Oxford Brookes University
28 October 2020

INSIGHTS FROM BUILDING PERFORMANCE EVALUATION STUDIES

Bill Bordass

USABLE BUILDINGS
www.usablebuildings.co.uk

Insights from Building Performance Evaluation
OUTLINE

PART 1
Introduction and background

BREAK

PART 2
Some findings and their implications

BREAK

PART 3
A possible future

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PART 1
Introduction and Background

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Building performance in use is in the public interest

- Buildings last a long time, well beyond the time horizons of their creators, with many players involved in different roles.
- As building users, the whole population has an interest in them working better in every respect.

- **Now we want to improve the performance of the new, and particularly the existing stock,** *especially (but by no means only) in terms of energy and carbon.* ***BUT …***
- the feedback loop from performance in use to construction and policymaking is poorly closed, *a disastrous oversight.*

SO DO WE UNDERSTAND WHAT WE ARE DOING?

BPE TO THE RESCUE ?

Why aren't designers and builders better tuned in to outcomes?

- Not what clients or government have asked them to do: *"hand over and walk away" is systemically embedded in standard procedures and contracts, so follow-through is not part of the standard offering*.
- Clients and government haven't set aside time and money for tuning-up after handover, *and have often preferred to bury any bad news.*
- The industry and the associated professions didn't fill the vacuum created while central and local government progressively outsourced its technical expertise, research and performance feedback work.
- The policy emphasis has been on construction, not performance in use, *even when feedback information has been revealing problems.*
- Rigid divisions between funding of capital and operational costs – *getting worse if anything, in spite of all the talk.*
- "Post-Occupancy Evaluation" (POE) is a construction industry perspective, with handover the end, not the beginning! *Too often seen as academic and mostly about perceptions.* Hence BPE.

Academics and policymakers often ignore Case Studies, *saying they are anecdotal:* ***THEY ARE NOT!***

FIVE MISUNDERSTANDINGS *(after Flyvbjerg)*

1. *General knowledge is better than context-specific knowledge.*
   NO: *They complement each other.*
2. *You can't begin to generalise from a single case.*
   NO: *Individual cases and outliers can be bellwethers.*
3. *They might help you make hypotheses, but other methods are better for hypothesis-testing and theory-building.*
   NO: *They can also test hypotheses, using multiple methods.*
4. *They have a bias to confirming the investigator's bias.*
   NO: *They often provide new and richer insights,*
   BUT *they need to be done with a degree of independence.*
5. *They do not let one develop general propositions and theories.*
   BUT: *They help us develop coherent strategies for the future.*

Why do people ignore advance warning signals - the dead canary in the coal mine? **SEEKING MORE DATA IS OFTEN A DELAYING TACTIC.**

REFERENCE: B Flyvbjerg, *Five misunderstandings about case study research,* Qualitative Enquiry ***12***, 219-245 (2006),

What put us on the track (1989)?


December 1989

BEST PRACTICE PROGRAMME

Good Practice Case Study 1

Low cost major refurbishment
Policy Studies Institute
100 Park Village East, London NW1

- New atrium avoids the need for air-conditioning.
- New, smaller double-glazed windows improve thermal performance.
- Good daylight gives low lighting costs.
- Air quality sensors regulate fresh air intake.
- Solar energy collection from atrium exhaust air.

The Project

The Policy Studies Institute (PSI) is an independent policy research organisation concerned with economic and social studies and the workings of political institutions. Their research work benefits from a cellular office environment, with extensive support facilities including a conference suite which is regularly rented-out.

A 5-storey office building in poor condition, was purchased for low-cost conversion into the necessary office accommodation, with library, conference, meeting rooms and kitchen. The building (originally a 1920's factory) has an unusual triangular floor plan.

PSI and their landlords — the Joseph Rowntree Memorial Trust — wanted the project to be as energy efficient as a limited budget would allow. The major design problem was to reconcile the large number of cellular offices needed with the windowless space in the centre of the building, whilst avoiding expensive air conditioning.

The Result

A small atrium was pierced through the top three floors to give a focus to the scheme, bring light and air to the centre of the building, expand the perimeter for cellular offices, avoid the need for air-conditioning, and collect solar heat.

The design solution allowed many of the rooms to be naturally-ventilated, with mechanical ventilation to the atrium and surrounding offices only, and to conference and meeting rooms on the ground floor. Most of the windows were replaced or upgraded with double-glazed units. Roof insulation was improved, but retrofit wall insulation was not economic. The boilers were overhauled.

The resulting building enjoys a moderate energy use of 193 kWh/m^2 of heated floor area, with particularly low electrical and lighting costs. Heating energy use predominates (85% of energy consumption and 55% of energy cost). It could have been significantly lower had the old boilers been replaced with modern high-efficiency equipment.

ENERGY EFFICIENCY IN OFFICES

Energy Efficiency Office
DEPARTMENT OF ENERGY

CI/SfB 1976 32 R3 W8 Y7

1998: Energy Efficiency Best Practice programme replaced the Energy Efficiency Demonstration Scheme, *where results had been disappointing.*

Case Study 1 performed well in terms of its energy use, particularly electricity.

It had also been studied as part of the Building Use Studies (BUS) *Office Environment Survey* of occupant satisfaction in 50 buildings, where it also performed unusually well.

Was there a link?
We sought opportunities to combine occupant and energy surveys.

SOURCE: Energy Efficiency Best Practice Programme, Case Study 1, *Policy Studies Institute* (December 1989)

What put us on the track (1991)?

May 1991

BEST PRACTICE PROGRAMME

Good Practice Case Study 21

ENERGY EFFICIENCY IN OFFICES

One Bridewell Street, Bristol

A new high quality air conditioned office with low energy costs

- **Low fan energy consumption for an air conditioned office.**
- **High frequency lighting with effective central and local control.**
- **Naturally lit corner atrium.**
- **Effective energy management aided by electronic BEMS.**

The Project

One Bridewell Street, in the centre of Bristol, was developed by MEPC to be the accountants Arthur Young's South-West regional office.

The building was to have a contemporary, high profile image. Developer's and occupier's requirements, although not specific about energy efficiency, included high quality and low running costs.

The brief also required flexibility in occupancy and operation, both to support increasing densities of desk-top information systems, and to permit any parts of the building not required by Arthur Young to be sub-let.

The six-storey building, completed in 1987, includes a full height corner atrium facing south-east and a small 2-storey wing accessible both from the main offices and separately.

Arthur Young initially occupied the first and second floors, with tenants on the top three floors. Their merger with Ernst & Whinney in October 1989 confirmed the flexibility of the building, with their occupancy first increasing from 115 to 165 and subsequently expanding onto part of the third and all the fourth floor.

The shared ground floor contains car parking, minicomputer room, storage and maintenance areas, and a small gym/fitness facility.

The Result

The building provides a high quality of environment, flexibility of operation and an attractive and bright appearance. It has been commended by the RIBA and was joint runner-up for the Institute of Administrative Management's (IAM) Office of the Year Award 1989.

The atrium provides an impressive entrance with reception at ground level and circulation on the floors above. Temperatures in the atrium are not tightly controlled and daylight is good, giving a possible nett benefit in energy terms — however this aspect has not been specifically monitored.

Air conditioning is conventional VAV, but well designed for low fan power and fully zoned with computerised BEMS controls to allow a close match to the varying needs of the occupants. Similarly, lighting is high efficiency under effective central and local control. Ernst & Young also manage the whole building very effectively, helping them to win the IAM Facilities Management Award 1989. The resulting good design and good management has led to unusually low energy costs for an office of this type, no greater than for many naturally ventilated offices.

At 139 kWh/m^2 of treated area, energy use is very low for an air conditioned building, approaching half of the CIBSE Energy Code part 4's "good" level.

Energy Efficiency Office
DEPARTMENT OF ENERGY

(Y2)
CI/Sfb 1976 331/(57) (R3)

This air-conditioned building had an energy performance similar to some of the good naturally-ventilated buildings.

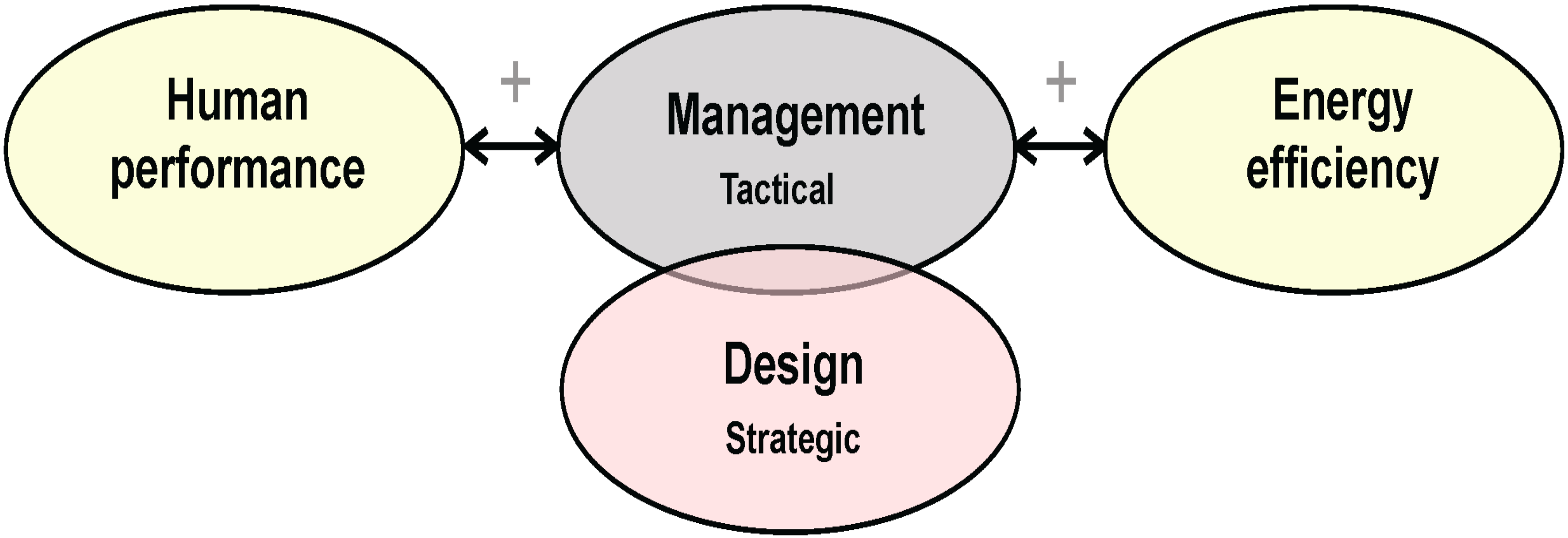
A building in London, with the same design team and a similar technical specification had three times the carbon footprint from annual energy use.

What was going on?
We sought opportunities to do a deeper investigation, including an occupant survey by Building Use Studies.

SOURCE: Energy Efficiency Best Practice Programme, Case Study 21. *One Bridewell Street* (May1991)

Where good things happened …

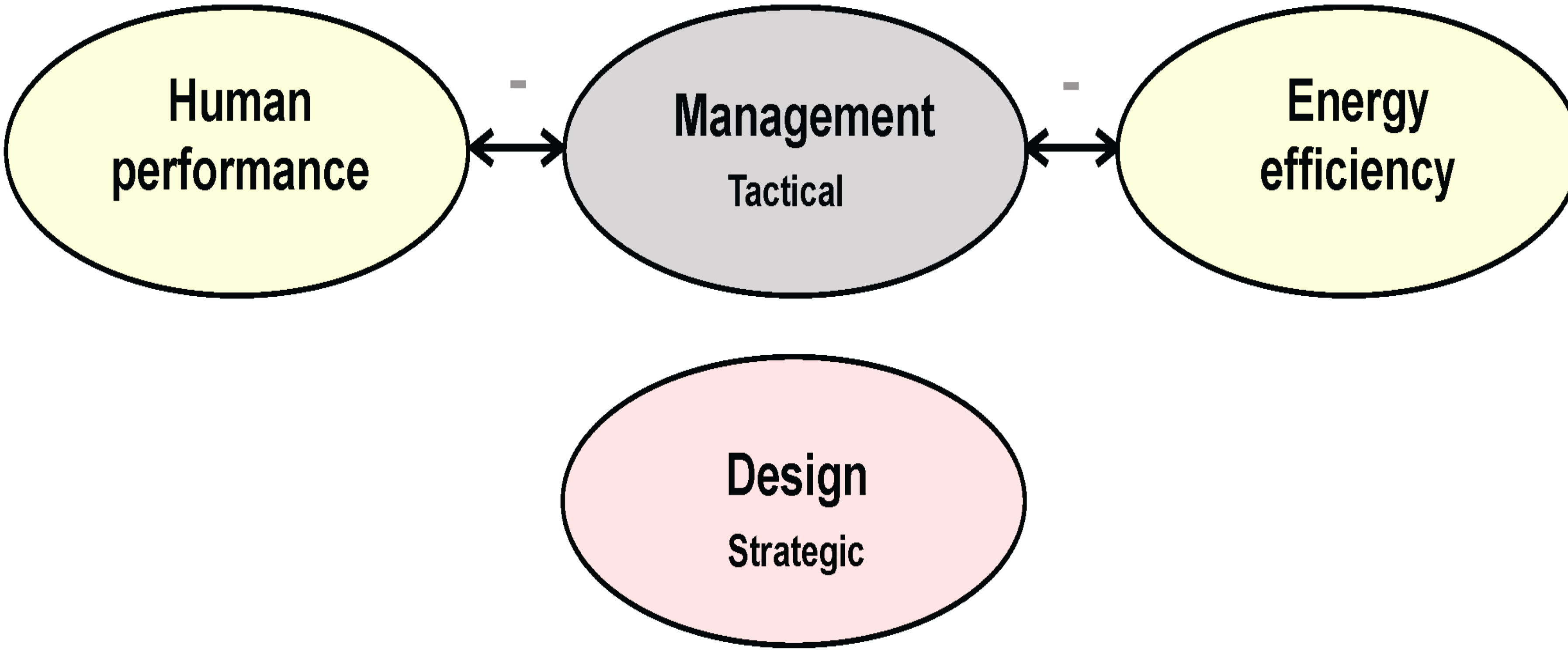
associations of low energy with happy occupants



The better-performing buildings tended to be where there was a better understanding of user requirements during procurement, and better follow-through to good management in use.

One could usually name the individual or individuals responsible for championing the building in use and driving the virtuous circles.

… and where they didn't
no positive associations



Without this understanding and commitment - *linking design to use and management* – performance in use could be disappointing, in terms of energy and/or occupant satisfaction. *So we need to bring out the leaders.*

You can’t tell how good your building is
… *unless you find out how it is working*

Elizabeth Fry building has the last laugh

The story of the Elizabeth Fry building (AJ 23.4.98) contains a number of ironies. My favourite is that it didn’t even make the shortlist of the Green Building of the Year Award in 1996.
DR ROBERT LOWE
Leeds Metropolitan University

LETTER TO ARCHITECTS’ JOURNAL

The good performers don’t necessarily impress the judges

The original Elizabeth Fry Probe paper was published in *Building Services Journal,* 37-41 (April 1998).

It was the practice, not just the product

Factors for success at the Elizabeth Fry Building, UEA

But only the technical features were mentioned when a Royal Commission used it an exemplar

- A good client
- A good brief *incorporating the client's previous experience.*
- A good team *(worked together before on the site).*
- Specialist support *(especially on insulation and airtightness).*

- A good, robust design, efficiently serviced *(mostly).*
- Enough time and money *(but to a normal budget).*
- An appropriate specification *(and not too clever).*
- An interested contractor *(with a traditional contract).*

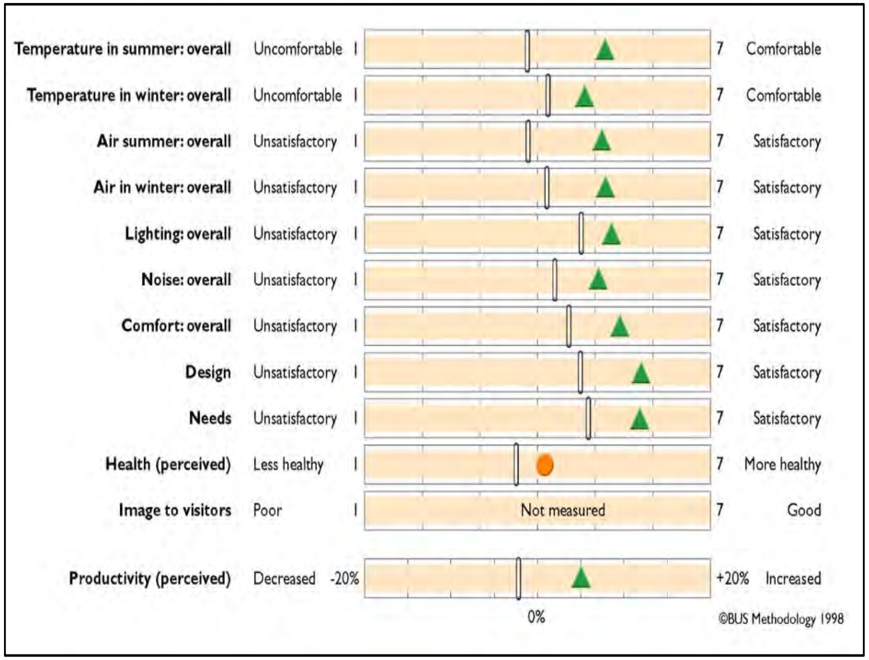
- Well-built *(attention to detail, but still room for improvement).*
- Well controlled *(but only eventually, after monitoring and refit).*
- Post-handover support *(triggered by independent monitoring).*
- Management vigilance *but has it been sustained?*

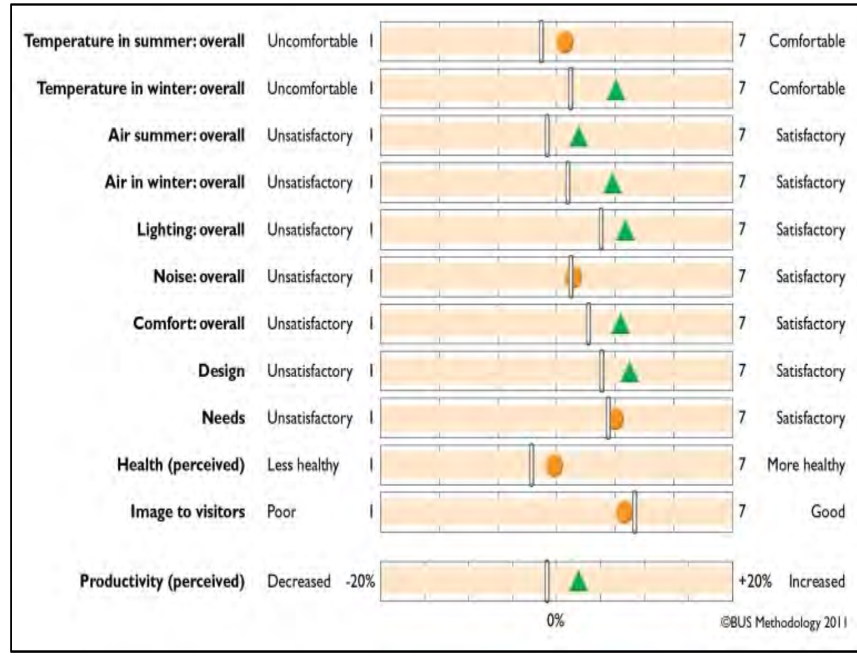
SOURCE: W Bordass et al, *Assessing building performance in use 5*, BR&I **29** (2), 144-157 (March-April 2001), Figure 6.

E Fry Revisit – *Pressure test Sept 2011*

Elizabeth Fry Revisit – *BUS Occupant Survey*

1998 *2011*





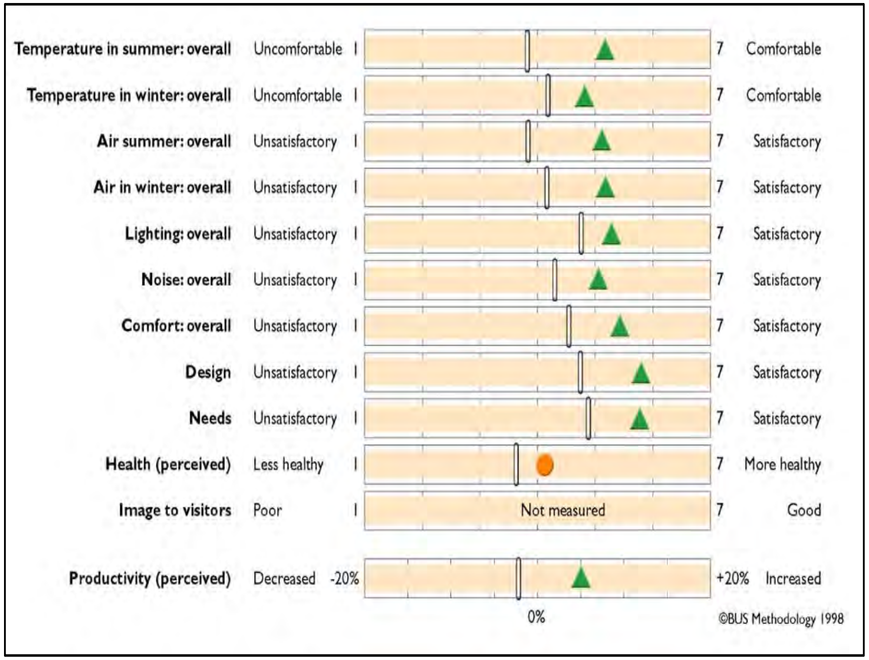
Average scores from BUS occupant survey questionnaire:
Vertical bars = benchmark medians from similar buildings.
Green triangles = significantly better than benchmark.
Orange circles = indistinguishable from benchmark, Red squares = worse

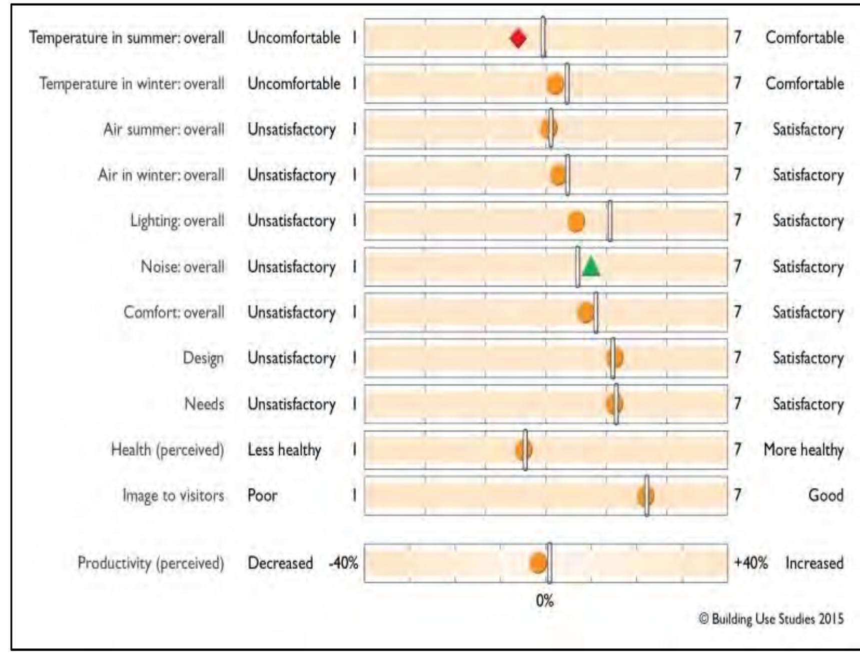
Some degradation over the years, but recognisably similar

SOURCE: W Bordass and A Leaman, *The Elizabeth Fry Building revisited,* Building Services Journal, 30-36, (March 2012).

