

Tay Bridge

A sky that tastes of rain that's still to fall
And then of rain that falls and tastes of sky...
The colour of the country's moist and subtle
In dusk's expected rumour. Amplify
All you can see this evening and the broad
Water enlarges, Dundee slips by an age
Into its land before the lights come on.
Pale, mystic lamps lean on the river-road
Bleaching the city's lunar after-image,
And there's the moon, and there's the setting sun.

The rail bridge melts in a dramatic haze.
Slow visibility – a long train floats
Through a stopped shower's narrow waterways
Above rose-coloured river, dappled motes
In the eye and the narrow piers half-real
Until a cloud somewhere far in the west
Mixes its inks and draws iron and stone
In epic outlines, black and literal.
Now it is simple, weathered, plain, immodest
In waterlight and late hill-hidden sun.

High water adds freshwater-filtered salt
To the aquatic mirrors, a thin spice
That sharpens light on Middle Bank, a lilt
In the reflected moon's analysis.
Mud's sieved and rained from pewter into gold
Conjectural infinity's outdone
By engineering, light and hydrous fact,
A waterfront that rises fold by fold
Into the stars beyond the last of stone,
A city's elements, local, exact.

Douglas Dunn

from *New Selected Poems 1964–2000* (Faber, 2003)

Design Intent to Reality: Closing the Performance Gaps

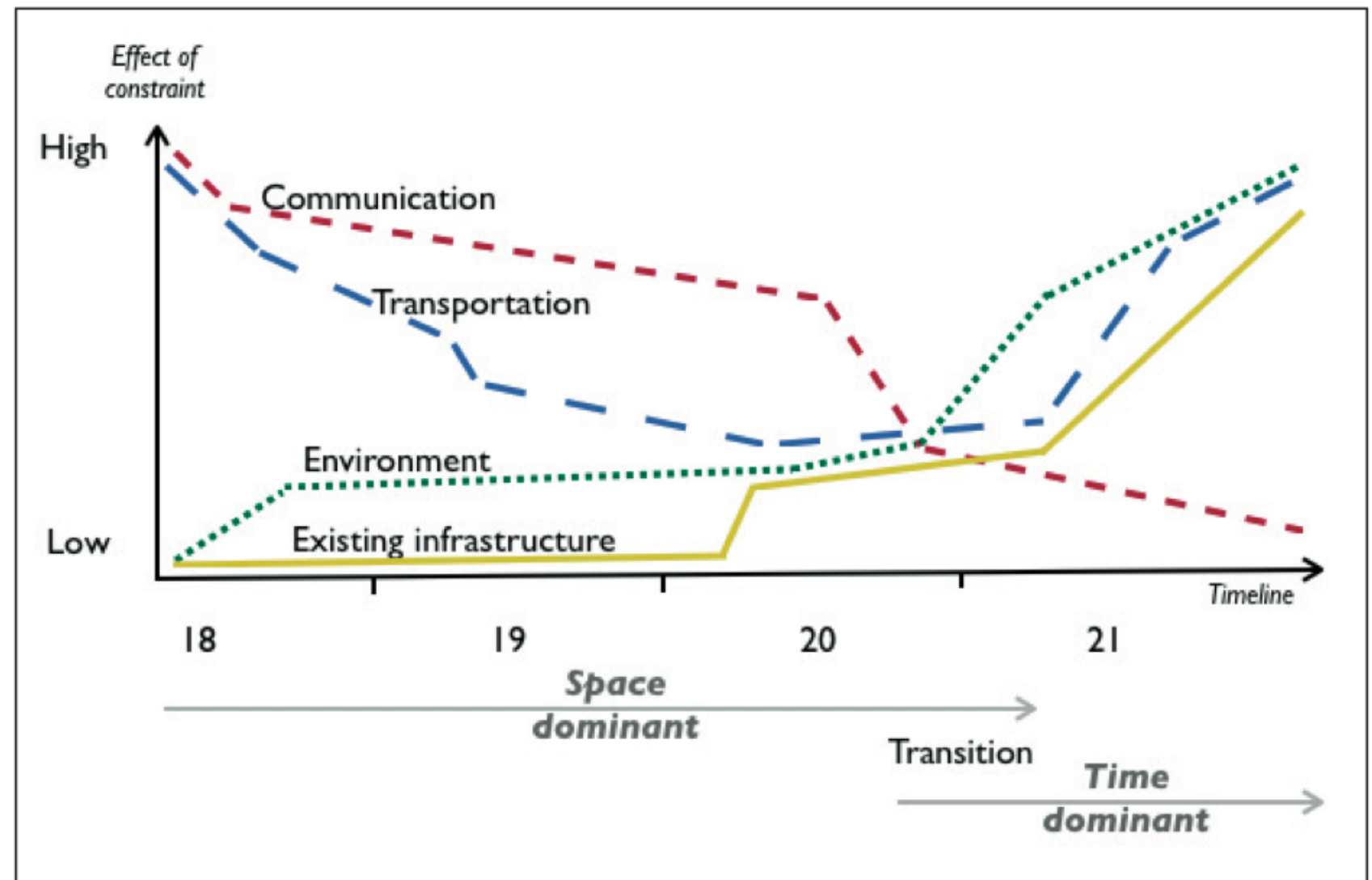
