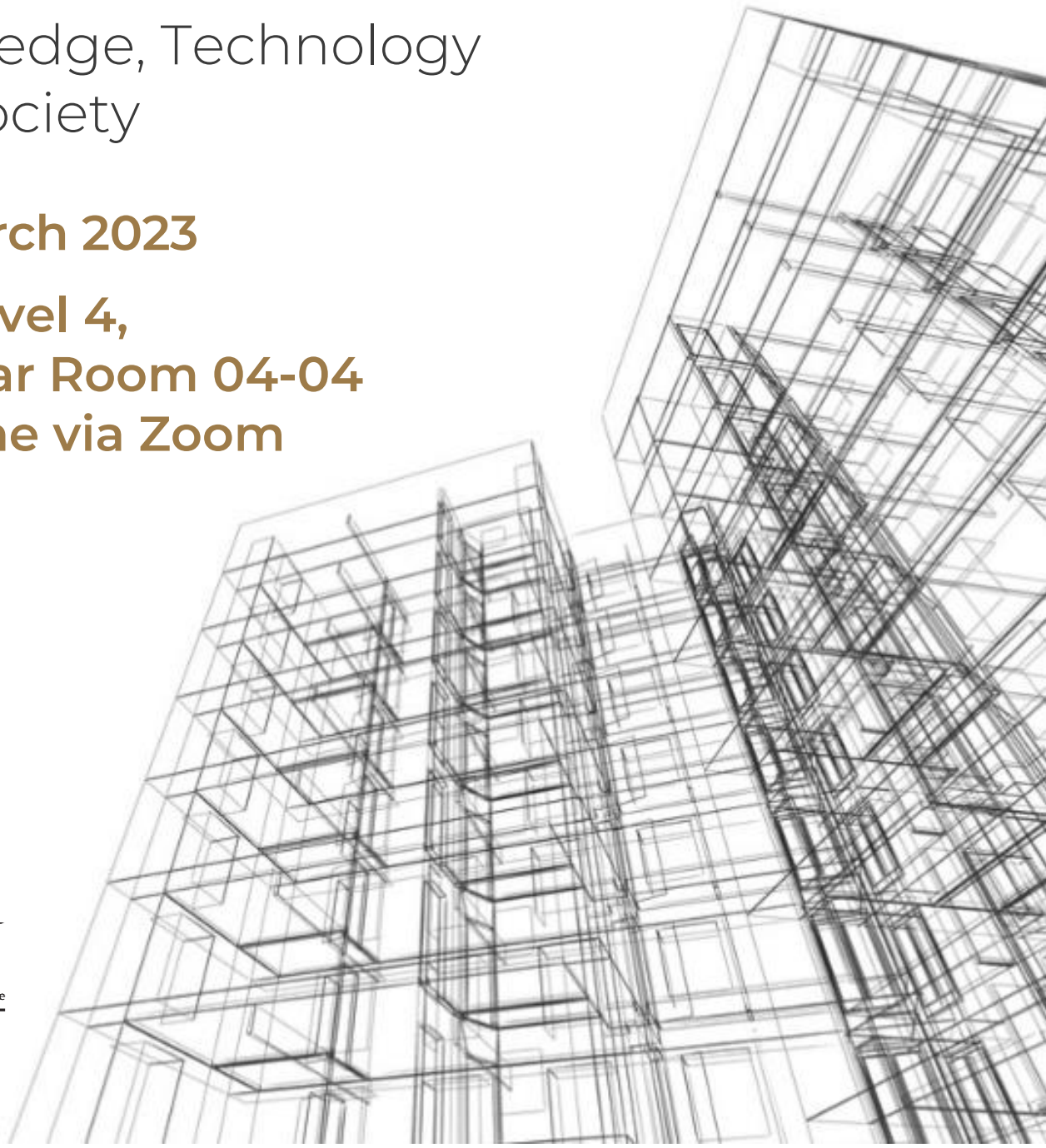
This workshop is organised by the Asia Research Institute, National University of Singapore (NUS); with support from the NUS Humanities and Social Sciences Seed Fund – Follow the Code: Urban Models and Resilient Future.

URBAN MODEL MAKING

Knowledge, Technology and Society

2-3 March 2023

AS8 Level 4,
Seminar Room 04-04
& Online via Zoom



ARI
ASIA RESEARCH INSTITUTE
National University of Singapore

This workshop is organised by the Asia Research Institute, National University of Singapore (NUS); with support from the NUS Humanities and Social Sciences Seed Fund – Follow the Code: Urban Models and Resilient Future.

Urban models have been used to construct views on urban environments and manage and project the unpredictable future of cities amid the current pandemic risks and the pressing threat of climate change. Such models construct different understandings of possible futures (e.g. through scenarios) and the past (e.g. through explaining past events). Moreover, they facilitate experimentation with adaptive strategies and communication between scientists and policy-makers, and thus provide justifications in decision-making and policy formulation. As these models are designed and used by people, entail complex processes, involve diverse stakeholders, and have long life-cycles, the consequences or impacts can often be unexpected, unintended and even negative (Tenner, 1997). This social embeddedness further bind models and technologies by normative rules that members of the group follow and construct (Friedland and Yamauchi, 2011), including rules concerning knowledge construction, generalisability and validation (Edwards, 1999). Exactly how design strategies construct these models, how they generate knowledge, how they are subject to power relations are empirical questions that cannot be anticipated in entirety. Situating urban models within the social and political context they are developed helps establishing a reflexive practice in model making for modellers to better understand and communicate the potential impacts and limits of their models (Stahl, 2011; Kitchin, 2014).

