

Dear all,

“The evolution of surveying from early Bronze-age to early Cyber-age”

I am guessing that the title of my lecture last week to AFI1001 (FoA's new 'Built Environment 101') has never been used before. I was asking our students of Landscape, Planning, Architecture, Conservation and Surveying to think about the skills needed to envisage, plan and construct a building or town and to consider what skills may rise to the surface to confer upon their holders, a leadership position in the production of the built environment. As a provocative abstraction, I identified three historical milestones (out of many).

First, the **designer-engineer-surveyor-builders** of the Pyramids (and monumental buildings in other ancient civilisations). These were the people who designed in the sand, set-out on the ground, calculated quantities and oversaw the masses of skilled and unskilled construction workers. Judging by social scenes depicted in ancient Egyptian wall-art, these craftsmen had high social status. Their skills would have been seen as mystical.

Imagine: how does someone design a building with so many repeated symmetries, in 2D, 3D, spherical geometry and fractal geometry? How could anyone then map this out so precisely on the 2D ground surface that when a building's apex is finally completed, all the lines join up, angles complete and solar, lunar, astronomic and viewing properties manifest as if by magic? The art would have been learned, practiced and passed on in early family and professional groupings that predated the medieval guilds. Information is power and the knowledge about how to manipulate geometric data to produce great edifices conferred these early engineer-surveyor-architects much influence.

The underlying maths was not well formalised and they would have worked from heuristics, pre-Euclidean geometry and other prototypical formula. There were essentially two ways a human could conceive of and produce such miracles. They either 'felt', emoted or intuited the proportions, angles, dimensions and mass; or they calculated them. Either way, they were geniuses or magicians and the scarcity of these skills would have given them the power to organise grand projects. Civil engineers, surveyors, architects, craftsmen and freemasons all claim these magician-engineers as their professional antecedents.

In the late medieval European building boom of churches, cathedrals and castles, a later version of the designer-engineer-surveyor-builder emerged to lead the production process, for the same reasons as did their classical predecessors. In medieval times these were the Master Masons. Why did stone masons emerge as leaders of the construction industry? Because stone was the principal and most valuable material factor of production and those who mastered the art of working with it most efficiently and creatively, would have assumed the greatest scarcity value and organisational power. Their skills were also getting better by the century. By the 1200s, Fibonacci had decoded the fractal maths of the golden rectangles of the Greeks and Romans and the 3D golden triangles of the Egyptians before them. The gothic building boom of the time consequently produced even more impressive magic, like flying buttresses and impossibly large windows. When the black death interrupted this boom, cutting the size of Europe's labour force in half, wages and labour power inflated massively with the scarcity, more so with highly skilled labour. Master-builders gained even more power. Between June 1351 and January 1354, wages of master masons in Ghent in present day Belgium, rose 26% from 38 to 48 groats, while the wages of their 'aids' ('journeymen' in the English labour market – still a skilled job) remained static. By 1373, twenty-two years after the bubonic plague's peak in Europe, wages for Flemish master builder and their aids had both doubled ¹.

By the early Renaissance, a clever and maverick goldsmith was eventually able to do what no one had been able to do since the Romans: design and build a masonry dome. Brunelleschi had done the maths, first with his gold work, then with his physics experiments and against all the odds and naysaying of Italy's famous designer-engineer-builders, he had a solution for constructing the long awaited dome to seal Florence Cathedral from the Tuscany rains.

Brunelleschi lost out to another goldsmith, Lorenzo Ghiberti in the tender for the ornate doors of Florence Baptistery nearby the cathedral. Ghiberti won the commission aged 21 and went on to produce magnificent innovative works of art like the bronze sculpture of John the Baptist in Florence's Orsanmichele church, commissioned by the same client (Wool Merchant Guild) that commissioned Brunelleschi's dome. The work of building craftsmen and artists were merging in a big way under the riches of mercantile Europe. Like John the Baptist, greatest of the Old Testament prophets, Brunelleschi was about to give way to a new kind of master builder.

The second historical milestone is the **artist-architect**. A new kind of magic was in the air by the 15th century. Partly inspired and enabled by the new sophisticated heights of mathematical scholarship, artists were in the ascendancy. Michelangelo was known as 'Il Divino', *the divine*. God-like, not so much in his engineering genius, as in his ability to create visual art that inspired awe, through its realism, three-dimensional depth, and beauty. The artist-architects, like the Egyptian surveyor-engineers, achieved elevated social status as they wielded their magical god-like powers to create. Their cultural importance was buttressed by both their science and art, fed by their religious patrons – church, state and the new merchant class made wealthy by the rising wave of post-classical global economic expansion. Thus began what many would recognise now as the contemporary poise of the architect: the dominant profession giving leadership in the construction industry. Artists who design buildings and cities.

¹ Blockmans WP (1980) The social and economic effects of plague in the Low Countries : 1349-1500. *Revue belge de Philologie et d'Histoire* Année 1980 Vol 58-4 pp. 833-863.
https://www.persee.fr/doc/rbph_0035-0818_1980_num_58_4_3301

Until, that is, the second half of the twentieth century, when maths and data started to become rather more important. Brunelleschi outwitted his more famous competitors in securing the dome design-and-build contract, because he had crunched the data. Others disbelieved his absurd claims to be able to make an unsupported dome without formwork or scaffolding. One creative Master Mason architect-engineer proposed erecting a central wooden pillar to support his own version of the dome. Others designed wooden structures. Another is said to have proposed an earth embankment to the height of the top of the thirteenth century uncapped cathedral, filled with coins. The embankment would facilitate the building process and the coins would incentivise the townsfolk to clear it away after the job. Master Masons had graduated into artfully creative design-thinkers. But the one with the data had it on that occasion.

And so has it again become the case. My **third milestone: the rise of the numerical project managers** happens as the buildings of the twentieth century have grown ever more complex. The complexity has grown in finance, logistics, organisation, law, marketing, materials, geometry, height, technology, function, social art, environmental and energy performance, and much more. No longer can artist-architects, by extension from their own design skills, master the entire production process. The tasks have become too complex.