Adrian Leaman

Drawing on material developed with Bill Bordass

University of Dundee
Thursday 25 September , 2014

Sustainability

Constraints



<http://www.usablebuildings.co.uk/Pages/Unprotected/Logistical1.pdf>

Options



<http://markbrinkley.blogspot.co.uk/2007/06/yvette-cooper-at-offsite-2007.html>



Berriedale, Near Wick, Caithness

Consequences



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

Elizabeth Fry Probe study

A new professionalism?

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.

Design intent

If users understand how something is supposed to work, they will be more tolerant if it does not work properly.



<http://www.idostuff.co.uk/sections/DIY/Sash%20Windows/Sash%20History%204.html>

This device has no labelling or annotation. It looks like an on/off switch but is a push-button for an unidentified system.



The switch is for stepless operation depending on the length of time the switch is depressed.

Usability criteria	Ranking (controller as supplied)	
	Poor	Excellent
Clarity of purpose	<div><div></div></div>	
Intuitive switching	<div><div></div></div>	
Labelling and annotation	<div><div></div></div>	
Ease of use	<div><div></div></div>	
Indication of system response	<div><div></div></div>	
Degree of fine control	<div><div></div></div>	

<http://www.usablebuildings.co.uk/Pages/UBPublications/UBPubsControlsForEndUsers.html>