Elizabeth Fry Revisit – *BUS Occupant Survey*

1998 *2015*



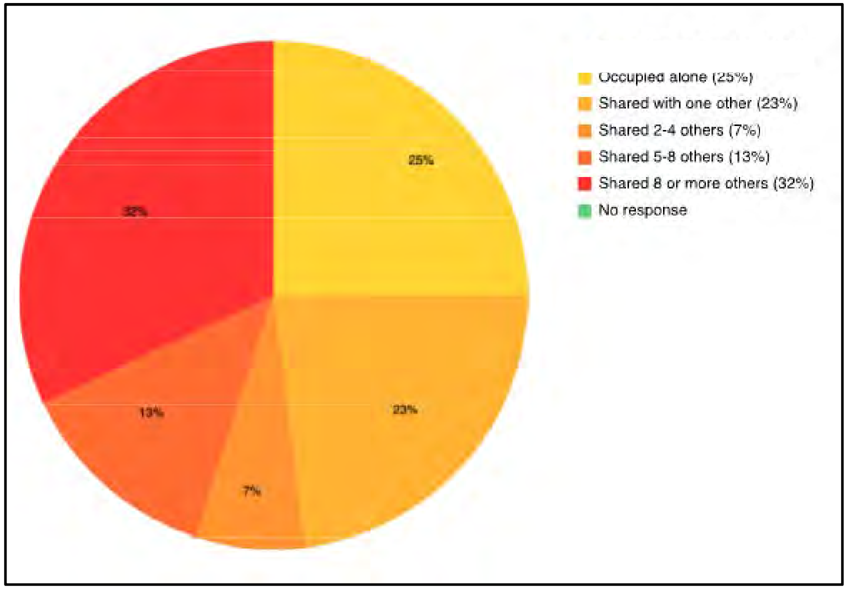


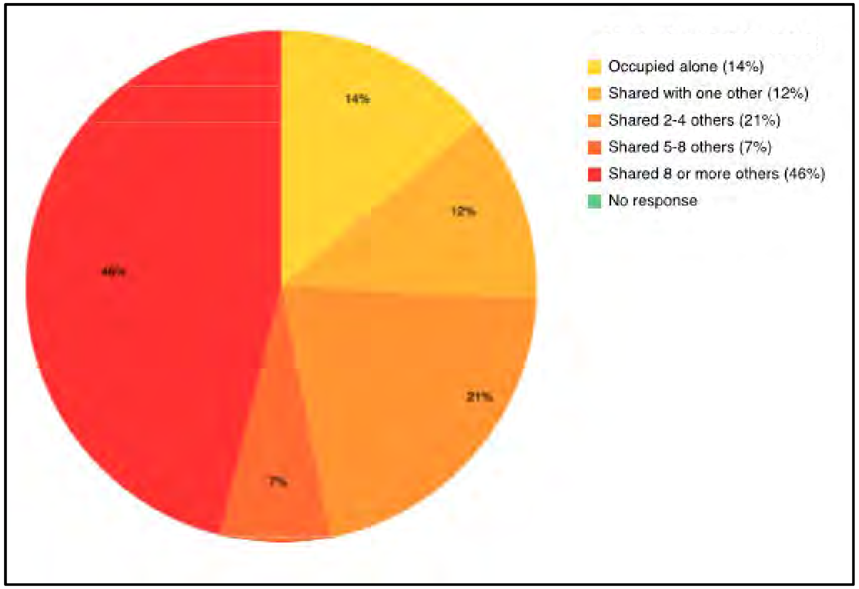
Average scores from BUS occupant survey questionnaire:
Vertical bars = benchmark medians from similar buildings.
Green triangle = significantly better than benchmark.
Orange circle = indistinguishable from benchmark, Red diamond = worse.

Now very much average – WHAT WENT WRONG?

SOURCE: R Bunn and L Marjanovich, *Occupant satisfaction signatures: Longitudinal studies,* CIBSE Symposium (April 2016).

BUS occupant questionnaire responses on room size at Elizabeth Fry: 2011 and 2015





Fewer people in individual or twin offices: *Down from 48% to 26%.*
More people in offices with 3-8 people: *Up from 20% to 28%.*
More people in large shared spaces (8 or more): *Up from 32% to 46%.*

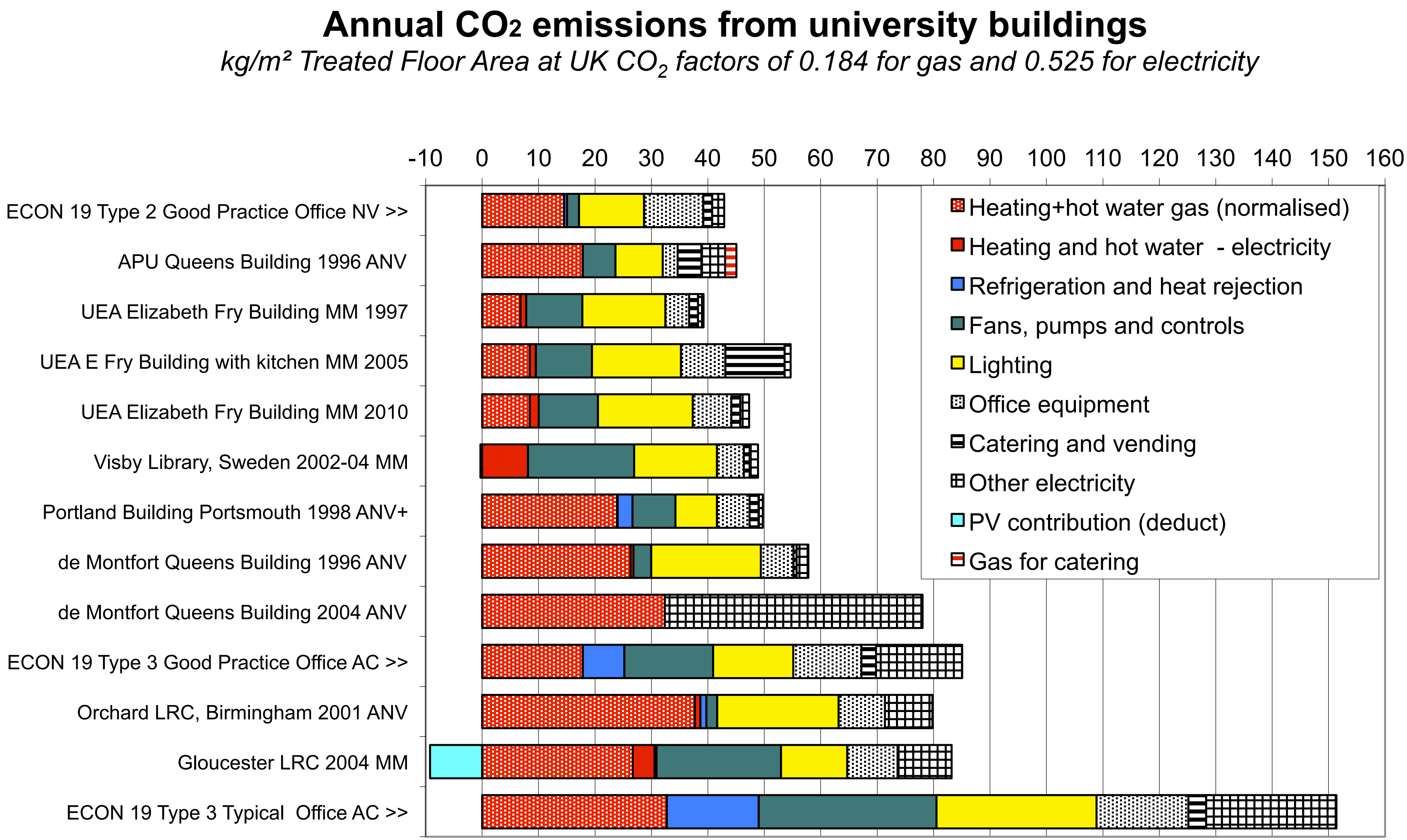
Managers and architects tend to like open-plan spaces – *but there is much more that can go wrong. COVID of course makes this worse.*

SOURCE: R Bunn and L Marjanovich, *Occupant satisfaction signatures: Longitudinal studies,* CIBSE Symposium (April 2016).

Here is one of the converted spaces

Increased occupant density: heat, noise, interruptions, etc., etc..
Loss of thermal mass of partitions and ceiling.
Trickle-charge cooling system with no local control can barely cope.
Contractor design. Less oversight by Estates or professionals.

E Fry Revisit – Energy Performance



RIBA proposed a feedback stage 55 years ago in its **Plan of Work (1963) STAGE M**

PURPOSE

To analyse the management, construction and performance of the project.

TASKS TO BE DONE

Analysis of job records.
Inspections of completed building.
Studies of building in use.

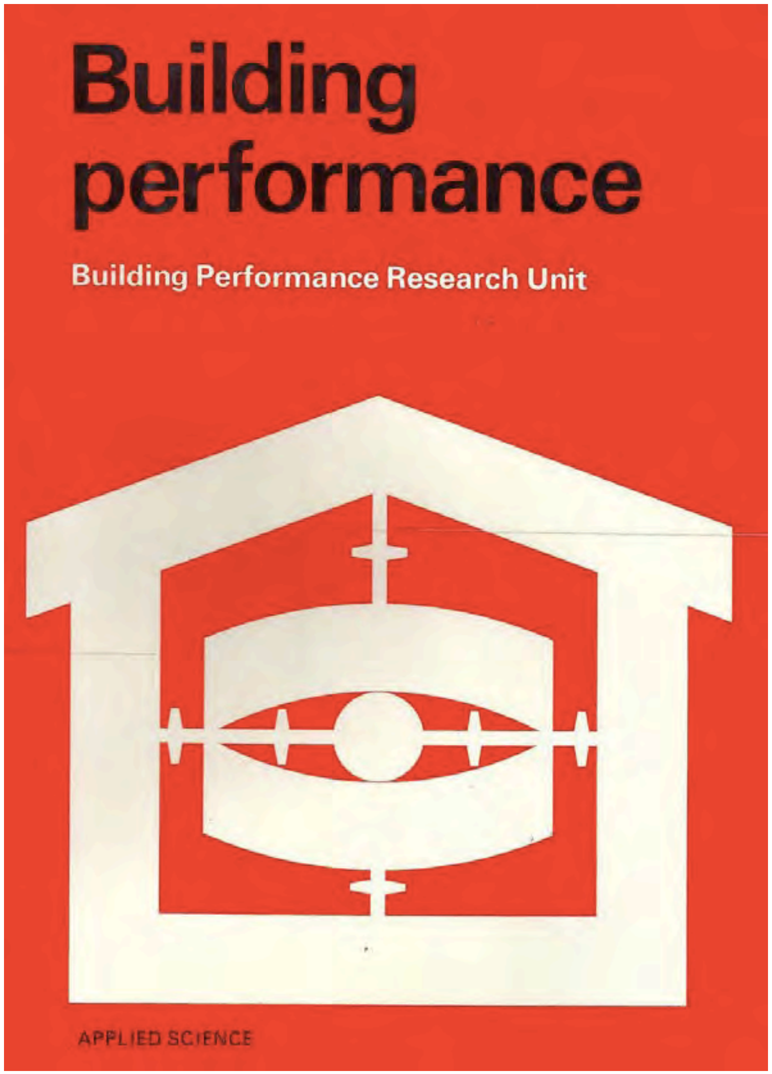
PEOPLE DIRECTLY INVOLVED

Architect, engineers, QS, contractor, client.

SO WHY ISN'T BPE ROUTINE?

SOURCE: Bruce Flye, 2012, www.bruceflye.com/concept-graphics/illustrations/4092610

Building performance evaluation started in some universities in the 1960s



Pioneers included the University of California, Berkeley and the Building Performance Research Unit at Strathclyde (BPRU).

However, after BPRU's seminal book in 1972, the subject failed to gather momentum, as it did not fit well with academic criteria, or get sustained client, government or industry support.

"*Unfortunately, interdisciplinary subjects have a way of escaping from any discipline whatever.*" … ERIC DREXLER

In 1972 the RIBA removed Stage M: Feedback from its publication *Architect's Appointment.*

REFERENCE: T Markus et al, *Building Performance,* Applied Science Publishers (1972)

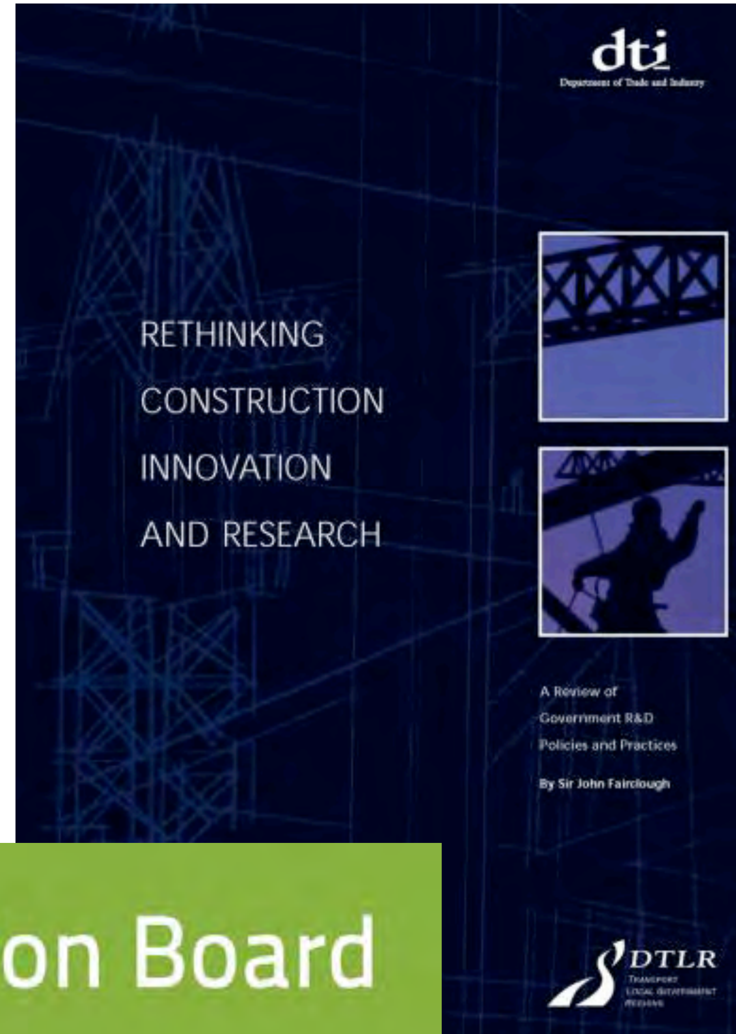
the tide also turned in government …

- Widespread disruption and disillusionment in the 1970s.
- Ascendancy of ideas about free markets, competition and choice; a *de facto* inefficient public sector, and *"no such thing as society".*
- Professionals began to be seen as an elitist conspiracy against the public, and treated by government as just another business.
- The Rothschild Report 1972, advocated a customer-contractor relationship for government-sponsored applied research …
  but what happened to its idea of an intelligent government customer?
- Outsourcing and privatisation of professional skills and in-house research from government, including Building Research Establishment.
- Dismemberment of the Department of the Environment 1997-2002.

WHERE IS THE INSTITUTIONAL MEMORY?

Nobody else (e.g. professional institutions), has helped enough to fill this gap and provide continuity, so policy is based more on hope, predictions, & lobbies, than experience of what works and what really needs attention.

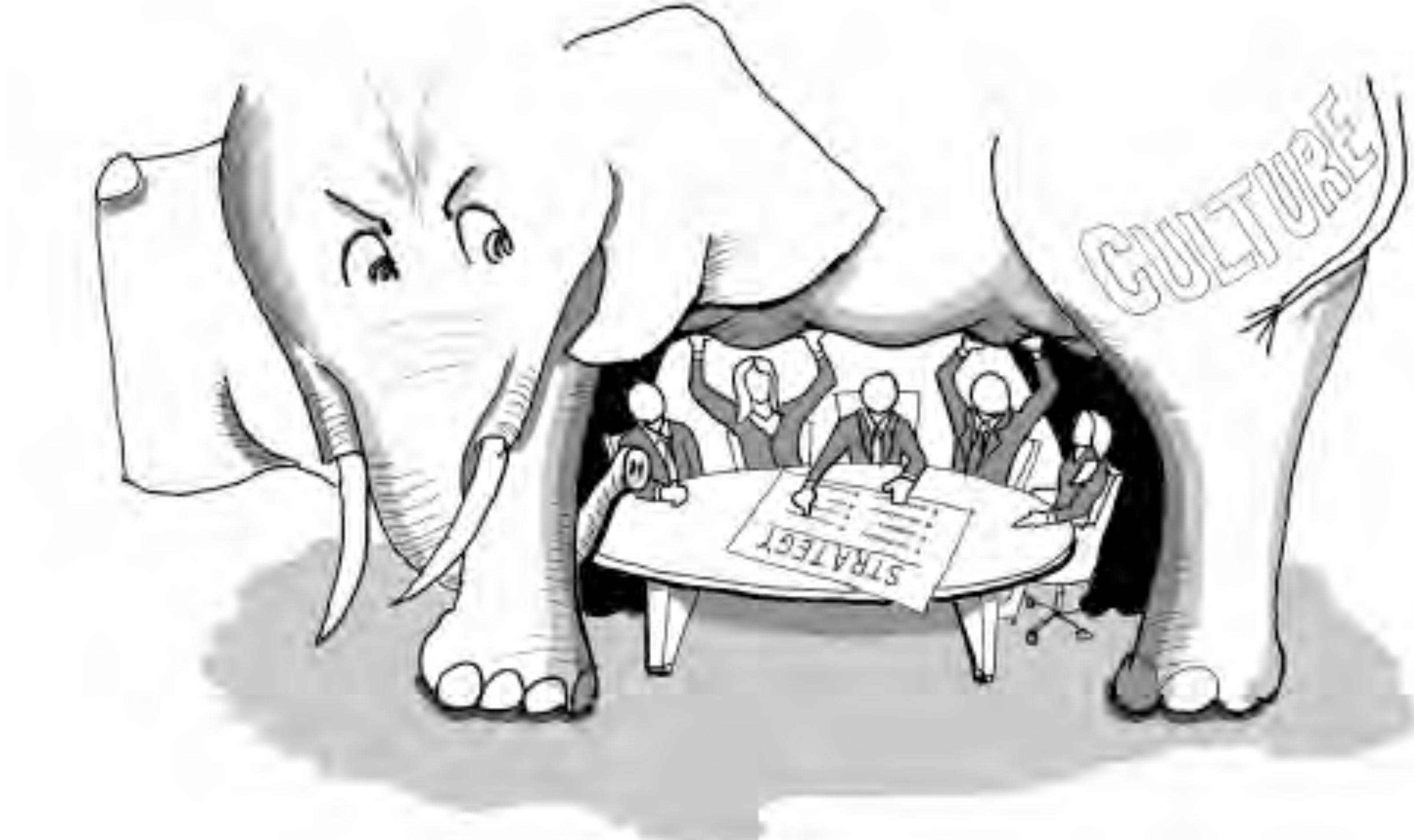
Buildings policy has also tended to focus on construction, *not performance in use …*



The Green Construction Board

REFERENCES: The Egan Report (DTI, 1998), the Fairclough Report (DTI and DTLR, 2002)

