the interdisciplinary area of Architecture, Engineering and Construction, and Distributed AI.

Ronald Coase Centre for Property Rights Research

1. Professor K. W. Chau

- was interviewed by the TVB programme, Futurescope, in an episode about Hong Kong's land supply on 18 February 2021. During the interview, Professor Chau introduced the idea of 'Land Bonds' and shared his views on the city's future development, such as value-added agriculture and integration with the Greater Bay Area.

Watch Professor Chau's interview at the programme website.

2. Professor Lawrence Lai

- hosted a press briefing on 3 March 2021, where he and his team shared their 10-year research on the World War II Japanese defensive relics at Luk Keng, followed by a guided field trip to the site. The research project is summarised as follows:

  On 3 March 1943, many Japanese soldiers and Kampeitai raided the village of Nam Chung, Luk Keng, fought, killed and arrested members of the Hong Kong and Kowloon Branch of the East River Column, the guerrilla force officially under KMT establishment and active in Hong Kong for the Allied cause. This is the so-called '3 3 Incident' (The Incident).

  After 10 years of documentary and field research in connection with a HKU CCC course, 'Property Rights, Built Heritage and Sustainable Development', Professor Lawrence W. C. Lai and some members of his research team, which includes a town planner, a land surveyor, a building surveyor, and a military expert-historian (the Team), held in the Faculty a press briefing on 3 March 2021. It unveiled the most well-preserved WWII Japanese military relics in a Hong Kong country park. The day was the 78th anniversary of the Incident, the 77th anniversary of the armored victory of the Chinese expeditionary force at the Battle of Walawbum, and the 80th anniversary of the Battle of Hong Kong of 1941.

  Located at Luk Keng, the Japanese-built comprehensively fortified base with at least 14 pillboxes connected by communication trenches is believed to be more likely a facility to monitor and to suppress partisans than to cope with an anticipated Allied landing.

  There are over 200 military relics across Hong Kong, already reported in a press conference held at the Faculty 19 years ago. The Team calls on the authorities to better conserve and make use of these built military relics as they are cultural and historical legacies with tourism and educational potential. 'The authorities can make reference to the trail along The Twins at Stanley and turn the Luk Keng site into a more accessible place with proper facilities for the public to learn more about the relic in its architectural and historical context,' Prof. Lai said.

  The press briefing and its guided field trip attracted filming crews from more than 30 TV channels and print media, and the research project has been widely covered by them:

  - https://hku.hk/press/press-releases/detail/22480.html
  - https://www.scmp.com/news/hong-kong/society/article/3124346/hong-kong-military-heritage-researchers-dismayed-find
  - http://hd.stheadline.com/amp/news/realtime/hk/2015610
  - https://www.hk01.com/社會新聞/594809/鹿頸隱藏 14 個日軍建設機槍堡-屬保存最好遺址-團隊促列古蹟
  - https://www.hk01.com/01 觀點/596967/鹿頸碉堡磋砣十年-研究保護皆見不足
  - https://hk.appledaily.com/local/20210307/7ZXLODSA2JBSFDHDCHVXFBTPWQ/

- http://paper.wenweipo.com/2021/03/07/HK2103070043.htm
- http://news.tvb.com/local/60440dbc34b031f16dbe28b1
- https://www2.hkej.com/instantnews/current/article/2730626/港大團隊耗時十載+研究日軍戰時在港軍事遺跡
- https://news.rthk.hk/rthk/ch/component/k2/1579231-20210307.htm
- https://hk.on.cc/hk/bkn/cnt/news/20210307/bkn-20210307020045237-0307_00822_001.html
- http://cablenews.i-cable.com/ci/news/article/37/725362
- https://www.singtao.ca/4809456/2021-03-07/post-鹿頸槍堡群見證游擊隊頑強抗日史
- https://www.singtao.ca/4809613/2021-03-06/news-鹿頸二戰日軍遺迹+學者倡整個山頭保育
- https://news.mingpao.com/pns/港聞/article/20210307/s00002/1615055866521/
- https://news.now.com/home/local/player?newsId=426443

Research team members include Professor Lawrence W. C. Lai, Honorary Professor Stephen N. G. Davies, Professor Daniel C. W. Ho, Mr Y. K. Tan, Dr Mark Hansley Chua, Dr Ken S. T. Ching, Mr Stephen Y. H. Yip, the late Mr L. M. Cheung, Mr Nixon T. H. Leung and Mr Vincent N. H. Chan.

