AUM2022 Session Details

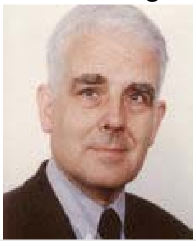
All sessions, breaks and meals are held in the **Crausaz Wordsworth Building** and its gardens.

Address: **4a Adams Road, Cambridge, CB3 9AD**

(Note this is to on the north side of the grounds of Robinson College – use '**4a Adams Road, Cambridge**' **in your online navigation search** so that you reach the venue directly; there is no need to go through the main entrance of the College.

Session 1: Retrospect and the start of prospect

	Session 1: Retrospect and the start of prospect	
	Chair: Michael Batty (University College London)	
	Host: Ying Jin (University of Cambridge)	
Paper 1.1	Marcial Echenique (University of Cambridge)	Infrastructure plan for Chile 2020-2050
Paper 1.2	Michael Wegener (Spiekermann and Wegener Urban Research, Dortmund)	No-growth urban development

Michael Batty 	is Chairman of the Management Board of the Centre for Advanced Spatial Analysis (CASA) and Bartlett Professor of Planning (Emeritus) at University College London. https://www.ucl.ac.uk/bartlett/casa/prof-michael-batty
Marcial Echenique 	is Professorial Fellow of Churchill College and Emeritus Professor of Land Use and Transport Studies at Dept of Architecture, University of Cambridge. https://www.arct.cam.ac.uk/people/me15@cam.ac.uk
Michael Wegener 	Michael Wegener is a Professor Emeritus of Urban and Regional Planning at the University of Dortmund and a partner at Spiekermann & Wegener Urban and Regional Research in Dortmund, Germany. http://www.spiekermann-wegener.de/per/scv2_e.htm
Ying Jin 	is a Professor of Architecture and Urbanism at Dept of Architecture, University of Cambridge, and he was elected a Commissioner of the UK2070 Commission and the Independent Transport Commission in 2022. https://www.arct.cam.ac.uk/people/yj242@cam.ac.uk

Paper 1.1

Author(s)	Marcial Echenique, University of Cambridge
Corresponding author	Marcial Echenique <me15@cam.ac.uk>
Title	Infrastructure plan for Chile 2020-2050
Synopsis	This presentation first reviews how the previous plan 1995 - 2020 turned out by comparing them with data measuring actual developments, and it then discusses the new plan proposals in the context of the uncertainties that we face.
Abstract	25 years ago a National Transport Infrastructure Plan for Chile was published. The Plan was based on the predictions of a LUTI model using the MEPLAN software. The Plan has been largely implemented successfully. The Plan has now been updated for the next 30 years based on a similar model but using different software. The paper presents the comparison of the model's predictions against real information. It demonstrates that the inputs to the model of (i.e. GDP growth) is crucial in relation to the timing of the predicted outcomes but doesn't influence the use of the infrastructure. The policies implemented were based on the principle of user paying for their chosen infrastructure, including externalities. The investment and operations were done by a mixed of public-private sector implementation: The public sector planed the infrastructure and the charging price (tolls and tariffs) and the private sector, trough concessionaires, invested in the building and operation of the infrastructure. For the future Plan, apart from the macroeconomic inputs of GDP and labour productivity changes, there are a number of unknowns which are discussed; i. The extent of telecommunications used as a substitute for commuting and services travel. It doesn't affect the money flows which is the main outcome of the spatial Input-output model, but it does affect the mode of transport chosen. Should we treat the use of telecommunications as another mode of transport? ii. As the use of telecommunication increase the accessibility of places it is expected more separation of origins from destinations which means less frequent but longer trips. Will mobility of people and goods increase? What are the effect of buying goods from distant destinations in terms of delivering them? iii. What will be the impact of increase automation of vehicles? Will it increase the use of cars as younger and older people will have easier access to them? Will the automation increase the capacity of the networks as the circulation is faster but safer? Will it increase the circulation of vehicles as they return to pick up more passengers without needing parking space? Will this affect the ownership of vehicles? iv. How fast will technological improvements such as electric vehicle will be adopted? The increase of electric vehicles will have a significant impact in the reduction of CO2 provided that the generation of electricity is from non-contaminant and renewable sources. With these uncertainties the best use of the model is to make a range of predictions and chose those policies which show a less reliance on particular forecasts and are thus more robust for an uncertain future.
Further reading	[speaker to add]

Paper 1.2

Author(s)	Michael Wegener, Spiekermann and Wegener Urban Research, Dortmund
Corresponding author	Michael Wegener <mw@spiekermann-wegener.de>
Title	No-growth urban development
Synopsis	Since the Middle Ages successful cities have grown faster than their suburban environment. However, today it has become likely that further material growth of human settlements will lead to a destruction of life on the planet Earth. Continued application of the neoliberal growth paradigm as the dominant target of spatial planning is therefore counterproductive and not sustainable. In this paper it is attempted to show a way how despite powerful continuous inclination to growth urban development models could lead to overall sustainable no-growth cities.
Abstract	Because of the uncertainty of spatial development, we cannot deliver precise forecasts of urban development but only *what-if* scenarios: How will cities and regions develop, if our assumptions about their spatial development become real? A goal of spatial development is the development of what-if scenarios of the development and transport in cities and regions. subject to the following three assumptions: (1) *The COVID pandemic* will be finished, (2) digitalization will continue and (3) climate change will occur. In doing that we are not interested in short-term adjustments of behaviour during the Corona crisis, but in long-term changes until 2050. Following Hägerstrand (1970) the spatial development of cities and regions is determined by restrictions of mobility of individuals, such as financial budgets time budgets, availability of transport facilities and the ability to use them, and of restrictions of coupling of activities through restrictions of the access to activities, such as location, opening hours or entrance fees. Based on these restrictions we make the following three *assumptions*: The COVID-19 pandemic will be largely overcome in the year 2021 by efficient vaccines. The economy of cities and regions will recover from the losses through the COVID-19 pandemic like after the economy crisis of 2008 despite continuation of regional disparities, and the daily behaviour of humans will remain relatively stable despite the changes in the framework conditions through pandemic, digitalization and climate change The world after COVID-19: What will change? Following the assumptions made the following changes of spatial development and transport must be expected: - Changes in spatial development - *further suburbanisation, enlarged by home offices* - *stronger demand for residential space through home office* - *weaker demand for inner city offices* - *weaker demand for retail space* - *new logistic centres* - Changes in mobility: - *less commuting* - *less peak-hour traffic* - *more cars* - *more logistic traffic*

	The three assumptions suggest a revision of the theoretical foundations of understanding urban planning. The traditional neoliberal objective of urban planning, increase of income per capita, or GDP, needs to be replaced, in practice and planning education, by a more sustainable and broader, set of objectives, which address the likely well-being not of the present generation, but of their grandchildren The dominant growth-oriented behaviour of individuals and firms has to be replaced by more environmental behaviour. This leads to the question whether a larger diversity of behaviour of individuals and firms be more appropriate. New ethics of spatial planning. The three assumptions require a re-examination of the ethical standards of spatial planning. It is becoming more and more likely that a continuation of the growth orientation of the actors of spatial planning will lead to a large-scale destruction of life on the planet earth. This leads to the question whether not in practice and education of spatial planning increasingly fundamental questions should be handled.
Further reading	[speaker to add]

Session 2: The world's metropolitan areas

	Session 2: The world's metropolitan areas	
	Chair: Jamil Nur (University of Cambridge)	
	Host: Shanshan Xie (University of Cambridge)	
Paper 2.1	Remy Sietchiping, Rafael Forero and Maria Tellez Soler (UN Habitat Metropolitan Studies team)	Progress with the world's metropolitan areas: a global overview (Online)
Paper 2.2	Ola Uduku, University of Liverpool	Urban development in Africa [title bc]
Paper 2.3	Ying Jin (University of Cambridge)	How many applied urban models are there for the world's cities and city regions?

Jamil Nur 	is a post-doctoral fellow at the Martin Centre for Architectural and Urban Studies at the University of Cambridge https://sites.google.com/site/jamilnurscpo/home
Remy Sietchiping 	leads the Policy, Legislation and Governance Section within the Global Solutions Division (GSD) of UN-Habitat https://urbanpolicyplatform.org/remy/
Rafael Forero 	is an Urban Policy, Governance and Metropolitan Expert at the UN-Habitat https://urbanpolicyplatform.org/rafael-forero/
Maria Tellez Soler	is a Metropolitan Development Consultant at the UN-Habitat https://urbanpolicyplatform.org/maria-tellez/

	
Ola Uduku 	is Head of the Liverpool School of Architecture, University of Liverpool, UK. https://www.liverpool.ac.uk/architecture/staff/ola-uduku/
Ying Jin 	is a Professor of Architecture and Urbanism at Dept of Architecture, University of Cambridge, and he was elected a Commissioner of the UK2070 Commission and the Independent Transport Commission in 2022. https://www.arct.cam.ac.uk/people/yj242@cam.ac.uk
Shanshan Xie 	is a PhD candidate at University of Cambridge.

Paper 2.1

Author(s)	Remy Sietchiping, Rafael Forero and Maria Tellez Soler, UN Habitat – Secretariat General for Metropolitan Studies
Corresponding author	Rafael Forero <rafael.forero@un.org>
Title	Progress with the world's metropolitan areas: a global overview
Synopsis	[Speaker to add]
Abstract	[To come]
Further reading	[Speaker to add]

Paper 2.2

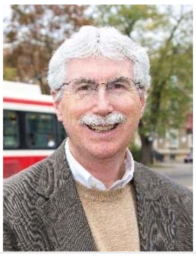
Author(s)	Ola Uduku
Corresponding author	Ola Uduku (O.Uduku@liverpool.ac.uk)
Title	How many applied urban models are there for the world's cities and city regions?
Synopsis	[Speaker to add]
Abstract	[To come]
Further reading	[Speaker to add]

Paper 2.3

Author(s)	Ying Jin
Corresponding author	Ying Jin <yj242@cam.ac.uk>
Title	How many applied urban models are there for the world's cities and city regions?
Synopsis	[Speaker to add]
Abstract	[To come]
Further reading	[Speaker to add]

Session 3: Understanding and modelling urban systems

	Session 3: Understanding and modelling urban systems	
	Chair: Adam Dennett (University College London)	
	Host: Yue Ying (University of Cambridge)	
Paper 3.1	Michael Batty (University College London)	The linear city: Illustrating the logic of spatial equilibrium
Paper 3.2	Eric Miller (University of Toronto)	Towards next-generation integrated urban systems modelling

Adam Dennett 	is Head of Department and Associate Professor in Urban Analytics, in the Bartlett Centre for Advanced Spatial Analysis (CASA), University College London https://www.ucl.ac.uk/bartlett/casa/dr-adam-dennett
Michael Batty 	is Chairman of the Management Board of the Centre for Advanced Spatial Analysis (CASA) and Bartlett Professor of Planning (Emeritus) at University College London. https://www.ucl.ac.uk/bartlett/casa/prof-michael-batty
Eric Miller 	Director of Mobility Network, University of Toronto https://civmin.utoronto.ca/home/about-us/directory/professors/eric-miller/
Yue Ying 	is a PhD candidate at University of Cambridge.

Paper 3.1

Author(s)	Michael Batty, University College London
Corresponding author	Michael Batty <m.batty@ucl.ac.uk>
Title	The Linear City: Illustrating the Logic of Spatial Equilibrium
Synopsis	An alternative but attractive way of thinking about the future form of cities is to develop hypothetical city models that one can explore using simulations that enable us to generate multiple forms we can then assess in terms of the sustainability. Here we form an idealised but extreme linear city and show how the equilibrium which is assumed quickly degenerates into the more usual monocentric circular form that cities display. These ideas are based on explorations of post pandemic cities as in https://www.sciencedirect.com/science/article/pii/S0264275122000336?via%3Dihub
Abstract	Linear cities where activity is spread out along a transportation line, aim to offer the highest levels of accessibility to their adjacent populations as well as to the countryside. These city forms are popular amongst architects and planners in envisioning ideal cities but they are difficult to implement as they involve strict controls on development which often ignore human behaviour associated with where we locate and how we move. We briefly explore the history of these ideas, noting the latest proposal to build a 170 km city called Neom in north west Saudi Arabia, a plan that has attracted considerable criticism for its apparent ignorance of how actual cities grow and evolve. We use a standard model of human mobility based on gravitational principles to define a set of equilibrium conditions that illustrate how a theoretical city on a line would, without any controls, successively adapt to such a new equilibrium. First, we represent the city on a line, showing how its population moves to an equilibrium along the line, and then we generalise this to a bigger two-dimensional space where the original line cutting across the grid evolves as populations maximise their accessibility over the entire space. In this two-dimensional world, we simulate different forms that reflect a balance of centralising versus decentralising forces, showing the power of such equilibria in destroying any idealised form. This approach informs our thinking about how far idealised future cities can depart from formal plans of the kind that the linear city imposes.
Further reading	Open Access Batty *Computational Urban Science (2022) 2:8* https://doi.org/10.1007/s43762-022-00036-z https://link.springer.com/content/pdf/10.1007/s43762-022-00036-z.pdf

Paper 3.2

Author(s)	Eric J. Miller, Director of Mobility Network, University of Toronto, Toronto
Corresponding author	Eric Miller <eric.miller@utoronto.ca>
Title	Towards Next-Generation Integrated Urban Systems Modelling
Synopsis	This paper is a preliminary discussion of a proposed new conceptual framework for integrated urban modelling that is based on the key concepts of agent-based modelling, complexity theory and recognition of both markets and networks as the primary "spaces" within which urban activity and evolution occur.
Abstract	*Introduction & Motivation* In this age of economic, social and technical disruption of our urban regions due to COVID-19, climate change concerns, rapid technological advances, continuing urbanization, and accelerating calls for improved social equity, the need for a systematic and comprehensive approach to modelling personal travel, freight demand and multi-modal transportation system performance within an integrated context of urban form (land use), the economy and demographics to support policy analysis and decision-making has never been more pressing. This need for integrated models of land use and transportation (or, more generally, integrated urban models) has been recognized since the beginnings of modern transportation systems analysis (Lowry, 1964; Manheim, 1978). Various generations of integrated models employing a variety of methodological approaches have been developed over the past 60 years, with varying degrees of successful implementation. Despite this long history, integrated urban model implementations remain the exception rather than the rule in urban regions worldwide, although numerous operational examples do exist in the US (UrbanSim, PECAS, TLUMIP), UK (Delta), South America (TRANUS, MEPLAN) and Europe (ILUMASS, Silo), among others. Miller (2018a,b) presents a critical review of the current state of practice in integrated modelling which builds on numerous previous reviews dating back to Lee's seminal 1973 paper "Requiem for Large Scale Models" (HBA Specto & Miller, 2013a,b; Miller, 2009; Wegener, 2004; Timmermans, 2003; Miller, et al., 1998; Wegener, 1995; Southworth, 1995; Lee, 1994; Webster, et al., 1988; Lee, 1973). In the 2018 review it is argued that integrated modelling has been "in the doldrums" (co-opting Pas' terminology, Pas (1990)) for a variety of reasons that are a combination of institutional, "cultural" and technological factors. *Some Key Elements in Next Generation Model System Design* Building on these prior critiques, this paper presents a preliminary conversation about some necessary elements/attributes of next generation integrated urban models that will exploit current and emerging computing capabilities, data availability and behavioural understandings, and that will be responsive to policy analysis needs. This "conversation" incorporates "lessons learned" from the University of Toronto's long research history in developing a first-generation version of the ILUTE (Integrated Land Use, Transportation, Environment) integrated urban model system for the Greater Toronto-Hamilton Area (GTHA). (Chingcuanco and Miller; 2018; Beykaei, et al., 2014; Rosenfield, et al., 2013; Miller, et al., 2011; Salvini and Miller, 2005)

The first key concept that we believe helps form a starting point for next generation model system design is the need to step initially away from specifying an explicit computational algorithm and to think, instead, in terms of designing a data management and computational *platform* for modelling complex urban systems that:

- Supports various applications from short-run to long-run applications.
- Is usable by many researchers for a number of different purposes, but within a consistent theoretical/analytical framework, in order to:
  - Avoid reinventing wheels.
  - Build upon and incorporate the work of others. Many good models already exist: how can they be most readily used within a comprehensive modelling system?
  - Be open to new ideas, knowledge and methods: “We know a tremendous amount about how the world works, but not nearly enough. Our knowledge is amazing; our ignorance even more so” (Meadows, 2008). We need a computing environment (a “virtual world”) within which we can experiment with new methods and test new theories without having to create the entire virtual world to do so.
- Avoids locking into a “monolithic” modelling software system that makes modelling extensions and the testing of new modelling theories difficult or, possibly, even impossible.
- Is open to the use of new sources of data on both demand and performance, such as smartcards, WiFi, Bluetooth, etc.
- Similarly, the system should be open to leveraging new analytical methods in Artificial Intelligence, Machine Learning, optimization, etc., ideally in a “plug and play” mode.

The second issue is the need to deal with the complexity of urban systems from both computational efficiency and behavioural fidelity perspectives. This need lies at the heart of Lee’s famous “seven sins of large-scale models” (Lee, 1973), which are still with us today. But we argue that the field is far better placed today to deal with these “sins” than were the pioneers who wrestled with them in the 1960’s and 1970’s. In addition to vastly superior computing power and data, our theoretical foundations derived from complex systems theory in general and “urban science” in particular (Bettencourt, 2021; Martinez, 2018; West, 2017; Samet, 2013; Batty, 2005) can provide a rich foundation for a new generation of integrated models.

Third is the concept of human agency. The city evolves through the actions of:

- “Demographic agents”: the people living in it (persons and households).
- “Collective agents”:
  - “Economic agents”: firms and business establishments.
  - Local government.
  - Other “social agents” (NGOs, schools, community groups, religious organizations, sports and recreational organizations, etc.).
  - Other “external agents” responsible for decisions affecting the city (upper-levels of government, national and multinational corporations, etc.).[1]

[1] Major exogenous events such as extreme weather, war, etc., of course can have significant effects on the urban state as well, but these are generally beyond the scope of the current discussion.

- The demographic and firmographic evolution of the resident population of people and firms.

Thus, an *agent-based* approach is fundamental to modelling complex urban dynamics, since the urban "system state" at any point in time is inherently the path-dependent emergent outcome of all the agents acting within the system. This does not mean that all agents/processes necessarily need to be explicitly modelled at the disaggregate level of the individual agent (economic processes, for example, may be modelled at various levels of aggregation) or that all processes need to be endogenously modelled (government policies, for example, generally may be represented as exogenous inputs; a similar approach generally holds for the actions of national and international corporations). But it does mean that the agent is taken as fundamental "organizing principle" for the modelling of urban system dynamics.

Agents exhibit motivated behaviour (Maslow, 1970) in trying to accomplish objectives. All agent activities involve both the use of *resources* (time, money, knowledge, land, technology, etc.) and the acquisition of resources (money, knowledge, technology, etc.)[2] in the pursuit of needs satisfaction (utility, profit, etc.). Thus, agent activity can be viewed as largely a case of *resource management*. In the short-run, this consists of making "best use" of available, fixed resources (the current number of household cars, current income, etc.). Long-run decisions then are ones in which these resources are changed (change job; move to a bigger house; buy/sell a car; etc.).