The elephant isn't in the room, *IT IS THE ROOM!*



WE HAVE A SYSTEMIC PROBLEM: Blindness to performance in use

It's not just the construction industry, it's the way we all go about things

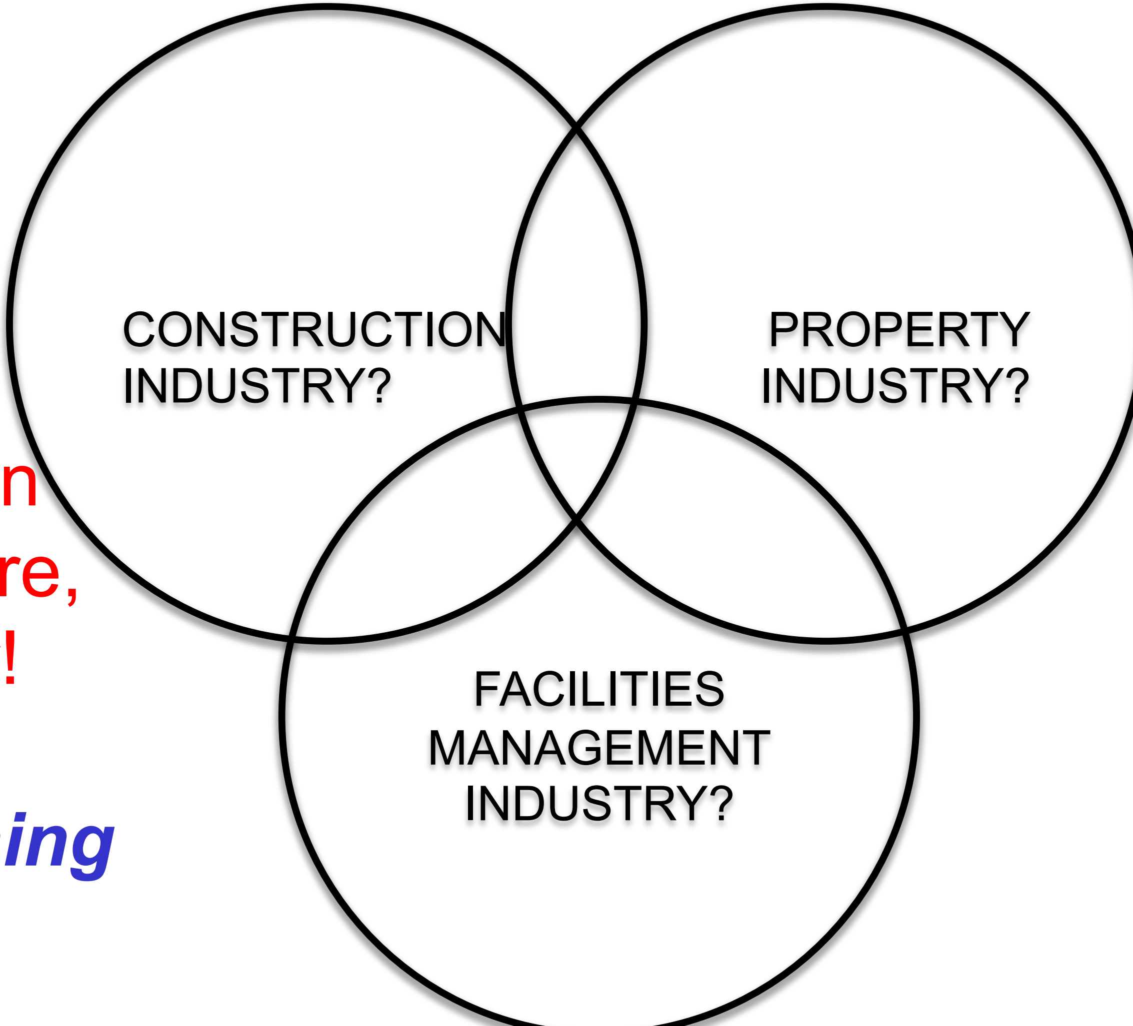
SOURCE: Bruce Flye, 2012, www.bruceflye.com/concept-graphics/illustrations/4092610

Which industry and market is really responsible for building performance?

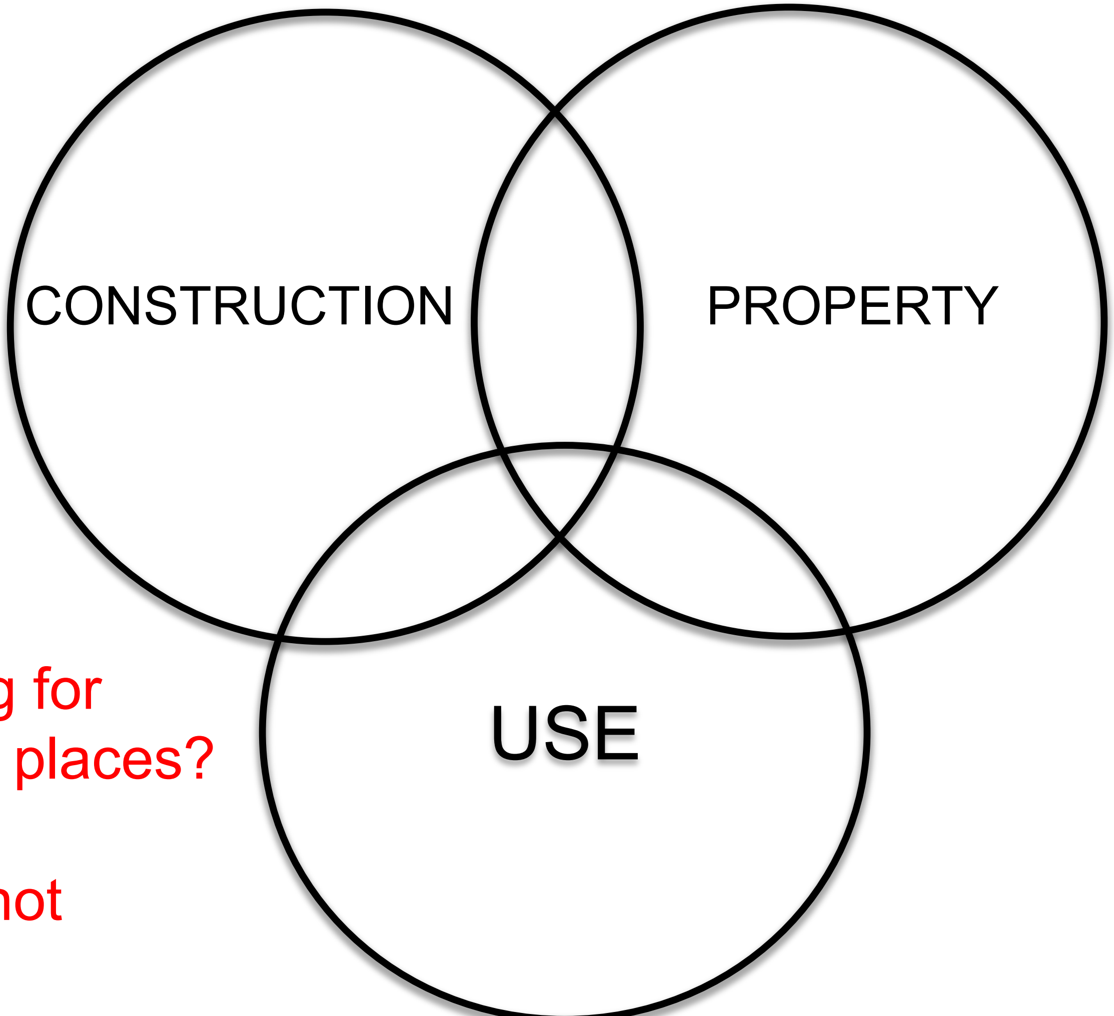
None of these:
it's much more complicated than that.

The lack of traction is not market failure, but category error!

We need something more …



There needs to be more shared territory, *with much more emphasis on use*



Do policymakers
really understand this …

or have they been looking for
the answers in the wrong places?

Performance in use has not
been well represented in
industry and policy measures.

Sustainability raises challenging moral and ethical dilemmas

- Work ‘after us’ and for ‘the other’.
- Intergenerational equity.
- Deferred impacts over long periods.
- Differential geographical and social impacts.
- Growing levels of uncertainty and unpredictability.

It needs vision, imagination, reflection and commitment

“[it] does not tempt us to be less moral than we might otherwise be; it invites us to be more moral than we could ever have imagined.” … MALCOLM BULL

RIBA Plan of Work 2013 let sustainability checkpoints be switched on and off ! Fortunately the 2020 Plan doesn’t.

SOURCES: S Hill, Edge debate, New Professionalism, 20 Feb 2013, M Bull, London Review of Books, 3-6, 24 May 2012

Some general conclusions

- If we are to meet the challenges of sustainability, the role of the building professional must change.
- We need to be concerned not just with inputs and outputs, but in-use outcomes.
- We must close the feedback loop and initiate virtuous circles of rapid improvement, involving all players.
- This is a systemic problem: the perspective must be wider than just buildings and construction.
- Building performance in use needs to become an independent and properly-resourced knowledge domain, in the public interest.

The role of the building professional needs re-defining

- There's a big job to do, *in making new and existing buildings more sustainable.*
- We're short of money:
  we can't afford to spend it on the wrong things.
- Our current procurement systems are not fit for purpose:
  we need to do things very differently.
- We can't change everything tomorrow …
  but we can change our attitudes to what we do.
- It's not a question of whether we can afford to do it:
  We can't afford not to !
- WHEN DO WE START?
  NOW.

BREAK

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INSIGHTS FROM BUILDING PERFORMANCE EVALUATION STUDIES

PART 2

Some findings and their implications

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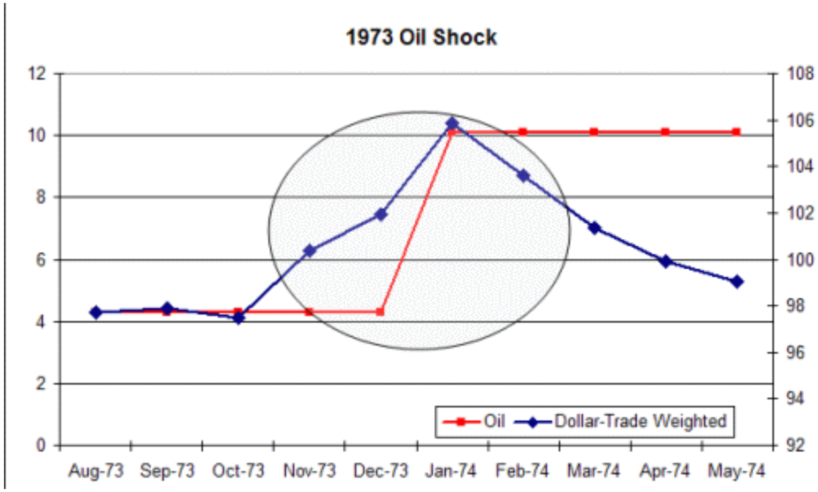
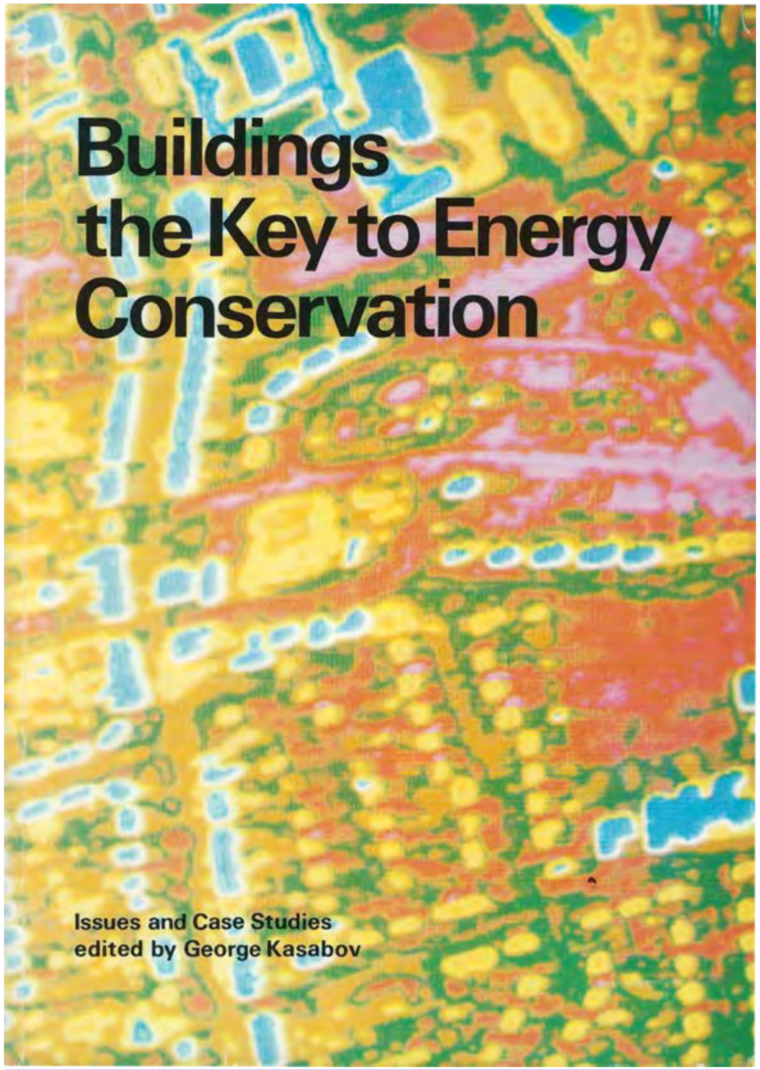
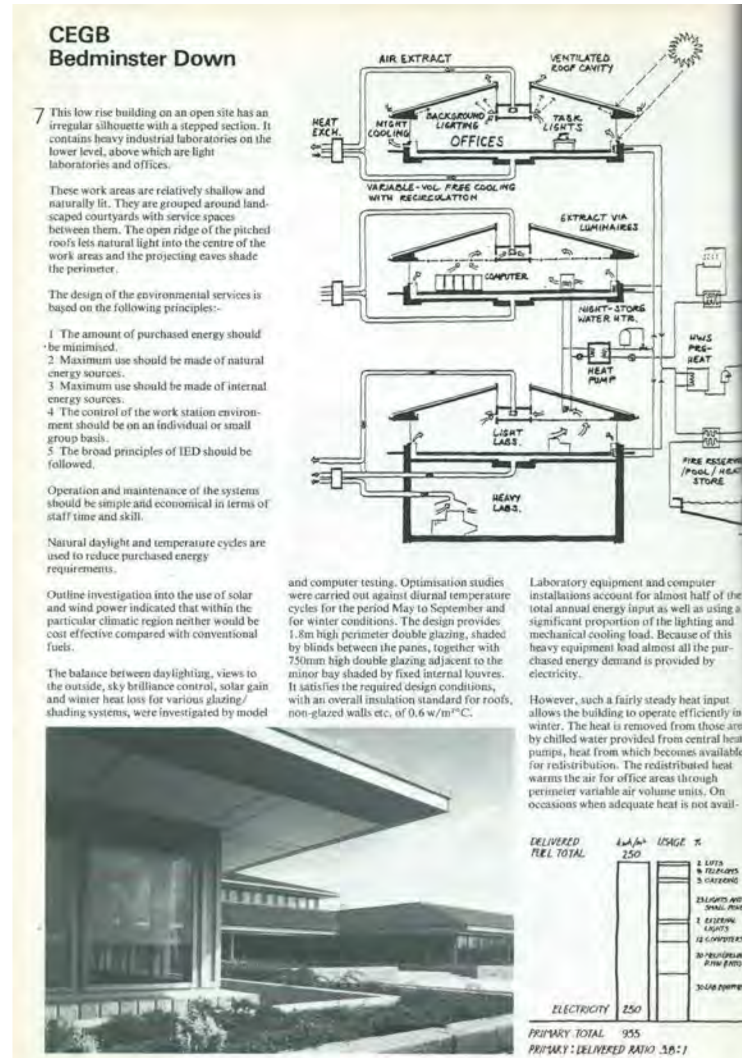
At the end of 1973, we had the oil crisis



In 1974, coal supplies also ran short in the UK, through trade union action, bringing on the 3-day week and bringing down the Tory Government …

RIBA Energy Group 1979 – *8 papers on issues, 50 Case Studies of low-energy buildings, with data*





CEGB
Bedminster Down

7 This low rise building on an open site has an irregular silhouette with a stepped section. It contains heavy industrial laboratories on the lower level, above which are light laboratories and offices.

These work areas are relatively shallow and naturally lit. They are grouped around landscaped courtyards with service spaces between them. The open ridge of the pitched roofs lets natural light into the centre of the work areas and the projecting eaves shade the perimeter.

The design of the environmental services is based on the following principles:-

1 The amount of purchased energy should be minimised.
2 Maximum use should be made of natural energy sources.
3 Maximum use should be made of internal energy sources.
4 The control of the work station environment should be on an individual or small group basis.
5 The broad principles of IED should be followed.

Operation and maintenance of the systems should be simple and economical in terms of staff time and skill.

Natural daylight and temperature cycles are used to reduce purchased energy requirements.

Outline investigation into the use of solar and wind power indicated that within the particular climatic region neither would be cost effective compared with conventional fuels.

The balance between daylighting, views to the outside, sky brilliance control, solar gain and winter heat loss for various glazing/shading systems, were investigated by model and computer testing. Optimisation studies were carried out against diurnal temperature cycles for the period May to September and for winter conditions. The design provides 1.8m high perimeter double glazing, shaded by blinds between the panes, together with 750mm high double glazing adjacent to the minor bay shaded by fixed internal louvres. It satisfies the required design conditions, with an overall insulation standard for roofs, non-glazed walls etc. of 0.6 w/m²°C.

Laboratory equipment and computer installations account for almost half of the total annual energy input as well as using a significant proportion of the lighting and mechanical cooling load. Because of this heavy equipment load almost all the purchased energy demand is provided by electricity.

However, such a fairly steady heat input allows the building to operate efficiently in winter. The heat is removed from those areas by chilled water provided from central heat pumps, heat from which becomes available for redistribution. The redistributed heat warms the air for office areas through perimeter variable air volume units. On occasions when adequate heat is not avail-

SOURCE: G Kasabov (ed), *Buildings, the Key to Energy Conservation,* RIBA Energy Group, 1979, 96 pages.

but 10 years later, in 1990 …

Tales of the unexpected

Office buildings claimed to be energy efficient, in reality often fall short of their quoted performance because of simple calculation errors and unknown energy-consuming extras. Matthew Coomber *reports.*

BUILDING owners beware – your energy-efficient building may not be as efficient as you have been led to believe.

Bill Bordass, an independent energy consultant and something of a guru in the field of energy efficient design, claims many offices are touted as energy efficient, but turn out not to be on closer examination.

He is helping to prepare a series of case studies of energy use in offices as part of the Energy Efficiency Office's Best Practice programme.

The studies detail energy usage and cost figures for each energy consumption elements missing or had recorded building areas much larger than that actually serviced," he says.

Errors in calculation had arisen either through mismeasurement of floor area or a failure to understand what constitutes the treated area, that is, the area of a building that consumes energy, in whatever form.

"We found that energy researchers have a tendency to look in great detail at where the energy goes, but will often ask somebody else for a building area." Usually rounded up or

Bordass says some people measure energy consumption by the whole building, some by building services only, and some by landlord's building services only. "This can produce great discrepancies when you come to measure the floor area and the devices properly," Bordass notes.

In addition, tenants can be confused about who pays for services, resulting in the doubling-up or omission of important elements of the energy bill.

The next problem concerns the assumptions that the people

SOURCE: M Coomber, *Tales of the Unexpected,* Building Magazine 38-39 (17 August 1990).

ELSEVIER

… and in the USA

Energy and Buildings 21 (1994) 121–131

ENERGY AND BUILDINGS

Two-to-one discrepancy between measured and predicted performance of a 'low-energy' office building: insights from a reconciliation based on the DOE-2 model

L.K. Norford, R.H. Socolow, E.S. Hsieh, G.V. Spadaro[1]

Center for Energy and Environmental Studies, Princeton University, Princeton, NJ, USA

Received 1 February 1989; accepted in revised form 25 April 1994

Abstract

Computer models of building energy use, if calibrated with measured data, offer a means of assessing retrofit savings, optimizing HVAC operation (on- or off-line), and presenting energy-consumption feedback to building operators. The calibration process itself can pinpoint differences between how a building was designed to perform and how it is actually functioning. Our initial goal was to identify why the actual annual energy consumption of an office building was 325 kWh/m^2, over twice the predicted value of 125 kWh/m^2. Part of our effort to understand its performance involved calibrating a DOE-2 model prepared at the design stage. In the process, we formulated calibration guidelines and developed insights that may be of use to others. Of particular interest are the major sources of the wide discrepancy between predicted and actual energy use. Unanticipated tenant energy consumption, both during the day and the night, contributed 64% of the two-fold increase. Heating, ventilation and air-conditioning (HVAC) equipment operation beyond the expected 10 h per weekday contributed 24%. We attributed the remaining 12% to HVAC equipment not operating up to specification; building conductive heat loss in excess of the design-stage prediction; and minimum outdoor-air intake differing from the design value. The calibration process involved working on major input parameters independently of the others, then combining the results into one simulation. The calibrated model accounted for 94% of measured site energy for the building.

… and in Australia, *though its NABERS system has improved things in rented offices*

Why good buildings go bad while some are just born that way

Dr Paul Bannister, Exergy Australia Pty Ltd

ABSTRACT

With the realisation that climate change is not going to be resolved by inaction or unrealised promises, the issue of actual building performance has become focal in today's commercial buildings sector. With this has come the genuinely problematic issue of delivering and operating buildings at levels of efficiency higher than have been achieved before.

