

# Sensing & analytics for sustainable built environment

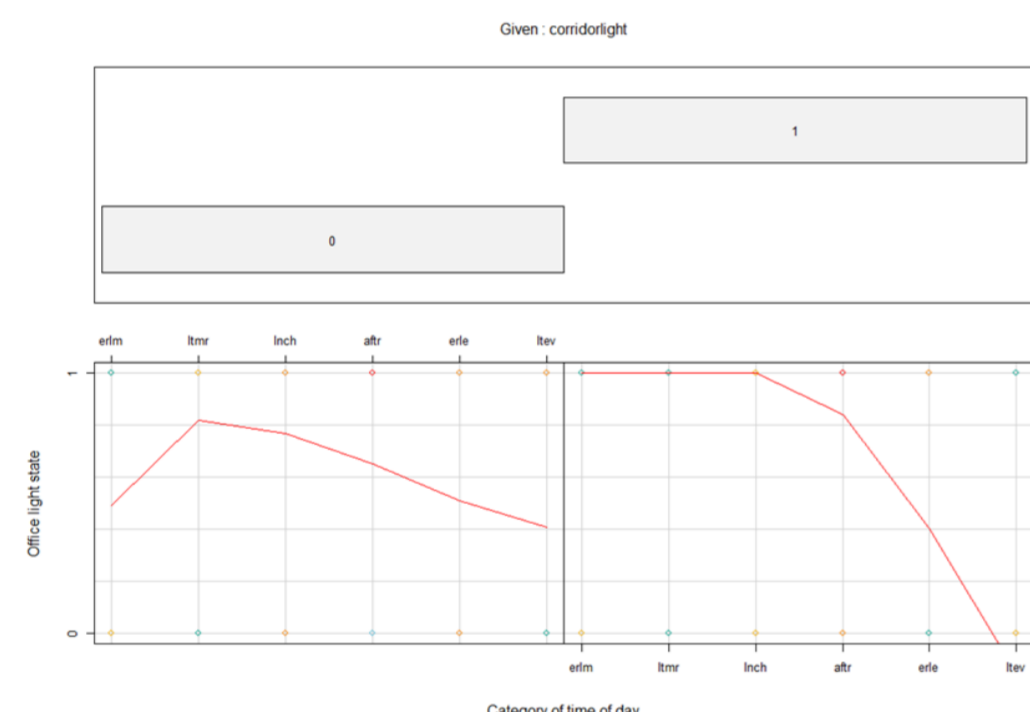
Professor Li Shao, Director

## Summary

**A range of innovative sensing and data analytics research has been carried out at the Technologies for Sustainable Built Environments (TSBE) Centre, a £6m 9 year program at the University of Reading, UK. The work helps to advance the sustainability of buildings as well as the wellbeing and productivity of their users. Example projects are outlined in the following.**

## Sensing lighting energy behaviour

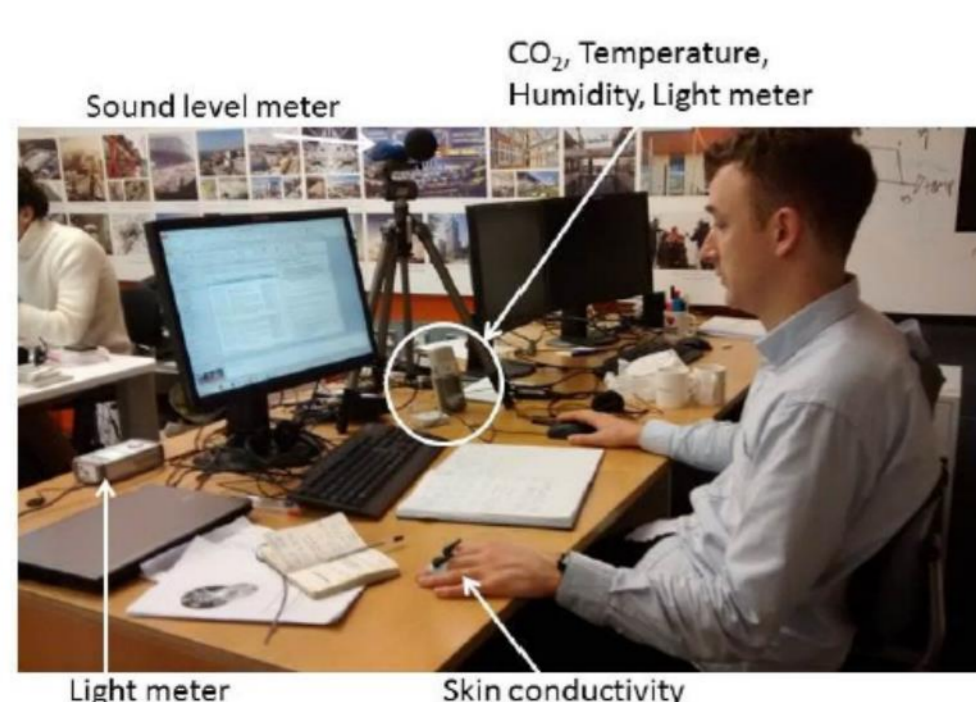
Embedded sensors in buildings measure occupancy, lighting conditions and energy consumption. Data analytics using R and innovative data visualisation of the sensor data have generated richly informative and quantitative new insights, including the significant impact corridor lighting conditions have on office user light switching behaviour, the impact of room size and occupant number on the lighting efficiency of a space. Psychology research underpins the data analytics.



