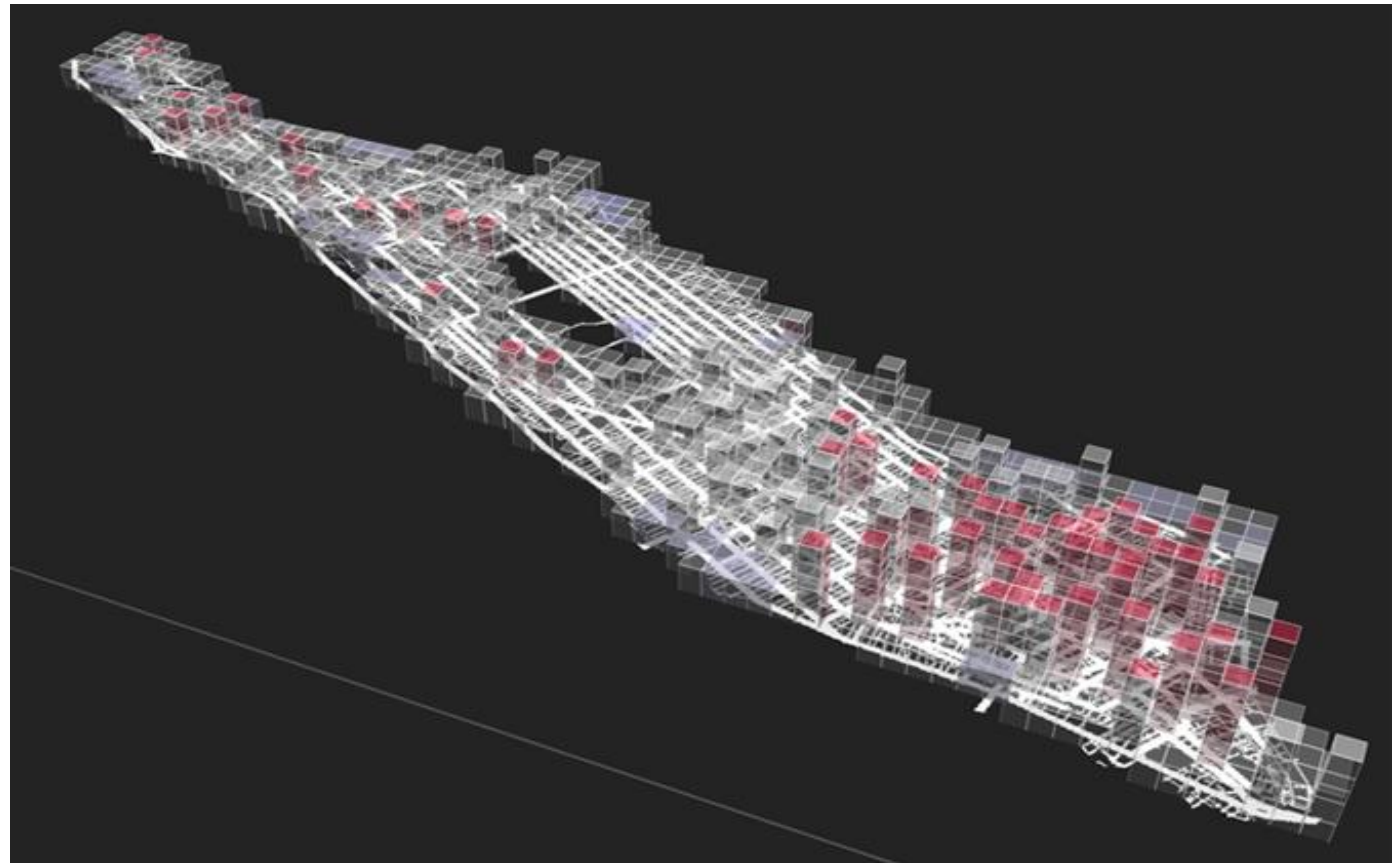# Towards an extended network-based description for BIM and Smart Cities

Towards an extended network-based description for BIM and Smart Cities

Organizer
Kinda Al_Sayed, UCL

Academic support
Professor Alan Penn, UCL

Industry support
Tim Stonor, Space Syntax Limited

Summary

The pervasive deployment of "smart city" and "smart building" projects in cities world-wide is driving innovation on many fronts including; technology, telematics, engineering and entrepreneurship. Decades ago, theoretical frameworks and predictive models were mostly dependent on the need to predict more variables by using very little data. Space Syntax was one of these theoretical and modelling frameworks, established back in 1984 through the work of Bill Hillier and Julienne Hanson, to reason about the relationship between physical space and society; between the built environment and human behaviour. In Space Syntax, urban systems were often represented as networks of streets, where accessibility of the street network infrastructure was considered as the main predictor for other urban variables such as; Pedestrian and vehicular movement, retail land use, property prices, indices of socioeconomics. In the meanwhile, the positivist approach in geography led by Mike Batty, Alan Wilson, Peter Allen, and many others was more focused on simulating complexity dynamics of urban systems using agent-based models. Long term transformations were traditionally targeted in both the

analytical and modelling approaches. Andy Hudson-Smith has recently indicated that this trend in urban research has diverted towards thinking and modelling short-term challenges induced by the era of Big Data and the Internet of Things (IoT). As argued recently by Mike Batty, short term and real-time visualizations of how an urban system operates are absolutely crucial to understand the impact of major disruptions on urban systems and to identify thresholds (percolation limits) at which these disruptions cause major breakdowns. An understanding as such is a key to embrace these new technologies in the design and evolution of the more durable infrastructure, moving forwards to an integrated smart city framework.

