Usable Buildings and the Performance Gap

Adrian Leaman

Usable Buildings Trust | Building Use Studies

Friday, February 8, 2013

Links enabled in pdf with live web connection

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Usable Buildings is a free resource for practitioners, managers, building owners, developers, students and anyone else who wants to make buildings more suitable for the people who use them, less damaging to the natural environment and a better long-term investment. Usable Buildings is run by the Usable Buildings Trust.

The Usable Buildings Trust is a UK educational charity, dedicated to improving the performance of buildings in use. We try to understand how buildings actually work in practice, and create a feedback loop from in-use performance to improved delivery by the organisations that can make a difference. We were set up in 2002, because buildings policy and research was becoming too focused on construction, and doing little on performance in operation in the hands of their users. UBT spreads findings through its website, user groups, collaborative working and input to postgraduate courses. UBT is also a home for approaches which are not quite ready for widespread application and an incubator for their development. Aims Background

Who we are and what we do:
Trustees' Report summarises activities and plans. What Do We Do?

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Topical Oldie: Usability in Buildings: the Cinderella subject

Basics: POE and Feedback: Getting Started | Probe 9 | A Guide to Feedback and Post-Occupancy Evaluation |

One liners: "What we want is a quiet life except when there are problems, when we want good information quickly." Ian Walmsley | "This is a very, very bad question." Renzo Piano | "If at first you don't succeed, try, try again. Then quit. There's no point in being a damn fool about it." W.C. Fields | "Every time history repeats itself the price goes up." John Tainter | "When you read 1984, were you aware that it was a novel, not an instruction manual?" Tweet to Tony Blair Q&A session | "[In the 20th century] ... we built a really inefficient environment with the greatest efficiency ever known to man" Andy Karsner | More

Hosting : We host the Feedback Portfolio: Techniques and the Probe archive.

Support : We developed and support Soft Landings.

Searching : Most of the material available here is in pdf files, about two-thirds of which are password protected. If you wish to search within files that are not password protected use the Google search syntax:"filetype:pdf site:www.usablebuildings.co.uk*search term*" . Example: for articles on health type in the Google search area: "filetype:pdf site:www.usablebuildings.co.uk health" Show example

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Monday, February 4

Myths about building performance ...

Major capital investment is needed to improve building performance.

In fact relatively minor changes to control, management, space and equipment can often have large effects.

Where capital investment is required, start with the fabric.

Yes, for new construction. *However, in existing buildings the engineering services, equipment and controls are usually more important, unless there are major shortcomings with the fabric. Habits, operation and management are also prime considerations.*

Building performance is a matter for the construction industry.

No, it is much broader than that. Building use needs to be well represented. Designers and builders have normally walked away at handover.

Cue: Usable Buildings Trust

Innovative technologies are the key to better performance.

No, often the innovations required are to bring people, processes and products together in subtly different ways for markedly better results, and with only minor technical changes, e.g. for better usability.

Cue: Soft Landings.

Modelling can provide all the answers.

No, we need feedback of actual performance.

Cue: Real-world research.

More technology produces better buildings.

Not if the technologies require too much integration, support and maintenance. Simpler buildings with attention to detail often perform better.

Generic catch-alls?

Not normally. Context, constraints and options are the (hidden) briefing keys.

But exceptions prove the rule!

Evidence from Irish Generic Schools programme.

ISSN 2072-7925
Ireland's generic repeat design schools programme
CELE Exchange 2011/5

Ireland's generic repeat design schools programme

By Tony Sheppard, Department of Education and Science, Ireland

The Irish Department of Education and Skills (DoE) is strongly committed to energy efficiency and to reducing CO_2 by developing and implementing energy level ceilings in relation to school design that aim to remain below half of the accepted good practice in the field. This approach works within normal departmental budgetary limits to create school buildings that are breaking ground for building designers.

INTRODUCTION

Practical simplicity

The DoE's Planning and Building Unit is now developing low-energy educational buildings with the help of generic repeat design (GRD). This is a programme delivering many primary schools, not just a single demonstration prototype building. To minimise risk on so many projects, it brings together proven-in-use technologies. It is significant because of the practical simplicity of its low energy design and repeatability on sites with varied orientations.

South-facing two-storey classroom block and entrance of first-completed GRD school

