BSO 2016

BUILDING SIMULATION
& OPTIMIZATION

Third IBPSA - England Conference www.bso16.org

12th-14th September 2016 - Great North Museum, Newcastle

BOOK OF ABSTRACTS

Editors: Neveen Hamza and Chris Underwood

DesignBuilder
SOFTWARE

IES

TEMPCON
MEASUREMENT • CONTROL • DATALOGGING SOLUTIONS

MONDAY 12TH SEPTEMBER 2016

8:00 - 9:15am	REGISTRATION - **Venue: First Floor Gallery**

9:15 - 9:30am	Welcome and opening the conference ***Prof: Pieter DeWilde*** (IBPSA - England Chair) - **Venue: Clore Suite**
9:30 - 9:45am	BSO16 Conference ***Chair Dr.Neveen Hamza*** (IBPSA - England Vice Chair) - **Venue: Clore Suite**
9:45 - 10:30am	***Keynote Speaker: Harsh Thapar*** (Foster and Partners) - **Venue: Clore Suite**
10:30 - 11:00am	***Dr. Michael Wetter***: IBPSA world presentation - **Venue: Clore Suite**

11:00 - 11:30am	COFFEE BREAK - **Venue: The Gallery**

11:30 - 1:00pm	**Venue: Clore Suite**	**Venue: Exhibition ONE**
	Theme: Progress in simulation tools and optimization method ***Session Chair: Dr. Michael Wetter***	Theme: Applications of environmental sustainability (case studies) ***Session Chair: Dejan Mumovic***
	ID 1031: NUMERICAL MODELLING OF THERMAL COMFORT IN NON-UNIFORM ENVIRONMENTS USING REAL-TIME COUPLED SIMULATION MODELS	**ID 1114:** PARAMETRIC ANALYSIS OF SOLAR SHADING PARAMETERS IN INTERMEDIATE ORIENTATIONS LOCATED IN DESERT CLIMATES
	ID 1018: OPTIMAL DESIGN OF ENERGY CONVERSION UNITS AND ENVELOPES FOR RESIDENTIAL BUILDINGS	**ID 1052:** INVESTIGATING THE POTENTIAL IMPACT OF STAKEHOLDER PREFERENCES IN PASSIVHAUS DESIGN
	ID 1043: THE IMPORTANCE OF DERIVATIVES FOR SIMULTANEOUS OPTIMIZATION OF SIZING AND OPERATION STRATEGIES: APPLICATION TO BUILDINGS AND HVAC SYSTEMS	**ID 1008:** THE IMPACT OF CLIMATE CHANGE ON THE ENERGY-EFFICIENT REFURBISHMENT OF SOCIAL HOUSING STOCK IN ITALY
	ID 1035: INTEGRATING ARCHITECTURAL AND ENERGY VIEW POINT FOR A MULTI OBJECTIVE OPTIMIZATION DURING EARLY DESIGN STAGE	**ID 1077:** ASSESSMENT OF INDOOR VISUAL ENVIRONMENTS USING DEMENTIA-FRIENDLY DESIGN CRITERIA IN DAY CARE CENTRES
	ID 1089: BRIDGING THE PERFORMANCE GAP: INFORMATION DELIVERY MANUAL FRAMEWORK TO IMPROVE LIFE-CYCLE INFORMATION AVAILABILITY	**ID 1078:** COST-EFFECTIVE MEASURES FOR ENERGY IMPROVEMENT OF 1980S DETACHED HOUSES IN COLD CLIMATE

1:00 - 2:00pm	LUNCH BREAK - **Venue: The Gallery Space (First Floor)**

2:00 - 3:30pm	Venue: Clore Suite	Venue: Exhibition ONE
	Theme: Progress in simulation tools and optimization method ***Session Chair: Christina Hopfe***	Theme: Applications of environmental sustainability (case studies) ***Session Chair: Rajat Gupta***
	ID 1073: PLACING USER NEEDS AT THE CENTRE OF BUILDING PERFORMANCE 2 SIMULATION: TRANSFERING KNOWLEDGE FROM HUMAN COMPUTER INTERACTION	**ID 1013:** ASSESSMENT OF DAYLIGHT IN RELATION TO THE AGITATION LEVELS OF PEOPLE WITH DEMENTIA
	ID 1074: EXHAUSTIVE SEARCH: DOES IT HAVE A ROLE IN EXPLORATORY DESIGN?	**ID 1024:** A HOLISTIC MODELLING FRAMEWORK FOR RETROFITTING HARD-TO-TREAT HOMES IN LONDON: ENERGY, COMFORT, COST AND VALUE PROPOSITIONS
	ID 1086: INFLUENCE OF DESIGN CONDITIONS ON THE DISTRIBUTION OF OPTIMAL WINDOW-TO-WALL RATIO FOR A TYPICAL OFFICE BUILDING IN JAPAN	**ID 1033:** PERFORMANCE OF PERSONAL VENTILATION SYSTEMS IN A MULTI-BED MATERNITY WARD
	ID 1038: INVESTIGATING THE IMPACT OF MODELLING UNCERTAINTY ON THE SIMULATION OF INSULATING CONCRETE FORMWORK FOR BUILDINGS	**ID 1036:** ENERGETIC PERFORMANCE AND ECONOMIC FEASIBILITY OF ONSITE GENERATION TECHNOLOGIES IN A NEARLY ZERO ENERGY BUILDING
	ID 1034: HYBRID DISCRET-CONTINUOUS MULTI-CRITERION OPTIMIZATION FOR BUILDING DESIGN	**ID 1070:** STUDY ON DISTRICT ENERGY CONSUMPTION PREDICTION MODEL OF OFFICE BLOCKS IN COLD REGION, CHINA WITH SIMULATION AND REGRESSION ANALYSIS

3:30 - 4:00 pm	COFFEE BREAK - **Venue: The Gallery**

4:00 - 5:30 pm	Venue: Clore Suite	Venue: Exhibition ONE
	Theme: Progress in simulation tools and optimization method ***Session Chair: Jon Wright***	Theme: Advanced Simulation of Building Systems ***Session Chair: Charles Barnaby***
	ID 1095: NEW PROFILES OF OCCUPANCY DRIVEN APPLIANCE, LIGHTING, AND HOT WATER USE FOR RESIDENTIAL SECTOR ENERGY DEMAND MODELING	**ID 1003:** PDEC TOWER COOLING ENERGY PERFORMANCE ASSESSMENT USING SPECIFIC ENTHALPY CALCULATION METHODOLOGY
	ID 1101: NEW EXTENSION OF MORRIS METHOD FOR SENSITIVITY ANALYSIS OF BUILDING ENERGY MODELS	**ID 1044:** MULTI-MODE MODEL OF AN AIR HANDLING UNIT FOR THERMAL DEMAND CALCULATIONS IN MODELICA
	ID 1115: DATA DRIVEN BOTTOM-UP APPROACH FOR MODELLING INTERNAL LOADS IN BUILDING ENERGY SIMULATION USING FUNCTIONAL PRINCIPAL COMPONENTS	**ID 1049:** THE POTENTIAL OF PREDICTIVE CONTROL IN MINIMIZING THE ELECTRICITY COST IN A HEAT-PUMP HEATED RESIDENTIAL HOUSE
	ID 1120: LOW-RISE COMMERCIAL BUILDINGS OPTIMIZATION – ENERGY PERFORMANCE AND PASSIVE COOLING POTENTIAL IN FRANCE	**ID 1100:** IMPLICATIONS OF A DECARBONISED GRID ELECTRIC SYSTEM FOR BUILDING EMISSIONS CALCULATION
	ID 1152: MEASURING AND SIMULATING LIGHT THROUGH TREES FOR DAYLIGHT ANALYSIS: A PHOTOGRAPHIC AND PHOTOMETRIC METHOD	**ID 1146:** DYNAMIC SIMULATION METHODS OF HEAT PUMP SYSTEMS AS A PART OF DYNAMIC ENERGY SIMULATION OF BUILDINGS
	ID 1121: ECODESIGN OF A 'PLUS-ENERGY' HOUSE USING STOCHASTIC OCCUPANCY MODEL, LIFE-CYCLE ASSESSMENT AND MULTI-OBJECTIVE OPTIMISATION	**ID 1167:** DEVELOPMENT OF AN OPTIMISED MODEL-PREDICTIVE CONTROL (MPC) ALGORITHM BASED ON HIGH-FIDELITY ENERGY MODELS FOR REAL-TIME CONTROL OF HVAC SYSTEMS

TUESDAY 13TH SEPTEMBER 2016

8:00 - 9:00am	REGISTRATION

9:00 - 9:15am	BSO16 Conference ***Chair: Dr.Neveen Hamza*** (IBPSA-England Vice Chair)
9:15 - 9:30am	Welcome to Newcastle University
9:30 - 10:15am	***Keynote Speaker: Prof. Ian Beausoleil-Morrison*** (Carlton University)
10:15 - 11:00am	IESVE presentation

11:00 - 11:30am	COFFEE BREAK - **Venue: The Gallery**

11:30 - 1:00pm	**Venue: Clore Suite**	**Venue: Exhibition ONE**
	Theme: Progress in simulation tools and optimization method ***Session Chair: Malcolm Cook***	Theme: Advances in Building Performance Simulation tools ***Session Chair: Pieter DeWilde***
	ID 1124: AUTOMATED OPTIMUM GEOMETRY GENERATION OF A BUILDING FOR THE MINIMIZATION OF HEATING AND COOLING ENERGY DEMANDS	**ID 1010:** AUTOMATIC CALCULATION OF A NEW CHINA GLARE INDEX
	ID 1118: REAL WORLD COMPLEXITY IN REFLECTANCE VALUE MEASUREMENT FOR CLIMATE-BASED DAYLIGHT MODELLING	**ID 1053:** AN ADVANCED TOOL TO VISUALIZE RESULTS OF PARAMETRIC ANALYSES
	ID 1061: A SIMULATION BASED OPTIMIZATION APPROACH FOR DETERMINING THE OPTIMUM ENERGY SAVING SOLUTIONS FOR BUILDINGS	**ID 1055:** PLACING USER NEEDS AT THE CENTER OF BUILDING PERFORMANCE SIMULATION (BPS) TOOL DEVELOPMENT: USING 'DESIGNER PERSONAS' TO ASSESS EXISTING BPS TOOLS
	ID 1113: MULTIVARIABLE OPTIMIZATION FOR ZERO OVER-LIT SHADING DEVICES IN HOT CLIMATE	**ID 1065:** INVESTIGATION OF THE EFFECTIVE PARAMETERS IN SQUARE UNIT BASED FAÇADES AS A SCOPE OF ACHIEVING BALANCE BETWEEN DAYLIGHT AND THERMAL PERFORMANCE
	ID 1093: PERFORMANCE COMPARISON BETWEEN KNN AND NSGA-II ALGORITHMS AS CALIBRATION APPROACHES FOR BUILDING SIMULATION MODELS	**ID 1068:** OPTIMAL PLANNING TOOL FOR NEARLY ZERO ENERGY DISTRICT

1:00 - 2:00pm	LUNCH BREAK - **Venue: The Gallery Space** and DesignBuilder presentation **(First Floor)**

1:30 - 3:00pm	Venue: Clore Suite	Venue: Exhibition ONE
	Theme: Urban Performance Simulation ***Session Chair: Neveen Hamza***	Theme: Applications of environmental sustainability (case studies) ***Session Chair: Jon Hand***
	ID 1138: SECOND-LEVEL SPACE BOUNDARY TOPOLOGY GENERATION FROM CITYGML INPUTS	**ID 1128:** EVALUATION OF ENERGY AND INDOOR ENVIRONMENTAL PERFORMANCE OF A UK PASSIVE HOUSE DWELLING
	ID 1129: A PARAMETRIC STUDY OF THE IMPACTS OF PITCHED ROOFS ON FLOW AND POLLUTION DISPERSION IN STREET CANYONS	**ID 1132:** COMPARISON OF DYNAMIC THERMAL SIMULATION RESULTS WITH EXPERIMENTAL RESULTS: TROMBE WALL CASE STUDY FOR A CYPRUS TEST BUILDING
	ID 1134: EXPLORING THE USE OF REMOTE SENSING AS A MEANS OF IMPROVING OUR UNDERSTANDING OF THE URBAN HEAT ISLAND'S CONTRIBUTION TO THE RISK OF INDOOR OVERHEATING	**ID 1145:** DATA REASONING IN THE EVALUATION OF DOMESTIC THERMAL ENERGY USE
	ID 1112: OPTIMISING THE URBAN ENVIRONMENT THROUGH HOLISTIC MICROCLIMATE MODELLING – THE CASE OF BEIRUT'S PERICENTER	**ID 1106:** THERMAL ANALYSIS OF A MULTIFUNCTIONAL FLOOR ELEMENT
	ID 1047: CITYGML IMPORT AND EXPORT FOR DYNAMIC BUILDING PERFORMANCE SIMULATION IN MODELICA	**ID 1111:** OPTIMUM ATRIA TYPE IN TERMS OF THERMAL COMFORT FOR HIGH RISE OFFICE BUILDINGS IN THE SEMI-ARID CLIMATE OF MIDDLE EAST WITH THE USE OF DYNAMIC THERMAL SIMULATION TOOL
	ID 1022: THREE-DIMENSIONAL HIGH-RESOLUTION URBAN THERMAL & MECHANICAL LARGE EDDY SIMULATION INTERACTIVE PHYSICS BETWEEN BUILDINGS, LAND COVER AND TREES	**ID 1116:** OPTIMIZATION OF OFFICE BUILDING FAÇADE TO ENHANCE DAYLIGHTING, THERMAL COMFORT AND ENERGY USE INTENSITY