On the building scale, Space Syntax research has offered spatial network descriptions for building layouts pioneered by the work of Alan Penn, Ruth Conroy Dalton, Alasdair Turner, and more recently by Kerstin Sailer and Daniel Koch. A different line of research was led by Philip Steadman with more emphasis on finding a universal modelling description for building layouts and their typologies, accounting in parts for the role of size and depth of building blocks in their energy performance. Considering these different research threads and their potential contribution to current initiatives on Building Information Modelling, a combined modelling description of building layouts that enables measuring different social and environmental performance would be of great value to industry.

Focusing on the design phase of construction projects, there has been some extensive research on automating architectural and urban design systems. Some of that research incorporated conceptualizations of how to model information in buildings and cities, whilst also using Space Syntax modelling tools as to evaluate the social and economic performance of spatial layouts. There is a real value in that, since Space Syntax often accounted for empirical definitions of the relationship between spatial configurations, formal dimensions of physical space and spatial economic (functional) variables. To extend this research, there is a need to appropriate a framework to incorporate other types of data including overall building specifications (i. e. shape and depth of buildings), carbon footprint, natural lighting, supply networks, landownership and other variables. The rules that are used to test and simulate building performance prior to construction, need to learn from the operational performance of buildings during post-occupancy as to close the design-operation loop and allow the design and engineering models developed to better inform planning and design. Furthermore, there is a need to turn the models into workable applications where spatial data might be classified and structured to maximize efficiency in data retrieval and to respond to issues related to missing data, and data fidelity.

This workshop is dedicated to provide a platform for discussing these challenges between academics, construction and engineering experts, and policy makers. The workshop aims to discuss a theoretical framework and a representational scheme for establishing network-based models as the backbone skeletal representation of both building and urban complexity. Through representing relationships between different infrastructure components and linking the resultant network to smart systems, it is perhaps possible to provide better predictions of the operational performance of buildings and cities. It will

be argued therefore that network-based models that account for both solid and void elements in the built environment are fundamental to comprehend and represent the complexity of cities and inform urban design and public policy practices, during the design, construction, and operation phases of infrastructure projects.

About the organizer

Kinda Al_Sayed

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Bio

Dr. Kinda Al_Sayed is a teaching fellow on the MSc Spatial Design: Architecture and Cities and the MSc Adaptive Architecture and Computation courses at the Space Syntax laboratory, Bartlett School of Architecture, UCL. She worked as a researcher on PROXIES, a project to understand how street accessibility can be used as a proxy indicator for the London riots, Screens in the Wild: Exploring the potential of networked urban screens for communities and culture. Prior to that, she occupied several research positions. She worked with Ruth Conroy Dalton and Christoph Hoelscher on simulating wayfinding in virtual environments. She also worked on the Welcoming Workplace project at JSA Architecture and the RCA's Helen Hamlyn Centre. She has a PhD on modelling network dynamics of urban growth and an MSc on Advanced Architectural Studies from UCL. She was invited to give talks at Umea University, TUWien, University of Applied Arts Vienna, London South Bank University, University of Hamburg, University of Sofia. She is an architect with a practice experience in the UK working at Elspeth Beard Architecture. Her main research interests are focused on -but not limited to- complexity modeling of urban dynamics, knowledge-based architectural and urban design, design cognition, BIM and smart cities. She was awarded the Teaching Innovation Grant; to lead on cross-school workshop initiatives at UCL, and a PhD symposium between the Bartlett (UCL) and the University of Cambridge. Recently, she worked on smart cities and BIM at the UK Government department of Business Innovation and Skills, contributing to the Digital Built Britain government strategy. She is also a member in the Smart Cities Interoperability committee and the Smart Cities data committee at the British Standards Institution. Kinda's research record exceeds twenty five publications in areas that span over architecture, urban design, planning, geography, computer science, artificial intelligence, cognitive psychology, HCI, crime science, and more. She is currently guest editing two special issues; one on Design, Cognition and Behavior for the *International Journal of Design Creativity and Innovation* and one on BIM and Smart Cities for *Environment and Planning B.* Together with leading academics at UCL, she is writing a textbook on Space Syntax Methodology for a UCL Press publication.