Reality

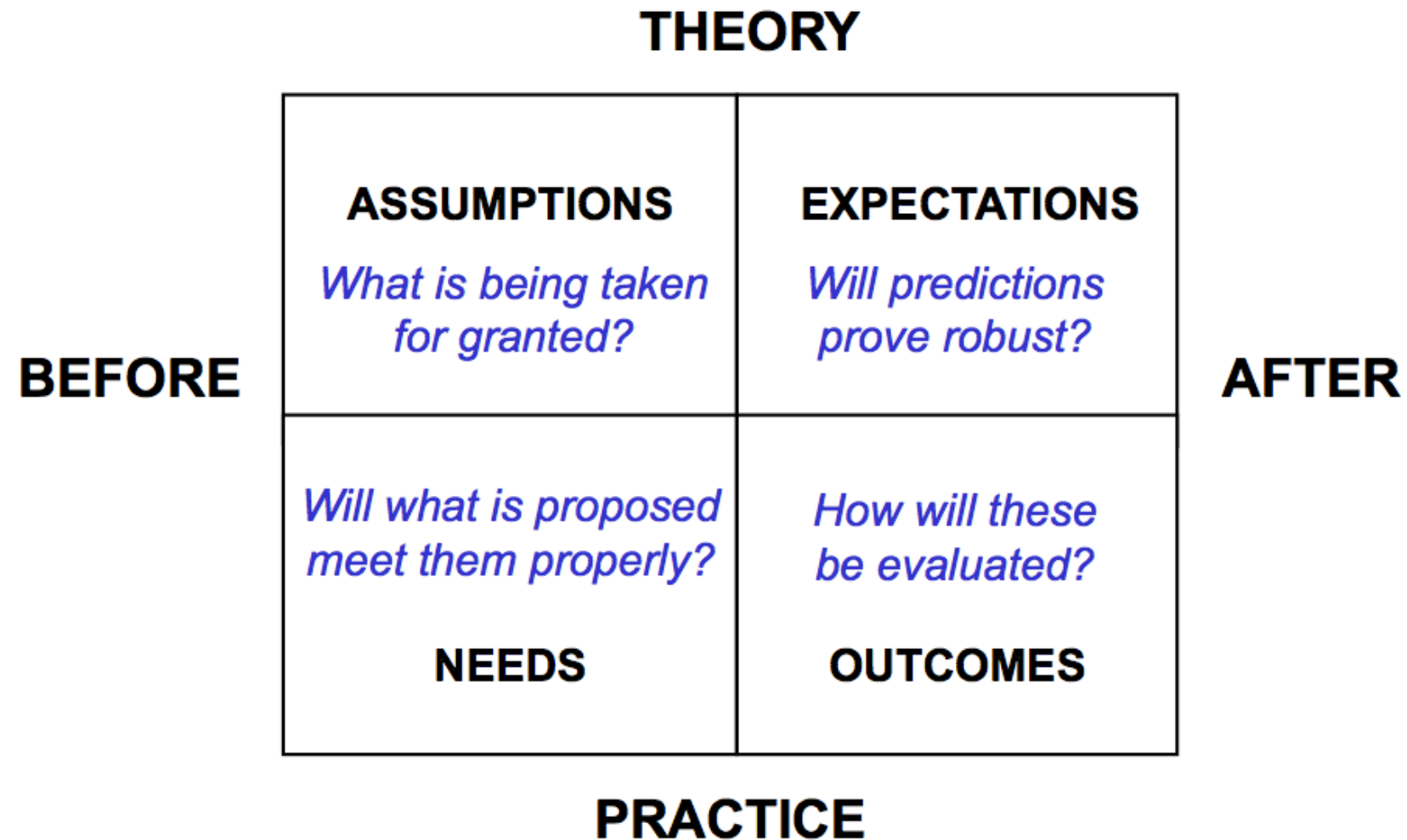
Places to intervene in a system

1. The underlying mindset or paradigm. *But is it appropriate?*
2. How are goals set? *And by and for whom? Are contradictions highlighted?*
3. Are they actually met? *And compromises identified?*
4. What skills and resources are required to meet them?
Are they realistically available over time? Scope for self-organisation?
5. What rules and constraints emerge in the particular context?
Scope, boundaries, degrees of freedom. And who sets the rules?
6. What are the required information flows?
e.g. what feedback is needed and how can it get leverage in the population?
7. What are the positive / 'virtuous' feedback processes?
Promoting things that make significant improvements to the system.
8. What are the negative / 'vicious' feedback processes?
Avoiding things that lead to chronic, and more seriously, acute, failures.
9. What are the stocks (people, energy, goods) and flows in the system?
Where are the buffers, constraints and bottlenecks?
- 10. Parameters, standards, targets.**

Adapted from Donella Meadows, Places to Intervene in a System, Whole Earth, Winter, 1997

“In theory, theory and practice are the same. In practice, they are not.”

Albert Einstein (attributed)





<http://www.theguardian.com/commentisfree/2014/sep/12/jeremy-paxman-king-for-a-day-ban-open-plan-offices>



<http://www.theguardian.com/business/2014/sep/14/office-designs-apple-bbc-google>



Mainstreaming Post Occupancy Evaluation

The Lighthouse, Glasgow - 15th September, 2009

by Richard Atkins

This edition of the magazine focuses on Mainstreaming Post Occupancy Evaluation (POE), an event that SEDA held in collaboration with the Glasgow Buildings Trust and SOST on the 15th September at the Lighthouse in Glasgow.

SEDA first explored POE in this magazine in March 2007 - 2½ years later it was time for a review. We were delighted to have presentations from leading practitioners, clients, regulators, business and data specialists, all delivered under the watchful eye of our Chair for the day, Richard Mahony.