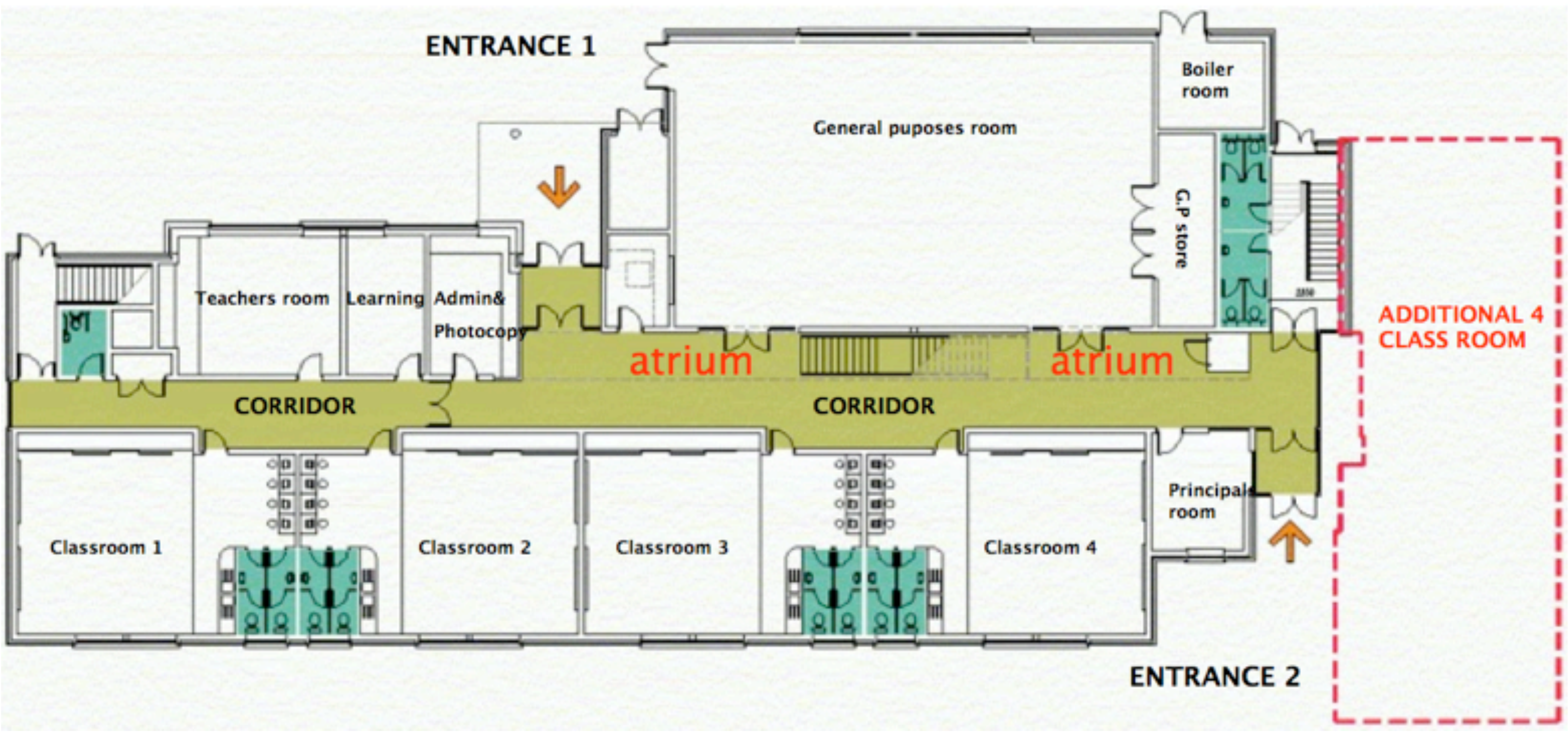
© David Barbour/BDP

Precedent

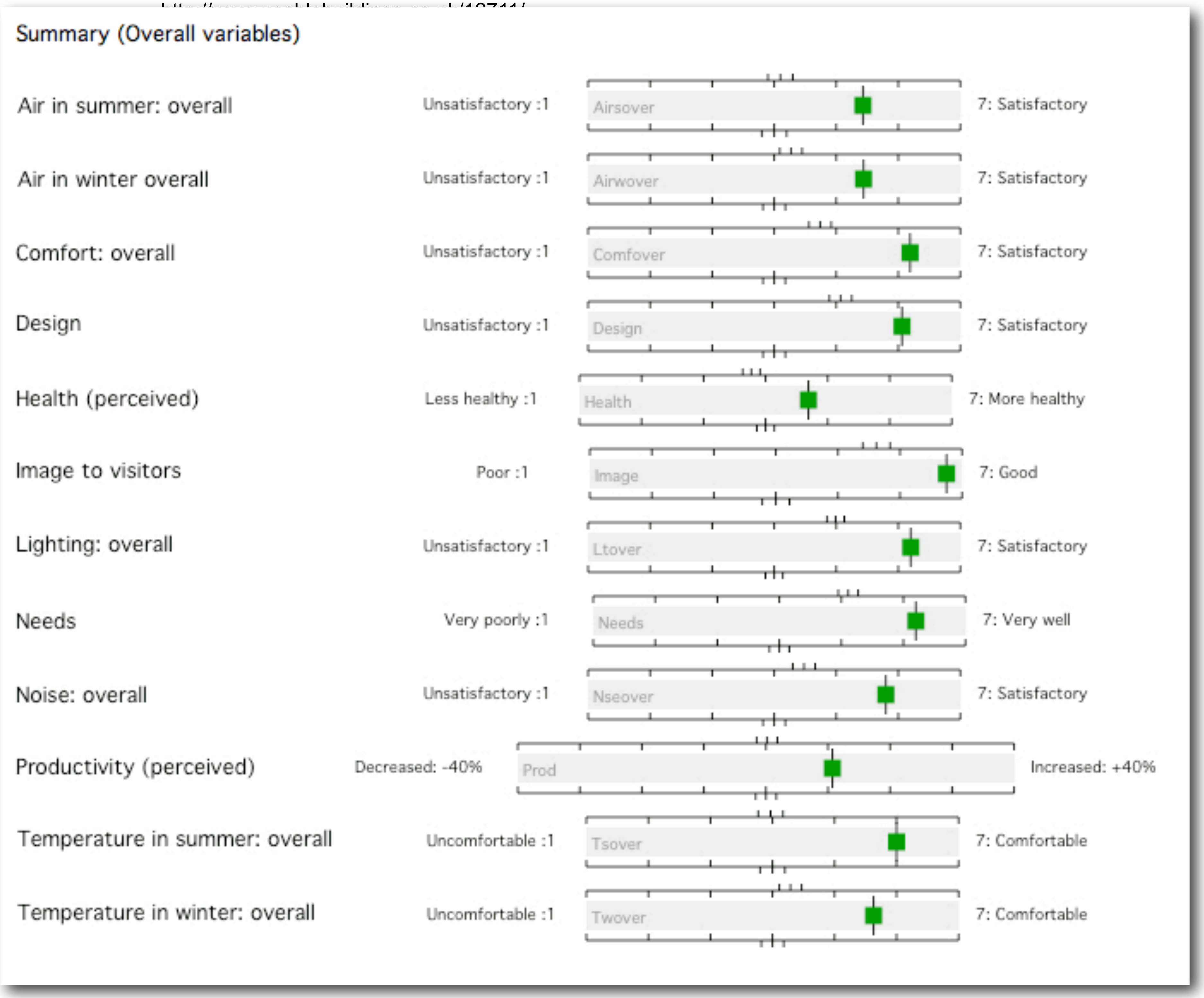
There are clear precedents in Ireland for the use of highly refined standard school plans as part of the government's response to the demands of providing accommodation for large numbers of pupils. The GRD has evolved this procurement method with complete superstructure tender packages available.

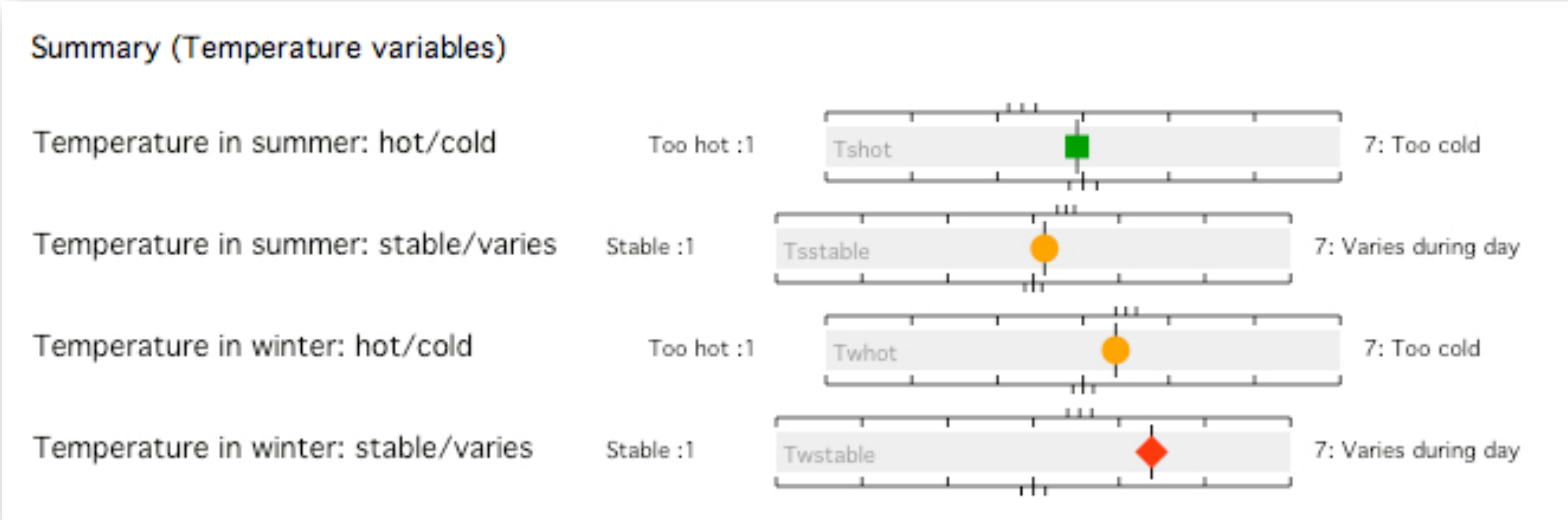
Previous research

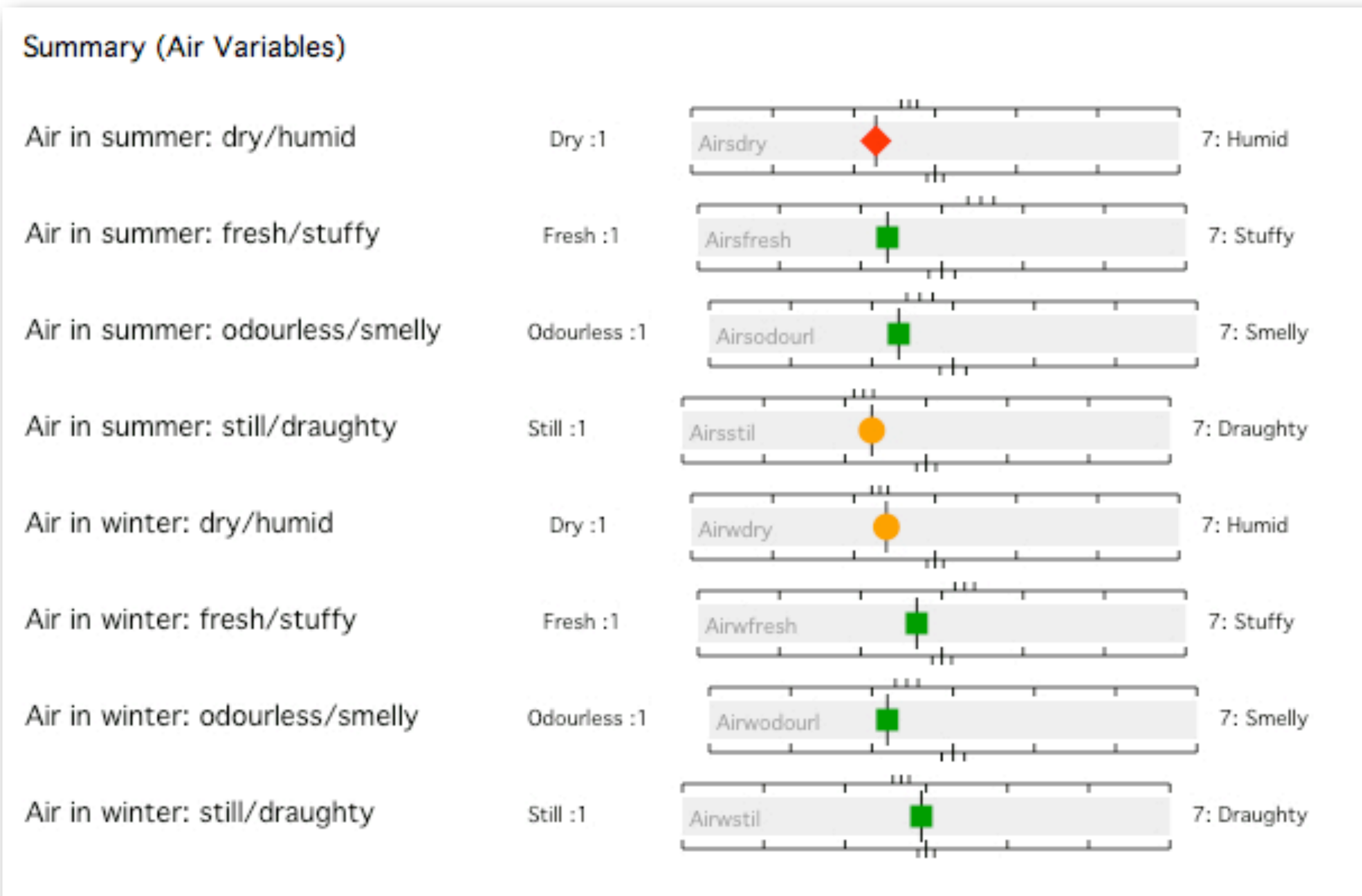
Given the requirement to minimise risk on multiple projects, the GRD brings together all currently available proven and tested-in-use technologies.

