ENVIRONMENTAL QUALITY - THE NEW AGENDA

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1 Introduction

Environmental quality involves meeting needs of businesses, users and occupiers in ways which do not compromise wider social and environmental agendas. However, the commercial property market still seems to care mainly about short-term investment value, and give relatively little thought to medium- and long-term performance for occupants and the environment. Nowadays the challenge is to resolve all three: value for investors, users and the environment alike. At first sight these attributes appear to be in conflict, but there is increasing evidence that they can go together. However, this is not automatic: it has to be made to happen.

The Probe studies [1] point to strategies for buildings which can help to improve occupant comfort and productivity [2]. Successful strategies tend to be either simple and largely self-managing or more complex, with high levels of management, as at Tanfield House [3]. Some buildings – but only a very small percentage of the UK stock - go further and combine good occupant satisfaction and energy performance, as at the Elizabeth Fry Building [4]. As here, the factors for success are often clear objectives and good management of both the procurement process and the completed building. Even rarer, but now increasingly necessary, is the “triple whammy” - buildings that have good user comfort, energy efficiency and high investment value.

This paper uses energy in buildings as an illustration of how environmental issues may affect facilities management, and identifies some tools which might be useful in keeping ahead of the game. At last year’s BIFM conference, energy was reportedly bottom of the list of hot topics and environment only two places higher. One year later, there has been continued growth in the political and technical importance of environmental issues, and greater scientific agreement that man-made global warming is happening. Certainly something funny is going on: the global average temperature for every single month so far this year has been the hottest ever recorded.

2 The national scene

Buildings are responsible for about half the energy use and carbon dioxide emissions in the UK. In the 1990s, the UK has been one of the very few nations to meet its commitment to stabilise carbon dioxide emissions. However, this has been almost entirely due to the unintended consequence of the privatisation of the electricity industry - the “dash for gas” - offsetting growth elsewhere. We are unlikely to have such a fairy godmother next time – and the government has a manifesto aim to reduce CO_2 emissions by 20% by 2010!

Of the three main consumers of energy - buildings, transport and industry - the axe is likely to fall hardest on buildings. The task is huge: for example if building designers were asked to bear the burden, one way to meet the target would be for every new building to use no energy at all, and every refurbishment to make reductions of 40%. Pretty unrealistic, so equipment, usage, management and energy supply will all have to come under the microscope.

Possible economic instruments include:

- Carbon taxes on fuels. However, energy consumption is not very price sensitive, except for low-income families, where political sensitivity is high - viz. the reaction to VAT on domestic fuel. To carry its true environmental costs, fossil energy would have to cost perhaps five times as much as it is now. In practice, anything more than a few percent per year is likely to be economically, socially and politically unacceptable; the price hikes in the 1970s also had major inflationary effects.
- Tradeable emissions permits. These are attractive [5], because potentially they allow the market to decide where it is most efficient to invest. They have worked well in the USA to tackle sulphur dioxide emissions from major industries, but application is less certain as diffuse a market as buildings.
- Supply contracts in which unit costs increase with consumption. This causes howls of anguish from major industrial consumers, struggling within a competitive international market.

3 Building regulations

Another approach is regulation. Bringing air conditioning within the scope of the building regulations has been under discussion for several years, starting with rather crude attempts to ban it and evolving into a somewhat convoluted method to benchmark a design’s overall efficiency [6]. A review of energy-related building regulations is now under way, exploring options for improving new construction and narrowing the gap between theoretical and as-built performance. Unused powers may also be activated to require improvements to the existing building stock, and the efficiency with which buildings are operated.

In recent consultative seminars [7], it was widely felt that more emphasis should be placed on:

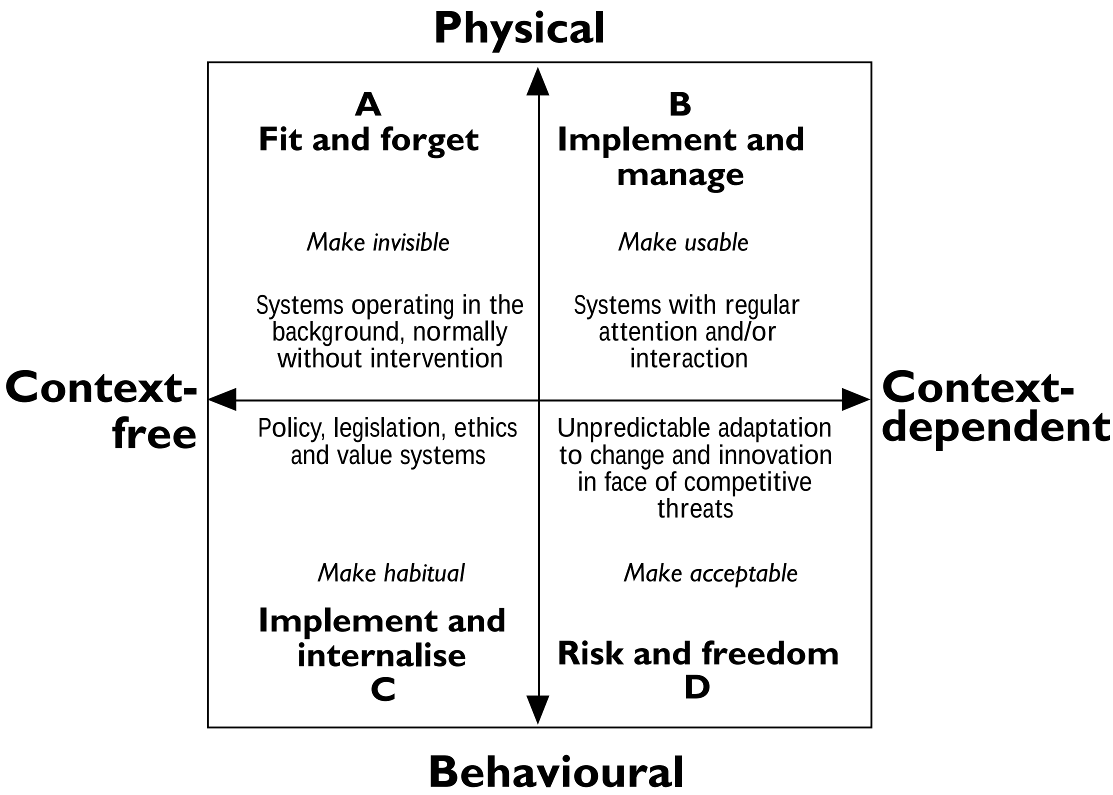
- Rapid adoption of much higher energy performance standards.
- Including energy aspects in planning applications.
- Including performance testing.
- Seeking much higher levels of operational efficiency.
- Requiring improved energy performance whenever alterations or fitouts are undertaken
- Undertaking “building MoTs”, (the MoT is the UK’s statutory annual “Ministry of Transport” test for cars) of the performance of fabric, plant, systems and controls, and identifying opportunities for improvement.
- Requiring occupiers to manage systems effectively (perhaps with certificates of competence), to achieve energy target levels, and to maintain logbooks.

MoT checks might be carried out initially on new construction and alterations, and at “property transactions”, e.g. when a property was purchased or rented, or at rent reviews. They would then develop into a more routine procedure, undertaken at regular intervals. To avoid shades of the “energy police”, self-certification would be possible, with random checks from time to time. Statutory reporting of energy performance in company annual returns was also mentioned, and has also been suggested by ACBE - the Advisory Committee for Buildings and the Environment. Many of these issues will affect the practice of facilities management.

4 Fit and forget?

The task ahead - the new agenda of the title - is the triple whammy, giving new and refurbished buildings value in richer and more profound ways than at present. How is this to be done? Figure 1 is a diagram which we have found useful in discussing what goes where. The vertical axis (physical-behavioural) and the horizontal (context-free/context-dependent) divide it into four quadrants.

FIGURE 1: A STRATEGIC DIAGRAM



QUADRANT 1 – "FIT AND FORGET"
This means making sure that things which are designed to work "invisibly" in the background actually do. Supposedly fit and forget features - like air-conditioning - often impose extra and unwanted management burdens on occupiers because they are not fit and forget at all (Quadrant 3)!

QUADRANT 2 – IMPLEMENT AND INTERNALISE
This means making sure that rules and regulations - formal or informal - are useful, properly understood and acted on smoothly at the right time. This is easiest when they match normal procedures, habits and behaviours. Otherwise special training will be required: but will this happen; how often will people need to be reminded; and will the rewards be in proportion to the effort?

QUADRANT 3 – FIT AND MANAGE
This is where the FM belongs: looking after systems which can't either look after themselves or be taken care of the occupants. Are the management tasks in proportion to the rewards, or time-consuming burdens?