Mainstreaming POE faces a number of challenges: convincing a design team and client's reluctance to what might be seen as bad news; finding the funding; finding the funding to implement improvements; defining a methodology; determining a way of conveying the evaluation outcomes.

All of these are clearly doable and achievable. There can be few other industries where habitually no one checks that the client and end users of the product are happy in any systematic way.

Look at most other consumer product and there will be a Watch Guide, comparing, analysing and reporting competing options. Consider the car industry. Speculate for a moment about buying a car. You are deluged with customer feedback surveys, an analysis of miles per gallon, reliability, longevity and robustness. Growth in opinion on this model or that are of interest. Financial information on models and running costs are set out for consumer comparison.

Most importantly, the car makers digest all of this information about their product and that of their rivals. They undertake their own focus groups and listen to their customers and dealers. The results in terms of reliability and comfort, even by comparison with say 20 years ago, are there to be seen.

Stretching this analogy further, some may say to breaking point, many cars now have their own on board, continuous POE. They tell you when they need a service, if the brakes are worn or fluid levels low. Some tell you their fuel consumption while you are driving, giving you the 'live' fuel back to tell the right foot as the needle moves into the red.

So what is an ideal world would see POE mainstreamed?

There is a debate to be had about the methodology(s) used. We had presentations from a number of practitioners who have all developed different approaches based on what their customers required.

With methodologies comes benchmarking. You need to know how your building performs relative to similar buildings, those in the remainder of your estate, location or sector. More importantly, as a society we need an overview of building per-

formance in order to target policy interventions and subsequently assess their effectiveness.

Should POE be driven from the top down by Government regulation, or by driving POE through Government funding policy, as it already is beginning to happen in the education sector?

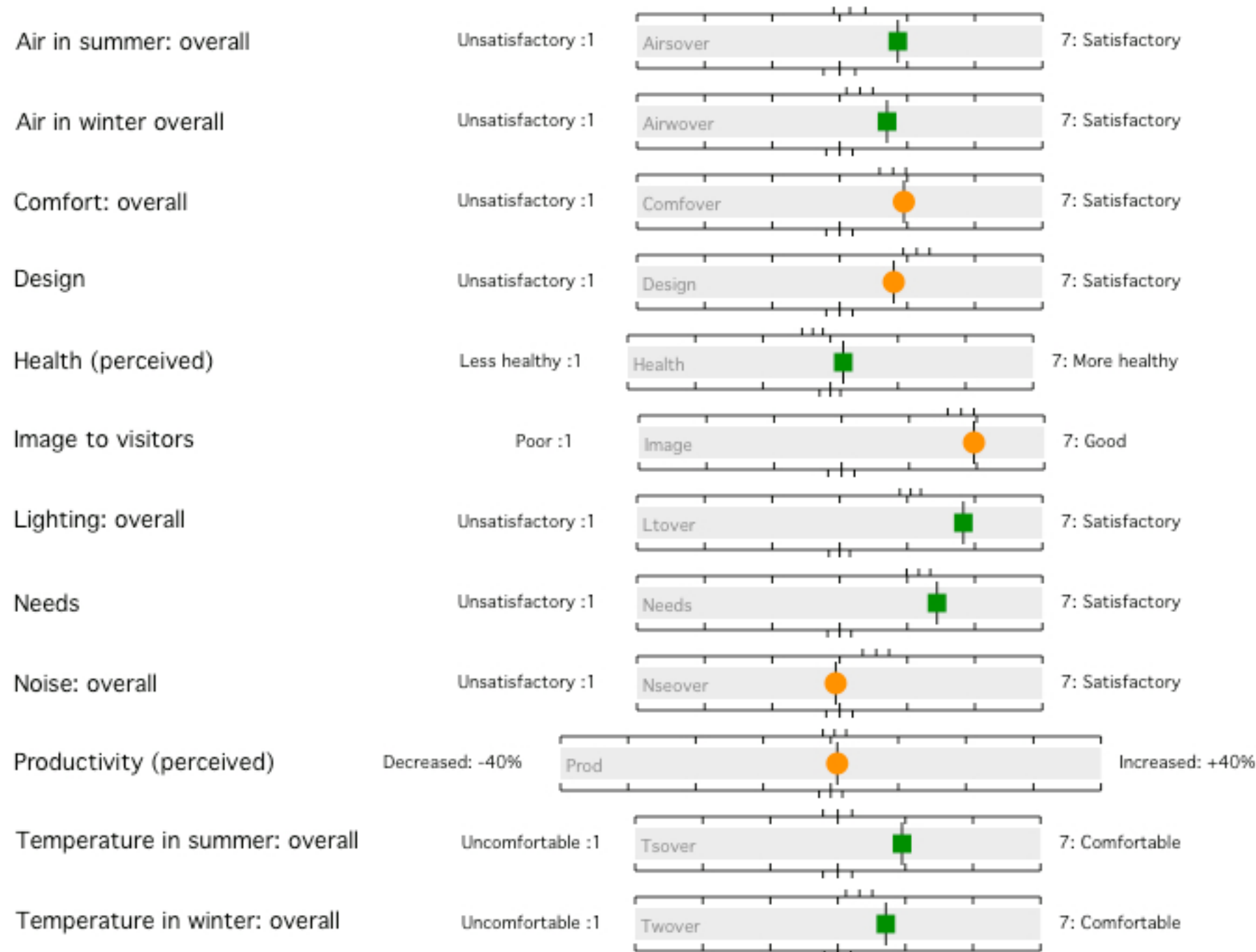
Consider how we measure the added value of enhanced productivity, educational or health outcomes. Should we be looking at different contractual relationships where the builder and the design team see a direct financial benefit from exceeding minimum performance criteria, as well as suffering a penalty for falling short on these?

