SEAHA CENTRE FOR DOCTORAL TRAINING IN SCIENCE AND ENGINEERING IN ARTS HERITAGE AND ARCHAEOLOGY

SEAHA Studentship:

Total Performance of 'Passivhaus' Schools – Making Heritage Schools Fit for Purpose

There are approximately 25,000 schools in England and Wales with a total school floor area of 60,000,000 m^2 and a replacement value of £130 billion. A significant proportion of the school building stock in England and Wales could be considered as heritage: pre-1919 (13%), inter war (9%), 1945-1966 (26%), 1967-1976 (23%), post-1976 (24%) and contemporary (5%).

According to DfE and DECC, schools in England and Wales are responsible for 15% of the energy used in public buildings, with an annual spend on energy of more than £400 million on average. School building age is a strong predictor of carbon intensity. The challenge of reaching the Government's target to reduce national carbon emissions by 80% compared to 1990 levels by 2050 is overwhelming, and this project addresses whether and how the Passivhaus standard could be applied to the new and existing school stock.

The Passivhaus principles include: a) good levels of insulation with minimal thermal bridges, b) using passive solar gains and internal heat sources, c) excellent level of airtightness and d) good indoor air quality, provided by a whole building mechanical ventilation system with highly efficient heat recovery. All of these interventions can have detrimental effects on heritage schools.

The Building Schools for the Future (BSF) Programme (2005-10) resulted in the construction of a large number of good quality new school buildings. However, post-occupancy performance evaluation studies showed that 80% of the new schools examined emitted more carbon emissions than the median UK school building. The Passivhaus standard has potential to deliver on carbon reductions, but there are serious concerns that this is mostly at the expense of overheating and poor indoor air quality, as well as heritage characteristics. UK schools house almost 10 million pupils who spend almost 30% of their life in schools and about 70% of their time inside a classroom during school days. The quality of the classroom environment not only affects the health and comfort of the pupils, but has a major impact on their cognitive performance and the whole learning process.

Before wider adoption of Passivhaus standards across the historic UK school building stock occurs, this project aims to explore and compare the operational performance of contemporary schools built to the Passivhaus standard and of historic schools that are listed or with outstanding heritage characteristicts, to analyse possible implications to retrofit of historic schools and to contemporary school buildings with the potential of becoming future heritage.

Research questions

1. How do Passivhaus schools compare to the historic UK school building stock in terms of energy performance, overheating and indoor air quality?
2. What is the impact of different building design factors on aspects/metrics of indoor environmental quality for Passivhaus and non-Passivhaus heritage schools?
3. How do Passivhaus schools compare to the historic UK school building stock in terms of student and staff health, comfort and wellbeing?
4. Based on experimental and modelling work, what are the implications of Passivhaus standards to the retrofit of historic schools and to historic significance?

The project will be supervised by Dr Anna Mavrogianni and Professor Dejan Mumovic, UCL Institute for Environmental Design and Engineering, Professor Matija Strlic, UCL Institute for Sustainable Heritage and

Mark Lumley, Architype (industrial sponsor). The candidate will collaborate closely with Historic England (heritage partner).

Research methodology

The project will focus on extensive analysis of empirical data collected in Passivhaus and historic school buildings that are listed or with outstanding heritage characteristicts (such as SINPHONIE and DEC IAQ and energy databases held by Professor Mumovic). Collection of original data relevant to case study school buildings' energy use, classroom indoor environmental quality, comfort and wellbeing will be carried out. This will include high-resolution longitudinal measurements of energy expenditure, indoor air contaminant levels (in particular Particulate Matter (PM), Volatile Organic Compounds (VOCs), Nitrogen Oxide (NO_x), Ozone (O_3) and allergens), indoor hygrothermal conditions, student satisfaction with indoor air quality and perceived wellbeing, thermal, acoustic and visual comfort. The case study schools will be selected by taking into consideration the views of all stakeholders in the project. A placement by the student with Historic England will also be organised in the early stages of the project with the aim to understand how the heritage significance of these buildings can be decided. The inclusion of school buildings of different construction eras and types will allow the comparison of building performance and impacts across a representative range of school types. School- and classroom-specific analyses will include:

(i) Detailed time-series analyses of classroom indoor air pollutant concentrations, temperature and relative humidity profiles during periods of occupancy in relation to outdoor air pollution levels and temperatures.

(ii) Multi-variable linear and logistic regression analyses of the association between parameters of the classroom indoor environment (measures of indoor air pollution, overheating etc.) and occupant discomfort, energy use, self-reported performance and wellbeing;

(iii) Meta-level analyses of school and classroom summative parameters of indoor air quality, thermal conditions, and building properties.

Building physics-based models will also be developed using appropriate building energy and air contaminant transport simulation techniques in order to examine the performance of schools/classrooms now and under climate change with and without adaptation measures.

It is envisaged that the outcomes of this study will inform both: a) heritage practitioners faced with the challenge of preserving historic school building stock, which is fit for purpose in the context of carbon emission commitments, and b) enabling the Government (DfE and DECC) to understand unintended consequences of their carbon reduction commitments to heritage school buildings and their learning environments.

Academic entry criteria

The successful candidate will have a good first degree in a relevant discipline such as engineering, architecture, science, physics, material science, conservation or heritage science.

This project is part of the EPSRC Centre for Doctoral Training in Science and Engineering in Arts, Heritage and Archaeology at University College London, University of Oxford and University of Brighton (www.seaha-cdt.ac.uk). As a SEAHA student, you will have unparalleled access to research infrastructure and expertise across three universities and more than 50 heritage, research and industrial partners. In addition to the university doctoral training requirements, SEAHA students take part in an exciting range of cohort activities, ranging from residential events and group projects, to conferences and careers events. Please visit the SEAHA website (www.seaha-cdt.ac.uk) for details.

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The SEAHA Studentship will cover home fees and an enhanced stipend of up to £17,690 per year (to be confirmed at point of offer) for eligible applicants (http://www.seaha-cdt.ac.uk/opportunities/eligibility-criteria/), and a substantial budget for research, travel, and cohort activities.

To apply, submit your online application to study on the MRes Science and Engineering in Arts, Heritage and Archaeology, via http://www.ucl.ac.uk/prospective-students/graduate/taught/degrees/science-engineering-arts-heritage-archaeology-mres

As part of the application, please upload all the required elements, and in addition:

- A 2000 word project proposal for the 4-year PhD research, explaining a work plan that aims to answer the research questions, and which is based on the relevant literature.
- A covering letter clearly stating:
    - Your motivation and how the course will contribute to your career development
    - Your residency status and eligibility for funding according to the information provided http://www.seaha-cdt.ac.uk/opportunities/eligibility-criteria/, or how you intend to sponsor your studies if not eligible for funding

You are encouraged to contact the SEAHA Manager (manager@seaha-cdt.ac.uk) or the project supervisor Dr Anna Mavrogianni (a.mavrogianni@ucl.ac.uk) before producing the application.

Application deadline: 1st September 2016

UCL UNIVERSITY OF OXFORD University of Brighton EPSRC