The Asian context is unique in the development of urban models and the implementation of technology in decision making processes. There is a significant body of work studying different kinds of models historically, socially and epistemologically in Science, Technology and Society (STS) studies (eg. Godin, 2006; Sundberg, 2009; Edwards, 2016; Weinkle and Pielke, 2017; Hansen, 2021), but less examining specifically urban environmental models and the practice of model construction in the particular cultural context of Asia or Singapore or with a focus on stakeholder decision-making and modeller practice. This workshop aims to create a venue to investigate the social life of scientific urban model construction and use with a focus of Asian cities. The workshop is planned in two parts to firstly anchor the discussion of urban models locally in the Singaporean context and then further to expand the treatment of models and modelling practices to other Asian and inter-Asian contexts. Through a series of invited talks and panel discussions, the workshop will reflect on and compare different models and start to develop a network of scholars in Singapore, Asia and beyond.

Many events around scientific urban modelling focus on the computer science and engineering aspects of urban modelling. This workshop aims focus on interdisciplinary STS approaches to initiate develop an understanding of politics, reflexive practice and fairness, with focus on the relationship between modelling teams and stakeholders such as urban planners and policy-makers. Such processes are deeply influenced by the cultural and political structures in which the knowledge creation happens. Given the strong preponderance and impact of Smart City rhetoric in Singapore and other Asian cities, it is timely and necessary to investigate the politics within and around scientific urban models in Singapore and other Asian countries. By initiating a conversation with Asian scientific urban models as the starting point, this workshop aims to reflect on and investigate the politics that shape model building practices from perspectives that are situated directly in the Asian context.

The objectives of this workshop are to:

1. understand and reflect on the practices of building scientific models of the built environment that manage, plan for and simulate the future of cities in Asia;
2. compare different uses of models of environments (e.g. buildings, urban space, climate, economy, health) across different Asian cites and inter-Asia;
3. understand the positionalities of multiple stakeholders in Singapore across academia, government agencies, and industries;
4. begin to develop an Asian and global network of urban modelling scholars.

The broader foci are to:

1. situate urban models within the unique socio-political context in Asian cities to deeper understand the practice of urban model building;
2. develop an understanding of how different kinds of models construct, practice and relate knowledge and the future;
3. discuss the methods and value of establishing a reflexive practice to develop specifically better urban models.

2 MARCH 2023 • THURSDAY

09:45 – 10:00	**WELCOME REMARKS**
09:45	**Connor Clive Graham** | National University of Singapore **Chaewon Ahn** | Yale-NUS College
10:00 – 12:30	**PANEL 1 • CRITICAL PERSPECTIVES ON URBAN MODELS**
Chairperson	**Eric Kerr** | National University of Singapore
10:00	**Digital Twin Cities: The 'Simplification' of Urban Prototyping?** **Simon Marvin** | University of Sydney
10:30	**Modeling Inequalities in Urban Environmental Challenges** **Angel Hsu** | University of North Carolina – Chapel Hill
11:00	**Advancing Urban Modelling with Emerging Datasets and Crowdsourcing** **Filip Biljecki** | National University of Singapore
11:30 *via Zoom*	**Critical Notes on Urban Twins: Origin Myths, Tropes, and Realities** **Farzin Lotfi-Jam** | Cornell University
12:00	Discussion
12:30 – 13:30	**LUNCH**
13:30 – 15:30	**PANEL 2 • DEFINING AND USING URBAN AND DIGITAL TWIN MODELS**
Chairperson	**Chaewon Ahn** | Yale-NUS College
13:30	**Urban Digital Twins: What Are They or What Could They Be?** **Rudi Stouffs** | National University of Singapore
14:00	**Greening the 3D Landscape: Measuring the Impact of Tree and Building Shades on the Urban Heat Island** **Yujin Park** | Chung-Ang University
14:30	**Urban Models for Collective Narratives** **Jie-Eun Hwang** | University of Seoul
15:00	Discussion
15:30 – 15:45	**TEA BREAK**
15:45 – 18:15	**PANEL 3 • DIGITAL TWIN MODELS: PRACTICES AND KNOWLEDGE-MAKING**
Chairperson	**Connor Clive Graham** | National University of Singapore
15:45 *via Zoom*	**The Epistemology, Praxes and Politics of Urban Science and Urban Modelling** **Rob Kitchin** | Maynooth University Social Sciences Institute
16:15 *via Zoom*	**(Re)Constructing the City – Urban Models and Digital Twins: Inside Out and from the Ground Up** **Oliver Dawkins** | Maynooth University Social Sciences Institute
16:45 *via Zoom*	**Data Practices and the Epistemologisation of Urban Futures in Taiwan and Japan** **Sung-Yueh Perng** | National Yang Ming Chiao Tung University
17:15	**World Building Urban Digital Twins: Designing for the Future** **Paul Cureton** | Lancaster University
17:45	Discussion
18:15 – 18:30	**CLOSING REMARKS**
18:15	**Jiat Hwee Chang** | National University of Singapore
18:30	**END OF DAY 1**
19:00 – 20:30	**WORKSHOP DINNER**

3 MARCH 2023 • FRIDAY

10:00 – 12:30	**PANEL 4 • URBAN MODELS IN ACTION**
Chairperson	**Chaewon Ahn** | Yale-NUS College
10:00	**Perspectives on Unlocking Value from Urban Analytics and Modelling** **Zhongwen Huang** | Smart Nation Digital Government Office
10:30	**Mapping Singapore in 3D** **Victor Khoo** | Singapore Land Authority
11:00	**Integrated 2D-3D Urban Planning and Design for a Sustainable and Resilient City** **Julian Cheng** | Urban Redevelopment Authority
11:30	**Understanding the Open Digital Platform's Digital Twin Technology and its Role in Smart Cities** **James Tan** | Jurong Town Corporation, and Government Technology Agency
12:00	Discussion
12:30 – 12:45	**CLOSING REMARKS & NEXT STEPS**
12:30	**Connor Clive Graham** | National University of Singapore **Chaewon Ahn** | Yale-NUS College
12:45 – 13:30	**LUNCH**
13:30	**END OF WORKSHOP**

Digital Twin Cities: The 'Simplification' of Urban Prototyping?

