Masterplanning

James McCosh, partner at van Heyningen and Haward Architects, says that estate masterplanning must never be done on an ad hoc basis. Instead, base it on evidence and consider the holistic needs of the school to minimise operational and reputational risks, maximise return on investment and make decarbonisation commercially feasible.

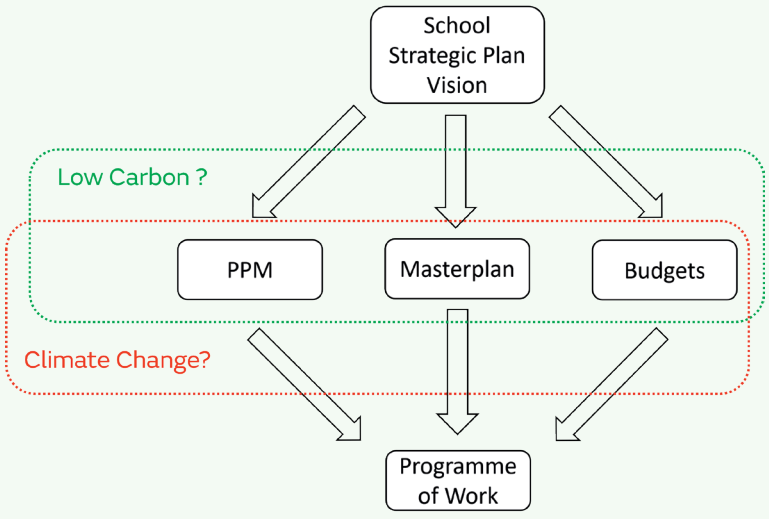
All schools need to consider how sustainable their operations are. In recent years there has been a shift in public perceptions, from sustainability being seen as a niche activity with few serious implications, to the realisation that climate change is presenting real risks – with an impoverished natural world, higher risks from fire, flooding, extreme weather events and greater heat that makes buildings less fit-for-purpose. At the same time, governing bodies are ever more aware of the costs of energy and insurance, and the reputational aspects as environmental, social and governance (ESG) considerations become commonly understood. So sustainability now needs to be embedded in the core of all schools' operations, their business plans and risk assessments.

School buildings and grounds are absolutely central to their purpose and thus, to their reputation. If buildings are wasteful of energy, vulnerable to climate change risks, or have poor comfort, teaching and learning is disrupted, potentially significantly, and running costs increase. Schools often have complex estates and financial challenges – yet leaving the problem will only make it more challenging later, either because of a crisis like a flood or fire, or simply a tide of issues that becomes commercially impossible to deal with.

Managing school estates is often undertaken with several largely unrelated workstreams. A well-run estate will normally have a schedule of planned preventative maintenance, administered by the estates team, there may be a capital works programme, usually more closely overseen by the bursary, and sometimes a decarbonisation plan.

When we visit school sites, our general impression is that despite their best efforts, most estate teams operate in reactive mode, permanently addressing mini crises, as they are not operating strategically. There may be a preventative maintenance plan and budget, but very often it is not followed. That is not surprising as many schools operate without any effective schedule of condition, which would inform their future maintenance budgets, warn of foreseeable risks, and document the service life of their plant.

▼ Does your school programme of planned capital works consider the need to increase climate resilience and decarbonisation?



Decarbonisation

The capital works agenda is often set by the governing body, or by a head, making a judgement on the school's pedagogic needs and, often, in response to the facilities offered by competitors. Sometimes this simply results in new facilities, which do not always successfully complement the rest of the school's site, or operation, or stand the test of time. For that reason, many architects, including ourselves, like to work within a considered, long-term, framework for development, i.e. a masterplan. That might be done at the start of a building project, but is normally more objective and useful if it has been prepared as an end in itself. It can be very simple or quite involved, but if it establishes a spatial strategy that frames development over a defined period, and is clear and useful, it will do.

Decarbonisation is the third strand. As it becomes obvious that our civilisation must wean itself off fossil fuels, numerous specialist consultancies have become available to tell schools how they might achieve this. Typically, these are based on considering building services, in isolation and in the abstract, and assume that everything else stays the same – your community's expectations, peoples' behaviour, and your good, bad, and indifferent buildings. The problem is that if one just swaps endless gas boilers (a smallish school estate we visited recently had more than 30) for various combinations of heat pumps, this requires more plant space and/or distribution, involves huge capital outlay and will use a lot of power, guaranteeing even higher running costs. The aspiration to decarbonise a school's operation is then quietly forgotten – as the works seem commercially unachievable.