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Big data, smart cities and city planning

Michael Batty

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Bio

Michael Batty is, by training, an architect-planner and geographer. He is currently Bartlett Professor of Planning at University College London where he is Chairman of the Management Board of CASA. His career began in the University of Manchester in 1966 where he was appointed an Assistant Lecturer in Town and Country Planning. He then spent 10 years at the University of Reading as Research Assistant, Lecturer and Reader in Geography, before moving to the University of Wales Institute of Science and Technology (now the University of Cardiff), where he was Professor of Town Planning. During this time he acted as Head of Department, and Dean of the Faculty of Environmental Design. In 1990, he moved to direct the NSF National Centre for Geographic Information and Analysis (NCGIA) at the State University of New York at Buffalo (SUNY-Buffalo) where he was a Professor of Geography. His research work involves the development of computer models of cities and regions, and he has published many books and articles in this area. His book **Cities and Complexity** (MIT Press, Cambridge, MA, 2005) won the Alonso Prize of the Regional Science Association in 2010. His most recent books are **The New Science of Cities** (MIT Press, Cambridge. MA, 2013) and the edited volumes **Virtual Geographic Environments** (ESRI Press, Redlands, CA, 2011) and **Agent Based Models of Geographical Systems**(Springer, Berlin, 2012). He is editor of the journal **Environment and Planning B: Planning and Design**. The work of his group can be seen on the CASA web site http://www.casa.ucl.uk/ and in his blogs http://www.spatialcomplexity.info/ and http://www.complexcity.info/

Abstract

I define big data with respect to its size but pay particular attention to the fact that the data I am referring to is urban data, that is, data for cities that are invariably tagged to space and time. I argue that this sort of data are largely being streamed from sensors, and this represents a sea change in the kinds of data that we have about what happens where and when in cities. I describe how the growth of big data is shifting the emphasis from longer term strategic planning to short-term thinking about how cities function and can be managed, although with the possibility that over much longer periods of time, this kind of big data will become a source for information about every time horizon. By way of conclusion, I illustrate the need for new theory and analysis with respect to 6 months of smart travel card data of individual trips on Greater London's public transport systems.

Related Links

Oyster Gives up Pearls, Michael Batty and Dr Soong Kang, UCL Engineering
http://www.engineering.ucl.ac.uk/projects/oyster-gives-up-pearls/

Presentation on Big Data by Michael Batty
https://vimeo.com/62000852

Space syntax as an integrative tool for smart cities

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Director of Space Syntax Limited

Bio
Bill Hillier is Professor of Architectural and Urban Morphology in the University of London, Chairman of the Bartlett School of Graduate Studies and Director of the Space Syntax Laboratory in University College London. He holds a DSc (higher doctorate) in the University of London.
As the original pioneer of the methods for the analysis of spatial patterns known as 'Space Syntax', he is the author of The Social Logic of Space (Cambridge University Press, 1984, 1990) which presents a general theory of how people relate to space in built environments, 'Space is the Machine' (CUP 1996), which reports a substantial body of research built on that theory, and a large number of articles concerned with different aspects of space and how it works. He has also written extensively on other aspects of the theory of architecture.

Abstract
In this presentation, we examine the potential of space syntax as an integrative tool for the understanding and creation of smart cities. We argue first that cities can in themselves be smart, and that as a modelling tool space syntax has a number of attributes which makes it apposite for bringing this smartness to light and exploiting it in design:

- As a representation, it is based on a very localised element, the street segment between junctions, but at the same time it has shown that segment based maps are computationally viable for the entire street and road network of the UK;

- It allows three representations of distance – metric, fewest turns and least angle change - which can be used as needed for different kinds of analysis;

- It allows measures to be applied a different radii from each segment – this multi-scale analysis is particularly useful for the analysis of different scales of movement and the scale and location of centres;

- The spatial model has been shown to be in itself predictive of movement, and movement related activities, in a very large number of studies; and recently it had been shown to be

predictive even at the national scale of analysis;

- At the same time, because it is based on the street segment (rather than the intersection or the area) it allow any other properties that can be expressed numerically (land uses, densities, scale factors) to be precisely assigned to their location in the system;

- Exactly the same model as in used for urban analysis can be used for planning and design through simulation and experimentation - this advantage underlies the fact that space syntax is now be extensively applied, both to planning and design projects, and to identify the spatial dimension in urban problems;

- The model is based on an explanatory and testable theory, and every application, whether in research or design, is a test of the theory – this means that knowledge of urban spatial systems and how they work can grow on a consistent basis;

- Perhaps most important of all, the way the model links mathematical analysis with multi-colour representation, accesses urban complexity to the intuition of the designer and planner, so linking science to creativity.