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Over the last decade there has been the development of a new urban imaginary – the 'digital twin city'. States, urban governments, technology companies, academics and consultants have argued that the DTC is a novel urban product and potentially a transformative capacity in enhancing the rapid prototyping of cities. This paper subjects these claims to critical scrutiny in three ways. First, it locates the emergence of the imaginary of DTCs in a wider experimental shift that is rapidly transmuting a bricolage of 4th Industrial Revolution technologies to urban contexts with limited societal debate. Second, it traces the development of the DTC showing how it is heterogeneously engineered from an earlier set of urban technical applications primarily drawing on virtual cities, cybercities and the smart city with insufficient attention paid to learning about their limits. Third, it explores the distinctive capacity of DTCs to 'simplify' urban prototyping by dispensing with the need for constructing material prototypes and their testing in 'real-world' socio-material contexts without recognising what might be lost through these exclusions. The paper argues that urban studies should be concerned about this 'simplified' mode of urban prototyping that enhances exclusive technical expertise, curbs the construction and testing of material experiments and reduces the inclusivity of social interests in experiments.

Simon Marvin is an internationally recognised academic with an excellent publication profile, with expertise in constructing conceptual understanding and empirical evidence of the changing relations between socio-technical networks and urban and regional restructuring. He is also Director of the Urban Institute at Sheffield University. He was also a fractional professor in the School of Architecture Design and Planning at Sydney University for 2020/21. Simon previously worked at Newcastle, Salford, and Durham Universities before joining Sheffield in 2015 and Sydney in 2020. His research interests focus on socio-technical change and the urban condition. He has recently completed large collaborative programmes of work on the politics of urban transitions, urban living labs and the smart cities. His latest book with Andres Luque-Ayala "Urban Operating Systems: Producing the computational city" will be published by MIT press in 2020 as a freely available open access publication. His recent work is focused on the development of interior climate control for humans, animals and plants charting the increasingly strategic role of technologically mediated climates constructed to ensure comfort, convenience and survivability in a period of climate turbulence. At Sydney his new work "Over Heating Cities" focuses on understanding the dynamics, practices and consequences of the outdoor cooling industry that through a range of socio-technical systems provide active cooling through misting, FOG and even air conditioning in order to try to guarantee outdoor comfort and all-year round weather. Simon will work closely with Sydney Urbanism and colleagues in the school and university who specialises in different disciplinary approaches to urban overheating.

Modeling Inequalities in Urban Environmental Challenges

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Cities, as global engines of economic growth, are not only sites of opportunity but also environmental degradation and inequality. With the 2015 Sustainable Development Goals identifying the need for cities to be both sustainable and inclusive (SDG-11), a series of targets were set for urban areas to mitigate the unequal exposure to air pollution, waste, and climate impacts, as well as to increase equitable access to green spaces and public transportation. By identifying specific quantitative targets, these global goals have motivated a number of academic and private sector initiatives to attempt to measure progress towards the 169 indicators identified. Applied to cities, the challenge of quantifying, measuring and modeling the unequal distribution and impacts of environmental harms, while evaluating where progress towards sustainable and inclusive urban policies is met, is compounded by a number of larger difficulties in modeling the urban environment. In this paper, I will discuss challenges in modeling inequalities in urban environmental challenges, drawing upon parallel trends in earth observation and large-scale data that have opened new possibilities and new research questions.

Angel Hsu is Assistant Professor of Public Policy and Environment, Energy and Ecology at the University of North Carolina – Chapel Hill. She is Founder/Director of the Data-Driven EnviroPolicy Lab, an interdisciplinary research group that innovates and applies quantitative approaches to pressing environmental issues. Her research explores the intersection of science and policy and the use of data-driven approaches to understand environmental sustainability, particularly in the areas of climate change and energy, urbanisation and air quality. She was a contributing author to the IPCC Sixth Assessment Report and was a lead author of the 2018 UNEP Emissions Gap Report special chapter on non-state and subnational actors. She holds a PhD in Environmental Policy from Yale University and was formerly Assistant Professor of Environmental Studies at Yale-NUS College in Singapore.

Advancing Urban Modelling with Emerging Datasets and Crowdsourcing

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The talk presents recent research efforts on urban modelling at the NUS Urban Analytics Lab, and it focuses specifically on understanding the usability of emerging datasets and crowdsourcing. The Lab spearheads a holistic and intertwined research agenda that covers the entire geospatial process in the urban realm: from advancing means to acquire data and standardising it to developing new use cases and unlocking value with AI and analytics. For example, the group has developed the first global open registry of rooftops for urban sustainability. Digital twins are in particular in focus of the research group, and the presentation includes a sneak peek of a digital twinning project conducted in the campus.