But our experience suggests that the sooner schools can take steps to address this change, the more achievable it is.

If undertaken gradually and steadily, the cost becomes more manageable, risks are reduced and yet overall progress is achievable.

A fit-for-purpose masterplan

We think the way to do this is to combine the various 'lenses' through which one sees the estate:

- regular maintenance;
- small refurbishments; and
- decarbonisation plans.

These need to be considered together with the pedagogic and operational needs. By seriously addressing issues of condition, energy use and decarbonisation and development, together, then reasonable and proportionate solutions can be devised.

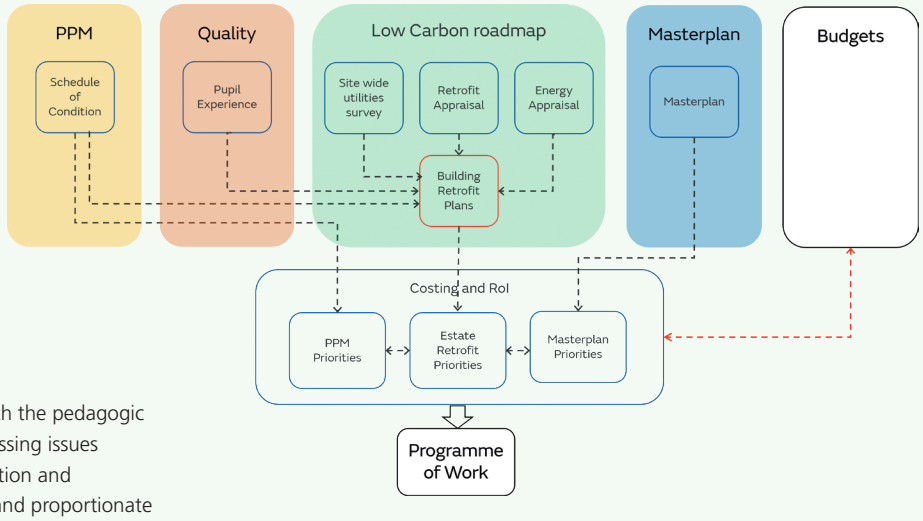
We would still suggest this is a masterplan – but that now, a fit-for-purpose masterplan should be combining evidenced knowledge of your estate with your assessment of the school's future spatial needs. At the same time as providing what pupils and staff need, its aims are to address the risks of climate change and reducing energy and running costs whilst decarbonising the estate's operation and building resilience.

Schools spend large amounts of money looking after their estates. This is normally a recurring budget item, spent year after year, to stand still. Sometimes this money is spent on re-roofing and repainting, or it is used to do cosmetic internal refurbishment. Repair and maintenance are vital; not only will it keep buildings looking good, safe and working well, but it avoids future problems, 'a stitch in time', and improves performance, especially for traditional buildings.

Upgrades and retrofitting

These works can also be seen as an opportunity for upgrade and the budget supplemented to make it possible. Every time a roof is replaced but the gutters and downpipes remain the same size, and/or insulation is not fitted, that is a waste. A large proportion of construction costs lie with procurement, logistics, access and supervision – you will be getting better value for money if you leverage regular maintenance to carry out gradual improvements at the same time. We suggest that every repair, maintenance, or refurbishment project is considered to see if it can improve the building fabric and, if it does, to turn it into retrofit.

Retrofitting is the addition of new technology or features to older systems. In buildings, retrofit is normally used to mean adding features to improve its performance and to increase resilience, especially to climate change. Increasing the performance of a building's envelope makes it possible to improve comfort, lower heating (and cooling) demands and thus reduce running costs. One example is solar gain and overheating, which can be addressed by fixed solar shading, window design and ventilation plant, avoiding energy-hungry air conditioning.



▲ Bringing together the various strands into your masterplan (including condition, adaptations to climate change and decarbonisation) allows a robust programme of works to be established

Heating

Heating energy is by far the largest energy demand for school buildings, whether teaching or residential. On many older buildings heat loss can be more than halved by adding insulation and improving air tightness and demand further reduced by optimising plant, controls and settings. As well as reducing running costs, this reduces the size and thus costs of heating plant needed, making it much more feasible to heat electrically with some type of heat pump, bringing the potential to remove fossil fuels.