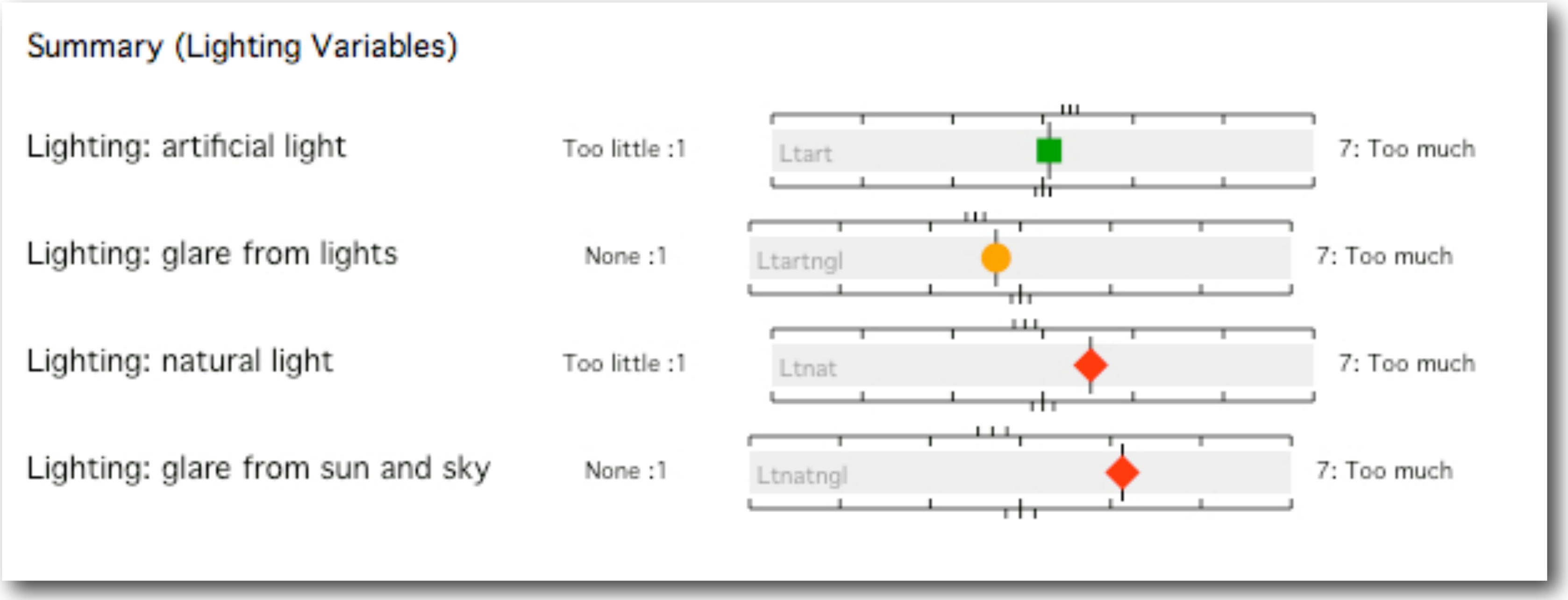


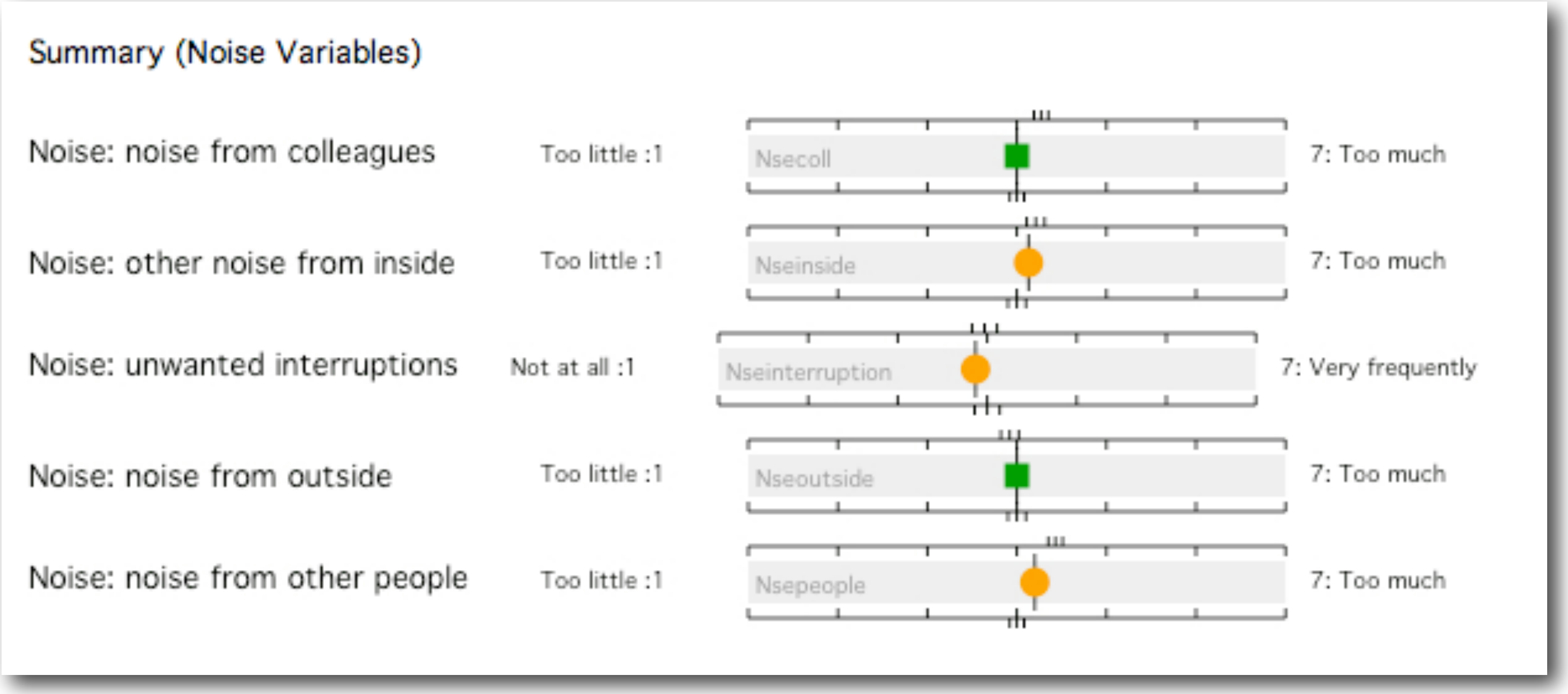
GRD Schools Ireland download


Summary (Overall variables)
Air in summer: overall
Unsatisfactory :1
Airsover
7: Satisfactory
Air in winter overall
Unsatisfactory :1
Airwover
7: Satisfactory
Comfort: overall
Unsatisfactory :1
Comfover
7: Satisfactory
Design
Unsatisfactory :1
Design
7: Satisfactory
Health (perceived)
Less healthy :1
Health
7: More healthy
Image to visitors
Poor :1
Image
7: Good
Lighting: overall
Unsatisfactory :1
Ltover
7: Satisfactory
Needs
Very poorly :1
Needs
7: Very well
Noise: overall
Unsatisfactory :1
Nseover
7: Satisfactory
Productivity (perceived)
Decreased: -40%
Prod
Increased: +40%
Temperature in summer: overall
Uncomfortable :1
Tsover
7: Comfortable
Temperature in winter: overall
Uncomfortable :1
Twover
7: Comfortable