Filip Biljecki is Assistant Professor at the National University of Singapore (NUS) and the founder of the NUS Urban Analytics Lab. He holds a MSc and PhD degree from the Delft University of Technology in the Netherlands. Filip's research and teaching are converging geomatic engineering, geospatial technologies, and urban data science to support digital twins, smart cities, and data-driven urban planning. At NUS he has been awarded for teaching and research, and has supervised dozens of students leading them to publications in top journals and placements at top universities and organisations. He delivered talks at more than 60 universities and organisations worldwide, including MIT, Stanford, Harvard, Berkeley, University of Tokyo, Hong Kong University, and ETH Zurich.

Critical Notes on Urban Twins: Origin Myths, Tropes, and Realities

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"Digital twins" are the latest product being marketed to city governments by global logistics companies and smart city technology firms. At stake in this technology is the reliance on computational models to make the city legible to decision makers, who then use these models to create urban futures. The digital twin, though, is a loose term applied to any number of products. According to perhaps the most pervasive narrative, the idea was first conceived in 2002 by Product Lifecycle Management expert Michael Grieves, who was inspired by collaborations with experts at NASA. But digital twins are not entirely new – they are only the latest and most visible encounter between spatial and temporal techniques of monitoring and computer prediction. The desire to virtualize the world, to connect physical entities to electronic networks, and to render dynamic environments knowable to computational systems is informed by a longer postwar military history.

This paper revisits the digital twin concept and surveys recent global case studies in light of this longer history. It will present findings from a research database that surveys new urban simulation technologies that virtualize urban environments and urban subjects. Asking, where do virtual humans live, and, what does it mean to simulate a city for reasons of control and capitalization, the paper will examine the implications of the data-collecting practices, mapping systems, and artificial human decision-making models behind digital twins. The paper will contextualize these techniques within the history of military and video game simulators. By tracing connections between military-entertainment-simulators and new urban simulators, this history reveals how new urban technologies visualize city residents through paradigms of warfare and consumerism. Examining the blind spots of supposedly all-immersive, all-seeing simulations shows how such simulations foreclose on urban futures outside the purview of military, security, and financial motives.

Farzin Lotfi-Jam is an architect whose work explores the politics of technology and cities. He is Assistant Professor in Architecture at Cornell University where he directs the Realtime Urbanism lab. The lab uses and invents new spatial media and technologies to visualize and simulate how algorithms, models, and notions of "real time" govern urban life. He is also Director of Farzin Farzin, an interdisciplinary design studio working across architecture, urbanism, computation and media. From modeling the control matrices of smart cities to spatializing the cultural logics of social media, his individual and collaborative projects are research-based and multimediatic. Lotfi-Jam's work has been collected by The Centre Pompidou and the Sharjah Art Foundation, and he is recipient of the 2022 Architecture League of New York League Prize, as well as recent grants and support for his research from the Alexander S. Onassis Foundation, the Graham Foundation for Advanced Studies in the Fine Arts, M+/Design Trust, and The Shed where he was an inaugural Open Call Artist. He has been exhibited at Storefront for Art and Architecture, MAXXI, the Venice Architecture Biennale, the Oslo Architecture Triennale, the Istanbul Design Biennial, the Seoul Architecture Biennial, the Sharjah Architecture Triennial, and elsewhere. His co-authored book *Modern Management Methods: Architecture, Historical Value, and the Electromagnetic Image* was published by Columbia University Press.

Urban Digital Twins: What Are They or What Could They Be?

Rudi STOUFFS
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A digital twin can be said to be a virtual imitation of physical processes that can be updated in real-time with their physical counterparts. This implies a two-way data and information flow between the digital twin and the physical counterparts. When upscaling the notion of a digital twin to the urban scale, this two-way flow is harder to ensure. At the operational level, we can imagine urban subsystems to be impacted by their digital twin, for example in traffic and transport. However, urban digital twins also serve many other use cases, such as city-level forecasting, emergency planning, participatory planning, policy development and scenario modeling, where results from the digital twin do not necessarily impact the city or its development in real-time. Numerous scholars emphasise this conflict in the definition of an urban digital twin. How can we distinguish a digital twin from a simulation model? As big data and time-sensitive data enable scenario modeling within design and planning processes, it may be perfectly fine to adopt a new term for what is basically an evolution of an existing notion. Also, a digital twin for operational optimisation doesn't need to be defined in the same way as an urban digital twin for scenario modeling. At the same time, we can adopt some minimum requirements that define the next iteration of urban simulation models. The presentation of an example urban digital twin, currently under development, serves to clarify this.

Rudi Stouffs is Assistant Dean (Research) in the College of Design and Engineering and Dean's Chair Associate Professor in the Department of Architecture, at National University of Singapore. He leads the Technologies Research Cluster and the Architectural and Urban Prototyping Lab in the Department of Architecture and is Principal Investigator in the Future Resilient Systems II and the FCL Global research programmes at the Singapore-ETH Centre. He has held previous appointments at Carnegie Mellon University, ETH Zurich, and TU Delft. He is the current president of eCAADe, the association for Education and research in Computer Aided Architectural Design in Europe. His research expertise and interests include computational issues of description, modelling, and representation for design, in the areas of shape recognition and design generation, building information modelling and analysis, virtual cities and digital twins.