As fossil fuel prices have climbed over the past 60 years, there have been sharp peaks that have made all building owners improve their energy efficiency, but then inertia sets-in. Many schools have new buildings that perform well, but a long tail of older buildings, which are often dreadful, with inefficient plant, draughty single-glazing and uninsulated fabric. The logic with retrofit is to assess the particular fabric of each building and that building's impact on the performance of the estate, and then address the most significant and/or easiest first.

Lessening the challenges

So as part of the evidence base for the masterplan, ideally one would assess both the condition and retrofit opportunities for every major building to understand priorities and impacts. This assessment must be well considered, particularly with heritage buildings, but there is no fundamental reason why one cannot, appropriately, retrofit a Grade 1 listed and Scheduled building – as we are currently designing for the Chatham Historic Dockyard Trust. (LETI will publish their Guide to Non-Domestic Retrofit later this year, which will summarise the considerations, processes, and sign-post available guidance resources.)[1]

The key aspect to understand is that retrofit can be harmful to buildings if done wrong, but can also be executed carefully in a gradual process. Having an overall plan for the entire building sets appropriate strategies, and allows for discrete interventions when the budget is available – or when you need to scaffold the roof. If you undertake gradual retrofit when you are addressing the condition issues, then the approaching decarbonisation challenge lessens, as the overall energy loads will be less.

A simple retrofit plan for each building can identify the main opportunities and constraints and summarise the actions needed – and can be updated as they are undertaken.

Unseen infrastructure

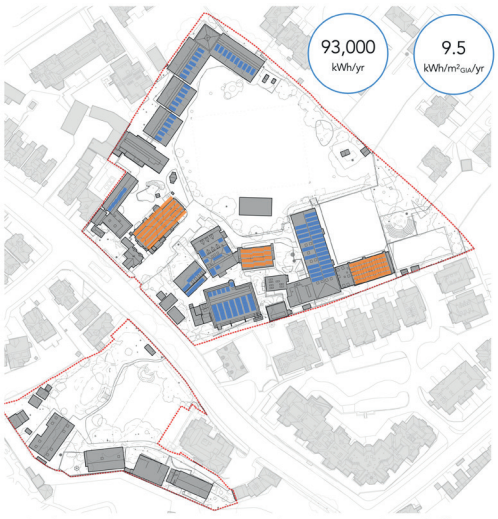
Recently we have been combining commercially available 3D models of schools, (derived from city LIDAR scans, or drone-based scanning), and our revit software, to undertake school masterplans. Use of this software allows us to gather, record and show the data at a granular level – for each building or individual room and to generate clear drawings showing different criteria, all from the same data.

By using the 3D data with this we sidestep the need to have the whole site conventionally surveyed and can show topography and levels accurately enough. Most powerfully, the 3D data, which can show roof, wall and window/door areas on elevation, allows preparation of simple energy models to predict energy performance, thus allowing simple retrofit plans for the buildings to be developed (even when the building has no sub-metering).

The condition and capacity of schools' unseen infrastructure is often poorly assessed – even less than the condition of buildings and grounds. Schools need to consider the vulnerabilities of their estates in the light of climate change and the issues for decarbonisation. To do this you need to know the capacity and condition of estate infrastructure. We are aware of a school where a flash flood from a 20-minute summer storm destroyed its main server and flooded two buildings because of an undersized and partially collapsed surface water drain that was made critical by an extreme weather event.

Drainage infrastructure will be critical in extreme rainfall and the electrical infrastructure will be fundamental to the decarbonisation trajectory. You will only be able to use heat pumps if you have sufficient electrical supply and if you can distribute between buildings you will be able to maximise the benefit of photovoltaic generation (now significantly cheaper than grid power, even with finance costs).

▶ PV arrays generate very quick returns, but the opportunities need to be assessed with your electrical distribution and substations (image courtesy of Etude)



Site plan of KAS site showing an indicative extensive solar PV array mounted on roofs. (blue) Buildings are omitted where they are significantly shaded, or where the roof scape is challenging for installation, however in the future it may make economic sense to install PV on these areas as well. (orange)

Evidence-based masterplans

To summarise, schools face increasing commercial demands while risks from climate change rise. These include operational, financial and reputational impacts, as the climate becomes less stable and as society's expectations change. A masterplan used to be a relatively simple spatial document, just considering facilities and their arrangement. This is no longer adequate.

