Building Evaluation Primer

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Arup
Building Use Studies
The Usable Buildings Trust

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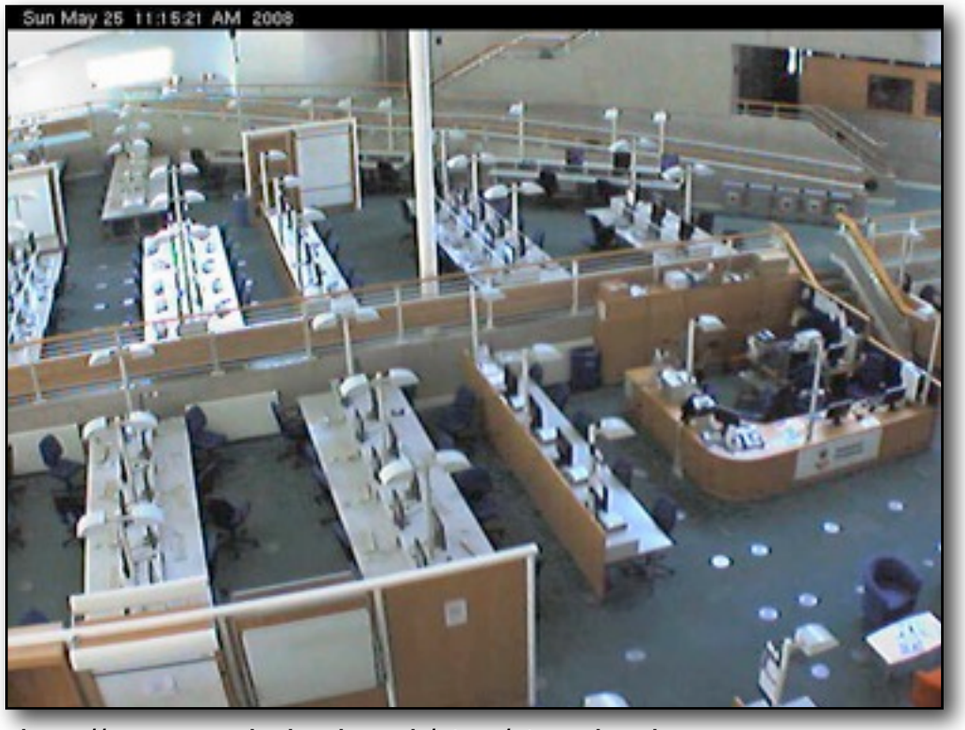
This is … ?

- A **review of evidence** from four recent office case studies …
- … illustrating how well the **buildings perform for their occupants** …
- … and the **environment.**
- Some **rules of thumb for happy and productive occupants**.
- **All cases are in the public domain** and downloadable from www.usablebuildings.co.uk
- **For more material on building evaluation / post-occupancy evaluation go to** www.usablebuildings.co.uk

Personal likes # 1 ...

Sunderland School of Computing



http://argus.sunderland.ac.uk/view/view.shtml

York Centre for Early Music

http://www.ncem.co.uk/

Museum Kroller Muller, Otterlo, Netherlands

http://www.kmm.nl/

MIT Building #20

www.eecs.mit.edu/building/20/

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… and dislikes

Alexander Fleming House, now Metro Central Heights
http://en.wikipedia.org/wiki/Alexander_Fleming_House

http://www.boston.com/news/local/articles/2007/11/06/mit_sues_gehry_citing_leaks_in_300m_complex/

MIT Stata Center

St John's House, Bootle

http://news.bbc.co.uk/1/hi/england/1688081.stm

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4. Solutions conceived by design and management theory may not suit the occupants: *"****Designers are not users, though they often think they are****!" - Jacob Neilsen*
5. **Difficult to meet the three objectives of human, economic and environmental performance simultaneously**. *It can be done, but with a relatively high degree of difficulty. It needs commitment.*

Targeted briefing

Brief taking, reality checking, communicating design intent, making sure things work properly, making sure needs are met.

Targeted brief main headings

Context

1. **Goals**
   Educational, health, business etc
2. **Site and local**
3. **Environmental**
4. **Technical change**
5. **The wider future**

Qualities

1. **Space requirements**
2. **Image**
3. **Operational**
4. **Building performance**
   including sustainability
5. **Cost**

Implications

1. **Users**
2. **Organisational effectiveness**
3. **Management**
4. **Investment**
5. **Strategy**

Assumptions	Needs	Expectations	Outcomes
Are assumptions properly thought through and in the open at the outset?	Are user needs made crystal clear?		Are likely and actual outcomes evaluated against the brief requirements?
	Are risks and potential downsides realistically mapped out?	Are expectations managed appropriately and realistically?	Are targets met?
Are all points of interest properly represented and resolved?	Are value propositions clear?	Are likely outcomes monitored against effects of change and potential volatility, e.g. for future adaptability?	Does the building work as intended?
			Are user needs met?
Are strategic implications and consequences thought through?	Is usability and manageability for the occupier properly resourced?		What are the lessons for the future?

What are buildings for ?

They enabled us to store energy, food and information and to move into towns and cities. In turn, the buildings we have define partly the context for further development. Most are created not for their own sake, **but as means to further ends**.

Buildings **increase potential** by:

- **Enabling** activities to take place which otherwise would not: helping us to do things, make things and help people.
- **Improving control and communication**.
- Creating **indoor conditions more stable and predictable** than outdoors.
- Expressing **cultural and aesthetic values**.
- Letting all this happen **without challenging the social order** too much.
- Creating and adding (commercial) **value**.

The most vital things are ...

- A **properly-controlled interface between inside and outside -** for security, privacy, environmental control and so on.
- **Adequate space** and services for the activities which need to be undertaken.
- **Protection from acute failure**, e.g. flood, fire and structural collapse.
- **Remedial action for chronic faults**, e.g. over-heating, noise.
- **Meeting needs**, quickly and efficiently.

When people move into a new building by choice, they expect things to be better - with the building reinforcing its role as the means to this end. This applies whether you are an individual, a business, or any type of organisation.

In spite of their criticality, many buildings do not pass all the tests even at this basic level.

What works well?

Two types of buildings perform particularly well for their users:

A. **Technologically complex, and often deep-plan, buildings which demanded a lot from their management - and got it**.

B. **Simpler, often shallow plan, buildings designed deliberately to reduce the management requirements.**

Sadly, many buildings we survey fall into a third category - those which demand more than their management is prepared or able to give.

These are particularly common in the public sector, in which the business case for more management is particularly hard to justify.

… and less well?

Technological complexity

More

Less

Management input

More

Type A	Type D
Effective but often costly	*Can be thoughtful and imaginative, but rarely user-friendly*

Less

Type C	Type B
Risky with performance penalties	*Effective but often small scale*

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Human factors: the bottom line

'Green' buildings normally deliver only on three out of the five things that people say are good for their productivity at work.

1. **Comfort can often be good**, but not always. There is higher risk in delivering good comfort conditions, but the best can be very good. Thermal comfort is usually the most important: summertime over-heating but also too cold in winter. Noise is also increasingly a downside.

2. **Rapid response** when things go wrong. Needs tend to be better met often because there are e.g. more user controls like openable windows and controllable blinds.

3. **Design intentions are usually more clearly communicated** and briefing and monitoring is better too. 'Green' buildings are often designed in a way that all buildings are supposed to be designed. People may be more willing to forgive perceived faults.

However ...

4. Beware **unmanageable complexity,** especially with deeper spaces. ‘Green’ buildings often repeat earlier mistakes by underestimating requirements for commissioning, handover, ‘sea trials’, ‘soft landings’ and facilities management downwind of design.

5. Beware **poor space and workgroup layouts**, peremptory space planning (especially when, e.g., furniture layouts block access to user controls), lack of provision for wider ranges of work tasks and use patterns, and staff made to sit in ‘left over’ spaces.

- High occupant densities (from 4 and 5) are a risk.

Charities Aid Foundation

THE PROBE PROJECT

Post-occupancy Review Of Buildings and their Engineering (PROBE) was a research project managed by *Building Services Journal* (*BSJ*).

Design and construction details of the Charities Aid Foundation headquarters were featured in the March 1996 issue of *BSJ*, while the PROBE study of 1997 was reported in the February 1998 edition.

BSRIA Members can access all *BSJ* building analyses and PROBE articles via BSRIA's on-line abstracting service, IBSEDEX. PDF versions of PROBE investigations, including that of the CAF headquarters, can also be downloaded from www.usablebuildings.co.uk.

