Make do and mend?

Every school must ***target zero carbon status*** for their estate and its running

Retrofit is going to win over new-build in embodied energy calculations

There is more ***cost certainty and less energy*** in use with new-build

Tear down or spruce up?

In the march towards zero carbon, what should we do with our existing buildings and how much should these decisions be affected by their embodied energy?

This summer, something bizarre happened in the national media. Summer is normally the silly season for news, when for lack of meaty content editors fill their columns and broadcasts with oddball stories to win our attention. There was no need for such frothy filler this year: nationally and internationally there was quite enough going on. The four horsemen of the apocalypse were out of the gates and galloping around the globe, jockeying for attention alongside the alarmingly cataclysmic results of climate change, the burgeoning hardships signalling economic meltdown, and the Conservative leadership contest.

Yet somehow, amongst this media stampede, one stolid, stationary, boring building popped up on the front pages as the subject of lively controversy and debate. Why?

The Marks & Spencer department store on Oxford Street, London, is hardly an icon, and certainly not a looker – it's a clunky inter-war block with a hint of bunker about its attic floor, and inside is a messy and tatty warren. M&S applied for permission to knock it down and replace it with a smart new building, bigger but not brutish, with a mix of retail below and offices above. A classy modern design, the proposal came with a detailed analysis of how its carbon footprint in the long run

▼ Embodied carbon calculators are a valuable benchmarking tool both during the design process and for retrospective analysis

would be less than if the existing building was retained and upgraded. 'Greenwash!'? shouted the carbon police, prompting Michael Gove to call in the application.

Who is right? The M&S report was convincing enough to persuade Westminster Council that their sums added up, but the retrofit campaigners countered that the refurbishment model in the report was light touch only, whereas a fuller retrofit would have a lower long-term carbon footprint. We will have to wait for the final verdict, but in the meantime the debate highlights two things:

- firstly, there is not yet a national standard methodology for assessing total carbon footprint over a building's lifetime. The parameters and the algorithms differ which makes comparisons debatable; and
- secondly, this is now a huge and urgent topic. It is literally front-page news.

The relevance to school bursars

It is, I think, now an unquestionable imperative that every school targets zero carbon status for their estate a nd for the running of the school, and makes this target a key driver for every capital project. And every school – certainly every ISBA school – has a stock of existing buildings of varying ages and varying states of usefulness and repair, which will need upgrading, re-purposing or possibly replacing at some point. How to choose between those three options in light of the zero carbon imperative depends heavily on the robust and accurate evaluation of total carbon footprint and, increasingly, of the embodied energy component of that footprint.

When carbon footprints of buildings first became a matter of concern, the focus was purely on the energy they consumed while in use. The building professions became reasonably well versed in how to calculate that, and how to reduce it to zero over the lifetime of a building, both by improving the building performance to require less energy and by generating sufficient renewable energy to meet the need.

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The realisation that we need to consider not just the energy in use but also the energy expended in the actual construction of the building came later, growing in importance as the in-use energy of buildings shrank. When buildings used a lot of energy over their lifetime, the energy embodied during construction was relatively insignificant, but as in-use energy dwindles, the proportion of the total carbon footprint that is the embodied energy expands and thus becomes the critical issue it is today.

Because this is a relatively new field it is still unregulated, but architects and the wider construction industry are lobbying government to bring in national standards. Measuring embodied carbon is a complex and currently somewhat imprecise science. The biggest challenge is gathering the correct data. Each component of a building needs to be understood in terms of its climate impact, from its manufacture, transport to site, installation, maintenance, and end of life waste or recycling. Many suppliers have now begun to produce Product Passports which provide much of this information, but as yet they are far from universally available. (As an aside for future consideration, a key winner in this is timber, which really helps reduce the embodied energy when it is used in a building because its growth process takes carbon out of the atmosphere; so it is carbon negative, countering all those build elements which produce carbon in their manufacture and so are carbon positive.)

Embodied carbon calculators

To help building consultants assess the embodied energy in their designs there are now a number of 'embodied carbon calculators' that can be accessed online for free, or purchased. It is fair to say that these are still evolving and are not yet fully capable of measuring non-standard construction methods, but they are a valuable benchmarking tool both during the design process and for retrospective analysis.

There are a whole host of these which are free, and consequently quite basic; the one my architectural practice likes is the Mesh, Energy Embodied Carbon Calculator. There are also paid-for tools, notably the LCA OneClick software. This gives you access to the entire global database of existing Product Passports, providing a much greater degree of certainty that the data is valid and allowing designers to make early decisions as to the best products and materials to use for low embodied energy. There are also several additional features that allow a much more dynamic interaction with the data, making it easy to spot areas where embodied carbon could be reduced from the earliest design stages.