3:00 - 3:30 pm	COFFEE BREAK - **Venue: The Gallery**

3:30 - 5:00 pm	Venue: Clore Suite	Venue: Exhibition ONE
	Theme: Progress in simulation tools and optimization method ***Session Chair: Lubo Jankovic***	Theme: Applications of environmental sustainability (case studies) ***Session Chair: Kosonen Risto***
	ID 1072: DOMESTIC HEAT PUMP ENERGY DEMAND: MODEL CALIBRATION USING HIGH-RESOLUTION MONITORING DATA	**ID 1102:** A GENERATIVE PERFORMANCE-BASED DESIGN FOR LOW-COST 2 BRICKWORK SCREENS
	ID 1172: USING PARAMETRIC DESIGN TO OPTIMIZE BUILDING'S FAÇADE SKIN TO IMPROVE INDOOR DAYLIGHTING PERFORMANCE	**ID 1041:** INFLUENCE OF HIGH PERFORMANCE FAÇADE ON ENERGY USAGE IN OFFICE BUILDINGS IN LONDON AND HONG KONG
	ID 1012: EVALUATION AND COMPARISON OF BUILDING PERFORMANCE IN USE THROUGH ON-SITE MONITORING AND SIMULATION MODELLING	**ID 1163:** CORRELATION BETWEEN RETROFITTING BUILDING ENVELOPE AND THERMAL IMPROVEMENT ON SOCIAL HOUSING IN HOT-ARID CLIMATE
	ID 1083: SIMULATION ANALYSIS OF A PREDICTIVE CONTROL ALGORITHM FOR EMBEDDING IN A MICROPROCESSOR CONTROLLER	**ID 1059:** USING INTERPOLATION TO GENERATE HOURLY ANNUAL SOLAR POTENTIAL PROFILES FOR COMPLEX GEOMETRIES
	ID 1030: HYBRID APPROACH FOR BUILDING ENVELOPE OPTIMISATION USING GENETIC ALGORITHMS AND SIMULATED ANNEALING	**ID 1147:** BUILDING PERFORMANCE SIMULATION OF ADVANCED ENERGY TECHNOLOGIES TO ACHIEVE NET ZERO ENERGY DWELLINGS IN UK
	ID 1011: IEA ANNEX 60 ACTIVITY 2.3: MODEL USE DURING OPERATION, APPROACH AND CASE STUDIES	**ID 1029:** TEACHING THE PRINCIPLES OF THE EXTERIOR ENVIRONMENT IN BUILDING SIMULATION THROUGH ACTIVE EXPERIMENTATION

WEDNESDAY 14TH SEPTEMBER 2016

9:30 - 10:15am	***Keynote Speaker: Maja Nesdale (Gensler)***
10:15 - 11:00am	DesignBuilder presentation

11:00 - 11:30am	COFFEE BREAK - **Venue: The Gallery**

11:30 - 1:00pm	**Venue: Clore Suite**

Theme: Advances in Building Performance Simulation tools
Session Chair: Malcolm Cook

ID 1094: AN OPEN IFC TO MODELICA WORKFLOW FOR ENERGY PERFORMANCE ANALYSIS USING THE INTEGRATED DISTRICT ENERGY ASSESSMENT BY SIMULATION (IDEAS) LIBRARY

ID 1108: INTEGRATED REFURBISHMENT OF COLLECTIVE HOUSING AND OPTIMIZATION PROCESS WITH REAL PRODUCTS DATABASES

ID 1135: BIM BASED CLASH DETECTION APPLICATIONS: POTENTIALS AND OBSTACLES

ID 1126: BIM ENABLED BUILDING ENERGY MODELLING: DEVELOPMENT AND VERIFICATION OF A GBXML TO IDF CONVERSION METHOD

ID 1133: PERFORMANCE IMPLICATIONS OF FULLY PARTICIPATING FURNITURE AND FITTINGS IN SIMULATION MODELS

ID 1021: VALIDATION OF ATMOSPHERIC BOUNDARY LAYER CFD SIMULATION OF A 2 GENERIC ISOLATED CUBE: BASIC SETTINGS FOR URBAN FLOWS

1:00 - 1:30pm	Conference close and announcement of next BSO18 conference in Cambridge University

Papers in proceedings Only

ID 1175: ENERGY PERFORMANCES OF FUTURE DYNAMIC BUILDING ENVELOPES

ID 1154: A PERFORMANCE EVALUATION OF MIXED-MODE VENTILATION INCORPORATING AN OPTIMAL CONTROL

ID 1002: DAYLIGHTING IN RENOVATED SCHOOL BUILDINGS

ID 1054: SIMULATION-BASED OPTIMIZATION ON WINDOW PROPERTIES

Chair: Neveen Hamza

Neveen is a Senior Lecturer in Architecture and Programme Director: MSc in Sustainable Buildings and Environments in the School of Architecture, Planning and Landscape. She is the current Vice-Chair of IBPSA-England and has been elected for this position since 2010. She is on the Board of Directors for the journal of renewable energy among others and on the Board of Directors for a number of organizations working on net Zero energy building conservation. She has over 80 research publications and research grants in the field of building and urban energy performance evaluation in developed and developing countries.

Chair of Scientific Committee: Chris Underwood

Chris Underwood is professor of Energy Modelling for the Built Environment at Northumbria University in Newcastle upon Tyne. He is an internationally-recognised expert in HVAC plant and controls and urban renewable energy systems. He has published over 100 research and scholarly outputs including 5 books and book chapter contributions. He is a former editorial board chairman of the CIBSE journal Building Services Engineering Research and Technology and holds CIBSE's Dufton and Napier-Shaw medals for contributions to research.

CONFERENCE EXECUTIVE ORGANIZING COMMITTEE:

Dr. Neveen Hamza – Newcastle University *(Vice Chair IBPSA-England)*

Prof. Chris Underwood – *Northumbria University*

Prof. Malcolm Cook – *Loughborough University*

Prof. Dejan Mumovic – *The Bartlett, UCL, UK*

Prof. Pieter De Wilde – *Plymouth University (Chair of IBPSA-England)*

CHAIR OF SCIENTIFIC COMMITTEE:

Prof. Chris Underwood – *Northumbria University*

CONFERENCE EXECUTIVE SCIENTIFIC COMMITTEE:

Prof. Jon Wright – *Loughborough University*

Prof. Malcolm Cook – *Loughborough University*

Prof. Pieter De Wilde – *Plymouth University (Chair of IBPSA-England)*

Dr. Neveen Hamza – *Newcastle University (Vice Chair IBPSA-England)*

Dr. Liora Malki-Epshtein – *UCL*

CONFERENCE REVIEWERS:

Dr. Neveen Hamza – *Newcastle University (Vice Chair IBPSA-England)*
Prof. Chris Underwood – *Northumbria University*
Dr. Hasim Altan – *British University of Dubai*
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Mr. Mark Anderson – *Ulster University*
Mr. Dietmar Backes – *UCL*
Dr. Phillip Biddulph – *UCL*
Dr. Clarice Bleil de Souza – *Cardiff University*
Dr. Richard Buswell – *Loughborough University*
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Prof. Rajat Gupta – *Oxford Brookes University*
Mr. Ian Hamilton – *UCL*
Prof. Vic Hanby – *De Montfort University*
Dr. Jon Hand – *University of Strathclyde*
Dr. Reazul Hasan – *Northumbria University*
Dr. Christina Hopfe – *Loughborough University*
Dr. Draco Iyi – *Robert Gordon University*
Prof. Lubomir Jankovic – *Birmingham City University*
Dr. Rory Jones – *Plymouth University*
Prof. Maria Kolokotroni – *Brunel University London*
Dr. Simon Lannon – *Cardiff University*
Dr. Vincent Luo – *University of Reading*
Dr. Liora Malki-Epshtein – *UCL*
Prof. John Mardaljevic – *Loughborough University*
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Prof. Dejan Mumovic – *UCL*
Mr. Edwards Murphy – *Mott MacDonald*
Dr. Sukumar Natarajan – *University of Bath*
Dr. Bobo Ng – *Northumbria University*
Prof. Marialena Nikolopoulou – *University of Kent*
Dr. Rokia Raslan – *UCL*
Dr. Simon Rees – *De Montfort University*
Dr. Paula Sassi – *Oxford Brookes University*
Prof. Paul Strachan – *University of Strathclyde*
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Prof. Chris Underwood – *Northumbria University*
Dr. Sara Walker – *Northumbria University*
Dr. Andrew Wright – *De Montfort University*
Prof. Yigzaw Yohanis – *Ulster University*
Dr. Simon Tucker – *Liverpool John Moores University*
Prof. Keon Steemers – *University of Cambridge*
Dr. Simon Taylor – *Loughborough University*
Prof. Adrian Pitts – *University of Hudersfield*
Prof. Jake Hacker – *UCL*
Prof. Emeka Efe Osaji – *Bells University of Technology*
Dr. Hector Altamirano – Medina – *UCL*
Dr. Amira Elnokaly – *Lincoln University*
Prof. Hisham Elkadi – *Salford University*

Harsh Thapar

CEnv. MIEnvSc . MSc . BArch
Performance Driven Design: Simulation, Experiments and more

Harsh Thapar is an Associate at Foster and Partners. He works in the Specialist Modelling Group, which is an in house research and development team involved with complex geometry, environmental design research and innovation for projects.

He joined Foster+Partners in 2007 upon completing his MSc from Architectural Association School in London (AA), where he studied Sustainable Design. Harsh worked for leading architectural practises in India after his BArch degree at School of Planning and Architecture, New Delhi. He became a licensed architect in India and was involved in successful execution of Commercial and Hospital buildings for prominent Indian clients like Unitech. He was the project architect for India's first energy rated green hospital building in New Delhi for Fortis Healthcare.

His MSc research at the AA was focussed on design of 'Urban Form for Hot Climates'. For this he travelled extensively in UAE carrying out field measurements, surveys and technical simulation work. His research developed solutions for increasing outdoor comfort in hot humid climate and used advanced simulation software to test the hypothesis. He presented his research at the Passive and Low Energy Architecture Conference at Dublin on 2008 and was published.

At Foster+Partners, he has worked on low energy building design and sustainable Urban Form design on numerous projects like Hangzhou Financial District, China , Ireo Masterplan India etc. He has worked extensively on Masdar City, in Abu Dhabi, where he carried out field studies to understand outdoor comfort performance. These have been widely published. He was accepted as Member of Institute of Environmental Sciences, UK and became a Chartered Environmentalist in 2014.

Ian Beausoleil-Morrison

BPS: How did we get to where we are today and what are the key challenges for the future?

Ian Bausoliel-Morison is a professor in the faculty of Engineering and Design in Carlton University, Ottawa, Canada. He holds the Canada research Chair in Innovative Energy Systems for residential buildings. He is co-founder and has been co-editor of the Journal for Building Performance Simulation since its establishment in 2008.

Ian held various roles in the IBPSA world organization, an IBPSA-World director since 2004, and a Vice president from 2006- 2010, then president from 2010-2015. He was awarded a IBPSA-fellow status in 2015 He has been a n operating agent for the international Energy Agency Energy conservation in Buildings Implementation Agreement, is past chair of ASHRAE's technical committee 4.7 on energy calculations. He has also been a theme leader for the Canadian research networks on solar buildings and is a member of the EPSRC peer review college.

Prior to joining Carlton in 2007, Ian worked for 16 years for Canmet ENERGY, where he led a team of researchers who developed models for innovative energy systems, such as micro-cogeneration and developed simulation tools for industry.

His research interests include solar housing, seasonal thermal storage, micro-generation and understanding occupants' behaviour. Currently is the lead investigator of the Urbandale Centre for Home Energy research, a research House situated on the Carlton University campus, that is dedicated to the study of solar-thermal and other innovative energy systems for radically reducing the dependence of housing on fossil fuels.

Maria Nesdale

ARB, RIBA, LEED® BD+C
Education Practice Area Leader, Senior Associate

As a Firmwide Leader of the Education Practice Area, in Gensler, London, Maria guides teams in designing enhanced educational environments that deliver a vastly enhanced learning experience for students of all levels. A Senior Associate and Registered Architect, Maria is highly regarded as a specialist in her field. She was invited to participate on the World Architecture News awards jury panel for education in 2012 and the World Architecture News Effectiveness Awards in 2013. She earned a B.A. (Hons) in Architecture at the University of Portsmouth and a Diploma in Architecture at the University of Westminster, where she also pursued Postgraduate Certificate Professional Practice in Architecture.

MONDAY

Theme: Progress In Simulation Tools And Optimization Method

Theme: Applications Of Environmental Sustainability (Case Studies)

Theme: Advanced Simulation Of Building Systems

TUESDAY

Theme: Progress In Simulation Tools And Optimization Method

Theme: Urban Performance Simulation

Theme: Progress In Simulation Tools And Optimization Method

Theme: Advances In Building Performance Simulation Tools

MONDAY

12TH SEPTEMBER 2016

VENUE: CLORE SUITE

THEME: PROGRESS IN SIMULATION TOOLS AND OPTIMIZATION METHOD

ID: 1031

NUMERICAL MODELLING OF THERMAL COMFORT IN NON-UNIFORM ENVIRONMENTS USING REAL-TIME COUPLED SIMULATION MODELS

Francesco Babich[1], Malcolm Cook[1], Dennis Loveday[1], and Paul Cropper[2]

[1]Loughborough University, School of Civil and Building Engineering, LE11 3TU Loughborough, UK
[2]Institute of Energy and Sustainable Development, De Montfort University, LE1 9BH Leicester, UK

This research aimed to test and validate the only existing real-time coupled model of human thermal comfort by comparing simulation results and measured data for a number of different realistic non-uniform scenarios. This model incorporates detailed and realistic human figures in CFD, coupled with the IESD-Fiala model which enables the reaction of human occupants and their influence on the environment by heat and mass transfer to be modelled. A set of likely configurations have been created in an environmental chamber. Typical furniture, a thermal manikin and a portable fan have been used to generate non-uniform controlled environments, and detailed measurements have been taken. The same configurations have been modelled using the coupled model. The initial results highlight that this coupled model can effectively predict human thermal comfort in non-uniform environments, being able to represent dynamic conditions around the body in real time. Further work is addressing more complex configurations.