The impact of the artist-architect culture of the previous 600 years led to even greater complexity towards the end of the twentieth century as architects embraced data and maths to make their artistic designs even more magical. Naturalistic geometry replaced Euclidean geometry and its extensions. The curvilinear and deconstructed forms and unconventional materials and engineering of some of the greatest 20th and 21st century architects ironically forced the centre of gravity of the construction process further towards those who can work magic with complex big data.

And so the question I left FoA's freshmen to think over: **will there emerge a Renaissance-man of the cyber-age?** Can a magical mix of design+ data-science+ vision ever find its way into a single person? Or via refreshed curricula, into a class of graduates? Is it even possible? What would it look like? True Renaissance men like Brunelleschi were extremely rare. Those whose names we know were the most brilliant. But they inspired a movement that lasted 600 years. Looking back 4400 years to the Pyramids, whatever the particular blend of art-magic thrown into the mix, the competitive skills that empowered leaders of important moments in the shaping of our buildings and towns, were skills of data manipulation coupled with artistry and organisational prowess. Vision alone did not make a leader. Brunelleschi talked the Guild of Wool Merchants into parting with their 200 golden florin design-and-build fee because of vision and magical imagination backed with math. What skill mix, if any, will be the equivalent in the Cyber-age?

I posed these ideas to our first year undergrads as an historical hypothesis (check it out with whatever historic evidence you can find) and a future-looking hypothesis (what will become of the artist-architect in your lifetime and what might a cyber-age renaissance-person look like?). I also pointed out that my speculative analysis arises from a single theoretical conjecture, taken from the field of economic history: *those with command over the scarcest factor of production in a particular production process, tend over time to acquire the power to organise that process.*

Congratulations to colleagues listed below for so many sparkling achievements. Juan Du's *The Shenzhen Experiment* (Harvard UP, 2020) was chosen from among 50 books from as many publishers for ASU's Institute for Humanities Research Book Award. Watch her award lecture at <https://www.youtube.com/watch?v= Qx9em0yJaY>. I was delighted to discover recently that another FoA colleague is well advanced in the

writing of another potentially seminal book on the backstory of one of China's other great contemporary urban experiments. More to report on that next year, hopefully.

Chris

Teaching and other Achievements

DoA

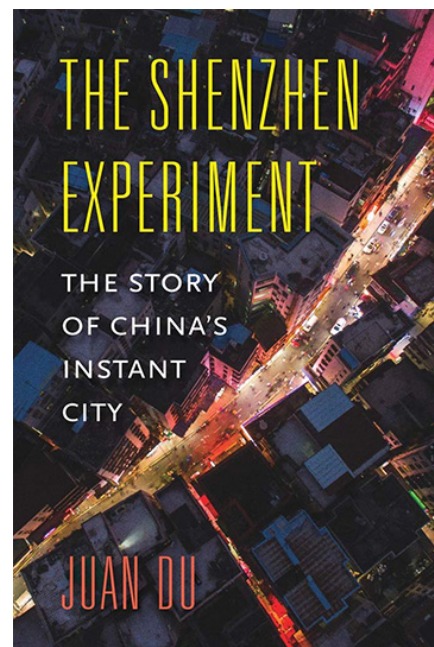
1. Dr. Juan Du

- won the [ASU Institute for Humanities Research](#) Book Award 2020:

Congratulations to [Dr. Juan Du](#), whose non-fiction title, *The Shenzhen Experiment: The Story of China's Instant City* ([Harvard University Press, 2020](#)), has received this year's [ASU Institute for Humanities Research \(IHR\) Book Award](#).

The book is praised by IHR for showing “the value of a lively heterotopia at work under the surface of the State’s myth of a homogeneous community”; it “gives insight into the future of China but also provides ways of thinking about the histories and communities in our own city.”

Since 2008, the ASU Institute for Humanities Research (IHR) Book Award has been presented annually to a non-fiction work of humanities-based scholarship. It celebrates outstanding writers whose contributions to the humanities change the conversation by fostering new directions for their discipline.



DUPAD

1. Dr. Mandy Lau

- Dr. Lau served on the Jury Panel of the Hong Kong Institute of Housing (HKIH) Elite Awards on 19 September and 26 September 2020. The Elite Awards recognizes outstanding housing managers for their professionalism and contribution.

2. Professor Anthony Yeh

- Two DUPAD PhD Students won the Peking University-Lincoln Institute Center for Urban Development and Land Policy (PLC) Dissertation Scholarship:
 - i) **Li Yishiqin**, year 3 PhD candidate (Primary Supervisor: **Dr. Weifeng Li**; Co-Supervisor: Professor Chris Webster)

Proposed research: Redeveloping Collectively-owned Land in Urban China: Transitional Institutions, Negotiation Process and Planning Effectiveness

Shiqin will use the funding to conduct fieldworks in Shenzhen, Guangdong

- ii) **Mengzhu Zhang**, year 3 PhD candidate (Primary Supervisor: **Professor Anthony Yeh**; Co-Supervisor: Professor Chris Webster)

Proposed research: Schooling for Sale and Entrepreneurial Urbanism: Making New Mobility, Identity and Urban Politics in Chinese Cities.

Mengzhu will use the funding to conduct fieldworks in Mianyang and Chengdu, Sichuan.

Every year PLC launches the PLC Dissertation Scholarship Program open for all the postgraduate research students who are doing the research on urban economics, land use and policy, urban development and regional planning, public finances and real estate taxes, urban transportation, housing policy, environmental policy and sustainable development.

A total of 12 prize-winners will be selected through two rounds of competitions. The first round competition is based on the quality of research proposals. The short-listed applicants will be invited to defend their research proposal in a face-to-face meeting. A 30,000-40,000 CNY scholarship will be awarded to the prize-winners to fund the proposed research.

Research Achievements

1. Professor Wilson Lu, Associate Dean (Research)

- Dr. Xingjian Liu has entered the list of [HKU Scholars in the Top 1%](#) in 2020. This list recognizes HKU researchers ranked by Clarivate Analytics in the top 1% worldwide by citations in at least one of the 22 research fields. Data is drawn from [Essential Science Indicators](#) (ESI).

