Tailor-made efficiency

In the low-carbon age, building services engineers need to seize hold of a discipline that helps create a truly sustainable building devoid of green bling, writes **Doug King**

During the 20th century, architecture was liberated by abundant cheap energy, allowing forms of building that could not previously have existed. In the 21st century, buildings must evolve to meet the twin challenges of climate change and energy security. In order to conserve diminishing fossil fuel supplies, we will have to cut down on waste and inefficiency.

The need for genuinely sustainable buildings is more pressing than ever; it is no longer acceptable to bolt green bling onto conventional, energy-hungry designs. Before renewable energy generation is even considered, it is vital to ensure that buildings are as energy-efficient as possible, otherwise the potential benefits are simply wasted in offsetting unnecessary consumption.

The shift to a new low-carbon paradigm will require engineers to take the lead. Building projects are traditionally led by architects or project managers, but building energy performance hardly features in architectural education. This lack of essential knowledge to inform strategic design decisions early in a project's life has led to the perpetuation of an experimental approach to building performance, rather than an approach based on rigorous analysis, synthesis, testing and feedback.

Building physics, the engineering of the building form and materials, creates the opportunity for engineers to engage with the design at early concept stage when the critical decisions affecting passive performance are made.

In order to address the root issues of sustainability, professionals throughout the construction industry need to be well-versed in the discipline of building physics. Building physics emerged during the latter part of the 20th century at the interface between building services engineering, applied physics and building construction engineering.

> "Without a dramatic increase in skills, the proposed acceleration towards zero-carbon new buildings by 2020 will be hard to deliver"

Unique mix

Building physics investigates the areas of natural science that relate to the performance of buildings and their indoor and outdoor environments. Yet few people in the industry are presently aware of the discipline, and it is taught only as a minor part of a limited number of engineering degree courses.

Building physics deals principally with the flows of energy – both natural and artificial – within and through buildings. It covers a unique mix of heat and mass transfer physics, aerodynamics, material science, meteorology, construction technology and human physiology.

The discipline complements and supports building services engineering, formalising many aspects of the work that building services engineers are already called upon to do. Building physics provides the tools to analyse the thermal and energy performance of parts of the building not traditionally considered to be building services systems, such as the structural frame and envelope.

In an industry where each product is essentially a prototype, and when it may take years or decades for building performance problems to come to light, we can no longer afford the luxury of experimenting with the physical form of buildings. In order to create buildings fit for the 21st century, rigorous performance analysis and energy prediction needs to replace experimental building development.

Systems engineering recognises that complex products, such as buildings, require many interdependent systems to function in harmony. Building physics already encompasses architecture, structure, façades and building services, and so can provide the framework for developing a systems approach.

Clients of industry and construction need clear guidance on which parties in the design team >