Summary (Temperature variables)
Temperature in summer: hot/cold
Too hot :1
Tshot
7: Too cold
Temperature in summer: stable/varies
Stable :1
Tsstable
7: Varies during day
Temperature in winter: hot/cold
Too hot :1
Twhot
7: Too cold
Temperature in winter: stable/varies
Stable :1
Twstable
7: Varies during day

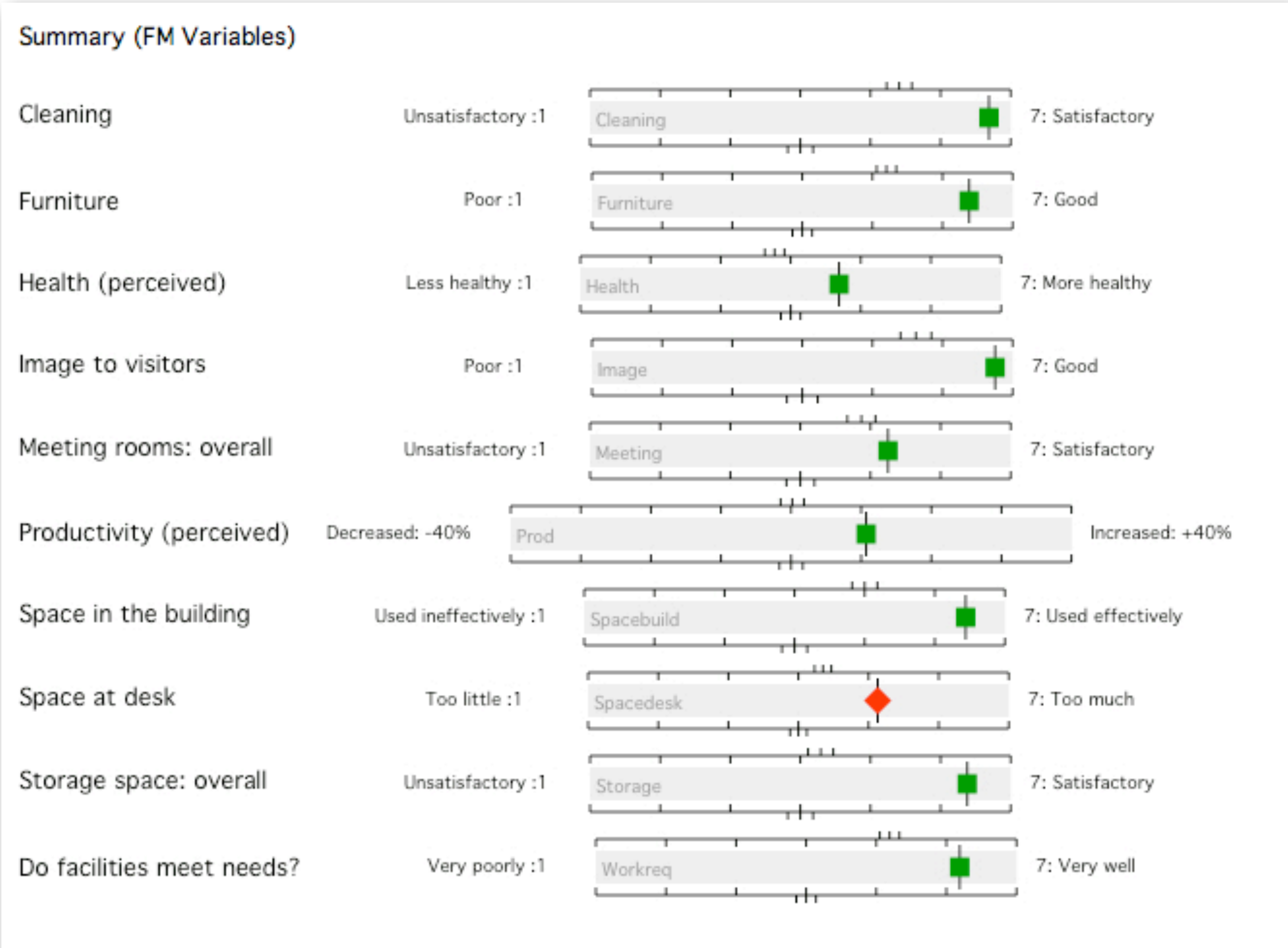

Summary (Air Variables)
Air in summer: dry/humid
Dry :1
Airsdry
7: Humid
Air in summer: fresh/stuffy
Fresh :1
Airsfresh
7: Stuffy
Air in summer: odourless/smelly
Odourless :1
Airsodourl
7: Smelly
Air in summer: still/draughty
Still :1
Airsstil
7: Draughty
Air in winter: dry/humid
Dry :1
Airwdry
7: Humid
Air in winter: fresh/stuffy
Fresh :1
Airwfresh
7: Stuffy
Air in winter: odourless/smelly
Odourless :1
Airwodourl
7: Smelly
Air in winter: still/draughty
Still :1
Airwstil
7: Draughty


Summary (Lighting Variables)
Lighting: artificial light
Too little :1
Ltart
7: Too much
Lighting: glare from lights
None :1
Ltartngl
7: Too much
Lighting: natural light
Too little :1
Ltnat
7: Too much
Lighting: glare from sun and sky
None :1
Ltnatngl
7: Too much

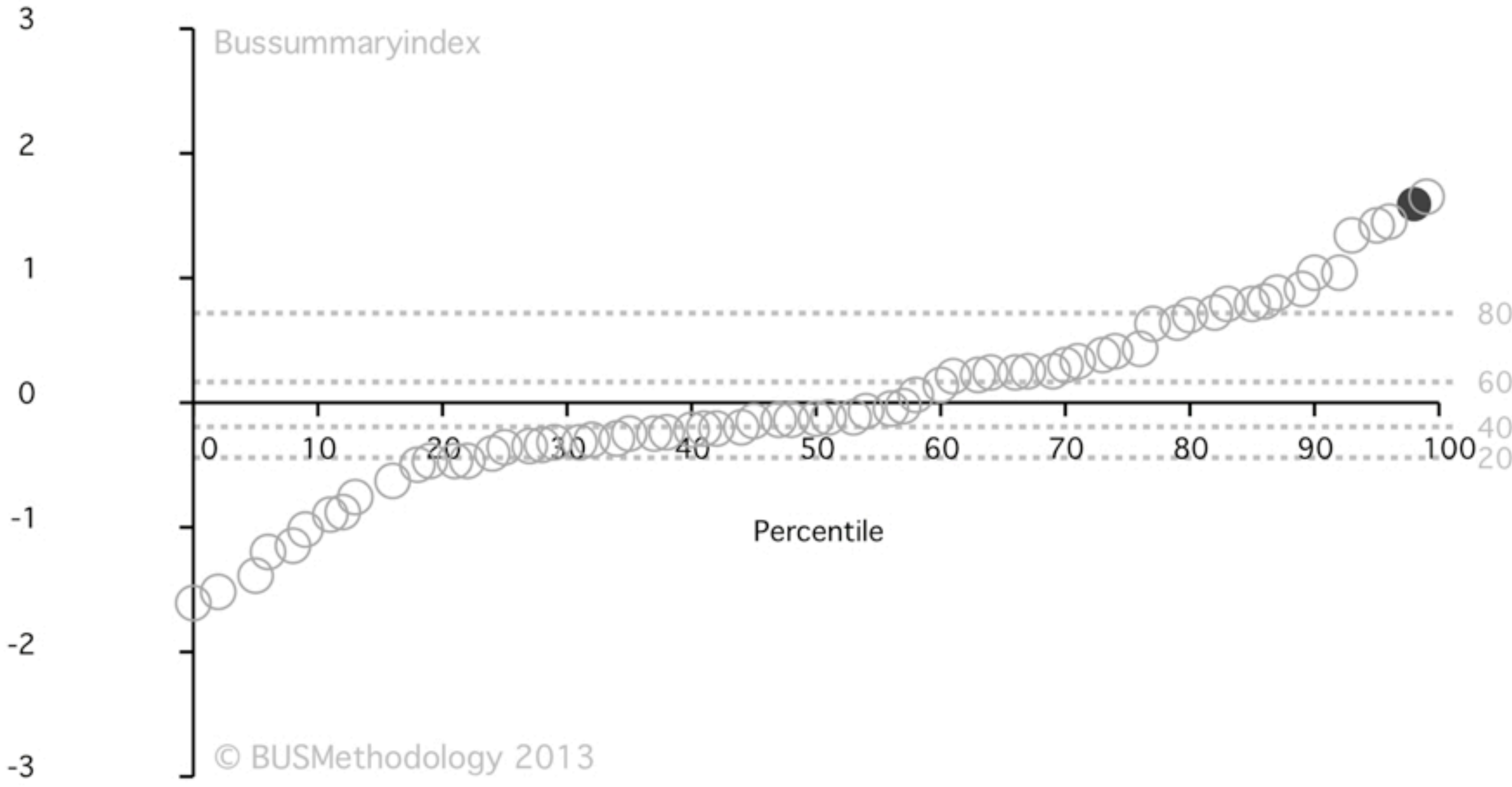

Summary (Noise Variables)
Noise: noise from colleagues
Too little :1
Nsecoll
7: Too much
Noise: other noise from inside
Too little :1
Nseinside
7: Too much
Noise: unwanted interruptions
Not at all :1
Nseinterruption
7: Very frequently
Noise: noise from outside
Too little :1
Nseoutside
7: Too much
Noise: noise from other people
Too little :1
Nsepeople
7: Too much