Sorry if this comes as a shock, but new build is not the answer to the zero-carbon challenge. The sobering fact is that less than two percent of the nation's building stock is renewed every year, which means that 90 percent of the buildings we have now will still be around in 2016 – the government's first zero-carbon target.

New build will also become more of a privilege as lending for capital projects gets expensive and the cost of fuel climbs higher. Add to that increasing control over energy use in buildings through legislation, and it's clear that we need to do far more with what we've already got. Retrofit, then, is going to be the next big thing.

The passive solar buildings of the 1990s that we got so excited about, with their natural or mixed-mode ventilation, night cooling algorithms, intelligent controls, and smart solar shading, are coming round for their first major refit. The headquarters of the Charities Aid Foundation (CAF) is typical of this mid-1990s take on what constituted a low energy building, so what can we learn from its refurbishment?

Building design

Details of the building's construction was well documented in the March 1996 edition of *BSJ*. Suffice to say that the mainly open-plan 3700 m^2 (treated), three-storey building began life as a home for around 200 administrative staff. It's located on the former West Malling aerodrome in Kent and was developed as a pre-let by Roune Kent (a joint venture between Roune and Kent County Council).

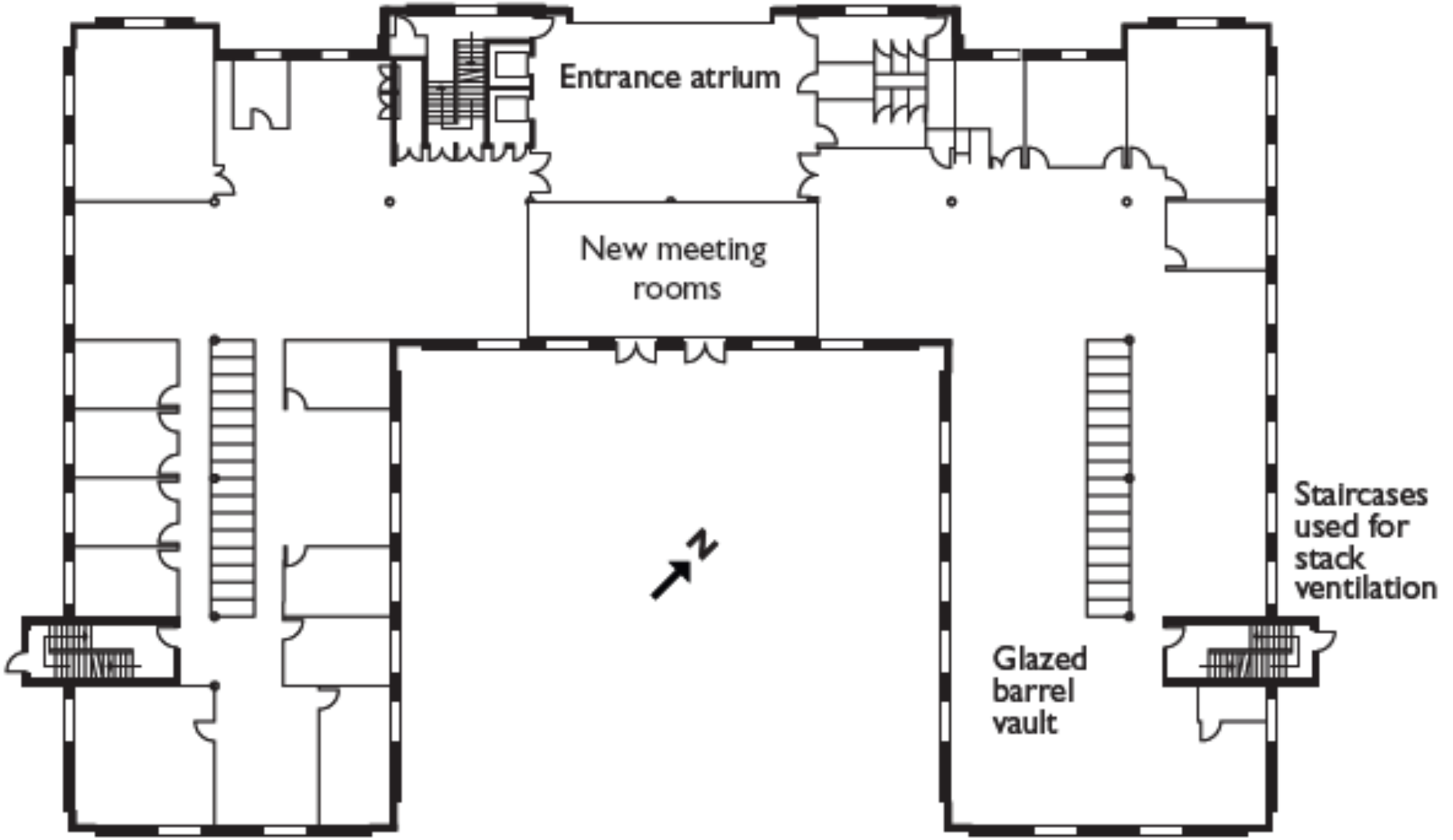
The steel-framed, U-shaped building is brick-clad. Largely open-plan offices occupy the 13·5 m plan depth and are arranged around a south-east facing open-sided courtyard. Entry to the building is through a full-height glazed reception area, onto which the top two floors once opened out but which is now enclosed by new meeting rooms.

Ventilation was by openable windows and fanlights, with mechanical displacement ventilation via a pressurised floor plenum. In keeping with the times, mechanical refrigeration was avoided by the use of an an innovative indirect evaporative cooling system, whereby a fine water spray was used to cool the exhaust air. The extract air then passed through a plate heat-exchanger which cooled the incoming air.

The floor slabs were exposed to provide thermal mass and some beneficial radiant cooling, while the building's insulation values were in excess of that demanded by the *Building Regulations* of the time.

The glazing was of a high standard, comprising double-glazed Pilkington Suncool solar glass for the south-east and south west elevations, and low emissivity glass on the remaining elevations.

The CAF still occupies its building 12


Entrance atrium
New meeting rooms
Staircases used for stack ventilation
Glazed barrel vault

FACTS AND **FIGURES**

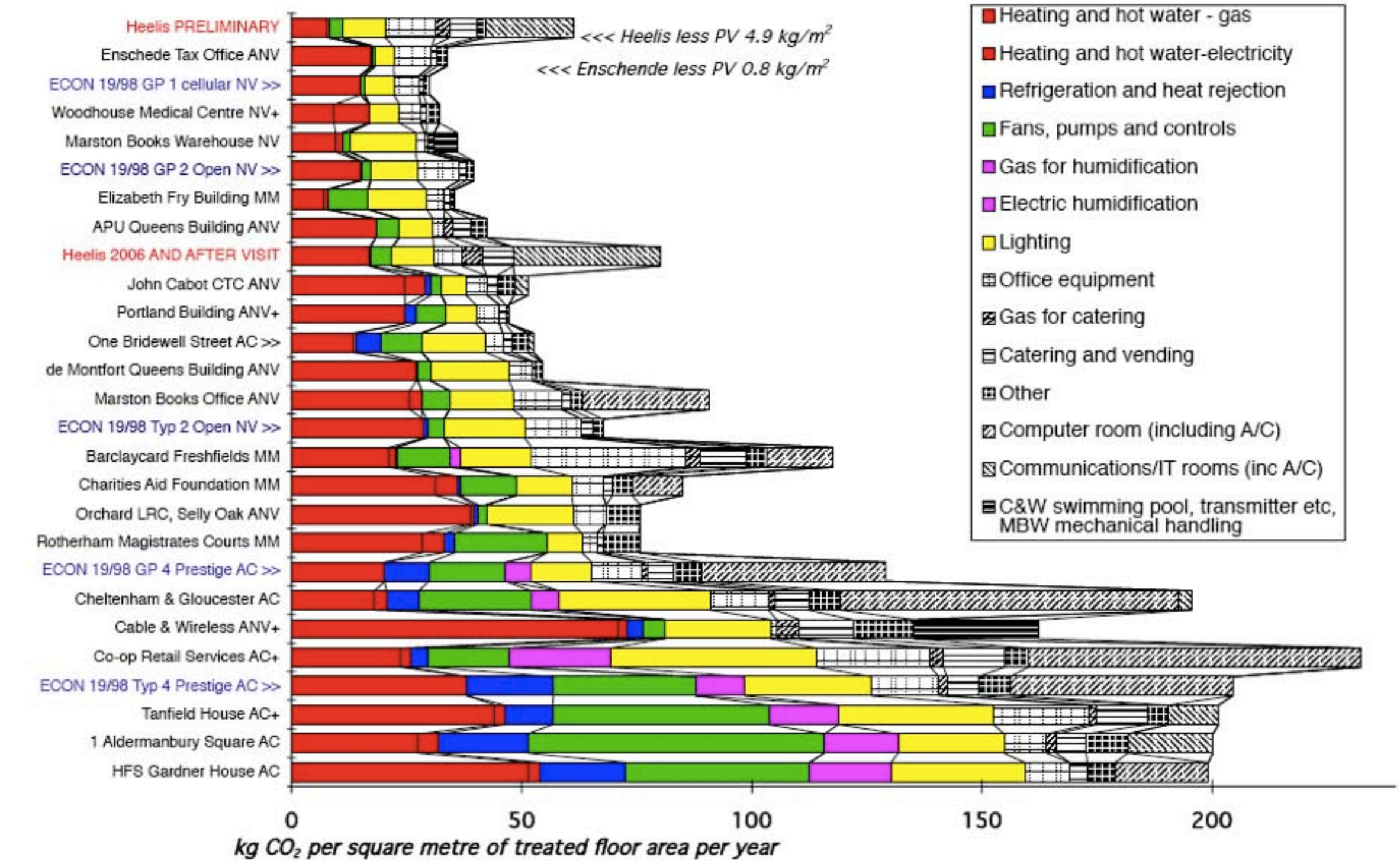
Developer Rouse Kent
Tenant Charities Aid Foundation
Original architect Nicholas Hare Architects
Original services consulting engineer atelier ten
Completion date December 1995
Occupancy
1998: 160
2008: 430 (360 average)
Normal weekday occupancy hours
06.30 - 17.00 h