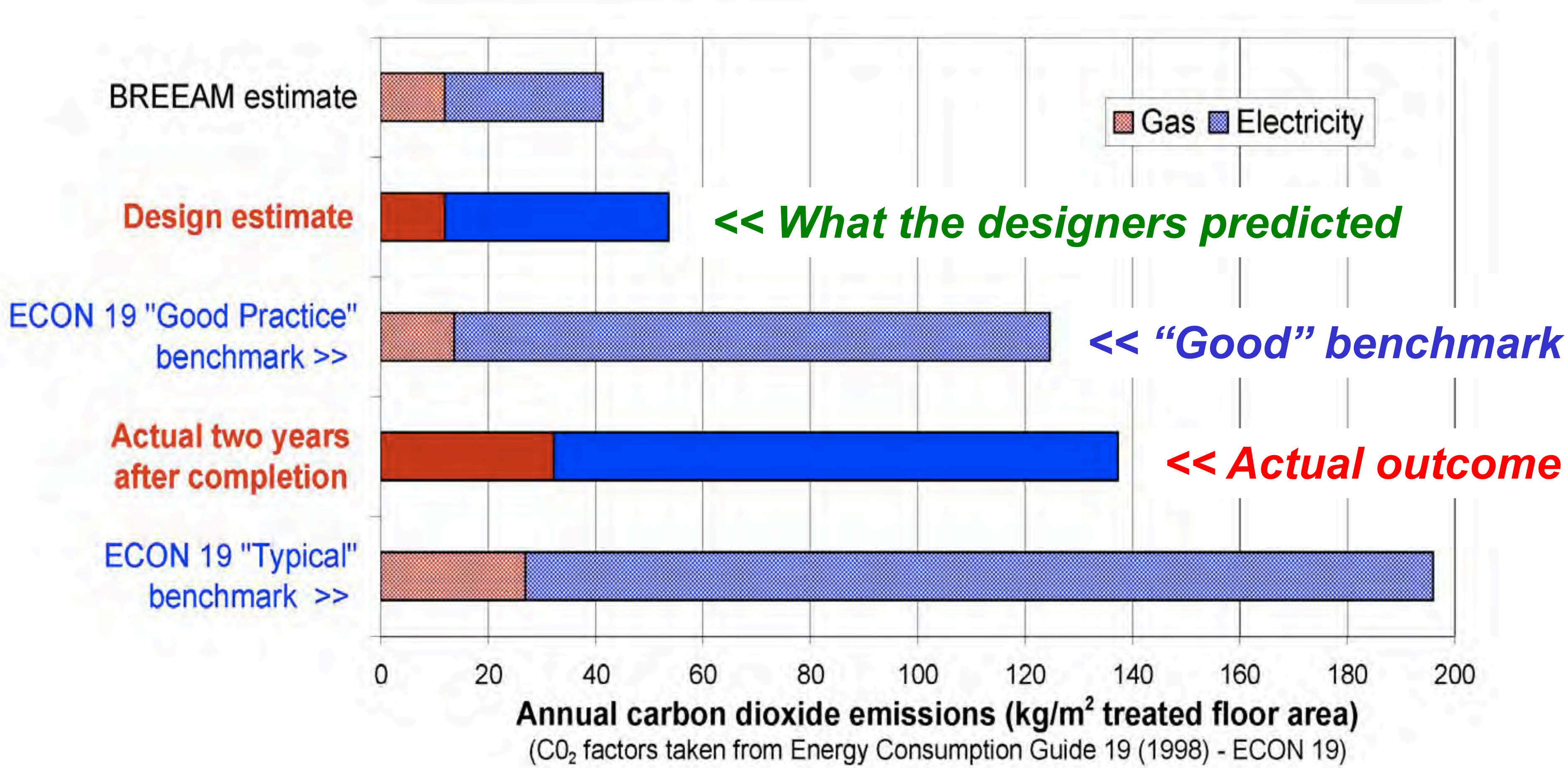
While some argue that good design is all, those involved in operating buildings are generally aware that the issues of delivering and operating high-efficiency buildings are somewhat more complex. A building that has a good theoretical performance may not perform well in practice, while many lesser buildings may be easier to operate and improve.

In this paper, a range of issues that cause apparently well designed buildings to perform poorly are explored, with particular emphasis on the issues affecting base buildings under the Australian Building Greenhouse Rating scheme. These issues include items that can be seen as the responsibility of various participants in the supply chain, as well as many that are the product of numerous such participants. It is identified that delivering and operating high-efficiency buildings is a complex and multifaceted problem that requires a holistic rather than reductionist view of the building process. Some guidelines for more reliable delivery of efficient buildings are also provided.

SOURCE: Ecolibrium, the Journal of the Australian Institute of Refrigeration, AC and Heating, 24-32 (February 2009)

BREEAM for offices was introduced in 1990, *but performance gaps persisted…*

Data from the winner of the Green Building of the Year Award 1996



SOURCE: see discussion in S Curwell et al, *Green Building Challenge in the UK,* Building Research+Information **27**(4/5) 286 (1999).

New non-domestic buildings:
What we found in the Probe studies 1995-2002

- They often perform much worse than anticipated, *especially for energy and carbon, often for occupants, and with high running costs, and sometimes technical risks.*

- Design intent is not communicated well through the process; and designers and builders go away at handover.

- **Unmanageable complication: the enemy of good performance.**

- Buildings are seldom tuned-up and controls are a muddle. So why are we making things complicated?

- Modern procurement systems make it difficult to pay attention to critical detail. ***A bad idea when promoting innovation.***

- ***"The English spare no expense to get something on the cheap".*** *… **NIKOLAUS PEVSNER***

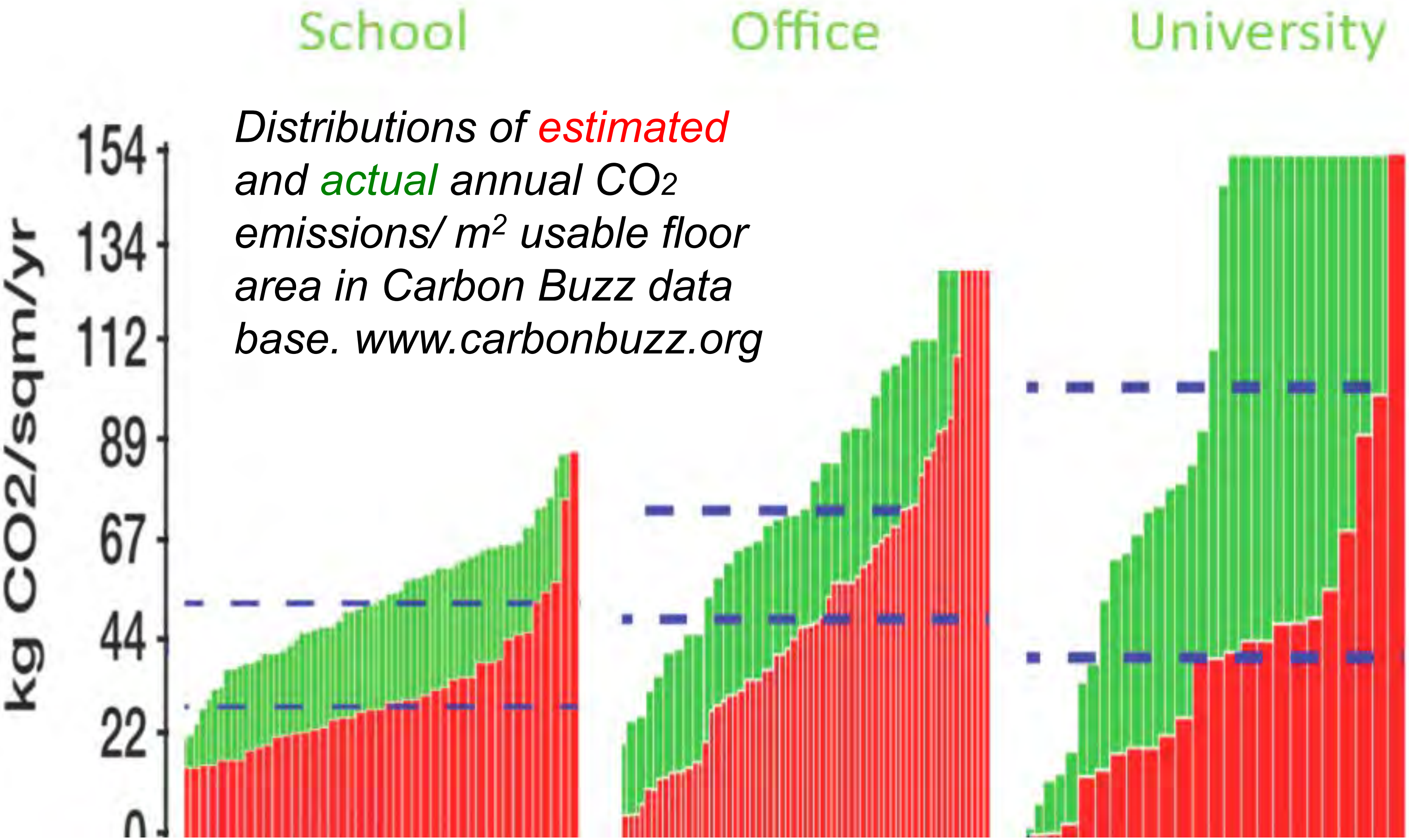
SOURCE: For more information, go the Probe section of www.usablebuildings.co.uk

New non-domestic buildings:
What we found in the Probe studies 1995-2002

- They often perform much worse than anticipated, *especially for energy and carbon, often for occupants, and with high running costs, and sometimes technical risks.*
- Design intent is not communicated well through the process. **SO …** ***Understand how buildings work in use, follow through after handover, and learn from the experience.***
- **Unmanageable complication: the enemy of good performance.** **SO …** ***Stop making buildings complicated in the name of sustainability and get the simple things right.***
- Buildings are seldom tuned-up and controls are a muddle. **SO** … ***Design to enhance usability and manageability.***
- Modern procurement systems make it difficult to pay attention to critical detail. **SO** … ***Change the processes.***
- **AND THEREFORE**… **Focus on in-use performance, communicate it clearly and manage it properly.**

SOURCE: For more information, go the Probe section of www.usablebuildings.co.uk

Evidence of UK performance gaps is now overwhelming; *in some other countries too.*



SOURCE: Ian Taylor and Judit Kimpian, *Carbon Buzz Launch slides,* 6 June 2013. www.carbonbuzz.org

Even CIBSE admits it

UK Chartered Institution of Building Services

CIBSE Energy Performance Group

CARBON BITES

From the CIBSE ENERGY PERFORMANCE GROUP

The Performance Gap

What is The Performance Gap?

There is significant evidence to suggest that buildings do not perform as well as anticipated at design stage. Findings from the PROBE studies (Post Occupancy Review of Buildings and their Engineering) demonstrated that actual energy consumption in buildings will usually be twice as much as predicted. This was based on post-occupancy reviews of 23 buildings previously featured as 'exemplar designs' in the Building Services Journal (BSJ) between 1995 and 2002. More recent findings from the Carbon Trust's Low Carbon Buildings Accelerator and the Low Carbon Buildings Programme have demonstrated that in-use energy consumption can be 5 times higher that compliance calculations. Both studies suggest that lack of feedback following occupancy is one of the biggest contributors to this gap. Another key factor is that calculations for regulatory compliance do not account for all energy uses in buildings. These calculations are commonly misinterpreted as predictions of in-use energy consumption, when in fact they are simply mechanisms for compliance with Building Regulations. Unregulated sources of energy consumption such as small power loads, server rooms, external lighting, etc, are rarely considered at design stage. Yet these typically account for more than 30% of the energy consumption in office buildings, for example.

The gaps occur in new housing too:
a full 40 years after the 1973 oil crisis

Minister launches Hub-led project
performance challenge **Ecobuild**

A new project to examine the energy performance of new homes is unveiled today. The industry-backed project brings together leading housebuilders and industry experts to investigate the actual performance of homes and better understand how this compares to that expected by the original design. Communities and Local Government minister Rt Hon Don Foster MP announced a new £380,000 grant for

CLOSING THE GAP BETWEEN

DESIGN

&

AS-BUILT PERFORMANCE

END OF TERM REPORT

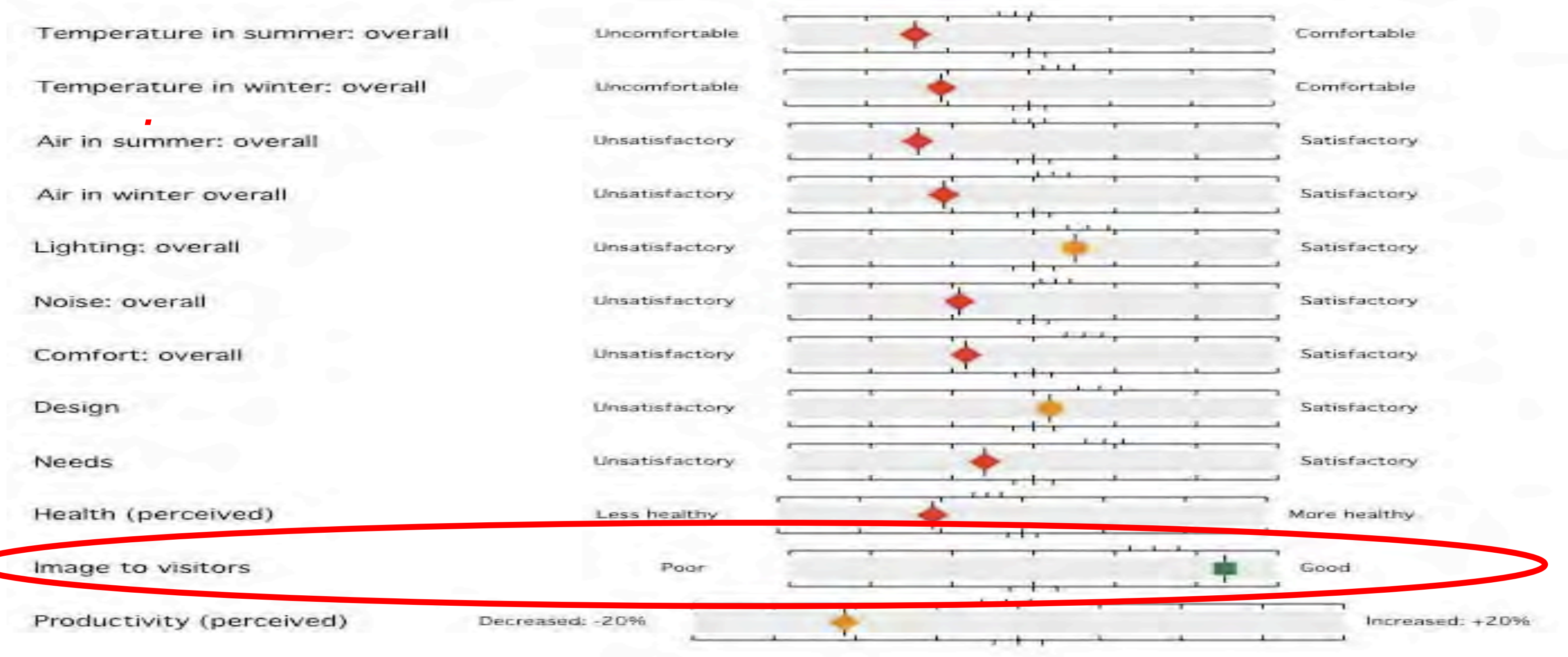
July 2014

ZERO CARBON HUB

Zero Carbon Hub, *Closing the gap between design and as-built performance* (July 2014)

Performance gaps are not just for energy: *occupant survey, multi-award-winning school*

RED: below average; AMBER: Average; GREEN: Above average



" … the architecture showed next to no sense. It leaked in the rain and was intolerably hot in sunlight. Pretty perhaps, sustainable maybe, but practical it is not." … STUDENT

SOURCE: BUS Method survey of a building services engineering award-winning Academy school in South East England, 2009

The gaps are not just for new buildings: *Knowledge base for retrofit*

SOME CONCLUSIONS

Industry and policy lack understanding of traditional building performance.

Lack of connection between research intelligence and guidance procedures.

Significant uncertainty in application of models and software.

Some methods used are inappropriate.

A systemic approach is necessary to avoid unintended consequences.

There are good opportunities, but some will need to be developed using a rather different basis and structure.

SOURCES: Report (Sept 2012) downloadable from www.stbauk.org Guidance Wheel at www.responsible-retrofit.org/wheel

Simple dysfunctions in recent buildings: *Poor window design, leading to overheating*

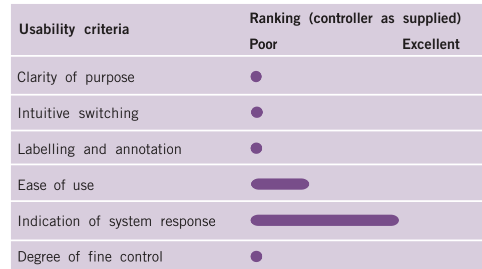
Cambridge sheltered housing, opened 2011. *No secure, fine control ventilation available: could easily have been small windows in the panel between the doors. Doors need two hands to operate: not clever if you have arthritis!*

Sheffield student housing, new circa 2007.
Tilt and turn windows locked off by management, owing to concerns about possible suicides.
Room can overheat in February, let alone summer.

Wasteful overprovision in new buildings:

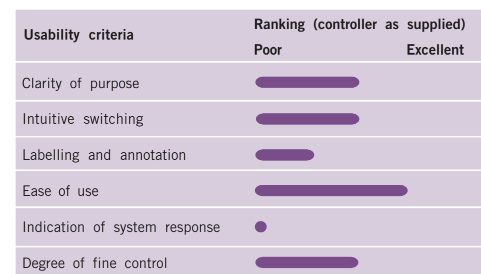
Five times too much light in a "low energy" building's kitchen

… and widely dysfunctional controls



This control for lighting has clear switching with four settings clearly illuminated, plus an off setting. The numbers by the setting are arbitrary.

Apart from the numbering, the switch is not labelled as to what it does. The red light for setting 1 is on the far left of its button, hinting that there be more than one stage for each setting. Is the off button for system off, or does it apply to each of the four stages in turn? Does the vertical button to the right raise or lower the lighting generally, or on each setting? In the absence of clear annotation, the user is forced to experiment.



This controller is clearly a control device for ventilation. The knob at the lower left appears to offer control over a setpoint (presumably for temperature), against an arbitrary scale of plus or minus. In the absence of controller feedback, the user would need to learn the settings by experimentation. The function of the knob on the right is clearer, with three fan speed-settings, but is it for room ventilation or a fan in a heating/cooling unit? Probably the latter, as experience has forced the facilities manager to append a label telling users not to switch off the fan.

"we sell dreams and install nightmares"
– CONTROLS SUPPLIER

SOURCE: www.usablebuildings.co.uk/Pages/Publications/UBPubsControlsForEndUsers.html and BSRIA

Technology - management interactions:
conclusions from the Probe studies of public and commercial buildings and confirmed by later work

		Technological complexity	
		More	**Less**
Building management input	**More**	*Type A* Effective, but often costly	*Type D* Rare, not replicable?
	Less	Risky with performance penalties *Type C*	Effective, but often small-scale *Type B*

Diagram first appeared in: *Probe 19: Designer Feedback,* Building Services, the CIBSE Journal, page E21 (March 1999).

Technology - management interactions:
conclusions from the Probe studies of public and commercial buildings and confirmed by later work

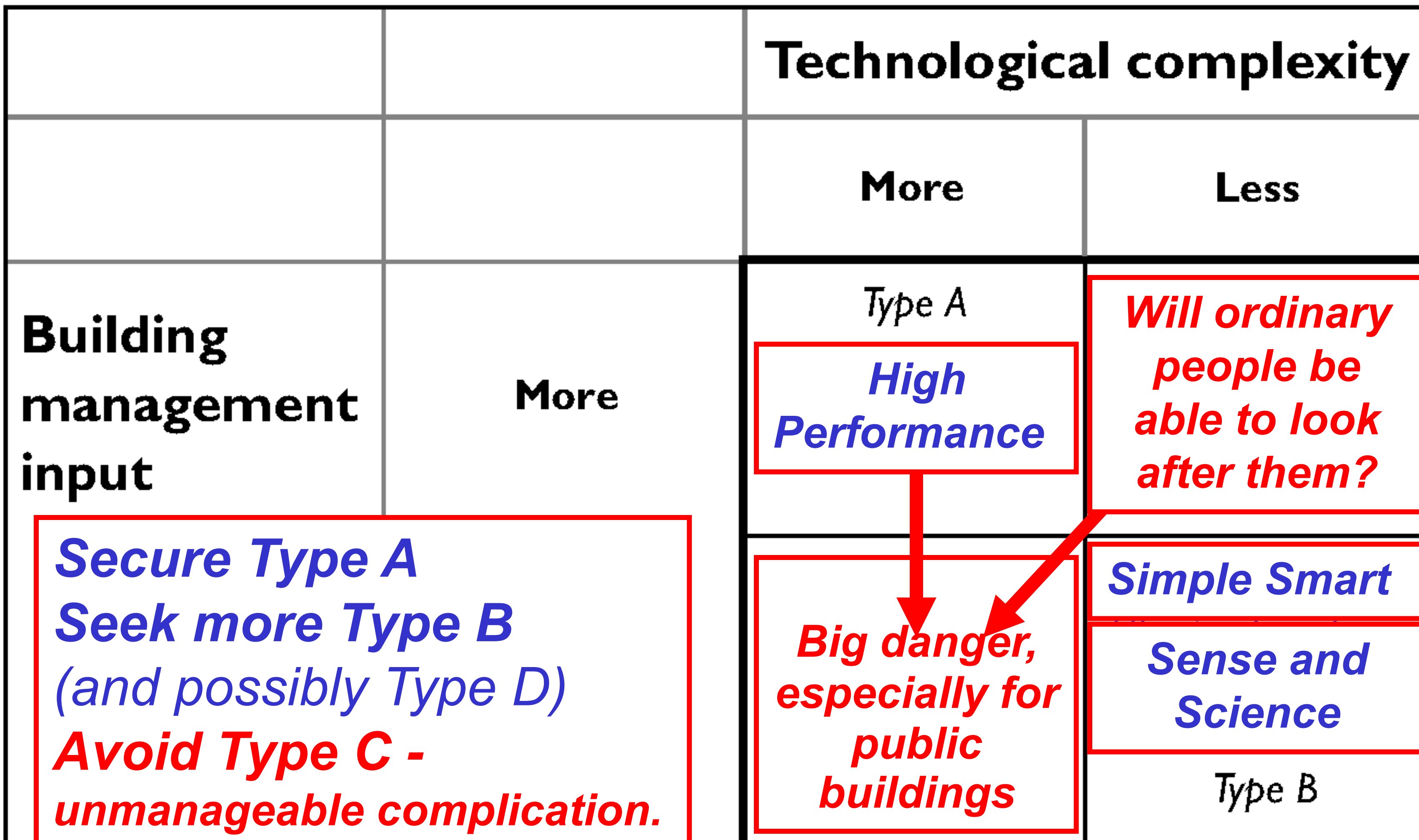


Diagram first appeared in: *Probe 19: Designer Feedback,* Building Services, the CIBSE Journal, page E21 (March 1999).