Agents manifest their behaviour and, in so doing, interact with each other in two primary "fora" or "spaces":

- **Markets.** A market is physical or virtual place within which exchanges of goods, services, knowledge, etc. occur. Markets are multi-agent, imperfect-information, stochastically-risky games, in which buyers and sellers compete with one another as each tries to maximize its own benefit from the exchange of the good/service, buyers compete with one another for limited supply, and suppliers similarly compete with one another for limited demand. Virtually all long-run processes of interest within an integrated urban market (land development, location choices, labour, etc.) occur within markets.

- **Networks.** People, goods, services, information, etc. all flow (interact) across space through networks. Networks are what make space usable and cities feasible. Workers travel to work through the transportation network, while goods flow from a point of production to a point of consumption. Water flows from pumping stations and electricity flows from generating plants to homes, offices and factories. Networks and markets are intertwined: we contract to exchange goods and services within markets (workers agree to "sell" their labour to employers within the labour market; firm A agrees to sell X units of widgets to firm B), with the physical exchanges occurring as flows occurring within networks (a worker commuting to work; widgets

[2] In the case of economic agents (firms), this obviously includes the consumption of inputs (labour, capital, materials) and the production of outputs (goods and services).

moving from A to B through a multimodal freight network – and, in all cases monetary payments flow in the opposite direction via a financial network handling the payment transfers).

Agent activities play out within the physical world, consisting of land, buildings, infrastructure and the environment, as well as society. Through agent actions land is developed, buildings are occupied, infrastructure (transportation, energy, etc.) systems are constructed and operated, and the environment and society are both altered. Notably, agent actions inevitably generate "externalities" that alter the world in the form of material waste, air and water pollution, GHG emissions, roadway accidents, congestion-induced delays, social disparities, etc. This evolution in the system state, in turn, generates lagged feedbacks that influence future agent behaviour.

References

Batty, M. (2005). *Cities and Complexity: Understanding Cities with Cellular Automata, Agent-based Models and Fractals*, Cambridge MA: MIT Press.

Bettencourt, L. (2021) *Introduction to Urban Science: Evidence and Theory of Cities as Complex Systems*, Cambridge, MA: MIT Press.

Beykaei, S.A., E.J. Miller and J. Vaughan (2011). Testing the stochastic behaviour of a microsimulation model of demographic and housing market dynamics", presented at the *2nd World Symposium in Transport and Land Use Research*, June 26, 2014.

Chingcuanco, F. and E.J. Miller (2018). The ILUTE demographic microsimulation model for the Greater Toronto-Hamilton Area: Current operational status and historical validation", in GeoComputational Analysis and Modeling of Regional Systems , J.C. Thill and S. Dragicevic (eds), Springer, 2018, pp. 139-162.

Goldner, W. (1971). The Lowry model heritage". *Journal of the American Institute of Planners*, XXXVII:2, March, 100-110.

HBA Specto and E.J. Miller (2013a). *Best Practice Review of Integrated Land Use – Transportation Models, Jurisdictional Scan Report*, Project Technical Report 2, prepared for the Ontario Ministry of Transportation, Calgary.

HBA Specto and E.J. Miller (2013b). *Best Practice Review of Integrated Land Use – Transportation Models, Literature Review*, Project Technical Report 1, prepared for the Ontario Ministry of Transportation, Calgary.

Lee, D.B. (1973). Requiem for large scale models. *Journal of the American Institute of Planners*, 39:163-178.

Lee, D.B. (1994). Retrospective on large scale urban models. *Journal of the American Planning Association*, 60:35-40.

Lowry, I.S. (1964). *A Model of Metropolis*. RM-4035-RC, Santa Monica: RAND Corporation.

Manheim, M.L. (1978). *Fundamentals of Transportation Systems Analysis Volume 1: Basic Concepts*, MIT Press

Maslow, A.H. (1970). *Motivation and Personality*, Second Edition, New York: Harper & Row.

Meadows, D.H. (2008). *Thinking in Systems: A Primer*, edited by Diana Wright, Chelsea Green Publishers, White River Junction, VT.

Miller, E.J. (2009). Integrated urban models: Theoretical prospects. Invited resource paper, Chapter 14 in Kitamura, R., T. Yoshii and T. Yamamoto (eds.), *The Expanding Sphere of Travel Behaviour Research: Selected Papers from the 11th International Conference on Travel Behaviour Research*, Bingley, UK: Emerald, 351-384.

Miller, E.J. (2018a). Integrated urban modelling: Past, present & future. *Journal of Transport and Land Use*, 11:1, 387-399.

Miller, E.J. (2018b). The case for microsimulation frameworks for integrated urban models. *Journal of Transport and Land Use*, 11:1, 025-1037.

Miller, E.J., B. Farooq, F. Chingcuanco and D. Wang (2011). Historical validation of an integrated transport – land use model system", *Transportation Research Record, Journal of the Transportation Research Board*, 2255, 91-99.

Miller, E.J., D.S. Kriger and J.D. Hunt (1998). *Integrated Urban Models for Simulation of Transit and Land-Use Policies, Final Report, Transit Cooperative Research Project H-12*, Toronto: University of Toronto Joint Program in Transportation (www4.nas.edu/trb/crp.nsf).

Miller, E.J., B. Farooq, F. Chingcuanco and D. Wang (2011). Historical validation of an integrated transport – land use model system. *Transportation Research Record, Journal of the Transportation Research Board*, 2255, 91-99.

Pas, E.I. (1990). Is travel demand analysis and modelling in the doldrums? In P.M. Jones (ed.) *Developments in Dynamic and Activity-Based Approaches to Travel Analysis*, Gower, Aldershot, 3-27.

Rosenfield, A. F. Chingcuanco and E.J. Miller (2013). "Agent-based housing microsimulation for integrated land use, transportation, environment model system", *Procedia Computer Science*, 19, 841-846.

Salvini, P.A. and E.J. Miller (2005). ILUTE: An operational prototype of a comprehensive microsimulation model of urban systems, *Networks and Spatial Economics*, 5, 217-234.

Samet, R.H. (2013). "Complexity, the Science of Cities and Long-Range Futures, *Futures* 47:49-58.

Timmermans, H. (2003). The saga of integrated land use-transport modeling: how many more dreams before we wake up? Conference keynote paper, 10th International Conference on Travel Behaviour Research, Lucerne.

Waddell, P., H. Sevcikova, D. Socha, E.J. Miller, and K. Nagel (2005). Opus: An international collaboration to develop an open platform for urban simulation. Presented at the CUPUM Conference, London, June 29 - July 1.

Webster, F. V., P.H Bly, N.J. Paulley, and J.F. Brotchie (1988). *Urban land-use and transport interaction: policies and models: report of the International Study Group on Land-Use/Transport Interaction (ISGLUTI)*, Aldershot, Hants, England, Avebury.

Wegener, M. (1995). Current and future land use models. *Travel Model Improvement Program Land Use Modeling Conference Proceedings* (eds. G.A. Shunk, et al.), Washington, D.C.: Travel Model Improvement Program, 13-40.

Wegener, M. (2004). Overview of land use transport models. Chapter 9 in D.A. Hensher and K. Button (eds.), *Transport Geography and Spatial Systems. Handbook 5 of the Handbook in Transport*. Pergamon/Elsevier Science, Kidlington, UK, 127-146.

	West, G. (2017). *Scale: The Universal Law of Growth, Innovation, Sustainability, and the Pace of Life in Organisms, Cities, Economics, and Companies*, New York: Penguin Random House.
Further reading	[Speaker to add?]

Session 4: New models for new trends

	Session 4: New models for new trends	
	Chair: Robin Morphet (University College London)	
	Host: Ying Jin (University of Cambridge)	
Paper 4.1	Ian Williams (Ian Williams Services, UK)	Do we need van models?
Paper 4.2	Matthew E Kahn (University of Southern California)	Going remote: How the flexible work economy can improve our lives and our cities (Online)

Robin Morphet 	is an Honorary Professor in the Bartlett Centre for Advanced Spatial Analysis (CASA), University College London
Ian Williams 	is a mathematician/statistician by training and has many years of research, academic and consultancy experience in passenger and freight transport modelling and planning https://www.linkedin.com/in/ian-williams-73bb2b23/?originalSubdomain=uk
Matthew E Kahn 	is a Provost Professor of Economics and Spatial Sciences at the University of Southern California. He is a research associate at the National Bureau of Economic Research and a research fellow at IZA. https://spatial.usc.edu/team-view/matthew-e-kahn/
Ying Jin 	is a Professor of Architecture and Urbanism at Dept of Architecture, University of Cambridge, and he was elected a Commissioner of the UK2070 Commission and the Independent Transport Commission in 2022. https://www.arct.cam.ac.uk/people/yj242@cam.ac.uk

Paper 4.1

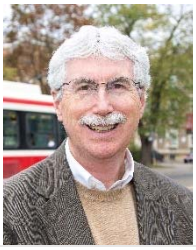
Author(s)	Ian Williams
Corresponding author	Ian Williams <iannicholaswilliams@gmail.com>
Title	Do we need van models?
Synopsis	In many countries vans are a rapidly increasing component of road traffic but paradoxically the least likely to be well modelled. The reasons why this must change are discussed and suitable methods for van passenger and freight modelling are presented.
Abstract	The usage of models of vans for policy testing continues to be comparatively rare by comparison with the ubiquitous use of models of car travel. This is unhelpful because vans in many European countries are: the fastest growing segment within road traffic; are major emitters of dangerous particulates within dense urban areas; and contribute strongly to urban road congestion and to carbon emissions. We need tools to analyse the policies that would enable these impacts to be mitigated. The reasons why vans have tended not to be modelled explicitly are explored. The inconsistencies in van data collection and publication are reviewed, together with the potential enhancements to van data collection that would facilitate improved van models. The key to modelling the demand for vans lies in segmenting the distinct transport purposes for which vans are used, both for passenger travel and for goods deliveries. The model formulations that are suited to each of these individual transport purposes are presented, together with examples of how these models have recently been implemented within the UK. Finally, it is argued that stand-alone van models should not be the way ahead. Instead van usage: for passenger travel purposes should be integrated explicitly into passenger demand models; and for goods deliveries integrated explicitly into the supply chain structure within road freight models.
Further reading	Department for Transport (2004) *Survey of Privately Owned Vans Results of survey October 2002 - September 2003.* Transport Statistics Bulletin SB (04) 21. http://webarchive.nationalarchives.gov.uk/20060820162202/http://dft.gov.uk/stellent/groups/dft_transstats/documents/page/dft_transstats_026991.hcsp Department for Transport (2008) *Road Freight Statistics 2006, Revised August 2008*. Transport Statistics Bulletin SB (06) 23. http://webarchive.nationalarchives.gov.uk/20110503144935/http://www.dft.gov.uk/pgr/statistics/datatablespublications/freight/goodsbyroad/ Department for Transport (2021) Final Van Statistics April 2019-March 2020. DfT Statistical Release 15 April 2021. https://www.gov.uk/government/collections/van-statistics Le Vine S, J Luan & J Polak (2013) Van Travel in Great Britain: What do we know from the National Travel Survey? Report to the Independent Transport Commission. http://www.theitc.org.uk/our-research/research-reports-2/ WSP (2014) *DfT LGV Forecasting Model: Overview of Delivered Model*. Report for DfT. https://www.gov.uk/government/publications/light-goods-vehicle-lgv-model-overview

Paper 4.2

Author(s)	Matthew E. Kahn, University of Southern California
Corresponding author	Matthew E. Kahn <kahnme@usc.edu>
Title	Going Remote: How the Flexible Work Economy Can Improve Our Lives and Our Cities
Synopsis	[Speaker to add]
Abstract	[Speaker to add]
Further reading	See the author's book of the same title: https://www.amazon.co.uk/Going-Remote-Flexible-Economy-Improve-ebook/dp/B09T9DXBHL

Session 5: An e-bike city?

	Session 5: An e-bike city?	
	Chair: Eric Miller (University of Toronto)	
	Host: Steve Denman (University of Cambridge)	
Paper 5.1	Kay Axhausen (ETH Zurich)	Dilemma of transport planning and why an e-bike city might be a new starting point (Online)

Eric J Miller 	Director of Mobility Network, University of Toronto https://civmin.utoronto.ca/home/about-us/directory/professors/eric-miller/
Kay Axhausen 	has been Professor of Transport Planning at the Eidgenössische Technische Hochschule (ETH) Zürich (Swiss Federal Institute of Technology) since 1999. The work of his group focusses on the measurement and modelling of travel behaviour feeding large scale agent-based models of travel demand and flow. https://fcl.ethz.ch/people/CoreTeam/KayAxhausen.html
Steve Denman 	has been a senior Research Fellow at the Martin Centre for Architectural and Urban Studies since 2011, and he has recently become a Data Scientist in population mobility at the Data Science Campus of the UK's Office for National Statistics. https://datasciencecampus.ons.gov.uk

Paper 5.1

Author(s)	Kay W. Axhausen, ETH
Corresponding author	Kay W. Axhausen <axhausen@ivt.baug.ethz.ch>
Title	Dilemma of transport planning and why an e-bike city might be a new starting point
Synopsis	Transport policy is in a dead end, as all measures known to be effective are so far politically unacceptable in most places where voters, i.e. car drivers, are being asked to approve them. The acceptable and hoped for alternatives are bound to generate large amounts of induced demand offsetting much of their benefits in the medium run. The talk will discuss these options and add a new one: the e-bike city, a vison of a new fast “slow” mode.
Abstract	[to come]
Further reading	Ballo, L., L. Meyer de Freitas, A. Meister and K.W. Axhausen (2022) The e-bike city as a radical shift towards zero-emission transport: Sustainable? Equitable? Desirable?, paper presented at the 22nd Swiss Transport Research Conference (STRC 2022), Ascona, May 2022.

Session 6: Advances in LUTI modelling

	Session 6: Advances in LUTI modelling	
	Chair: Michael Batty (University College London)	
	Host: Yaotian Ma (University of Cambridge)	
Paper 6.1	Joseph Ferreira, Jr (MIT)	Next steps for next-generation - land use and transportation interaction (LUTI) models

Michael Batty 	is Chairman of the Management Board of the Centre for Advanced Spatial Analysis (CASA) and Bartlett Professor of Planning (Emeritus) at University College London. https://www.ucl.ac.uk/bartlett/casa/prof-michael-batty
Joseph Ferreira Jr. 	Is Professor (post-tenure) of Urban Information Systems in the Department of Urban Studies and Planning of the Massachusetts Institute of Technology (MIT). https://dusp.mit.edu/faculty/joseph-ferreira
Yaotian Ma 	is a PhD candidate at University of Cambridge.

Paper 6.1

Author(s)	**Joseph Ferreira, Jr, MIT**
Corresponding author	**Joseph Ferreira, Jr** <jf@mit.edu>
Title	Next Steps for Next-Generation - Land Use and Transportation Interaction (LUTI) models
Synopsis	In this presentation, we examine recent LUTI modeling, draw on our experience, and suggest priorities for next-generation LUTI models. In particular, they need more attention to near-term dynamics of housing/land-use/transportation interactions using sub-model components that can be federated across agencies and applied to synthetic populations that are public and privacy-preserving as well as spatially-detailed and behaviorally heterogeneous.
Abstract	The past few decades have witnessed considerable advancement of land use-transport interaction (LUTI) modelling. Much of the progress has been aided by significant improvements in standardized and open-source geospatial data and high-performance computing infrastructure. However, many of the critiques of LUTI models made in the '70s still ring true – they remain too time-consuming and cumbersome, and are often inadequate to handle the policy questions of the day at a sufficiently detailed scale. This is especially true for the land use dimension, where the potential improvement is the greatest with the standardization and collection of detailed geospatial data, but there is still a long way to go. Transportation modeling has vastly improved in statistical rigor over the years, but remains too focused on automobiles, commuting trips, and network flows, with little innovation in travel demand modeling and limited integration with land use models. As a result, LUTI models tend not to be integrated in a manner that is well-suited for simulating near-term market dynamics and assisting with housing and mobility policy analysis. In this presentation, we explore recent LUTI modeling, comment on our experiences developing an open-source LUTI model, and make suggestions on next steps and priorities for next-generation LUTI models that are adequate for the post-pandemic era. A number of students and research colleagues have contributed to these comments, but I would particularly like to acknowledge Rounaq Basu, a current PhD student with whom I have collaborated on several recent enhancements and applications of our LUTI model (SimMobility). Over the next decade or two, several exogenous phenomena (such as the pandemic, increased focus on sustainability goals, and improvement in vehicle electrification and automation technologies) will affect how planners design resilient, equitable, and sustainable cities. To shape policies that respond to anticipated but uncertain changes in infrastructure and behavior, we expect there will be many pilots that will experiment with new mobility options and urban designs. These pilot projects will focus on neighborhoods and small parts of metropolitan areas before rolling out technologies and policies at metro scale. Much could go wrong in these early years, which could prevent the follow-through to equilibrium, however desirable. For example, to what extent does the post-pandemic era involve hybrid work patterns? How would that impact travel demand, suburban congestion, and social inequality? Which study areas for pilot projects that improve local accessibility are most likely to reduce car ownership (or use) without exacerbating gentrification problems? By simulating the daily behavior of residential housing markets at the scale of individual households and housing units, an appropriately calibrated LUTI model could examine how pilot projects in different neighborhoods might respond differently. It could track changes in housing prices (by unit type and location) and relocation choices (by socioeconomic category) as new mobility options, pilot

projects, and regulatory changes impact accessibility in different ways depending upon household type, neighborhood choices, and urban activity patterns. Running agent-based LUTI microsimulations at this scale has been computationally intensive, but advances in parallel computing and high-speed storage have made them more practical and affordable. Such models can also take advantage of the vast improvement in the spatially-detailed urban information infrastructure that has emerged during recent decades. Nevertheless, funding for LUTI modeling is limited. Connecting LUTI models to the (much bigger) IT budgets and data infrastructure of operational agencies is complex and requires serious attention to maintainable data processing pipelines across multiple agencies, interoperability standards, privacy and security issues, and interchangeable model components.

There have been reports of ‘peak car’ (car ownership and use becoming stagnant) in several industrialized countries. Economists might argue that these are examples of stable equilibria with high car ownership. There are also examples of stable equilibria with low car ownership, such as in transit-rich countries like Singapore. While CGE models can be helpful to identify such equilibria, they cannot identify a path to get from one to the other with politically feasible policy changes and a soft landing. Moreover, the policies and behaviors that they assume are likely to be changed based on near-term outcomes, new technologies, or unforeseen pandemics.

Most LUTI models fail to consider the heterogeneity of the population to an adequate extent. This leads to difficulty in addressing socio-inequality issues and an inability to model complex policies that have cross-subsidies, such as integrated housing-transport subsidy policies. Yet, the racial and social equity impacts of economic and technological disruptions are increasingly important, so it is imperative that the future development of LUTI models is better able to address such impacts.