Gas consumption (heating)
1997-1998: 151 kWh/m^2 per annum
2007-2008: 158 kWh/m^2 per annum

Incomplete metered data for electricity prevented an analysis of current electricity consumption

Refurbishment team
Services consulting engineer John Packer Associates
Ventilation contractor Natural Ventilation Solutions (SE Controls)
Passive ventilators Colt International
Window actuators and controls Window Master Controls
Building management system Trend

CO_2 comparisons from Probe surveys



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The provision of automatic, thermostatically-controlled vents in the upstand of the rooflights help to alleviate solar overheating and also aid ventilation in the office space.

Here, the (original) venetian blind is mounted internally, which not only compromises air flow from the open fanlight, but may also direct air down behind the partition causing cold draughts around the legs. Mid-pane blinds may have been a more robust solution for all likely desk combinations.

To solve overheating in the entrance atrium, four panels of planar glazing were replaced with glazed louvres. The location of the louvres were dictated by the planar glazing support structure; the louvres required their own framework.

Fire doors opening onto stairwells have been fitted with electro-magnets to provide additional stack ventilation on warm days. The outward-opening stairwell windows on the second floor are motorised to provide the point of extract.

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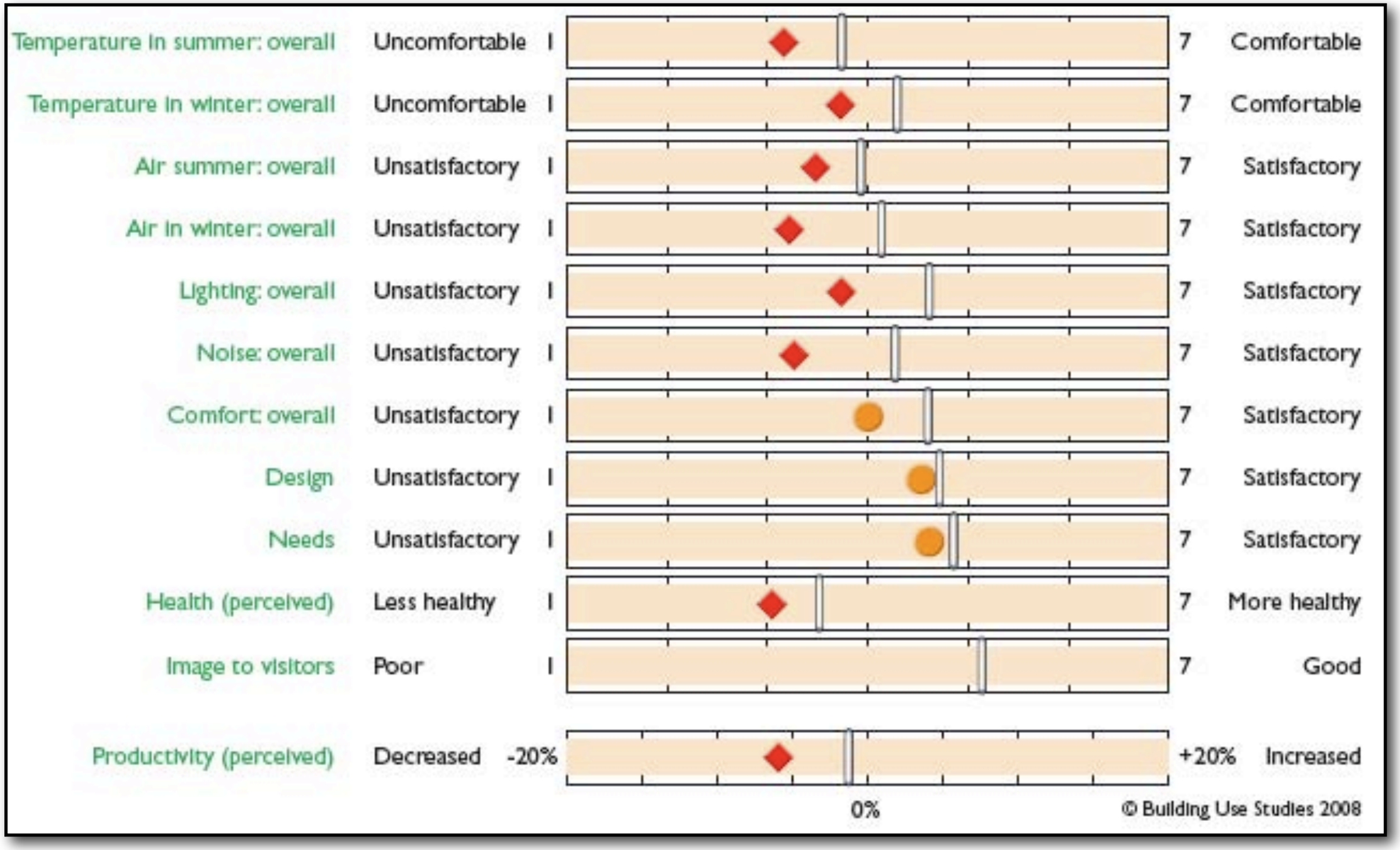
Temperature in summer: overall
Uncomfortable
1
7
Comfortable
Temperature in winter: overall
Uncomfortable
1
7
Comfortable
Air summer: overall
Unsatisfactory
1
7
Satisfactory
Air in winter: overall
Unsatisfactory
1
7
Satisfactory
Lighting: overall
Unsatisfactory
1
7
Satisfactory
Noise: overall
Unsatisfactory
1
7
Satisfactory
Comfort: overall
Unsatisfactory
1
7
Satisfactory
Design
Unsatisfactory
1
7
Satisfactory
Needs
Unsatisfactory
1
7
Satisfactory
Health (perceived)
Less healthy
1
7
More healthy
Image to visitors
Poor
1
7
Good
Productivity (perceived)
Decreased
-20%
+20%
Increased
0%
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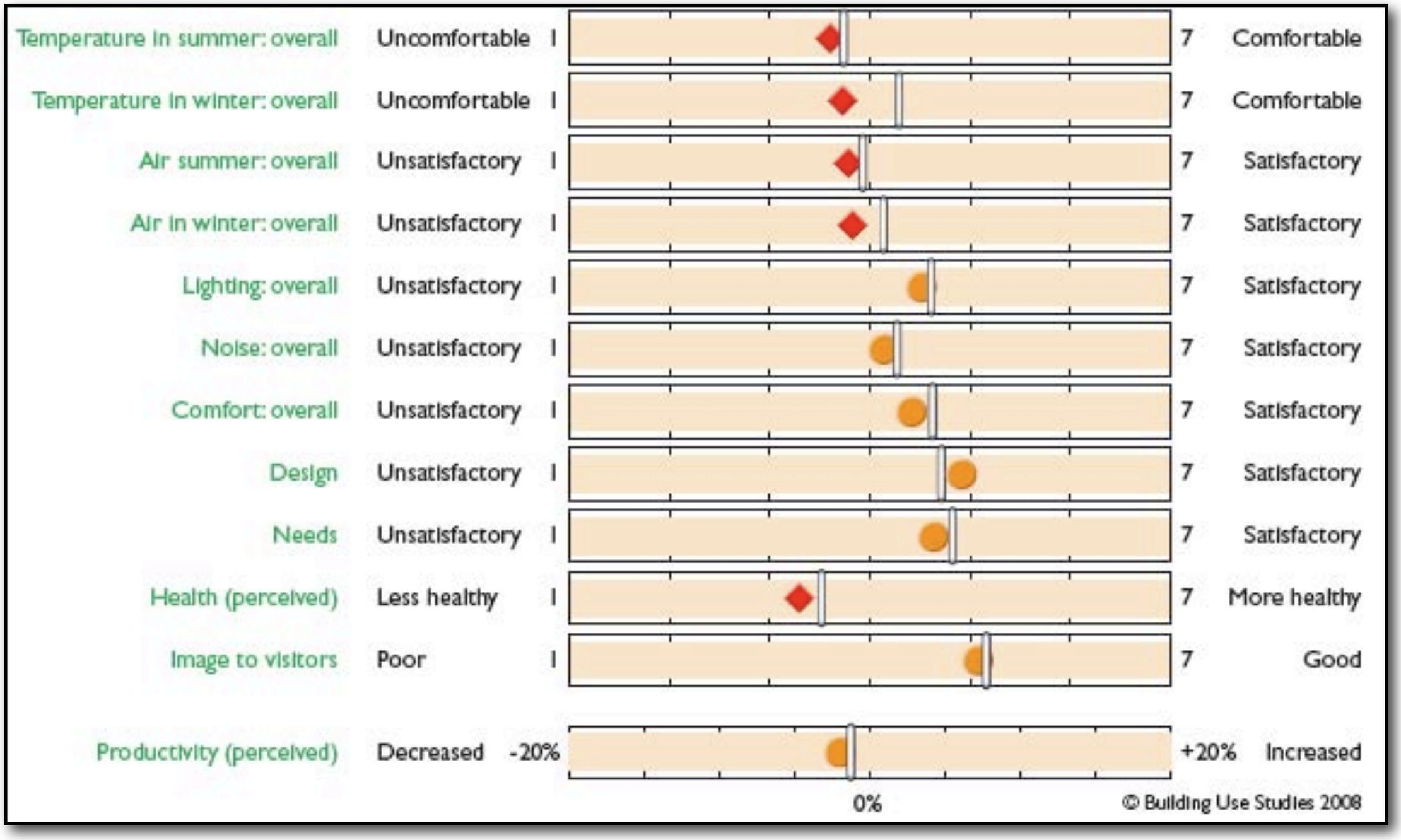
1997