Digital innovation and built environment foresight

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Bio
Tim recently moved to UCL following a career in industry, and has substantial experience as corporate director of technology, innovation and sustainability for globally operating engineering design consultancies, including both Atkins and Halcrow. In addition he was CEO of construction industry research body CIRIA from 2002 to 2007. Within his new role he works with leading individuals in industry and government to understand and prepare for the challenges and opportunities that lie ahead. This recently included the responsibility for a 'foresight' input to the UK Government's developing strategy for construction as well as leading the strategic planning of the UK's development and implementation of BIM.
Tim is a Fellow of the Royal Academy of Engineering, the Institution of Civil Engineers and the Royal Society for Arts, manufactures and Commerce. He is also a Visiting Professor in Construction Management at the University of Reading and in Civil Engineering at the University of Dundee. He has maintained an active engagement in the development and deployment of BIM techniques for over a decade. Tim Broyd is Vice Chairman of BuildingSmart (UK) Ltd and sits on the UK Government's BIM Task Force. He is also a Director of CEEQUAL Limited, which is responsible for developing and marketing CEEQUAL, the world's leading technique for assessing the sustainability of infrastructure projects. He became Vice President of the Institution of Civil Engineers in 2011, with particular responsibility for Public Voice and Policy, and is scheduled to be President in 2016/7.

Abstract
Physical assets – buildings and infrastructure (including transport, energy, water and waste) and their equipment - are increasingly dependent on digital systems for their effective design, construction, management and operation. 'Big data', the 'Internet of things' and mobile devices are already delivering masses of real time data for producers and consumers to better utilise these assets, with substantial growth forecast. Yet many challenges remain, that demand research both pure and applied. The UK Government, acting through BIS and its subsidiary organisations EPSRC and Innovate UK (formerly the Technology Strategy Board), has already signalled that significant new funding will be made available for work in this domain. This presentation is going to focus on introducing the new Institute of Digital Innovation at UCL. Digital innovation for the purpose of iDIBE can be defined as: "innovations made possible through digital technology and computing advancements" and that is directly affected and/or related to design, construction, operation, refurbishment and decommissioning/ demolition of Built Environment assets. iDIBE will be a new venture within UCL. Its mission will be to bring disciplines together and develop a central focal point of reference for research, teaching and training activities related to Digital Innovation in the Built Environment both, in academia and practice.

Digital Built Britain strategy

Mark Bew

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Bio
Mark Bew is the Managing Director of Engineering Construction Strategies, Chairman of the UK Government BIM Task Group and BuildingSMART (UK). He is tasked with the delivery of Building Information Modelling and Soft Landings into the UK Public Sector by 2016. The programme was awarded the International Fiatech award for outstanding leadership and innovation of a programme recognised as world leading.
Mark Bew is a Chartered Engineer with strong technical and commercial skills and a BSc in Computer Science. He is currently researching the use of BIM to improve the social outcomes of the built environment for a PhD.
Mark Bew was previously Business Systems Director at both Scott Wilson Group and Costain Group plc, and has held positions with John Laing, Kvaerner Construction and GEC Avionics. He was awarded the MBE for services to construction in January 2012.

Abstract
Digitisation has delivered a step-change in productivity and performance across manufacturing industry over the last two decades. But in construction, a sector bigger than aerospace, automotive, and energy put together and where the technology is also applicable, productivity has flat-lined. Digitising construction is challenging because buildings and infrastructure have traditionally been bespoke developments with little opportunity for production runs or standardisation, and the built environment is complex with many interactions between assets and their users. In addition construction is a highly fragmented sector. For these reasons the market has not been able to meet the coordination challenge of digitising the industry.

Digitisation in construction is referred to as Building Information Modelling or BIM. It is essentially the same technique used by the advanced aerospace industry in pre-production to design, build and test new aircraft, with all their critical components (airframe, propulsion etc.) modelled in a digital environment to provide surety of production and to deliver "as designed" operational performance. In the UK BIM is now starting to take off following a two-pronged Government and Industry programme to overcome the coordination failure described above. In 2011 it was announced that BIM would be a requirement of all central Government construction procurement from 2016, providing a powerful incentive to firms to invest in BIM capability to remain

eligible to compete for future government contracts. Second, it committed to fund a BIM Task Group to develop the necessary common standards and protocols, and to make them available in accessible formats without cost to encourage widespread take-up especially among SMEs. The BIM Task Group has been responsible for the delivery of the Government's current BIM programme, known as BIM Level 2, has already achieved 20 per cent cost savings as part of the Government's Construction Strategy for its construction procurement. The programme is on track to contribute significantly to Government's overall saving of £1.2bn this year, increasing from £840m in 2013/14. The Construction Leadership Council has put BIM at the heart of its sector strategy Construction 2025, which commits to cut built asset costs by 33 per cent, and time and carbon by 50 per cent.

Level 2 BIM applies to the design and construction of individual assets through the sharing of traditional files and open data (COBie) to drive the use of technology and the sharing of high quality digital information. The Level 3 programme will build on this and will extent the Capex/Opex savings paradigm to a whole life process.

Level 3 will make the shift from file based collaboration to the more scalable and flexible semantic web. This will provide opportunities for integration into performance data from the Internet of Things and the widespread sharing of structured BIM (IFC based) data with Linked Open Data. The concepts of data security, provenance and data quality and fidelity also ensure that the constraints of engineering and commercial controls can be brought together with the flexibility and opportunity of the web.