We suggest that a masterplan should be synthesising the school's development plans with estate information on buildings and infrastructures condition, and a route map to decarbonisation, including building retrofit plans. Basing this masterplan on evidence and considering the holistic needs of the school will minimise operational and reputation risks, maximise return on investment and make decarbonisation commercially feasible. ◀●

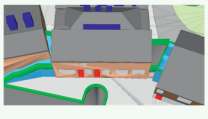
▼ Simple estimation of heat losses by using 3D data to establish retrofit plans to focus investment on fabric upgrades – ideally as and when issues of condition are tackled

Admin Building

Element	Construction (interior to exterior)	Area	Location
Roof	Timber truss structure, unknown insulation, tiles	165.99	North Block
	Timber truss structure, unknown insulation, tiles	125.52	Central Block
	Timber frame, unknown, corrugated metal sheet	110.1	South Block
Total		**421.61**	
	Timber truss structure, unknown insulation, tiles	311.51	
	Timber frame, unknown, corrugated metal sheet	110.1	
Rooflights	Timber frame, single glazing	7.63	North Block gable windows
	Unknown frame, unknown glazing	11.2	Central Block - pitched curtain wall
	Timber frame, unknown glazing	3.69	Central Block - three skylights
	Steel frame(?), double glazing(?)	14.51	South Block - curtain wall
Total		**37.03**	
	Timber frame, single glazing	7.63	
	Unknown frame, unknown glazing	11.2	
	Timber frame, unknown glazing	3.69	
	Steel frame(?), double glazing(?)	10.25	
Walls	Unknown, unknown, brick exterior	47.3	Ground Floor balcony wall - North Block
	Blockwork, unknown insulation, brick exterior	60.01	North Block - North wall
	Blockwork, unknown insulation, brick exterior	58.78	North Block - East wall
	Blockwork, unknown insulation, brick exterior	48.81	North Block - West wall
	Blockwork, unknown insulation, brick exterior	24.09	Central Block - East wall
	Blockwork, unknown insulation, brick exterior	29.18	Central Block - West wall
	Blockwork, unknown insulation, brick exterior	25.8	South Block - East wall
	Blockwork, unknown insulation, brick exterior	68.05	South Block - South wall
	Blockwork, unknown insulation, brick exterior	39.17	South Block - West wall
	Blockwork, unknown insulation, brick exterior	27.72	Admissions Building on East side
Total		**428.7**	
	Unknown, unknown, brick exterior	47.3	
	Blockwork, unknown insulation, brick exterior	381.4	
Windows	N/A	N/A	Ground Floor balcony wall - North Block
	Wooden frame, metal window, single glaze	7.9	North Block - North wall
	Metal window, single glazing	10.04	North Block - East wall
	Metal window, single glazing	8.08	North Block - West wall
	Timber frame, single glaze	2.97	Central Block - East wall
	Timber frame, single glaze	2.9	Central Block - West wall
	N/A	N/A	South Block - East wall
	Metal window, single glazing	21.2	South Block - South wall
	Metal window, single glazing	2.73	South Block - West wall
	Unknown glazing	4.79	Admissions Building on East side
Total		**60.61**	
	Wooden frame, metal window, single glaze	7.9	
	Metal window, single glazing	42.05	
	Timber frame, single glaze	11.05	
	Unknown glazing	4.79	

North Elevation

East Elevation


South Elevation

West Elevation

Doors	Wooden frame, metal door single glaze	1.84	North Block - North wall
	N/A	N/A	North Block - East wall
	Unknown frame, unknown glazing	2.82	North Block - West wall
	Unknown frame, unknown glazing	9.95	Central Block - East wall
	Unknown frame, unknown glazing	1.73	Central Block - West wall
	Unknown frame, unknown glazing	1.78	South Block - East wall
	Unknown frame, unknown glazing	6.18	South Block - South wall
	N/A	N/A	South Block - West wall
	Unknown frame, unknown glazing	1.94	Admissions Building on East side
Total		**26.04**	
	Wooden frame, metal door single glaze	1.84	
	Unknown frame, unknown glazing	24.4	

1. LETI is a network of more than 1,000 built environment professionals, working together to put the UK on the path to a zero carbon future. The voluntary group is made up of developers, engineers, housing associations, architects, planners, academics, sustainability professionals, contractors and facilities managers. **www.leti.uk**

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