ID: 1018

OPTIMAL DESIGN OF ENERGY CONVERSION UNITS AND ENVELOPES FOR RESIDENTIAL BUILDINGS

Thomas Schütz, Lutz Schiffer, Hassan Harb, Marcus Fuchs, and Dirk Müller

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The optimal design of buildings is a complex task involving energy systems as well as construction measures. Typically, in exact optimization models, only energy systems are considered, whereas envelope components are neglected. When considering both, heuristics are commonly used, which do not guarantee optimal or close to optimal results. Thus, this paper presents a building model that can be used in exact optimization problems for simultaneously considering energy systems and building envelopes. The developed model is based on ISO 13790 and verified

according to ASHRAE 140 and further compared to a more detailed model. The findings show that the developed model fulfills the ASHRAE requirements for heating and cooling loads. The model computes similar heat demands as the more detailed model; however, cooling loads differ. Since our focus is on heating systems, the model is suitable for this application. The simultaneous optimization of energy system and envelope is further demonstrated for a residential building.

ID: 1043

THE IMPORTANCE OF DERIVATIVES FOR SIMULTANEOUS OPTIMIZATION OF SIZING AND OPERATION STRATEGIES: APPLICATION TO BUILDINGS AND HVAC SYSTEMS

Van-Binh Dinh, Benoit Delinchant, and Frederic Wurtz

Univ. Grenoble Alps, CNRS, G2Elab, F-38000 Grenoble, France

This paper presents optimization approaches for a complex nonlinear constrained optimization problem: sizing integrating operation strategies of energy systems (heating, ventilation) for positive energy buildings. This is a multi-criteria optimization problem of big size with differentiable objective functions (thermal comfort and life-cycle cost) and a lot of continuous decision variables. To solve it, 2 optimization methods will be studied: (i) derivative-free method (NSGA2) et (ii) derivative-based method (Sequential Quadratic Programing). The study case is a positive energy house in South-East of France in which we will show that derivative-based optimization approach will be more efficient with much less computation time and a better quality of Pareto front solutions.

ID: 1035

INTEGRATING ARCHITECTURAL AND ENERGY VIEWPOINT FOR A MULTI OBJECTIVE OPTIMIZATION DURING EARLY DESIGN STAGE

Sudip Kumar Pal[1], Atsushi Takano[2,3], Kari Alanne[1], Kai Siren[1]

[1] Department of Mechanical Engineering, School of Engineering, Aalto University, Sähkömiehentie 4 A, 02150 Espoo, Finland
[2] Department of Architecture, School of Arts, Design and Architecture, Aalto University, Miestentie 3, 02150 Espoo, Finland
[3] Department of Architecture and Architectural Engineering, Kagoshima University, Japan

In recent years, applying optimization techniques towards the design of energy efficient buildings has become very useful. These techniques are particularly effective if they are used during architectural design stage, because early decisions have more profound effect on the final energy performance of buildings compared with later decisions. In this research, an optimization is performed on a hypothetical detached house to determine minimum energy performance with optimum cost level. The purpose is to demonstrate the use of simulation based optimization for an early

design stage case study. An emphasis is placed on choosing design variables with a perspective of both architectural and engineering viewpoint. Particularly architectural design variable like geometry are inflexible to change later in the design process. The results suggest lowering the U-value for the external wall and window from their values mentioned in Finnish Building code D3. A 2-floor design is energy and cost optimal compared to 1-floor design. Space heating demand is the dominant energy component affected by the choice of design variables. Although the results are rather obvious, the power of simulation based optimization during the early design stage is shown. This investigation solves the problem of relevant data scarcity during early design phase and guides the decision making in an optimal manner.

ID: 1089

BRIDGING THE PERFORMANCE GAP: INFORMATION DELIVERY MANUAL FRAMEWORK TO IMPROVE LIFE-CYCLE INFORMATION AVAILABILITY

So Young Hyun[1], Ljiljana Marjanovic-Halburd[2], Rokia Raslan[3], and Dimitrios Rovas[4]

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Buildings account up to one-third of all global energy, and it will more than double in the next 50 years. In order to accurately predict the energy performance of buildings and improve the analysis methodologies, researchers have developed hundreds of algorithms to simplify or semi-automate the analysis process.

However, there is significant evidence to suggest that buildings do not perform as well in practice as was anticipated at the design stage. Findings from a number of existing studies revealed that actual energy consumption is often twice as much as predicted. The major contributors to the performance gap are lack of available information that exists at different stages of the formal building life cycle and delivery process.

This paper proposes a framework to develop an integrated and seamless Information Delivery Manual (IDM) by

extending the existing IDM approaches to identify and document the information required for building performance analysis.

ID: 1073

PLACING USER NEEDS AT THE CENTRE OF BUILDING PERFORMANCE SIMULATION: TRANSFERING KNOWLEDGE FROM HUMAN COMPUTER INTERACTION

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This paper reviews and explores some principles and theories of Human-Computer Interaction (HCI) and the related field of Interaction Design in relation to Building Performance Simulation (BPS). HCI seeks to make computer systems and software more useable and more attractive to its users. The main focus of the paper is on the interaction between user and computer system and how interaction could facilitate the knowledge transfer of BPS procedures and processes from experts to non-experts.

The paper discusses users and their tasks, designing for interaction, and the level of control different users might have over BPS. Design patterns are proposed as a means of interaction between user and computer system. The aim of the paper is to provide a platform for a future discussion on the extent to which BPS has engaged with HCI practices and principles, and the possibilities HCI holds for the further development of BPS. A number of research directions are identified.

ID: 1074

EXHAUSTIVE SEARCH: DOES IT HAVE A ROLE IN EXPLORATIVE DESIGN?

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Building performance simulation (BPS) is used routinely in design practice to evaluate the performance of candidate design solutions. However, two sources of uncertainty exist in the design process: in the selection of an optimum design solution; and in the predicted performance of the building (say, due to uncertain boundary conditions). These uncertainties can be evaluated and reduced through the use of an “explorative design” process, in which uncertainty quantification, multi-objective optimization, and sensitivity analysis are combined to provide information on the choice of robust and optimal design solutions. This paper investigates the use of an exhaustive search method to

sample all combinations of design solutions and uncertain boundary conditions. The number of samples, and therefore the range of designs considered, are limited by the computation time of BPS. However, this paper concludes that design standards can be used to identify a viable range of design options, and that an exhaustive search applied to a limited design space provided enough information to identify and select robust design solutions. The paper also demonstrates the use of a new approach to identifying robust solutions that are guaranteed to remain optimal, regardless of the prevailing uncertainty in the boundary conditions.

ID: 1086

INFLUENCE OF DESIGN CONDITIONS ON THE DISTRIBUTION OF OPTIMAL WINDOW TO WALL RATIO FOR A TYPICAL OFFICE BUILDING IN JAPAN

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This paper simulates a typical Japanese open office building to investigate the influence of design conditions on the distribution of optimal window-to-wall ratio (WWR). Results are expected to be adopted to create a recommended WWR range map for default value assignment in early performance simulations. The impact of lighting power density, climate conditions, window orientation, internal gain, and building scale are investigated. Results are discussed under the normal lighting power density of 10 W/m^2 and an assumed value of 5 W/m^2. A larger WWR is liable to be advantageous for CO_2 emission reduction under the normal lighting power density in the main island of Japan. However, the distribution of optimal WWR is found to be sensitive to all the investigated design conditions when the lighting power density is reduced. A comparison study demonstrates that internal gain and building scale can be regarded as minimal influential conditions. Climate conditions and window orientation should be considered in the future map creation.

ID: 1038

INVESTIGATING THE IMPACT OF MODELLING UNCERTAINTY ON THE SIMULATION OF INSULATING CONCRETE FORMWORK FOR BUILDINGS

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Insulating Concrete Formwork (ICF) walls consist of cast in situ concrete poured between two layers of EPS insulation. The system can achieve very low U-values and high levels of air-tightness. This paper investigates the inconsistency in simulation results provided by nine widely used Building

Performance Simulation (BPS) tools when calculating the energy consumption and the thermal performance of buildings using ICF. The aim is to identify the impact that the various modelling methods have on the simulation results. There were significant inconsistencies in the simulation results, especially for the annual and peak heating demand. Moreover, among the different calculation methods, the surface emissivity, the infiltration rate and the specification of the internal gains were found to cause significant variations.

ID: 1034

HYBRID DISCRET-CONTINUOUS MULTI-CRITERION OPTIMIZATION FOR BUILDING DESIGN

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This paper presents multi-physics modeling and optimization to design buildings by simultaneously treating the thermal comfort and the total cost (CAPES/OPEX). It focuses on real situations of the design of buildings in which it is required to use real components (Material Database) and to resolve the mixed continuous discrete optimization problem.

This optimization will be ensured, thanks to the optimization software of our lab (FGot or the commercial version GOT-It) using GMGA (Grid Multi-objective Genetic Algorithm). The coupling between optimization and the building model is integrated using a RESTful Web Service (HTTP protocol).

The aim of the optimization is to find the optimal settings for the design of the studied building, regarding insulation, windows, etc... while targeting energy performance, comfort and economic goals. It is thus a multi-criterion optimization that can be reached by a weighted mono-objective method or by finding optimal Pareto front.

So in this paper, we are dealing with global modelling for optimization purpose, model and optimization algorithm coupling, mixed discret-continuous optimization concerning database existing components.

ID: 1095

NEW PROFILES OF OCCUPANCY DRIVEN LOADS FOR RESIDENTIAL SECTOR ENERGY DEMAND MODELLING

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Energy modelling is used by researchers to estimate aggregate energy consumption and time-step demand (power) of buildings. When considering new building technologies, time-step demand modelling plays an

important role on several levels: 1) it allows homeowners and builders to determine viability within time-of-day energy and demand pricing schemes and smart-metering response; 2) it can help utilities accurately forecast short term loads so that they can procure sufficient capacity, especially with consideration of residences opting for new technologies that affect load profile; 3) it can inform the creation of energy policy to support implementation of technologies that may have a desirable effect on community load profiles.

Building simulation tools can address these issues by providing accurate energy consumption estimates for homes and communities. However, researchers often rely on a limited number of synthetically developed electricity and domestic hot water (DHW) load profiles and these do not permit comprehensive demand evaluation at a community scale. Recently, occupant load data has become available through electrical utility 'smart metering' programs, academic and industrial research endeavors, and municipal energy savings programs. Four separate datasets have been obtained for our research project:

- two datasets including 1-minute time-step DHW consumption measurements from 41 and 119 houses
- one dataset including 15-minute time-step whole-house electricity load measurements from 161 homes
- one dataset including 1-minute time-step disaggregated electricity load measurements from 23 homes

From these datasets, annual time-step DHW and electricity load profiles have been generated. To demonstrate the effect of using a variation of profiles, a community scale energy model is being created, utilizing a set of single-family detached house Archetype building models developed by the U.S. Department of Energy. This paper presents these new profiles and the initial stages of work completed to demonstrate the effect of using a variation of profiles on a community scale.

ID: 1101

NEW EXTENSION OF MORRIS METHOD FOR SENSITIVITY ANALYSIS OF BUILDING ENERGY MODELS

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Sensitivity analysis is commonly used in numerical modelling to identify those inputs that have a large impact on model outcomes. We scrutinise the Morris method, known to be computationally efficient for parameter screening, through a case study. This paper demonstrates that the current Morris method with the absolute mean as measure of parameter ranking yields unstable results. We show that using the median value, which is less sensitive to outliers, yields more robust parameter rankings for evaluations with small sample

sizes. The performance of the improved Morris method is validated against the variance-based sensitivity analysis. We also investigate correlations between elementary effects and parameter values and find that they can be efficiently used to identify higher-order parameter interactions from a single set of samples used in the Morris method.

ID: 1115

DATA DRIVEN BOTTOM-UP APPROACH FOR MODELLING INTERNAL LOADS IN BUILDING ENERGY SIMULATION USING FUNCTIONAL PRINCIPAL COMPONENTS

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Internal loads in a building are difficult to quantify efficiently in a way which envelopes existing demand yet permits estimation of the impact of changes in building operation. The standard characterisation by energy-use intensity and diversity profile is well established; while quantification of energy-use intensity is achievable using monitored data, there is no standard approach for quantification of diversity profiles. This paper investigates an efficient method for the representation of the shape of the diversity profile using a functional data analysis approach together with electricity consumption data monitored at a spatial resolution that permits correlation of consumption with space use type. The approach has been applied to a case study building and has been shown to give a good agreement with monitored electricity consumption data.

ID: 1120

LOW-RISE COMMERCIAL BUILDINGS OPTIMIZATION – ENERGY PERFORMANCE AND PASSIVE COOLING POTENTIAL IN FRANCE

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Large indoor volumes and lightweight materials characterize low-rise commercial buildings. Thermal and visual comfort is a commercial issue usually solved with air conditioning and artificial lightings. This could be considered in the building envelope design itself, throughout a passive building design. These envelopes are characterized by high thermal interactions of ground floor and roof surface to environment. In order to optimize energy performance and passive thermal strategies, several parameters have

been selected: thermal insulation of various walls, natural ventilation, roof radiative characteristics, windows and skylights surfaces.

The proposed optimization process has been developed considering both mitigation objectives of energy consumption and summer thermal discomfort. Moreover, we consider here all French climates, with passive cooling only for summer, and climate change effects. Using NSGA-II optimization algorithm, this study points out that optimal solutions depend greatly on climate characteristics.

For stakeholders, the optimal design can be chosen given the Pareto front results, and compromises are mapped for France considering both objectives and construction costs. This methodology and the numerical results can be helpful for design guidelines of new commercial building or refurbishments as the proposed study is based on a typical low-rise building for commercial.