Probe conclusions: *Less can DO more*

INTERVIEW

09

Architect Rab Bennetts and Usable Buildings consultant Bill Bordass put forward a modest proposal for sustainable design

'Keep it simple and do it well'

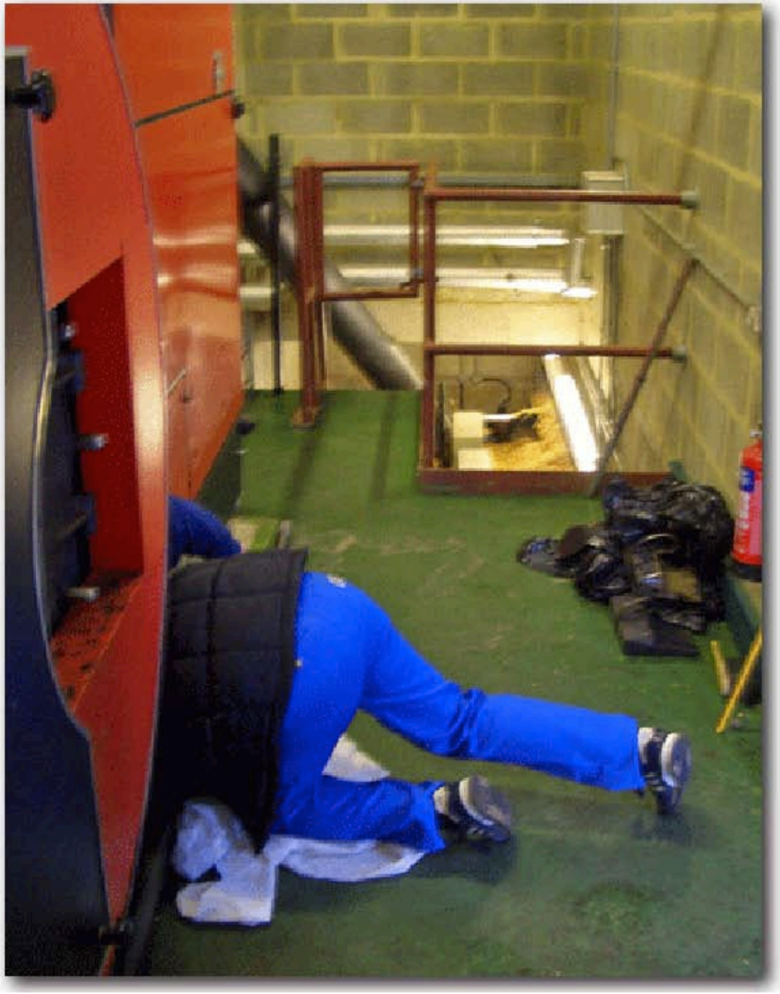
SOURCE: R Bennetts and W Bordass, Building Magazine Sustainability Supplement 8-11 (28 Sep 2007)

Controls, manageability and usability need much more attention at all stages

"An intelligent building is one that doesn't make its occupants feel stupid"… ADRIAN LEAMAN

"We sell dreams and install nightmares"… BMS SUPPLIER

Don't procure what you can't afford to manage



In spite of these insights from the 1990s, *complication has burgeoned in recent years*

- Technical complication
- Legislative complication
- Contractual complication
- Bureaucratic complication
- Tick-box procedures: feature creep
- Complication for building users and managers

So less money to spend on basics

The complication disease has now spread to housing too!

AND NOTHING JOINS UP PROPERLY!

"Complexity is profitable, [it] makes people believe you understand it."
JON DANIELSSON

F Stevenson et al,: *The usability of control interfaces in low-carbon housing,* Architectural Science Review, 1-13 (2013).

Examples of unmanageable complication in domestic buildings …

SIGMA HOUSE, BRE *(illustrated)*

- Extensive feedback from occupants, including comfort, ergonomics, space.
- Complicated, confusing and unreliable technologies and renewables.
- Energy use much higher than predicted.

ELMSWELL, ORWELL

- Two-thirds of residents could not programme their thermostats.
- Mechanical ventilation with heat recovery was present, but 95% of people had windows open in winter.
- Design air change was 0.5 to 1 ac/h. One open window could provide 17 ac/h!

SOURCE: Sigma monitoring by Oxford Brookes University, Elmswell by Buro Happold in KTP with Bristol University.

So yet again ... *Some conclusions from TSB Building Performance Evaluation programme 2010-14*

Significant problems with integrating new technologies, especially configuring and optimising BMSs. Insufficient thought given to how occupants will use them.

"Controls are something of a minefield." Tendency to make control of heating, lighting and renewable energy systems over-complicated. The one air source heat pump had operational issues in cold weather.

Problems with automatic window controls.

Multiple systems fighting each other e.g. cooling vs heating, different heating systems jockeying for control.

Maintenance, control & metering problems, especially with biomass boilers, PVs and solar heating.

SOURCE: J Palmer & P Armitage, BPE Programme, Early findings from non-domestic projects, Innovate UK (Nov 2014)

BREAK

www.usablebuildings.co.uk

Oxford Brookes University
28 October 2020

INSIGHTS FROM BUILDING PERFORMANCE EVALUATION STUDIES

PART 3

A possible future

Bill Bordass

USABLE BUILDINGS
www.usablebuildings.co.uk

“The house is on fire”
… GRETA THUNBERG

- We must save energy and carbon in a hurry *embodied not just operational …* and remember.
- this is a but a small – *but essential* - part of what we need to do to improve the environment.
- We need more thinking and less stuff; and
- to make much better use of what we already have.

Much of what we have got used to,
we’re not necessarily entitled to.

If you wanted to improve building performance in use, *what would you do …*

A. Focus on building performance in use?

OR

B. Do lots of other things and hope that performance will improve …?

Why have we been barking up the wrong tree?

Why is actual performance not the proper target?

A glimmer of hope: Stage M came back!

as Stage 7 in the RIBA Plan of Work 2013 and 2020

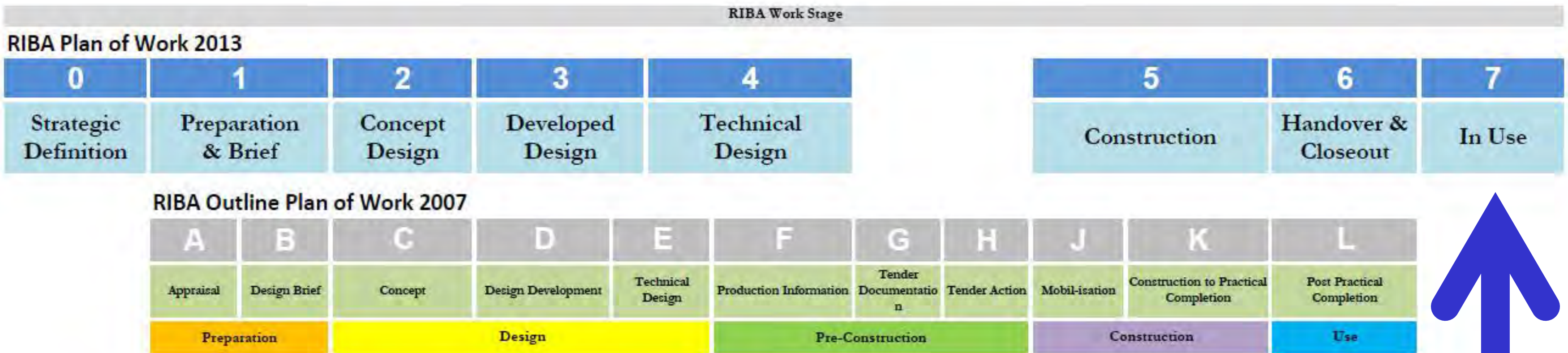


Fig 1. RIBA Plan of Work 2013 compared with RIBA Outline Plan of Work 2007

And of course some universities are becoming more active - with Oxford Brookes one of the leaders .

But most design professionals *(particularly those in the larger firms)* still get very little exposure to how their buildings actually work.

SOURCE: RIBA Plan of Work overview (March 2013). See also www.architecture.com/planofwork

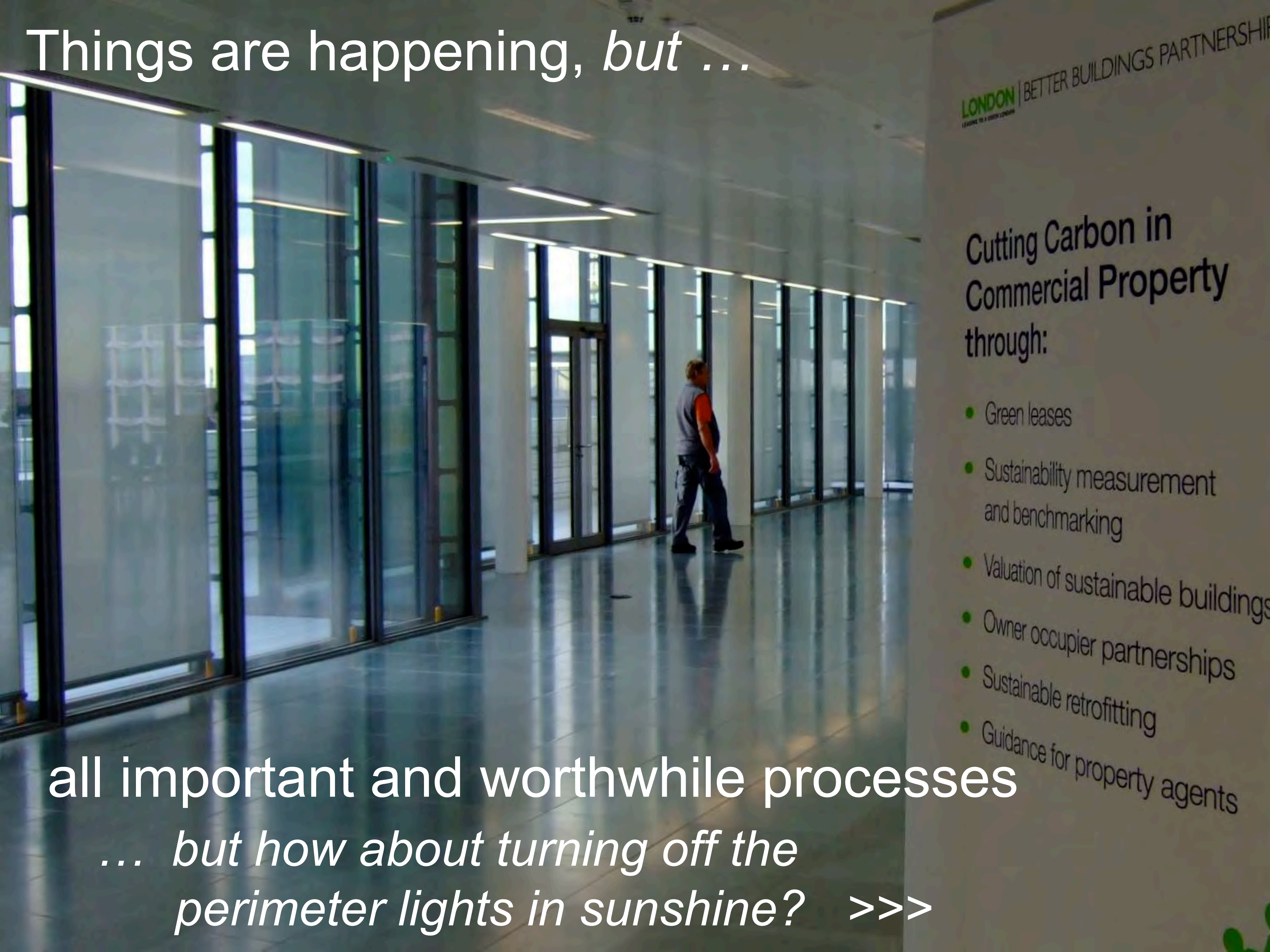
Changing the way we do things

- Many construction-related institutions require their members to understand and practice sustainable development.
- How can members do this unless they understand the consequences of their actions? *The real outcomes.*
- If they don't, they are working outside their region of competence …
- **or in other words, not acting in a fit manner for a professional !**

SO HOW ABOUT?

- Changing attitudes to the nature of the job.
- Re-defining perceptions of the professional's role,
  to follow-through properly and to engage with outcomes.
- Closing the feedback loop – rapidly and efficiently.
- Making much more immediate, direct and effective links between research, practice and policymaking.

Things are happening, *but …*



all important and worthwhile processes

… but how about turning off the perimeter lights in sunshine? >>>

Our proposed sticky interventions:
seeding things with potential to snowball over time

Cultural adaptations, not just technical "solutions".
To create virtuous circles of continuous improvement.

MAKE IN-USE PERFORMANCE CLEARLY VISIBLE
In a way that motivates people to strive to improve it.
This needs a well-informed technical infrastructure to help the plethora of different systems to converge, particularly for energy and carbon.

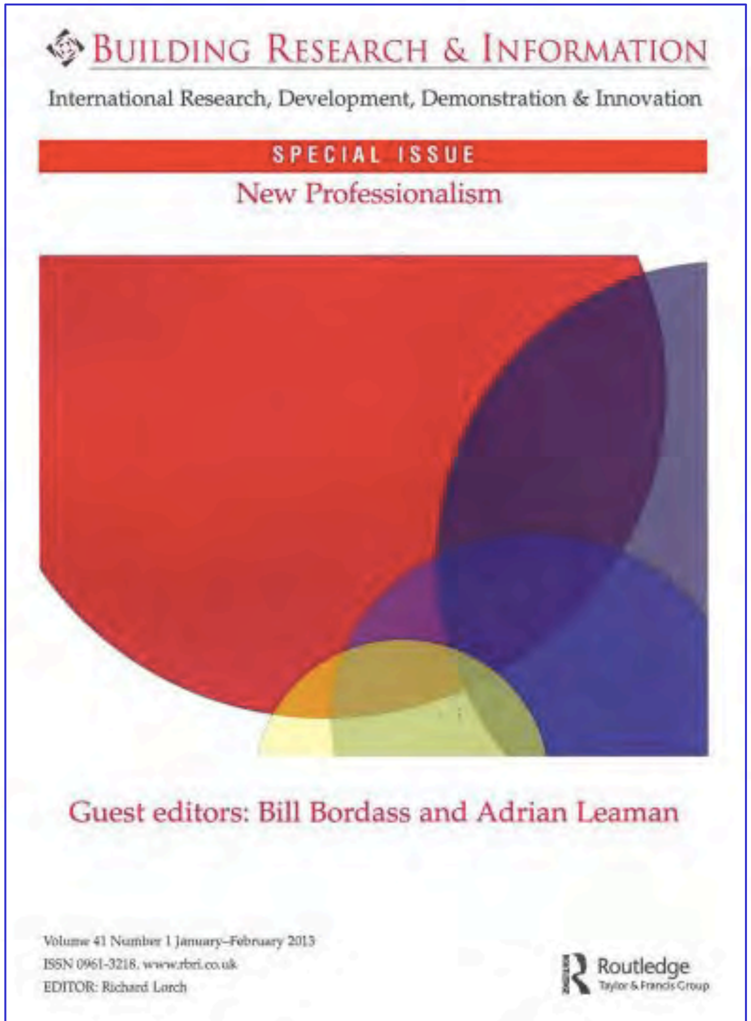
CONSOLIDATE THE KNOWLEDGE DOMAIN
Develop building performance as an independent knowledge domain, to gain the evidence and authority to inform practice and policymaking.

REVIEW PROFESSIONAL ETHICS AND PRACTICES
A shared vision for building-related professionals to work in the public interest and engage properly with outcomes: *NEW PROFESSIONALISM*

SEE ALSO: Bill Bordass, George Henderson Memorial Lecture, University College London (12 June 2013).

New Professionalism: getting started

Principles anyone can adopt tomorrow



PROVISIONAL LIST DEVELOPED WITH THE EDGE

ETHICS AND CONDUCT:

1. Be a steward of the community, its resources, and the planet. Take a broad view.
2. Do the right thing, beyond your obligation to whoever pays your fee.
3. Develop trusting relationships, with open and honest collaboration.

ENGAGEMENT WITH OUTCOMES:

4. Bridge between design, project implementation, and use. Concentrate on the outcomes.
5. Don't walk away.
   Provide follow-through and aftercare.
6. Evaluate and reflect upon the performance in use of your work. Feed back the findings.
7. Learn from your actions and admit your mistakes. Share your understanding openly.

THE WIDER CONTEXT:

8. Seek to bring together practice, industry, education, research and policymaking.
9. Challenge assumptions and standards. Be honest about what you don't know.
10. Understand contexts and constraints. Create lasting value. Keep options open for the future.

SOURCE: The Editorial of BR&I **41**(1), Jan-Feb 2013 can be downloaded at www.tandfonline.com/toc/rbri20/41/1

Professionalism and the Institutions
Morrell report for Edge 2015, revised 2020

The report focuses largely on the role of the institutions: ***Top Down***.

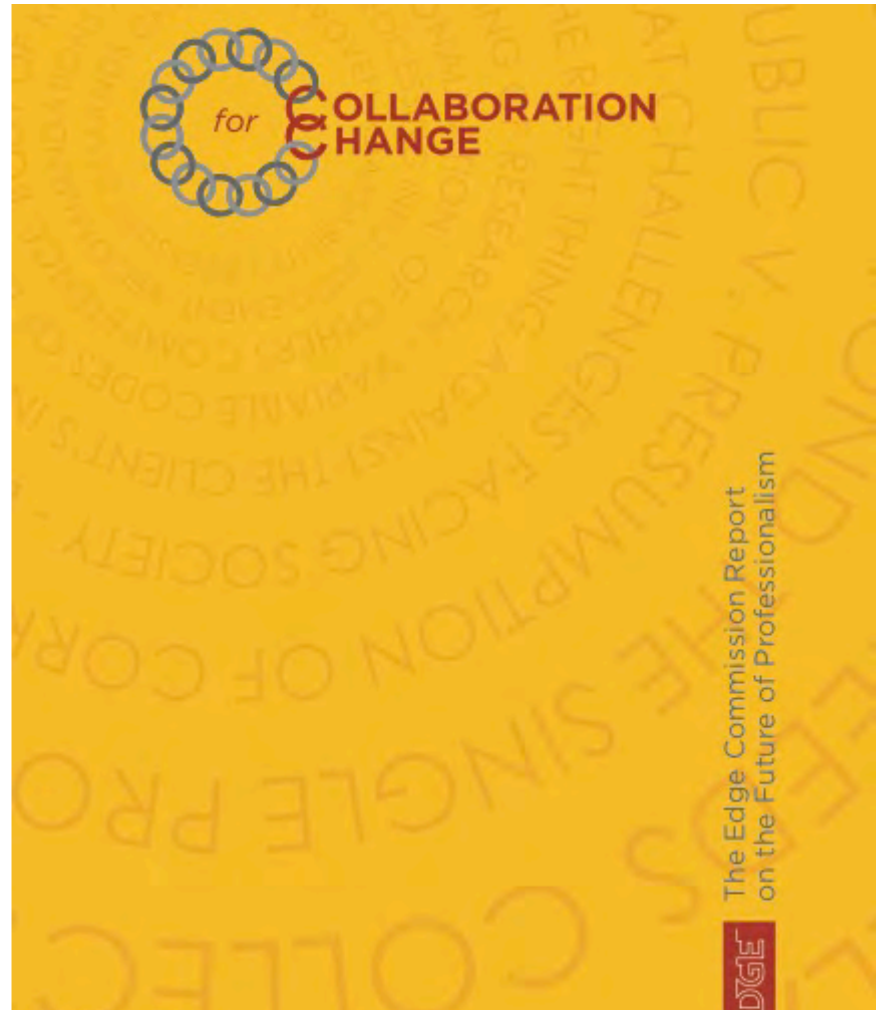
Key themes: *Ethics, Education, Knowledge, Collaboration.*

Two complementary approaches:

Bottom-up*:* The individual, *e.g. adopting the ten points.*

Middle-out:
At organisational and practice level.

Collaboration events held around the country, with practice, education, clients and government.
Major impetus with institutions in 2019-20, but needs shared core.



Achieving projects that work better in use: ***Soft Landings*** *may help*

It augments the duties of the design and building team, *(and of client representatives),* especially:

- During the critical briefing stage.
- With closer forecasting of building performance.
- With greater involvement with users before and after handover, and on-site presence during settling-in; and
- including monitoring and review for the first 3 years of use.

It can:

- *Be used on any project, in any country, with any procurement route.*
- *Provide a fast track to raising building performance.*
- *Help to provide more customer focus for the industry.*
- *Improve client relationships and user satisfaction.*
- *Build recognition that some debugging is to be expected.*

It is primarily about a change in attitude.
It needs champions to take it forward - The new professionals.

Soft Landings: the Five main stages

From the Framework published in July 2009

1. Inception and Briefing
   Appropriate processes.
   Assigned responsibilities.
   Well-informed targets.
2. Design development
   and expectations management.
3. Preparation for handover
   better operational readiness.
4. Initial aftercare
   Information, troubleshooting,
   fine tuning, training.
5. Longer-term aftercare
   monitoring, review, independent
   POE, feedback and feedforward.