Greening the 3D Landscape: Measuring the Impact of Tree and Building Shades on the Urban Heat Island

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Devising a nature- and design-based solution to combat climate challenges is a very important issue in urban planning to step up urban sustainability. Recent technological advances and the proliferation of big geospatial data allow for a more sophisticated digital representation of urban geometry in 3D. One underexplored but critical aspect is the impact of vertical urban features and their shading. Shading objects, including trees and buildings, are generally omnipresent in cities and can be utilized by urban planners to create effective local and regional plans for urban cooling. This presentation discusses the role of urban shades created by trees and buildings, focusing on the effects of shade extent and location on land surface temperature (LST) mitigation. A realistic 3D digital representation of urban and suburban landscapes, combined with detailed 2D land cover information, is developed. Shadows projected on horizontal and vertical surfaces are obtained through GIS analysis, and then quantified as independent variables explaining LST variations over grids of varying sizes with spatial regression models. The estimation results show that the shades on different 3D surfaces, including building rooftops, sun-facing façades, not-sun-facing façades, and on 2D surfaces including roadways, other paved covers, and grass, have cooling effects of varying impact. More detailed results are further decoded to assess if they can help urban planners to design 3D land-use solutions for effective heat mitigation.

Yujin Park is Assistant Professor in the Department of Urban Planning and Real Estate at Chung-Ang University, Seoul, South Korea. Prior to joining Chung-Ang, she was an assistant professor in the Department of City Planning and Real Estate Development at Clemson University, South Carolina, USA. Dr Park's research aims at advancing understanding of sustainable urban form and design in 3D, with an emphasis on exploring the trade-offs between different design strategies. Her recent work examines the varied role of urban trees and green spaces in moderating urban temperatures leveraging the capabilities of 3D city modeling, remote sensing, and statistical techniques. She received her PhD in City and Regional Planning from Ohio State University in 2020, and her MS in City Planning and BA in Humanities from Seoul National University. Dr Park currently serves as the book review editor of *Journal of Planning Literature*.

Urban Models for Collective Narratives

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Current urban morphology of Seoul emerged by rapid development in a short period of time. The myth of rapid growth from the mid 20th century is still effective in urban policy while the new democratic standard for community development and citizen participation has been developed in the planning realm. This talk will present the rigorous field survey work of the Sewoon district conducted by the consortium of architects, activists, and technologists, who believe in the power of narratives for the future of this area. The consortium collaborates on in-depth field interview, sketch and 3D scanned data acquisition process into producing comprehensive narrative sources of characters, maps, scenes, and analysis materials. The project was originally launched by the Participatory Budget System of the Seoul metropolitan government by citizen proposal. Compared to precedent survey records by planners which mostly simplify the reality for the sake of legible planning rationale, this work will represent a rich data repository as active evidence - how the city has been shaped.

Jie-Eun Hwang is Professor at Department of Architecture in University of Seoul, and currently directs Beta City Center at Sewoon Campus in the heart of the urban manufacturing district of Seoul. Her research interests include spatial information representation, digital tectonics, design media and interface, open data. As an educator, new media experiments and alternative education are also recent challenges. She pursued various research projects, including: digital twin based urban regeneration platform, participatory mobile augmented reality contents, a spatio-temporal timeline system for monitoring public space, monitoring index development for UNESCO heritage. She co-curated Production City at Seoul Biennale of Architecture and Urbanism 2017. Art galleries: Gallery Factory, Gwangju Design Biennale, Culture Station Seoul 284, and Kumho Gallery, have invited her for media art installations that represent social commons. Recently, she founded a startup venture, TechCapsule, to examine business opportunities of place based content media.

The Epistemology, Praxes and Politics of Urban Science and Urban Modelling

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The paper will critically examine the conceptual underpinnings and practices of urban science and urban modelling. It will first detail the approach adopted by urban science drawing comparison with urban studies more generally. It will then apply a critical data studies approach to urban modelling, focusing on six key issues: epistemology, scope and access, veracity and validity, usability and literacy, use and utility, and ethics. The argument will be informed by research undertaken on the Building City Dashboards project that attempted to build 3D digital twins for Dublin and Cork. The final part of the paper will make the case for a more critical framing and application of urban science that aligns with approaches adopted in critical GIS, radical statistics, feminist data science and digital humanities.

Rob Kitchin is Professor in the Maynooth University Social Sciences Institute at Maynooth University, for which he was the director in 2002-2013, and 2021-2022. After studying at Lancaster University (BSc Geography), Leicester University (MSc GIS), and the University of Wales Swansea (PhD Geography), he took up a post in Queen's University Belfast in 1996, moving to Maynooth University in 1998. He is Principal Investigator (PI) on the Data Stories project (funded by the European Research Council, 2022-2027) and was PI for the Building City Dashboards project (funded by Science Foundation Ireland, 2016-2021), the Programmable City project (funded by the European Research Council, 2013-2018), the Digital Repository of Ireland (2009-2017) and the All-Island Research Observatory (2005-2017). He was Chair of the Irish Social Sciences Platform in 2007-2013. He has published widely across the social sciences, including 33 authored/edited books and over 200 articles and book chapters, and has delivered over 270 invited talks at conferences and universities. He has been the managing editor of the international journals, *Dialogues in Human Geography* (2011-2020) and *Social and Cultural Geography* (2000-2009) and an editor of *Progress in Human Geography* (2010-14). He was the editor-in-chief of the 12 volume, *International Encyclopedia of Human Geography*. He has successfully written or been a principal investigator on fifty funding awards, totalling c.€39m (€19m to MU), including funding from PRTLI 2, 4, 5, ERC, SFI, ESRC, NSF, Special EU Programmes Body, Interreg and RIA, and a number of government departments and public bodies. He was the 2013 recipient of the Royal Irish Academy's Gold Medal for the Social Sciences and recipient of the Maynooth University Research Achievement Award, 2018. He received the Association of American Geographers 'Meridian Book Award' for the outstanding book in the discipline in 2011, and his research has been discussed over 600 times in local, national and international news media.