ID: 1152

MEASURING LIGHT THROUGH TREES FOR DAYLIGHT SIMULATIONS: A PHOTOGRAPHIC AND PHOTOMETRIC METHOD

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Trees play a significant role in influencing daylight availability inside and outside buildings. They temper, scatter and transmit light subsequently reducing the availability or acting as a passive source of daylight. Current daylighting simulation practices either avoid modelling trees or model them as cones, spheres or cylinders with an assumed reflectance value. Trees are complex in their shape and—depending on crown density and clumping nature—their optical properties change considerably. In order to predict the effect of trees on daylight, researchers need to first measure and quantify this effect. Hence, in this paper the authors propose a low-cost method employing high dynamic range photography and automated image processing to measure two variables of the tree crown: gap percentage and transmittance percentage. These measured variables can be used in daylight simulation platforms such as Radiance to geometrically model the crown of a tree and specify its optical properties

ID: 1121

ECODESIGN OF A 'PLUS-ENERGY' HOUSE USING STOCHASTIC OCCUPANCY MODEL, LIFE-CYCLE ASSESSMENT AND MULTI-OBJECTIVE OPTIMISATION

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Designing plus energy buildings, at lower environmental impact and lower cost, is a complex optimisation problem. In this context, this paper presents an ecodesign approach of

a plus-energy house assisted by multicriteria optimisation. Illustrated by a real case, this approach uses a genetic algorithm to find a set of solutions as close as possible to the theoretical Pareto front, corresponding to the best compromises for the formulated problem. The solutions' performance was evaluated using a dynamic building energy model (*COMFIE*), a life cycle analysis model (*novaEQUER*), and a construction cost database. In order to study the solutions' robustness, the diversity of occupants' behaviour was stochastically modelled. The proposed approach is thus contributing to the decision making process, beyond simple evaluation by simulation.

VENUE: EXHIBITION ONE

THEME APPLICATIONS OF ENVIRONMENTAL SUSTAINABILITY (CASE STUDIES)

ID: 1114

PARAMETRIC ANALYSIS OF SOLAR SHADING PARAMETERS IN INTERMEDIATE ORIENTATIONS LOCATED IN DESERT CLIMATES

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Improving daylighting performance for offices provides positive effects on well-being, productivity and energy savings. High exposure to direct solar radiation in desert climates has been addressed in the literature by the use of shading devices. A study of the effect of four parameters (screen rotation, depth and tilt, window-to-wall ratio) on daylighting of a generic office in the deserts of Cairo, Egypt was carried out in two intermediate orientations (SE and NE) through a parametric simulation approach using Rhino 3D, Grasshopper, SpeedSim-for-DIVA and Diva-for-Rhino. The newly approved IES metrics were used to evaluate the 1120 iterations with an exhaustive method. The use of mainly horizontal shading, downward tilting shades, high window-to-wall ratio (WWR), and large screen depths were suggested.

ID: 1052

INVESTIGATING THE POTENTIAL IMPACT OF STAKEHOLDER PREFERENCES IN PASSIVHAUS DESIGN

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Low-energy buildings have a major role to play in achieving carbon emission reduction targets. The Passivhaus standard is driven by improved thermal comfort and has stringent targets for limiting energy consumption. Such constraints can be difficult to achieve with aesthetically pleasing results. In early stage building design, decisions are often made based on preferences, without assessing their impact on energy performance.

Multi-criteria decision-making provides a technique of evaluating competing criteria using a robust framework. However, existing research in building performance focusses on quantitative measures, leaving a research gap in the subjective area of design preferences.

This paper applies a modelling technique that incorporates user preferences, alongside quantitative building performance measures, by applying multi-criteria decision-making to a Passivhaus case study. Potential building forms are evaluated using dynamic simulation, then the impact of stakeholder preferences is assessed.

ID: 1008

THE IMPACT OF CLIMATE CHANGE ON THE ENERGY-EFFICIENT REFURBISHMENT OF SOCIAL HOUSING STOCK IN ITALY

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From the ‘40s to the late ‘70s, Italy implemented an extensive plan of public social housing. The building typologies and their urban aggregation plans have represented an high quality standard till today and well represented the national building stock; conversely, their energy performance is extremely poor, and their energy-efficient refurbishment have a key role in the national targets of GHG emissions reduction.

For these reasons, by historical research and survey of 145 social housing buildings, a building typology matrix with six references building has been identified, in analogy with IEE TABULA project. Then, some typical refurbishment measures have been analysed in term of global costs and energy response to climate change. The results of this study show that the measures with moderate performance level can be considered the most favorable in term of global costs reduction for the most of the economic and climatic scenarios considered.

ID: 1077

ASSESSMENT OF INDOOR VISUAL ENVIRONMENTS USING DEMENTIA-FRIENDLY DESIGN CRITERIA IN DAY CARE CENTRES

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This research assesses whether the indoor visual environment in three day care centres in Galicia (Spain) for people with Alzheimer's disease and other dementia (ADOD), complies with a set of dementia-friendly design criteria and principles of environmental psychology. Qualitative evaluations, combined with measurements of indoor lighting parameters (i.e. horizontal and vertical illuminances - E_H, E_v; correlated colour temperature - CCT), are conducted to assess the indoor visual conditions. Building Performance Simulation (BPS) is used to evaluate the indoor daylight availability. The study highlights that indoor visual aids and lighting levels for task undertaking and circadian entrainment are insufficient. Altough BPS can underpin daylight contribution from the design stage, further research regarding daylight metrics is needed to include non-visual effects of light within the BPS capabilities.

ID: 1078

COST-EFFECTIVE MEASURES FOR ENERGY IMPROVEMENT OF 1980'S DETACHED HOUSES IN COLD CLIMATE

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The paper presents cost-effective energy performance improving measures in a Finnish (cold climate) detached house built in the 1980's. The studied building represents a typical relatively energy efficient Scandinavian detached house with direct electrical heating system. The main objective of the research was to study and compare the cost-effectiveness and energy performance of modern renewable energy production systems and different HVAC systems in addition to the more traditional energy performance improving measures. The research method of the study was simulation-based multi-objective optimization, which was used to minimize the life-cycle cost and the total energy consumption of a case study building. The air-to-water heat pump system with water-based floor heating system in all spaces, combined with additional thermal insulation of roof and new air handling unit with improved heat recovery system (75-80 %) proved to be the global cost-optimum solution. All of the studied heat pump systems and the original direct electrical heating system proved to be more cost-effective main heating systems than the district heating system.

ID: 1013

ASSESSMENT OF DAYLIGHT IN RELATION TO THE AGITATION LEVELS OF PEOPLE WITH DEMENTIA

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This research aims to develop the design guidelines for designing daylight levels that may positively impact on reducing agitation behaviour in people with dementia based on principles of behavioural and psychological symptoms. The research methodology was based on the literature review, fieldwork and building performance simulation (BPS). Quantitative and qualitative approach was conducted by assessing indoor daylight quality and agitation levels. In addition, evaluation of daylight parameters (i.e. daylight factor and relation to the agitation level) was also carried out during the observation. The results suggest that agitation level is indeed higher in the top floor of the nursing house, mostly in the most occupied areas such as: communal area and dining room. According to the carers, the main reason to such phenomenon might be due to the sundown syndrome that usually happens after tea time. Moreover, the daylight strategies were carried out to increase the effectiveness of daylight illuminance levels for indoor environment.

ID: 1024

A HOLISTIC MODELLING FRAMEWORK FOR RETROFITTING HARD-TO-TREAT HOMES IN LONDON: ENERGY, COMFORT, COST AND VALUE PROPOSITIONS

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This study proposes a holistic framework to aid stakeholders make informed decisions for the retrofit of Hard-to-Treat homes, i.e. properties that cannot accommodate cost-effective or 'staple' fabric energy efficiency measures. The impact of fabric retrofit measures in compliance with Part L1B and EnerPHit on space heating energy consumption and summer overheating was assessed in typical Hard-to-Treat London mid- and end-terraced dwelling archetypes using the IES VE dynamic thermal simulation software. Wall insulation, depending on its position (internal or external) and its thickness, was found to be most effective in reducing space heating loads (30-48%) and combined application of the tested measures indicated a potential reduction in the range of 40-55%. However, internal wall insulation was found to increase the risk of summer overheating beyond the 2030s under the Medium and High emissions climate change scenarios with its severity varying depending on the provision of climate change adaptation measures. The thermal modelling outputs were combined with a cost benefit analysis for each retrofit package to generate value propositions for residents and homeowners, private investors and the Government.

ID: 1033

PERFORMANCE OF PERSONAL VENTILATION SYSTEMS IN A MULTI-BED MATERNITY WARD.

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Personal ventilation (PV) is a method of supplying a small zone of an occupied space, with cool fresh supply air. Many studies have concentrated on, and shown positive benefits of, personal ventilation in office environments. However little has been done for hospitals. Computational fluid dynamics (CFD) was used to evaluate four different mechanical personal ventilation configurations in a maternity ward: canopy, pillow, headboard and footboard systems, with a fully naturally ventilated system as a base case. The results suggest a horizontal sinking flow will deliver supply air into the patient breathing zone (BZ). The head- and foot- board systems were able to accommodate changes in patient orientation, with negligible change in ventilation performance in terms of age of air, as well as providing comfortable uniform conditions. However, in order to achieve this, a compromise on air quality, albeit a small amount, is required. Overall evaluation suggests that the headboard-based PV system might offer the best all-round performance.

ID: 1036

ENERGETIC PERFORMANCE AND ECONOMIC FEASIBILITY OF ONSITE GENERATION TECHNOLOGIES IN A NEARLY ZERO ENERGY BUILDING

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By the end of 2020, all new buildings must be nearly zero energy as instructed by the European Commission. In southern Finland, a demonstration project building tries to reach the zero energy level by minimizing energy demand and integrating photovoltaic panels, solar thermal collectors, and a ground source heat pump. An analysis of measured data has been conducted. The net energy consumption per unit area was 15 and 21 kWh/m^2 in 2014 and 2015, respectively. With said measured data and a simulation model of the building, several installed capacities of photovoltaic panels and an alternative wind generation system are simulated. An economic analysis is conducted for the proposed systems, based on simple payback period, internal rate of return, and levelized cost of electricity. The results provide three lessons: i)energy self-consumption makes the investments more attractive, ii)the notion of economies of scale (cost benefits through larger output) should be taken with caution in residential generation systems, and iii)neither the commercially available photovoltaics nor the wind turbine residential systems are attractive investments under the current conditions in Finland.

ID: 1070

STUDY ON DISTRICT ENERGY CONSUMPTION PREDICTION MODEL OF OFFICE BLOCKS IN COLD REGION, CHINA WITH SIMULATION AND REGRESSION ANALYSIS

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Prediction of district energy consumption plays an important part in building energy conservation. In this study, the simulation method is adopted to predict the energy consumption of standard building, and the statistical data combined with Bayesian model for optimized forecasting district energy consumption is also used. A sample survey is first conducted in Harbin. And, standard buildings sets are developed according to classification employing orthogonal experiment. Moreover, simulation is performed based on typical morphological data set derived from the sample survey. The Bayesian model is adopted to optimize method of area superposition with energy consumption value of standard buildings and statistical data. And finally, the prediction model for district energy consumption and a simplified energy consumption formula for office district are obtained by the integrated method. Compared with other prediction methods, the optimized approach has a significant influence on accuracy in terms of error analysis. The method proposed in this study can accurately predict the district energy consumption of office building blocks in the planning stage where detailed building information is lacked, to guide the energy planning, project design, product development etc.

THEME: ADVANCED SIMULATION OF BUILDING SYSTEMS:

ID: 1003

PDEC TOWER COOLING ENERGY PERFORMANCE ASSESSMENT USING SPECIFIC ENTHALPY CALCULATION METHODOLOGY

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Passive downdraught evaporative cooling (PDEC) is a method of passively cooling an internal space using water micronisation i.e. introducing moisture into ventilation supply air streams. To date, PDEC design tools are very limited and varying relative humidity limits are not fully considered. This paper presents a design methodology using specific enthalpy calculations. A theoretical commercial building case study is developed (base case) using dynamic thermal simulation (DTS). Climate locations are hot climates (Lisbon, Portugal and Nairobi, Kenya) to compare differences in cooling potentials. Calculated values show that humidity levels at 50% have a greater rate of cooling

capacity compared with lower RH values. Calculated annual mechanical cooling energy reductions while incorporating PDEC Tower are:

- 12% (30% RH), 14% (40%RH) and 16% (50% RH) for Portugal. one dataset including 15-minute time-step whole-house electricity load measurements from 161 homes
- 7% (30% RH), 8% (40% RH) and 9% (50% RH) for Kenya.

This methodology is effective for calculating minimum PDEC cooling available in these climates. This method can be used for RIBA stage 2 analyses (concept design) and enable assessment PDEC system payback.

ID: 1044

MULTI-MODE MODEL OF AN AIR HANDLING UNIT FOR THERMAL DEMAND CALCULATIONS IN MODELICA

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This paper describes a simulation model to calculate thermal energy demand of air handling units (AHU) centrally installed in buildings with focus on laboratories. The model's design gradually supports energy demand calculations of multiple buildings, e.g. on district level. The AHU is modelled in the open source, object-oriented modelling language Modelica®. The model uses particular operation modes while neglecting dynamic transitions as this reduces computational effort to allow simulations on district level. A comparison of simulation results to experimental results, gained with a test bed at the Institute for Energy Efficient Buildings and Indoor Climate, RWTH Aachen University gives insights into the model's accuracy. The results justify using the model in district simulations, where reduced calculation efforts outweigh acceptable deviations.

Moreover, this paper presents thermal demand simulations of a research site with 195 buildings and a comparison to monitoring data. The computed hourly heating power is satisfying compared to this measured data, e.g. in terms of the coefficient of determination with a value of R^2=0.939.