The Faculty now has 5 academics on the list:

Professor Anthony Yeh (since 2009)
Professor Shenjing He (since 2016)
Professor Chris Webster (since 2017)
Professor Wilson Lu (since 2017)
Dr. Xingjian Liu (since 2020)

Centre of Urban Studies and Urban Planning

1. Professor Shenjing He

- Prof. Shenjing He has new publication:

Xiang Yan and Shenjing He (2020) The co-evolution of therapeutic landscape and health tourism in Bama longevity villages, China: An actor-network perspective. *Health and Place*, Volume 66, 2020, 102448, ISSN 1353-8292, DOI: <https://doi.org/10.1016/j.healthplace.2020.102448>

Abstract: *Many locales featuring therapeutic landscapes have seen a rise in health tourism recent years. This study introduces an actor-network perspective to examine the co-evolution of therapeutic landscapes and health tourism, and its inherent dynamism. We argue that therapeutic landscapes and health tourism are emerging out of an integrated actor-network, and thus are in continuous processes of (re)ordering and co-evolution. We also propose a typology of dynamics for the study of such an actor-network, substantiated with an empirical study of the Bama longevity villages in China, in which four interrelated and cascaded dynamics are closely scrutinized: tourists as part of the therapeutic landscape; tourism's impact on the landscape; the heterogeneous therapeutic perceptions of tourists; and the extension of the therapeutic network by health tourism. This study contributes to the relational thinking of therapeutic landscapes and health tourism, and enriches the understanding of their interlacing dynamics from the vantage point of the tourismscape.*

2. Dr. Derrick Ho and Dr. Yimeng Song

- published the following article as co-authors:

(i) Liu, L., Song, F., Fang, J., Wei, J., Ho, H. C., Song, Y., Zhang, Y., Wang, L., Yang, Z., Hu, C., & Zhang, Y. (2021). Intraday effects of ambient PM1 on emergency department visits in Guangzhou, China: A case-crossover study.

Background: Short-term exposure to PM_{2.5} has been widely associated with human morbidity and mortality. However, most up-to-date research was conducted at a daily timescale, neglecting the intra-day variations in both exposure and outcome. As an important fraction in PM_{2.5}, PM₁ has not been investigated about the very acute effects within a few hours.

Methods: Hourly data for size-specific PMs (i.e., PM₁, PM_{2.5}, and PM₁₀), all-cause emergency department (ED) visits and meteorological factors were collected from Guangzhou, China, 2015–2016. A time-stratified case-crossover design with conditional logistic regression analysis was performed to evaluate the hourly association between size-specific PMs and ED visits, adjusting for hourly mean temperature and relative humidity. Subgroup analyses stratified by age, sex and season were conducted to identify potential effect modifiers.

Results: A total of 292,743 cases of ED visits were included. The effects of size-specific PMs exhibited highly similar lag patterns, wherein estimated odds ratio (OR) experienced a slight rise from lag 0–3 to 4–6 h and subsequently attenuated to null along with the extension of lag periods. In comparison with PM_{2.5} and PM₁₀, PM₁ induced slightly larger effects on ED visits. At lag 0–3 h, for instance, ED visits increased by 1.49% (95% confidence interval: 1.18–1.79%), 1.39% (1.12–1.66%) and 1.18% (0.97–1.40%) associated with a 10-μg/m³ rise, respectively, in PM₁, PM_{2.5} and PM₁₀. We have detected a significant effect modification by season, with larger PM₁-associated OR during the cold months (1.017, 1.013 to 1.021) compared with the warm months (1.010, 1.005 to 1.015).

Conclusions: Our study provided brand-new evidence regarding the adverse impact of PM₁ exposure on human health within several hours. PM-associated effects were significantly more potent during the cold months. These findings may aid health policy-makers in establishing hourly air quality standards and optimizing the allocation of emergency medical resources.

3. Dr. Derrick Ho

- Dr. Ho published the following article as 2nd author:

Xu, Y., Ho, H.C., Knudby, A. & He, M. (2020). Comparative assessment of gridded population data sets for complex topography: a study of Southwest China. *Population and Environment*, DOI: <https://doi.org/10.1007/s11111-020-00366-2>

Abstract: Population estimates for high-resolution spatial grid cells data can reflect detailed spatial distribution of population, which are valuable for epidemiological studies, disaster risk assessments, and public resource allocation. However, choice of source data and methods for producing gridded population data sets can introduce spatial bias, especially in regions with complex geography. We assess the performance of four gridded population data sets from 2015 for the Dian-Gui-Qian region of Southwest China: Gridded Population of the World version 4 (GPW4), Global Human Settlement (GHS), LandScan, and WorldPop. At the town-scale, we found that GHS and WorldPop most closely resembled the 2015 population data used for validation. At the intra-town scale, for which spatially disaggregated population validation data do not exist, we compared each data set against Google Earth high-resolution images and found that WorldPop most closely resembled the population distribution that could be inferred from the

imagery. We conclude that in general, WorldPop performs better than GPW, GHS, and LandScan.

- Dr. Ho published the following article as a co-author:

James et al. [GBD collaborators] (2020). Estimating global injuries morbidity and mortality: methods and data used in the Global Burden of Disease 2017 study. Injury Prevention, 26:i125–i153. DOI: <https://doi.org/10.1136/injuryprev-2019-043531>

Background: *While there is a long history of measuring death and disability from injuries, modern research methods must account for the wide spectrum of disability that can occur in an injury, and must provide estimates with sufficient demographic, geographical and temporal detail to be useful for policy makers. The Global Burden of Disease (GBD) 2017 study used methods to provide highly detailed estimates of global injury burden that meet these criteria.*

Methods: *In this study, we report and discuss the methods used in GBD 2017 for injury morbidity and mortality burden estimation. In summary, these methods included estimating cause-specific mortality for every cause of injury, and then estimating incidence for every cause of injury. Non-fatal disability for each cause is then calculated based on the probabilities of suffering from different types of bodily injury experienced.*

Results: *GBD 2017 produced morbidity and mortality estimates for 38 causes of injury. Estimates were produced in terms of incidence, prevalence, years lived with disability, cause-specific mortality, years of life lost and disability-adjusted life-years for a 28-year period for 22 age groups, 195 countries and both sexes.*

Conclusions: *GBD 2017 demonstrated a complex and sophisticated series of analytical steps using the largest known database of morbidity and mortality data on injuries. GBD 2017 results should be used to help inform injury prevention policy making and resource allocation. We also identify important avenues for improving injury burden estimation in the future.*

4. Dr. Kyung-min Nam

- On 16 September 2020, Dr. Nam delivered an invited lecture through online, targeting graduate students in the [Department of Agricultural Economics and Rural Development](#) at [Seoul National University](#). His lecture is titled “Agglomeration Economies and Efficient City Size.”