The social and economic value of network and agent descriptions of buildings

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Bio
Alan is the Dean of the Bartlett Faculty of the Built Environment at UCL, a founding director of Space Syntax Ltd, a UCL knowledge transfer spin out with a portfolio of over 100 applied projects per year, including whole city masterplans, neighbourhood development plans and individual buildings. He is a member of the Space Syntax Laboratory at UCL, an EPSRC Platform funded research group. He was the founding Chair of the RIBA's Research and Innovation Committee, and served in that role until 2006. He was Chair of the Architecture & Built Environment sub-panel 30 for the UK National Research Assessment Exercise 2008, and a member of its Main Panel H. He was the Chair of the Architecture, Built Environment and Planning sub-panel 16 and a member of Main-panel C for the Research Excellence Framework 2014. He was the lead academic on the £5m Urban Buzz: Building Sustainable Communities knowledge exchange programme which promoted more sustainable forms of urban development and intensification in London and the greater South East Region of the UK. He has recently been awarded EPSRC funding to develop the UK Regions Digital Research Facility, a five year £11m programme which will use urban and regional spatial modeling to develop capacity in evidence based policy in the UK's core cities and devolved regions, and so help rebalance the UK economy.

Abstract
The ideas behind Building Information Modeling (BIM) have been around since the late 1970's when Liverpool University and later GMW Computers Ltd. developed the Really Universal Computer Aided Production System (RUCAPS). This consisted of a single information model that captured all geometric and physical information along with symbolic representations required for 2D drawings at different scales. Embedded parametric rules in building components allowed form to shape itself algorithmically in response to changes to connected components. Embedded material properties allowed building analysis to optimise the design for environmental performance.

In the early 1980's we worked with GMWC to incorporate Space Syntax analysis in the RUCAPS system. This was aimed at allowing analysis and testing of the social and economic function of building form since this was the missing component in the concept. It required us to automate the analysis of spatial configuration and to systematise aspects of interpretation. Ultimately RUCAPS was 40 years ahead of its time. Here I will reflect briefly on why this was so, and what can be learned for current attempts to develop Level 3 and 4 BIM.

This presentation will demonstrate how the analysis of spatial configuration allows us to talk about the social and economic function of buildings to support organisations in their primary objectives: hospitals to make people healthy, schools to educate learners, research labs to generate new knowledge. The element of the building that works like this is the pattern of space contained by the material elements of construction – the walls and floors, connected by doors and stairs. Analysis of this pattern can inform design at the earliest stage to achieve greater organisational effectiveness and to maximise value.

The presentation will demonstrate the application of agent simulation to predict aspects of likely space use in buildings and to forecast the operational performance of buildings. I will conclude that real time simulation using these kinds of analysis will require design teams to develop radically new time-based methods of collaboration. This will have effects not only on the nature of practice, but for the way that we train designers.

Internet of (School) Things

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Bio
Duncan Wilson is Intel Director at ICRI Cities in London and is responsible for driving the research agenda of the institute. The Intel Collaborative Research Institutes (ICRI's) are Intel-funded, jointly-led research collaborations between Intel and the academic community. At ICRI Cities, researchers at UCL and Imperial College are developing community scale solutions that make cities a better place to live. They focus on the city experience delivering human centric services that are socially, economically and environmentally sustainable. He is currently working on large scale deployments of sensor networks in London and through a national "Internet of School Things" project with schools across the UK was involved in specifying Hypercat – a framework for sharing data between heterogeneous sensor networks.

Abstract

This presentation will focus on the work that is being developed at Intel on the Internet of (School) Things (IoST). We want to use IoST to transform the way students learn about our world. We have worked with teachers and students from eight schools to design connected devices and learning materials that encourage people to explore the Internet of Things.

The initial project (DISTANCE) was one of eight funded by Innovate UK to test methods for sharing data from IoT networks between different vertical industries. One of our key objectives for the project was to understand how data from connected devices in one school could be extended to provide access to learning materials to the other 24,000 schools in the UK. The result of the first phase of this work was the creation of the Hypercat framework.

We will present an overview of Hypercat, the API's using Mashery and Aepona being developed as part of the Intel Collaborative Research Institute for Sustainable Connected Cities and will introduce the work of the Open Interconnect Consortia.
The DISTANCE project was a collaborative consortium and included the following partners: Birmingham Urban Climate Laboratory, Explorer HQ, Intel, Open University, UCL CASA and Xively.

Usability of Buildings and HCI

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Bio
Professor Dalton is an alumna of University College London. As a licensed architect, she has worked for Foster and Partners (London) and Sheppard Robson Corgan Architects (London) and key projects upon which she has worked include the Carré d'Art de Nîmes, in France, the Palaçio de Congresos in Valencia, Spain, and the Kings Cross International Terminal (unbuilt). She has taught at the Architectural Association, London, the Georgia Institute of Technology, Atlanta, USA and the Bartlett School of Architecture, UCL.
Professor Dalton's research interests are centred around the relationship between the spatial layout of buildings and environments and their effect on how people understand and interact in those spaces. Professor Dalton is an expert in Space Syntax analysis and is passionately interested in the use of virtual environments as a method for researching human factors in the built environment.