Temperature in summer: overall
Uncomfortable
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Temperature in winter: overall
Uncomfortable
1
7
Comfortable
Air summer: overall
Unsatisfactory
1
7
Satisfactory
Air in winter: overall
Unsatisfactory
1
7
Satisfactory
Lighting: overall
Unsatisfactory
1
7
Satisfactory
Noise: overall
Unsatisfactory
1
7
Satisfactory
Comfort: overall
Unsatisfactory
1
7
Satisfactory
Design
Unsatisfactory
1
7
Satisfactory
Needs
Unsatisfactory
1
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Satisfactory
Health (perceived)
Less healthy
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7
More healthy
Image to visitors
Poor
1
7
Good
Productivity (perceived)
Decreased
-20%
+20%
Increased
0%
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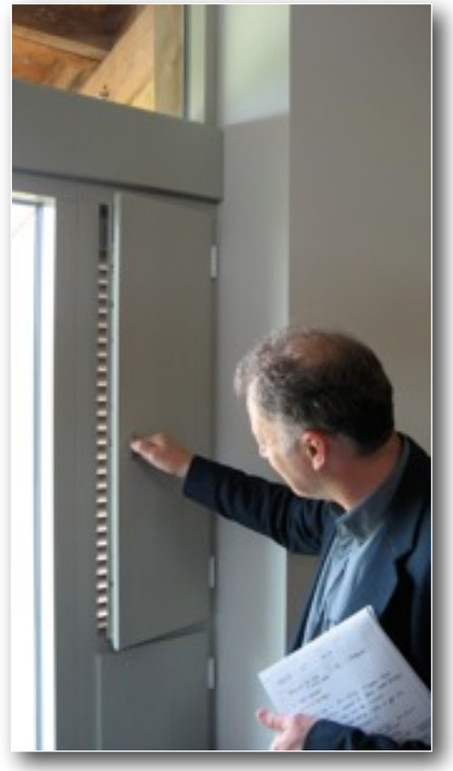
Rivergreen Centre



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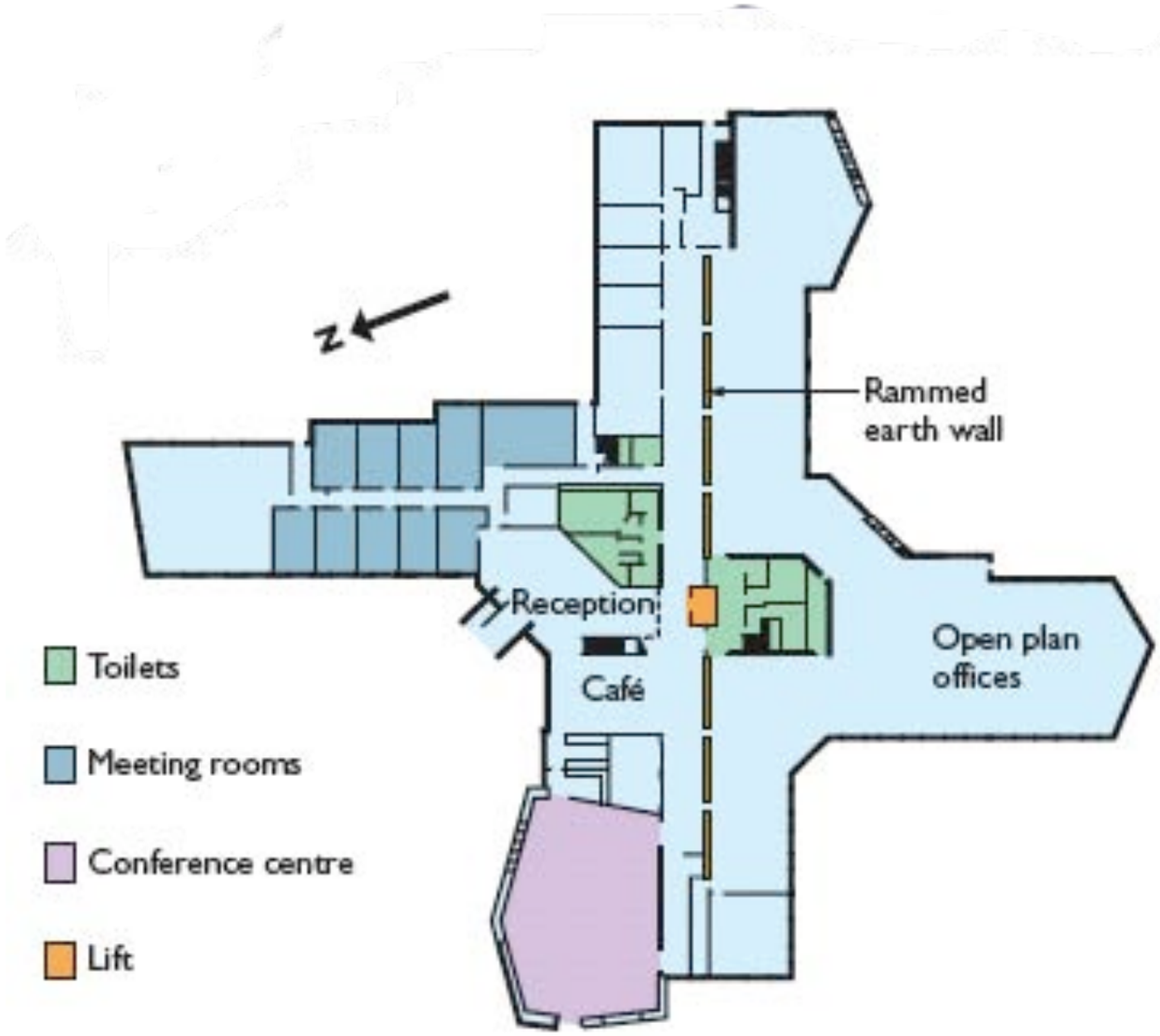
Above: A typical open-plan office. Note the rammed-earth wall to the left, openable windows and T5 dimmable fluorescents (controllable by hand-held controllers). The corridor zone has underfloor heating to accommodate future full-height partitioning.