Urban Analytics and Interventions Research Lab

1. Dr Guibo Sun

   - established the **Urban Analytics and Interventions Research Lab** under the Faculty's HKUrbanLabs:

     Urban Analytics and Interventions Research Lab aims to apply urban analytics to longitudinal data generated from built environment interventions (e.g., open space, new metro, urban renewal). Using rigorous research design such as natural experiments, the Lab is interested in collecting practice-based evidence of the social and health impacts imposed by urban planning and design. With the scientific evidence and situated knowledge in local contexts, the Lab aims to facilitate evidence-based policies and practices in place and space making.

     Research team members: Dr Guibo Sun, Dr Eun Yeong Choe, Jianting Zhao and Yao Du.

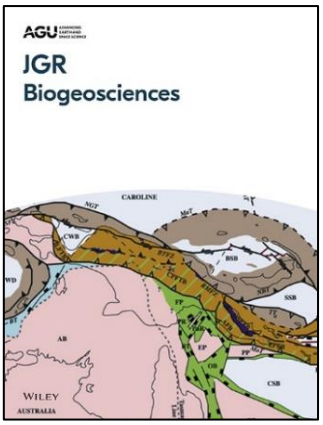
     Advisory Board members: Dean Webster, Dr Juan Du and Professor Mei-Po Kwan of CUHK Department Resource Management.

Virtual Reality Lab of Urban Environments & Human Health

1. Dr Bin Chen

   - has published a co-authored paper:

     Chen, B., Jin, Y., Scaduto, E., Moritz, M. A., Goulden, M. L., and Randerson, J. T. (2021). Climate, fuel, and land use shaped the spatial pattern of wildfire in California's Sierra Nevada. Journal of Geophysical Research: Biogeosciences, 126(2), 2169-8953, e2020JG005786.
     DOI: https://doi.org/10.1029/2020JG005786



***Abstract**: California's Sierra Nevada has experienced a large increase in wildfire activities over recent decades. This intensifying fire regime has coincided with a warming climate and increasing human activity, but the relative importance of the biophysical and anthropogenic drivers of wildfire remains unclear across this diverse landscape, especially at a finer spatial scale. We used multisource geospatial data sets of fire occurrence, and human, climatic, and biophysical variables to examine the spatial pattern and controls on Sierra Nevada wildfires averaged from 1984 to 2017. The maximum entropy model driven by both biophysical and anthropogenic variables predicted the spatial distribution of fire probability well, with an area under the curve (AUC) score of 0.81. Model diagnostics revealed that aspects of the climate, including vapour pressure deficit (VPD), temperature, and burning index (difficulty of control), dominated the spatial patterns of fire probability across the whole Sierra Nevada region. The VPD was the leading control, with a relative contribution of 32.1%. Population density and fuel amount were also significant drivers, each accounting for 15.8%-12.4% of relative contribution. VPD and burning index were the most important factors for fire probability in higher elevation forests, while population density was comparatively more important in the lower elevation forest regions of the Sierra Nevada. Our findings improved our understanding of the relative importance of various factors in shaping the spatial patterns of historical fire probability in the Sierra Nevada and across various subecoregions, providing insights for targeting spatially varying forest management strategies to limit potential future increases in wildfires.*

This paper has been featured by the American Geophysical Union (AGU) Eos Research Spotlight, and referred by other media such as UN Office for Disaster Risk Reduction and Science X.

2. Dr Bin Jiang

- won a Type-B RPg place entitled 'Virtual nature as medicine: exploring impacts of highly simulated nature on patient's mental health at an orthopaedic rehabilitation hub in Hong Kong' from the Central Pool Research Postgraduate Places 2021/22 in the interdisciplinary area of Virtual Reality, Therapeutic Nature Landscape, Mental Health and Well-being.