Abstract
It should be self-evident that architects design buildings for the people who will ultimately come to inhabit them and therefore it could be assumed that the architectural design process might exemplify a user-centred design approach. The reality unfortunately falls short of this ideal. Frequently, the needs of a building's end-user/s fade into the background due to the fact of being subsumed by innumerous other, and often conflicting, design constraints such as the needs of the client (where the client and end users are not one and the same) or functional, programmatic, structural, material and legal requirements. Conversely, the needs of the user may receive less consideration as experienced architects may believe that they can intuitively, and hence implicitly, design for building's inhabitants without any need to make this an explicit part of the design consideration. (Sometimes this is true; sometimes not.). It is the position of this contribution that by explicitly placing the needs of users at the centre of the architectural design process, the overall quality of public architecture and cities can be increased. If so, how might this be achieved? One suggestion is to look to another field where the needs of their users are integral to their methodologies, namely human-computer interaction.

Ultimately, human-computer interaction is a type of human-artefact interaction, and HCI research is characterized by analysing human behaviour, cognitive processes and task structures. Buildings can

also be understood as artefacts, and humans interact with these artefacts in numerous ways. In psychology, this has been investigated under the label "environmental psychology" since the 1970s. While a large number of studies in environmental psychology, as well as the field of spatial cognition, have tried to identify how people react to environmental settings and how they mentally represent spatial relations, such research has had little impact on architectural design practice in comparison to the established role of HCI professionals and their methodology in contemporary software and IT systems design. In the last 10 years there has been an important revitalization of the interaction between cognition and architecture. One example is the 'evidence-based design' movement in architecture (originating from healthcare design) which calls for better data on human behaviour. The paradigm of Evidence-based Design is becoming increasingly popular in certain sections of the architectural design community. The main thrust is to obtain performance measures of implemented designs (existing buildings) and/or derive predictions of such measures for design options under consideration. Besides issues such as energy-efficiency, human factors are now seen as a component of building performance, ranging from perception, emotion and aesthetic appraisal, psychological well-being to behavioural and cognitive factors of movement in a building or through cities.

The field of human-computer interaction has the potential to provide a methodological framework for investigating how people understand buildings and cities and how the cognitive processes of their orientation and navigation behaviours are structured. Analytic methods such as cognitive task analysis and cognitive walkthroughs have been adapted to the task performance of building users, and observation techniques with video analysis, movement tracking and virtual reality simulation have also been adopted, increasingly relying on usability metrics like task performance, error classification etc. Taking HCI methods to architecture requires a rigorous framework for capturing environmental properties, like saliency of landmarks or complexity of layout geometry. Space syntax techniques make building features accessible to quantification and capture features relevant for understanding cognitive deficits of buildings. While traditionally, research into human behaviour in architecture has only been able to investigate usability after the fact, i.e. after building completion, techniques like virtual reality simulation allow for collecting user data during the design process, as is long established in HCI. In addition to this, 'big data' increasingly captured via sensor-enabled buildings and cities, contribute to this corpus of user data. Important questions to be addressed for the future include how to establish a user-centred perspective in the architectural design process, and how to refine analytic techniques suitable for use in design practice. Here the field of HCI can serve as a model of best practice for evidence-based approaches in architectural design.

Selected publications

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Space - Design. Syntax. Semantics. Cognition: Reflections on spatial cognition and computation for architecture design

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Bio
Mehul Bhatt is Professor of Human-Centered Cognitive Assistance within the Faculty of Mathematics and Informatics at the University of Bremen, Germany. He is member of the Cognitive Systems group, and also serves as principal investigator within the Spatial Cognition Research Center (SFB/TR 8). He obtained a bachelors in economics (India), masters in information technology (Australia), and a PhD in computer science (Australia). He has been a recipient of an Alexander von Humboldt Fellowship, a German Academic Exchange Service award (DAAD), and an Australian Post-graduate Award (APA). Mehul's basic research is at the interface of Artificial Intelligence and Computational Cognitive Systems. Mehul is co-founder of the DesignSpace Group. He has edited for journals: Spatial Cognition and Computation, Journal of Experimental and Theoretical Artificial Intelligence (JETAI), Human-Centred Computing and Information Sciences, Ambient Intelligence and Smart Environments, and Automation in Construction. Mehul has initiated and co-steered initiatives such as: Spatio-Temporal Dynamics (STeDy), Space, Time, and Ambient Intelligence (STAMI), SHAPES – The Shape of Things, and the International Association for Ontology and its Applications (IAOA) SIG on 'Design Semantics'. Mehul also served as co-chair for the DFG-NSF symposium on Spatial Cognition for Architecture Design (SCAD 2011, USA); and the 27th Qualitative Reasoning Workshop (QR-2013, Germany).