QUADRANT 4 – RISK AND FREEDOM
Tidy people like to predict everything – but that is impossible. A context which is too carefully prescribed tends to mean that change will not be accommodated and innovation will be stifled - hence the common plea for flexibility in the face of uncertainty

5 Applying the thinking

Within these complex dynamics one needs to consider:
- What makes good "fit and forget"?
- What can individual occupants be expected to do?
- How much management is needed in a particular context?
- How much freedom and flexibility is possible, given the attendant risks?

These issues will be developed below, with particular emphasis on energy efficiency.

6 Energy benchmarking

In spite of technical advances, progress over the past twenty years in improving the energy efficiency of commercial and public buildings has been slow. Government programmes' stress on financial payback also backfired when competition in the supply industry made energy cost savings much easier to achieve by fuel purchasing than by technical and management measures.

Studies such as Probe indicate that achieving buildings with good all-round technical performance, occupant satisfaction and energy efficiency is less certain than it should, or could be. Problems occur throughout the chain:

- Briefs – for new buildings, for fitouts, and in building selection - often pay scant attention to energy efficiency.
- The need for better-integrated design is well recognised, but it takes time to develop the skills to do it effectively.
- Innovative HVAC systems may not work well in leaky buildings, but we are not yet good at designing or building for airtightness.
- Assumptions on control and operational strategies may work well on the computer, but often do not suit - or are not tailored to suit - occupants and management.
- Savings-driven energy management has often given way to service-driven FM. Energy monitoring is usually absent (metering is often poor too, and meters unread).

Good organisations in good buildings with good, responsive FM can square the circle by delivering both happy and productive occupants and low energy consumption. However, most find it easiest to let systems rip.

Clearly, we need to do much better - in existing buildings, in new buildings, and in alterations, refurbishments and fit-outs - if we are to begin to realise the potential for making major reductions in greenhouse gas emissions. Designers can only do so much: all players will need to find better ways of working together to create virtuous circles of continuous improvement. We outline below how clear, simple and effective ways of describing energy performance could assist better understanding and more rapid and effective action.

7 Setting and reviewing energy targets

Design targets are often set at the whole-building level (e.g: in kWh/m^2 per year or kg CO2/m^2 per year) in order to give designers freedom in the route they choose to meet them. In practice, however, this approach has been of limited effectiveness in delivering energy-efficient buildings, because designers may not address each constituent of energy consumption, and occupiers cannot tell whether or not the targets are being met until they have been in the building for several years. As outlined by Grigg and Welsh [10], there can be problems with definitions, so like is seldom compared with like.

In addition, targets are often set and buildings compared in terms of total delivered energy. This can be worse than useless, as it assigns equal weight to consumption of fuels which have very different levels of cost and environmental impact. The safest thing is to keep separate the annual consumption of each different fuel (and especially electricity and fossil fuels) at least until the final evaluation process [11]. This also permits quoted figures to be re-assessed using different assumptions.

Whole-building targets can also obscure meaning and inhibit decision. In particular:

- the assumptions used in modelling sometimes bear little relationship to the actual design of the services and the performance of the building in use; but
- this may not be clear to the client, or indeed to the design team; and
- they tend to be very blunt instruments, when fighting the inevitable battles which occur on most projects (e.g: between cost, appearance and energy performance); and hence
- they are also of little direct help in the quest for continuous improvement.

In addition:
- the numbers are not readily accessible to, or understandable by, clients and occupiers;
- they cannot be verified until long after the building has been occupied; and then
- if inconsistencies are revealed it is not easy to relate them to the design assumptions and to feed them back to clients, designers, and modellers.

In short, they provide few opportunities for control and management.