Free download available at www.usablebuildings.co.uk and www.softlandings.org

Soft Landings **Stage 1**: *Inception and briefing*

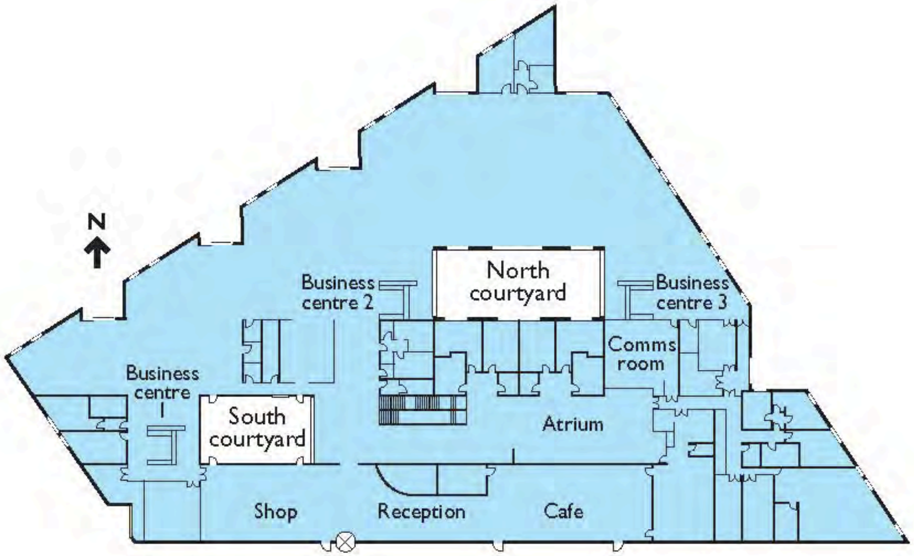
The most important stage, because it binds the team and sets the whole style of engagement with outcomes.

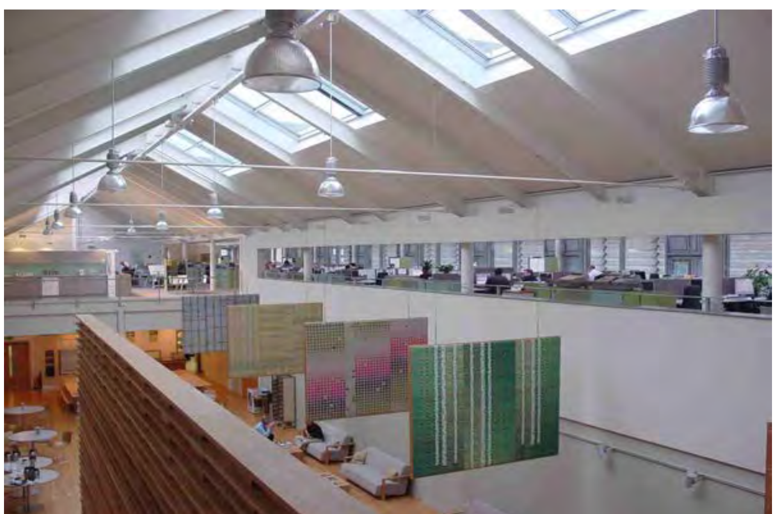
- However, clients have been reluctant to pay, thinking that the industry ought to be doing it anyway.
- Modern procurement methods have often salami-sliced things, making it difficult to maintain *the golden thread* of maintaining and refining design intent throughout a project and on into use.
- *Some clients are writing it into their briefs.*
- *Some PFI teams are starting to put it into their bids.*
- *Some designers want it to be in their standard service.*
- *Supposed to be mandatory for Central Government projects (2016).*
- *RIBA soon to publish its interpretation – **Plan for Use** (2020).*

FEEDBACK:
Client buy-in and follow-through is more difficult than might be hoped.
The project team should select a **Soft Landings Champion** or Champions, who can provide the leadership to help things along … **these are in effect the new professionals.**

See also the Green Overlay to the RIBA Plan of Work.

Pioneer example by research team members:
National Trust Heelis Building, Swindon





Scheme design by Feilden Clegg Bradley Studios (architects), Max Fordham (building services), Adams Kara Taylor (structural).

Soft Landings **Stage 2:** *Managing expectations during design and construction*

- Set stretching but realistic expectations, *not pie-in-the-sky.*
- Manage them through the process.
- Undertake regular reviews and reality checks.
- Leave elbow room: *this is systemic improvement, not exact science.*

FEEDBACK:

- Any costs up to handover can usually be met by efficiency gains, *though there may be a learning curve to pay for.*
- Soft Landings Champion(s) can provide leadership, maintain the emphasis on outcomes, and remind project managers that it is not enough just to keep to time and budget.
- This must all be done in the sprit of learning, not blaming.

Soft Landings research team members Feilden Clegg Bradley and Max Fordham use an expectations management process, e.g. on Heelis, the National Trust's award-winning headquarters in Swindon, completed 1985.

SEE: R Bunn: *Pitstopping: BSRIA's reality-checking process for Soft Landings,* BSRIA Guide BG 27 /11 (2011).

Managing expectations:
Sustainability matrix approach used at Heelis

Sustainability Matrix: Offices — **Feilden Clegg Bradley** Architects LLP ©

Operational Energy Consumption and CO² Emissions

	1. GOOD PRACTICE	2. BEST PRACTICE	3. INNOVATIVE	4. PIONEERING	NOTES
1. CO² Emission Target	40kgCO²/m²/yr	30kgCO²/m²/yr	15kgCO²/m³/yr	"Carbon neutral" 0kgCO²/m	Industry standard EEO targets
2. Heating Load Target	79kWhr/m²/yr	47kWhr/m²/yr	30kWhr/m²/yr	20kWhr/m²/yr	Industry standard EEO targets
3. Electrical Load Target	54kWhr/m²/yr	43kWhr/m²/yr	35kWhr/m²/yr	25kWhr/m²/yr	Industry standard EEO targets
4. U Values: Wall	0.35	0.25	0.2	0.1	good practice=current
Average Window	2.2	1.8	1.4	0.9	building regulations
Roof	0.2	0.18	0.15	0.1	pioneering=Bedzed values
Ground Floor	0.25	0.22	0.2	0.1	
5. Airtightness	<10m³/hr/m²	<8m³/hr/m²	<5m³/hr/m²	<3m³/hr/m²	All measures require careful attention to details and monitoring construction.
6. Ventilation	Natural ventilation where possible. Mechanical ventilation where not.	Designed natural ventilation with automatic openers, mechanical ventilation to WCs etc.	Mechanical ventilation with heat reclaim in winter and BMS controlled natural ventilation in summer.		BMS with manual overrides preferable on all windows.
7. On Site Energy Generation		Solar domestic water heating to WCs.	Solar domestic water heating to WC cores. Cost effective PV installation using PVs to shade rooflights. Gas fired CHP installation.	Solar water heating to kitchens. Maximum PV installation using most efficient PVs. Wood/waste fired CHP.	Potential 50% grant available from DTI for wolar water heating, up to 65% for PV installation.
8. Daylighting	"Reasonable" to BS8206 part 2. A 2% daylight factor.	80% office space daylit to meet criteria of BS8206: part 2.	100% of office space daylit to BS8206 part 2		Ensure prevention of solar heat gain/glare by building form/shading systems
9. Artificial Lighting Controls	PIR detectors in WCs etc. Low energy fittings throughout.	Luminance and presence detectors throughout building. No dimming.	Luminance and presence detection at all fittings with dimming to zero and BMS override.		Personalised controls strongly recommended by Rob Jarman
10. Cooling Systems/Sources	Zero ozone depletion refrigerants in high efficiency comfort cooling/air conditioning systems.	Night time structural cooling with automatic window vents.	Evaporative cooling to rooms with high internal heat gains.	Borehole/ground water cooling to rooms with high internal heat gains.	Need to provide for areas where cooling is required and provide upgrade path for entire building.
11. Embodied Energy in Structural Materials	Steel and concrete frame engineered to minimise mass of materials.	Use of cement replacements eg GGBFS in concrete. Use recycled steel.	Timber structure in lieu of steel or concrete but retaining concrete floors. Use of recycled aggregates in structural concrete.	All timber structure with thermal mass provided using minimum amount of concrete.	NB. Rob Jarman particularly keen on use of timber for low embodied energy

REF: W Gething & W Bordass, *A rapid assessment checklist for sustainable buildings*, BR&I **34**(4), 416-426 (2006).

Design intent to reality:
how the credibility gaps can open up

DESIGN ESTIMATES NOT SET CLEARLY OR REALISTICALLY:

- Little or no transparency between design estimates and in-use outcomes.
- Not everything is counted: *only normal "regulated" services in typical spaces.*
- Estimates are too optimistic, e.g. *no night loads, perfect control.*
- A policy concentration on carbon draws a veil over energy performance.

SLIPPAGE DURING DESIGN AND CONSTRUCTION:

- Design does not get into areas of critical detail, or understand the users.
- Changes to design and client requirements, *vandal "Value Engineering".*
- Changes during construction and commissioning: *negotiations, substitutions, build quality, systems, deployment of controls, delays.*

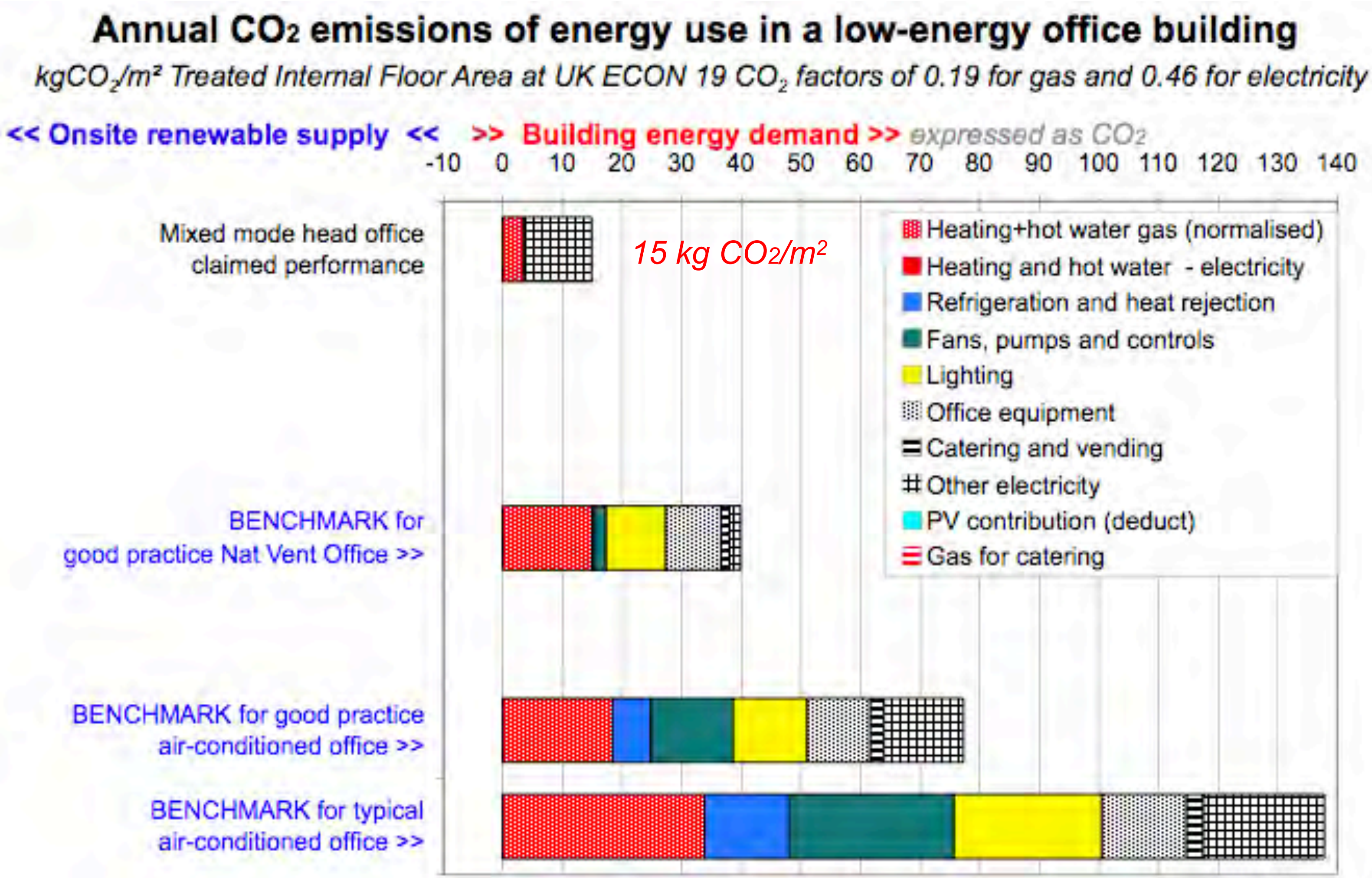
SLIPPAGE AFTER COMPLETION:

- No follow-through, initial aftercare, fine-tuning, monitoring, or feedback.
- Fitout changes and clashes.
- Spilt responsibilities: *developer/owner, landlord/manager/tenant, outsourcing. Principal/agent problems. Procurement of controls and FM services.*
- Unintended consequences and revenge effects, *technical and management shortcomings, controls problems, poor user interfaces, default to ON.*

