Sustainability

The changing built environment

Professor Martin Sexton discusses the implications of sustainability on the built environment and on the industries which support it.

The built environment is where we live, work and play, and it affects how we do these things. The design and function of buildings in terms of their support and impact on people have always been an important part of this. However, until recently not much thought has been given to the impact this has on the wider environment. As society is becoming more aware of environmental issues, sustainability in all aspects of life is rising on the agenda.

Societies and governments are now asking for fundamentally different sustainable built environments which will require the construction and property sectors to radically change. This is certainly the case in the UK, where currently our buildings significantly impact the environment throughout their life. For example, our buildings are responsible for 45% of total carbon emissions; 32% of all landfill waste comes from their construction and demolition; and households alone account for 58% of all public water consumption. In response to this immense environmental burden, there is a growing raft of legislation, regulation and user demand requiring that buildings and settlements become far more environmentally sustainable.

The importance of this is recognised by the UK Government, and consequently the Climate Change Act 2008 has placed a target of reducing carbon emissions b y 26% by 2020 (compared to a 1990 baseline) and by a minimum of 80% by 2050. There are many different ways of working towards achieving this, but due to the impact that our built environment has on carbon emissions, looking at how to reduce emissions through the life of buildings is a high priority. For example, there is a target that all new homes will need to be zero-carbon by 2016, public sector buildings by 2018 and private buildings by 2019.

The requirements placed on built environment are systemic; they do not just include buildings, they involve whole communities and environments. The scale, complexity and urgency of the sustainability challenges we face require radical complex changes in the regulation, design, delivery and operation of buildings and infrastructure.

Transition

The process of transition to more sustainable built environments brings about many questions, and integrated research has a big role to play in developing appropriate solutions.

Energy companies are investing in renewable energy generation and exploring new ways to optimise the interplay between supply and demand through smart grid infrastructure, which is a form of electricity network using digital technology. New tools are being developed to assist designers, clients and users in determining the environmental performance of buildings and settlements. Construction and property companies and global supply chains are developing digitally-enabled service delivery capabilities to produce sustainable buildings, as well as embedding sustainability in their own businesses through corporate social responsibility. Finally, users are being asked to play a part in adopting sustainable technologies and practices which reduce energy consumption.

Individuals and organisations are not guaranteed to always make changes by choice, and any policy to encourage change needs to be appropriate. So how do we best design and implement appropriate regulations that support innovation and investment?

It is also important to investigate how users respond to policies, practices and technologies and how they shape behaviour and energy consumption in reality. One way of doing this is to analyse consumption data and use this to better understand and predict behaviour.

Economic considerations play an important role in the transition to more sustainable built environments. Who will pay for new incentives and changes? Major purchasing decisions, such as buying a house, value for money and location are seen as more important than sustainability by the vast majority of the population. The transition to a sustainable built environment will therefore require a redesign of current business models and value propositions. Capital cost and value models which work through the life of buildings will need to be considered, and how these actually work in real-world situations.

What is clear from all of this is that no one part of society or single activity can bring about the required transition to sustainable built environments. There needs to be a co-ordinated transition management approach which galvanises these multiple strands of activity into an integrated whole. The unanswered question is whether or not we have the knowledge capital, technologies, systems, processes and skills to make it happen? This challenge has been distilled into stark terms for the construction industry, for instance, by the UK Government's Low Carbon Construction Innovation and Growth Team, in the simple question: 'is the construction industry fit for purpose for the transition to a low carbon economy?'. There is a compelling need for a multidisciplinary research agenda to ensure the answer to this question is a credible, enduring 'yes'.

Integrated approaches to low carbon built environments

Dr Runming Yao, Construction Management and Engineering

Delivering a low carbon built environment requires an in-depth understanding of energy consumption in buildings and its mitigation and adaptation stratagems in built environment design and management. During the past four years, our research has been focusing on integrated approaches to link the urban climate with indoor environments, energy consumption, building energy system control, and occupant behaviour and adaptation.

We have recently developed a coupled thermal and airflow mathematical model to simulate microclimate. This model can perform real-time simulations using a range of data including urban air temperature, external wall surface temperatures, ground surface temperatures, and solar radiation falling on the facades of buildings and the ground. Investigations using real locations compared against simulation results show that the model provides a very good indication of microclimate. This is a useful strategic tool for sustainable architectural design and urban planning. It links microclimate with building energy models enabling assessment of the impact of urban form and texture (such as vegetation, and building and road materials) on building energy consumptions.

We are also developing domestic energy predicting models, which take into account the impact of occupants' behaviour. One of these is a multi-criteria decision-making method for building energy system design and operation. We are also investigating workplace thermal comfort, occupants' adaptation and its impact on energy consumptions in a building.

The Technologies for Sustainable Built Environments (TSBE) Centre is an industrial doctorate centre whose programme offers the expertise of internationally-renowned researchers to UK industry in order to develop industry-based research. One of the aims of the Centre is to aid in the development of an industrial knowledge-base capable of responding to the challenges of sustainability and climate change issues by reducing the environmental impact of construction and its carbon footprint.