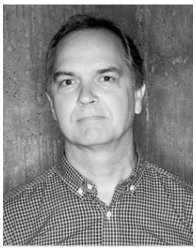
Can we push LUTI modeling in a direction that can handle people/building-scale models with sufficient supply, demand, and spatial heterogeneity to address near-term market dynamics? Can we do this in a way that fully utilizes the new urban sensing and geospatial data infrastructure? There will be increasing need for modular sub-model components with standardized key elements and input/output measures that are well matched to ‘official’ data sources of relevant sectoral agencies. We need a collective effort similar to the development (since the 70s) of ‘four-step’ travel demand models. That effort has evolved - and been well funded - across many local, state, and federal levels through academic and professional collaborations. Another notable example is the recent global coordination effort motivated by climate change concerns to build an infrastructure for the ‘global earth observation system of systems’ (GEOSS).

To accelerate model development we also need better modeling infrastructure. We still lack virtual cities and test datasets that have the spatial- and people-level of detail needed to serve as sandboxes for testing and comparing models. UrbanSim developers made a good start in that direction more than a decade ago, and new efforts are needed that would take advantage of improved data infrastructure and computation. The data acquisition and data processing pipelines needed to support LUTI modeling and use are often so slow that the policies and planning motivating the modeling effort are changed before any detailed scenario modeling is completed. Streamlining the process of constructing and sharing privacy-preserving synthetic populations could remove a significant impediment to the use and support of LUTI models.

Further reading	Adnan, M., Pereira, F. C., Azevedo, C. M. L., Basak, K., Lovric, M., Raveau, S., Ferreira, J., ... & Ben-Akiva, M. (2016). "SimMobility: A multi-scale integrated agent-based simulation platform," 95th Annual Meeting of the Transportation Research Board. Basu, R. and Ferreira, J. (2020). Planning car-lite neighborhoods: Examining long-term impacts of accessibility boosts on vehicle ownership. Transportation Research Part D: Transport and Environment. (v.86, Sept. 2020) https://doi.org/10.1016/j.trd.2020.102394 Basu, R. and Ferreira, J. (2020). A LUTI microsimulation framework to evaluate long-term impacts of automated mobility on the choice of housing-mobility bundles. Environment and Planning B: Urban Analytics and City Science. (v47-8, Oct. 2020) https://doi.org/10.1177/2399808320925278 Basu, R., Ponce-Lopez, R., and Ferreira, J. (2021), "A framework to generate virtual cities as sandboxes for land use-transport interaction models," Journal of Transport and Land Use (JTLU), 14(1), 303-323, https://doi.org/10.5198/jtlu.2021.1791 Ponce-Lopez, Roberto and Joseph Ferreira Jr., (2021), "Identifying spatio-temporal hotspots of human activity that are popular non-work destinations," Environment and Planning B: Urban Analytics and City Science, https://doi.org/10.1177/2399808320970209 Ponce-Lopez, Roberto and Joseph Ferreira Jr. (2021), "Identifying and characterizing popular non-work destinations by clustering cellphone and point-of-interest data," Cities 113 (2021) 103158. https://doi.org/10.1016/j.cities.2021.103158 Zhou, M., Le, D., Nguyen-Phuoc, D. Q., Zegras, P. C., Ferreira, J (2021), "Simulating impacts of Automated Mobility-on-Demand on accessibility and residential relocation," Cities (2021), https://doi.org/10.1016/j.cities.2021.103345 Zhu, Y., Diao, M., Ferreira, J., & Zegras, C. (2018). An integrated microsimulation approach to land-use and mobility modeling. Journal of Transport and Land Use, 11(1). https://doi.org/10.5198/jtlu.2018.1186

Session 7: New data, new methods, new fields (1)

	Session 7: New data, new methods, new fields (1)	
	Chair: Ian Williams (Ian Williams Services, UK)	
	Host: Louise Luo (University of Cambridge)	
Paper 7.1	Paul Waddell (University of California Berkeley)	[tbc]

Ian Williams 	is a mathematician/statistician by training and has many years of research, academic and consultancy experience in passenger and freight transport modelling and planning https://www.linkedin.com/in/ian-williams-73bb2b23/?originalSubdomain=uk
Paul Waddell 	is a Professor of City and Regional Planning at University of California Berkeley https://ced.berkeley.edu/ced/faculty-staff/paul-waddell
Louise Luo 	is a PhD candidate at University of Cambridge.

Paper 7.1

Author(s)	Paul Waddell, UC Berkeley
Corresponding author	Paul Waddell
Title	[to come]
Synopsis	[Speaker to add]
Abstract	[Speaker to add]
Further reading	

Session 8: New data, new methods, new fields (2)

	Session 8: New data, new methods, new fields (2)	
	Chair: Steve Denman (University of Cambridge)	
	Host: Zhou Fang (University of Cambridge)	
Paper 8.1	Fernando Benitez-Paez (The Alan Turing Institute), Hadrien Salat (The Alan Turing Institute), Dustin Carlino (The Alan Turing Institute), Daniel Arribas-Bel (The Alan Turing Institute and The University of Liverpool), Mark Birkin (The Alan Turing Institute and The University of Leeds)	Towards multi-level urban modelling: Spatially enriched synthetic micro data, with a focus on the population and its social interactions
Paper 8.2	Maider Llaguno-Munitxa (UCLouvain), Martin Edwards (UCLouvain), Stephane Grade (CECOTEPE), Marie Vander Meulen (UCLouvain), Clement Letesson (Independent Consultant), Elena Agudo-Sierra (UCLouvain), Sergio Altomonte (UCLouvain), Emilie Lacroix (UCLouvain), Biayna Bogosian (FIU), Kris Mun (ANFA), Eduardo Macagno (UCSD)	360° image and video urban scene immersions to evaluate the role of urban green infrastructure in stress level reduction (Online)
Paper 8.3	Juste Raimbault (LASTIG, Univ Gustave Eiffel, IGN-ENSG, Saint-Mande´, France; CASA, UCL, London, UK; UPS CNRS 3611 ISC-PIF, Paris, France; UMR CNRS 8504 Ge´ographie-cite´s, Paris, France) and Julien Perret (LASTIG, Univ Gustave Eiffel, IGN-ENSG, Saint-Mande´, France)	Quantifying the co-evolution of economic activities locations with geo-historical data: Paris, 19th century

Steve Denman 	has been a senior Research Fellow at the Martin Centre for Architectural and Urban Studies since 2011, and he has recently become a Data Scientist in population mobility at the Data Science Campus of the UK's Office for National Statistics. https://datasciencecampus.ons.gov.uk
Fernando Benitez-Paez	is a Research Associate at the Alan Turing Institute https://www.turing.ac.uk/people/researchers/fernando-benitez

	
Hadrien Salat 	is a Research Associate at the Alan Turing Institute
Dustin Carlino	
Daniel Arribas-Bel	
Mark Birkin	
Maider Llaguno-Munitxa 	
Martin Edwards	
Stephane Grade	
Marie Vander Meulen	
Clement Letesson	
Elena Agudo-Sierra	
Sergio Altomonte	
Biayna Bogosian	
Kris Mun	

Eduardo Macagno	
Juste Raimbault 	is a Research Fellow in the UCL Faculty of Mathematical and Physical Sciences https://www.ucl.ac.uk/bartlett/casa/people/dr-juste-raimbalt
Julien Perret	
Zhou Fang 	is a PhD candidate at University of Cambridge.

Paper 8.1

Author(s)	Fernando Benitez-Paez (The Alan Turing Institute), Hadrien Salat (The Alan Turing Institute), Dustin Carlino (The Alan Turing Institute), Daniel Arribas-Bel (The Alan Turing Institute and The University of Liverpool), Mark Birkin (The Alan Turing Institute and The University of Leeds)
Corresponding author	Hadrien Salat <hsalat@turing.ac.uk>
Title	Towards multi-level urban modelling: Spatially enriched synthetic micro data, with a focus on the population and its social interactions
Synopsis	We present a new Urban Analytics Toolkit developed by a group at the Alan Turing Institute. Its foundation stone is the Synthetic Population Catalyst (SPC), which generates a synthetic population with daily activities and social interactions for any area in England with well optimised runtimes. We then detail various application models.
Abstract	There is an ongoing debate about what the future holds for urban modelling. Some scholars discuss how spatial microsimulation can integrate census data with detailed surveys to help analyse local policy strategies (Hermes & Poulsen, 2012; Tanton 2013,2017; Spiekermann & Wegener 2018). With new methodological developments, validation metrics and integration of new survey data, an increasing number of microsimulation use cases around the world produce synthetic, spatially enriched, microdata to model time-sensitive, national-scale issues (e.g. public health, climate change and transportation) that may have quite different impacts across different local communities. Originally developed for economic studies, spatial microsimulation is one way to construct synthetic, and fine-tuned population datasets (Glenn, 2016; Birkin, 2021). Synthetic data is being used as an answer to a variety of problems in several domains, typically in relation to privacy, which is increasingly important following the progressive tightening of data protection regulations. However, in urban modelling, synthetic data go beyond privacy, and have been promoted as a means for data augmentation and for robustness (Jordon et al., 2022). With multiple pressing challenges such as air pollution, the energy crisis directly impacting the cost of living (including fuel poverty impacting different communities), and the need for tangible actions to battle climate change consequences, synthetic population datasets are needed to feed other models that attempt to represent the complex interactions and characteristics of a population. As computational capabilities have increased, so has the number of models. To an extent, along with the creation of additional detailed survey data and the increase of accessible new data streams, the number of possible model parameters is equally growing, therefore the different variations of any given model which could be a recipe for not solving the problem at all (Batty, 2021). In this context, spatial microsimulation offers a way to parametrise or add new levels of complexity into existing models. Despite the latest progress in this approach, its applications remain to be developed further. Few examples satisfy the rising demand for spatially disaggregated data and more efficient technology frameworks to process national level synthetic micro data. The estimation of variability and methods that create linked multi-level models to make the results clear to policy makers and to the public are equivalently described as future directions for spatial microsimulation (Tanton 2017). 'Digital twin' has become the latest buzzword in governmental and academic venues that relates the idea of creating sophisticated, as realistic as possible,

models. With significant computational resources, new technological frameworks, and access to multiple data sources, extensive parametrizable models aim to be a duplication of reality, determined mostly to be a tool for 'what-if' scenario modelling. As expected, this view has been critically assessed and questioned under the basis that a true digital twin cannot be a model per se, as a model is a simplification of reality – an abstraction (Batty, 2021).
Spiekermann & Wegener (2018) similarly support the idea of multi-level and multiscale urban models that are more fundamental and possibly more necessary towards integration across space, time, and turned towards public policy. This vision emphasises that with enough complexity incorporated into the model, researchers should not lose their focus and model what is indeed required. The challenge is, therefore, to find out the balance between complexity and the description of a given issue, keeping the model as complex as strictly necessary, bearing in mind what needs to be done rather than what can be done.
Massive shocks, such as the ongoing pandemic, highlight the fragility of societies and economies around the world. They help us understand what needs to be modelled. Political instability, growing inequalities, economic uncertainty, and climate change are all equally likely to trigger the next global crisis. Considering such threats, the creation of greater resilience in social systems is an urgent priority. As part of a major programme to develop and demonstrate the importance of AI and data science for government and planning systems, the Alan Turing Institute has established multiple research programs to exploit the power of behavioural modelling and spatial analysis to increase the robustness of social systems.
In this talk, we will present the vision of a group at the Alan Turing Institute to develop a new Urban Analytics Toolkit. Inspired by previous efforts on agent-based and spatial microsimulation modelling, we aim to learn the lessons from the current pandemic to imagine new methods for swift decision making amidst uncertainty in support of greater resilience to shocks in economy, society or the environment. At the heart of this toolkit are the Synthetic Population Catalyst (SPC), which generates a synthetic population with daily activities and social interactions for any area in England with well optimised runtimes; and the Agent-based Simulation of ePIdemics at National Scale (ASPICS), a universal version of a previous pandemic model. We will also describe other multi-level models under development to study energy efficiency, mobility, as well as inequality following urban redevelopment. We will briefly present each model and show how they focus on some major themes (e.g. inequality, energy efficiency and the potential impact of rising temperatures in urban environments) and how they all fit inside a common demarcated 'road-map' to provide and deliver tools or methods that contribute positively to multi-level and multi-scale urban modelling.

References

Batty, M. (2021). Multiple models. Environment and Planning B: Urban Analytics and City Science, 48(8), 2129–2132. DOI: 10.1177/23998083211051139
Birkin, M. (2021). Microsimulation. In: Shi, W., Goodchild, M.F., Batty, M., Kwan, MP., Zhang, A. (eds) Urban Informatics. The Urban Book Series. Springer, Singapore. DOI: 10.1007/978-981-15-8983-6_44
Glenn, E. H. (2016). Spatial Microsimulation with R. Journal of Statistical Software, Book Reviews, 72(1), 1–3. DOI: 10.18637/jss.v072.b01

	Hermes, K., & Poulsen, M. (2012). A review of current methods to generate synthetic spatial microdata using reweighting and future directions. Computers, Environment and Urban Systems, 36(4), 281–290. DOI: 10.1016/j.compenvurbsys.2012.03.005 Jordon, J. et al. (2022). Synthetic Data - what, why and how? DOI: 10.48550/arxiv.2205.03257 Spiekermann, K., & Wegener, M. (2018). Multi-level urban models: Integration across space, time and policies. Journal of Transport and Land Use, 11(1), 67–81. DOI: 10.5198/jtlu.2018.1185 Tanton, R. (2013). A Review of Spatial Microsimulation Methods. International Journal of Microsimulation, 7(1), 4–25. DOI: 10.34196/ijm.00092 Tanton, R. (2017). Spatial Microsimulation: Developments and Potential Future Directions. International Journal of Microsimulation, 11(1), 143–161. DOI: 10.34196/ijm.00176
Further reading	

Paper 8.2

Author(s)	Maider Llaguno-Munitxa (UCLouvain), Martin Edwards (UCLouvain), Stephane Grade (CECOTEPE), Marie Vander Meulen (UCLouvain), Clement Letesson (Independent Consultant), Elena Agudo-Sierra (UCLouvain), Sergio Altomonte (UCLouvain), Emilie Lacroix (UCLouvain), Biayna Bogosian (FIU), Kris Mun (ANFA), Eduardo Macagno (UCSD)
Corresponding author	Maider Llaguno-Munitxa <maider.llaguno@uclouvain.be>
Title	360° image and video urban scene immersions to evaluate the role of urban green infrastructure in stress level reduction
Synopsis	[Speaker to add]
Abstract	Urban stress is one of today's most critical health challenges that urban stakeholders need to urgently address. However, while the positive role of nature for mental health and stress level reduction has been widely reported, the role distinct urban green infrastructure design characteristics play in citizen stress level reduction is yet to be understood. This paper presents a novel methodology where virtual reality, eye-tracking technologies, biometric sensing for heart rate variability, and participant questionnaires have been combined, to evaluate the psychological and physiological stress level reduction capacity of urban green infrastructure. We will be presenting the results obtained for 60 subjects that have participated in a virtual reality immersion of 12 urban squares. The urban squares are located in two of the densest neighbourhoods in the city of Brussels - St. Gilles and Molenbeek. Both neighbourhoods are currently under transformation given an urban demineralization initiative promoted by the city. 360° images and videos were captured for each square, and mapped on a virtual sphere surrounding the participant. For each urban square, the green view index was computed using semantic image classification, and based on the obtained green view index values, the images were organized in two blocks: green >35% and non-green <20%. We have so far analyzed the results for 30 participants, and the eye-tracking data showed significant differences between green and non-green blocks. Fixation counts decreased in the green image block, which is an indicator of stress reduction. The perceived restorativeness scale questionnaire also reported highly significant differences with higher global scores for the green image block. The study will also be analyzing the differences on the results between the participants that experience 360° images vs the participants that have experienced 360° videos that also included the audios recorded on site.
Further reading	[Speaker to add]

Paper 8.3

Author(s)	Juste Raimbault (LASTIG, Univ Gustave Eiffel, IGN-ENSG, Saint-Mande´, France; CASA, UCL, London, UK; UPS CNRS 3611 ISC-PIF, Paris, France; UMR CNRS 8504 Ge´ographie-cite´s, Paris, France) and Julien Perret (LASTIG, Univ Gustave Eiffel, IGN-ENSG, Saint-Mande´, France)
Corresponding author	Juste Raimbault <juste.raimbault@gmail.com>
Title	Quantifying the co-evolution of economic activities locations with geo-historical data: Paris, 19th century
Synopsis	[Speaker to add]
Abstract	Urban systems are highly complex, what poses issues to ensure their resilience and sustainability and plan future cities [1]. One aspect of this complexity is their multidimen- sionality, even within subsystems such as the intra-urban location of economic activities. Indeed, different types of activities have specific location processes, yielding various patterns for their accessibility for example [2]. Understand- ing past dynamics of such social processes is crucial to build better urban models, theories and in practical terms insights for sustainable planning [3]. While recent and current urban dynamics are more and more easily tracked and quantified through the emergence of large urban data [4], historical dynamics on long time scales or on timeframes in a distant past are difficult to quantify due to the sparsity and heterogeneity of geo-historical data. At the macroscopic scale of urban systems, major transitions of past settlements systems have been modeled from an in- terdisciplinary perspective [5], and simulation models cap- turing various dimensions of systems of cities have been de- veloped [6]. At the mesoscopic and microsocpic intra-urban scales, several issues are encountered when trying to build consistent dataset, such as geocoding [7] or vectorisation to reconstruct the dynamics of road networks [8]. This contribution builds on data produced by the Soduco research project [9] to investigate co-evolutionary dynamics in the location of economic activities. More precisely, we focus on the case of Paris in the middle of the 19th cen- tury. Using public domain scans for main economic activ- ity repertoires (“Didot-Bottin”), an other work package of the project focused on building geo-referenced data contain- ing activities of various professionals, using Optical Char- acter Recognition techniques. We work on a sample of this data currently available, spanning 4 years between 1841 and 1844. Starting from an initial dataset of 415,976 entries, we keep the ones with correct geographical coordinates (33%), and apply natural language processing (stemming and stop-word removal) to raw strings describing activities. From there, we focus on the stems with more than 100 occurences (578 stems), and code manually a broad category of economic activity for each (obtaining the coarse grain classification within: food, craftsmanship, art and literature, health, law and governance, service, teaching). We end at this stage with 36,072 entries with identified coordinates and broad ac- tivity. Source code and results are openly available on the git repository of this work at https://github.com/ JusteRaimbault/HistoricalData.

To study co-evolutionary dynamics, we use the defini- tion and characterisation method proposed by [10], which is based on weak Granger causality: two urban attributes will be co-evolving if they statistically exhibit a circualar causal relationship in this context. Aggregating spatially on raster cells (10x10 grid for the whole Paris), we thus com- pute lagged correlations between the variations of activity counts between successive dates for each cell, for each pair of activity. We find several significant correlations (using Fisher confidence intervals), mostly negative for lagged cor- relations. This corresponds to a dynamic of sustitution of activities, with clusters rapidly replaced. Food and health are positively correlated and in co-evolution, while the other significantly co-evolving couple of activities is health and art but in a negative manner: in some districts medical pro- fessions replace artists and the contrary in others. We also consider simultaneous correlations, and find for example that food and craftsmanship have joint dynamics in the last time interval, but not during the first considered. Altogether, these results first confirm the existence of a co-evolution be- tween some activities, unveil a precise characterisation of intra-urban socio-economic dynamics, and open the path to- wards more advanced thematic interpretations within an in- terdisciplinary context, such as with historians.