Summary (Control Variables)
Control over cooling
No control :1
Cntco
7: Full control
Control over heating
No control :1
Cntht
7: Full control
Control over lighting
No control :1
Cntlt
7: Full control
Control over noise
No control :1
Cntnse
7: Full control
Control over ventilation
No control :1
Cntvt
7: Full control


Summary (Design/needs Variables)
Comfort: overall
Unsatisfactory :1
Comfover
7: Satisfactory
Design
Unsatisfactory :1
Design
7: Satisfactory
Needs
Very poorly :1
Needs
7: Very well



Summary (FM Variables)
Cleaning
Unsatisfactory :1
Cleaning
7: Satisfactory
Furniture
Poor :1
Furniture
7: Good
Health (perceived)
Less healthy :1
Health
7: More healthy
Image to visitors
Poor :1
Image
7: Good
Meeting rooms: overall
Unsatisfactory :1
Meeting
7: Satisfactory
Productivity (perceived)
Decreased: -40%
Prod
Increased: +40%
Space in the building
Used ineffectively :1
Spacebuild
7: Used effectively
Space at desk
Too little :1
Spacedesk
7: Too much
Storage space: overall
Unsatisfactory :1
Storage
7: Satisfactory
Do facilities meet needs?
Very poorly :1
Workreq
7: Very well


Bussummaryindex
3
2
1
0
-1
-2
-3
0
10
20
30
40
50
60
70
80
90
100
80
60
40
20
Percentile
© BUSMethodology 2013

St John the Apostle

Total 31 kWh/m2

2011-2012 19 kWh/m2 gas 12 kWh/m2 electricity

Occupied 8:50 to 2:30 Mondays to Fridays for 183 days in the year.

Some after hour classes

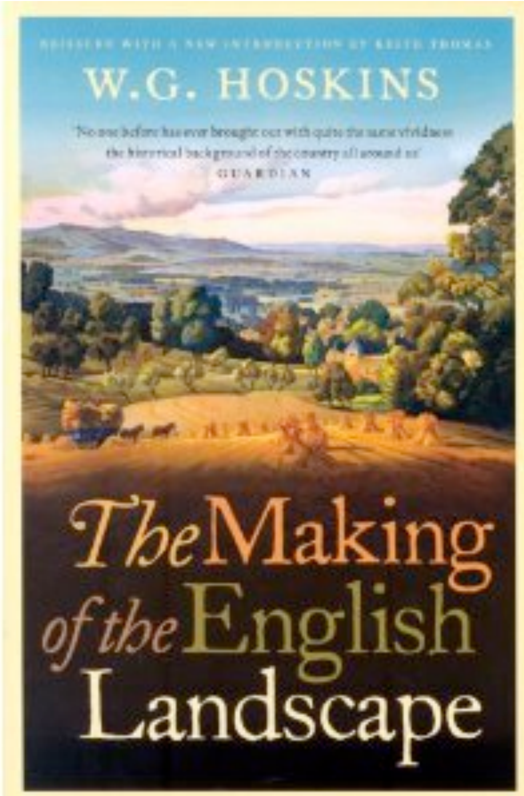
Community group on Sundays

Heating switched off from April to October,weather permitting

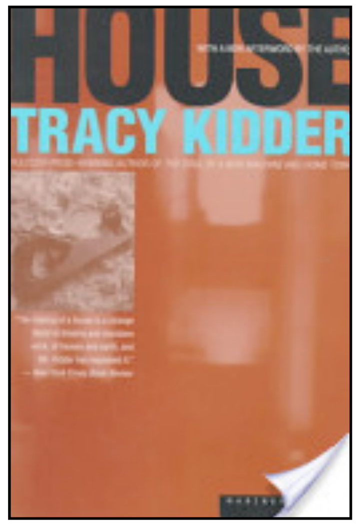
During heating season heating switched on for 2.5 hours a day on a school day and 2 hours on a Sunday.

Influences …

Multi-disciplinary, not just about design, architecture or physical form.

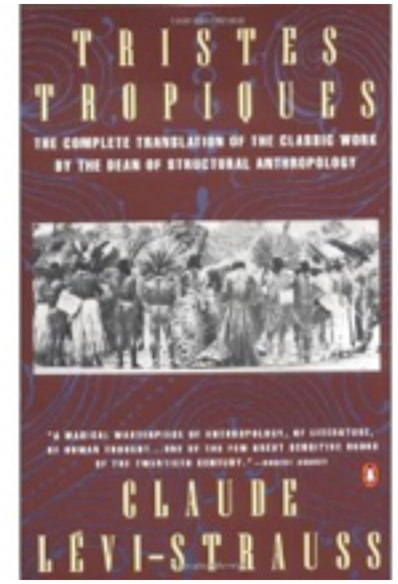


W.G. Hoskins



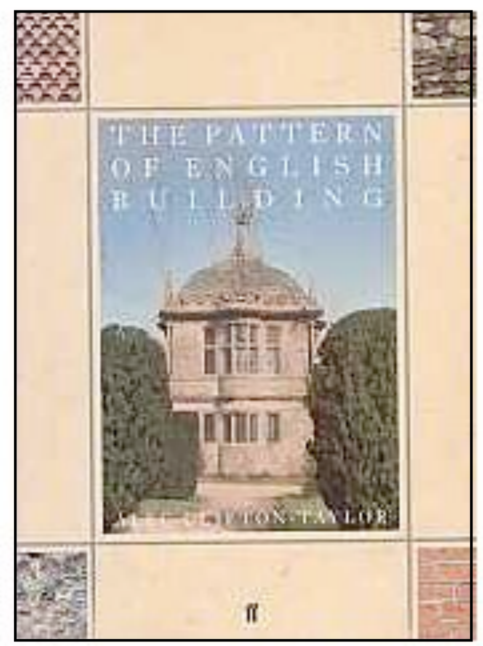
Tracy Kidder

D'Arcy Thompson

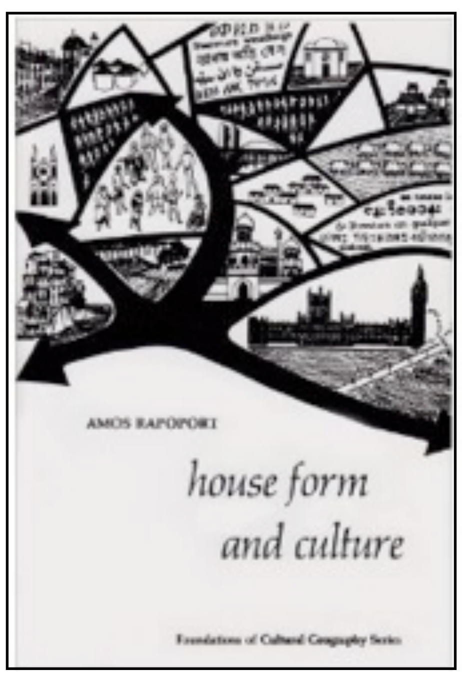


Claude Levi-Strauss

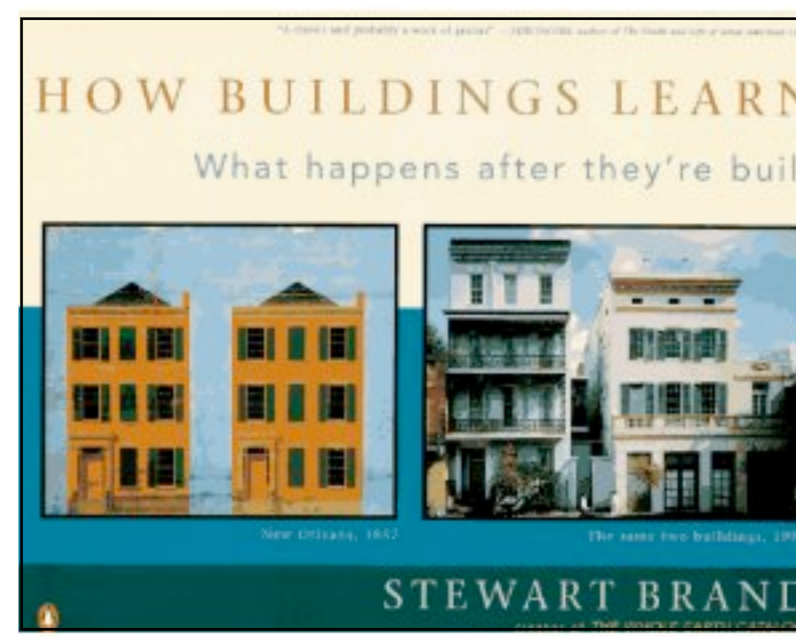
Peter Haggett and geographers like Bill Bunge and David Harvey.