N
Rammed earth wall
Reception
Café
Open plan offices
Toilets
Meeting rooms
Conference centre
Lift

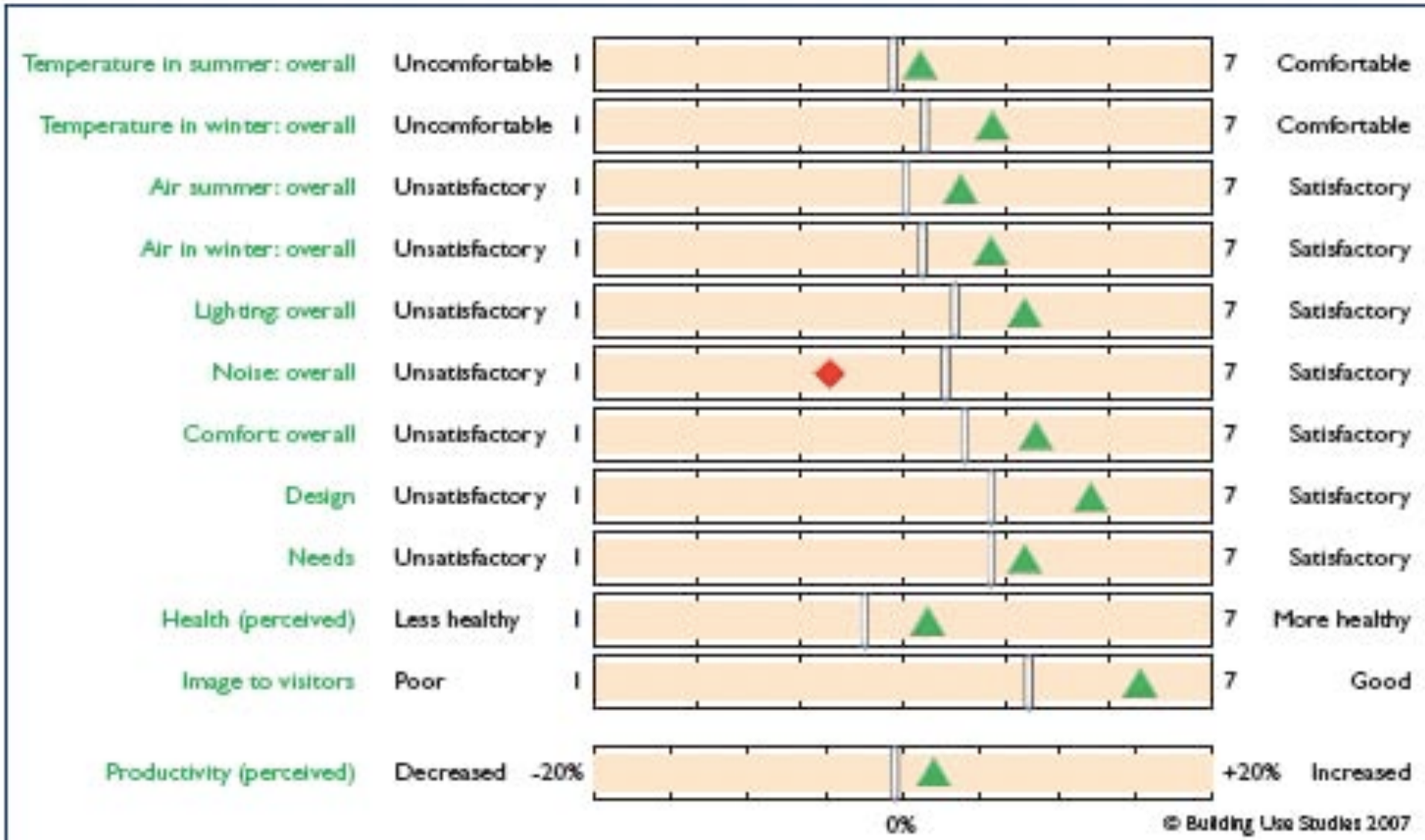
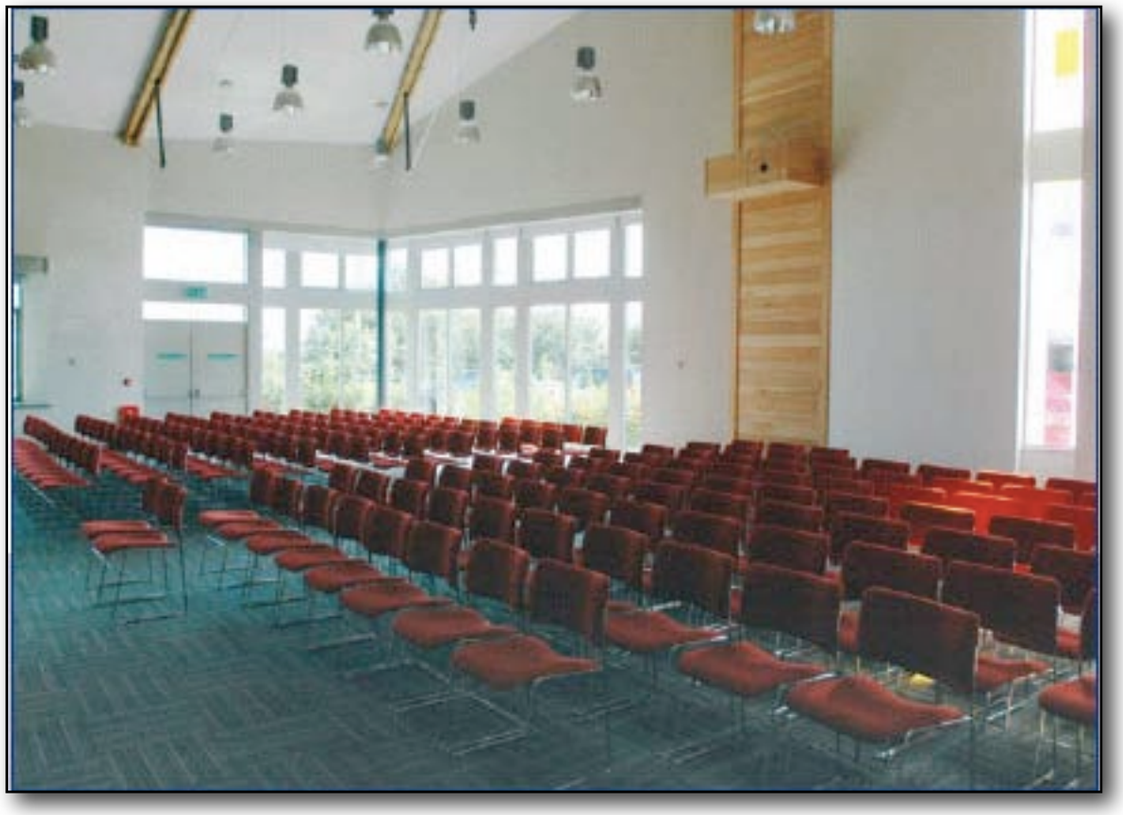
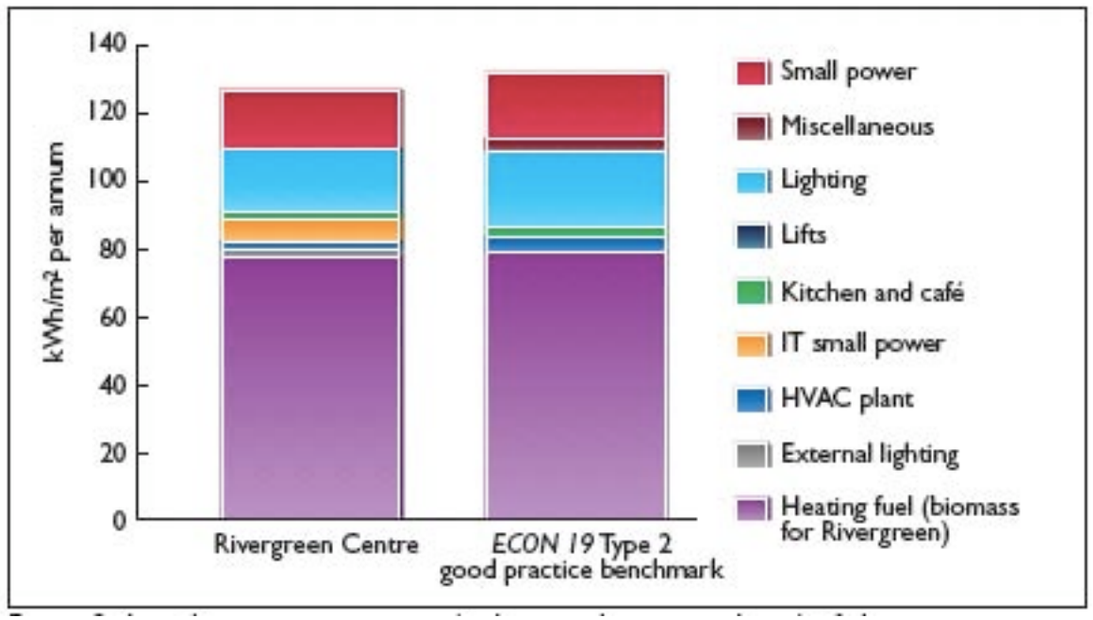
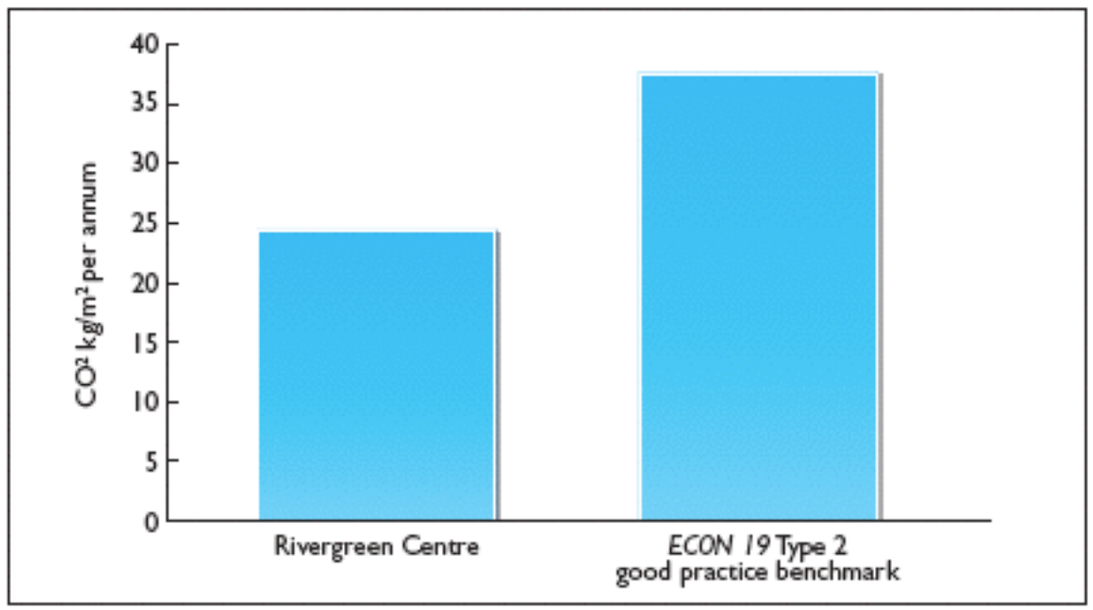