*Nudging effect of corridor lighting on office lighting switching behaviour*

## Physiological sensing for POE

This project utilised physiological sensing (skin conductivity, ECG, blood pressure, etc.) to assess user comfort and satisfaction with building indoor environments. Conventional Post occupancy evaluation (POE) of people satisfaction typically involves questionnaires and interviews which are one-off, and often based on memories of the study participants. Physiological sensing could potentially transform POE into continuous assessment based on rich quantitative sensor data. Interim results point to differentiation between information and energetic indoor environment events in terms of applicability of this sensing approach.



### Contact information

- School of Construction Management & Engineering, University of Reading, Whiteknights, RG6 6AH
- Email: [l.shao@reading.ac.uk](mailto:l.shao@reading.ac.uk)

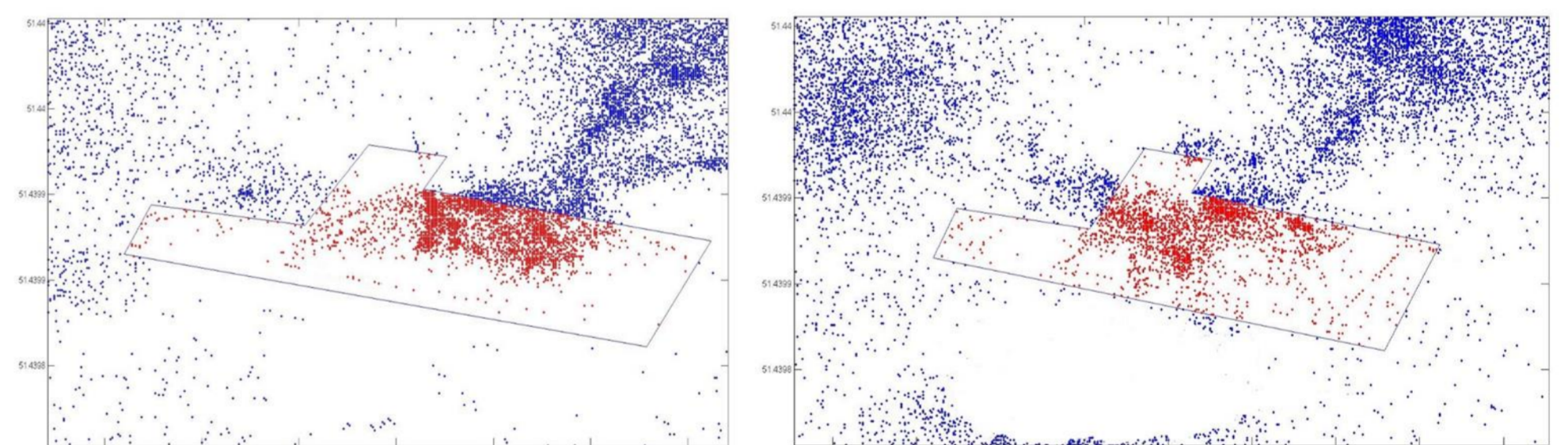
## Wi-Fi based occupancy monitoring

Building occupancy is an important parameter for building energy efficiency, indoor air quality and space use optimisation. Experimental investigation into a novel Wi-Fi indoor location system has been conducted in a range of public spaces to explore their suitability and usefulness for building occupancy monitoring.



*One of the test buildings – University Library*

The technique has been combined with other sensors and data analytics to yield valuable and previously unavailable information relating to energy efficiency opportunities, user wellbeing, space use efficiency and user productivity.



*One-day occupancy for Knowledge Exchange Room: Term time (left) Vacation (right)*

## Virtual Sub-metering

The project develops an algorithm run in Matlab to identify signature features, in both the time and frequency domains, in the electric signals of different electrical appliances. This will allow the measurement of energy consumptions of a range of appliances using a single power meter, thus greatly reducing investment in sub-metering infrastructure. The work also greatly enriches information from smart meters.

## Big Data for energy benchmarks

Energy consumption of thousands of pubs in the UK have been monitored through AMR meters and data analysed to generate the most reliable and up-to-date energy benchmarks for commercial kitchens, which has led to significant improvements for a range of professional guidance, recommendations and scheme.

### Research teams for the highlighted projects at the TSBE:

- Lighting Behaviour: Katherine van Someren, Dan Fernbank, Phil Beaman, Li Shao
- Physiological Sensing: Trevor Keeling, Etienne Roesch, Derek Croome
- Wi-fi occupancy study: Yan Wang, Li Shao
- Virtual sub-metering: Ana Rodriguez Arguelles, Ben Potter, Stefan T Smith
- Energy Benchmarking: Sam Mudie, Maria M. Vahdati

### Acknowledgements

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