Current and future work also include (i) the extension of this study on longer time spans; (ii) the combination of Granger causality with geographically weighted regression, to optimise spatial neighbourhood considered in regressions [11], and (iii) the benchmark of methods to characterise co-evolution (including e.g. instrumental variables or causal machine learning methods) on this particular dataset.

[1] Michael Batty. Inventing future cities. MIT press, 2018.
[2] Antonio Paez. Network accessibility and the spatial distri- bution of economic activity in eastern asia. Urban Studies, 41(11):2211–2230, 2004.
[3] Ce´line Rozenblat, Denise Pumain, and Elkin Velasquez. In- ternational and transnational perspectives on urban systems. Springer, 2018.
[4] Jens Kandt and Michael Batty. Smart cities, big data and ur- ban policy: Towards urban analytics for the long run. Cities, 109:102992, 2021.
[5] Lena Sanders. Peupler la terre: De la pre´histoire a` l'e`re des me´tropoles. Presses universitaires Franc¸ois-Rabelais, 2018.
[6] Denise Pumain and Romain Reuillon. Urban dynamics and simulation models. Springer, 2017.
[7] Re´mi Cura, Bertrand Dumenieu, Nathalie Abadie, Benoit Costes, Julien Perret, and Maurizio Gribaudi. Historical col- laborative geocoding. ISPRS International Journal of Geo- Information, 7(7):262, 2018.
[8] Hanae El Gouj, Christian Rinco´n-Acosta, and Claire Lagesse. Urban morphogenesis analysis based on geohistorical road data. Applied Network Science, 7(1):1–26, 2022.
[9] Social dynamics in urban context. Open tools, models and data - Paris and its suburbs, 1789-1950. https://soduco.github.io/.
[10] Juste Raimbault. Characterising and modeling the co- evolution of transportation networks and territories. arXiv preprint arXiv:2110.15950, 2021.
[11] Chris Brunsdon, Stewart Fotheringham, and Martin Charlton. Geographically weighted regression. Journal of the Royal Sta- tistical Society: Series D (The Statistician), 47(3):431–443, 1998.

Further reading	[Speaker to add]

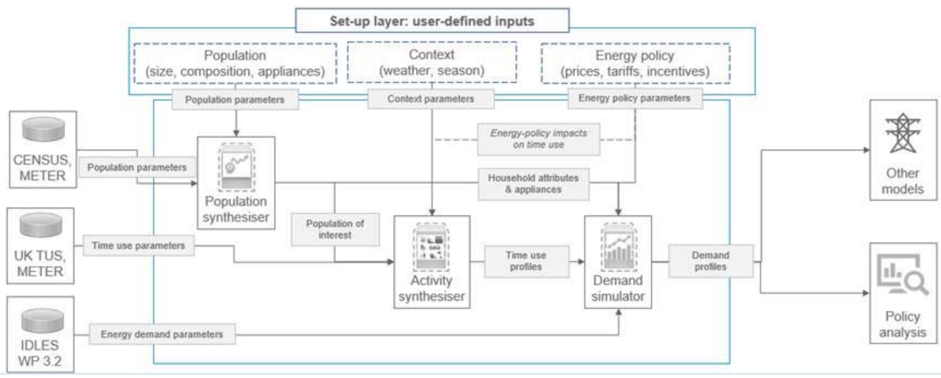
Session 9: Advances in agent based modelling

	Session 9: Advances in agent based modelling	
	Chair: David Simmonds (David Simmonds Consultancy, UK)	
	Host: (tbc)	
Paper 9.1	Aruna Sivakumar (Imperial College)	Challenges in developing an agent- and activity-based microsimulation model of mobility and energy demands: Experiences from the IDLES programme at Imperial College London
Paper 9.2	Yuan Liao, Frances Sprei, Çaglar Tozluoglu, Sonia Yeh (Department of Space, Earth and Environment, Division of Physical Resource Theory, Chalmers University of Technology, Gothenburg)	On the impact of EV charging behaviours: Spatiotemporal patterns of demand from user perspective using agent-based modelling

David Simmonds 	is an internationally recognized specialist in analysis and modelling of the interactions between land-use transport and the economy, with over 30 years' experience in this field. He established David Simmonds Consultancy (DSC) in 1990, and has led its growth to the present position where it is the leading practice in its particular field. https://www.davidsimmonds.com/people
Aruna Sivakumar 	is reader in consumer demand modelling and urban systems at the Centre for Transport Studies, Imperial College London. https://www.imperial.ac.uk/people/a.sivakumar
Yuan Liao 	is a postdoctoral researcher in mobility data science at the Transport and Energy Systems Group, Chalmers University of Technology. Her active research interests include mobility data science, urban big data, GIS, and sustainable transport. https://yuanliao.netlify.app/
Frances Sprei	is an Associate Professor in sustainable mobility from the Transport and Energy Systems Group, Chalmers University of Technology. Her research

	interests include electrification of transport & mobility, shared mobility, and autonomous vehicles. https://www.chalmers.se/en/staff/Pages/frances-natasha-sprei.aspx
Çaglar Tozluoglu 	is a PhD student in transport modelling from the Transport and Energy Systems Group, Chalmers University of Technology. His research interests include agent-based modelling, data analytics, visualization, GIS and urban big data. https://www.chalmers.se/en/staff/Pages/caglar-tozluoglu.aspx
Sonia Yeh 	is a Professor in Transport and Energy Systems from the Transport and Energy Systems Group, Chalmers University of Technology. Her research interests include long-term projections of transport energy systems, energy policy, and mobility. https://www.chalmers.se/en/staff/Pages/sonia-yeh.aspx
Swapnil Dhamal 	is a postdoctoral researcher as part of the Synthetic Population project from the Transport and Energy Systems Group, Chalmers University of Technology. His research interests include Social Networks, Game Theory, Transport Planning, Blockchain, Multi-armed Bandits. https://sites.google.com/site/swapnildhamal/
(Host)	

Paper 9.1

Author(s)	Aruna Sivakumar, Imperial College, London
Corresponding author	Aruna Sivakumar <a.sivakumar@imperial.ac.uk>
Title	Challenges in developing an agent- and activity-based microsimulation model of mobility and energy demands: Experiences from the IDLES programme at Imperial College London
Synopsis	[Speaker to add - 50 words or so]
Abstract	Driven by decarbonisation and high cost of infrastructure expansion, the energy sector increasingly looks at harnessing flexibility in consumer activities, i.e. to support energy consumption that meets their needs while delivering the policy objectives of shifting energy-intensive activities to times of high renewable energy generation or acquisition of local generation and storage capabilities (PV panels, batteries etc). The prize is substantial as the associated load shifting leads to 'hard benefits' in the form of deferral or avoidance of network reinforcement/addition or reduced needs for back up capacity, estimated at £4.7bn by 2030. To realise such benefits by the relevant stakeholders: transmission networks, energy suppliers, but also consumers or electric vehicle suppliers, it is essential to accurately and realistically characterise and simulate demand at the level of heterogeneously-responsive agents: individual households, firms, buildings etc, under a variety of policy (pricing, incentive schemes) and socio-environmental contexts (COVID lockdowns, weather-induced events, lifestyle changes). As part of the EPSRC-funded Integrated Development of Low-carbon Energy Systems (IDLES) programme, researchers at the Urban Systems Lab in Imperial College London are developing an agent- and activity-based microsimulation model to produce the necessary bottom-up high-resolution capabilities at scale (city/region), bridging between the energy sector needs and existing activity-based models used in transport systems modelling. The model system (Figure 1) consists of three primary components: population synthesiser, activity synthesiser and demand simulator.  **Figure 1: Activity-based microsimulation model system: schematic framework** The ***population synthesiser*** creates digital representation of the desired agents consistent with observed population (e.g. census). The *activity synthesiser* in turn simulates the desired representation of time use (activity participation), given parameters set by the user, e.g. day of the week or weather, which ensures accurate reflection of people's in- and out-of-home activities. The

	resulting activity patterns, alongside attributes of the households, are fed into an ***energy demand simulator*** that forecasts energy consumption profiles with an arbitrary level of spatial (household, neighbourhood, district, etc.) and temporal (minute, hourly, etc.) resolution. The current model system is calibrated using a combination of the 2014-15 UK Time Use Data, University of Oxford's Project METER, London Travel Demand Survey and National Travel Survey data. The demand simulator provides a means of comprehensively representing scenarios of interest along three dimensions of set-up (using the Set-up layer in Figure 1): (a) *Population:* to reflect (changes to) population composition, household attributes, employment, affluence, residential conditions, (electric) vehicle ownership, or (smart) appliance possession; (b) *Activity:* to reflect (shifts in) activity timing, preference for in-, out-of-home or virtual activity participation, flexible working arrangements, co-participation in activities; (c) *Energy policy:* to reflect (changes in) energy tariffs, pricing as well as per-activity energy consumption under particular circumstances of the household. In this presentation, we will briefly describe the microsimulation model system and go on to discuss a number of challenges in developing the model system including the representation of uncertainty, data limitations in modelling trade-offs between physical and digital activities, and mismatch in temporal and spatial scale of analyses for mobility patterns and energy loads.
Further reading	[Speaker to add]

Paper 9.2

Author(s)	Yuan Liao, Frances Sprei, Çaglar Tozluoglu, Sonia Yeh (Department of Space, Earth and Environment, Division of Physical Resource Theory, Chalmers University of Technology, Gothenburg)
Corresponding author	Yuan Liao <yuan.liao@chalmers.se>
Title	On the impact of EV charging behaviours: Spatiotemporal patterns of demand from user perspective using agent-based modelling
Synopsis	We investigate the spatiotemporal patterns of charging demand, energy, and infrastructure needs based on three EV charging strategies. This simulation study gives us the picture of when and where charging should happen from the user's perspective in a future of 100% electrification of personal cars.
Abstract	Electric vehicles (EVs) play a vital role in the sustainable transformation of future urban transport systems. The proportion of EVs in private fleets has been increasing, but a future scenario of 100% EV adoption needs a carefully designed charging infrastructure to deliver a good-quality driving experience. Such an infrastructure should consider realistic charging behaviours and enable travellers to maintain their desired daily activities when shifting from internal combustion engine vehicles (ICEVs) to EVs. The current literature on charging infrastructure rarely considers the complexity of charging behaviours, partly due to the studies so far being about early adopters who mostly have access to home chargers. In a future with 100% EV adoption, how do we provide charging support for all car users? We apply agent-based modelling (ABM) to a synthetic population of Sweden, assuming 1) all the future car users drive/ride EVs, and 2) they charge their EVs based on different charging strategies and needs. Based on these scenarios, we calculate the spatiotemporal patterns of charging demand, energy, and infrastructure needs. The simulation gives us the picture of when and where charging should happen given different charging behaviour models. We compare the simulation results with where today's charging infrastructure is located. Such a comparison sheds light on planning EV charging infrastructure for the future. **Importance**. When designing the location and sizing of charging infrastructure, the existing literature tends to make oversimplified assumptions about charging behaviours. For example, some studies locate the candidate charging stations at today's fuel stations. Some studies assume that EV users will only charge when the state of charge (SOC) drops below a certain threshold. These assumptions are based on our understanding of how we use ICEVs today. However, EVs have distinct characteristics from ICEVs. For instance, EVs need a significantly longer time than ICEVs to charge to cover the same upcoming distances. Future EV users will develop different strategies for charging, depending on their preferences, activity plans, and mental models. It remains unclear how these charging strategies affect charging demand and infrastructure. Moreover, many studies directly assume all private EV owners have access to home chargers therefore, their need for public charging is minimal. In a future of 100% EV adoption, the magnitude of the demand for public charging from private EV owners remains elusive, especially for those who do not have a home charger. **Objectives**. The existing literature lacks the integration of realistic charging behaviours and the corresponding quantification of charging demand for different dwellers. Accordingly, this study aims to bridge the identified research gaps by applying ABMs with a synthetic moving population of Västra Götaland,

Sweden (VG). We simulate typical weekdays' EV driving & charging for the agents, maximising their activity plans. Through the simulation, we reveal the spatiotemporal patterns of charging demand considering different strategies of EV charging. And by comparing the demand with today's charging infrastructure, we provide insights for a better-informed future planning. Specifically, we attempt to answer the following questions: 1) How many public charging points at work and other places should be provided to private EV owners to meet their charging demand? What are the spatiotemporal patterns of charging? 2) How do different charging strategies affect the number of public charging points and types that should be provided and their power distribution?

Methodology. ABMs have gained popularity in the last decade and have become an important modelling tool in transport. This study utilises the generated agents from the Synthetic Sweden Mobility Model (SySMo), an agent-based decision support framework for modelling and analysis of future urban transport scenarios. SySMo provides heterogeneous agents' daily activity plans while preserving privacy and capacity for being modified for future scenarios. This study feeds the generated agents and their daily activity plans into MATSim for replanning until they converge on a set of reasonable activity plans and extracts the corresponding travelling speed, traffic volume, spatiotemporal charging opportunities, trajectories of individual agents, etc. The EV simulation is implemented on the individual agents' moving trajectories considering today's car fleet composition, road slope distribution, and EV charging & discharging dynamics. Specifically, we abstract three types of charging behaviours: 1) Liquid-fuel strategy, 2) Plan-ahead strategy, and 3) Event-actuated charging. These behaviour types have varying SOC thresholds and conditions to commence the charging when the agents' EVs are parked for more than 10 min. On the supply side, we provide two types of charging points according to the length of their parking and their EVs' SOC, no matter when and where the agents desire to charge: 1) Fast charging (up to 150 kW) and 2) Intermediate charging (22 kW). Every EV user is assigned an EV model based on his/her income group and starts the simulation day with a SOC randomly drawn between a certain range depending on the assumed availability of the home charger.

Expected results. The simulation provides detailed charging and discharging trajectories of all agents given their charging behaviour types, from which we get spatiotemporal patterns of power required from where the agents desire to charge their EVs. At the same time, we are able to quantify the minimum capacity needed to maximise their activities and the corresponding charging behaviour patterns. We further compare the charging demand from the user's perspective with existing charging stations and identify when and where we need to improve today's charging infrastructure to meet future demand.

Contributions. This study contributes solid insights into charging infrastructure planning from the demand side, by using a large synthetic population with socio-economic attributes and varying activity plans. Aimed at 100% EV adoption, this study implements a unique taxonomy of charging behaviours, realistic EV charging & discharging dynamics, and the corresponding quantification of charging demand for private EV owners of different dwellings. We quantify the number of public charging points at work and other places for private EV owners to meet their charging demand, considering different charging strategies.

Further reading	Tozluoglu, Çaglar. *Agent-based Transport Models as a Tool for Evaluating Mobility*. Chalmers Tekniska Hogskola (Sweden), 2022. https://research.chalmers.se/publication/530488

Session 10: Modelling of activities

	Session 10: Modelling of activities	
	Chair: Robert Cervero (University of California Berkeley)	
	Host: Jamil Nur (University of Cambridge)	
Paper 10.1	Adam Dennett (University College London), Gavin Chait (OpenLocal) and Christina Botros (CACI Ltd)	The Health of the High Street revisited – A new Urban Analytics Perspective

Robert Cervero 	is Professor Emeritus of City and Regional Planning at the University of California, Berkeley https://ced.berkeley.edu/ced/faculty-staff/robert-cervero
Adam Dennett 	is Head of Department and Associate Professor in Urban Analytics, in the Bartlett Centre for Advanced Spatial Analysis (CASA), University College London. Adam is a Geographer with broad interests but a body of work concentrating on migration, residential mobilities and human spatial interactions more generally. He has also published work various aspects of human urban existence including gentrification and urban craft brewing economies. https://www.ucl.ac.uk/bartlett/casa/dr-adam-dennett
Gavin Chait	Gavin Leads Consultant & Data Scientist at Whythawk; and built OpenLocal. Gavin has consulted globally for twenty years, including leading international and UK open data projects. Combining data science with economics, spatial analysis and property expertise Gavin has provided data to support MHCLG's levelling up fund allocation and evidence to help the GLA and London Boroughs plan for recovery from Covid-19. With a passion for open data Gavin has led on work for the Open Data Institute, analysed open data platforms for the World bank and been Commercial Director at the Open Knowledge Foundation, a global non-profit promoting open data for economic and social development, as the head of their commercial operations.
Christina Botros	Christina is a Consultant in the Location Intelligence Group at CACI Ltd. She completed her MSc in Spatial Data Science and Visualisation in CASA in 2020, passing with Distinction, and has a first class degree in Geography from the University of Leeds.

Jamil Nur 	is a post-doctoral fellow at the Martin Centre for Architectural and Urban Studies at the University of Cambridge https://sites.google.com/site/jamilnurscpo/home

Paper 10.1

Author(s)	Adam Dennett (University College London), Gavin Chait (OpenLocal) and Christina Botros (CACI Ltd)
Correspondin g author	Adam Dennett <a.dennett@ucl.ac.uk>
Title	The Health of the High Street revisited – A new Urban Analytics Perspective
Synopsis	This paper covers a brief background to the historic and recent focus on town centres and high streets by policy makers alongside recent changes in behaviours and policy which threaten their continuing existence as commercially focused entities. We briefly explore attempts at and challenges with defining these areas spatially and outline issues and challenges in the data landscape which have limited analysis and modelling at scale before reporting on a preliminary longitudinal analysis in West London and a more detailed analysis of Camden made possible by new linked data from OpenLocal.
Abstract	Concerns around the health and vitality of our town centres and high streets are not new. Over a decade on from the now famous Portas Review which was produced against the backdrop of the global financial crisis of 2008 and set out a series of recommendations for ensuring the economic and communal vitality of our urban centres, the global COVID-19 pandemic has renewed fears for their ongoing viability as work patterns shift and consumer habits evolve. Since the Portas Review many have lamented the dearth of robust (quantitative) evidence to support policy initiatives in this area. Putting it simply, the data have simply not existed at a level of spatial and temporal granularity to enable us to even successfully baseline – at scale, across all towns and local authorities – the characteristics of the businesses that inhabit our high streets and town centres, let alone assess how they are changing, or whether they are 'healthy'. This paper reports on some preliminary analysis using new longitudinal, business-level and spatially explicit data from OpenLocal who have linked publicly available (but not readily accessible) data from the valuation office agency and local business rates registers to build an intricate picture of town centre and high street profiles and dynamics. We aim to showcase how these data can facilitate a nuanced understanding of business activity and health, while arguing for a dynamic data-driven approach to defining our town centres and high streets - which in some places may challenge political conceptions of commercial importance. Finally using a case study of Camden, we demonstrate how typologies of high street activity can be devised while survival analysis reveals what healthy or otherwise patterns of commercial occupancy, vacancy and turnover might look like.
Further reading	Bolton, T., and L. S. Vaughan. 2014. "The Past, Present and Futures of the High Street: Report on the Closing Conference of the Adaptable Suburbs Project." Report. The Bartlett School of Graduate Studies, UCL (University College London): London. London: The Bartlett School of Graduate Studies, UCL (University College London). https://uclsstc.files.wordpress.com/2014/06/highstreetconference_report.pdf. Campello, Ricardo J. G. B., Davoud Moulavi, and Joerg Sander. 2013. "Density-Based Clustering Based on Hierarchical Density Estimates." In Advances in Knowledge Discovery and Data Mining, edited by Jian Pei, Vincent S. Tseng, Longbing Cao, Hiroshi Motoda, and Guandong Xu, 160–72. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer. https://doi.org/10.1007/978-3-642-37456-2_14.