DESIGN INTENT NOT MANAGED THROUGH THE PROCESS AND INTO USE

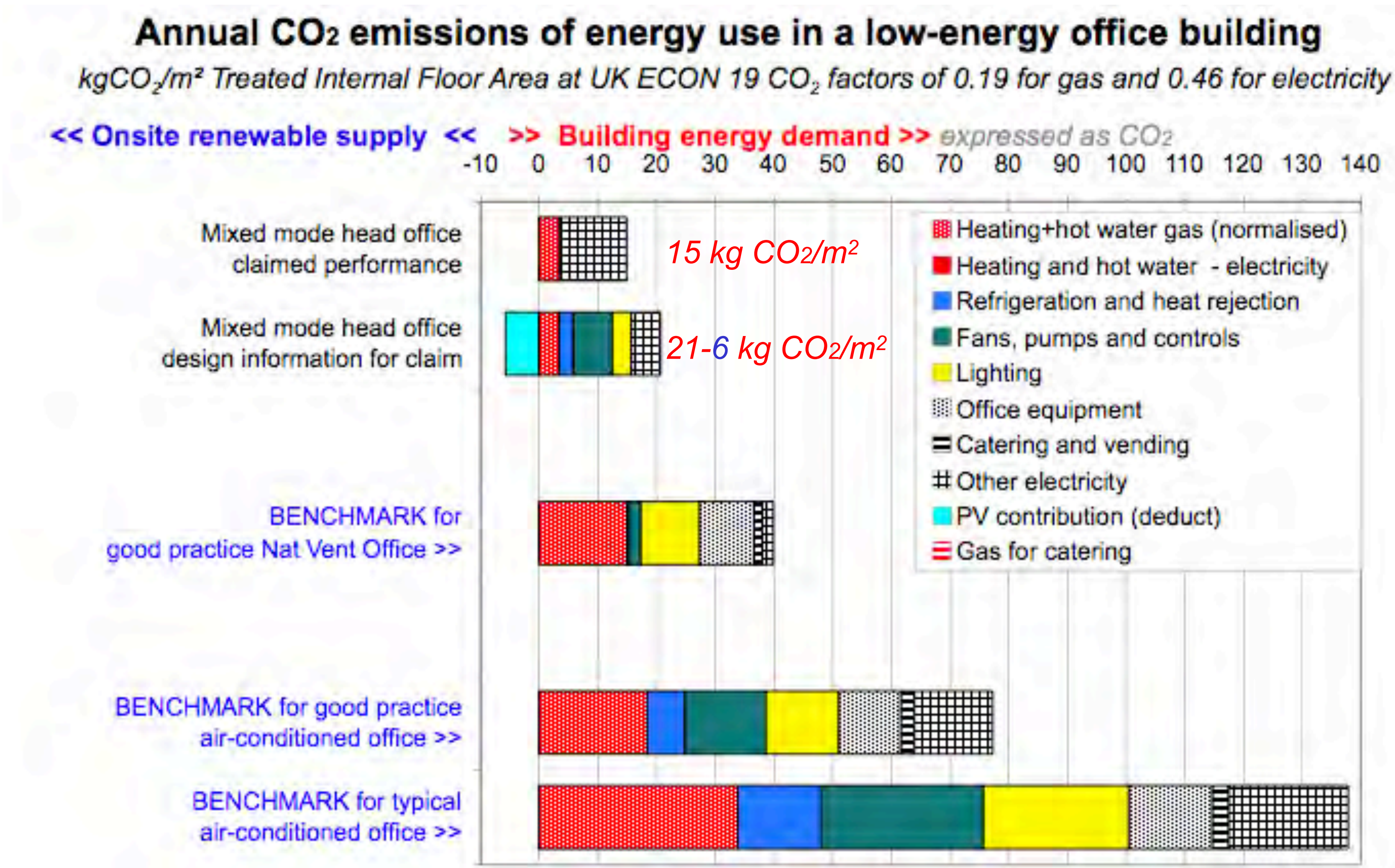
Managing expectations: an example

1: the design claim, as published



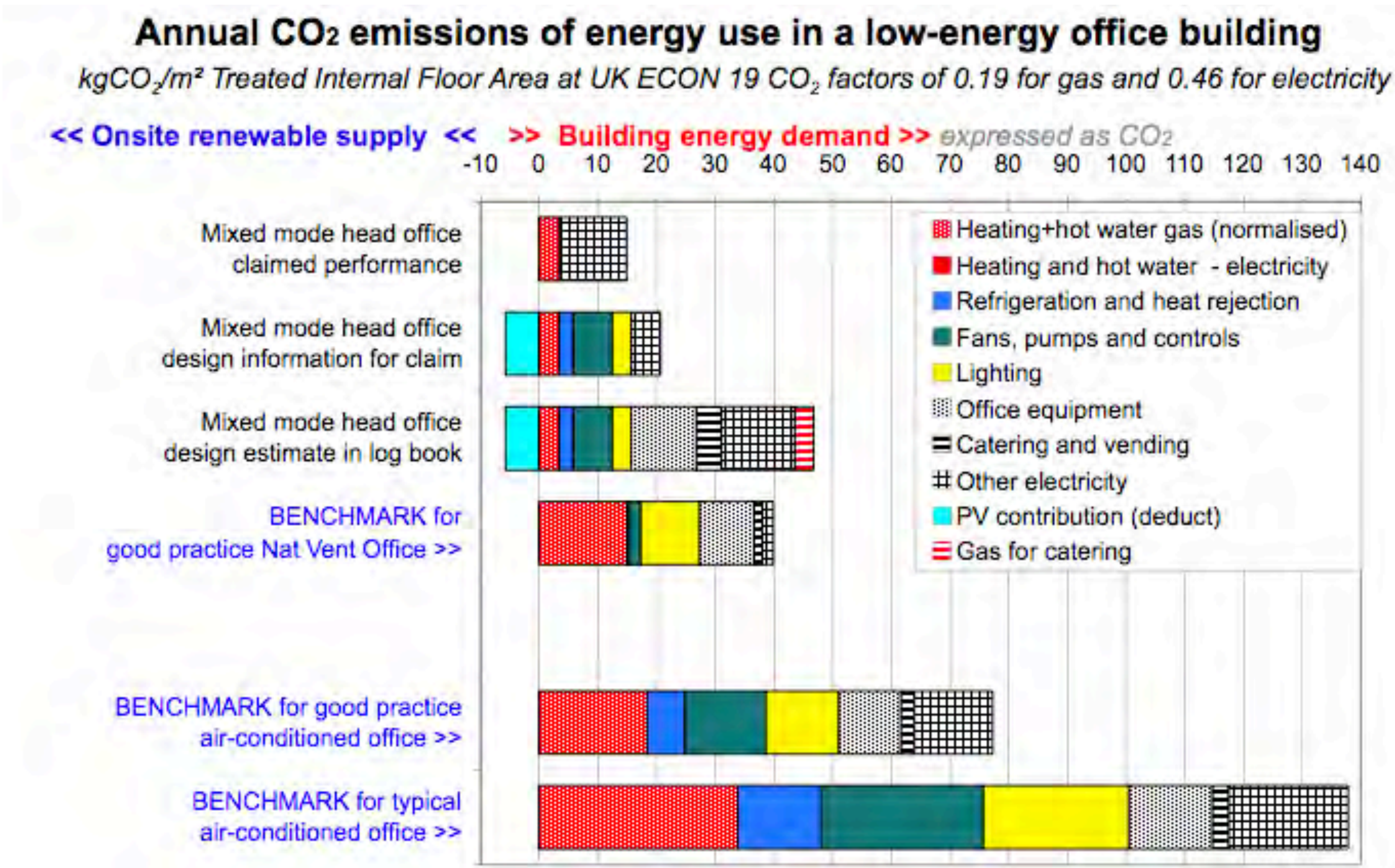
Managing expectations: an example

2: the basis for the design claim



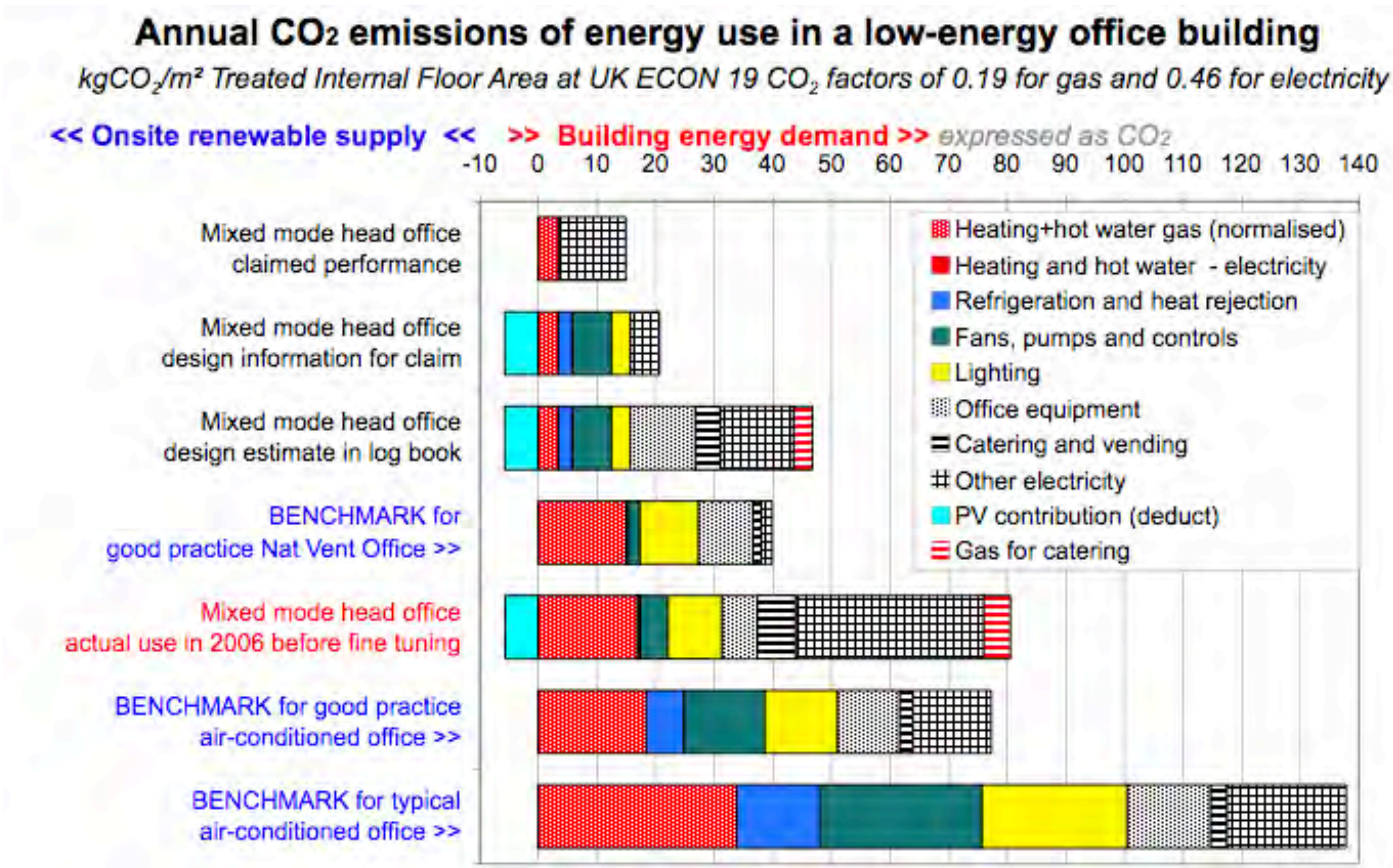
Managing expectations: an example

3: what it said in the log book supplied at handover



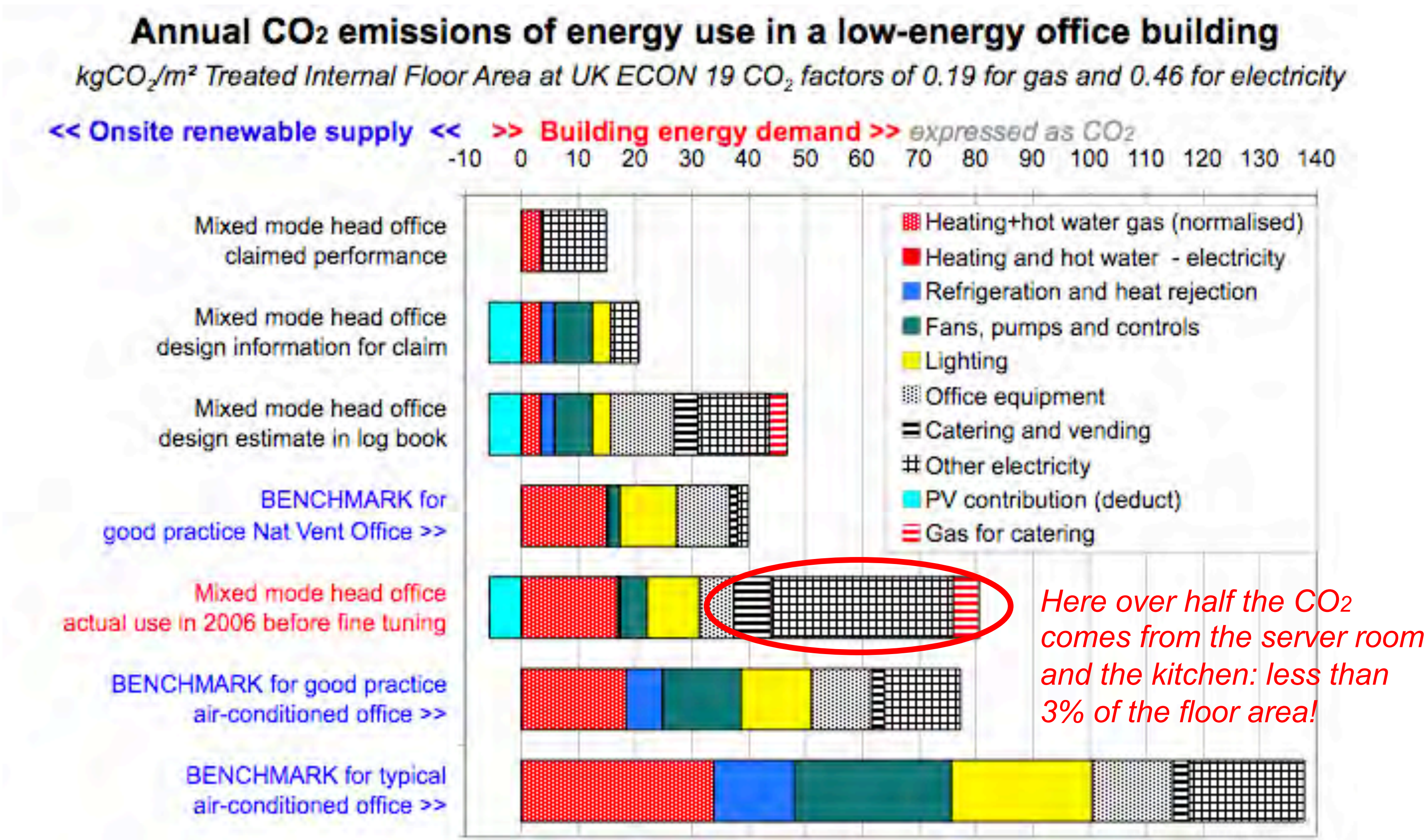
Managing expectations: an example

4: actual performance in use, before fine tuning

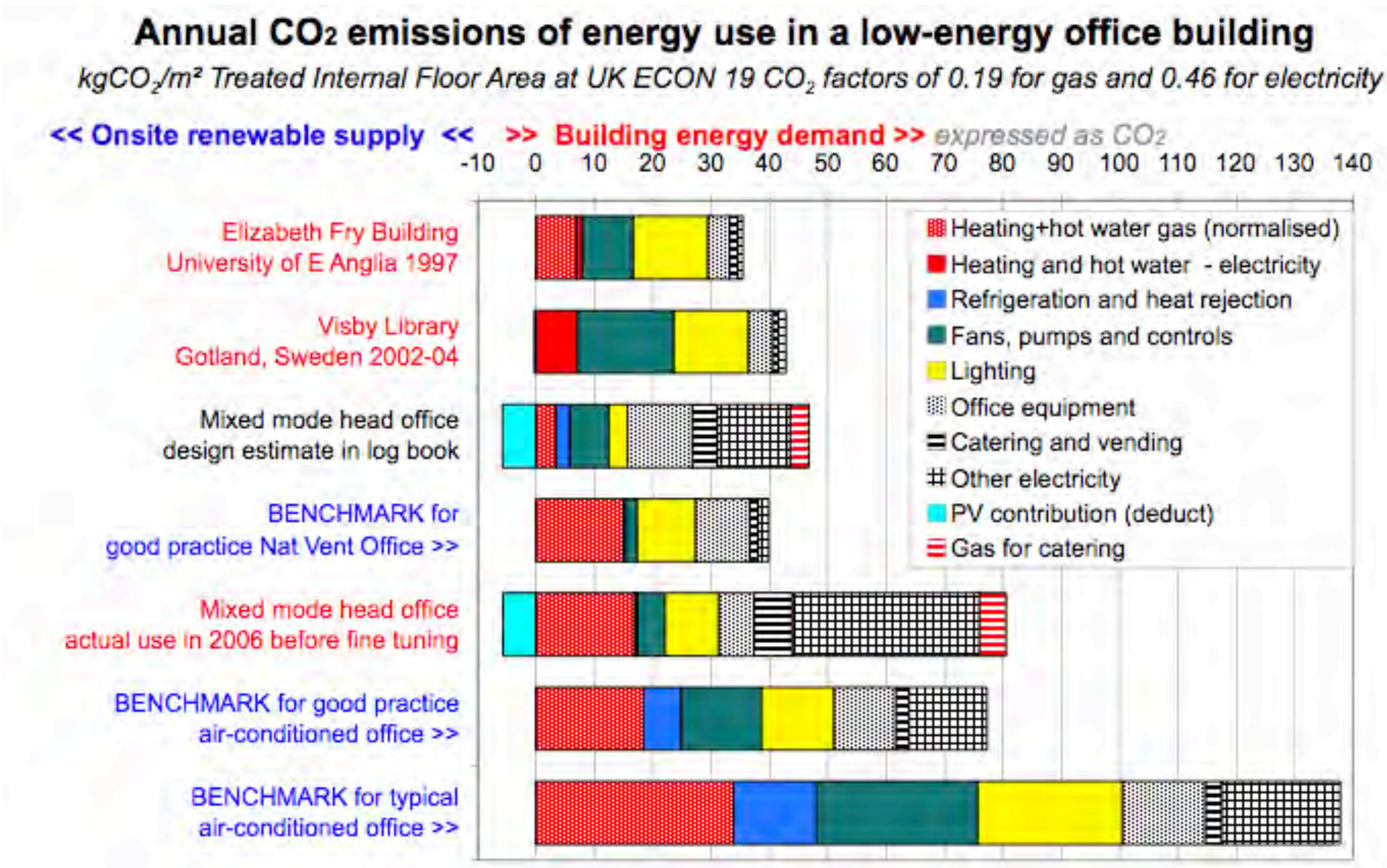


Managing expectations: an example

5: it's not all bad news, and the feedback is vital



We must learn from the fine structure:
6: how it relates to two other low-energy buildings



Soft Landings **Stage 3:**
Preparation for handover

- **A change in concept:** Handover becomes an event within an extended *Finish* stage, not the point at which the design and building team sign off and walk away.
- **Preparation for operational readiness** includes not just the static and dynamic commissioning of the fabric and building services, but much closer engagement with the occupier's move-in and their management and maintenance team, *if they have one.*
- **Preparation for aftercare,** with representatives of the design and building team on site after handover. *The time allocation depends on the size and complexity of the project - it might be one person for half a day a week or less, or much more.*
- **If there is unfinished business,** e.g. owing to a forced early handover, then the *golden thread* is easily carried through into STAGE 4: initial aftercare and fine tuning.

FEEDBACK: Early appointment of a facilities management team is not enough, they also need to be brought into the process deliberately.

Soft Landings **Stage 3:**
Preparation for handover

Do not remove from: *Post room*

Building Log Book

Facilities manager to complete green italic sections

Building Log Book

New Central Offices for the National Trust

Heelis
Kemble Drive
Swindon
Wilts
SN2 2NA
tel: 0870 242 6620

Building owner
National Trust

Facilities manager responsible for log-book: *Liz Adams* Signed:

Emergency contact details

This building log book was prepared by Max Fordham LLP,
42-43 Gloucester Crescent,
Camden, London.
Tel 0207 267 5161.
email - post@maxfordham.com

Log book version: *1* Date: *02/08/2005*

This building log book is analogous to a car handbook, providing the facilities manager with easily understood information about how the building is intended to work. It also allows ongoing building energy performance and major alterations to be recorded.

Please ensure that this log book is kept up-to-date and in a readily accessible (designated) position, e.g. in the main building operations room. It contains important information for anyone carrying out work on the building and its services.

This log book is to be kept at all times in: *Post room.*

Electronic version is kept at: Server/PC directory name and file name

Page 1/31

Section 3: Operating and Maintenance Instructions

CRITERION 5 – PROVIDING INFORMATION

82 In accordance with Requirement L1(c), the owner of the building should be provided with sufficient information about the building, the ***fixed building services*** and their maintenance requirements so that the building can be operated in such a manner as to use no more fuel and power than is reasonable in the circumstances.

Building log-book

83 A way of showing compliance would be to produce information following the guidance in CIBSE TM31 Building Logbook Toolkit[32]. The information should be presented in templates as or similar to those in the TM. The information could draw on or refer to information available as part of other documentation, such as the Operation and Maintenance Manuals and the Health and Safety file required by the CDM Regulations.

84 The data used to calculate the ***TER*** and the ***BER*** should be included in the log-book.

It would also be sensible to retain an electronic copy of the input file for the energy calculation to facilitate any future analysis that may be required by the owner when altering or improving the building.

Soft Landings **Stage 4:** *Initial aftercare*

- **Design and building team members visit regularly:** *who and how many visits will depend on project.*
- **They need a home in the building where they are visible to occupants,** *not be hiding in the site hut.*
- **They explain the building to the users,** *in simple guides and in one or two introductory events.*
- **They help the management to take ownership,** *the occupier must take the initiative, not stand back.*
- **They keep people informed,** *e.g. via a newsletter on the organisation's website, e.g. alerting to any problems.*
- **Troubleshooting and fine tuning can be undertaken,** *the best insights have been where the soft landings team does some of its own work in the building and experiences its facilities.*

FEEDBACK: Contractors find it difficult to engage properly.
Aftercare priorities are different from just dealing with snags and defects.

Without aftercare, designers may never learn from unintended consequences

Occupant dissatisfaction with gloomy solar film

After refurbishment of a university building in 2014

SOFT LANDINGS FOR SCHOOLS

Case Studies

Feedback from use of the Soft Landings Framework in new schools

Edited by Mike Buckley, Bill Bordass and Roderic Bunn

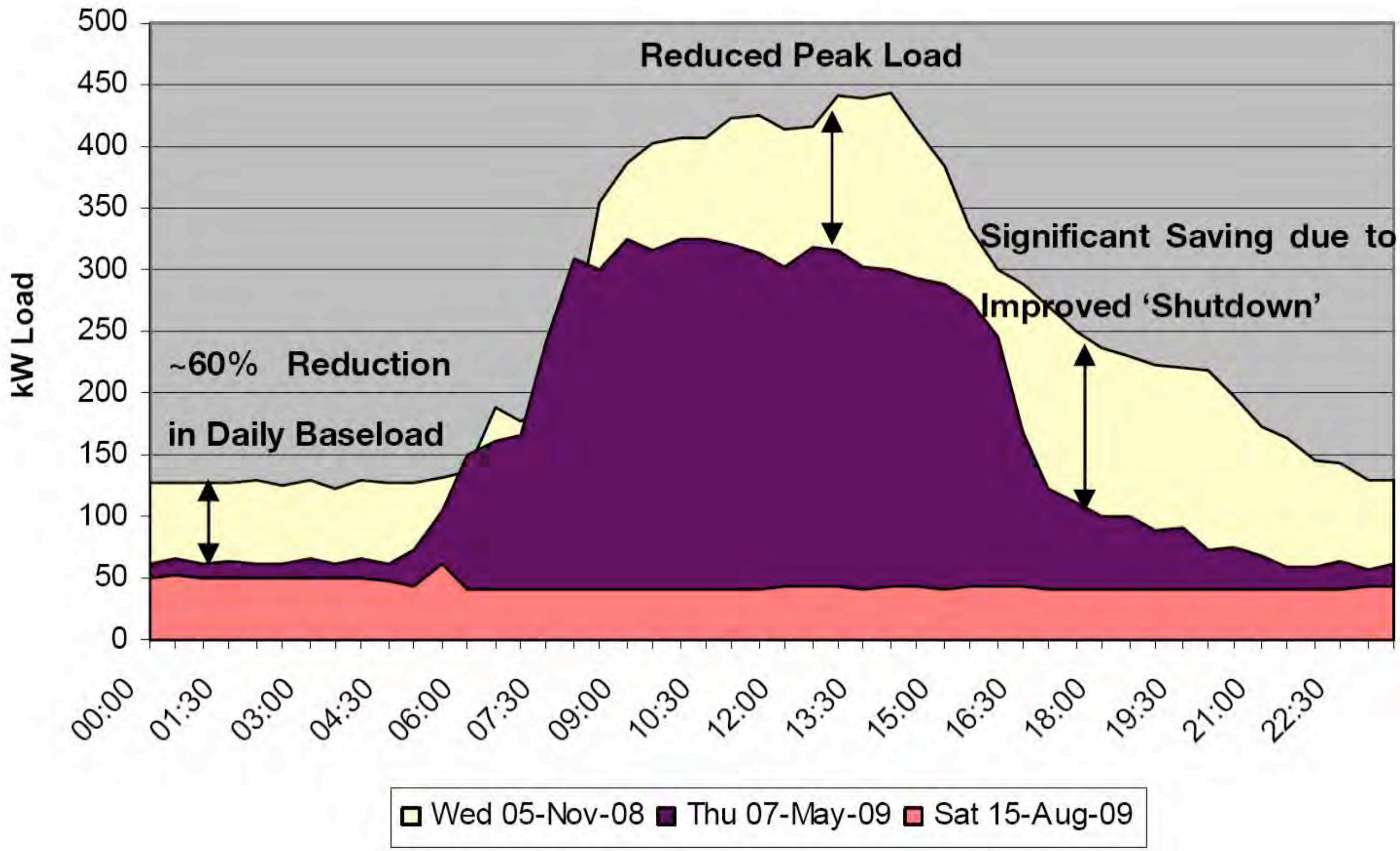
BSRIA BG 9/2010

SOFT LANDINGS

Research funded by
Technology Strategy Board

Follow-through can pay for itself

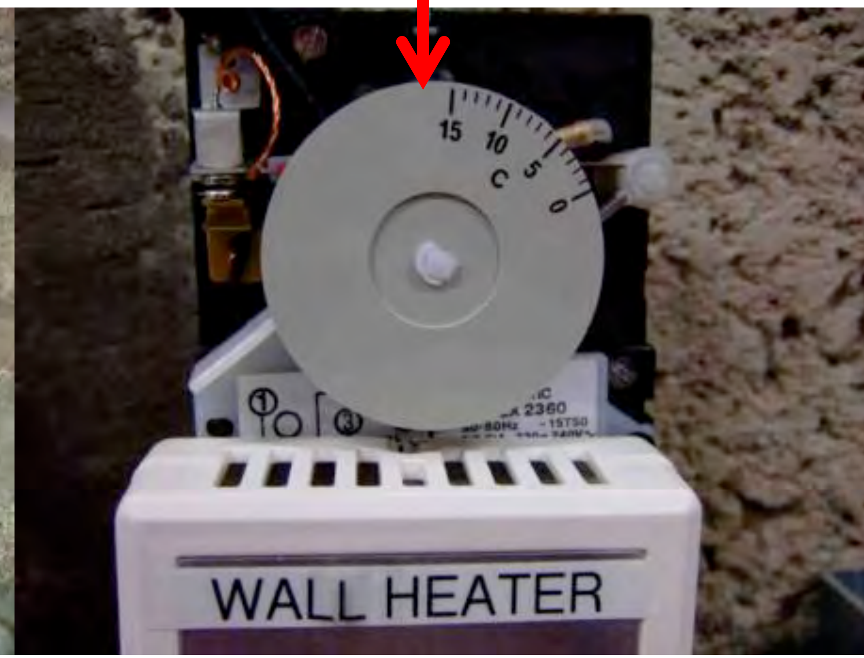
Intervention in a new secondary school



Saving over £ 50,000 p.a. in electricity bills: avoid default to ON

SOURCE: Buro Happold Engineers, *Soft Landings Trials* (2009).

Stages 4+5 can trap unintended consequences:
Example: sprinkler frost protection in a primary school



In 2008-09, this frost thermostat *(improperly set at 17° C on installation)* energised the wall heater in the sprinkler pump room. Over a year, this wasted more electricity than the wind generator *(intended to offset the entire building's annual heating energy use)* produced.