ID: 1049

THE POTENTIAL OF PREDICTIVE CONTROL IN MINIMIZING THE ELECTRICITY COST IN A HEAT-PUMP HEATED RESIDENTIAL HOUSE

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This study aims to investigate the energy demand response (DR) actions on energy consumption and cost for a thermal energy storage system with a ground source heat pump in a detached residential house in a cold climate. This aim was applied for two building structures, including light weight passive and massive passive structures. This study introduces a control algorithm based on checking current hourly electricity price (HEP) and trend of future HEPs. This research was carried out with the validated dynamic building simulation tool IDA Indoor Climate and Energy. The results show that the control algorithm reduces annual delivered energy for heating system and energy cost about 12% and 11%, respectively. The results also illustrate that the performance of the control algorithm is independent of the building structure.

ID: 1100

IMPLICATIONS OF A DECARBONISED GRID ELECTRIC SYSTEM FOR BUILDING EMISSIONS CALCULATION

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Achieving the UK Government's green house gas emission reduction targets require significant reductions in emissions from the electricity generation. This has implications for emissions from UK building stock as electrified building services will generate fewer emissions than their fossil fuel alternatives. In reviewing the National Calculation Methodology, which is used to show compliance with Building Regulations, it is found that the use of electrified building services are encouraged as are biofuel district energy systems.

This study considers how two case study buildings under different services arrangements performed in terms of their building emission rate (BER) when the carbon intensity of grid electricity reduces. It is found that the fully-electrified scenarios performed well at all carbon intensities and that at a value of 0.1kgCO2/kWh the fully-electrified scenarios have a lower BER than all others considered including biofuels. Perhaps more significantly it is also found that poorly performing buildings which offset emissions with onsite low/zero carbon generation such as CHP or photovoltaic generation are shown to perform far worse under decarbonised grid scenarios. In conclusion it is suggested that current assessment tools could do more to encourage consideration of the impending grid decarbonisation. This study omitted to consider domestic buildings, district energy

systems or financial aspects of the design decision process leaving much scope for future investigations.

ID: 1146

DYNAMIC SIMULATION METHODS OF HEAT PUMP SYSTEMS AS A PART OF DYNAMIC ENERGY SIMULATION OF BUILDINGS

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The paper presents simulation modelling and validation of heat pump systems as a part of dynamic energy simulation of buildings. The study focuses on modelling of heat pump systems with IDA Indoor Climate and Energy (IDA ICE) simulation software with field-testing for simulation model validation. The studied heat pump systems included a ground source heat pump, an air-to-water heat pump and an exhaust air heat pump. The results of the study indicated that the studied dynamic simulation tool is an accurate and reliable method to simulate the energy performance of the studied heat pump systems. Simulation results of different case studies indicated that the installation method of the heat pump system has a relatively significant impact on the operation and energy performance of the system. According to the study, modern heat pump systems on the market can be simulated accurately in different operating conditions by calibrating the default heat pump models of the Early Stage Building Optimization (ESBO) Plant model.

ID: 1167

APPLICATION OF AN OPTIMISATION APPROACH FOR THE CALIBRATION OF HIGH-FIDELITY BUILDING ENERGY MODELS TO SUPPORT MODEL-PREDICTIVE CONTROL (MPC) OF HVAC SYSTEMS

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Heating, ventilation and air-conditioning (HVAC) accounts for up to 50% of building energy consumption, and studies have shown significant potential for savings through the utilisation of fault detection and smart predictive control in place of traditional reactive based control systems. This paper proposes a strategy for implementing intelligent model-predictive control (MPC) of HVAC systems based on calibrated high-fidelity models and real-time performance data. A genetic optimisation algorithm is proposed to improve the initial calibration of the high-fidelity building energy models (BEM), and to generate on a semi-automatic basis, the reduced-order models (ROM) on which the control optimisation algorithms are based. We also present a case study showing the application of the genetic optimisation approach on the development and calibration of a BEM for a 2,775m2 commercial building in Helsinki, Finland.

TUESDAY

13TH SEPTEMBER 2016

VENUE: CLORE SUITE

THEME: PROGRESS IN SIMULATION TOOLS AND OPTIMIZATION METHOD

ID: 1124

AUTOMATED OPTIMUM GEOMETRY GENERATION OF A BUILDING FOR THE MINIMIZATION OF HEATING AND COOLING ENERGY DEMANDS

Ala Hasan[1], Teemu Vesanen[1], Nusrat Jung[1], Riikka Holopainen[1]

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This paper reports first results of our work in using simulation-based optimization in automatic generation of building shapes considering multiple objectives, variables and constrains. An optimization problem is presented for finding the optimum geometry solutions for an office building that has a basic cross-shape. The problem is solved as a two-objective optimization problem with the aim of finding the optimal trade-off solutions between the cooling energy and heating energy as two conflicting objectives. The solutions are generated by re-distributing the building's zones in four orientations and selecting the number of floors while keeping the total floor area of the building constant. Different challenges were faced in the representation of the building with undefined exact dimensions in the simulation program during the optimization process. The optimal solutions showed the trends of the distribution of the zones and the number of the floors and gave guidance for exploring other new solutions.

ID: 1118

REAL WORLD COMPLEXITY IN REFLECTANCE VALUE MEASUREMENT FOR CLIMATE-BASED DAYLIGHT MODELLING

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The magnitude and distribution of inter-reflected light is often the most important factor in any assessment of daylight illumination. This is so for the traditional Daylight Factor (DF) method as it is for metrics founded on climate-based daylight modelling (CBDM). A recent study of classroom spaces showed how wall reflectivity is a key determinant of the outcome of a climate-based daylight evaluation. Typically, when a real space is occupied, interior walls get partially covered by fixtures, furniture, posters, etc. Hence they can become very different from the initial design assumptions used for the computer modelling of daylight.

The work presented here examines the differences between assumed and real surface reflectance values, assessed on a case study by means of different methods, and the consequences that this may have for predicted measures of daylighting performance. This is of particular importance now that climate-based measures of daylighting performance are a mandatory requirement for the UK's Priority Schools Building Programme (PSBP). One of the techniques used to determine real-world surface reflectance values is based on High Dynamic Range (HDR) photography; it allows for the measurement of luminance on a per-pixel basis and thus for the creation of interpolated reflectance maps of complex patterns. This new technique is applied for the first time on real spaces here and an initial assessment of its values and limits is presented.

The resulting reflectance values obtained from the measurements on the case study are invariably different than those typically assumed when carrying out daylight simulations. The impact this can have on the outcomes determined using daylight simulation is presented and discussed.

ID: 1061

A SIMULATION BASED OPTIMIZATION APPROACH FOR DETERMINING THE OPTIMUM ENERGY SAVING SOLUTIONS FOR BUILDINGS

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In this study, a simulation based optimization approach that combines variance based sensitivity analysis (VBSA) with multi-objective optimization (MOO) is implemented to determine the optimum energy saving solutions while optimizing the building heating and cooling energy savings and, Net Present Value (NPV) criteria simultaneously. Sketch-up Open Studio plug-in is utilized for building energy modelling process. EnergyPlus dynamic simulation software, Matlab, Simlab and Microsoft Excel are all used together for the execution of VBSA. As for MOO process, GenOpt optimization package, EnergyPlus and Excel are used in an integrative way. The existing school building in the Western city of Izmir that represents a hot humid climate in Turkey is used as a case study to show the applicability of the approach. The case study results show that the proposed approach is capable of identifying the parts of the building to be primarily focused on and optimizing the building heating and cooling energy savings and NPV.

ID: 1113

MULTIVARIABLE OPTIMIZATION FOR ZERO OVER-LIT SHADING DEVICES IN HOT CLIMATE

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The climate in Egypt is gifted with a clear sunny sky most of the year, providing the excellent opportunity to benefit from natural lighting yet, there is high risk to exceed the amount of daylighting required for doing a specific task based on the latest standards. Thus, the design for highly efficient and optimized shading device is essential at the first stage.

This research aims to study a South oriented facade and to present optimized solutions for an oval-shaped shading device for a typical office space. The optimization process triggers two main targets, zero over lit floor area with maximum daylit area. Final results also fulfilled the highest daylighting quality based on the values recommended by both IES and LEED V4 standards.

ID: 1093

PERFORMANCE COMPARISON BETWEEN KNN AND NSGA-II ALGORITHMS AS CALIBRATION APPROACHES FOR BUILDING SIMULATION MODELS

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In this paper, a study of calibration methods for a thermal performance model of a building is presented. Two calibration approaches are evaluated and compared in terms of accuracy and computation speed. These approaches are the Nearest Neighbour (KNN) algorithm and NSGA-II algorithm.

The comparison of these two approaches was based on the simulation model of the Birmingham Zero Carbon House, which has been under continuous monitoring over the past five years. Data from architectural drawings and site measurements were used to build the geometry of the house. All building systems, fabric, lighting and equipment were specified to closely correspond to the actual house.

The preliminary results suggest that the predictive performance of simulation models can be calibrated quickly and accurately using the monitored performance data of the real building. Automating such process increases its efficiency and consistency of the results while reducing the time and effort required for calibration. The results

show that both NSGA-II and KNN provide similar degree of accuracy in terms of the results closeness to measured data, but whilst the former outperforms the latter in terms of computational speed, the latter outperforms the former in terms of results wide coverage of solutions around the reference point, which is essential for calibration.

ID: 1138

SECOND-LEVEL SPACE BOUNDARY TOPOLOGY GENERATION FROM CITYGML INPUTS

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Although CityGML geometrical data exported either from GIS data or from compatible design software are suitable for scene rendering and navigation, they are not directly usable for energy simulation purposes because the second-level space boundary information, essentially surface pairs through which thermal energy exchange among buildings or building rooms or among a building room and its outside environment occurs, is missing. In order to address this need, a district space boundary topology generation algorithm, that takes as input data formatted according to the CityGML standard, is introduced. The algorithm is based on four main processes and special operations which are designed according to specific input data scenarios. The algorithm is demonstrated with successful results on examples with Level Of Detail 2, 3 and 4, as defined in the CityGML standard. Also certain cases requiring further investigation are discussed.

ID: 1129

A PARAMETRIC STUDY OF THE IMPACTS OF PITCHED ROOFS ON FLOW AND POLLUTION DISPERSION IN STREET CANYONS

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This study uses Computational Fluid Dynamics (CFD) to simulate flow and pollutant dispersion in a regular urban structure that consists of six equally spaced street canyons with a centred test street. This structure is known to be adverse for local ventilation and pollutant removal. The impacts of pitch rise and roof arrangement on the flow and dispersion in the test street are studied parametrically. The pitch rise is set in the range of 1–3m, which gives rise-to-run ratios of 2:12–6:12. Four different roof arrangements of flat and pitched roofs on the adjacent buildings of the test street are tested, to give a total of 12 case studies. The case with flat roofs on all the buildings is modelled to provide a reference for comparison.

It is found that for all the studied cases, the flow in the

test street canyon maintains a single vortex flow pattern. However, all the studied cases have lower velocity and TKE in the test canyon, which leads to reduced ventilation. After analysing the results of each case, we conclude that a high pitch rise and the presence of a pitched roof on the leeward building are the main contributors to this adverse effect. Owing to the lower velocity and TKE, the average pollutant concentration in the canyon is increased in each studied case. In the worst case scenario, the average pollutant concentration is increased by 19%.

ID: 1134

MODELLING AND MONITORING TOOLS TO EVALUATE THE URBAN HEAT ISLAND'S CONTRIBUTION TO THE RISK OF INDOOR OVERHEATING

Rochelle Schneider dos Santos[1], Jonathon Taylor[1], Mike Davies[1], Anna Mavrogianni[1] and Phil Symonds[1]

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The growth of cities increases urban surface areas and anthropogenic heat generation, causing an Urban Heat Island (UHI) effect. In the UK, UHI effects may cause positive (winter) and negative (summer) health, comfort and energy consumption consequences. With the increasing focus on climate change-related heat exposure and consequent increased mortality risk, there is a need to better investigate the UHI during hot seasons. This paper reviews the current literature regarding UHI characterisation using monitoring, modelling, and remote sensing approaches, their limitations, and applications in building simulation and population heat exposure models. Ongoing and future research is briefly introduced in which downscaling techniques are proposed that provide higher temporal and spatial information to assess and locate heat-associated health risk in London.

ID: 1112

OPTIMISING THE URBAN ENVIRONMENT THROUGH HOLISTIC MICROCLIMATE MODELLING: THE CASE OF BEIRUT'S PERI-CENTER

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Various studies have suggested that urbanisation may significantly alter microclimate conditions. To address this, expanding urban vegetation cover can be used to aid the dissipation of excess heat through enhancing

evapotranspiration. This study aims to numerically assess and optimize the use of green corridors to reconnect leftover and in-between building plots within Beirut city centre through the use of ENVI-met V4, a holistic microclimate modelling system used to optimize green infrastructure strategy to improve pedestrian comfort levels.

Analysis results illustrate the significant effect of urban intervention strategies in decreasing pedestrian heat stress, where the air temperature is reduced by 4-5 (PET) °C. Furthermore, a correlation between the leaf area density and PET values was identified.

In the wider context, this work supports the case for the application of ecological urbanism supported by integrated micro-urban environment modelling as a catalyst for the improvement of the quality of urban space.