The conclusion of the day was a call to action to form a working group to explore these questions in detail, in order to inform and influence those policies which can mainstream POE.

(Continued page 2)



Summary (Overall variables)



Changed behaviour because of conditions in building

Always leave desk to take phone calls - no "quiet areas" to make private calls. Drink a lot of tea in winter when it's cold in office and lots of water in the summertime as it gets very hot at times.

Bought in additional clothing.

Difficult to concentrate when you are freezing cold.

End work day early if too noisy.

Go home to work when too cold.

Hard to work when cold. Forced to work from home in evenings rather than staying late at work.

I am used to my own office (previous employer) and being in an open plan office I have had to change my behaviour (clutter/conversation) to be more considerate of other users.

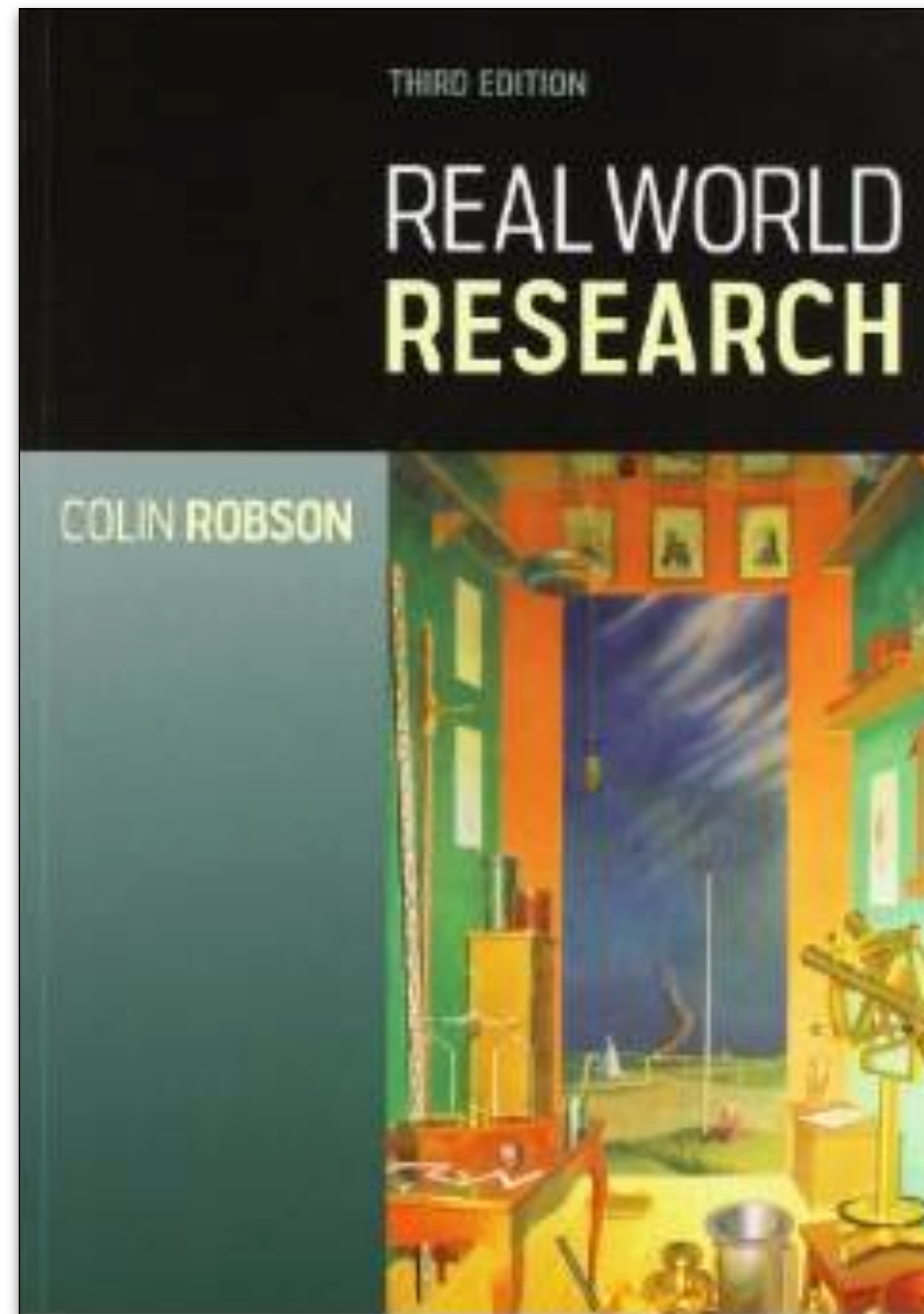
I bring in coats and warm clothes. I often find I need to move around more and make more trips to get hot drinks.

I get angry when I'm cold indoors.

I get irate when too hot, frustrated when too cold. I get frustrated when too loud, bored when too quiet. I get angry if someone microwaves fish and stinks the place out all day, it lasts for hours.

I had to change the time schedule of my work due to the noise, open plan office - colleagues sitting next to you.

I have a Spotify subscription which I use so whenever it gets too noisy I listen to music.



<http://www.waterstones.com/waterstonesweb/products/colin+robson/real+world+research/7708065/>

[http://scholar.google.co.uk/scholar?hl=en&q=real-world+research&btnG=&as_sdt=1%2C5&as_sdt=](http://scholar.google.co.uk/scholar?hl=en&q=real-world+research&btnG=&as_sdt=1%2C5&as_sdt=1%2C5)

Real-world emphasis

- Solving problems
- Robust results
- Finding bases for action
- Often in the field
- Strict time constraints
- Strict cost constraints
- Little consistency of topic
- Generalist researchers
- Oriented to client needs
- Viewed as dubious by many academics
- Need highly developed social skills