Alec Clifton-Taylor



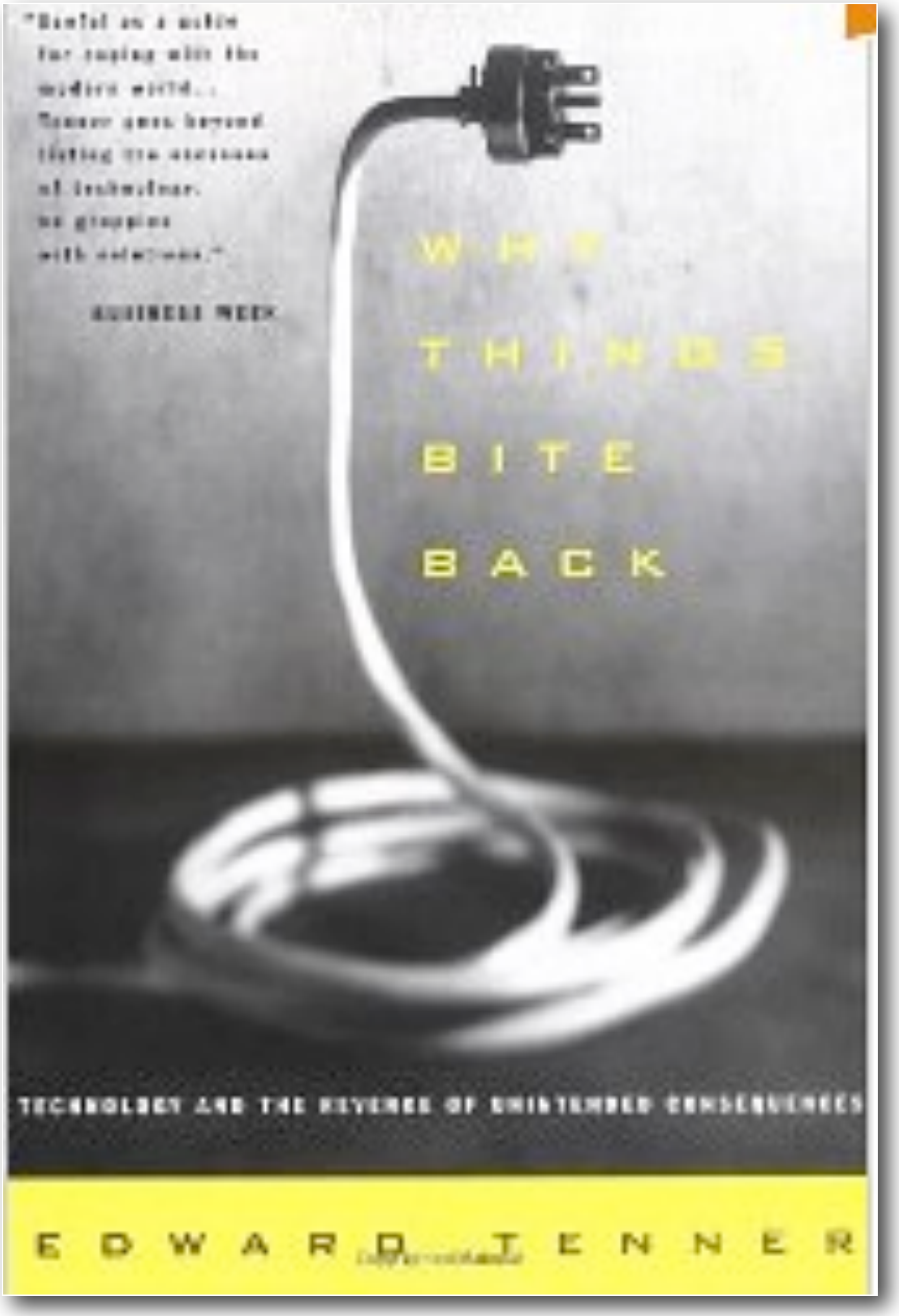
Amos Rapoport



Stewart Brand

and especially …

Consequences, usability and manageability



Edward Tenner

Donald Norman

Likes …

Buildings that are known to work well.

House at Grizedale, 1900 C.F.A. Voysey

“Never look at an ugly thing twice. It is fatally easy to get accustomed to corrupting influences.”
C.F.A. Voysey

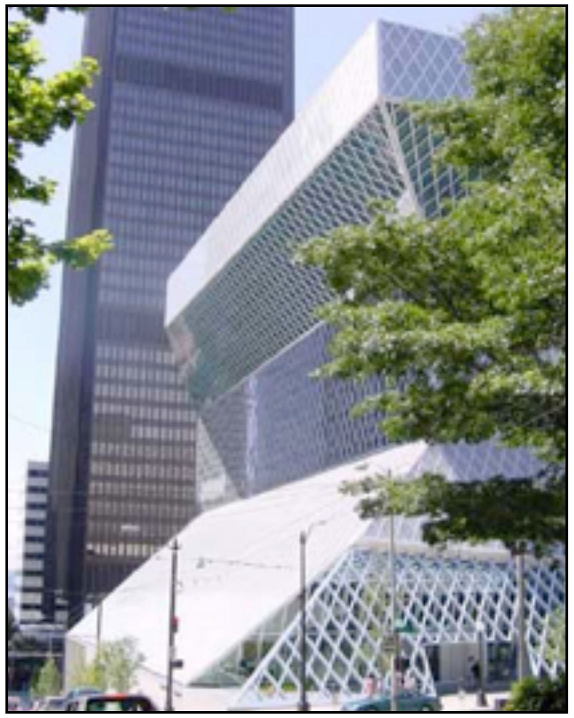
University of Sunderland School of Computing, BDP, 1995

Kingsmead Primary School, Northwich, Cheshire, White Design, 2004

… and dislikes

St John's House, Bootle
1971
Occupied 1981
Demolished 2001

Trellick Tower, London,
1966-1972,
Ernő Goldfinger. Grade II* .



Seattle Public Library, Rem Koolhaus

‘Measuring’ buildings

‘There is nothing more dangerous than a heckler with statistics.’

Rich Hall

Three perspectives

Human needs: Are needs being met?
Environmental performance: How benign?
Affordable and manageable?

One objective

Better feedback aimed at the most effective people in the process.

TEST of TIME

Too many new public and commercial buildings fail to live up to their expectations for energy savings and user comfort, but can the good ones maintain their performance? With support from CIBSE, a team of experts returns to a university building that was found to perform exceptionally well in the late 1990s. **Bill Bordass** and **Adrian Leaman** report on their findings. A separate article on the performance of school buildings generally starts on page 39

A 'PROBE' investigation into the Elizabeth Fry Building at the the University of East Anglia in the 1990s found that it had exceptionally good performance in many respects. A recent follow-up visit found that, despite some inevitable 'drift' in its operations, it is still performing better than many brand-new buildings. In the background is the Queen's Building, an earlier building by the same design team

In the early 1990s, the editorial advisory board of *Building Services Journal* (the forerunner of *CIBSE Journal*) had wondered how well the buildings it featured actually performed in practice. In 1994 the *Journal* made a successful bid under the government's Partners in Technology programme to undertake and publish the 'PROBE' (Post-occupancy Review Of Buildings and their Engineering) studies.

Between 1995 and 2002, a total of 20 non-domestic buildings were surveyed, typically two to four years after handover. The process, results and general findings are described in 29 articles in the *Journal*, and in reviews elsewhere.