Abstract: *Agglomeration economies arising from density and size are the very reason why cities exist, but there also exist negative externalities like congestion and pollution, creating counter forces. Thus, a question regarding an ideal distribution of population and economic activities over geographical space touches a continuous spectrum of efficient city size, rather than a binary response. Taking this perspective, in this lecture, I introduce theories and scientific methods underlying this concept, and discuss Korea’s on-going policy debate on the relocation of its national capital.*

- On 25 September 2020, Dr. Nam delivered an invited lecture as part of the MUA-LandsD Seminar Series on Urban Analytics. His lecture is titled “Spatial Science for Public Decisions: With Chinese and Korean Case Examples,” and over 100

Hong Kong Government's Lands Department employees attended his lecture held in HKU's Faculty of Architecture (KB419) either physically or through Zoom.

Abstract: *"Spatial" science explores complex socioeconomic workings of human societies within the urban or regional context. Multidisciplinarity makes it hard to clearly define the field in methodological aspects, but a strong motivation to assist planning or policy interventions offers some common ground for spatial science research. In this lecture, I demonstrate how spatial science can help arrive at a scientifically solid public decision with Chinese and Korean case examples.*

Healthy High Density Cities Lab

1. Dean Webster

- has been invited by the [United Nations \(UN\) Economic and Social Commission for Asia and the Pacific \(ESCAP\)](#) Environment and Development Division (EDD) to give a keynote speech at the UN ESCAP Virtual Expert Group Meeting on the topic of "Response and Recovery: Asia-Pacific Cities on the Front Line of COVID-19", on October 5th 2020, hosted in Bangkok, via zoom.

2. Miss Yvonne Lai

- has the following paper accepted for publication:

K. Y. Lai, C. Sarkar, C. Webster, L. Cheung, M. Ni, J. Gallacher. Exposure to light at night (LAN) and risk of breast cancer: a systematic review and meta-analysis. [Science of the Total Environment](#). (Manuscript No.: STOTEN-D-20-13169R1)

Sustainable High Density Cities Lab

1. Dr. Ren Chao, Dr. Junyi Hua

- has a co-authored reported accepted for publication at the Lancet

Cai, W. *, Zhang, C., Suen, H. P., Hua, J., Ren, C., Gong, P. *, et al. The 2020 China report of The *Lancet* Countdown on health and climate change. [The Lancet Public Health](#). (* Corresponding author)

Executive summary

The Lancet Countdown in China

Left un-mitigated, climate change poses a catastrophic risk to human health, demanding an urgent and concerted response from every country. As the home to one fifth of the world's population and the largest carbon dioxide emitter in the world, China's interventions here are of pivotal importance, both to human health and to the warming planet. As in other countries, climate change mitigation and adaptation would bring immense health benefits for China's 1.4 billion people, and building these considerations into any Corona Virus Disease (COVID-19) recovery strategy will ensure it improves human wellbeing both today, and in the future.

Decisions made over the coming months and years, will determine the course of climate change policy for decades.

To meet this challenge, Tsinghua University, partnering with University College London and 17 Chinese and international institutions has produced the Chinese Lancet Countdown report, focusing at the national level, and building on the work of the global *Lancet Countdown: Tracking Progress on Health and Climate Change*. Drawing on the international methodologies and frameworks, this report aims to more completely understand and track the links between public health and climate change at the national level. This work is one part of the Lancet Countdown's broader efforts to develop regional expertise and understanding, and comes at the same time as the launch of the Lancet Countdown Regional Centre in Asia, based at Tsinghua University. Uniquely, the data and results in this report are presented at the provincial level where possible, in order to facilitate the targeted response strategies for local decision-makers.

The impacts of climate change on health and the response to climate change for health in China

Taken as a whole, the findings of the 23 indicators, which represent the work of 19 institutions and 77 experts, convey two key messages.

1. The health impacts from climate change in China are accelerating, posing an unacceptably high level of health risk if global temperatures continue to rise. Every province is affected, each with its unique health threats, and targeted response strategies should be made accordingly.

The effects of climate change, manifested in rising temperatures, more intense extreme weather events, and shifting vector ecology, are being felt in China, today. Heatwave-related mortality has risen by a factor of four, from 1990 to 2019, reaching 28,000 deaths in the year that's past. The monetised cost of this is equivalent to the average annual income of 1.4 million people in China. Elderly people, who face a 10.4% higher risk of dying during heatwave days, endured an average of 21 more heatwave days in 2019 compared to the 1986-2005 baseline. For outdoor workers, their potential heat-related labour productivity loss reached 0.5% of total national work hours, costing 1% of China's Gross domestic product (GDP), equivalent to its annual fiscal expenditure on science and technology. Driven in-part by rising temperatures and a changing climate, the advent of more extreme wildfires, and the spread of dengue fever will in turn lead to profound health impacts.

Different regions have unique health threats, requiring a targeted response – 15 provinces have experienced at least a 10% rise over the past two decades in four or more of the six health impact indicators reported. Importantly, a number of highly populated and economically advanced provinces, such as Henan and Shandong, are faced with health risks that are larger and more rapidly accelerating than others.

2. Impressive and concerted improvements have been made across a number of sectors in China, however the gap in China's response to the health impacts of climate change remains large.

