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Heading off sustainability crisis through an integrated Building Physics approach

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Thought piece from Mike Ward, Associate Technical Director, Arcadis

COP26 identifies that 80% of the buildings responsible for carbon release in 2050, when the world aims to be net zero, have already been built.

Anything we build new – and anything we revisit – therefore needs to go beyond contemporary targets and standards if we are to avoid irreversible planetary change and a more hostile environment for all due to not achieving net zero ahead of the 2050 target.

Decarbonisation targets are there for all the right reasons, but rarely are they met through coordinated and combined multi-disciplined efforts by Clients, Architects and Engineers to achieve true integrated design. Real world outcomes often lack the application of principles that go beyond historically-anchored targets and standards to genuinely minimise embodied carbon and carbon emissions. The guiding intention is often to create or repurpose a building that holistically meets all the requirements of a client's brief and standards to become an environmentally benign thing of beauty, yet the harsh truth is that too often different. While the intention is 'eco-friendly' what emerges is a building that then needs a multitude of costly and resource intense 'bolt-on' systems and carbon offsetting technologies that compromise the integrity of the architect's vision and scheme affordability.

The routine 'bolt-on' system and technology approach to realising net zero is arguably unsustainable. Instead the building itself must be designed to meet the challenge, not challenge Architects and Engineers through 'silo' working arrangements to make it fit for the future. Involving Building Physics during the early stages of a building design can reduce the need for 'bolt-on' systems and technologies from the outset. Applied Building Physics will maximise the potential of the external envelope, internal spaces, and human tolerance whilst respecting or enhancing the architectural vision.

Building Physics is a relatively new discipline to gain recognition by the wider building design community that scientifically optimises building design and energy usage through early combined architectural and engineering working. This approach results in buildings that are less reliant on 'bolt-on' systems and technologies to achieve the same level of thermal comfort, ventilation, and building functionality – so buildings are not just equipped but born or reborn ready for the future, achieving decarbonisation through integrated design.

Building Physics has become the scientific understanding of energy use and thermal moderation within the Built Environment. A Building physicist goes beyond simply applying 'routine' systems and technologies to meet historically informed requirements and standards, and instead develops passive multi-functional and integrated building features to achieve low energy and low carbon outcomes. A Building Physicist will promote integrated design building features at an early stage in the design process, and generate bespoke analytical models to optimise, predict, or test the holistic value and worth of suitable building design features.

It's not about new techniques or technology, it's about new and reliable strategies. For example, the use of form and fabric (integral to the design) to control and regulate a building's environment has been practiced for millennia. Roman architects designed for climates across the Empire. Buildings needing heat stored in columns and floor structures – the famous 'hypocaust' system – was central to Roman sites. While Roman Architects knew hypocausts would heat buildings, it was way beyond their ken to estimate the capacity and effectiveness of these passive integrated structures. Much in the same way wind catchers were – anecdotally – integrated within Middle Eastern buildings at a time without the means to analyse their effectiveness or value, nor to optimise their cooling performance.

In these examples, the modern building physicist would work with the design team to promote, analyse, and integrate these passive building features to maximise their impact, and to optimise the composition, thickness, and configuration of heat radiating slabs or naturally ventilating towers. The modern building physicist would also optimise the distribution of below slab hot air, and in the case of wind catchers the delivery of passively cooled or heated outdoor air to maximise benign building and system performance, whilst minimising energy use and carbon emissions.

Ultimately, the building physicist would work out the value of the hypocaust and wind catcher (and any other integrated passive features) to either justify their inclusion or their rational exclusion from the scheme. This approach would have been completely alien to the Romans and Middle Eastern Architects, despite their relatively advanced design thinking, and this lack of empiricism has been the status quo ever since – while 'green is good' has been the mantra for decades, it has been a qualitative thing – 'greenwashing' constrained by budget and sometimes aesthetic quests. The result has too often been buildings that environmentally disappoint or miss intended environmental performance targets, requiring 'bolt-on' systems or carbon offsetting technologies – both at great financial and resource expense.

Including the analytical skillset of the Building Physicist during the early stages of the design process and maintaining this involvement during design development means that every environmentally benign measure, every mixed mode option is promoted, and value is quantified, naturally guiding designs towards net zero carbon outcomes. Where previously it has proven very difficult to choose the right solutions –

ones that add up to and exceed decarbonisation targets within construction budgets – designers working with Building Physicists can optimise design and then demonstrate the value of building features instead of hoping or expecting “this should help”.

Without quantifying the effect any passive building feature in any given place would have on the overall energy and carbon budget when integrated within the architectural design, the feature will likely underperform. Building designers must think about carbon while drawing up the form and fabric of the building, putting specialists around the table who bring a scientific approach to the study of form, mass, and envelope from the outset. This will not only help save the world – a building physics approach with carbon reduction as a part of the building design process and not through equipment based ‘bolt-on’s’ –can lead to very real savings in lifecycle cost.

With the continued need for customer movement and comfort, plus equipment demands for heating, cooling, and electrical power, buildings are relatively demanding and expensive places to apply carbon mitigation measures.