PROBE number 14 investigated the Elizabeth Fry Building at the University of

30 CIBSE Journal March 2010 www.cibsejournal.com

Trust in construction

In the atrium, the stairs and wall cladding are made entirely of wood from National Trust estates. A very hard wearing carpet, produced from Herdwick sheep grazed on Trust farmlands, is used in the office areas.

FACTS AND FIGURES

Client
The National Trust/Kier Ventures
Project architect
Feilden Clegg Bradley
Environmental design consultants
Max Fordham LLP

Construction value £10.4 million (shell and core)

Start on site: January 2004

Occupation: 4 July 2005

Treated floor area: 7350 m²

Occupancy: 470 (350 average)

Airtightness: 5.51 m³/(h.m²)

Like many organisations with a strong environmental conscience, the National Trust was keen to ensure that its new central office building trod upon the earth as lightly as possible. In Trust language, sustainability translated into low energy consumption, low running costs, and an outstanding place to work. The Trust also wanted open-plan offices to encourage good communication between departments, formerly in different buildings.

The Trust also desired a brownfield site. A suitable location was found on a plot of land among former railway engineering sheds in Swindon. The trapezoidal site was a challenge for architect Feilden Clegg Bradley and environmental consultant Max Fordham who designed the shell and core.

The footprint of the Heelis building closely follows the boundaries of the site (Figure 1). The building's design - from its pitched roofs to the use of blue engineering brick – gives an affectionate nod to the nineteenth century sheds.

The building was needed as the Trust wanted to centralise staff from six sites. People came from 1970s smoked-glass office blocks and converted stately homes. They therefore arrived with varying expectations of the new building.

Design description

The Heelis building was developed by Kier Ventures as a pre-let for the National Trust.

In the analysis that follows, it is important to recognise that Keir Ventures used the RIBA Stage D report as the basis of costing and financing the project. Although the design team developed the engineering concepts to get the most effective packages, they were not aware that the developer had already set the budget. Ultimately, this affected the choice of some engineering systems, which are not as tightly specified as they could have been.

The design team settled on a two-storey deep-plan building on a north-south axis, with the longest facade angled due south. The construction is conventional, being of a steel frame on a concrete base, with a pitched roof, in-filled with exposed, 80 mm thick, pre-cast concrete planks to provide thermal mass.

The 30° pitched roofs on the south side provided a suitable orientation for 1554 photovoltaic panels, while the north-facing slopes provided a location for northlights. These are located between prominent motorised extract ventilators (called snouts).

The envelope is a mixture of aluminium curtain walling to the south, with smaller windows set into brick walls of the remaining elevations. Two courtyards break up the deep-plan nature of the building and to enable cross-ventilation. Lightwells through the first floor mezzanines bring daylight to the deep plan areas of the ground floor.

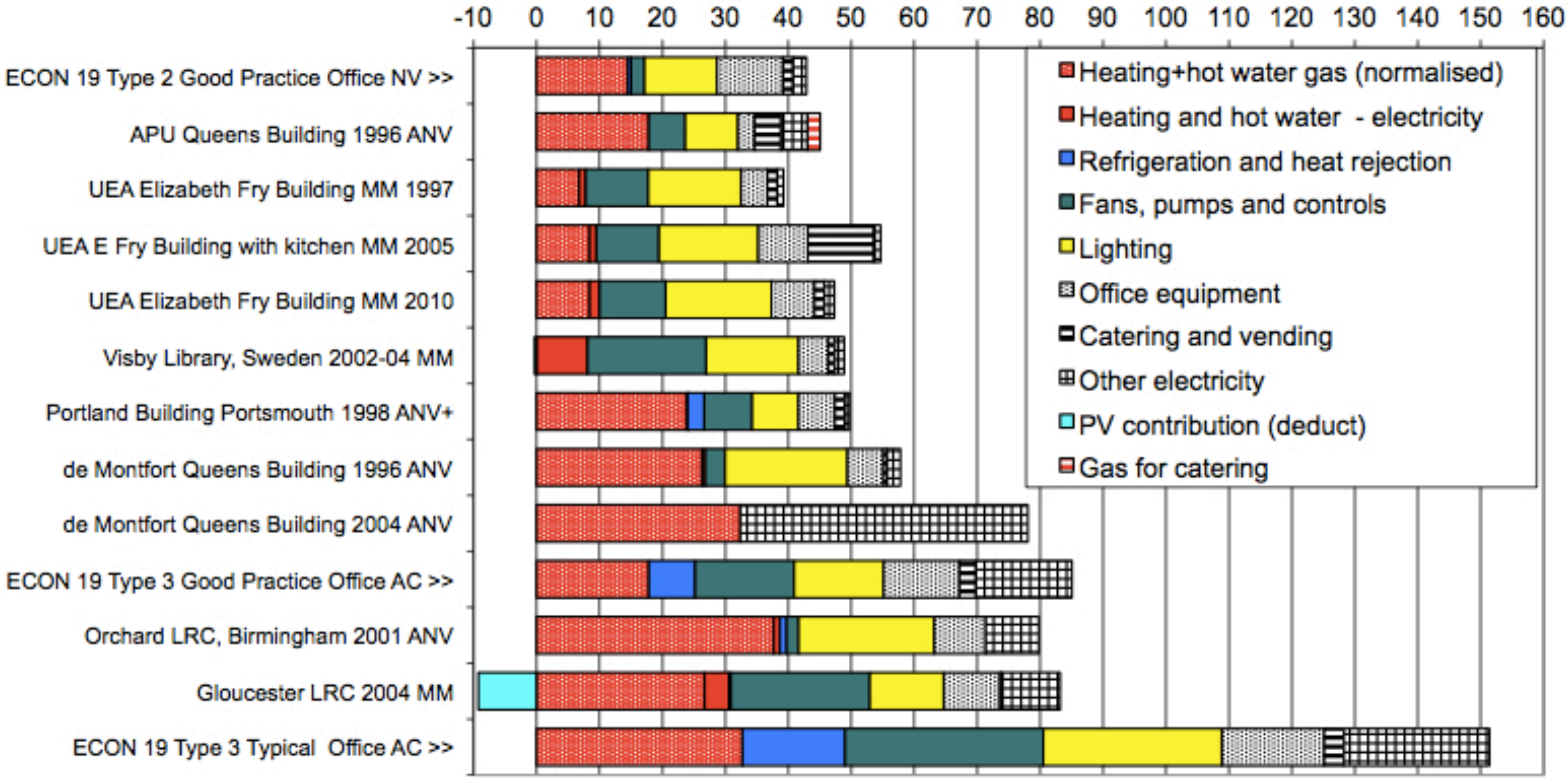
The Heelis building is mostly naturally-ventilated, with fresh air supplied through

10 BSRIA Delta t MARCH 2007

Test of Time download

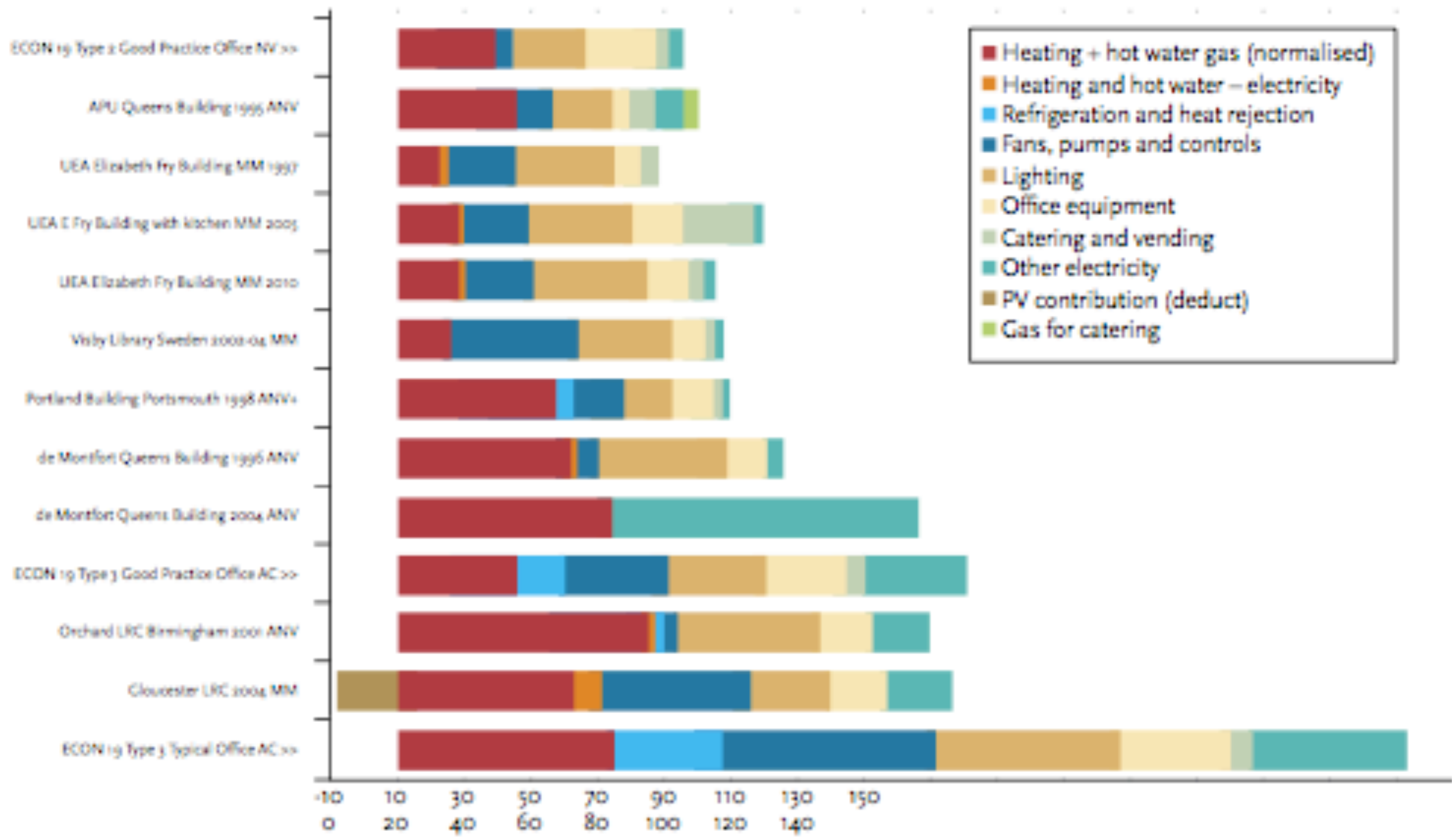
Annual CO_2 emissions from university buildings