Figure 2: Building Use Studies carried out an occupant satisfaction survey in the Rivergreen Centre in March 2007. Green triangles represent mean values significantly better or higher than both the benchmark and scale midpoint. Amber circles are mean values no different from benchmark. Red diamonds are mean values worse or lower than benchmark and scale midpoint. Be careful to read the directions of the scales and the scale labels. The UK benchmarks are represented by the white line through each variable.




kWh/m² per annum
140
120
100
80
60
40
20
0
Rivergreen Centre
ECON 19 Type 2 good practice benchmark
Small power
Miscellaneous
Lighting
Lifts
Kitchen and café
IT small power
HVAC plant
External lighting
Heating fuel (biomass for Rivergreen)


CO² kg/m² per annum
40
35
30
25
20
15
10
5
0
Rivergreen Centre
ECON 19 Type 2 good practice benchmark

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Council House 2 (CH2)

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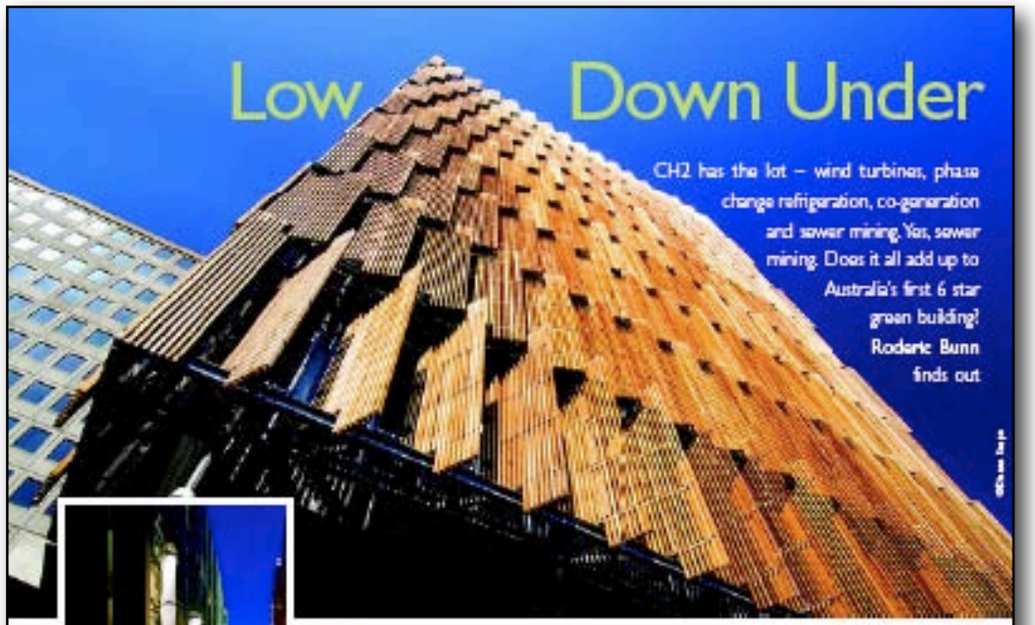
Low Down Under

CH2 has the lot – wind turbines, phase change refrigeration, co-generation and sewer mining. Yes, sewer mining. Does it all add up to Australia's first 6 star green building? Roderic Bunn finds out



Above: The shower-towers on the south side of the building supply evaporatively-cooled air to the shop areas. They are claimed to reduce air supply temperatures by about 3°C. (After legionella was detected in the tanks, some parts of the system have been replaced.)

Tourists gawp. Gawping is what tourism is all about. And many things are worth a good gawp: the Royal Family for example. The Angel of the North. Stonehenge. The London Eye was created specially for gawpers of all nationalities.

People even gawp at buildings of a questionable quality. They're on the south bank of the Thames, gawping at the GLA building, or at Foster's gherkin in the City. Marketing clearly has a lot to answer for.

But now and then you come across a building that's worth a really good gawp. A slack-jawed, goggle-eyed, catatonic gawp. Council House 2 in downtown Melbourne is that building. Your author came, he saw – he gawped.

The gawp was a long time in the making – there was so much to take in: the huge, yellow wind turbines, the gently swivelling timber solar-shading, the so-called adiabatic cooling shower-towers that resemble, well, over-sized condoms on the side of the building. (And if XXL condoms on a building aren't worth an extended gawp, you tell me what is).

This building's gawp-potential is well earned. It's Australia's – possibly the World's – first truly ultra-low energy city centre office block. It's been awarded six stars under the Green Building Council of Australia's Greenstar design rating¹ (see box: Green rating schemes).

Compared with Council House 1 across the road, a 1970s office block typical of the period, Council House 2 aims to:

- Use 85% less electrical power
- Consume 87% less gas
- Get through 72% less mains water
- Achieve an 13% reduction in emissions.

All this equates to a target saving of 330 kWh/m² per annum – or 64% less than a five star Greenstar building.