Cheshire, Paul, Christian A. L. Hilber, Piero Montebruno, and Rosa Sanchis-Guarner. 2017. “Using Micro-Geography Data to Identify Town-Centre Space in Great Britain.” SERCDP0213. Centre for Economic Performance, LSE. https://cep.lse.ac.uk/_new/publications/abstract.asp?index=5413.
Dolega, Les, Michalis Pavlis, and Alex Singleton. 2016. “Estimating Attractiveness, Hierarchy and Catchment Area Extents for a National Set of Retail Centre Agglomerations.” Journal of Retailing and Consumer Services 28 (January): 78–90. https://doi.org/10.1016/j.jretconser.2015.08.013.
Ester, Martin, Hans-Peter Kriegel, Jörg Sander, and Xiaowei Xu. 1996. “A Density-Based Algorithm for Discovering Clusters in Large Spatial Databases with Noise.” In , 226–31. AAAI Press.
Gill, Caroline. n.d. “Southall Gasworks.” Ealing 1.12 WISP Migration. UK. Accessed April 28, 2022. https://www.ealing.gov.uk/info/201283/our_neighbourhoods/2613/southall_gasworks.
GLA. 2015. “Annex Two: London’s Town Centre Network.” London City Hall. October 28, 2015. https://www.london.gov.uk//what-we-do/planning/london-plan/past-versions-and-alterations-london-plan/london-plan-2016/london-plan-annexes/annex-two-londons-town.
———. 2022. “Town Centre Boundaries - London Datastore.” 2022. https://data.london.gov.uk/dataset/town_centre_boundaries.
Hughes, Cathy, and Cath Jackson. 2015. “Death of the High Street: Identification, Prevention, Reinvention.” Regional Studies, Regional Science 2 (1): 237–56. https://doi.org/10.1080/21681376.2015.1016098.
Jones, Samuel, Andy Newing, and Scott Orford. 2021. “Understanding Town Centre Performance in Wales: Using GIS to Develop a Tool for Benchmarking.” Applied Spatial Analysis and Policy, August. https://doi.org/10.1007/s12061-021-09417-z.
McInnes, L, J Healy, and S Astels. n.d. “The Hdbscan Clustering Library — Hdbscan 0.8.1 Documentation.” Accessed April 28, 2022. https://hdbscan.readthedocs.io/en/latest/index.html#.
ODPM, and CASA. 2004. “Producing Boundaries and Statistics for Town Centres: London Pilot Study -Technical Report.” http://www.casa.ucl.ac.uk/towncentres/cd/Technical.pdf.
Pavlis, Michalis, Les Dolega, and Alex Singleton. 2018. “A Modified DBSCAN Clustering Method to Estimate Retail Center Extent.” Geographical Analysis 50 (2): 141–61. https://doi.org/10.1111/gean.12138.
Portas, Mary. n.d. “The Portas Review: The Future of Our High Streets.” GOV.UK. Accessed May 24, 2022. https://www.gov.uk/government/publications/the-portas-review-the-future-of-our-high-streets.
Thurstain-Goodwin, M., and D. Unwin. 2000. “Defining and Delineating the Central Areas of Towns for Statistical Monitoring Using Continuous Surface Representations.” Working / discussion paper. (CASA Working Papers 18). UCL (University College London), Centre for Advanced Spatial Analysis (UCL): London, UK. (2000). London, UK: UCL (University College London), Centre for Advanced Spatial Analysis (UCL). January 2000. https://discovery.ucl.ac.uk/id/eprint/1363/.
“VOA Rating List Downloads.” n.d. Accessed April 28, 2022. https://voaratinglists.blob.core.windows.net/html/rlidata.htm.
Wrigley, Neil, and Les Dolega. 2011. “Resilience, Fragility, and Adaptation: New Evidence on the Performance of UK High Streets during Global Economic Crisis

	and Its Policy Implications.” Environment and Planning A: Economy and Space 43 (10): 2337–63. https://doi.org/10.1068/a44270. Wrigley, Neil, and Dionysia Lambiri. 2014. “High Street Performance and Evolution: A Brief Guide to the Evidence.” Monograph. University of Southampton. July 28, 2014. https://doi.org/10.13140/2.1.3587.9041.

Session 11: Advances in model integration

	Session 11: Advances in model integration	
	Chair: R Rolf Moeckel (Technical University of Munich)	
	Host: Shanshan Xie (University of Cambridge)	
Paper 11.1	Nael Alsaleh and Bilal Farooq (Toronto Metropolitan University)	Sustainability analysis of shared on-demand transit with a focus on equity, diversity, and inclusion
Paper 11.2	Fulvio D Lopane, Tianqu Shao, Eleni Kalantzi, Michael Batty (University College London)	The HARMONY Strategic Simulator: urban and transport modelling to inform policy and decision making
Paper 11.3	Richard J Hewitt, Charlotte Astier, Juan Balea-Aneiros and Eduardo Caramés (Complutense University of Madrid)	Integrated modelling for sustainability transitions in cities: progress and challenges from the INTRANCES project
Paper 11.4	Juste Raimbault (LASTIG, Univ Gustave Eiffel, IGN-ENSG, Saint-Mande´, France; CASA, UCL, London, UK; UPS CNRS 3611 ISC-PIF, Paris, France; UMR CNRS 8504 Ge´ographie-cite´s, Paris, France) and Micael Batty (University College London)	Coupling heterogeneous urban models

Rolf Moeckel 	is an Associate Professor in the Department of Mobility Systems Engineering at the Technical University of Munich. His research focuses on travel behavior analytics and transport modelling, including, activity-based, freight, long-distance, health and integrated land use/transport modelling. https://www.mos.ed.tum.de/en/tb/team/rm/
Nael Alsaleh 	is a Ph.D. candidate in Transportation Engineering at Toronto Metropolitan University (Formerly Ryerson University). https://litrans.ca/team/alsaleh-n/
Bilal Farooq	is an Associate Professor at Toronto Metropolitan University (Formerly Ryerson University). He is the Founding Director of Laboratory of Innovations in Transportation (LiTrans). https://litrans.ca/team/farooq-b/

	
Fulvio D Lopane 	is a Research Fellow in Urban and Transport Modelling at the Bartlett Centre for Advanced Spatial Analysis (CASA) at University College London. https://www.ucl.ac.uk/bartlett/casa/people/fulvio-lopane
Tianqu Shao 	is a Research Assistant at the Bartlett Centre for Addvanced Spatial Analysis (CASA) at University College London.
Eleni Kalantzi 	is a Research Assistant in Geospatial and Planning Analytics at the Bartlett Centre for Advanced Spatial Analysis (CASA) at University College London.
Michael Batty 	is Chairman of the Management Board of the Centre for Advanced Spatial Analysis (CASA) and Bartlett Professor of Planning (Emeritus) at University College London. https://www.ucl.ac.uk/bartlett/casa/prof-michael-batty
Richard J Hewitt	
Charlotte Astier	
Juan Balea-Aneiros	
Eduardo Caramés	

Juste Raimbault 	is a Research Fellow in the UCL Faculty of Mathematical and Physical Sciences https://www.ucl.ac.uk/bartlett/casa/people/dr-juste-raimbalt
Shanshan Xie 	is a PhD candidate at University of Cambridge.

Paper 11.1

Author(s)	Nael Alsaleh and Bilal Farooq, Toronto Metropolitan University
Corresponding author	Nael Alsaleh <nael.alsaleh@ryerson.ca>
Title	Sustainability Analysis of Shared On-Demand Transit with a focus on Equity, Diversity, and Inclusion
Synopsis	In this presentation, we explore the demand switching point between various shared on-demand public transit services, i.e., crowdsourced, dedicated fleet, and hybrid, and discuss the sustainability, equity, and inclusion aspects of each design.
Abstract	Recently, there is an increased interest by the transit agencies to replace the conventional fixed-route transit services with shared on-demand public transit (ODPT) services. However, due to their infancy, it is still unclear when and where each of these services is more efficient and sustainable. It is also unclear whether they offer equal opportunities for residents, whether they contribute to the inclusion of disadvantaged communities, and whether they can reduce vehicle-kilometres and greenhouse gas emissions. In the last Applied Urban Modelling symposium (AUM2020), we modelled the demand for dedicated fleet ODPT services and examined the factors that affect it. In the current work, we develop a microsimulation model to identify the demand switching point between several ODPT designs, e.g., crowdsourced, dedicated fleet, and hybrid transit services, as well as to evaluate the sustainability, equity, and the inclusion aspects of each service. The model inputs are utilized from the Town of Innisfil, Ontario, which included the road network, traffic volumes, and the actual ride request data for Uber transit service. Moreover, the simulated transit services are evaluated using the total cost analysis method.
Further reading	1. Alsaleh, N., & Farooq, B. (2022). The Impact of COVID-19 Pandemic on Ridesourcing Services Differed Between Small Towns and Large Cities. arXiv preprint arXiv:2201.10961. 2. Alsaleh, N., Elbeshbishy, M., & Farooq, B. (2022). Exploring On-demand Transit Options for The Town of Innisfil. https://litrans.ca/projects/smart-mobility/Innisfil_Transit_Report_V2.pdf

Paper 11.2

Author(s)	Fulvio D. Lopane; Tianqu Shao; Eleni Kalantzi; Michael Batty (UCL)
Correspondin g author	Fulvio Lopane <f.lopane@ucl.ac.uk>
Title	The HARMONY Strategic Simulator: urban and transport modelling to inform policy and decision making
Synopsis	The HARMONY Model Suite is a modelling framework that provides integrated tools accessible via a web platform, modelling new forms of mobility for both freight and people. It captures decisions and interactions among travellers, logistic operators, mobility services operators and decisions makers on three different levels: strategic, tactical and operational.
Abstract	HARMONY is a project under the CIVITAS Initiative, an EU-funded programme whose aim is to provide metropolitan authorities with a multiscale spatial and transport planning framework to foster a sustainable transition towards a low-carbon new mobility era. HARMONY's main objective is to assist metropolitan authorities with evidence-based decision making, by providing a state-of-the-art model suite that quantifies the multidimensional impact of various policies, investments, and mobility concept applications. To achieve this goal, the HARMONY Model Suite (MS) is structured on three different levels: 1) Strategic (long-term) demographic land-use transport models, 2) Tactical (mid-term) people and freight activity-based models and 3) Operational (short-term) multimodal network models. The focus of this paper is the Strategic level, whose outcome is the Strategic Simulator, which captures long-term decisions and emerging patterns in terms of population distribution, job market, land uses, economic sectors, infrastructure development and travel and activity demand. The HARMONY MS is a web-based platform for urban and transport modelling and is applied to several UK and EU case studies (e.g. Turin, Rotterdam, Athens, Oxfordshire etc.). This paper presents the Oxfordshire application of the Strategic Simulator, which encompasses: i) a demographic forecasting model, ii) a regional economy model, iii) a land-use transport-interaction model, iv) a land development model, v) a spatial-interaction freight model, vi) a synthetic population model and vii) a long-term households and individual choice model. The structure of the framework is modular and allows the employment of all or only a selection of components according to data availability and the scope of the analysed case study. Different templates can be set up in the web portal to evaluate different what-if scenarios, like the new housing development presented in this paper as proof of concept. The HARMONY Strategic Simulator presents a wide portfolio of results and outputs that support decision-making processes, strategic planning and allocation of resources, enabling the evaluation of impacts and cost-effectiveness of developments, interventions or policies in urban planning. In this paper, we will outline how the different strategic models are linked but focus specifically on the demographic model, which originates from the Leeds microsimulation model SPENSER, the LUTI model which relates to QUANT, and the purpose-built Land Development Model.
Further reading	Kamargianni M, Yfantis L, Chaniotakis M, Pappelis D, Fermi F, Martino A, Lopane F D, Batty M, De Bok M, Tavasszy L, Tsirimpa A, Tsouros I, Polydoropoulou A, Georgakis P, Salas A, Djukic T, Bothos E, Magoutas B (2021). "Harmony Model Suite: An Integrated Spatial and Multimodal Transport Planning Tool to Lead a Sustainable Transition to a New Mobility Era". European Transport Conference 2020, September 9-11.

	(https://www.researchgate.net/publication/351022294_Harmony_Model_Suite_An_Integrated_Spatial_and_Multimodal_Transport_Planning_Tool_to_Lead_a_Sustainable_Transition_to_a_New_Mobility_Era

Paper 11.3

Author(s)	Richard J Hewitt, Charlotte Astier, Juan Balea-Aneiros and Eduardo Caramés (Complutense University of Madrid)
Corresponding author	Richard Hewitt <rhewitt@ucm.es>
Title	Integrated modelling for sustainability transitions in cities: progress and challenges from the INTRANCES project
Synopsis	[Speaker to add]
Abstract	The EU-funded INTRANCES project (Integrated modelling of transport scenarios from stakeholders for air quality and emissions) looks at ways to help cities worldwide address sustainability requirements in an integrated way without compromising social goals. Implementing strategies to reduce air pollution and greenhouse gas emissions without reducing citizens' well-being, negatively impacting businesses, or generating unintended environmental consequences is a major challenge. Trade-offs and complementarities between transport, energy and land-use need to be considered in an integrated way, and buy-in must be sought from a wide range of stakeholders. Models of various kinds can be developed to project the evolution of particular change tendencies as cities transform and grow, simulate the possible outcome of particular policy trajectories or explore stakeholders' visions for their cities. INTRANCES attempts to address these aspects simultaneously using the idea of modelling as an ecosystem of different overlapping tools and approaches, with application to the case of Madrid, Spain. As the project nears its conclusion, we summarize our main results and discuss limitations and challenges encountered. We conclude by identifying some directions for future research and offering some recommendations and discussion points for progressing sustainability transitions in cities.
Further reading	[Speaker to add]

Paper 11.4

Author(s)	Juste Raimbault (LASTIG, Univ Gustave Eiffel, IGN-ENSG, Saint-Mande´, France; CASA, UCL, London, UK; UPS CNRS 3611 ISC-PIF, Paris, France; UMR CNRS 8504 Ge´ographie-cite´s, Paris, France) and Micael Batty (University College London)
Corresponding author	Juste Raimbault <juste.raimbault@gmail.com>; <juste.raimbault@ign.fr>
Title	Coupling heterogeneous urban models
Synopsis	[Speaker to add]
Abstract	The integration of multiple dimensions of urban systems is essential for their sustainable planning and management. As decision-making tools, simulation models are in that context a useful medium to link together these various aspects. The coupling of heterogeneous urban models, in terms of scale, ontology, data, and implementation among others, is therefore an important methodological hurdle to be dealt with. In this contribution, we summarise some recent use of scientific workflow engines to build modular urban models. In particular, the OpenMOLE workflow engine enables seamless modle embedding - whatever the implementation - and provides a scripting language which is used to couple such heterogeneous models and implement the intermediate tasks, resulting in some sort of meta-model in the workflow engine. We illustrate this by coupling the QUANT spatial interaction model with the SPENSER microsimulation model, for the case of the planned Cambridge-Oxford railway corridor. This coupling allows anticipating the infrastructure impacts within the projected demographic context. The second illustration we develop is the coupling of the Matsim transport model with QUANT and SPENSER to build a four-step multimodal transport model generic to any UK functional area. We show the advantage of using this approach by applying model validation methods provided by the OpenMOLE platform: first by running a Global Sensitivity Analysis to model parameters, and second by applying a genetic calibration algorithm to adjust mode shares to observed commuting flows.
Further reading	[Speaker to add]

Session 12: Modelling the long term: theory and practice

	Session 12: Modelling the long term: theory and practice	
	Chair: Michael Batty (University College London)	
	Host: Yue Ying (University of Cambridge)	
Paper 12.1	Francisco Martínez, Ariel Castillo, Pedro Donoso, Leonel Gutiérrez and Ricardo de la Paz Guala (Universidad de Chile, FCFM, Santiago, Chile)	VLT-LUT: Modeling the very long term land use and transportation evolution of cities (Online)
Paper 12.2	John Douglas Hunt (University of Calgary), JE Abraham (HBA Specto Inc), Abdelrahman Muhsen (KAPSARC, Saudi Arabia), G Fuenmayor (HBA Specto Inc)	Forecasting Household Energy Demand in Riyadh Using PECAS (Online)

Michael Batty 	is Chairman of the Management Board of the Centre for Advanced Spatial Analysis (CASA) and Bartlett Professor of Planning (Emeritus) at University College London. https://www.ucl.ac.uk/bartlett/casa/prof-michael-batty
Francisco Javier Martinez 	is Professor and Dean of the Faculty of Physic and Math Sciences, University of Chile https://www.cec.uchile.cl/~dicidet/francisco.html
Ariel Castillo	
Pedro Donoso	
Leonel Gutiérrez	
Ricardo de la Paz Guala	
Juste Raimbault	is a Research Fellow in the UCL Faculty of Mathematical and Physical Sciences https://www.ucl.ac.uk/bartlett/casa/people/dr-juste-raimbalt

	
John Douglas Hunt 	is a professor in the Engineering department at University of Calgary https://schulich.ucalgary.ca/contacts/john-hunt
JE Abraham	
Abdelrahman Muhsen	
G Fuenmayor	
Yue Ying 	is a PhD candidate at University of Cambridge.