ID: 1047

CITYGML IMPORT AND EXPORT FOR DYNAMIC BUILDING PERFORMANCE SIMULATION IN MODELICA

Peter Remmen, Moritz Lauster, Michael Mans, Tanja Osterhage and Dirk Müller

RWTH Aachen University, E.ON Energy Research Center, Institute for Energy Efficient Buildings and Indoor Climate

Energy supply of buildings in the urban context currently undergoes significant changes. To consider these changes in the energy systems and the buildings themselves, dynamic simulation, in particular the heat demand of multiple buildings, is one key element. The presented work introduces a methodology to use CityGML data sets for dynamic building simulation in Modelica. The framework includes the import of CityGML and the extraction of available geometric and semantic information. This information is mapped to a software tool called *TEASER*, which is available open-source (https://github.com/RWTH-EBC/TEASER). The tool extends available information with statistical data and generates a Modelica model. To proof the concept, we apply the methodology on two use cases. The first use case shows the general workflow with a fictitious CityGML data set. The second use case demonstrates the capability to handle large data sets, using a CityGML file with more than 2,800 buildings with different level of detail.

ID: 1022

THREE-DIMENSIONAL HIGH-RESOLUTION URBAN THERMAL AND MECHANICAL LARGE EDDY SIMULATION INTERACTIVE-PHYSICS BETWEEN BUILDINGS, LAND COVER AND TREES

Mohammed Bakkali[1], Atsushi Inagaki[2], Yasunobu Ashie[3], Manabu kanda[2], Mike Davies[1], Philip Steadman[1], and Siegfried Raasch[4]

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The large eddy simulation (LES) model 'PALM' was further developed for the computation of irregular turbulent vertical transports within real urban environments counting buoyancy-driven flows. The model was implemented with calculated initial boundary conditions for three-dimensional high-resolution heterogeneous sensible heat fluxes from buildings, tree crowns and different land use categories. These fluxes were initially computed by a multi-patch urban energy balance model (3D City Irradiance). The results were then inserted into the LES model through Neumann boundary conditions. Such detailed thermal effects in urban LES were not previously investigated. Results from this research showed that heterogeneous distribution of sensible heat fluxes at the wall surface led to more localised convections within the surface layer and above. This new numerical method aims at enhancing the capabilities of mathematical models for predicting extreme weather hazards stressed by urban environments such as overheating and turbulent mixing above the urban surface. The method was based on a binary approach grounded on aerodynamics and thermodynamics. More accurate estimates of maximum temperatures, their time of occurrence and their detailed spatial distributions are estimated. Two locations in Nagoya and Tajimi City in Japan were used for case studies by considering the effects of improved evaporation efficiency in building construction materials.

THEME: PROGRESS IN SIMULATION TOOLS AND OPTIMIZATION METHOD

ID: 1072

MODELLING AND CALIBRATION OF A DOMESTIC BUILDING USING HIGH-RESOLUTION MONITORING DATA

Dashamir Marini[1], Candy He[1], Richard Buswell[1], Christina Hopfe[1], and Dru Crawley[2],

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[2]Bentley software, US

Reducing energy consumption and managing energy supply/demand responses are key challenges facing the future built environment. The use of de-carbonised electricity to deliver space heating will make significant impact on CO2 emissions for the UK. A likely technology in UK homes is to replace conventional gas boilers with heat pumps. A high coefficient of performance may mean a reduction in energy consumed, in addition the potential to contribute to demand side response through switching controlled via pricing signals. Evaluating the likely energy demand patterns from such systems and understanding how the characteristics of such systems might affect comfort can be estimated using building simulation. This paper describes the modelling and calibration process of an UK family dwelling using high-resolution monitoring data. Monitoring data describing gas, electricity, hot water, window operation and room temperature at minutely interval are used in the process.

ID: 1172

USING PARAMETRIC DESIGN TO OPTIMIZE BUILDING'S FAÇADE SKIN TO IMPROVE INDOOR DAYLIGHTING PERFORMANCE

Aya Elghandour[1], Ahmed Saleh[2], Osama Aboeineen[1]and Ashraf Elmokadem[1]

[1]Port Said University, Egypt
[2]Suez Canal University, Egypt

This paper presents a performance oriented parametric approach for a façade's skin design to enhance indoor daylight quality. This approach utilizes daylight performance evaluation to search for skin design that improves the distribution of the daylight indoors by achieving the requirements of daylight metrics of both Leadership in Energy and Environmental Design (LEED V4) and Illuminating Engineering Society (IES) in early design stages. Parametric design procedure is proposed and consists of four integrated phases: (1) generate the skin, (2) analyse the skin's daylight performance, (3) evaluate the daylight performance and (4) search for the near optimum solution. "Genetic Algorithms" and "Exhaustive Search" as two different search and optimization techniques where implemented to understand the potentials of each one to be integrated in the proposed procedure in the forth phase. The study outlines the challenges and opportunities opened to architects to apply the proposed procedure to integrate daylight performance evaluation in early design stages where the most influential design decisions are taken.

ID: 1012

EVALUATION AND COMPARISON OF BUILDING PERFORMANCE IN USE THROUGH ON-SITE MONITORING AND SIMULATION MODELLING

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In recent years in Europe, the improvement of the energy efficiency in buildings has been constantly addressed as a priority. In order to achieve this goal, the first step is to have a calculation method that determines the energy performance of buildings. For this purpose, dynamic thermal simulation programs are used. However, numerous studies (Branco, Lachal, Gallinelli, & Weber, 2004; Burman, Mumovic, & Kimpian, 2014; Johnston, Wingfield, & Miles-Shenton, 2010; Majcen, Itard, & Visscher, 2013) have shown that the measured energy performance of buildings does not correspond to the simulated performance. This is referred to as the "performance gap" and thus, the predictive potential of these tools is reduced.

This paper is part of a research that aims to study the differences between measured and simulated thermal performance through two case studies. Monitoring equipment was installed in two flats located in two originally identical residential buildings, but one of them has been recently refurbished. Both buildings are located in the city of Madrid, Spain. In this paper, we showed only the results the refurbished building. This investigation shows how in-situ measurements and energy monitoring procedures in buildings in use can be used to adjust energy simulation models in order to bring the results closer to the actual thermal performance of buildings.

ID: 1083

DEVELOPMENT AND ANALYSIS OF A PREDICTIVE CONTROL ALGORITHM FOR EMBEDDING IN A MICROPROCESSOR CONTROLLER

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The aim of this paper is to develop a predictive control algorithm and compare it with thermostat based control. The approach is based on modelling thermostat based control in EnergyPlus, and creating a predictive model using Fast Fourier Transform (FFT). Thermostat based control was modelled in EnergyPlus using a simple single zone building with 42% of south glazing. Predictive model was developed as an FFT response function to heat input, thus obtaining an inverse model and applying it several time steps ahead. The heating load and predictive percentage of dissatisfied of thermostat based control and of the predictive control cases

were compared. The results show that in this particular study the predictive control approach leads to just over 20% reduction of energy consumption whilst keeping similar level of thermal comfort. In addition to investigating the modelling of predictive control using Fourier series, the aim of the research is to assess the feasibility of embedding this type of control algorithm in a microprocessor controller.

ID: 1030

HYBRID APPROACH FOR BUILDING ENVELOPE OPTIMISATION USING GENETIC ALGORITHMS AND SIMULATED ANNEALING

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Optimisation of building envelope for thermal performance is a complex problem involving a multitude of variables. While the combinations of variables lead to a vast dataset of discrete points forming the feasibility domain, the optimal solutions are only few and difficult to discern.

The objective is to develop a methodology using a hybrid approach involving both Genetic Algorithm (GA) and Simulated Annealing (SA) approach to optimise the building envelope with respect to thermal performance.

The GA and SA are complementary algorithms. The methodology uses the advantages of both these methodologies to improve the solution. The outcome indicates that Hybrid (GASA) approach improves the reliability of solution. While there is minor improvement in solution quality Hybrid (GASA) approach achieves the optimal frequently.

ID: 1011

IEA ANNEX 60 ACTIVITY 2.3: MODEL USE DURING OPERATION, APPROACH AND CASE STUDIES

Raymond Sterling[1], Thorsten Mueller[6], Ando Andriamamonjy[5], Alberto Giretti[2], Marco Bonvini[3], Zheng O'Neill[4], Michael Wetter[3], Mats Vande Cavey[5], Andrea Costa[1], Gesa Boehme[6], Wangda Zuo[7], Ralf Klein[5], Bing Dong[8], Marcus M. Keane[1]

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Annex 60 is developing and demonstrating new generation computational tools for building and community energy systems based on the non-proprietary Modelica modeling language and Functional Mockup Interface (FMI) standards. Demonstrations will include optimized design and operation of building and community energy systems. Within the Annex 60, Activity 2.3 focuses on the use of models to augment monitoring, control and fault detection and diagnostics methods. This promises to detect a degradation

of equipment efficiency over time because measured performance can be compared to expected performance at the current operating conditions. Furthermore, use of models during operation allows operational sequences to be optimized in real-time to reduce energy or cost, subject to dynamic pricing.

This paper will offer an overview of the work carried out within this IEA Annex 60 Activity 2.3 both in terms of approach and case studies with a particular focus on model use during operation for fault detection and diagnosis.

VENUE: EXHIBITION ONE

THEME: ADVANCES IN BUILDING PERFORMANCE SIMULATION TOOLS

ID: 1010

AUTOMATIC CALCULATION OF A NEW CHINA GLARE INDEX

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Lighting simulation is widely accepted and used to evaluate lighting performance including glare metrics. Digital technologies such as Computer Aided Design (CAD) and Building Information Modeling (BIM) can ideally reduce time consuming manual efforts in glare evaluation workflows and are commonly used to achieve automatic workflows. However, varying BIM standards and information interoperability present challenges when new metrics are introduced and existing tools can no longer achieve automatic workflows. Using a case study of the new China daylighting glare metric, we discuss the gaps in current software tools and present a new prototypical software to automate the calculation of the China Daylight Glare Index (DGI_{China}). Besides practical usage in industry, the new software facilitates technical investigations and clarifications for DGI_{China}, and discussions for future developments in BIM necessary for practical industry usage.

ID: 1053

AN ADVANCED TOOL TO VISUALIZE RESULTS OF PARAMETRIC ANALYSES

Mattia Donato[1], Roberto Caria[1], Toby Clark[1], Gianluca Rapone[1], Giovanni Zemella[1]

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Sensitivity and optimization analyses are used to explore a wide range of possible façade configurations during the first design phases. However, design teams fully benefit from these assessments very rarely as the available software tools might not be suitable or may deliver unclear results.

This paper presents an approach to parametric analyses that aims at overcoming these limitations.

A project specific and fully tailored post-processing tool was built to allow design teams to organically work together, saving time and resources. Different software were used to ensure flexibility and accuracy. Finally, a 3D linkage was developed to take into account the effect of the surrounding buildings.

To conclude, this paper presents a new approach to parametric analyses that relies on an interactive, flexible and user-friendly tool, to help teams take full advantage of the first design phases.

ID: 1055

PLACING USER NEEDS AT THE CENTER OF BUILDING PERFORMANCE SIMULATION (BPS) TOOL DEVELOPMENT: USING 'DESIGNER PERSONAS' TO ASSESS EXISTING BPS TOOLS

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This paper explores the development of 'building designer personas' to illustrate how Building Performance Simulation (BPS) can engage with Human Computer Interaction (HCI) knowledge and methods to place its users at the centre of development of new tools. It explains this concept and sets up the fundamentals to develop it further based on previous work on meaningful information for design decision making (Bleil de Souza and Tucker 2014 and 2015). An example of a building designer 'provisional persona' in a specific scenario is developed in detail. This example is then used to assess how current BPS tools satisfy this user's needs and to identify what is missing from BPS development through not carefully considering those needs. This concept can be applied to different types of BPS users and this paper briefly mentions how to explore it in future work.

ID: 1065

INVESTIGATION OF THE EFFECTIVE PARAMETERS IN SQUARE UNIT BASED SHADING SYSTEMS; A SCOPE OF ACHIEVING BALANCE BETWEEN DAYLIGHT AND THERMAL PERFORMANCE

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The façade of the building is considered as one of the main contributors to the energy requirements of building spaces especially office spaces. Shading is one of the solar protection strategies that was used for long years in the past. Recently, utilizing shading devices increases as a solar protection provider in the hot arid climate in Cairo. Many publications reported the positive effect of square-based egg-crate shading devices on both daylighting performance and thermal performance. Different parameters as perforation ratio, depth and the grid size of egg-crate systems could affect the performance on achieving the optimum performance visually and thermally. Therefore, this research aims to carry out a deep investigation on the effect of these parameters of the egg-crate shading system in order to improve the performance of the shading system. Brute-force parametric simulation was conducted in the form of predefined algorithms using different proposed parameters in order to conclude the optimum solutions for the studied window to wall ratios. Grasshopper plugin for Rhinoceros was utilized for carrying out the parametric modelling process of all the different design configurations of the studied shading device. The study adopted a simulation process constructed on two sequential phases, which were carried out using DIVA for Rhino the interface for the widely used simulation engines Radiance, Daysim and EnergyPlus. Moreover, the simulation was derived based on the IES approved daylight metrics, particularly Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE). Results carried out the optimum composition associated with specific WWRs, which improves the distribution of daylight and complies with LEED v4 daylighting standards. Finally, analysing results of the study revealed many findings regarding the potential of using the egg-crate system and screening the effect of each parameter. Evaluation process of the study was carried out.

ID: 1068

OPTIMAL PLANNING TOOL FOR NEARLY ZERO ENERGY DISTRICT

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This approach has the potential to increase energy efficiency, renewable and local resource application. This research work describes the development of optimal planning tool with on-site energy management model and the analysis of case study existing campus building stocks. This research focuses on the boundary of the building, thereby not being limited to only a single building but spanning over a cluster of buildings, so called "Zero Energy District". Using the developed methodology, the optimal CHP capacity for each building, optimal capacity distribution in the boundary for minimizing annual primary energy consumption was simulated. The series of results in case study show that the on-site energy generation has potential to reduce primary energy consumption and it is more effective by integrating buildings. Moreover, the proposed model makes it possible to utilize the measured database of existing building stocks for planning energy efficiency improvement in the campus.