(Re)Constructing the City – Urban Models and Digital Twins: Inside Out and from the Ground Up

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Urban Modelling initiatives have been widely criticised for propagating detached views of cities and urban processes. These criticisms become all the more pertinent as academic and commercial interest grows in machine learning and AI where supposed 'ground truth' may already be both a derived and heavily curated datum. In contrast to critical case studies which themselves assume a detached outside-in perspective, assembling a range of interviews, secondary sources and media artefacts, this paper discusses first-hand experience in the construction of urban models, at various scales, from the inside out, and from the ground up.

This paper discusses five projects: CASA's Virtual London (ViLo); the Here East Digital Twin; the Dublin City Dashboard's 3D model; the Innovate UK Construction Production Control Room; the UCL 3D Stock model. These projects afford a critical exploration of the practical aspects of constructing operative, three-dimensional, and real-time, digital representations of the built environment. Critical observations are made with reference to critical data perspectives and science and technology studies. In doing so we demonstrate how digital urban innovation is often a more complex process of iteration, negotiation, reverse engineering, and critical reimagining than may be apparent from the outside.

Oliver Dawkins is Creative Technologist on the Data Stories project at the Maynooth University Social Sciences Institute (MUSSI), Ireland. His role supports the technical aspects of research-creation by leading the development of interactive data stories to communicate issues concerning land use and development, housing, homelessness, commercial real estate, and urban infrastructure. Previously, as research fellow at the UCL Energy Institute, Oliver worked on the development and maintenance of a 3D digital twin and data dashboards utilising UCL's 3D Stock model for building energy analysis. In the UCL Connected Environments lab Oliver contributed to the usability assessment and testing of the Innovate UK funded AEC Production Control Room. While working as data and training coordinator on the Building City Dashboards project Oliver also prototyped 3D planning tools for Dublin, Ireland. Each of these projects extend aspects of Oliver's prior research: The Here East Digital Twin. This was an EPSRC and Ordnance Survey funded project which involved the end-to-end development and deployment of an operational digital twin at the Queen Elizabeth Olympic Park in London. This work was undertaken while participating as a member of the Intel Collaborative Research Institute for Urban IoT (ICRI), and studying at The Bartlett Centre for Advanced Spatial Analysis (CASA), UCL.

Data Practices and the Epistemologisation of Urban Futures in Taiwan and Japan

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The paper is concerned with the epistemologisation of urban futures through tracing 'diagrams' that connect data, emerging digital technologies, partially available datasets, existing and prospective infrastructure and multi-scalar statecraft. Diagrams for Deleuze occupy the centre of knowledge production, are not simply a form of representation or abstraction and retain a form of doing. Adrian Mackenzie (2017) draws on this conceptualisation of diagrams to consider data practices associated with machine learning. Diagrams are constituted by heterogeneous elements, including data, code, knowledge, hardware, infrastructure, experiences, institutions and power. They display many different relations between forces, map intensities or tendencies, enact new compositions of data, materialities and worlds, and propose ways of learning about or acting on them. The analytical focus on the operations and dynamics around machine learning in Mackenzie's work can be productively appropriated to make sense of the process of diagramming urban futures with data practices that build upon machine learners' abilities to classify, recognise, predict or model particular worlds. Through interviews, observations and document analysis, the paper discusses the diagramming of urban futures in two Taiwanese and Japanese cities, paying specific attention to the mobilisation of data in projects that feature artificial intelligence to innovate urban services. It explores practices that construct and arrange datasets, data streams, infrastructure, policies, visions and governance mechanisms in order to test and know how specific sets of technology and the promises they make can become operational. Epistopic connections are crucial in these practices because they offer a possibility to align epistemological practices in sciences and engineering with complex urban specificities even though the alignment might be partial and far from perfect. However, it is through diagramming these connections that energise the continuous iterations and accumulations of AI for engineering urban futures.

Sung-Yueh Perng is Associate Professor at the Institute of Science, Technology and Society, National Yang Ming Chiao Tung University, Taiwan, as well as Co-Editor of *Big Data & Society* and Executive Editor of *East Asian Science, Technology and Society*. His research explores everyday practices of the appropriation of digital and data-driven technology into diverse urban contexts and potential ways in which they can better inform governance mechanisms. Empirically, he has undertaken research on public participation in digital and data-centric initiatives to address societal issues in Western and non-Western cities, including Taipei, Dublin, Boston and Oslo. His current project examines the development and deployment of AI in the East Asia cities of Taipei and Yokohama. The project investigates how public and private bodies conceive, appropriate and enact smart cities and what infrastructural, regulatory and technological means have been pursed in developing urban AI. Before returning to Taiwan, he contributed to European research projects as postdoctoral researchers examining ethical and social issues in developing IT for emergency response and social consequences of smart city developments in Dublin and Boston.

World Building Urban Digital Twins: Designing for the Future

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Design fiction is a field of design research which involves 'world building' through situated practice to test and prototype a collective range of assets in plausible fictional worlds (Coulton et al. 2017). Design fiction methods correlate with current forms of urban modelling practice in urban planning as part of an Urban Digital Twin (UDT) system, which is a "digital representation at a set fidelity, of physical element(s) including its behaviour, which is connected and integrated for efficiency" (Cureton, forthcoming). Digital Twin global investments have increased exponentially, while at the same time, there is a critical need for the digitization of the built environment for agile and dynamic responses due to climate challenges and to avoid early smart city failures (Angelidou, 2018, van der Aalst et al., 2021, van der Valk et al., 2021). Therefore, as part of the science of digital twins, there is a need for research on the Design for Digital Twins, explicitly focusing on the socio-technical interface of UDT complex systems, forms of simulation and prediction produced and our interactions with such modelled futures generated.