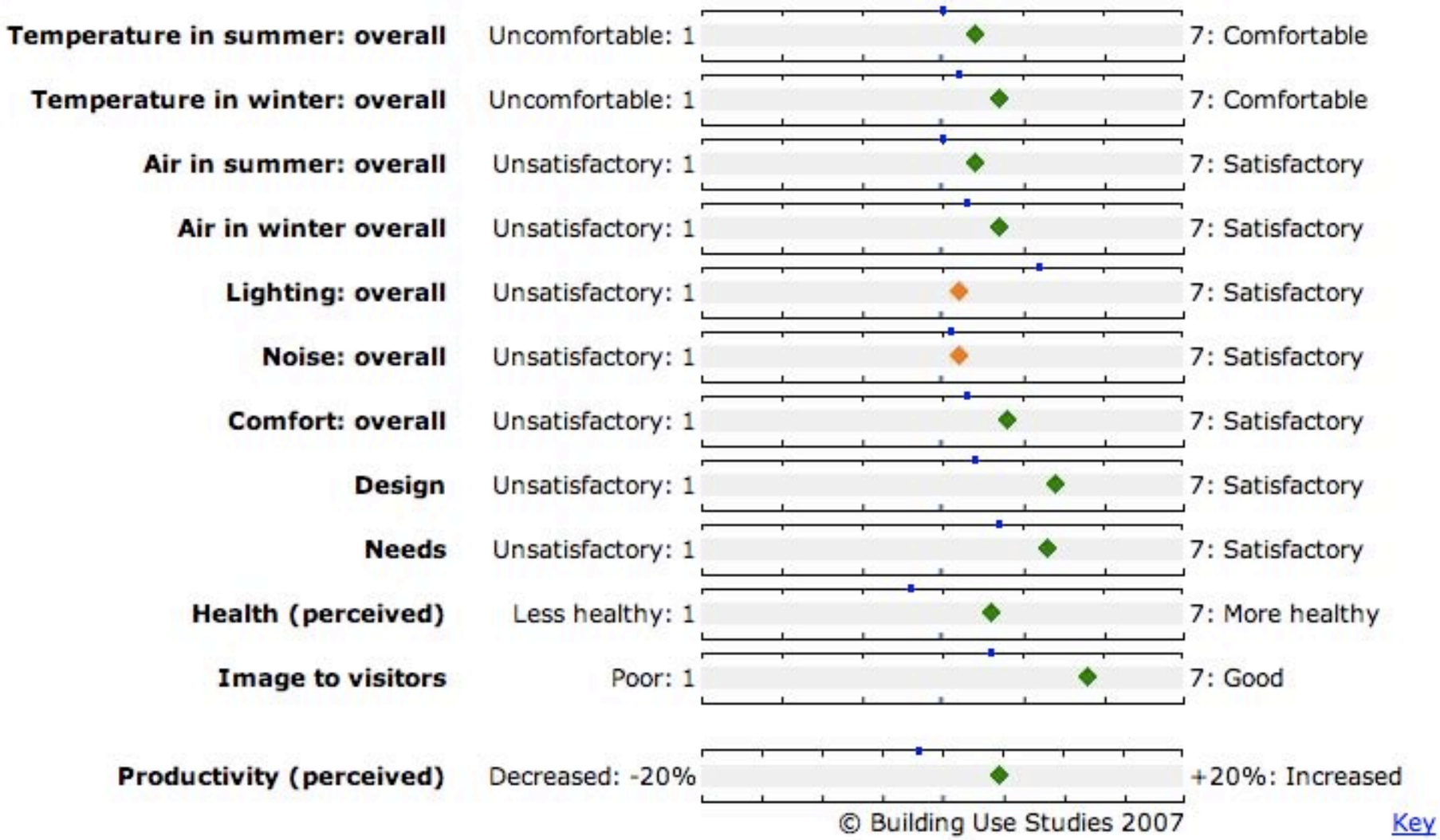
If that wasn't an onerous enough target for the designers, the business case for the building was predicated – officially dependent upon, mind you – a 4-9% actual increase in staff productivity, in part by reduced absenteeism. The expected increase in work output is predicted to save the City of Melbourne up to 1.12 million Australian dollars every year (Table 1).

Occupied by 540 (presumably very productive) council workers, the 10-storey building has been undergoing an extended commissioning period. This is wise given the fact that the building is equipped with the following systems: phase-change refrigeration, absorption cooling, co-generation, exposed concrete mass, chilled ceilings, photovoltaics, solar panels, night cooling and – last but certainly not least – a sewer mining system. The latter takes black water from Melbourne's sewers and turns it into grey water for toilet flushing and irrigation.

A gawp-fest of green features, no? But does it all work?

Ned Kelly hanging rack

CH2: BUS summary chart and index



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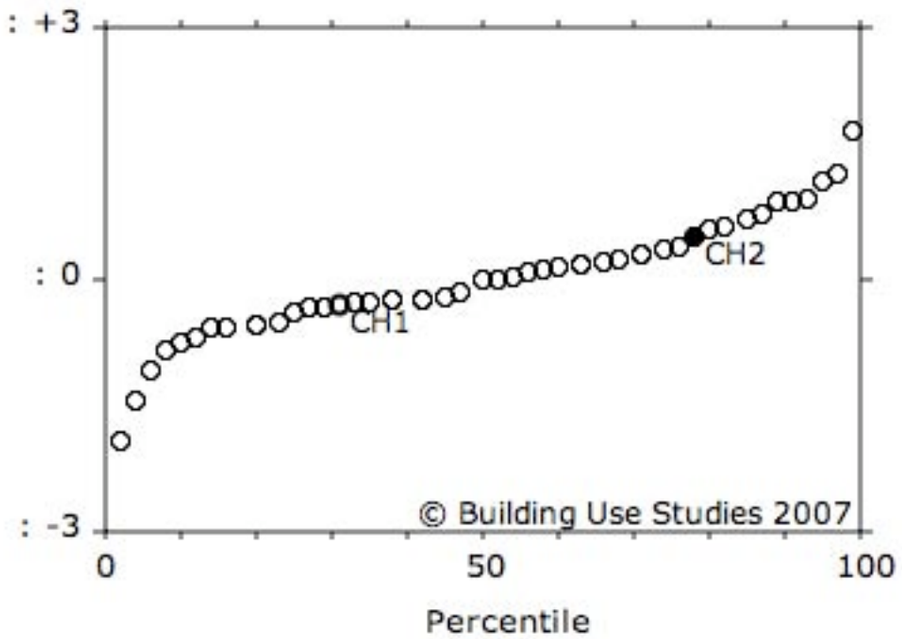