THEME: APPLICATIONS OF ENVIRONMENTAL SUSTAINABILITY (CASE STUDIES)

ID: 1128

EVALUATION OF ENERGY AND INDOOR ENVIRONMENTAL PERFORMANCE OF A UK PASSIVE HOUSE DWELLING

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The preliminary findings of the energy and indoor environmental performance of a Passive House dwelling in North East of England is presented in this paper. This dwelling is designed to comply with the Passive House Standard (certified by the International Passive House Association) which aims to reduce energy consumption and carbon emissions. The property benefits from advanced building fabric design and materials, PV array, mechanical ventilation with heat recovery system (MVHR) and high efficiency domestic hot water storage vessel to minimise operational carbon emissions. Power generated by the PV panel, imported grid electricity and mains gas consumption of this house are monitored by a proprietary monitoring

package; and data of indoor temperature, relative humidity and resident occupancy at several different locations in the dwelling are also recorded. A computational model of this property was developed using DesignBuilder software. The model was validated using the data monitored on site; and is used to predict and evaluate the performance of the house. The initial findings of this study shows the advantages of Passive House in achieving high thermal comfort and good indoor air quality with much lower energy consumption compares to the national average.

ID: 1132

COMPARISON OF DYNAMIC THERMAL SIMULATION RESULTS WITH EXPERIMENTAL RESULTS: TROMBE WALL CASE STUDY FOR A CYPRUS TEST BUILDING

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Cyprus' location offers abundant of solar insolation during heating season, which could be exploited by a Trombe Wall yielding comfortable built environment and reduced heating load.

This work investigates thermal performance of a Trombe Wall installed test building. The work compares the outputs from Energy Plus simulations with the experimental results that were obtained during a period of heating season in Cyprus.

The test building has floor area of 12.2 m^2 and involves south facing Trombe Wall with a surface area of 11.9 m^2. Monitoring of solar radiation, outdoor and indoor air temperatures, Trombe Wall indoor and outdoor surface temperatures was carried out from 13th January 2016 to 26th February 2016. Dynamic thermal simulation was carried out for the same period.

Simulation results showed good agreement with the monitoring results. Simulated and monitored Trombe Wall inside and outside surface temperatures were very similar whereas, indoor air temperatures were slightly higher for simulations.

ID: 1145

DATA REASONING IN THE EVALUATION OF DOMESTIC THERMAL ENERGY USE

Chris Fishlock, Keerthi Rajendran, Mohammad Royapoor and Anthony P. Roskilly

Sir Joseph Swan Centre For Energy Research, Newcastle University, UK

The decreasing cost of sensing equipment and developments in the field of data science are providing increased opportunities for the validation and enhancement of existing knowledge and solutions across many fields. With the primary aim of supporting the optimisation of domestic thermal energy use, this paper documents the early stages of the application of a data centric approach to extend the understanding of energy use at an individual property level. To facilitate this, a Semantic Web platform is designed, providing the foundation on which factors influencing thermal energy use are inferred using data reasoning techniques.

ID: 1106

THERMAL ANALYSIS OF A MULTIFUNCTIONAL FLOOR ELEMENT

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This paper presents the design of a multifunctional floor element. The floor element integrates multiple functions, such as structural and energy related aspects. This integration reduces material use, related space requirements and embodied emissions. The element is optimised for embodied energy in the structural domain, by using a vault and fin structural form. With this method, a significant volume of concrete is replaced by expanded polystyrene insulation at locations that improve the structural and thermal performance of the element. In the energy systems domain, improvements to operational energy are provided by an active hydronic heating/cooling system and a passive thermal mass resource. The thermal performance design was driven by the use of computational fluid dynamics with conjugate heat transfer effects.
The main advantage is a reduction in thermal losses by minimising the connection between the radiant panel and the structural supports. This increases the heat flow density, resulting in a lower supply medium temperature and an improved system efficiency of the radiant panel. This work provides design guidance to the development of improved lifecycle energy buildings.

ID: 1111

OPTIMUM ATRIA TYPE IN TERMS OF THERMAL COMFORT FOR HIGH RISE OFFICE BUILDINGS IN THE SEMI-ARID CLIMATE OF MIDDLE EAST

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Building sector is responsible for at least 40% of energy use in most countries worldwide around 33% of its energy is known to be used by HVAC systems in buildings. Tall buildings tend to have an increasing appetite for energy due to deep plans and provision of HVAC to maintain comfort levels especially in the Middle East with its hostile environmental conditions. However, the region has a tradition of successful climatic conscious design solutions; therefore, the paper aims to investigate the impacts of applying the traditional layout of courtyards to contemporary tall buildings in the form of atria. It also examines through a simulation technique the comparative energy consumption in relation to a number of different atria layouts. Moreover, it provides insight of the differences in energy consumption to maintain comfort levels of different layouts in tall office buildings. Dynamic Thermal Simulation (DTS) tool called Design Builder is used to achieve the aim. The software provides results of the prototypes over an annual period of time. By using Design Builder DTS tool the optimum form of atria type has been verified in semi- arid climate for rectangular and square plan shapes. It is concluded that rectangular shape buildings aligned on the east-west axis with atria orientated towards south seem to be the best option in using less energy to provide thermal comfort annually.

ID: 1116

OPTIMIZATION OF OFFICE BUILDING FAÇADE TO ENHANCE DAYLIGHTING, THERMAL COMFORT AND ENERGY USE INTENSITY

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The aim of this paper is to examine a framework in which an office building façade was optimized for the integrated performance of total energy consumption, daylight quality and thermal comfort. A south facing façade of an office space was modelled parametrically for two case studies in Cairo and Munich. The effect of changing the window dimensions, glazing system, insulation thickness, as well as different shading and daylighting systems was analysed using Radiance and EnergyPlus simulation tools. A multi-objective optimization was performed to reach an optimal range of solutions. The results from each case study and the relations between the design variables and objectives for each case were studied. Moreover, the practicality of using a simulation-based multi-objective optimization in generating high-performance design alternatives was examined. The results show that the use of multi-objective optimization for complicated design problems can aid in reaching

performative solution and clarify the relations between the design variables and objectives.

THEME: APPLICATIONS OF ENVIRONMENTAL SUSTAINABILITY (CASE STUDIES)

ID: 1102

A GENERATIVE PERFORMANCE-BASED DESIGN FOR LOW-COST BRICKWORK SCREENS

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[2]Department of Architecture, Cairo University, Cairo, Egypt.
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Brick was employed in buildings' facades as mediating terms to buildings aesthetics and low-cost. Recalling the inherent qualities of brick; aesthetic, economic, and environmental can enhance natural daylight qualities. Elegantly articulated perforated brickwork screen can provide an exhilarating play of light throughout the day, block direct sunlight and soften strong daylight while retaining some ventilation. Variation of brick arrangements creates unlimited patterns of light and shade, which could be parametrically optimized to achieve low-cost and efficient environmental performance. This paper is going to recall brick as a local and available construction material in Egypt for façade design by using generative design and simulation tools. Brick patterns are achieved by placing a single brick type into one of several possible positions within its framework. Research method will integrate different brick bonds' configurations (shifting, rotating and stepping), with pre-programmed analysis data of environmental changes for identifying the most efficient daylight performance. In conclusion, this paper has developed configurations that facilitate the new ecological approach to traditional brick screen.

ID: 1041

INFLUENCE OF HIGH PERFORMANCE FAÇADE ON HEATING/COOLING LOAD IN OFFICE BUILDINGS IN LONDON AND HONGKONG

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Office buildings are responsible for a significant amount of carbon emissions. A possible strategy for reducing emissions from this source in both hot and cold climates might be to specify high performance facades. This paper reports on an investigation using Tas on the merits of using high performance facades on office buildings in London and Hong Kong both of which have a high density of office buildings but quite different climates. The results show that whereas U-value has a marginal/negative effect on energy usage at these locations the influence of g-value is

somewhat more positive. Moreover, by selecting facades which minimise energy demand when solar irradiations are low and maximising the use of, for example, solar energy and air/ground source heat pumps at other times could significantly reduce carbon emissions from office buildings.

ID: 1163

CORRELATION BETWEEN RETROFITTING BUILDING ENVELOPE AND THERMAL IMPROVEMENT ON SOCIAL HOUSING IN HOT-ARID CLIMATE

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This study examines the effectiveness of a combined strategy of retrofitting building envelope using an agricultural residue (maize) as an external insulation material and natural ventilation behaviours to improve indoor thermal comfort in a residential building. A prototype for a social housing multi-storey building is selected in the hot arid climate of Cairo, Egypt. Building performance simulation using IES<VE> (the produced version of 2013) is used to predict the effectiveness of adding an external organic insulation material on the building envelope. Behaviours of natural ventilation are then included to predict a naturalistic approach for indoor thermal management. The simulation was conducted in a typical floor apartment that facing the warmest south orientation. Results revealed that -comparing to the base case - an improvement of 5.5% happened in winter period when applying external insulation only, while this percentage reduced to be 4.4% when applying the combined strategy. Further, this combined strategy was effective in summer period as it has improved indoor comfort by 58.3% while an improvement of 10.2% occurred when applying external insulation only. In addition, during spring-autumn period, the strategy was not effective as it made an improvement in indoor comfort by 6.0% from the base case and by 1.9% when applying external insulation only.

ID: 1059

USING INTERPOLATION TO GENERATE HOURLY ANNUAL SOLAR POTENTIAL PROFILES FOR COMPLEX GEOMETRIES

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In order to evaluate the feasibility of roof and façade mounted or building integrated solar technologies such as photovoltaic and solar thermal panels, information on the solar potential availability under consideration of local conditions such as geometrical obstructions is required.

Future sustainable urban energy systems will be characterised by multi-carrier systems, where the design and operation of conversion and storage technologies exploits synergies between technologies. This requires fundamentally different design methodologies, such as the 'energy hub' approach.

In the architectural design process of buildings and cities, whether manual or with the aid of computational optimization techniques, it is typical to iterate and change designs many times. A fast but sufficiently accurate model to evaluate the solar potential is crucial in this process.

This paper presents the first version of a new model, where an annual hourly solar profile for arbitrary geometry is generated based on weather data, basic equations for beam and diffuse irradiation on tilted surfaces, and interpolation methods. The novelty of this method is that the interpolation is only applied to the obstruction calculations, hence maintaining the full hourly fluctuations of the weather data. It is highlighted in which design and optimization approaches such a solar model is of interest. Results show a good fit of the general trends and of the total annual irradiation when comparing with EnergyPlus and Daysim.

ID: 1147

BUILDING PERFORMANCE SIMULATION OF ADVANCED ENERGY TECHNOLOGIES TO ACHIEVE NET ZERO ENERGY DWELLINGS IN UK

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Oxford Institute for Sustainable Development, Oxford Brookes University, Oxford UK

This paper systematically presents the methodology and initial findings from modelling and simulation of advanced energy conservation, generation and management technologies applied to two case study dwellings to achieve a net zero energy (NZE) target. The specific objectives are to meet the Energy Performance in Buildings Directive as follows: reduction of net regulated energy to or below 0 kWh/m2 per year and generation of at least 50 kWh/m2

per year, on average, in the NZE settlement. The findings reveal that to meet the specific targets set out for the project aligned with the EU Directive:

- A majority of technological intervention must come from community renewables,
- buildings built to current UK Building Regulations, will need to reduce regulated loads by about half, and
- the NZE targets in particular are not particularly stringent regarding energy efficiency but are highly expect

ID: 1029

TEACHING BUILDING PERFORMANCE SIMULATION: EVER DONE AN AUTOPSY?

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In previous papers we have presented a continuous learning cycle that includes exposure to theories and the application of tools from the start for effectively teaching BPS and we have described the course we have developed based upon this cycle. The important role played by the simulation autopsy in this cycle is the focus of the current paper. This is accomplished by examining the teaching methods we use for 2 of our course's 15 topics: determining the distribution of solar heat gains to internal building surfaces, and predicting solar irradiance on external building surfaces.

WEDNESDAY

14TH SEPTEMBER 2016

VENUE CLORE SUITE

THEME: ADVANCES IN BUILDING PERFORMANCE SIMULATION TOOLS

ID: 1094

AN OPEN IFC TO MODELICA WORKFLOW FOR ENERGY PERFORMANCE ANALYSIS USING THE INTEGRATED DISTRICT ENERGY ASSESSMENT BY SIMULATION (IDEAS) LIBRARY

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This paper presents the development of the open PYTHON IFC interface for the Integrated District Energy Assessment by Simulation (IDEAS) Modelica library. It adapts IFC to be compatible with IDEAS and subsequently generates automatically a graphically represented Modelica model. The interface was tested on a real world facility where the reliability of the data mining process was emphasized. Nonetheless, it was pointed out that an improved IFC schema towards Building Energy Simulation can improve the presented interface.

ID: 1108

INTEGRATED REFURBISHMENT OF COLLECTIVE HOUSING AND OPTIMIZATION PROCESS WITH REAL PRODUCTS DATABASES

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Building information modeling (BIM) and optimization method should allow new design processes including multiobjective and integrated design. A methodology to use these tools is developed and discussed here for building refurbishment and energy performance. A collective housing building is used as a case study but also to get feedbacks and to finetune the method regarding real needs. This refurbishment operation is on-going and stakeholders are setting up a BIM oriented management of the refurbishment. Considering the real process technical difficulties, an automated method using statistical and manufacturer databases has been prototyped through ontology rules. Predefined templates are set up to estimate direct construction costs. This integrated-design method is then used together with an NSGA-II algorithm considering a set of refurbishment techniques. The cost-energy performance trade-off problem is to decide an optimal combination of construction methods with the objective of minimizing total cost and energy performance. The proposed automated method linked with BIM and real databases can overcome uncertainties and extend design alternatives.