Abstract
Architects concerned with designing built environments (e.g., hospitals, airports) need to "anitcipate" and "ensure" that people-centered design objectives are fulfilled, e.g., people should (not) get lost, the environment should fulfil universal design criteria for diverse user groups and situations (e.g., disabilities, geriatric care, emergencies). Toward this, designers and architects need access to assistive technologies that manifest a basic understanding of human behaviour in spatial environments, in particular, aspects pertaining to "visuo-spatial perception and cognition", and "design semantics" from the viewpoint of users as well as designers & planners. Our research on people-centred spatial design addresses the question: how can cognitive modalities constitute the foundational building blocks of design education, discourse, systems, and the professional practice of spatial design for architecture?

In this talk, I will summarise basic research questions addressed, methodology adopted, and deliverables produced as part of research in the DesignSpace Research Group at the University of Bremen

(Germany). I will demonstrate the manner in which next-generation design systems, frameworks, assistive tools, educational discourse, and design policies & practices can be explicitly founded on the cognitive modalities of human perception, attention, action, dynamics, environmental affordance & user experience, and design conception & semantics. I will particularly focus on aspects of design conception, design computation, and design communication as they relate to processes of Design Tools, Real-World Design Practice, and Professional Design Learning & Education. Time permitting, I will also introduce community-based scientific initiatives aimed at broad-based interdisciplinary engagement related to the theme of spatial cognition and design that have emanated from research at the DesignSpace Research Group.

THE DESIGNSPACE GROUP

DesignSpace is a research and consultation group focussing on the development of cognitive technologies and educational discourse for people-centered spatial thinking and architecture design. DesignSpace research has developed cognitive assistive technologies for people-centred usability analysis and building performance evaluation at all phases of the architecture design process, including design conception, preliminary prototyping & iterative refinement, and evidence-based post-occupancy analysis with a specific focus on wayfinding, signage, and eye-tracking studies. DesignSpace offers a range of solutions for the universal design paradigm guided execution of large-scale built-up environments; the team has a track-record in providing customised technological solutions for the healthcare and aviation sectors. DesignSpace also conducts case-study driven intensive seminars and accredited training workshops both in academic / non-profit as well as private contexts. If you would like to obtain more information, or get involved, please send us an email at: info@design-space.org

Select Related Publications

Bhatt, M., Schultz, C. (2015). Architectural Design Cognition: People-Centred Visuo-Spatial Cognition, and its Role in Systems and Educational Discourse for Design Conception, Computing, and Communication, in: Editors: Sabine Ammon, Inge Hinterwaldner – Anthology on: Imagery in the Age of Modelling: Operative Artifacts in the Design Process in Architecture and Engineering / Bildlichkeit im Zeitalter der Modellierung. Operative Artefakte in Entwurfsprozessen der Architektur und des Ingenieurwesens, Fink Verlag, Munich. (in press: in English and German)

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3DStock: a new kind of three dimensional model of the building stock of England and Wales

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Bio

Philip Steadman is Emeritus Professor of Urban and Built Form Studies in the Bartlett, and Principal Research Fellow at the UCL Energy Institute. He works on the use of fuels in the national non-domestic building stock, and on the relationship of patterns of land uses to energy consumption and environmental effects, at the urban scale. He worked during the 1990s with a team of up to fifteen people, on the development of a database and model of energy use in the non-domestic building stock of Britain, for the British Government. This National Non-Domestic Building Stock database uses property taxation data and other sources, and covers some 1.8 million properties in England and Wales. The work continued in the four-year multi-university Carbon Reduction in Buildings (CaRB) project, funded by EPSRC and the Carbon Trust; and in two further EPSRC-funded projects on energy use in the building stock of Britain. At present Professor Steadman works in the Centre for Energy Epidemiology at UCL, where he and colleagues are building a new kind of 3D model and database of the building stock and its use of energy. In addition he works on issues to do with the representation of building geometry, and in 2014 has published a book on *Built Forms and Building Types*.

Abstract

This talk describes the development of a new three-dimensional model of the British building stock. The model differs from other 3D urban and stock models, in that it represents explicitly and in detail the spatial relationships between 'premises' and 'buildings'. It also represents the pattern of activities on different floors within buildings. The geometrical/ geographical structure of the model is assembled automatically from two existing national data sets, OS maps and Valuation Office Agency rating databases. Additional data from other sources including figures for electricity and gas consumption are then attached. The first purpose of the model is in the analysis of energy use in the stock. Other applications are envisaged. Models have been built to date of the London Borough of Camden and the cities of Leicester and Tamworth. Work is in progress to extend the modelling to other parts of Britain.

City Information Modelling

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Bio

Jorge is researcher at the Chair of Spatial Planning and Strategy, Faculty of Architecture, TU Delft. He works on the topic of regional urban form and sustainable mobility patterns, developing integrated multi-modal network models for measuring and evaluating the sustainable mobility potential of urban areas, using spatial analysis and data mining methods. Since 2013 he is also research associate at the Space Syntax Laboratory, the Bartlett, developing plugins to integrate space syntax methods with QGIS. Jorge is an architect and urban designer with an MSc in Virtual Environments from the Bartlett, UCL. Between 2004 and 2009 he worked at Space Syntax Limited, focusing on the development of GIS applications for the spatial analysis of architectural and urban design projects. From 2007 to 2011 he was researcher in the 'City Induction' project at the TU Lisbon, responsible for prototyping an urban design evaluation module for City Information Modelling.