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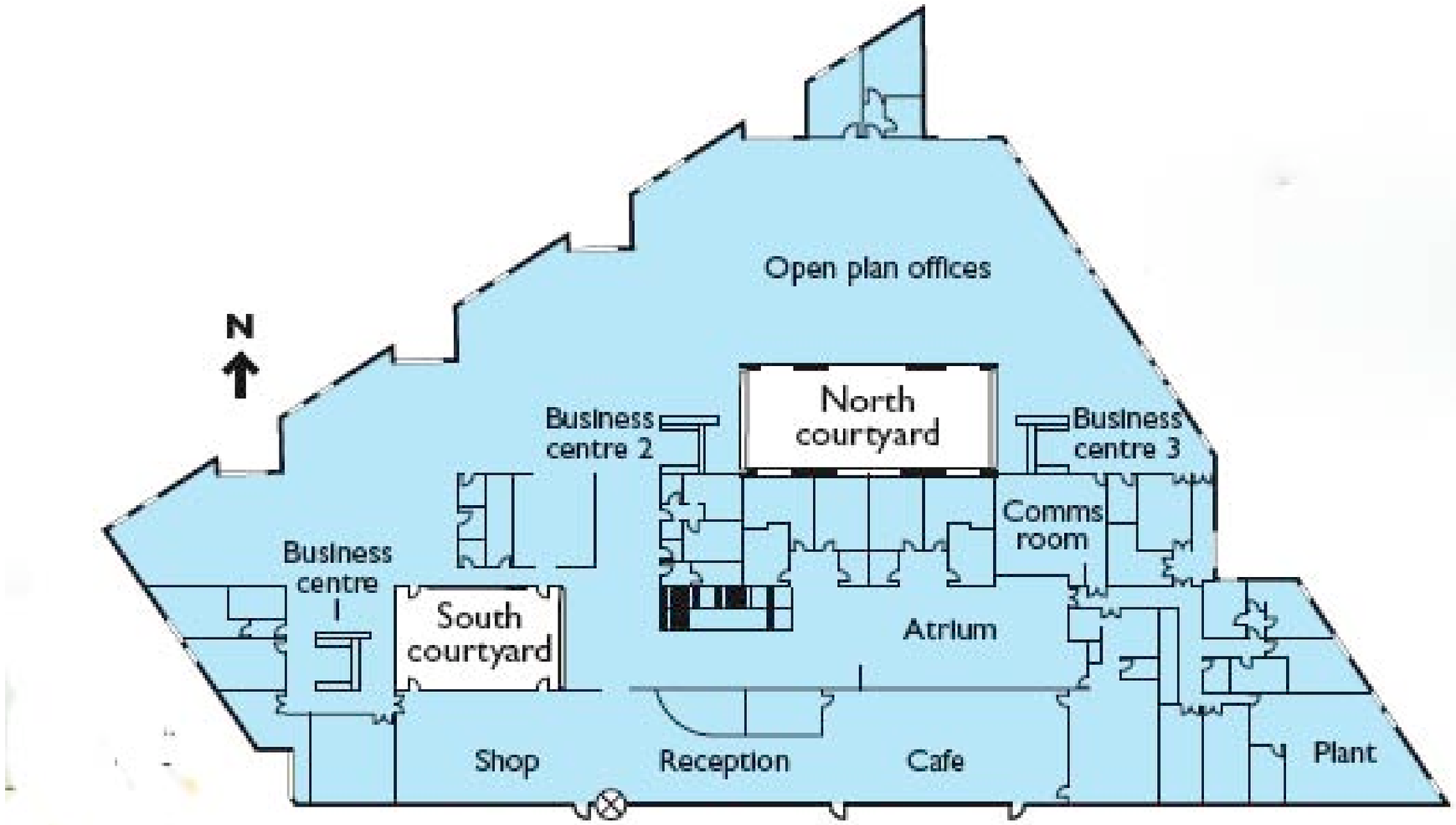
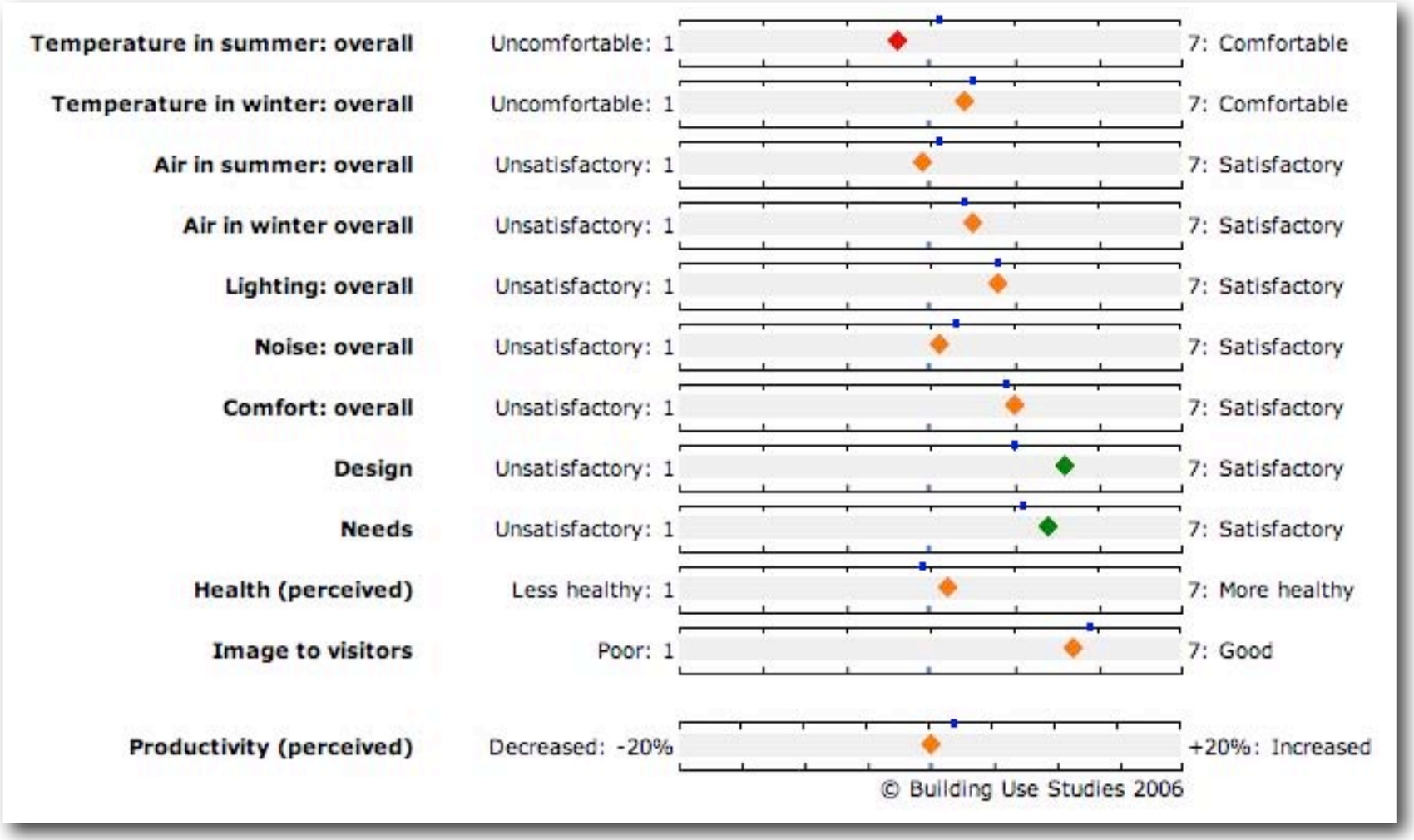

Open plan offices
N
Business centre 2
North courtyard
Business centre 3
Comms room
Business centre
South courtyard
Atrium
Shop
Reception
Cafe
Plant



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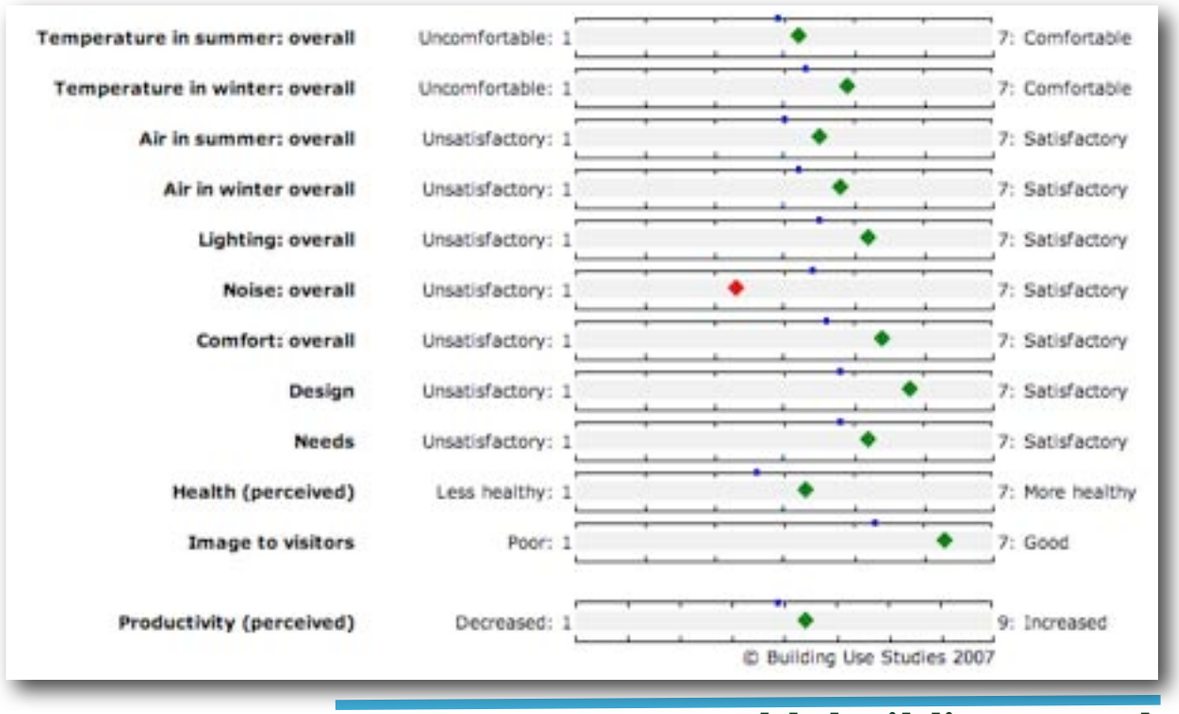

Main journey to work mode

	Count	Per cent	Bench-mark
Other	3	1	
Car or motorcycle (shared)	34	17	7
Car or motorcycle (own)	69	35	41
Train	15	8	29
Tram	0	0	10
Bus	33	17	
Cycle	10	5	9
Walk	34	17	8

Journey home mean time (mins)			
	Best	35	36
	Normal	44	46
	Worst	74	78

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DELTA t

Building the future

Green gloss code?

The Code for Sustainable Homes explained Page 6

Trust in construction

The Heelis Building aimed to be the new low energy home of the National Trust. How is the building faring? Page 10