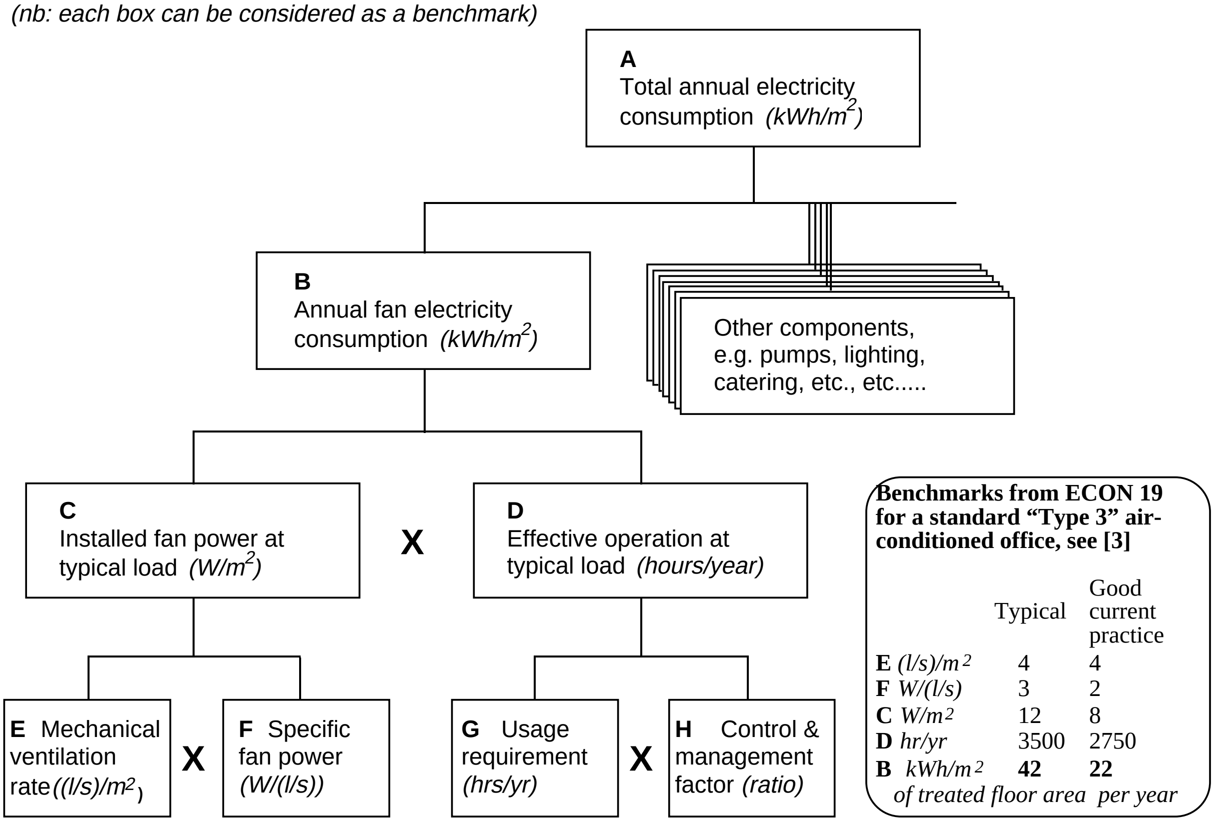
Buildings which claim to be energy efficient often have Achilles' Heels in which some aspect of the design fails a simple test. For example:
- An environmental award-winning office in which the installed lighting load was 26 W/m^2 (an everyday good practice standard would be 12 W/m^2 [12]). Here the lighting designer had taken pride in developing a system to meet the aesthetic requirements of the architect within the available budget, but performance had been sacrificed in the process, perhaps unknowingly. Clearly a design target for lighting efficiency had not been set.
- A low-energy building designed with continuous background mechanical ventilation, in which the specific fan power was 3.5 W/l.s. The design expectation had been lower (an everyday good practice standard would be 2 W/l.s [12], with 1 W/l.s as a truly electrically-efficient design). Since this had not been specified, the contractor was able to cut costs by installing a smaller and less efficient AHU with a bigger fan motor.

8 How might we rate buildings more effectively?

In Reference [10], Grigg and Welsh describe how annual energy use can be built up (and broken down) using "tree diagrams" - as described in [11] - and how these can be used in relating the energy statistics for a particular building to national reference data.

Such tree diagrams could have much wider potential as the basis of a simple but widely-usable common language for discussing and taking decisions about building energy use at all stages of a project. They could be used in briefing, design targets, design, modelling, regulation, specification, acceptance, evaluation, facilities management, and research. They could improve the clarity of expression of a wide range of issues and assumptions affecting the energy use of a building and foster a climate of better understanding and continuous improvement. How so? Figure 2 shows an example, for fans.

FIGURE 2
TREE DIAGRAM, WITH DETAILS OF FAN ENERGY CONSUMPTION AND SERVICE PROVISION
(nb: each box can be considered as a benchmark)



At the top of the tree, **Box A** is the total annual electricity consumption index for the building, of which the fan energy consumption (**Box B**) is one component. The figures could be expressed:
- for the building as a whole (i.e. total fan power, total treated floor area; and average levels of service,

efficiency and operation); which might suit regulatory purposes; or

- for specific systems - for example office ventilation - which would be important in briefing, design and technical evaluation.