This paper presents a systematic framework for a future UDT utilizing design fiction methods to unlock interdisciplinary perspectives, map technological challenges and reliability, and inform current real-world UDT roadmaps and adoption frameworks for Asian cities. Such speculative methods enable explicit details on state-of-the-art UDT research (Ketzler et al. 2020) and challenges in urban modelling, including aerial acquisition, open, 'real-time' and dynamic data, information management, process modelling, urban analytics and governance.

Paul Cureton FRSA is Director of Post-Graduate Research, LICA, Director of PhDs, Design and Senior Lecturer in Design at ImaginationLancaster, and a member of the Data Science Institute (DSI). His work transcends subjects in spatial planning, 3D GIS modelling and design futures. It is at the forefront of exploring the critical interface of new and emerging socio-technological relationships such as Design for Digital Twins, Drone Futures and novel process-based methodologies for Future Environments such as Geodesign and XR interactions. His recent publications include the monographs, *Strategies for Landscape Representation: Digital and Analogue Techniques* (Routledge, 2016) and *Drone Futures: UAS for Landscape & Urban Design* (Routledge, 2020). In addition, he is a co-author with Nick Dunn of *Future Cities: A Visual Guide* (Bloomsbury, 2020).

Perspectives on Unlocking Value from Urban Analytics and Modelling

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Zhongwen will share his perspectives on considerations and lessons learnt in his journey of unlocking value from urban analytics and modelling. He hopes that this will aid the community in contributing towards solving real problems and better outcomes for cities.

Zhongwen Huang heads the Smart City Projects Office at the Smart Nation Digital Government Office (SNDGO). He leads an inter-disciplinary team that partners Built Environment and DigiTech sectors in harnessing Cyber Physical Infrastructure and Data, to uplift the management of urban infrastructure and foster innovations. Prior to this, he led efforts to digitalise urban planning and design at Singapore's national land use planning authority. In his earlier days as a naval officer, he also worked on acquiring new capabilities to transform naval operations with technology.

Mapping Singapore in 3D

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Singapore Land Authority (SLA) led a whole-of-government (WOG) initiative to create and maintain a high-resolution nationwide 3D map to support the increasing needs in government agencies for up-to-date 3D data.

Today, our built environment has become more complex due to increasing multiple land use. Extensive developments have gone deep underground (e.g. rock cavern development) and high above ground. With this vast amount of overlapping land information, two-dimensional (2D) maps are no longer adequate to represent the complex 3D environment that we now live in.

The 3D mapping project is divided into two phases, which involved airborne and ground-based data acquisition and data modelling. The entire project is expected to be in completion in three years. To date, SLA has successfully completed the first phase which is the airborne data acquisition and data modelling for the whole country. The project is currently into the second phase whereby street-level data acquisition is robustly progressing on the roads. Moving forward the detailed ground-based 3D data such as roads, bridges, tunnels, and street furniture will complete the whole 3D digital built environment and form a seamless 3D virtual Singapore experience, leading to diverse range of endless possible applications, e.g. city planning, asset inventory management, tree management, autonomous vehicle, heritage preservation, wind simulation, development planning and many more. Ultimately, this 3D national mapping project produces high resolution survey-accurate 3D map data that supports the increasing needs of government and agencies in operation, planning and risk management. The project is the key component in development of the Digital Twin that will support the development of our Smart Nation.

Victor Khoo is Director for Survey and Geomatics Division at the Singapore Land Authority (SLA). He received his PhD and Master of Engineering from Nanyang Technological University (NTU), Singapore. Victor is a professional surveyor, registered under the purview of Land Surveyors Act, Singapore. Prior to joining SLA in 2002, he was involved in research and development work in area of Satellite Remote Sensing and Global Navigation Satellite System (GNSS). In SLA, Victor led diverse geospatial and mapping related initiatives and projects for agencies and industry. These included the setting up of Singapore's National Spatial Data Infrastructure, the establishment of national positioning infrastructure, the digital transformation in cadastral survey, and the 3D national mapping program. He also initiated the Digital Underground project in 2017, to develop a holistic ecosystem for the mapping of underground utility networks. On international front, Victor has been appointed the co-chair of the Expert Group on Land Administration and Management under the United Nation Global Geospatial Information Management (UNGGIM).

Integrated 2D-3D Urban Planning and Design for a Sustainable and Resilient City

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As a small city-state, land use planning in Singapore faces unique challenges and increased complexity amid a rapidly changing world. For Singapore to progress sustainably, our land use plans need to balance various needs across economic, social and environmental considerations, while remaining sufficiently flexible and resilient to meet changing circumstances. Global challenges like the COVID-19 pandemic as well climate change have demonstrated the relevance of good urban planning and design strategies to achieve a more liveable, resilient, and sustainable city.

This presentation shares how the Urban Redevelopment Authority leverages on urban analytics, modelling and simulation to fulfil our role as the national land use planning and conservation authority as well as the Urban Planning and Design Centre of Excellence (URBEX).

Julian Cheng is Deputy Director (Urban Design Technology) at the Design and Planning Lab in the Urban Redevelopment Authority (URA). He leads an inter-disciplinary team to drive the use of 3D digital tools, modelling and simulation to support advanced urban planning and design. Prior to his current role, he was with the Architecture and Urban Design Group where he was in charge of the planning and urban design of strategic growth areas such as the Greater Southern Waterfront and Woodlands Regional Centre. He was also with the Conservation Department where he worked on the conservation of Singapore's modern architectural icons such as the Golden Mile Complex as well as the planning of Singapore's Historic Districts such as Chinatown.