Abstract

Smart Cities require knowledge-based and performance oriented approaches to urban design and planning, involving stakeholders from different backgrounds and domains of expertise, using and sharing multiple levels of information, at multiple scales of analysis and intervention. While Building Information Modelling (BIM) presents a new paradigm in building design, offering an integrated platform for the delivery, monitoring and long term maintenance of sustainable buildings, City Information Modelling (CIM) is just emerging as a new operational concept. CIM is more than an amalgamation of all the BIM models in an urban area. It represents the higher level networks of infrastructure, governance and human activity that make up the urban environment; and ultimately it forms the structure that holds all BIM models together and supports their interactions. CIM allows the description, visualization, analysis and monitoring of the urban environment to support urban design and planning from the very local to the regional. CIM meets the needs of the various stakeholders with specific design and decision support tools, with different types of interface and output, but one information base. The backbone of CIM is an integrated, cross-disciplinary, spatial data model, with granular and relational information based on open standards. In this presentation I will illustrate the CIM concept with examples from industry and research, and with prototypes integrating network data models and analysis in CAD and GIS platforms, for

neighbourhood design and evaluation of sustainable mobility objectives.

Space Syntax applications in consultancy projects

Anna Rose

Director of Space Syntax Limited

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Bio

Anna Rose is a trained architect with a specialism in urban design, masterplanning and public realm design. She has extensive international experience advising public and private sector clients on projects at all scales. She trained at RWTH Aachen, Germany and as an exchange student at the Bartlett School of Architecture, University College London. Anna has lectured to architectural and landscape design audiences both in the UK, EU and USA. She has been teaching Urban Design in the MArch Urban Design programme at the Bartlett where she regularly run a popular Space Syntax masterplanning workshop. Anna joined Space Syntax as a project consultant in 2002, and became a Director in 2007. She has been involved in a large number of UK masterplans, including Birmingham Eastside, Camden Canal Market, Euston Area Plan and Bristol TQEZ. She has also contributed to a number of important public space projects, including Potters Field Park in London and Old Market Square in Nottingham. Current work on high profile, mixed use developments includes Elizabeth House in London, Penn Plaza in New York City and Crystal City in Arlington, US. Anna is a member of the UK Academy of Urbanism. She leads the company's activities in the EU with a particular focus on the German speaking markets, where she is frequently involved in projects in Berlin, Munich and Hamburg.

Abstract

This presentation is going to focus on the application of Space Syntax in different consultancy projects, on a range of different urban scales. The presentation will also show some of the new modelling work that is being done at the company on active transport modes in cities, and how that was applied in theSkyCycle project.

Certainly it is not only digital technologies that make cities smart. Yet, we need to learn and practice 'digital urbanism'. Not by coincident is internet activity concentrated in urban centres. The 'digital revolution' already impacts the shape of our cities e.g. in the retail sector or in other fields of the digital economy.

From a practice point of view, to enable 'knowledge neighborhoods' it is essential to understand how environments foster interaction and exchange. In order to create a successful city for the digital age three key needs must be addressed: 1) the recognition of the key role of spatial layout, 2) the modeling of active travel modes of citizens, 3) evidence-based decision making and open data.

Workshop attendees

Name	Organisation	Name	Organisation
Alan Penn	UCL, Space Syntax Limited	Miguel Serra	CITTA, University of Porto
Anna Rose	Space Syntax Limited	Paulina Zakrzewska	UCLH
Barry Blackwell	BIS	Philip Steadman	UCL
Bill Hillier	UCL, Space Syntax Limited	Rob Snyder	Bentley
Dan Jenkins	Parsons Brinckerhof	Robert Aish	UCL
Dan Palmer	BSI Group	Rollo Home	Ordnance Survey
Daniel Koch	KTH, Sweden	Stephen Marshall	UCL
Duncan Wilson	UCL, Intel	Tim Broyd	UCL
Francis Aish	Foster and Partners	Ulysses Sengupta	University of Manchester
Frank William Domoney	University of Essex		
Holger Schnädelbach	University of Nottingham		
Jorge Gil	TU Delft		
Kayvan Karimi	UCL, Space Syntax Limited		
Kinda Al_Sayed	UCL		
Liyu Tseng	Arup		
Marc Barthelemy	Institut de Physique Theorique, France		
Marc Thomas	Bentley		
Mark Bew	BIS/CO/BTG (Chair), E C Strategies		
Max Martinez	Space Syntax Limited		
Mehul Bhatt	University of Bremen		
Michael Mulquin	City Building Blocks, BSI		
Michael Pitt	UCL		