At the next level down, this is made up of the product of:
Box C the installed fan power (in W/m^2); and
Box D its equivalent full-load operating hours per year.
Again these figures provide useful benchmarks by which systems can be evaluated.

At the bottom level, the fan power is the product of:
Box E the ventilation standard (here expressed in l/s per m^2); and
Box F the specific fan power (in W/(l.s) for supply and extract combined [5].
Once more, these present opportunities for benchmarking.

Meanwhile, the hours of use are the product of:
Box G the hours of requirement for the service; and
Box H a control and management factor: this might be less than 1 (for example, if the ventilation plant was variable volume or demand-activated); or greater than 1 (if the system had to run out-of-hours, for example to help preheat the building).
Yet again, these offer more simple benchmarks which can be used to characterise the use of a system at any level, from initial targets and rules of thumb to summarising the results of detailed modelling and monitoring.

Tree diagram benchmarks can facilitate dialogue at many levels: between client and design team; within the design team itself; in specification and site quality control; in assessing buildings (or designs) prior to occupancy; in regulation; in facilities management; and in research. Marketing people have tended to say that such arrays of numbers are too complicated for clients and occupiers, what they need is a single index. However, in recent discussions our experience has been just the opposite, for example:

- DEVELOPER: At last I understand what this is all about; and how I can obtain better briefs and review how the design is going.
- FACILITIES MANAGER: Now I see how we can evaluate a design and check likely energy performance before we occupy the building. Usually we only find this out a year or two afterwards, when it is too late.......

9 Possible future developments

As outlined in reference[10], approaches and benchmarks based on tree diagrams have been developed by and for BRE and DETR; taking account of similar developments elsewhere. Until recently, applications had been largely for internal and development purposes, and to help underpin proposed regulatory procedures. Published outputs are now becoming more widely available, most recently the 1998 revision of Energy Consumption Guide 19 (ECON 19, [12]) for offices, which has explicit illustrations for lighting, office equipment, and fans (see box in figure 1).

Related to the strategic diagram, figure 1:

- Fit and Forget. The brief and the design should take care of the standard required (E) and the efficiency with which it is met (F). These should be capable of review at any time by the FM.

- Implement and Manage. The FM should be able to determine the usage requirement for the systems (G). The control and management factor (H) is more difficult, because it depends on the power of the control systems provided and the degree to which energy-consuming systems can respond efficiently to different patterns of use. Frequently they will default to substantially ON, even when demands upon the systems are small. How can this problem be minimised?

- Implement and internalise. Often designers envisage that users will adapt their behaviour to suit the building. This is unlikely. Things work best where what people have to do is made easy and intuitively obvious [13]. FMs should seek to undertake usability audits of design proposals to see if they are really sensible, “walking through” the buildings and its systems with the designers and asking “how would I use that”.

- Risk and freedom. Often unexpected requirements upset the apple cart as far as energy performance is concerned. For example, a natural lighting strategy may be completely undermined if windows are reflected in computer terminals. But a very common workstation layout today has screens set at 45° to the window wall. Is the design robust, where are its weaknesses, and how can the process of procurement and occupation be managed to avoid such unintended consequences?

Problems with a solely "fit and forget" attitude have also been recognised in the BRE environmental assessment method – BREEAM. To date its greatest impact has been on offices at the design stage [14]. However, this tends to have been seen as a hurdle to jump or an aid to marketing, and has seldom been carried through into the assessment, use and management of the completed building. BREEAM for existing offices [15] has had much less impact. The new BREEAM, coincidentally to be launched on 23 September 1998 – the day we are giving this paper – aims to establish an assessment methodology which will be valid throughout the life of the building, and take account of the management of the procurement process and of the completed building. It aims to be complementary to environmental management systems already being adopted by business, including EMAS and ISO 14001.

10 Conclusions

The new agenda will be to achieve the "triple whammy" without it all being too difficult. This will require good strategies and excellent tactics, keeping things simple but doing them well – with as much genuine "fit and forget" as possible. It will need to be much more aware of the consequences of briefing, design and tactical decisions for occupants and management, and be alert to critical details and to the potential for things to go wrong. It must encourage the processes of procurement, selection, occupation, and ongoing use and management of buildings to be constantly seeking opportunities for continuous improvement. It must provide simple but effective tools to help make this happen; and benchmarks against which to review results and to target further action.

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Please also see our Website (link live on PDF file) http://www.usablebuildings.co.uk

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