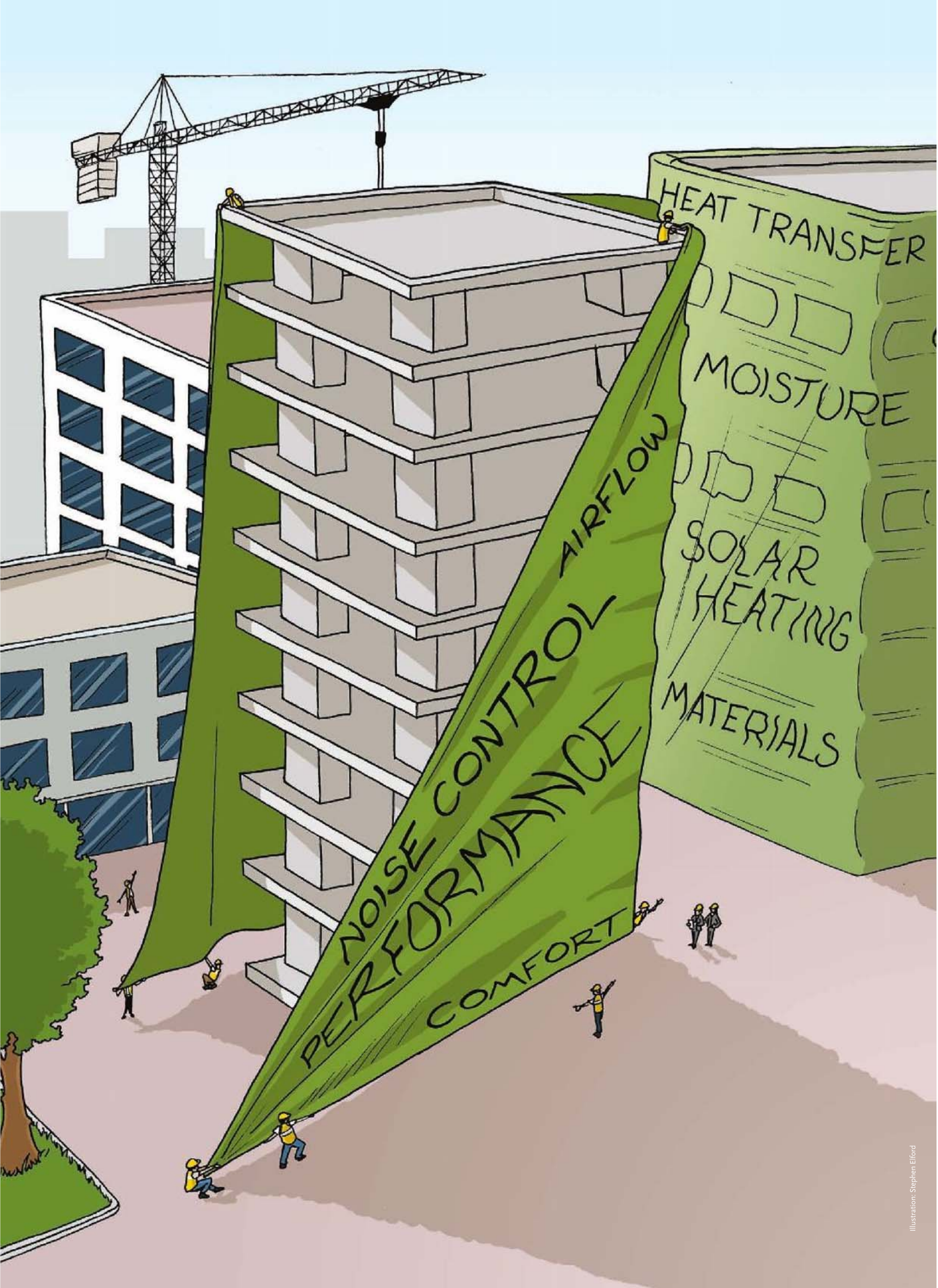

Illustration: Stephen Elford

should be responsible for low-carbon design. There is no universally accepted scope of services for low-carbon design in the way that there is for the building services engineer, as set out in the ACE Conditions of Engagement. The work is often undertaken by consultants from wide-ranging backgrounds, who may not be conversant with the principles of building physics – or even engineering. This lack of consistency results in enormous variations in the standard of service provided by practitioners.

Wider alignment

Furthermore, it is now common for confusion to arise between the architect and building services engineer over responsibility for the specification of thermal insulation, building air tightness, solar shading devices and window performance. In order to achieve genuinely low- carbon design, we will have to reallocate design responsibilities on the basis of whole building performance rather than on the basis of components.

The professional institutions and trade associations must therefore recognise a multi-discipline, problem-solving approach to design and delivery that overthrows conventional sectarian relationships and embraces building physics and a systems engineering approach.

CIBSE is ideally placed within the industry to adopt building physics as part of a wider alignment of science and engineering for low-carbon buildings. The institution will need to establish professional standards for conduct and service to ensure consistent and reliable delivery of low-carbon design. CIBSE should also develop new criteria for education and professional development, aligned with the UK Standard for Professional Engineering Competence.

Government must prioritise education and skills development in construction to deliver a manifold increase in low-carbon professionals that is vital to the achievement of national policy objectives. The current ‘trajectory’ for carbon reductions embodied in UK government policy requires a dramatic increase in skills right across the construction sector.

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Skills shortage

Yet the skills that will be essential to delivering this scale of reduction are simply not taught at present in the majority of universities. Building physics needs to become a core part of undergraduate teaching for all construction professions.

Government should also consider the opportunities for training and re-education in the field of low-carbon design and construction for professionals throughout the industry. At a time when we need to increase the professional skills necessary to deliver low-carbon buildings, the industry is losing swathes of experienced professionals through redundancy.

A further pressing need is for reliable information on the actual energy and carbon performance of recently constructed or refurbished buildings. This information is essential for the establishment of benchmarks and standards, and the validation of new designs and techniques. The dissemination of real building performance information, rather than the marketing hype so often published, will not just inform future low-carbon buildings, but also allow for the development of robust national policy and up-to-date, authoritative teaching materials.

Government should commission post-occupancy evaluation of all new buildings in the government estate constructed since the introduction of the 2006 Building Regulations. This would quickly establish a useful national database of design techniques and carbon performance. Government must also establish the benchmark for procurement practice, by setting and enforcing performance targets for its own buildings, something it has singularly failed to do to date. Achievement of carbon targets should be linked to financial outcomes for all publicly funded projects, with publication of the design criteria and measured performance data for the benefit of future designs.

The need for a radical overhaul in education and practice in the UK construction industry is urgent and undeniable. Our national goal is to deliver an 80 per cent cut in carbon emissions by 2050. The scale of the challenge in reducing fossil fuel dependency in the built environment is vast. The rapid pace of change in the regulation of building energy performance has already created problems for the construction industry.

Without a dramatic increase in skills, the proposed acceleration of regulatory change towards zero-carbon new buildings by 2020 will only widen the gulf between ambitious government policy and the industry’s ability to deliver.

The changes necessary to achieve a sustainable built environment need to be far reaching in the areas of policy, finance, procurement practice and management. However, unless we urgently equip the industry with the fundamental skills that will allow it to design and deliver genuinely efficient buildings, the transition to a low-carbon economy simply will not happen. ●

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