Paper 12.1

Author(s)	Francisco Martínez, Ariel Castillo, Pedro Donoso, Leonel Gutiérrez and Ricardo de la Paz Guala (Universidad de Chile, FCFM, Santiago, Chile)
Corresponding author	Francisco Martínez <fmartine200158@icloud.com>
Title	VLT-LUT: Modeling the very long term land use and transportation evolution of cities
Synopsis	[Speaker to add]
Abstract	In this work we simulate the cities' evolution to understand the very long-term impacts of urban planning. The cities' complexity is modeled with the very long term land use and transportation (VLT-LUT) model, a tool that simulates the evolution of the city according to two of its main characteristics: its land use and its transportation. The interaction of both of these dimensions in the very long term is modeled by applying results of urban microeconomic theory, considering population growth, socioeconomic migration, rents and incomes, among others. Given its memory property, the VLT-LUT model is not a sequence of consecutive static states of a city, but a dynamic construction where the current state is determined by its predecessor state. This feature keeps track of different aspects of the city's evolution, such as demolition rate and transport performance, that are fundamental to consistently embed a state with the next one. Another result is that land rents evolve super-linearly with population, in line with previous empirical and theoretical research. Preliminary simulation results are obtained from applying the model to an artificial city with 400 zones, a simplified road network and no policies during a time span of 300 years (in terms of population growth). Keywords: Land use; Transportation; Power law; Urban dynamics; Citie's evolution.
Further reading	[Speaker to add]

Paper 12.2

Author(s)	John Douglas Hunt (University of Calgary), JE Abraham (HBA Specto Inc), Abdelrahman Muhsen (KAPSARC, Saudi Arabia), G Fuenmayor (HBA Specto Inc)
Corresponding author	John Douglas Hunt <jdhunt@ucalgary.ca>
Title	Forecasting household energy demand in Riyadh using PECAS
Synopsis	[Speaker to add]
Abstract	A PECAS spatial economic model of Riyadh in Saudi Arabia has been developed drawing on various data sources including an input-output table, the parcel cadastre, a household survey of travel and electricity use, labour and housing statistics, and transport system characteristics from a 4-step travel demand model. Household in-home energy use is forecasted dependent on demographic and dwelling characteristics for each future parcel, while household travel patterns from the economic flow relationships are used to forecast energy consumption in travel. The model is being used to investigate scenarios where district cooling, building construction regulations, and zoning for transit-oriented-development help manage increases in energy demand while facilitating rapid growth in population and economic activity. The model structure and components provide explicit representation of the trade-offs to be made among household consumption and travel, technology and spatial patterns of development.
Further reading	[Speaker to add]

Session 13: Cities in East Asia

	Session 13: Cities in East Asia	
	Chair: Kazuki Nakamura (Meijo University, Nagoya)	
	Host: Louise Luo (University of Cambridge)	
Paper 13.1	Haixiao Pan, Miao Hu, Tao Chen (Department of Urban Planning, Tongji University, Shanghai)	Exploring jobs-housing balance along metro lines: A case study in Shanghai (Online)
Paper 13.2	Junyi Zhang (Hiroshima University, Hiroshima)	Integrated transport-energy modelling (Online)
Paper 13.3	Runsen Zhang (Hiroshima University, Hiroshima)	Long-term pathways to deep decarbonization of the transport sector in the post-COVID world (Online)
Paper 13.4	Jing Kang (Hiroshima University, Hiroshima)	Spatial analysis of EV users' demands for public infrastructure in the context of COVID-19, based on multi-source big data integration (Online)

Kazuki Nakamura 	is Associate Professor in the Department of Civil Engineering at Meijo University http://civil.meijo-u.ac.jp/lab/nakamura/
Haixiao Pan 	is Professor of Urban Planning at the College of Architecture and Urban Planning, Tongji University https://upd-caup.tongji.edu.cn/phx/list.htm
Miao Hu	
Tao Chen	
Junyi Zhang	is Professor at the Graduate School of Advanced Science and Engineering and the Graduate School for International Development and Cooperation, Hiroshima University https://home.hiroshima-u.ac.jp/~zjy/

	
Runsen Zhang 	is Assistant Professor at the Graduate School of Advanced Science and Engineering and the Graduate School for International Development and Cooperation, Hiroshima University https://seeds.office.hiroshima-u.ac.jp/profile/en.90690cc13329ebbe520e17560c007669.html
Jing Kang 	is Assistant Professor at the Graduate School of Advanced Science and Engineering, Hiroshima University https://drjingkang.github.io/mainpage/
Louise Luo 	is a PhD candidate at University of Cambridge.

Paper 13.1

Author(s)	Haixiao Pan, Miao Hu, Tao Chen (Department of Urban Planning, Tongji University, Shanghai)
Corresponding author	Haixiao Pan <hxpank@vip.126.com>
Title	Exploring Jobs-Housing Balance along Metro Lines: A Case Study in Shanghai
Synopsis	[Speaker to add]
Abstract	As a megacity in a developing country with a fast urbanization process, Shanghai is facing the commuting problems like other megacities: congestion, prolonged commuting time, unbalanced peak hour load on public transport, and so on. Many countermeasures were proposed, among which the most important ones are promoting public transport accessibility and jobs-housing balance. However, both methods are flawed: in a megacity, taking public transport may take double to quadruple the time compared to private cars in long-distance commuting, and the differences in the natural distribution patterns between employment and housing make it impossible to put all the workplaces to housing places in modern society. In this paper, we put these two approaches together; if the jobs and housing would achieve balance within a certain distance or commuting time along the metro line, it will alleviate the commuting load city-wide. We also hope to reach balanced inbound/outbound passenger flow on some parts of the metro networks. We can fully utilize metro capacity on those parts of the metro networks. The primary data in this research are cell phone data in each base station all over Shanghai, processed into raster data, then converted to vector data and overlapping with existing metro system vector data. In doing so, we acquire the quantity and density of household and job position counts in the vicinity of each metro station. According to the distribution of passenger flow under different commuting distances at all stations, we select 6km, 10km, and 12km as the geographical scope to calculate the corridor-wide jobs-housing ratio, and accessibility, Gini index of ridership at each station. The above indicators generally show a downward trend from the city center to the suburb area, but it is worth noting that some group of stations appears to have a different performance from the surrounding area. Combined with these indicators, we use K-Means to analyze the clusters of stations. While the category of groups varies from the city's center to the outskirts, the result also indicates which are the ones that are more job-housing balanced. For example, near the Century Park in the Pudong New District, stations along the Metro Line of No. 6 and No. 7 are clustered into two categories, one is with high accessibility and more balanced inbound/outbound ridership as well as jobs-housing ratio, while the other one is the opposite. Furthermore, we will use regression to explain the cluster analysis results better to analyze the correlation between the jobs-housing, ridership balance, and these indicators with new variables such as the attributes of service facilities around the station. Overall, this research can provide an intuitive understanding of the balancing performance within the metro network.
Further reading	[Speaker to add]

Paper 13.2

Author(s)	Junyi Zhang, Hiroshima University
Corresponding author	Junyi Zhang <zjy@hiroshima-u.ac.jp>
Title	Integrated transport-energy modelling based on the life-oriented approach
Synopsis	This talk is a part of research on the life-oriented approach, which argues the importance of incorporating various behavioral interdependencies across people's various life domains, including household energy consumption. (Zhang, J. (2017) Life-oriented Behavioral Research for Urban Policy, Springer). This talk will only focus on households' in-home and out-of-home energy consumption modelling issues. More general transport and energy research refers to Zhang, J. (2019) Transport and Energy Research: A Behavioral Perspective, Elsevier.
Abstract	This speech will report how to develop behaviorally-oriented energy-transport policymaking tools based on the life-oriented approach. The life-oriented approach argues that people's decisions on various life choices are not independent of each other and that an understanding of life choices should not be constrained by the boundary of any single discipline. Households' choices of residential location, ownership and usage of transport vehicles and in-home energy-consuming end uses, time use and so on are integrated based on advanced choice models with flexible structures and further incorporated into a dynamic active energy demand management system for evaluating the effects of various policies. Applications will be introduced and future challenges will be discussed.
Further reading	1. https://doi.org/10.1016/j.energy.2015.07.131 2. https://doi.org/10.1016/j.trd.2015.07.001 3. https://doi.org/10.1016/j.trd.2013.06.001 4. https://doi.org/10.1068/b38213 5. https://doi.org/10.1016/j.enpol.2012.03.067 6. https://doi.org/10.1016/j.enpol.2011.04.024

Paper 13.3

Author(s)	Runsen Zhang, Hiroshima University
Corresponding author	Runsen Zhang <zrs@hiroshima-u.ac.jp>
Title	Long-term pathways to deep decarbonization of the transport sector in the post-COVID world
Synopsis	Adjustment to the post-COVID new normal may create both unprecedented opportunities and challenges for the decarbonization of the transport sector. To understand the role of the transport sector in achieving climate change targets in the context of a post-COVID world, an urban economic model that accommodates detailed transport and energy technology representations is developed to offer a methodology appropriate for, and capable of, capturing the dynamics of transport demand, energy consumption, and emission profiles at the city scale. Compared to an individual transport model or an energy model, such an integrated approach can provide elaborate economic and technological descriptions of the transport sector to structure scenarios for the post-COVID new normal. This methodology allows urban planners, transport planners, energy scientists, and policymakers to collaborate and propose effective integrated policies and strategies promoting decarbonization of the transport sector with the arrival of the post-COVID world.
Abstract	The novel coronavirus disease 2019 (COVID-19) crisis has influenced economies and societies across the globe and will thoroughly reshape our world as it continues to unfold. The pandemic is likely to trigger permanent long-term impacts on the transport sector in the post-COVID world. While a post-COVID "new normal" will be likely to incur negative consequences, it may provide an opportunity to move toward a more sustainable transport sector. This paper is aimed at developing an urban economic model with an energy focus to depict the dynamics of travel demand, energy consumption, and emissions in the post-COVID world. A set of scenarios was created according to model assumptions regarding lifestyle changes and policy interventions accompanied by the expected post-COVID new normal, to explore long-term pathways toward a deep decarbonization of the transport sector. Scenario simulations demonstrated that working from home, online shopping, and a bike-friendly infrastructure will contribute to a reduction in energy consumption and CO2 emissions, whereas a significant shift from bus to car transport and the decreasing use of car-sharing services will adversely affect CO2 emission reductions. The arrival of the post-COVID world may contribute to an 11% reduction in CO2 emissions by 2060, while the maximum reduction potential could be as high as 44%. Supporting policies and strategies for encouraging remote work and online shopping as well as for promoting safe public transport, active transport, and carpooling services are needed to strongly decarbonize the transport sector in the post-COVID world. Moreover, population distribution and urban structure may also be influenced by the arrival of the post-COVID new normal, which warrant further attention for urban planning.
Further reading	https://www.sciencedirect.com/science/article/pii/S0967070X21001621

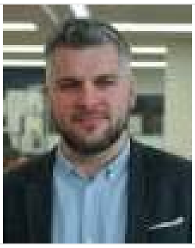
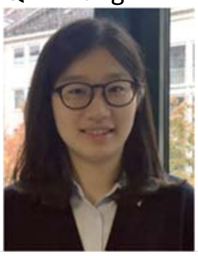
Paper 13.4

Author(s)	Jing Kang, Hiroshima University
Corresponding author	Jing kang <kj@hiroshima-u.ac.jp>
Title	Spatial analysis of EV users' demands for public infrastructure in the context of COVID-19, based on multi-source big data integration
Synopsis	Extensive discussions and speculations on the post epidemic era have been conducted, which requires data-driven evidence to support. Here, we will draw attention to a topic on the EV users' charging demands for public infrastructure, that is, to explore the supply-demand match or mis-match patterns, and analyze the possible changes affected by COVID-19. Taking Beijing China as a case study, we will use geo-spatial big data to capture people's actual activity demands; machine learning is used to define functional land use categories, emphasizing the human-driven activities on the mixed physical space.
Abstract	Distributing infrastructure on demand is an ideal state. When urban infrastructure planning does not match the actual demands of people, it will generate a waste of resources and lead to unbalanced development--even social injustice. These are all obstacles to SDG goals. Whileas, COVID-19 is reshaping our activities in many ways, such as travel behavior, telecommuting, and online shopping; It indicates that people have more chances to stay at home; then it may have effects on public charging demands, reflecting on the relationship between transportation and land use. How to examine the EV demands for public infrastructure, regarding its relationship with functional land use? This question has to do with the micro-scale changes of urban physical environment associated with people's travel patterns and lifestyles. Therefore, we use mobile phone big data integrated with remote sensing, to investigate the relationship between public charging stations and demands of EV users; also, the changes of public charging demands affected by the epidemic will be analyzed: before and after the epidemic. In particular, we propose a concept of Functional Land Use based on machine learning, highlighting the possibility of actual human activities in redefining urban layouts. This research finding may have multiple policy implications for transportation planning, energy management, and urban sustainability.
Further reading	https://doi.org/10.3390/rs12162513 https://www.sciencedirect.com/science/article/pii/S2210670721007733 https://www.mdpi.com/2072-4292/12/16/2513

Session 14: Upcoming challenges in transport and land use planning

	Session 14: Upcoming challenges in transport and land use planning	
	Chair: Chen Zhong (University College London)	
	Host: Louise Luo (University of Cambridge)	
Paper 14.1	Nick Malleson (University of Leeds), Alison Heppenstall (University of Glasgow) and Ed Manley (University of Leeds)	Challenges for ABM in Applied Urban Modelling (Online)
Paper 14.2	Rolf Moeckel (Technical University Munich), Corin Staves(University of Cambridge), James Woodcock(University of Cambridge), Qin Zhang(Technical University of Munich)	The next frontier: Modelling health impacts with integrated land use/transport models

Chen Zhong 	is Associate Professor in Urban Analytics at the Bartlett Centre for Advanced Spatial Analysis (CASA), University College London. https://www.ucl.ac.uk/bartlett/casa/people/dr-chen-zhong
Alison Heppenstall 	is Professor of Geocomputation within the School of Social & Political Sciences and the Social and Public Health Sciences Unit, University of Glasgow, UK https://www.gla.ac.uk/schools/socialpolitical/staff/aheppenstall/
Nicholas Malleson 	is a Professor of Spatial Science at the Centre for Spatial Analysis and Policy at the School of Geography, University of Leeds, UK https://environment.leeds.ac.uk/geography/staff/1069/dr-nick-malleson
Ed Manley	is a Professor of Urban Analytics at the Centre for Spatial Analysis and Policy at the School of Geography, University of Leeds, UK https://environment.leeds.ac.uk/geography/staff/9293/professor-ed-manley

	
Rolf Moeckel 	is an Associate Professor in the Department of Mobility Systems Engineering at the Technical University of Munich. His research focuses on travel behaviour analytics and transport modelling, including, activity-based, freight, long-distance, health and integrated land use/transport modelling. https://www.professoren.tum.de/en/moeckel-rolf
Corin Staves 	is a PhD Candidate in Public Health Modelling at the MRC Epidemiology Unit. Supervised jointly by Dr. James Woodcock (University of Cambridge) and Dr. Rolf Moeckel (Technical University of Munich), his research investigates how modelling innovations from transport science can be applied in the field of public health. https://www.mrc-epid.cam.ac.uk/people/corin-staves/
James Woodcock 	is Professor of Transport and Health modelling at the MRC Epidemiology Unit, University of Cambridge. He was lead investigator on the Propensity to Cycle Tool www.pct.bike and ITHIM (Integrated Transport and Health Modelling) tool.
Qin Zhang 	is a PhD candidate in the Department of Mobility Systems Engineering at the Technical University of Munich. She works with Prof. Rolf Moeckel on the integration of transport and health modelling. Her research focuses on pedestrian demand modelling and travel behaviour analytics. https://www.mos.ed.tum.de/en/tb/team/qin-zhang
Louise Luo	is a PhD candidate at University of Cambridge.

Paper 14.1

Author(s)	Nick Malleson, Alison Heppenstall and Ed Manley, University of Leeds
Corresponding author	Nicolas Malleson <N.S.Malleson@leeds.ac.uk>
Title	Challenges for ABM in Applied Urban Modelling
Synopsis	Agent-based modelling (ABM) is often presented as an ideal method for simulating many urban phenomena, but it has yet to evidence regular and robust use in developing or evaluating real-world policy. In this paper we present a number of challenges that are preventing ABM from being more widely used outside of fundamental research environments.
Abstract	Agent-based modelling (ABM) is often presented as an ideal method for simulating many urban phenomena, but it has yet to evidence regular and robust use in developing or evaluating real-world policy. In this paper we present a number of challenges that are preventing ABM from being more widely used outside of fundamental research environments. We ground each challenge with a concrete example from current research. The issues that we will discuss include: Rule initialisation and agent behaviour. Creating accurate rules to drive individual agent behaviour is fraught with difficulty. We will discuss some of the main issues around rule creation and problems with equifinality. We present the use of Reinforcement Learning and Inverse Generative Social Science as potential (albeit ambitious) solutions. Data. Agent-based models are extremely rich, but data are typically coarse. This poses many problems with respect to validation etc. The DyME COVID model is used as an example of a complex, rich simulation with large numbers of latent parameters that must be calibrated and validated on relatively sparse data COVID case data. Calibration / validation and uncertainty quantification. Calibration and validation of ABMs is an ongoing challenge. Here we summarise the main problems and present examples of the use of Uncertainty Quantification and related techniques (including probabilistic agent-based modelling) as a means of more efficient validation. Visualisation. Visualisation of complex models, like ABMs, is fraught with difficulty. We draw on recent collaborations that are developing new ways to visualise complex ABMs. Computational issues. Many of the aforementioned developments are predicated on running very large numbers of models. This is difficult or impossible for computationally expensive ABMs. Here we discusses this problem and uses the aforementioned DyME OpenCL model as an example of the potential if models are programmed with efficiency as a core aim. Conclusion: towards Digital Twins? The paper concludes with a discussion focussed on 'digital twins' and related initiatives. In particular we look at activities related to Glasgow as a living lab (a digital twin of Glasgow for health inequalities), and the SIPHER and GALLANT projects.

Further reading	An, L., Grimm, V., Sullivan, A., Turner II, B.L., Malleson, N., Heppenstall, A., Vincenot, C., Robinson, D., Ye, X., Liu, J., Lindkvist, E., Tang, W., 2021. Challenges, tasks, and opportunities in modeling agent-based complex systems. Ecological Modelling 457, 109685. https://doi.org/10.1016/j.ecolmodel.2021.109685 Spooner, F., Abrams, J.F., Morrissey, K., Shaddick, G., Batty, M., Milton, R., Dennett, A., Lomax, N., Malleson, N., Nelissen, N., Coleman, A., Nur, J., Jin, Y., Greig, R., Shenton, C., Birkin, M., 2021. A dynamic microsimulation model for epidemics. Social Science & Medicine 291, 114461. https://doi.org/10.1016/j.socscimed.2021.114461 Ghahramani, Z., 2013. Bayesian non-parametrics and the probabilistic approach to modelling. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 371, 20110553–20110553. https://doi.org/10.1098/rsta.2011.0553

Paper 14.2

Author(s)	Rolf Moeckel (Technical University Munich), Corin Staves(University of Cambridge), James Woodcock(University of Cambridge), Qin Zhang(Technical University of Munich)
Corresponding author	Rolf Moeckel <rolf.moeckel@tum.de>
Title	The next frontier: Modelling health impacts with integrated land use/transport models
Synopsis	Health impacts of land use and transport are severe. This research expands an agent-based land use/transport model by a health model. Exposure to emissions, injury risks and health benefits of physical activity are simulated to assess the health impacts of land use and transport.
Abstract	Integrated land use/transport models have been used extensively to analyze both land use (in particular zoning and varying growth assumptions) and transport policies (in particular pricing and infrastructure investments) (Acheampong & Silva, 2015). Further integration with environmental impact models made it possible to understand impacts on emissions and noise (Wegener, 2004). The trend towards agent-based land use/transport models (Moeckel et al., 2018) has expanded the range of scenarios and is used frequently to conduct equity analyses. Agent-based integrated land use/transport models are perfectly equipped to assess the impact of land use and transport policies on health, but this line of research has not been explored extensively yet. Agent-based land use models often incrementally update the population over time, which allows to model changes in the agents' health status. The transport model simulates health determinants including physical activity, pollution, and traffic fatalities, which are then fed back to the land use model to adjust survival probabilities. The project GLASST funded by an ERC Grant has introduces health exposures and impacts into the integrated land use model SILO (Moeckel, 2017) travel demand model MITO (Moeckel et al., 2020), and assignment model MATSim (Horni et al., 2016). The health calculations build on methods from the health impact model ITHIM (Woodcock et al., 2013). The microsimulation land use model SILO stores a synthetic population and incrementally updates each agent from year to year. Households may relocate and individual agents may age, get married, have children, get divorced, change job or school, move to a new dwelling or die. Individual households and agents can be traced over time. SILO is tightly integrated with the agent-based travel demand model MITO that creates travel demand for each agent for an average week. The agent-based traffic assignment model MATSim is used to select routes on a multi-modal network. MATSim has been extended to capture physical activity volumes, emissions and pollution exposures, and travel accident injury risks for each agent as they move around the study area. The health impacts module adjusts survival probabilities for each agent based on epidemiological relationships between physical activity levels, air and noise pollution exposure and mortality, and road traffic fatalities. Because of the high spatial and temporal resolution in MATSim, variations in physical activity intensity (e.g. topography) and air pollution exposure whilst travelling can be represented. The integrated model can now simulate how changes to travel behavior impact health outcomes. The model is implemented and calibrated for the Munich metropolitan area.