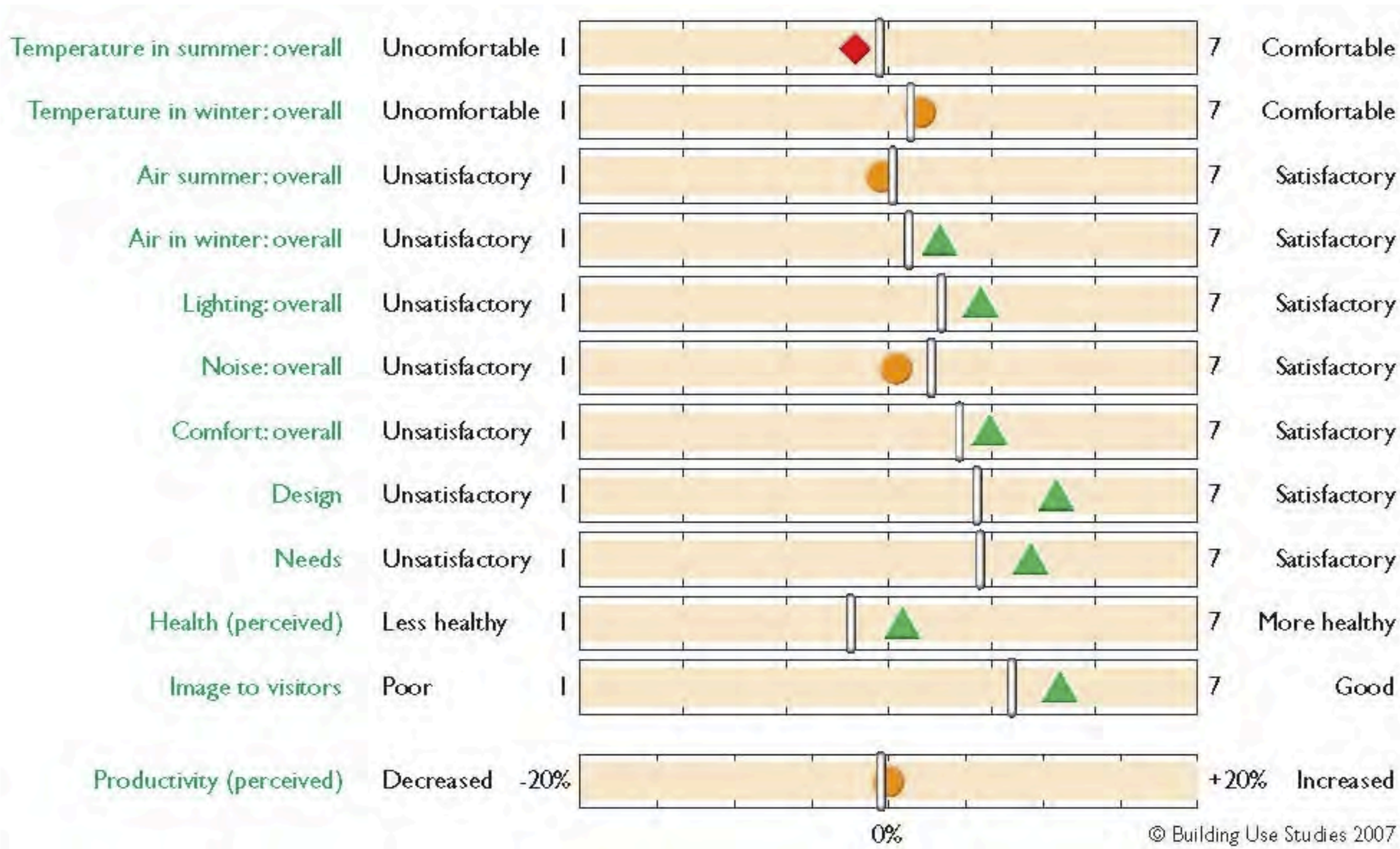
Soft Landings **Stage 5:**
Monitoring, evaluation and feedback

- **Extended aftercare period,** typically two or three years.
- **Occupiers must take ownership** and do most of the monitoring themselves. *They may need motivating.*
- **Independent post-occupancy evaluation (POE) can be included,** e.g. for occupant surveys, energy analysis & structured discussions. *Independent review & benchmarking can be helpful and reassuring.*
- **The findings can be fed through rapidly,** *e.g. to fine tune the systems, refine use and operation of the building and plan upgrades.*
- **The learning can also be spread much more widely,** via the people and organisations involved, and beyond.

FEEDBACK: Often this has needed external funding.
How can we make it routine? The value that can be added is enormous.

We can't afford not to do it; and it can be done with a light touch.

BUS questionnaire survey at Heelis



The building was subsequently tuned and satisfaction improved, then deteriorated after savings on FM, which were later restored.

SPREADING THE WORD:
Heelis designers report back in public

bsj building services journal: the magazine of CIBSE

Ba-graph-1-.jpg

2007-Study.jpg

Images

Building Analysis

So, how are you doing?

November 2007

Heelis, the National Trust's HQ in Swindon, is two years old. Senior engineer at Max Fordham Guy Nevill, who helped design it, takes a look at how it's been performing

By Guy Nevill

When the National Trust decided it needed a new headquarters to bring together staff from four different sites around the country, sustainability was a big part of the brief. The new building, Heelis, has now been in use for two years, so it is a good time to review how it is performing.

The Heelis complex, which covers about 7000m2 and accommodates 470 people, was designed by architect Feilden Clegg Bradley with Max Fordham as M&E consultant. The site in Swindon once formed part of Isambard Kingdom Brunel's Great Western Railway Works. The total cost was £16.73 million.

SOURCE: Building Services Journal, 32-37, (November 2007).

GAINING CLIENT CONFIDENCE:
Heelis FM comments in 2007

Heelis building facilities manager **Liz Adams** educated the staff on what to expect from their new home. "We told users not to expect stable conditions. We call it a 'layers building' as it won't suddenly react to changes in weather conditions, but take a while to heat up and cool down. So we remind people in September to bring in a cardigan.

"In the Autumn, when the outside temperature drops overnight, the building won't necessarily react immediately. So out come the cardies.

"Comfort has been better in year two as the building has settled into a pattern. People are far more used to how the building's systems work. The biggest problem is managing expectations about what the building will do in summer.

"We commissioned Max Fordham' to carry out monitoring and fine tuning in the first two years. We have a good relationship with the design team – it's been fantastic."

SOURCE: R Bunn, *Trust in construction,* BSRIA Delta T, 10-13, (March 2007).

Feeding forward in phased projects:

Window control improvements at Cambridge Maths building

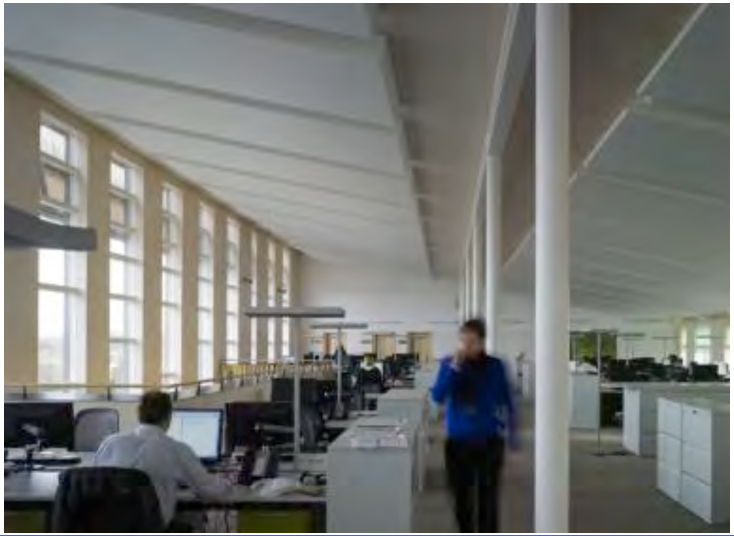
PHASE 1 **>>>**

- Difficult to understand
- Some poorly located
- Remote control problems

PHASE 2

- Improved, custom design
- Better located
- Not yet perfect

Feeding forward between projects:
National Trust to Woodland Trust



For further reading, see B Bordass et al, *Trees of Knowledge,* CIBSE Journal 20-26 (October 2014).

Soft Landings:
Everybody can win

- Better communication, proper expectations management, *fewer nasty surprises.*
- More effective building readiness. *Less rework.*
- Natural route for feedback and Post-occupancy evaluation, *to improve the product and its performance in use.*
- Teams can develop reputations for customer service and performance delivery, *building relationships, retaining customers, commercial advantage.*
- Vital if we are to progress towards more sustainable, low-energy, low-carbon, well-liked buildings and refurbishments, *closing the credibility gaps.*

SO WHAT IS STOPPING US?

- *ATTITUDES: Everybody needs to be committed, starting with the client - perhaps the biggest obstacle. The "golden thread" needs to be put in place.*
- *PROCESSES: There is a learning curve to pay for (probably best from marketing budgets), and the feedback has to be managed.*
- *TECHNIQUES: Independent POE surveys cost money (but not much).*
- *CAPACITY: We need facilitators, investigators, troubleshooters and fixers.*
- *MONEY: Particularly allocation for tune-up etc. after practical completion.*
- *IMAGINATION: Often constrained by burgeoning bureaucracy!*

THE FUTURE: Move from design for compliance to *Design for Performance*

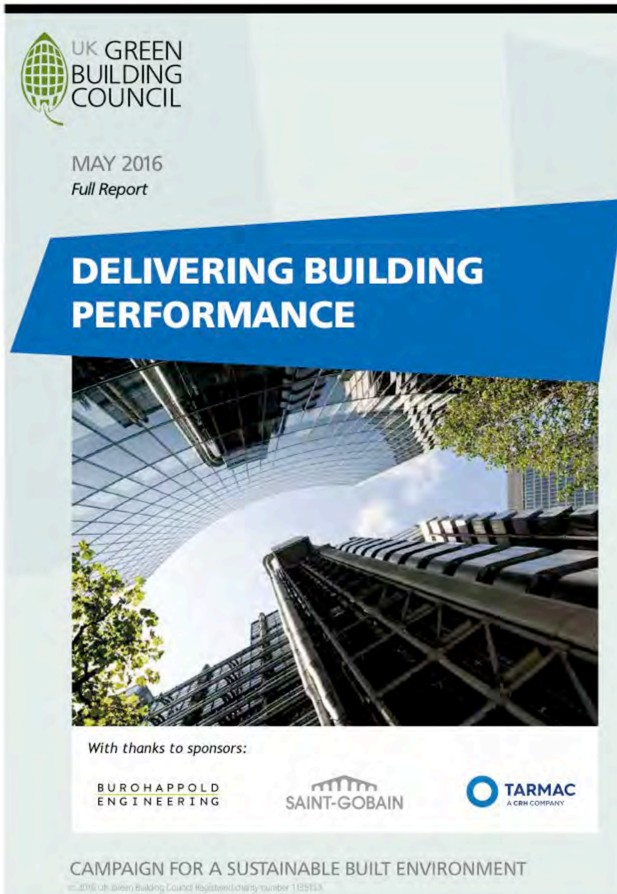
BBP | BETTER BUILDINGS PARTNERSHIP | OUR RESOURCES | OUR MEMBE

Design for Performance

The Design for Performance Project is an industry initiative led by Verco and including BSRIA, Arup and the Usable Buildings Trust (UBT), and supported by the BBP, which aims to change the way we design new office developments in the UK. The project looks abroad to the hugely successful Australian NABERS Commitment Agreement and explores the applicability and opportunity of developing and testing such a framework in the UK.

The energy efficiency of new offices in the UK is subject to Building Regulations Part L and represented in market transactions by Energy Performance Certificates (EPCs). Developers, owners and occupiers of new and refurbished buildings might reasonably expect that these mechanisms will produce a building that is energy efficient in operation. However, both focus on design and technology that improves predicted building performance, not on achieving directly measureable improvements in performance in-use.

The consequence has been a *design-for-compliance* culture, and a disconnect between the regulatory framework and the influence it has on the energy use and associated carbon emissions it is supposed to be limiting – the so-called 'Performance Gap'. Voluntary



SOURCE: http://www.betterbuildingspartnership.co.uk/node/360.

Design for Performance CAs - *Commitment Agreements, as developed by NABERS in Australia*

- Developer signs up to provide guaranteed in-use energy performance for the "Base Building" – *shared engineering services (mostly HVAC) and in all the common parts.*
- All new members of the design, construction and management team sign up to a *Commitment Agreement.*
- Advanced modelling used for the engineering systems, *including assessment of controls and "off-axis" scenarios.*
- Design and Model reviewed by *independent assessors.*
- Metering systems allow *outcomes* to be reviewed.
- The completed building is *fine-tuned* as necessary.
- Results are *benchmarked and reported.*

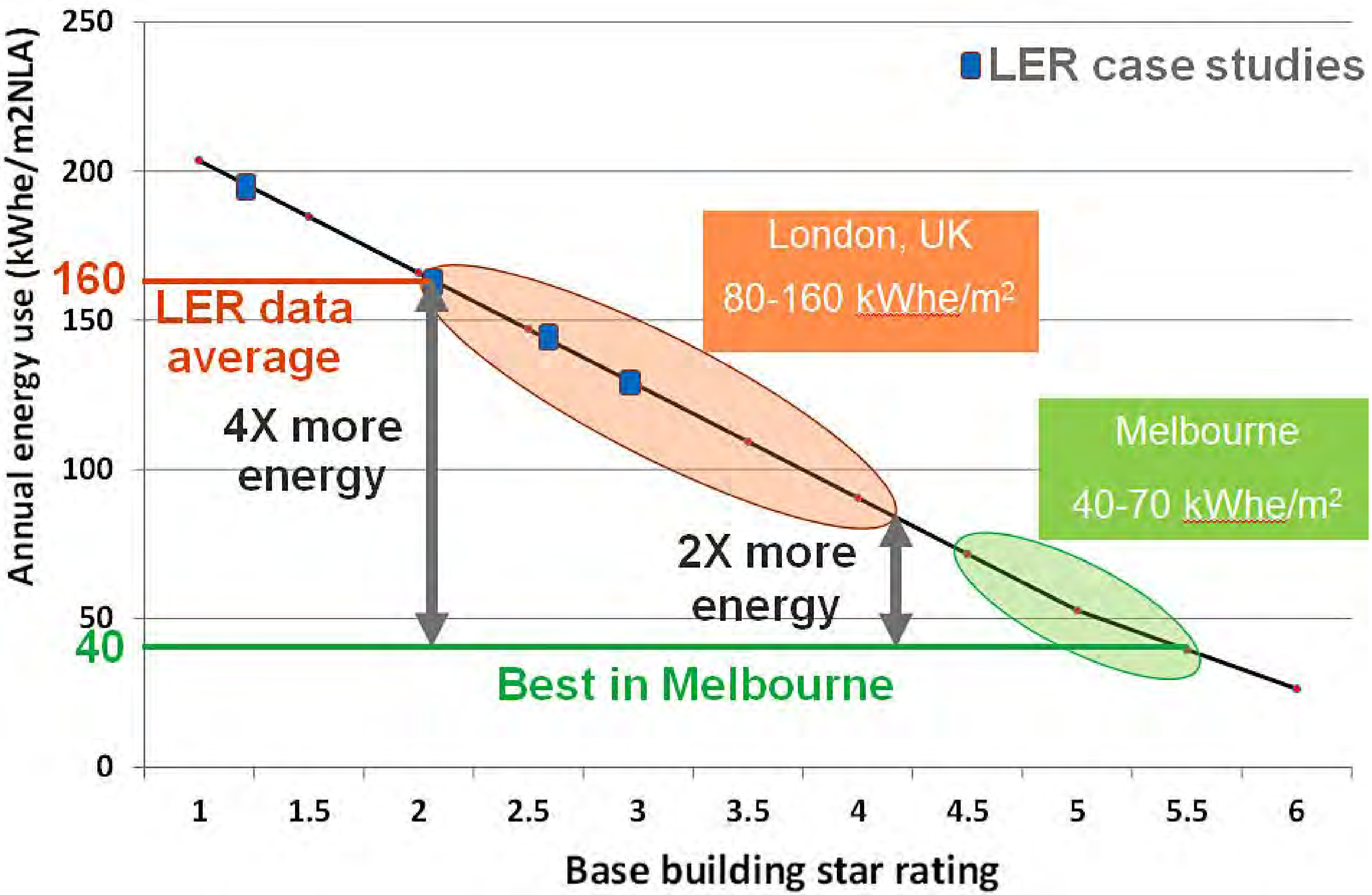
UK CONSULTANTS ARE COMING FORWARD TO SUPPORT THIS

Design for Performance - *Pioneers 2020*

Developer	Name	Location	NIA m^2	Complete
British Land	1 Broadgate	City of London	37,000	2024
Crown Estate	St James's Mkt	London	15,000	TBA
Derwent London	19-35 Baker St	London	19,000	2025
Gt Portland Estate	St Thomas Street	London	31,000	2025
Grosvenor	S Molton Triangle	London	13,500	TBA
Hermes MEPC	4 Angel Square	Manchester	18,500	2022
Hermes MEPC	Wellington Place	Leeds	21,300	2022
Landsec	Moorfields	London	48,000	2022
Landsec	Timber Square	London	32,000	2023
Lendlease	Turing Building	London	33,000	2023
L&G	Ralli Quays	Salford	12,500	2023
Royal London	Statesman House	Maidenhead	11,000	2023
Stanhope	2 Ruskin Square	Croydon	30,000	2023

SOURCE: *www.betterbuildingspartnership.co.uk/our-projects/design-performance* October 2020

Potential reward in landlord annual energy use:
London (without CAs) & Melbourne (with CAs)



SOURCE: R Cohen, P Bannister, B Bordass, *NZE buildings in reality, not just in theory,* REHVA Journal, 56-59 (May 2016).

Conclusions

- If we are to meet the challenges of sustainability, the role of the building professional must change.
- We need to be concerned not just with inputs and outputs, but in-use outcomes.
- We need to follow-through, reflect, close the feedback loop and initiate virtuous circles.
- This all needs leadership, *not more rules and processes.*
- Building performance in use needs to become an independent knowledge domain, properly resourced in the public interest. *It's too important to leave to the construction industry!*

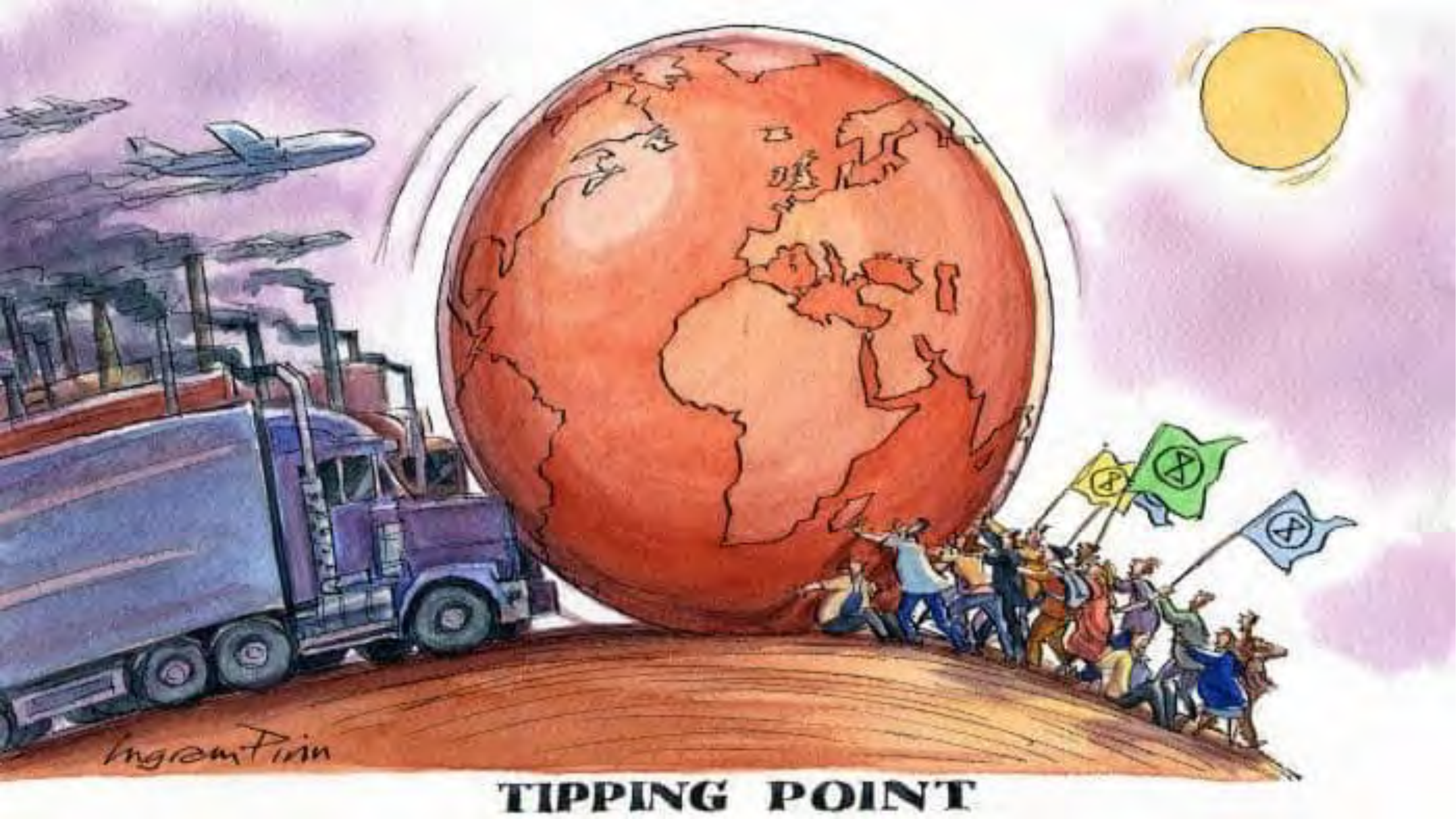
FUTURE PRACTICE? New professionals
follow design intent through into reality

- They understand what is needed — *strategic briefing*
- Are clear what they want, and communicate it plainly — *strategic design*
- Are ambitious, but realistic — *question all assumptions, understand users*
- Follow things right through — *e.g. using **Soft Landings** procedures*
- Review what they do — *manage expectations, undertake reality checks*
- Make others aware of what they are after — *specify: what, why and how*
- Check that things will work — *technical feasibility, usability and manageability*
- Get things done well, with attention to detail — *communicate, train, inspect*
- Finish them off — *commission, operational readiness, handover, dialogue*
- Help the users to understand and take ownership — *provide aftercare support*
- Review performance in use — *including **post-occupancy evaluation***
- Work with occupiers to make things better — *monitoring, review and fine tuning*
- Anticipate and spot unintended consequences — *revenge effects**
- Learn from it all — ***and share their experiences***

TRY TO MAKE THINGS SIMPLER AND DO THEM BETTER …
only making them complicated where this is essential.

*For Revenge Effects see: E Tenner, *Why Things Bite Back,* 4th Estate (1996).

Thank you **Final Questions**?



www.usablebuildings.co.uk