In certain sectors, China has taken large steps to address climate change. Solar power generation is growing at an unprecedented rate of 26.5% per year, rising to 26.8 GW of newly installed capacity in 2019. Investments in low-carbon

energy are now nine times greater than those in fossil fuels (rising from a 1:1 ratio in 2008) and, providing 4.1 million jobs in 2018, renewable energy now employs more people in China than fossil fuel extraction industries. As a result of strong policy measures, severe air pollution has also decreased, with a 40% reduction in annual average Particulate matter with an aerodynamic diameter equal to or less than 2.5 micrometres (μm) ($\text{PM}_{2.5}$) concentration in cities from 2014 to 2018, resulting in 90,000 fewer $\text{PM}_{2.5}$ -related premature deaths annually. These air pollution control policies have substantial co-benefits on addressing climate change - the coal share in China's total primary energy supply have declined from 66% in 2014 to 59% in 2018. Showing leadership at the subnational level, three provinces already have a provincial health and climate change plan in place, with four more underway.

However, whilst these changes have been rapid, further, far greater shifts are necessary to mount a response that is of the scale required to realize China's latest 'carbon neutrality by 2060' pledge and to minimise the rising health burdens of climate change, both in China and around the world. Whilst renewable energy is rising, coal stills holds a 59% share of total primary energy supply in China. Fossil fuel subsidies were \$41.9 billion in 2018, without considering the negative externalities of fossil fuels' contribution to the estimated US\$ 10.7 billion economic losses due to premature mortality from $\text{PM}_{2.5}$ air pollution. Although there have been substantial reductions in air pollution, 42% of China's population still live in areas failing to meet the interim air quality guideline from World Health Organization (WHO) and almost all cities have $\text{PM}_{2.5}$ concentrations above the recommended annual average of 10 Micrograms per cubic metre ($\mu\text{g}/\text{m}^3$). The health impacts of climate change are not adequately recognised or addressed, as climate change is not referenced in the Healthy China Action Plan (2019-2030), and China is yet to introduce a standalone national adaptation plan for health. Taking a broader perspective, media coverage and individual engagement in health and climate change remain low, with a limited spread of knowledge and engagement. China will need to scale up progress in all sectors in order to bend the rising curve of the health risks from climate change.

Policy recommendations from the 2020 Chinese Lancet Countdown Report

Based on the data and findings of the 2020 Chinese Lancet Countdown report, five recommendations are proposed to key stakeholders in health and climate change in China:

1. Enhance inter-departmental cooperation. Climate change is a challenge that demands an integrated response from all sectors. Although China commits to integrate health into all policies, substantial inter-departmental cooperation among health, environment, energy, economic, financial and education authorities are urgently needed.
2. Strengthen health emergency preparedness. Although the level of health emergency preparedness in China would be greatly enhanced after COVID-19, knowledge and findings on current and future climate-related health threats still lack due attention and should be fully integrated into the emergency preparedness and response system, so that future health service, medical supplies and infrastructure needs could be planned ahead.
3. Support research and raise awareness. Additional financial support should be allocated to health and climate change research in China, in order to enhance

the knowledge of health system adaptation, mitigation measures and their resulting health benefits. Media and academia should be fully motivated to raise the public and politicians' awareness on the topic. Meanwhile, in order to fully engage, the Government of China should build into an update of Healthy China Action Plan (2019-2030) that addresses the health risks of climate change as soon as possible.

4. Increase climate change mitigation. China's new pledges towards carbon neutrality by 2060 is certainly a major step forward. Speeding up coal phase-out process is therefore necessary to be consistent with the carbon neutrality pledges and continue China's progress on air pollution reduction. Fossil fuel subsidies must also be phased out in order to reflect the true cost of ongoing fossil fuel use and to avoid undermining the effect of China's Emissions Trading Scheme, due to take effect in 2021.
5. Ensure the recovery from COVID-19 protects health now, and in the future. Decisions made as part of China's efforts to recover from COVID-19 will shape the public's health for years to come. The longer-term prospects for lives, livelihoods, and a sustainable economy will be put in jeopardy if these interventions do not prioritise climate change.

iLab

1. Professor Wilson Lu and iLab researchers

- have published the following journal papers

- (i) Hao, J.L., Cheng, B., **Lu, W.S.**, Xu, J., Wang, J., Bu, W., and Guo, Z (2020). Carbon emission reduction in prefabrication construction: A BIM-based life-cycle assessment approach. Science of the Total Environment, Volume 723, 137870, ISSN 0048-9697. DOI: <https://doi.org/10.1016/j.scitotenv.2020.137870>

Abstract: *Prefabrication has gained its popularity in countries including China due to its various advantages such as quality control, waste reduction, onsite and offsite parallel coordination, and so on. It has also been recognized as a key strategy to reduce construction-induced carbon emissions. However, there is limited research to examine carbon emission reduction in prefabrication by using the advanced technological artefacts, e.g., building information modeling (BIM), emerging from the technology sphere. As a digital representation of a facility, BIM provides a cyber platform based on which many assessment and simulation works can be performed without having to construct the physical facility. This paper aims to develop a BIM-based approach to measuring carbon emission reduction during the materialization stage of a prefabricated building project. Findings from the study indicate that BIM is an efficient and effective method for measuring carbon emissions from the construction of new buildings and that prefabrication reduces carbon emissions when compared with conventional construction methods. The research contributes to the body of knowledge relating to the reduction of carbon emissions through prefabrication. This is pertinent to contractors, homebuyers and governments who are constantly seeking ways to achieve a circular economy.*

- (ii) **Xu, J.Y., Lu, W.S., Ye, M., Webster, C., and Xue, F.** (2020). An anatomy of waste generation flows in construction projects using passive bigger data. *Waste Management*, Volume 106, Pages 162-172, ISSN 0956-053X, DOI: <https://doi.org/10.1016/j.wasman.2020.03.024>

Abstract: *Understanding waste generation flow is vital to any evidence-based effort by policy-makers or practitioners to successfully manage construction project waste. Previous research has found that accumulative waste generation in construction projects follows an S-curve, but improving our understanding of waste generation requires its investigation at a higher level of granularity. Such efforts, however, are often constrained by lack of quality “bigger” data, i.e. data that is bigger than normal small data. This research aims to provide an anatomy of waste generation flow in building projects by making use of a large set of data on waste generation in 19 demolitions, 59 foundations, and 54 new building projects undertaken in Hong Kong between 2011 and 2019. We know that waste is generated in far from a steady stream as it is always impacted by contingent factors. However, we do find that peaks of waste generation in foundation projects appear when project duration is at 50~85%, and in new building projects at 40~70% of total project time. Our research provides useful information for waste managers in developing their waste management plans, arranging waste hauling logistics, and benchmarking waste management performance.*