	A second implementation for Greater Manchester is under development to test transferability, with addition of disease states planned. The presentation will describe the concept and show initial scenario results. References Acheampong, R. A., & Silva, E. (2015). Land use–transport interaction modeling: A review of the literature and future research directions [Land-use, Transportation, Four-step Model, Activity-based Approach, Micro-Simulation, Stochasticity, Uncertainty]. Journal of Transport and Land Use, 8(3). https://doi.org/10.5198/jtlu.2015.806 Horni, A., Nagel, K., & Axhausen, K. W. (Eds.). (2016). The Multi-Agent Transport Simulation MATSim. Ubiquity Press. https://doi.org/http://dx.doi.org/10.5334/baw. Moeckel, R. (2017). Constraints in household relocation: Modeling land-use/transport interactions that respect time and monetary budgets. Journal of Transport and Land Use, 10(2), 1-18. Moeckel, R., Kuehnel, N., Llorca, C., Moreno, A. T., & Rayaprolu, H. (2020). Agent-Based Simulation to Improve Policy Sensitivity of Trip-Based Models. Journal of Advanced Transportation, 2020, 1902162. https://doi.org/10.1155/2020/1902162 Moeckel, R., Llorca Garcia, C., Moreno Chou, A. T., & Okrah, M. B. (2018). Trends in integrated land use/transport modeling: An evaluation of the state of the art [https://doi.org/10.5198/jtlu.2018.1205]. Journal of Transport and Land Use, 11(1), 463–476-463–476. https://www.jtlu.org/index.php/jtlu/article/view/1205 Wegener, M. (2004). Overview of Land Use Transport Models. In D. A. Hensher, K. J. Button, K. E. Haynes, & P. R. Stopher (Eds.), Handbook of Transport Geography And Spatial Systems (Vol. 5, pp. 127-146). Elsevier. lit\wegener_2004.pdf Woodcock, J., Givoni, M., & Morgan, A. S. (2013). Health Impact Modelling of Active Travel Visions for England and Wales Using an Integrated Transport and Health Impact Modelling Tool (ITHIM). Plos One, 8(1), e51462. https://doi.org/10.1371/journal.pone.0051462
Further reading	[Speaker to add]

Session 15: The world going digital

	Session 15: The world going digital	
	Chair: Kaveh Jahanshahi (UK Office for National Statistics – Data Science Campus, Newport, Wales)	
	Host: Yue Ying (University of Cambridge)	
Paper 15.1	Claire Daniel and Chris Pettit (University of New South Wales, Sydney)	Digital planning survey of planners across five 'anglosphere' countries: Australia, New Zealand, the USA, Canada and the UK (Online)
Paper 15.2	Wei Yang (Co-chair of Digital Task Force for Planning, Chair of Wei Yang & Partners, Immediate Past President of the Royal Town Planning Institute) and Michael Batty (Co-chair of Digital Task Force for Planning, and University College London)	Development of the Digital Planning Task Force in the UK

Kaveh Jahanshahi 	is the lead data scientist at the Office for National Statistics and the fellow of Bennett Institute for Public Policy at the University of Cambridge https://datasciencecampus.ons.gov.uk/author/kaveh-jahanshahi/ https://www.bennettinstitute.cam.ac.uk/about-us/team/kaveh-jahanshahi/
Claire Daniel	
Chris Pettit 	is Professor and the inaugural Chair of Urban Science at the University of New South Wales https://cityfutures.be.unsw.edu.au/about-us/our-profiles/christopher-pettit/
Wei Yang 	is Chair of Wei Yang & Partners in London and an Honorary Professor at the Centre for Advanced Spatial Analysis (CASA) UCL. She is Immediate Past President of the Royal Town Planning Institute and Deputy Chair of UK Construction Industry Council. https://www.weiyangandpartners.co.uk/about/team/dr-wei-yang

Michael Batty 	is Chairman of the Management Board of the Centre for Advanced Spatial Analysis (CASA) and Bartlett Professor of Planning (Emeritus) at University College London. https://www.ucl.ac.uk/bartlett/casa/prof-michael-batty
Yue Ying 	is a PhD candidate at University of Cambridge.

Paper 15.1

Author(s)	Claire Daniel and Chris Pettit, University of New South Wales, Sydney
Corresponding author	Claire Daniel <claire.daniel@student.unsw.edu.au>
Title	Digital planning survey of planners across five "anglosphere" countries: Australia, New Zealand, the United States of America, Canada and the United Kingdom
Synopsis	I have just completed a survey or more than 800 planners from Australia, UK, USA, Canada and New Zealand asking then how they use data and technology in their work and how they expect things to change. I would love to present the results of the survey to those attending as I believe it will add valuable insight to the "applied" part of the conference. I have been working with an international advisory team including Prof. Chris Pettit, Prof. Elizabeth Wentz, Prof. Michael Batty, Dr Wei Yang and Dr Petra Hurtado.
Abstract	Improvements to technology mean that urban planners have access to more data and more computing power than ever before. There is growing interest in digital planning within the urban planning profession, with people hoping to use it to speed up bureaucratic processes involved in the regulation of development and generate evidence to support the development of planning policy. This new wave of interest has spurred various publications on the topic by professional planning organisations (Hurtado et al., 2022; PIA, 2021) and the taskforce for planning in the UK (Batty and Yang, 2022). There is also a small body of recent academic work looking how the fundamental digitalisation of planning information and a digital society may influence the theory and practice of urban planning (Hersperger et al., 2021; Potts, 2020). Although there may be renewed interest, the application of digital technology in urban planning is not new, dating back even to the early days of computing (Batty, 2014). These efforts have had mixed success. Whilst planning has undoubtedly become more digital in the widespread adoption of GIS, online mapping systems and websites allowing access to planning information, more complex urban modelling applications or planning support systems have yet to see widespread adoption (Daniel and Pettit, 2021; Russo et al., 2018). This longstanding implementation gap has prompted calls for more contextual research into the needs of professional practice (Geertman and Stillwell, 2020). Through late 2021 and early 2022 we ran a comprehensive digital planning survey of planners across five "anglosphere" countries: Australia, New Zealand, the United States of America, Canada and the United Kingdom. The survey incorporated a mix of closed and open questions asking professional planners to report their use of software and data in their role. As well as current use, importantly the survey importantly also asked respondents to outline expectations and desires for future change, perceived barriers to implementation and the impact of the COVID19 pandemic. The survey was promoted online in partnership with the professional institute or association of each country and 536 complete responses were received from across each country, making it one of the larger surveys on the topic of technology and planning undertaken in recent years. The results show that there are similar patterns in the use of technology between countries, and that the use of more complex or novel technologies such as digital twins, scenario planning tools and the use of artificial intelligence is still low across the board. There are however widespread expectations of change amongst planners in all countries regarding greater use of digital technologies

	and data, although there are differences to the form this change is expected to take. For example, Australian respondents anticipate relatively greater automation of development approval processes whilst Canadian respondents emphasise opportunities for digital public engagement. The results of this survey are particularly timely as new interest in digital transformation of the urban planning profession continues to grow. These results offer an important baseline from which future studies into the adoption of technology across the profession can be made. Importantly it also provides insights into what planners themselves expect of the future and where they struggle with new technology, allowing those involved in technology development and training to target their efforts to meet their needs. Batty, M., 2014. Can it Happen Again? Planning Support, Lee's Requiem and the Rise of the Smart Cities Movement. Environ. Plan. B Plan. Des. 41, 388–391. https://doi.org/10.1068/b4103c2 Batty, M., Yang, W., 2022. A Digital Future for Planning: Spatial Planning Reimagined. London. Daniel, C., Pettit, C., 2021. Digital disruption and planning – use of data and digital technology by professional planners, and perceptions of change to planning work. Aust. Plan. 1–15. https://doi.org/10.1080/07293682.2021.1920995 Geertman, S., Stillwell, J., 2020. Planning support science: Developments and challenges. Environ. Plan. B Urban Anal. City Sci. 47, 1326–1342. https://doi.org/10.1177/2399808320936277 Hersperger, A.M., Thurnheer-Wittenwiler, C., Tobias, S., Folvig, S., Fertner, C., 2021. Digitalization in land-use planning: effects of digital plan data on efficiently, transparency and innovation. Eur. Plan. Stud. 0, 1–17. https://doi.org/10.1080/09654313.2021.2016640 Hurtado, P., Shah, S., DeAngelis, J., Gomez, A., 2022. 2022 Trend Report for Planners. American Planning Association & Lincoln Institute of Land Policy. PIA, 2021. Planning Institute of Australia PlanTech Principles [WWW Document]. URL https://www.planning.org.au/planningresourcesnew/plantech-pages/pia-plantech-principles (accessed 12.7.21). Potts, R., 2020. Is a New 'Planning 3.0' Paradigm Emerging? Exploring the Relationship between Digital Technologies and Planning Theory and Practice. Plan. Theory Pract. 21, 272–289. https://doi.org/10.1080/14649357.2020.1748699 Russo, P., Lanzilotti, R., Costabile, M.F., Pettit, C.J., 2018. Adoption and Use of Software in Land Use Planning Practice: A Multiple-Country Study. Int. J. Human–Computer Interact. 34, 57–72. https://doi.org/10.1080/10447318.2017.1327213
Further reading	[Speaker to add]

Paper 15.2

Author(s)	Wei Yang (Wei Yang and Partners, London), Michael Batty (UCL)
Corresponding author	Wei Yang <wyang@weiyangandpartners.co.uk>
Title	Development of the Digital Planning Task Force in the UK
Synopsis	The paper will review the Digital Task Force for Planning's work and present the key finds and recommendations of its report, A Digital Future for Planning: Spatial Planning Reimagined, which presents a collective vision for a digital future for planning – not only from planners, but also from a spectrum of like-minded built and natural environment professionals – as they believe at this crucial moment in human history, we have to work beyond professional and political boundaries to tackle multifaceted grand challenges collaboratively. The paper will also discuss the next stage vision of the Task Force - to be at the driver seat to implement and promote the digitalisation of spatial planning.
Abstract	We are currently standing at a threshold, defined to an extent by the pandemic. This is a tipping point focused on how the planning profession and planning in society can best embrace a future increasingly based on the digital revolution. To raise the awareness, identify the needs, and urge actions, a Digital Task Force for Planning co-chaired by Michael Batty and Wei Yang was formed in February 2021 in the UK. It is an independent panel formed by a group of influential thought leaders across a broad spectrum relating to planning and digital technology. During 2021, the Task Force carried out a comprehensive cross-sector consultation programme, involving local and national government departments, agencies dealing with the natural and built environment, digital technology, public health, and higher education. Using a whole systems approach, the study is set against the UK government's commitment to science and technology and cutting-edge research. Different from previous reviews of the planning system which were focused on the legislative and policy aspects of planning, this review took an entirely open approach that links many grand challenges together. The study is beyond professional, political, and departmental boundaries. The purpose of this report is to present a collective vision on how planning needs to respond to the digital future. A big question was asked: "What should be done now to make our world a better place for our future generations through achieving a universal common good". The Task Force regarded a new digitally enabled systems approach to spatial planning as one of the keys to unlocking the move to multiple goals. The Task Force report, A Digital Future for Planning: Spatial Planning Reimagined (Batty & Yang 2022), was published in February 2022. In light of the transition to a circular economy and based on the fourth Industrial revolution's focus on redesigning systems, the report proposes a transformative digitalisation of spatial planning – a people-centric process which is enabled by digital technologies.

	In fact, the report is not about the planning profession itself. It is about reinvigorating the profession, about recreating a reimagined planning profession – a profession that can coordinate the best knowledge and advance the most appropriate digital tools and technologies from related disciplines so that we can achieve a shared vision and to create a better future for everyone. The report has been well received in the industry and has made direct policy impact to the work of several UK Government departments. The Task Force is now stepping into its next stage and will carry out further work to lead and promote the digitalisation of spatial planning.
Further reading	A Digital Future for Planning: Spatial Planning Reimagined, Batty & Yang (2022) https://digital4planning.com/a-digital-future-for-planning/

Session 16: Upcoming challenges in local planning

	Session 16: Upcoming challenges in local planning	
	Chair: Marcial Echenique (University of Cambridge)	
	Host: Yaotian Ma (University of Cambridge)	
Paper 16.1	Alistair Brereton-Halls and David Simmonds (David Simmonds Consultancy, UK)	Alternative approaches to appraising the benefits of land use and transport interventions

Marcial Echenique 	is Professorial Fellow of Churchill College and Emeritus Professor of Land Use and Transport Studies at the University of Cambridge. https://www.arct.cam.ac.uk/people/me15@cam.ac.uk
Alistair Brereton-Halls	
David Simmonds 	is an internationally recognized specialist in analysis and modelling of the interactions between land-use transport and the economy, with over 30 years' experience in this field. He established David Simmonds Consultancy (DSC) in 1990, and has led its growth to the present position where it is the leading practice in its particular field. https://www.davidsimmonds.com/people
Yaotian Ma 	is a PhD candidate at University of Cambridge.

Paper 16.1

Author(s)	Alistair Brereton-Halls and David Simmonds, David Simmonds Consultancy
Corresponding author	David Simmonds <david.simmonds@davidsimmonds.com>; Alistair Brereton-Halls <alistair.bh@davidsimmonds.com>
Title	Alternative approaches to appraising the benefits of land-use and transport interventions
Synopsis	[Speaker to add]
Abstract	Conventional methods of appraisal continue to play a fundamental role in assessing the valuation of transport and land-use policy. However, the shift from pure, bottom-line cost-benefit analysis to a more equitable approach, presents an opportunity to broaden the range of tools available to modern appraisal practitioner and urban modellers alike. We present two alternative packages, representing three distinct approaches to appraisal: first, WIC (the Wider Impacts Calculator) builds upon well-established practice in transport appraisal, not only measuring TAG-type wider economic impacts, but also appraising labour market effects, estimating distributional effects, and potentially counting the impact of transformational schemes which reduce structural unemployment. Second, an extension to WIC assesses accessibility-based land value uplift. Third, the ULTrA (Unified land-use/transport appraisal) package uses the concept of accessibility appraisal to implement a method of economic appraisal which is based on conventional principles but allows for the appraisal of either transport or land-use proposals, or combinations thereof, and explicitly recognizes land-use/transport interaction and the range of feedbacks that result. Whereas WIC extends conventional TEE analysis, ULTrA applies the theory shown through analysis of house prices - that accessibility is something that the large majority of households are willing to pay for, whether explicitly (in high rents or prices), implicitly (in accepting a smaller dwelling or a noisier location) or through a combination of the two. We will describe the methods involved in the packages and include some example results.
Further reading	[Speaker to add]

Session 17: Urban analytics and modelling

	Session 17: Urban analytics and modelling	
	Chair: Joseph Ferreira Jr. (MIT)	
	Host: Shanshan Xie (University of Cambridge)	
Paper 17.1	Kaveh Jahanshahi et al (UK Office of National Statistics Data Science Campus, Newport, Wales)	[Urban data analysis at the ONS]
Paper 17.2	Qili Gao (UCL), Chen Zhong (UCL), Yang Yue Shenzhen University)	SIMETRI: socio-spatial inequalities and human mobility in megacities

Joseph Ferreira Jr. 	is Professor (post-tenure) of Urban Information Systems in the Department of Urban Studies and Planning of the Massachusetts Institute of Technology (MIT). https://dusp.mit.edu/faculty/joseph-ferreira
Kaveh Jahanshahi 	is the lead data scientist at the Office for National Statistics and the fellow of Bennett Institute for Public Policy at the University of Cambridge https://datasciencecampus.ons.gov.uk/author/kaveh-jahanshahi/ https://www.bennettinstitute.cam.ac.uk/about-us/team/kaveh-jahanshahi/
Qili Gao 	is a research fellow in urban mobility and inequality at the Bartlett Centre for Advanced Spatial Analysis, University College London. https://www.ucl.ac.uk/bartlett/casa/people/staff
Chen Zhong 	is Associate Professor in Urban Analytics at the Bartlett Centre for Advanced Spatial Analysis (CASA), University College London. https://www.ucl.ac.uk/bartlett/casa/people/dr-chen-zhong
Yang Yue	is a professor at the department of urban informatics, Shenzhen University

	https://spatial.szu.edu.cn/info/1006/3376.htm
Shanshan Xie 	is a PhD candidate at University of Cambridge.