kg/m² Treated Floor Area at UK CO_2 factors of 0.184 for gas and 0.525 for electricity



AC= Air Conditioned, ANV = Advanced Natural Ventilation, MM = Mixed Mode.

Aside:
This happens when graphic designers take over …



Annual CO2 emissions from university buildings (kg/m² Treated Floor Area at UK CO_2 factors of 0.184 for gas and 0.525 for elecricity)

AC = air conditioned, **ANV** = advanced natural ventilation, **MM** = mixed mode, **NV** = naturally ventilated

The diagram shows the estimated breakdown of energy use in 1997, 2005 (when the catering kitchen was in full operation) and 2010, in relation to office benchmarks from the Carbon Trust's Energy Consumption Guide 19 (marked with chevrons) and to other university buildings reviewed in PROBE and related studies. The graphs are expressed as annual CO2 emissions at Defra 2011 UK factors. The data are sorted by CO2 emissions for heating, hot water, cooling, ventilation and lighting.

At all three dates, Elizabeth Fry still maintains its place towards the low-carbon end of the range. The biggest changes between 1997 and 2010 are in heating and hot water, largely due to the change to 24/7 hot water and the appearance of some additional electric heaters. Lighting and office equipment energy use have also gone up owing to increased occupancy and equipment levels.

In relation to other buildings and benchmarks, energy use for heating and hot water is still good, while lighting has deteriorated owing to the low efficiency of the original pelmet system and greater hours of use now. CO2 emissions from fans, pumps and controls (mostly fans) are reasonable in relation to the other mixed-mode buildings and to air-conditioned benchmarks, but nevertheless of a similar magnitude to those from heating and hot water.

Usability

BUILDING USERS NORMALLY PREFER

1 Predictable, normal, **background "default" states,** which habitually form the background to what they are doing.

2 **Opportunities to make interventions** or corrections if requirements or conditions alter.

3 **Clarity:** the ability to act clearly, quickly and effectively ... and to know immediately that an appropriate response has been obtained. *Simplicity and convenience is paramount.*

Aside:

"What we want is a quiet life except when there are problems, when we want good information quickly."

Ian Walmsley

Communication Breakdown Ian Walmsley download

USABILITY IS THE SATISFACTORY COMBINATION OF ALL THREE
(defaults, interventions, clarity)

Usually with most emphasis on CLARITY:
People tend to concentrate more on the functionality of the thing, and less on the background context in which it finds itself.

SCOPE FOR INTELLIGENCE:

1. Establishing *(and especially restoring!)* safe, comfortable, convenient and efficient default states.

2. Providing opportunities for intervention.

3. Providing information.

4. Not taking over, or getting in the way!

(

WHAT OFTEN GOES WRONG

UNREALISTIC ASSUMPTIONS
Frequently poor recognition of context, oversimplifying occupant requirements and activity and use patterns.

SUPPLY-SIDE CULTURE
Providing without enabling.

CONFLICTING STRATEGIES
Creating clashes and restricting trade-offs.

IGNORE UNUSUAL REQUIREMENTS
Look at averages, not ranges and rare events *(what if ... ?)*. Do not recognise differences between circumstances and individuals.

WASTEFUL DEFAULT STATES
Particularly now in the age of flexible working.

UNDERESTIMATED ABILITY OF MORE COMPLEXITY to increase burdens on everybody: *difficult to define requirements and get fulfilled; unintended behaviour; baffled occupants; stressed managers.*

FRUSTRATIONS FOR OCCUPANTS

Unable to change physical settings from an undesirable existing state to a preferred new one *(e.g. interlocked furniture in workstations)*.

Arbitrary changes in conditions which they can perceive but are not able to over-ride.

Working in non-standard situations, for example outside normal hours. *Can the default states and the facilities for intervention cope?*

Poor support in stressful situations either personally, or in an imposed emergency.

Unable to achieve speedy and effective response from their own actions, control systems or other people *(typically FM)*.

Little influence over **adverse effects,** *(e.g. draughts from grilles or distant windows; glare via a manager's glass partition; occupancy-sensed lights in peripheral vision; banging doors; circulation routes)*.

Deprivation of choice between the lesser of two evils *(e.g. between ventilation and noise)*.

“The BMS may know the temperature, but it doesn’t sit in the draught it causes”

... LIBRARY USER

unsolicited response in Probe questionnaire

USABLE END-USER CONTROL DEVICES

Easy to identify *what they are and do.*

Easy to understand,
and preferably intuitively obvious (at least after some simple instruction).

Easy to use
(or people will ignore, or take a more convenient route).

Operate and be effective as near to the point of need as possible *(this and the required device may differ with time and user).*

Work effectively, *with sufficient fine control to give the required level of adjustment (and inhibiting use of excessively coarse control).*

Immediate tangible feedback *that the device has operated.*

People may need reminding about basic actions, especially if these are not obvious and the device or feature is used only occasionally *(e.g. telephone call diversion).*

DON'T LET FEATURES TRIUMPH OVER CLARITY & FUNCTIONALITY

SOME IMPLICATIONS

LOOK AT WHOLE SITUATIONS
Not just people-machine interactions.

PUT PEOPLE IN THE CONTROL LOOPS
(but only where this makes good sense!).

CONSIDER THE FULL RANGE OF USERS AND CONTEXTS.
Don't focus on an average subset.

TAKE DEFAULT STATES SERIOUSLY
Will this be what you want? *... or what is least trouble, but is neither comfortable nor efficient.*

PROVIDE GOOD FACILITIES FOR INTERVENTION. *People who can get themselves out of trouble tend to be happier, more productive ... and less of a headache for management.*

IF YOU REMOVE OPPORTUNITIES FOR INDIVIDUAL ADJUSTMENT ... How will you replace what you take away?
This may require more money, design and management than you think!

AND FINALLY ...
Designers are not users, though they often think they are ... J NEILSEN

For more ...

Usable BUILDINGS ... for feedback and strategy

- Password
- Publications
- Events
- One-liners
- Probe
- Incubator
- Portfolio
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Usable Buildings is a free resource for practitioners, managers, building owners, developers, students and anyone else who wants to make buildings more suitable for the people who use them, less damaging to the natural environment and a better long-term investment. Usable Buildings is run by the Usable Buildings Trust.

The Usable Buildings Trust is a UK educational charity, dedicated to improving the performance of buildings in use. We try to understand how buildings actually work in practice, and create a feedback loop from in-use performance to improved delivery by the organisations that can make a difference. We were set up in 2002, because buildings policy and research was becoming too focused on construction, and doing little on performance in operation in the hands of their users. UBT spreads findings through its website, user groups, collaborative working and input to postgraduate courses. UBT is also a home for approaches which are not quite ready for widespread application and an incubator for their development. Aims Background

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Monday, February 4