- (iii) **Bao, Z.K., Lu, W.S., Chi, B., and JL. Hao** (2020). Construction waste management performance in green building: Contextualising LEED in China. *Detritus*, Volume 12, September 2020, Pages 125-134. DOI: <https://doi.org/10.31025/2611-4135/2020.13992>

Abstract: *Construction waste issues have raised considerable concern in recent decades. Green building (GB) has been adopted around the globe as a strategy to curtail building-related environmental issues, including construction waste. Particularly in China, with the soaring construction activities tied to urbanization and urban regeneration, massive construction waste has been generated, imposing tremendous pressure on the industry and beyond. China is also vigorously pursuing a national GB strategy, but its effects on construction waste management (CWM) are yet to be confirmed. This paper evaluates CWM performance in GB by putting the dyads into China's particular Political, Economic, Social, and Technical (PEST) context. By analysing a total of 310 LEED (Leadership in Energy and Environmental Design) accredited GB projects in China, it is surprisingly discovered that GB does not prominently improve CWM. The paper goes further to understand the causes of the mediocre CWM performance, by conducting ten semi-structured interviews with GB and CWM practitioners in China. Finally, a comprehensive PEST analysis is conducted to discuss the situation in the context of China. Factors such as (a) incomplete CWM regulations in China, (b) lack of economic incentives, (c) lacklustre awareness about CWM, and (d) lack of advanced technologies, caused the CWM performance in GB. Based on the PEST analyses, some targeted strategies are also recommended. This study is of benefits to both researchers and practitioners in the GB industry.*

- (iv) **Bao, Z.K. and Lu, W.S.** (2020). Developing efficient circularity for construction and demolition waste management in fast emerging economies: Lessons learned from Shenzhen, China. *Science of the Total Environment*, Volume 724, 138264, ISSN 0048-9697, <https://doi.org/10.1016/j.scitotenv.2020.138264>

Abstract: Proper management of construction and demolition (C&D) waste is a key challenge amid global advocacy of the circular economy. This is of particular urgency in fast-emerging economies, where economic development induces massive construction without the capacity to manage the associated waste. This paper reports lessons learned from Shenzhen, China, which has witnessed exciting economic growth in the past few decades but also been compelled to rapidly develop an effective C&D waste circular economy from a low base. The research adopts a mixed-method approach combining case study, site investigations, and interviews in Shenzhen. It is discovered that Shenzhen's success can be attributed to (a) implementing strong governmental interventions; (b) developing a thriving C&D waste recycling market; (c) introducing advanced recycling technologies; and (d) enacting responsive institutional arrangements. Further improvements related to (1) recycled product certification, (2) land use and economic subsidies, and (3) changing circular economy philosophies, inter alia, are desired to sustain the long-term prosperity of this circular economy. The research provides a reference which can be adapted to the unique context of other emerging economies in developing effective circularity.

- (v) **Lu, W.S.**, Tan, T., **Xu, J.Y.**, **Wang, J.**, Chen, K., Gao, S., and **Xue, F.** (2020). Design for Manufacture and Assembly (DfMA) in construction: the old and the new. *Architectural Engineering and Design Management*, DOI: <https://doi.org/10.1080/17452007.2020.1768505>

Abstract: Design for manufacture and assembly (DfMA) has become a buzzword amid the global resurgence of prefabrication and construction industrialization. Some argued that DfMA is hardly new, as there are concepts such as buildability, lean construction, value management, and integrated project delivery in place already. Others believe that DfMA is a new direction to future construction. This paper aims to review the development of DfMA in manufacturing and its status quo in construction, and clarify its similarities and differences to other concepts. A multi-step research method is adopted in this study: First, an analytical framework is generated; Secondly, a literature review is conducted on DfMA in general, and DfMA-like concepts in the AEC industry; The third step is to compare DfMA with related concepts. This study reveals that DfMA as a philosophy is hardly new in construction, and the empirical implementation of many DfMA guidelines has begun in the AEC industry. The findings suggested that DfMA is a new and mixed 'cocktail' of opportunities and challenges to improve construction productivity with the advancement of construction materials, production and assembly technologies, and ever-strengthened logistics and supply chain management. This study sheds light on three research directions: DfMA implementation and guidance strategies, DfMA frameworks and blueprints, and applications in cast in-situ or intermediate prefabrication construction. Our research findings provide a synopsis of DfMA research and development in construction. This paper can also serve as a point of departure for future theoretical and empirical explorations.

- (vi) **Xue, F.** and **Lu, W.S.** (2020). A semantic differential transaction approach to minimizing information redundancy for BIM and blockchain integration. *Automation in Construction*, Volume 118, 103270, ISSN 0926-5805, DOI: <https://doi.org/10.1016/j.autcon.2020.103270>.

Abstract: Those attempting to integrate building information modeling (BIM) and blockchain soon encounter the enormous challenge of information redundancy. Storage of duplicated building information in decentralized ledgers

already creates redundancy, and this is exacerbated as the BIM model develops and is utilized. This paper presents a novel semantic differential transaction (SDT) approach to minimizing information redundancy in the nascent field of BIM and blockchain integration. Whereas the conventional thinking is to store an entire BIM model or its signature code in blockchain, SDT captures local model changes as SDT records and assembles them into a BIM change contract (BCC). In this way, the version history of a BIM project becomes a chain of timestamped BCCs, and stakeholders can promptly synchronize BIM changes in blockchain. We test our approach in two pilot cases. The results show that SDT captures, in near real time, sequential and simultaneous BIM changes at less than 0.02% of the Industry Foundation Classes file size. We also prove model restoration from the lightweight BCCs in a small-scale BIM project. In addressing the fundamental issue of information redundancy in BIM and blockchain integration, this research can help the industry advance beyond the rhetoric to develop operable blockchain BIM systems.

- (vii) **Bao, Z.K., Lee, W.M.W., and Lu, W.S.** (2020). Implementing on-site construction waste recycling in Hong Kong: Barriers and facilitators. Science of The Total Environment, Volume 747, 141091, ISSN 0048-9697, DOI: <https://doi.org/10.1016/j.scitotenv.2020.141091>.