Paper 17.1

Author(s)	Chaitanya Joshi, Arif Ali, Thomas ÓConnor, Li Chen, Kaveh Jahanshahi
Corresponding author	Kaveh Jahanshahi <Kaveh.Jahanshahi@ons.gov.uk>
Title	Urban data analysis at data science campus, ONS; example of utilising federated data for evaluating COVID-19 influences at community level
Synopsis	[Speaker to add]
Abstract	Utilising big data sources in the era of digital and smart cities provides some unique opportunities for generating statistics in granular temporal and spatial levels. Our recent work on analysing COVID-19 influences at community level illustrates some of the potentials of fusing various data and Machine Learning Techniques to make causal inferences. This study evaluates community level influences on COVID-19 incidence in England with the main focus on understanding the contributing factors in relatively higher infection rates for workers in certain industries such as care homes and ware houses. Analysis at community level allows accounting for interrelations between socioeconomic and demographic profile, land use, and travel patterns -including residents' self-selection and spatial sorting- and also controlling for dynamic factors including vaccination rates and mobility. Moreover, Looking into community level influences can tailor and direct policy questions for further detailed epidemiological and individual level investigations. We have assembled a large set of data at small area statistical geographies (Lower Layer Super Output Areas, LSOA) in England making the dataset, arguably, the most comprehensive set assembled in the UK for community level analysis of COVID-19 infection. The data are integrated from a wider range of sources including telecommunications companies, test and trace data, national travel survey, Census and Mid-Year estimates. To tackle methodological challenges specifically accounting for highly interrelated influences, we have combined different statistical and machine learning techniques. We have adopted a two-stage modelling framework: a) Latent Cluster Analysis (LCA) to classify the country into distinct land use and travel patterns, and b) multivariate linear regression to evaluate influences at each identified distinct travel cluster. We have also segmented our data into different time periods based on changes in policies and evolvement in the course of pandemic. By segmenting and comparing influences across spaces and time, we examine more homogeneous behaviour and uniform distribution of infection risks which in turn increase the potential to make causal inferences and help understand variations across communities and over time.
Further reading	https://datasciencecampus.ons.gov.uk/use-of-hybrid-data-to-understand-the-community-level-influences-on-coronavirus-covid-19-incidence/

Paper 17.2

Author(s)	Qili Gao (UCL), Chen Zhong (UCL), Yang Yue (Shenzhen University)
Corresponding author	Qili Gao <qili.gao@ucl.ac.uk>
Title	SIMETRI: socio-spatial inequalities and human mobility in megacities
Synopsis	The research relies on SIMETRI project and focuses on urban inequality from the perspective of human mobility. Specifically, activity space concept and human mobility big data are applied to measure social differentiation and exclusion.
Abstract	The rapid growth of the population in mega-city regions is causing severe problems of social segregation, mobility, and income inequalities. To deal with these issues, new and powerful analytical approaches, such as those being developed employing real-time big data sources and new computing technologies, are required. The research project SIMETRI (SustaInable Mobility and Equality in mega-ciTy RegIons: patterns, mechanisms and governance) aims to develop a world-class science platform relevant to political decision-makers responsible for housing, transport, employment and urban development in the world's biggest mega-city region, the Pearl River Delta Greater Bay Area. Determining the inequalities in daily mobility across social or income groups serves as the first step toward developing effective interventions. Under the SIMETRI project, we take advantage of two kinds of human mobility data to provide evidence of the differences in activity spaces between different social groups. Taking Shenzhen, a mega-city in Greater Bay Area, as a case study, we first explore the activity differentiation by income status by using three kinds of different methods of characterising human mobility patterns. Then we leverage two types of transport data (public transit records and private car data) to examine the disparities in activity participation between the two social groups by transport mode. In combination with evidence from the two cases, we found that income status might be not the dominant factor determining activity spaces and transport mode plays a vital part in inequality in access activities and urban opportunities. Having this knowledge may provide more targeted implications for related policy to detect and reduce potential social exclusion for disadvantaged groups. The analytical framework and methods also have implications for a more in-depth assessment of mobility and social exclusion in other urban contexts as well.
Further reading	SIMETRI: https://simetri.uk/ Gao, Q. L., Yue, Y., Tu, W., Cao, J., & Li, Q. Q. (2021). Segregation or integration? Exploring activity disparities between migrants and settled urban residents using human mobility data. *Transactions in GIS*, *25*(6), 2791-2820.

Session 18: Frontiers in infrastructure modelling

	Session 18: Frontiers in infrastructure modelling	
	Chair: (tbc)	
	Host: (tbc)	
Paper 18.1	Bryant ML Lai (Transports Publics Fribourgeois SA, Givisiez, Switzerland), Claudio Martani (Purdue University), Orlando M Roman Garcia (ETH Zürich), Bryan T Adey (ETH Zürich)	Evaluating the use of responsive train stations gateways to minimize the risk of overcrowded platforms: the example of the London Bridge Station
Paper 18.2	Claudio Martani (Purdue University), Jonas Imfeld (ETH Zurich), Hazar N. Dib (Purdue University), Bryan T Adey (ETH Zurich)	Initial exploration of the stakeholder advantages of using robotic inspections and cleaning of water distribution pipes in urban areas (Online)

(Chair)	
Bryant ML Lai 	is graduated in MSc Spatial development and infrastructure systems at ETH Zürich in February 2022. He is now working as a traffic engineer at TPF SA
Claudio Martani 	is Assistant Professor at the Purdue School of Construction Management Technology and Director of the Laboratory for Future-Ready Infrastructure (FuRI Lab). https://polytechnic.purdue.edu/profile/cmartani
Orlando M Roman Garcia 	is graduated with an MPhil in Engineering for Sustainable Development at the University of Cambridge in 2018. He is now a doctoral researcher at the Infrastructure Management Group at ETH Zürich
Bryan T Adey	is the Professor for Infrastructure Management, and the head of the Institute for Construction and Infrastructure Management, ETH Zürich

	https://im.ibi.ethz.ch/en/people/prof-dr-bryan-adey.html
Jonas Imfeld	is a MSc student in Civil Engineering at the ETHZ Zurich
Hazar N. Dib 	is Associate Professor at the School of Construction Management Technology at the Purdue University. https://polytechnic.purdue.edu/profile/hdib
(Host)	

Paper 18.1

Author(s)	Bryant ML Lai (Transports Publics Fribourgeois SA, Givisiez, Switzerland), Claudio Martani (Purdue University), Orlando M Roman Garcia (ETH Zurich), Bryan T Adey (ETH Zurich)
Corresponding author	Claudio Martani <cmartani@purdue.edu>
Title	Evaluating the use of responsive train stations gateways to minimize the risk of overcrowded platforms: the example of the London Bridge Station
Synopsis	Overcrowding of train platforms is becoming a reccurent issue for train operators, inpacting the comfort and safety of the users, and generating delays that can spread over the whole network. The goal of this work is to assess the implementation of a sensing and responding system in a case study with railway station of London Bridge (UK).
Abstract	Train stations are an essential part of public transports systems, serving as hubs for large crowds of passengers moving daily between trains and local transports. The ability of train stations to provide an adequate service over time is subject to the continuous variability in the passengers' flow; that changes largely over different periods of the year (i.e. seasonal variation), days of the week (i.e. working days vs. weekends) and time of the day (i.e. peak hours vs. off-peak hours). When stations get overcrowded, the high concentration of people pose a prominent risk to passenger comfort and safety and further operational problems such as travel delays. The recent technological developments in real time crowd counting, and pedestrian microsimulations allow to develop responsive gateways to automatically control overcrowding and minimize these risks. The use of responsive gateways has been recently proposed and tested by Martani et al. (2015 and 2017) at the London Bridge Station (UK). Despite the promising positive economic and social effects of passengers' flow optimization, responsive gates are rather expensive due to the high cost of installation and maintenance. As such, whether or not the costs are worthy is to be demonstrated. In this paper the costs and benefit of using responsive gateways at the London Bridge Station are evaluated considering the long-term uncertainty on the passengers' flow. To that scope the real options method (as put forward by (Ellingham and Fawcett (2007) and De Neufville and Scholtes, 2011)) is used for the first time in this context to: quantify the service to be provided, identify and model the uncertainty on the passengers' flow and simulate scenario to estimate the expected effect of the responsive gateways. Results over 500 crowd simulations show that, considering the interests of both the owner - on the interventions costs - and these of the users - on safety and comfort -, the responsive gateways offer a better service ($95.5 \cdot 10^6$ [£] of yearly total cost, with a standard deviation of $35.0 \cdot 10^6$ [£]) than the static ones ($88.1 \cdot 10^6$ [£] of yearly total cost, with a standard deviation of $27.0 \cdot 10^6$ [£])). This is mainly due to the expected reduction in the risk on safety, travel time and comfort, with the responsive gateways, that compensate for a higher cost of construction and maintenance. Despite the encouraging results, further research is envisioned to improve the modelling of uncertainty on the passengers' flows, e.g. using systems dynamics model to illustrate the consequences on travel time and accidents that future uncertainties may have, and expand the objective function further to include the interests of more stakeholders, e.g. the environmental costs.

	References De Neufville, Richard, and Stefan Scholtes. 2011. Flexibility in Engineering Design. MIT Press; Ellingham, Ian, and William Fawcett. 2007. New Generation Whole-Life Costing: Property and Construction Decision-Making under Uncertainty. Routledge; Martani, C., Stent, S., Acikgoz, S. (2015). Real time station monitoring and modelling for peak flow management. Results of tests conducted on technology deployment at London Bridge Station and plans for future actions, AUM 2015 Cambridge, UK; Martani, C., Stent, S., Acikgoz, S., Soga, K., Bain, D., and Jin, Y. (2017). Pedestrian monitoring techniques for crowd-flow prediction. Proceedings of the Institution of Civil Engineers-Smart Infrastructure and Construction, 1-11.
Further reading	Martani, Claudio, Simon Stent, Sinan Acikgoz, Kenichi Soga, Dean Bain, and Ying Jin. 2017. "Pedestrian monitoring techniques for crowd-flow prediction." Proceedings of the Institution of Civil Engineers - Smart Infrastructure and Construction 170 (2): 17-27. doi:10.1680/jsmic.17.00001. Esders, Miriam, Nicola Della Morte, and Bryan T. Adey. 2015. "A Methodology to Ensure the Consideration of Flexibility and Robustness in the Selection of Facility Renewal Projects." International Journal of Architecture, Engineering and Construction 4 (3). doi:10.7492/ICSDM.2015.013. Le Glatin, Nicolas, Isabelle Milford, and Andrew Hutton. 2014. London Bridge: The Role Pedestrian Modelling Played in Designing the New Station. Vol. 1, in Pedestrian and Evacuation Dynamics 2012, edited by Ulrich Weidmann, Uwe Kirsch, and Michael Schreckenberg, 21-37. Cham: Springer International Publishing. doi:10.1007/978-3-319-02447-9_2.

Paper 18.2

Author(s)	Claudio Martani (Purdue University), Jonas Imfeld (ETH Zurich), Hazar N. Dib (Purdue University), Bryan T Adey (ETH Zurich)
Corresponding author	Claudio Martani <cmartani@purdue.edu>
Title	Initial exploration of the stakeholder advantages of using robotic inspections and cleaning of water distribution pipes in urban areas
Synopsis	Water distribution networks require constant cleanings and maintenance to provide an adequate level of service over decades. Pipe inspection and cleaning robots can improve significantly the maintainability of pipes and avoiding road disruptions and malfunctioning in the water provision. Despite their advantages, the high costs for buying and operating these robotic solutions triggers some skepticism on their use. In this paper an initial estimation of the benefits and costs for multiple stakeholders at the urban level from the use of inspection and cleaning robots is presented and demonstrated on a fictive example network section.
Abstract	Water distribution networks are built and operated to satisfy stakeholders' needs, e.g. the provision of sufficient amount and quality of water for the users and the reduction of intervention costs for owners, for decades. Over such a stretch of time these infrastructures require constant cleanings and maintenance to provide an adequate level of service, i.e. avoiding obstructed or broken piper. Interventions on underground pipes are traditionally executed based on statistical failure rates, with important costs both direct - for labor and material - and indirect - impact on traffic, when pipes are buried under roads, e.g. breaking pavements, excavations, doing new pavements. Therefore, despite being desirable for the users, executing the required cleanings and maintenance interventions produces undesirable consequences for other stakeholders. This is particularly the case in dense urban areas, where the pipe interventions temporary disrupt the road traffic, affecting the connectivity between numerous fundamental services (e.g. hospitals, schools). The ideal intervention strategies for these infrastructures would be the one that minimizes the negative consequences on all the involved stakeholders (i.e. optimizing the balance between costs of intervention, water quality provision and disruption of traffic). Pipe inspection and cleaning robots, often referred to as pipe drones, can improve significantly the maintainability of pipes by reducing the time and cost of maintenance, as well as avoiding road disruption and related loss of service. In light of this potential, they are one of the most promising applications for robotization in construction management. Despite their potentials, robotized inspection and cleaning of pipes with drones requires substantial initial investments. i.e. buying and operating the drones, and infrastructure manages are often concerned about whether the investments required to operate a functioning robotized maintenance of pipes could be justified by the reduction in the loss of service in the long-term. To improve understanding of the potential of the robotized maintenance of pipes, in this paper an initial estimation of the benefits and costs from the use of robotic solutions for inspections and cleaning of water distribution pipes is presented and demonstrated on a fictive example network section located in an urban area. The estimate is done considering future uncertainty on interventions need, by simulating the deterioration of infrastructure and the effects on stakeholders of not receiving the expected service (including the impact on traffic) when maintenance strategies are following with and without the use of robotic solutions for inspections and

	cleaning. Results from the example indicate that the consequences of using robotic inspections and cleaning of water pipes have considerable advantages in terms of both intervention costs and reduced service disruption for multiple stakeholders over 40 years.
Further reading	Adey, B. T., Martani, C., Papathanasiou, N., & Burkhalter, M. (2018). Estimating and communicating the risk of neglecting maintenance. Infrastructure Asset Management, 6(2), 109-128. Burkhalter, M., Martani, C., & Adey, B. T. (2018). Determination of risk-reducing intervention programs for railway lines and the significance of simplifications. Journal of infrastructure systems, 24(1), 04017038.

Session 19: Accessible and affordable cities

	Session 19: Accessible and affordable cities	
	Chair: Geoffrey Hewings (University of Illinois Urbana- Champaign)	
	Host: Ying Jin (University of Cambridge)	
Paper 19.1	Rounaq Basu (MIT)	Planning sustainable cities: Coordinating accessibility improvements with housing policies (Online)
Paper 19.2	Michael Reilly (Michael Reilly Research and Consulting)	Forecasting Bay Area Housing Affordability (Online)

Geoffrey Hewings 	is Director Emeritus of the Regional Economics Applications Laboratory at the University of Illinois at Urbana-Champaign as well as an Emeritus Professor in the Departments of Economics, Agricultural and Consumer Economics, Urban and Regional Planning, Geography and in the Institute of Government and Public Affairs http://www.real.illinois.edu/faculty/hewings.html
Rounaq Basu 	is a Ph.D. candidate in Urban Science and Planning in the Department of Urban Studies and Planning at the Massachusetts Institute of Technology. https://scholar.google.com/citations?user=Zx4Sk7YAAAAJ&hl=en
Michael Reilly	
Ying Jin 	is a Professor of Architecture and Urbanism at Dept of Architecture, University of Cambridge, and and he was elected a Commissioner of the UK2070 Commission and the Independent Transport Commission in 2022. https://www.arct.cam.ac.uk/people/yj242@cam.ac.uk

Paper 19.1

Author(s)	Rounaq Basu, MIT
Corresponding author	Rounaq Basu <rounaq@mit.edu>
Title	Planning sustainable cities: Coordinating accessibility improvements with housing policies
Synopsis	Using an integrated urban microsimulation model, I examine different ‘what-if’ scenarios of how the housing market might react to non-auto accessibility improvements (such as expanding transit lines, installing bikeshare stations, or implementing on-demand shuttle services). I find that better access to non-auto mobility options can make neighborhoods more car-free, but these car-free gains can be partially dampened by higher-income in-movers who are more likely to own and use cars. I also explore how coordinated housing policies such as increasing housing supply and reducing parking minimums may mitigate the gentrification side-effects while maximizing car-free gains from accessibility improvements.
Abstract	Emerging mobility services, such as mobility-on-demand and micromobility, have expanded the range of travel options available to individuals and offered ways to improve access to various opportunities. Emerging vehicle technologies, such as automated vehicles, may offer opportunities for private car manufacturers to rethink the paradigm of offering private vehicles for purchase. Unlike mass transit services, these emerging mobilities can be experimented with rather rapidly. As a result, they are also likely to induce relatively rapid changes in travel behavior and location choices. Therefore, it becomes important to understand the near-term effects of emerging mobilities on neighborhoods through the lenses of vehicle ownership and residential location choices over the first few years of change. Thus far, land use-transport interaction (LUTI) models have understandably focused on long-term ripple effects of metropolitan growth strategies and transportation infrastructure investments. However, currently operational LUTI models have been critiqued for (a) not being flexible enough to adapt to the rapidly changing mobility landscape, and (b) not being heterogeneous enough to capture widely varying market reactions to new transportation technologies and policies. In my dissertation, I introduced methodological extensions to a state-of-the-art LUTI model that can enable better modeling of the interdependencies between various choices and tradeoffs of housing and mobility. Using this improved LUTI model, I constructed multiple scenarios of how the housing market might react to neighborhood-level ‘car-lite’ pilot programs that aim to reduce private vehicle ownership by offering improved accessibility via emerging mobilities. I conducted agent-based microsimulations of long-term urban decisions (e.g., residential location choice and vehicle ownership choice) in Singapore to explore undesirable side-effects of car-lite programs, such as gentrification. Consequently, I tested whether and to what extent new housing development and reduced minimum parking requirements can mitigate these side-effects, while maximizing car-lite gains by reducing private vehicle ownership.

	This research is expected to contribute to our understanding of the effects of emerging mobilities on three fronts. From a conceptual perspective, this study can demonstrate how emerging mobilities can lead to inequitable urban development in the absence of coordinated multi-sector regulations. From a policy perspective, we can learn about the effectiveness of some housing and mobility policies in mitigating these undesirable outcomes while maximizing desirable outcomes. From a methodological perspective, the study contributes to the creation of a state-of-the-art planning support system that can be used to explore near-term market dynamics in reaction to new transportation technologies.
Further reading	(1) Basu, R., & Ferreira, J. (2020). A LUTI microsimulation framework to evaluate long-term impacts of automated mobility on the choice of housing-mobility bundles. *Environment and Planning B: Urban Analytics and City Science*, *47*(8), 1397-1417. https://doi.org/10.1177/2399808320925278 (2) Basu, R., & Ferreira, J. (2020). Planning car-lite neighborhoods: Examining long-term impacts of accessibility boosts on vehicle ownership. *Transportation research part D: transport and environment*, *86*, 102394. https://doi.org/10.1016/j.trd.2020.102394

Paper 19.2

Author(s)	Michael Reilly, Michael Reilly Research and Consulting, San Francisco Bay Area
Corresponding author	Michael Reilly <mkreilly@mac.com>
Title	Forecasting Bay Area Housing Affordability
Synopsis	[Speaker to add]
Abstract	The Bay Area's Regional Planning Agency, MTC, has successfully applied a customized version of the UrbanSim land use model to the past few regional plans. During the most recent effort, Plan Bay Area 2050, issues of housing unaffordability, gentrification, and displacement dominated early discussion and resulted in political demands for a more complete representation of the housing economy. In this vein, Bay Area UrbanSim was modified and expanded in four key directions. Housing "situations" provided a framework for examining particular household segments in combination with their expected housing cost trajectory. The impact of natural hazards on housing supply and policies to address these effects were added to the model. A wide range of housing policies were explicitly implemented to test their likely contribution toward achieving regional housing goals related to both increased supply and neighborhood stability. Finally, the MTC model system was modified so that changes in housing production resulting from policies modeled in Bay Area UrbanSim fed back into the overall regional forecast. These model improvements led to a richer understanding of the region's residential economy and aided MTC in its new role evaluating local governments' performance in providing much needed housing. Bay Area UrbanSim's combination of micro-simulated household demand and real estate pro forma feasibility provided a flexible framework for these model enhancements.
Further reading	[Speaker to add]

Session details produced by Lingzi Pan. All comments and feedbacks welcome; please email her (lp556@cam.ac.uk).