ID: 1135

BIM BASED CLASH DETECTION APPLICATIONS: POTENTIALS AND OBSTACLES

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Clash detection is a main advantage for using BIM technology. Despite the fact that there are already existing efforts and software tools in this domain, it has reached a plateau; where the flexibility of defining and managing clashes and performing accurate geometrical clash detection represents a main obstacle that hinders further developments in such a domain.

This paper addresses both the semantics as well as the geometrical aspects of BIM clash detection. It presents the potential of available algorithms and technologies to perform such operations in order to enhance such BIM functionality with relevance to end users as well as software developers.

An easy to trace prototype is used to demonstrate some of such functionalities based on an IFC Java toolbox and a Java3D viewer that are developed by the author.

Furthermore, this paper presents potential interoperability benefits that can be gained and puts forward some guidelines for the further development in this domain.

ID: 1126

BIM ENABLED BUILDING ENERGY MODELLING: DEVELOPMENT AND VERIFICATION OF A GBXML TO IDF CONVERSION METHOD

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As part of the Design4Energy retrofit scenario a methodology is developed that uses Building Information Modelling (BIM) of existing domestic buildings to assess their energy performance using a Building Energy Modelling (BEM) technique. The focus is on the conversion process from gbXML BIM export file to an idf file for EnergyPlus™. The conversion process is broken down into six steps of progressive addition of idf objects to enable verification. The measured operational data are used to assess the adequacy of the defaults being used.

ID: 1133

PERFORMANCE IMPLICATIONS OF FULLY PARTICIPATING FURNITURE AND FITTINGS IN SIMULATION MODELS

Jon Hand[1]

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Many simulation teams create models of empty buildings e.g. without furnishings and fittings. This paper explores what happens if sunlight actually falls on desks and chairs and filing cabinets rather than the floor as well as what happens if interior artefacts were treated with the same rigour as facades by the simulation engine.

Typically increasing model resolution is a tedious process and added detail if included, may not be fully utilised. To explore removing such barriers, a data store of pre-defined entities, which include provenance, visual form, explicit thermophysical composition, light distributions and mass flow attributes has been introduced in ESP-r. ESP-r facilities for calculating view-factors and insolation distributions have been updated to include this extended data model. Issues related to creating and managing such entities is discussed and the impacts of their use is quantified via case studies.

ID: 1021

VALIDATION OF ATMOSPHERIC BOUNDARY LAYER CFD SIMULATION OF A GENERIC ISOLATED CUBE: BASIC SETTINGS FOR URBAN FLOWS.

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Computational Fluid Dynamics (CFD) is a very useful and inexpensive method to study wind flow in and around buildings, but its accuracy is a subject of concern. Many commercial codes are available each with different levels of complexity and accuracy. Autodesk Simulation CFD (ASCFD) is a product that directly integrates complex Autodesk Revit modes. It is a very appealing option for architectural and urban studies. This research is a validation process to detect the best settings for ASCFD; it will be a base for further complicated urban studies in lack of access of a wind tunnel. The research conducted a systematic sensitivity analysis to examine the impact of many variables that affect Atmospheric Boundary Layer simulations. Generally, the code produced good results compared to a wind tunnel test in the stream wise velocity field, in a combined case the averaged deviation reached 7.5% and R^2=0.95. Nevertheless, a notable deviation persisted in the wake region.

PAPERS IN PROCEEDINGS ONLY

ID: 1175

ENERGY PERFORMANCE OF FUTURE DYNAMIC BUILDING ENVELOPES

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Innovative building envelopes have become more adaptive and interactive by responding to external climatic conditions and internal user comfort desires in ways that enhance energy performance and indoor comfort levels. Several emerging smart materials, such as variable-conductance vacuum insulation that operates by changing hydrogen gas pressure, thermal adaptive coatings made by electronic fibers, and various sandwiched walls with controllable thermal properties, all present a rapid development in the materials field and vast implementation potential in building envelopes. This research used a parametric simulation method that couples an optimization approach to access the potential energy savings of the dynamic building envelopes, as compared to the other three reference models in four cities representing four different climate zones. The findings indicate that the dynamic properties of the building envelopes significantly reduced the heating and cooling loads and peak demands of the buildings in the four cities.

ID: 1154

PERFORMANCE EVALUATION OF MIXED-MODE VENTILATION WITH AN OPTIMAL CONTROL

Xuyang Zhong and Hector Altamirano-Medina

The Bartlett, UCL Faculty of the Built Environment, University College London, UK

This study presents the assessment of a mixed-mode (MM) ventilation system with an optimal control to improve energy consumption and thermal comfort levels in a residential building located in Brighton, UK. An energy model was built via EnergyPlus and used to develop an optimal control with the Genetic Algorithm as an optimiser. When compared to conventional MM operations, it was found that a better control over indoor thermal conditions as well as reduced energy loads were achieved with the application of the optimal control. It was also demonstrated that enhanced existing building design features, such as increased thermal mass, could facilitate and highly improve the operation of MM ventilation, especially when an optimal control was considered.1002

ID: 1002

DAYLIGHTING IN RENOVATED SCHOOL BUILDING

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The paper is presenting a simulation study focusing on school classrooms' daylighting and some retrofitting strategies to improve the existing conditions for better visual environment in the renovated building. The renovated school building's window retrofit was limited due to the historically valuable facade. Several solutions have been suggested for enhancing indoor daylight levels through computer simulations in daylight software WDLS under the CIE overcast sky conditions.

ID: 1054

SIMULATION-BASED OPTIMIZATION OF WINDOW PROPERTIES BASED ON EXISTING PRODUCTS

Julian (Jialiang) Wang[1,4], Luisa Caldas[2], Lei Huo[1], and Yehao Song[3]

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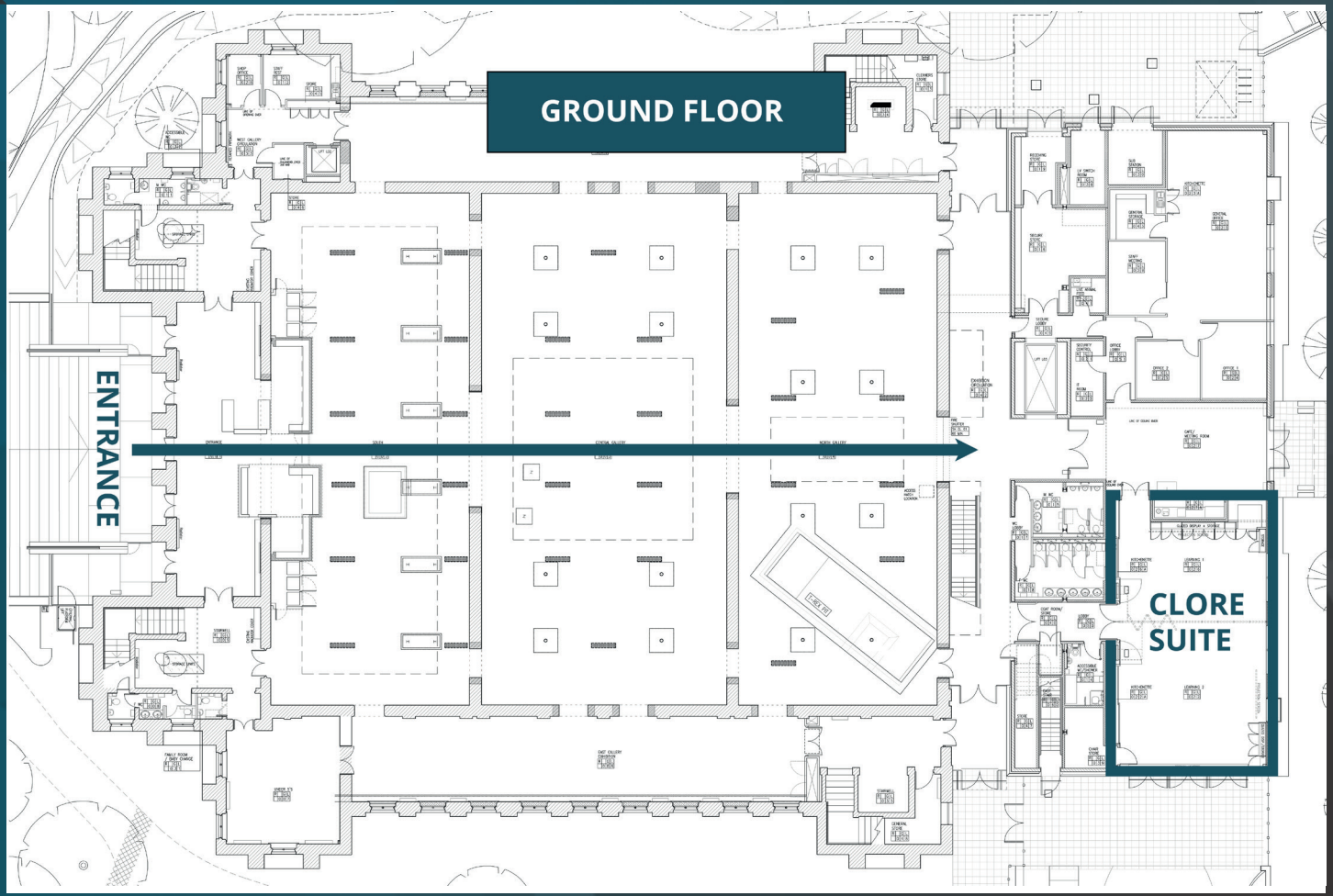
Before selecting new windows for a building, consideration of what types of windows will work optimally to improve building energy efficiency is paramount. In this decision process, three key factors are fundamental to assess windows performance: Visual Transmittance (VT), Solar Heat Gain Coefficient (SHGC), and U-factor. However, using low SHGC windows may decrease the building cooling loads, but has the potential to increase both heating and light loads due to the coatings, tints, and films applied to achieve the low SHGC. This paper introduces a genetic algorithm optimization approach to the selection of these three important window properties for the goal of energy efficiency, based upon the glazing product database of the National Fenestration Rating Council (NFRC). End energy use and savings associated with the optimized window properties are compared with baseline models. The findings of this research will benefit designers, contractors, suppliers, property owners and researchers to identify optimum window properties from databases of existing window products, which would help to further improve building energy efficiency.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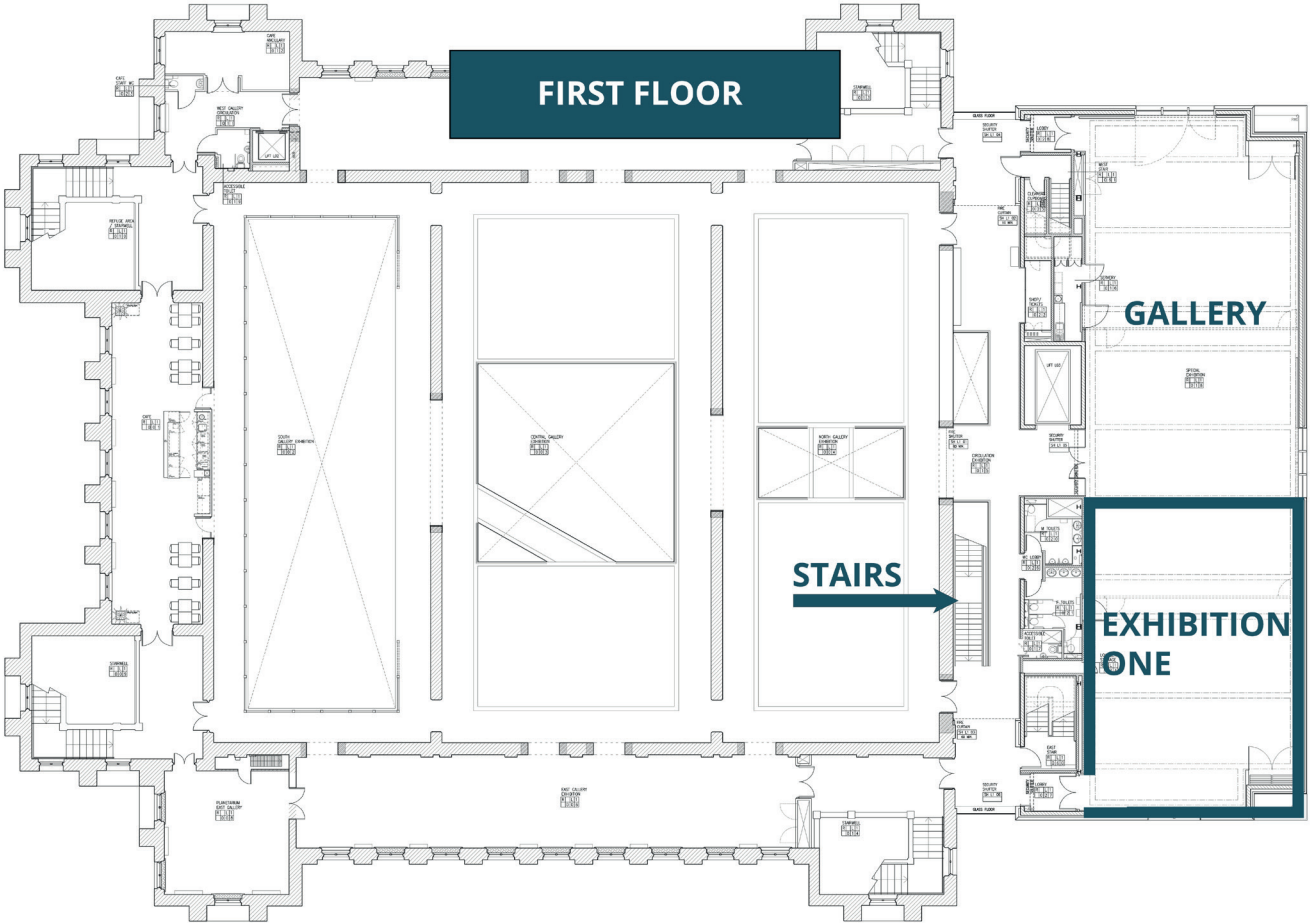
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