Abstract: *Construction and demolition (C&D) waste recycling constitutes an indispensable component in the overall waste management strategy. Unlike the traditional recycling approaches whereby C&D waste is transported to off-site facilities for treatment, construction managers are actively exploring the possibility of on-site recycling where C&D waste is treated directly at source. This study reports the barriers and facilitators of implementing on-site C&D waste recycling by contextualizing it in Hong Kong. It does so by adopting a mixed-method approach combining case study, site visits, and interviews. It is discovered that the barriers include (1) site space constraints, (2) narrow window of opportunity to trade recycled products, (3) vulnerable business case, (4) lack of support from off-site recycling, and (5) lack of government policy support. A series of facilitating measures are also proposed, including (1) developing customized on-site recycling equipment, (2) establishing a demand-supply information-sharing platform, (3) developing more thriving off-site recycling, and (4) providing more government support. This study probes into the real-life on- and off-site waste recycling practices in Hong Kong's prominent C&D management system. It can also provide useful references for others in developing their own C&D waste recycling strategies by rationally deploying on- and off-site recycling.*

- (viii) **Lu, W.S., Lee, W.M.W., Bao, Z.K., Chi, B., and Webster, C.** (2020). Cross-jurisdictional construction waste material trading: Learning from the smart grid. Journal of Cleaner Production, Volume 277, 2020, 123352, ISSN 0959-6526, DOI: <https://doi.org/10.1016/j.jclepro.2020.123352>.

Abstract: *Construction waste materials are resources misplaced. Trading them across different jurisdictions is an innovative way to reuse or recycle the materials, which in turn obtains “cleaner production” in the construction sector. It can achieve a win-win situation between the demand and supply sides, but several hurdles must be overcome first. A particular hurdle is that demand and supply of such materials arises sporadically in discrete sites, thereby matching the two sides is not always opportune. We find parallels in the energy sector, where smart grids have been developed to store power generated sporadically*

by small producers and distribute it to individual users based on their (erratic) needs. Learning from smart grids, this research aims to shed light on innovative institutional arrangements promoting the development of an effective cross-jurisdictional construction waste material trading market. Underpinning this research is a mixed-method approach including cross-sectoral learning and a case study encompassing a series of site visits and semi-structured interviews in China's Greater Bay Area. By comparing the commonalities between electricity and construction waste in terms of production, market, transmission, distribution, and consumption, we elaborate smart grid innovations and their possible applications to construction waste materials trading. Our research contributes to the body of knowledge on waste management, the circular economy, and the sharing economy. It will help establish a cross-jurisdictional waste material trading market in the Greater Bay Area. It also provides useful references to other regions in searching solutions for waste trading/sharing.

- (ix) **Xue, F., Lu, W.S., Chen, Z., and Webster, C.** (2020). From LiDAR point cloud towards digital twin city: Clustering city objects based on Gestalt principles. ISPRS Journal of Photogrammetry and Remote Sensing, Volume 167, Pages 418-431, ISSN 0924-2716, DOI: <https://doi.org/10.1016/j.isprsjprs.2020.07.020>

Abstract: Recent advancement of remote sensing technologies has brought in accurate, dense, and inexpensive city-scale Light Detection And Ranging (LiDAR) point clouds, which can be utilized to model city objects (e.g., buildings, roads, and automobiles) for creating Digital Twin Cities (DTCs). However, processing such unstructured point clouds is very challenging, epitomized by high cost, movable objects, limited object classes, and high information inadequacy/redundancy. We noticed that many city objects are not in random shapes; rather, they have invariant cross-sections following the Gestalt design principles, including proximity, connectivity, symmetry, and similarity. In this paper, we present a novel unsupervised method, called Clustering Of Symmetric Cross-sections of Objects (COSCO), to process urban LiDAR point clouds to a hierarchy of objects based on their characteristic cross-sections. First, city objects are segmented as connected patches of proximate 3D points. Then, symmetric cross-sections are detected for symmetric city objects. Finally, the taxonomy and groups of city objects are recognized from a hierarchical clustering analysis of the dissimilarity matrix. Experimental results showed that COSCO detected the correct taxonomy and types of 12 cars from 24,126 LiDAR points in 8.28 s. Based on the cross-sections and taxonomy, a digital twin was created by registering online free 3D car models in 29.58 s. The contribution of this paper is twofold. First, it presents an effective unsupervised method for understanding and developing DTC objects in LiDAR point clouds by harnessing innate Gestalt design principles. Secondly, COSCO can be an efficient LiDAR pre-processing tool for recognizing symmetric city objects' cross-sections, positions, heading directions, dimensions, and possible types for smart city applications in GIScience, Architecture, Engineering, Construction and Operation (AEEO), and autonomous vehicles.

- (x) **Xue, J., Shen, G. Q., Yang, R. J., Wu, H., Li, X., Lin, X., & Xue, F.** (2020). Mapping the knowledge domain of stakeholder perspective studies in construction projects: A bibliometric approach. International Journal of Project Management, Volume 38, Issue 6, August 2020, Pages 313-326. DOI: <https://doi.org/10.1016/j.ijproman.2020.07.007>

Abstract: Construction projects require the effective collaboration among the various types of stakeholders involved to succeed, thus leading to stakeholder

perspective studies in construction projects. The study proposes an integrated bibliometric approach to detect the knowledge evolution, domain and frontier with a broader searching scope compared with manual review. A total of 752 peer-reviewed academic papers published until the end of 2017 are used. The knowledge evolution indicates seven milestones in history, namely, stakeholder concept, method, identification, assessment, management, influence and complexity. The identified knowledge domain consists of four major research areas which are society, sustainability, analytical tool and project management. The knowledge frontier is also revealed, including a dearth of detailed discussions on stakeholder engagement in sustainable urban projects, lack of generalisation of stakeholder studies in complex construction projects, limited application of dynamic and simulation stakeholder analysis in uncertain project environment and few instant and accurate approaches to integrate stakeholder information. The study provides a holistic knowledge map for the past, current and future of stakeholder perspective studies in construction projects.