Understanding the Open Digital Platform's Digital Twin Technology and its Role in Smart Cities

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A digital twin is a real time virtual representation of a real world physical system. A digital twin at the national level is increasingly important as it allows simulation, testing and monitoring before implementing changes in the real world. It supports the planning process before deployment, operation management and historical studies that will facilitate use case discovery.

At Punggol Digital District (PDD), the Open Digital Platform (ODP) will function as a smart district operating system. Jointly developed by JTC and GovTech, the ODP will allow inter-connected systems to share estate-related data, control functions and provide an abstraction layer for smart business and social applications to connect to selected systems in PDD, such as lifts, doors, cooling system, lightings, and car parks.

James TAN is Director of Jurong Town Corporation (JTC)'s Smart District Division and Government Technology Agency (GovTech)'s Sensors and Internet of Things (IoT), and oversees the planning, development and deployment of Smart Systems in JTC's estates as well as the development of GovTech's IoT capabilities. He has more than 20 years of experience working in both the private and public sector. Prior to his current appointment, he was involved in several Smart Nation initiatives at GovTech, and has diverse experience and expertise in information and communications technology (ICT), IoT, and robotics systems. James previously led an inhouse team in the then-Infocommm Development Authority of Singapore (IDA) to successfully develop, build and deploy a drone for the world's first mail delivery from mainland Singapore to Pulau Ubin island in 2015, in collaboration with Singapore Post. Currently, James and his teammates are working with GovTech to develop the Open Digital Platform (ODP) for Punggol Digital District (PDD). Master planned and developed by JTC, PDD will be Singapore's first smart district. The ODP is a smart district operating system that allows smart systems such as building management systems, district cooling, pneumatic waste management, smart carparks and electric vehicle chargers to interoperate and be managed centrally by a 3D digital twin.

ABOUT THE ORGANISERS & CHAIRPERSONS

Connor Clive Graham is Research Fellow in the Science, Technology and Society (STS) Research Cluster at Asia Research Institute, and Senior Lecturer at Tembusu College, National University of Singapore. He has a background in information systems, human-centred computing and studies of science and technology, recently specialising in studies of the digital technology through ethnographic and visual methods. His most recent work is focusing on temporal and infrastructural perspectives on the digital and technology narratives and imaginaries. He has published over 30 peer-reviewed articles, co-edited ten journal special issues and co-chaired nine international workshops in Australia, the UK and Singapore. He has also been part of grants studying the human aspects of information technology amounting to over $900,000, working on grants funded by the National Health and Medical Research Council (Australia), Microsoft Research, Xerox Research Centre Europe and Nokia Research. He has conducted ethnographies in the UK, Australia and China using online and in place methods.
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Chaewon Ahn is an urban researcher who studies the relationship between social systems and the built environment using urban data and analytical frameworks. Her research interests are formed through academic and professional experiences in architecture, urban design, data visualisation, and urban studies. Her research focuses on social networks and communities in cities; their relationship to the structure of the built environment; and the influences of urban planning programmes that engage them. She uses analytical skills to conduct data driven analysis that primarily focuses on big data, participatory data collection, spatial analysis and social network analysis to expose persistent issues of power in urban development processes. Trained as an architect, urban designer and data visualisation designer, she holds a PhD in Urban and Regional Planning from Massachusetts Institute of Technology (MIT), and a Master's degree in Architecture and Urbanism from MIT. She has worked with various research laboratories at MIT including the Leventhal Center for Advanced Urbanism, the Civic Data Design Lab, the MIT Election and Data Science Lab, the JTL Urban Mobility Lab and the Senseable City Lab.
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Eric Kerr is Senior Lecturer and Director at Tembusu College and Research Fellow in the Science, Technology and Society cluster at the Asia Research Institute, National University of Singapore. Having originally trained as a lawyer in Scotland (LLB, Aberdeen), Eric moved into philosophy (PhD, Edinburgh) and now writes on a range of issues in science, technology, and society. His earlier work combined social epistemology, sociology of scientific knowledge, and philosophy of technology with ethnographic fieldwork with petroleum engineers in Thailand. More recently, he has worked on digital culture in Asia. Eric is Associate Editor of *Social Epistemology* and a member of the Advisory Board for *East Asian Science, Technology and Society*.
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Jiat Hwee Chang is Associate Professor of Architecture and Research Leader of the Science, Technology and Society (STS) Cluster at the Asia Research Institute, National University of Singapore. He is an interdisciplinary researcher working at the intersections of architecture, environment and STS. He is the author of *A Genealogy of Tropical Architecture: Colonial Networks, Nature and Technoscience* (2016), which is awarded an International Planning History Society Book Prize 2018 and shortlisted for the European Association for Southeast Asian Studies Humanities Book Prize 2017. He is currently working on a book manuscript on the socio-cultural histories and techno-politics of air-conditioning and climate change in urban Asia. Jiat Hwee's latest book (with Justin Zhuang and Darren Soh) *Everyday Modernism: Architecture and Society in Singapore* follows his other research trajectory on modernism in Asia. The book builds on his earlier co-edited volumes *Non West Modernist Past* (2011) and *Southeast Asia's Modern Architecture* (2018). Informed by his work with the NGO Singapore Chapter of Docomomo International, the book is an attempt to expand our understanding of modernism through its focus on the social histories of ordinary buildings, infrastructures, and landscapes in Singapore.
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