Re-framing the idea of retrofit

With these embodied carbon calculators and in-use energy calculators at hand, we can now make a decent stab at comparing the whole life carbon footprint of any new-build project and the same for any refurbishment project as well. Excellent. But wait: the lesson from M&S is not simply that we must go through this process. In that case it seems likely that they used this tool as a method of justifying demolition and re-build by being half-hearted in formulating the retrofit option. What is needed is for the retrofit option to be properly thought through, even if the new-build looks sexier and more likely to attract donors and prospective parents. That means re-framing the whole idea of retrofit.

Traditionally, architects have preferred new-build for the greater design potential and bursars have preferred new-build for its greater fund-raising potential. It is also undeniable that new-build comes without the compromises to function that an existing building may have. But maybe this is blinkered thinking, and maybe we simply must start thinking afresh because retrofit is going to win in whole-life energy calculations. Converting, extending, re-booting existing buildings can be just as creative as designing icons, and re-imagined buildings can trigger alumni who have fond associations with that freezing exam hall where they had to keep their gloves on to write.

Retrofit case studies

I have two brief examples to illustrate this from work my practice is currently engaged in.

The first is a project for a sixth form college in Oxford. The school owns a boarding house which occupies a quite small patch of land near Oxford station; the existing building is two storeys and they want to expand their provision. But they have no more land, so we had to think creatively. We proposed that rather than buying land or squeezing in more buildings on what they had, instead, they build upwards with one or two more floors added to the existing building, effectively doubling the height; with careful negotiation, the planners approved it. The structural engineers sucked their teeth but working as a team we came up with a solution where by drilling a few new piles through the floor of the existing building and by reinforcing the existing cross walls with more screws – yes, just more screws – it could work, as long as we took off the existing brick skin to make the whole thing weigh less. So, we then took up that challenge and changed the cladding to a (100 percent recycled) copper carapace with additional insulation within it. The result is a building hugely expanded and transformed in appearance; the look will be much improved, the thermal performance also. This will be a radical retrofit but not anything like as contrived a solution as was first envisaged. It has just taken creativity by the architects and ingenuity from the engineers. And the inside is going to be built from lightweight timber panels. Perfect.

The second example is more nuanced. A major public school with a capacious campus asked us to carry out a feasibility study comparing the conversion and extension of a cluster of existing buildings into a boarding house, against its demolition and replacement. The conversion was possible, but it did involve quite a bit of piecemeal demolition, re-modelling and extension because the existing cluster was quite a jumble. As a result, the total build costs came out remarkably similar, and although the conversion had less embodied energy, the in-use energy for the new-build was lower year-on-year. It was not an obvious decision on either cost or carbon grounds but in the end the school plumped for new-build for the following reasons:

1. There was more certainty on the new-build cost. It is a fact that building work involving existing buildings has more scope for variation because it is harder

▼ The new boarding house at Shrewsbury School designed by Adrian James Architects

to initially predict the scope of work with retrofit, and there are unknowns which will only reveal themselves once work starts.

2. When there are living quarters involved, there is the potential to avoid VAT with new-build. This is a quirk of tax legislation which currently weighs hugely in favour of new-build and which does feel misconceived and due for change, but as it stands is a major swing factor.
3. In this case, the school had the room elsewhere on their campus to build a new boarding house. This allowed them to retain the existing buildings for other future uses which involved less contrivance.

At the start of the exercise the assumption was that probably retrofit would win out. But in objectively testing both options, the costs did not prove lower, nor did the carbon footprint (although to be fair this was an approximate exercise which pre-dated the Mesh, Energy Embodied Carbon Calculator).

Clearly, then, retrofit is not a panacea and does have its limits. But nowadays it simply must be tested. And not in a lily-livered way; the proposal and the calculation must both be thorough. The embodied energy in existing buildings may well prove the decisive factor that makes retrofit a better option in terms of carbon footprint. And with imagination and ingenuity, that may be the better option in other respects too. That tired old M&S store may not need to be demolished to be re-born as a 21st century magnet for knicker shoppers; how about stripping it back to its carbon-heavy concrete frame, cladding it with a new façade of recycled copper petals, scooping a new top-lit atrium out of its centre for natural stack-effect ventilation, and roofing it with a rolling sinusoidal landscape of grass and trees? Yes please.

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▼This is not just a roof, it's a landscaped roof