As part of the TSBE programme, we work closely with industry and stakeholders to investigate how integrated solutions including building design, energy system design, implementation of renewable energy technologies, and occupants' adaptations can be used to achieve the Code for Sustainable Home level 6, a UK national standard for assessment and certification of housing sustainability. Since much of the work to move towards more sustainable built environments will require retrofit processes, we have also recently completed a report on carbon abatement options to listed buildings.

The control and management of the integration of the complex interactions between climates, buildings, energy systems and humans is vital when designing and managing sustainable built environments. The integrated approach to the research in low carbon built environments will need to apply a system thinking method (which is the process of understanding how things influence one another within a whole) to link urban climate, building design, energy management and end-user performance assessment as whole.

Sustainable design in the digital economy

Dr Jennifer Whyte, Construction Management and Engineering

To create sustainable built environments, we need to radically change the processes through which buildings and infrastructure are designed and re-designed. Sustainability is not achievable if design and operation are disconnected. Yet, too often designers start with 'a blank sheet of paper' and end up giving too little information about their design back to end-users, owners and facility managers.

Our research has a vision of a new mode of design in the digital economy. We are working with leading projects and firms: those that are beginning to use integrated software to create the models and rich data-sets that are vitally important to ensuring transition to sustainable built environments. This work involves designers, engineers, construction contractors, software suppliers and clients. What is shared is a commitment to generating, maintaining and making available relevant data right through the life of buildings and infrastructure.

At the start of design there are opportunities to use data about the environmental performance of the existing built environment to inform its modification. Here our research is investigating new ways of visualising data for shared design inquiry. We want to transform the focus of projects, so that what is measured and monitored is not only performance in terms of cost, budget and time, but also performance in terms of sustainability and design quality.

At the end of design there are opportunities to use design models and data to improve longer-term use and maintenance of buildings and infrastructure. Here our early research on data-handover to clients is investigating why data is often either not transferred, or transferred and not used in operations.

Yet there are substantial new challenges in using integrated software, and hence the connection between digital data and sustainable performance is the focus of a long-term research agenda. At the design stage, our research is beginning to examine a range of unintended consequences of attempts to transition to sustainable practices, such as how the increased use of computers adds to the carbon footprint of the design process itself; and how showy renewable solutions may be added to projects for legitimacy and status reasons, rather than as an integral part of a sustainable solution.

By examining what works and what does not work, our research is informing government policy, management practices, and design processes. The UK construction industry is globally leading in this area, and as the UK Government sets out a five-year strategy to implement 'Building Information Modelling and Management' to meet sustainability targets, research at Reading will continue to have a significant impact on policy and practice.

Sustainability, climate change and spatial planning

Professor Gavin Parker, Real Estate and Planning

There has been much attention paid to how spatial planning may aid the aim of sustainability and sustainable development. In many countries sustainability has become the touchstone or the explicitly primary aim for planning policy and practice over the last two decades. In the UK the Royal Town Planning Institute recently placed climate change as a key issue for planners to engage with. Indeed the longstanding aims of planning in terms of place-making and efficient land use sit very well alongside the associated goals and challenges of sustainable development and CO_2 reduction.

As such, questions of sustainability have lain at the heart of planning rationales for well over a century. Early planners were social engineers responding to market failure and highlighting the need to consider the appropriate relationships between land uses and place, people and work. Understanding and supporting the needs of industry and of communities are integral, and the appreciation and understanding of the ecological dimension is central.

While planners in practice develop and use plans and strategies to guide action, they also need underpinning evidence and research. Academic planners perform a pure and applied research function here in terms of understanding the impacts of development, and the most efficient use of resources and juxtapositioning of activities. There is also an important structuring role in drawing together knowledges, other researchers and multidisciplinary approaches that, in combination, are needed to provide fuller understandings and which can form more holistic and sometimes new interdisciplinary perspectives.

Thinking long-term and acting to mediate between interests are other features of planning concern and action. This thinking is applied across the key elements which have become more commonly discussed, for example, concerns over the resilience of settlements and ecosystems. Questions of mitigation, or how to minimise impacts, and the linked challenge of adaptation are pressing. These need to be planned and, crucially, the likelihood of implementation understood. Some of the changes that can be brought about are linked to behavioural changes and to policy adjustments that are both shorter and longer term. Some measures rest primarily at the micro or individual level, while others are more macro and require national impetus and international co-operation. Planners are very much interested in how to combine and adjust policy and regulation to help attain societal goals across scales and using different tools.

At Reading, we have a long history of pure and applied research and multidisciplinary research projects that help with the sustainability agenda. For example, some recent work has looked at: the re-use of Brownfield and barriers to development on such land; domestic energy use; examination of global flows between cities and the implications of this in terms of investment and resource use; developing awareness and engagement with processes; and public participation, water and waste management issues in India.

Multidisciplinary, multi-actor, multi-level, multi-phase problems require multidisciplinary, multi-actor, multi-level, multi-phase solutions. There is a need to integrate economists, planners, technologists, sociologists, psychologists and meteorologists. At Reading, in collaboration with national and international academic and industry partners, we are making strong contributions to this. We are drawing upon and integrating research from across the physical and social sciences' spectrum to develop the construction and property industry capacity to deliver high-value, sustainable built environments.

For more information please see:
www.reading.ac.uk/cme | www.reading.ac.uk/tsbe | www.reading.ac.uk/designinnovation