- (xi) Guo, H., Zhou, Y., Ye, X., Luo, Z., & **Xue, F.** (2020). Automated mapping from an IFC data model to a relational database model. *Journal of Tsinghua University (Science and Technology)*, in press. DOI: <https://doi.org/10.16511/j.cnki.qhdxxb.2020.22.030>

Abstract: BIM (Building Information Modelling) plays an important role in the construction industry, while IFC (Industry Foundation Classes), as an international data exchange model, provides a useful support for the research and application of BIM, particularly BIM-related redevelopment. However, the limitations of IFC make it difficult to use IFC as the main data format in redevelopment. Therefore, an automatic mapping method from IFC data model to relational database model is proposed in this research. According to the structure of IFC data model, first, mapping rules for Entity, Type, Function, Rule, Property Set, and Quantity Set are defined respectively to realize data analysis, data mapping, and information retrieval. Then two experiments are conducted to test the validity of the proposed method, indicating that the relational database is superior to IFC files in terms of information integrity and the efficiency of data management. Moreover, two cases are used to show the potential of the mapped relational database. The results show that the mapping method not only improves the integrity and efficiency of BIM data management, but also promotes the use of intelligent construction as well as the development of informatization of the construction industry.

- (xii) **Xu, J.Y.**, Ye, M., **Lu, W.S.**, **Bao, Z.K.**, and **Webster, C.** (2020). A four-quadrant conceptual framework for analyzing extended producer responsibility in offshore prefabrication construction. *Journal of Cleaner Production*. 124540, ISSN 0959-6526, DOI: <https://doi.org/10.1016/j.jclepro.2020.124540>

Abstract: Prefabrication has been widely advocated as a green production strategy to minimize the adverse environmental impacts of construction. Amid economic globalization, prefabricated construction materials are commonly sourced offsite and even offshore. As an issue emerging alongside offshore prefabrication, extended producer responsibility (EPR) is yet to be clearly identified, allocated, and implemented. This research develops a conceptual framework using a design thinking process, through which EPR associated with offshore prefabrication can be analyzed, agreed upon, and allocated. By considering the scope and scale of the responsibility and the procurement methods, the framework comprises four quadrants representing four typical scenarios for implementation of the EPR principle. It is applicable for both short-

term and lifelong EPR analysis, in both traditional and integrated project delivery contexts. The framework will be particularly useful for devising public policies to achieve an onshore and offshore stakeholder win-win situation.

2. Professor Wilson Lu

- Delivered two lectures at [2020 Tsinghua Summer School for International Construction](#) (22 to 29 June 2020):

On 23 June 2020, “Corporate Social Responsibility (CSR) in international construction”

On 29 June 2020, “BIM and blockchain platform for cross-border construction logistics and supply chain management (LSCM)”

3. Dr. Frank Xue

- Received a Seed Fund for Basic Research for his project titled “Matrix City: Big data-driven semantic vector modeling for urban computing” (HK\$55,460)
- Delivered an invited talk online, titled “Blockchain for Smart Construction” at [The 6th Joint Summer School of Frontiers in Construction Management and Cloud Summer Camp for Outstanding College Students in Civil Engineering](#), Huazhong University of Science and Technology, 23-24 July 2020, Wuhan, China.
- Presented a conference paper at [ICCCBE and CIB W78 2020 Virtual Joint Conference Technical Session Live 5A](#) (9:03 – 16:48) on 20 August 2020:

Xue, F., Guo, H., & Lu, W. (2020). Digital twinning construction objects: Lessons learned from pose estimation methods. In Proceedings of the 37th International CIB W78 Information Technology in Construction Conference, São Paulo - online, Brazil, pages 327-337, ISSN 2706 – 6568, DOI: <http://dx.doi.org/10.46421/2706-6568.37.2020.paper023>

Abstract: *Productivity and safety in the construction industry have long been hindered by the many uncertainties and lack of awareness in the semi-controlled site environment. The digital twinning of construction objects aims at offering digital replicas with real-time, trustable evidence for automated monitoring, human-centric decision-making, or fully automatic cyber-physical systems. This paper revisits the pose estimation methods for the digital twinning of various on-site construction objects, including construction components, equipment, and humans. From a machine learning perspective, all the pose estimation methods can be categorized into four classes, i.e., filtering, supervised, reinforcement, and unsupervised. The inputs, processes, output, and target objects of each class are introduced with demonstrative cases. Comparisons on the pros and the cons of the methods reveal the best choices for digital twinning under different objectives, such as a safer site and more productive construction, as well as constraints such as pose accuracy, computational time, and overall cost. The complexities of digital twinning different construction objects are compared to explain the distribution of existing cases in the literature. Opportunities and possible research directions in the new era of AI and blockchain are recommended at the end.*

4. Ms. Jing Wang (a Ph.D. candidate with Prof. Wilson. W.S. Lu)

- attended [2020 Construction Research Congress \(CRC\)](#) and presented the following conference papers:

(i) **Wang, J. & Lu, W.** Building a Process Model of Building Information Modelling Localization. In [2020 Construction Research Congress \(CRC\), Parallel Track 3E: Computer Applications and Simulation, Advanced Technologies and Data Analytics, No.421](#), Tempe, Arizona, the U.S., 8-10 March 2020.

(ii) **Guo, H., Lu, W. & Ye, M.** Corporate Environmental Responsibility and Financial Performance: Evidence from International Construction. In [2020 Construction Research Congress, Parallel Track 2D: Project and Organizational Management and Planning, No. 494](#), Tempe, Arizona, the U.S., 8-10 March 2020.

(iii) **Xu., J., Xue, F., Chiaradia, A. & Lu, W.** Indoor-outdoor navigation without beacons: Compensating smartphone AR positioning errors with 3D pedestrian network. In [2020 Construction Research Congress, Parallel Track 1B: Infrastructure Systems and Sustainability, No. 492](#), Tempe, Arizona, the U.S., 8-10 March 2020.

(iv) **Bao, Z., Lu, W., Chi, B., Hao, J., & Chin, C.S.** Construction Waste Material Cross Jurisdictional Trading: A PESTEL Framework of the Greater Bay Area in China. In [2020 Construction Research Congress, "Meet the Author" Poster Presentations, No. 586](#), Tempe, Arizona, the U.S., 8-10 March 2020.