Academic emphasis

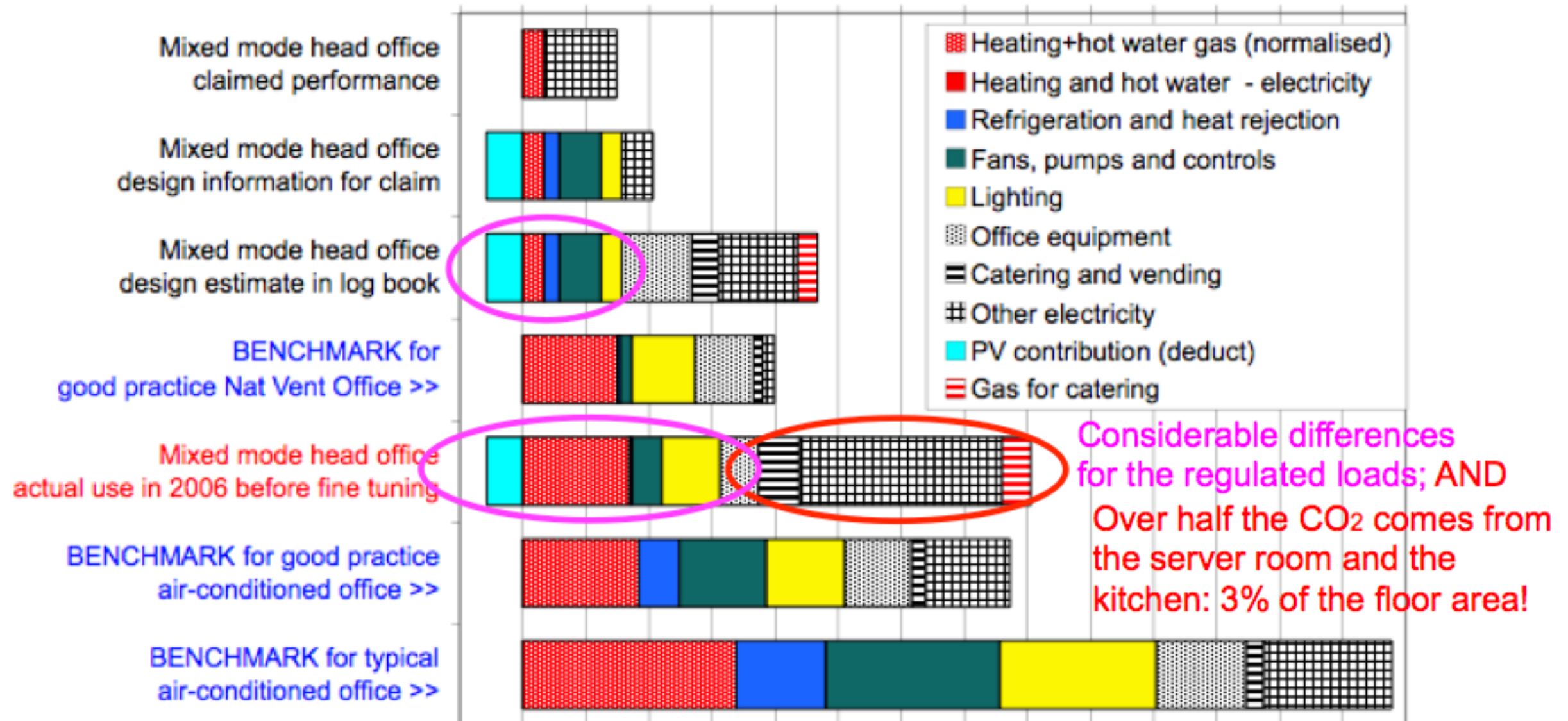
- Advancing the discipline
- Establishing relationships
- Developing theory
- Often in the field
- Often in labs
- As long as necessary
- As much finance as needed or don't attempt
- High consistency of topic from one study to the next
- Specialist researchers
- Oriented to academic peers
- Need some social skills

Closing the Performance Gap

Annual CO₂ emissions of energy use in a low-energy office building

kgCO₂/m² Treated Internal Floor Area at UK ECON 19 CO₂ factors of 0.19 for gas and 0.46 for electricity

<< Onsite renewable supply << >> Building energy demand >> expressed as CO₂



Slippage during initial estimation

1. Only estimated the energy use of the typical spaces (e.g. only the office space in an office building), and left out everything else, circulation areas, support spaces, car parks and so on.

Energy performance of non-domestic buildings: closing the credibility gap

2. Only reported the energy used by normal building services (heating, hot water, cooling, ventilation and lighting), not by anything else.

3. Assumed the building is empty at night with most systems off. Often they aren't.

4. Assumed near-perfect control and a close match of supply to demand.

In comparing design options, the above simplifications may be practical and legitimate, but in effect the designers are not predicting the actual energy use but some strange optimal energy use (a bit like the thermodynamic efficiency limit for a heat engine). Then the credibility gap really opens up when designers go on to claim how good their building will be by making direct comparisons between the total primary energy use or CO₂ emissions for this subset, with the totals in benchmarks such as ECON 19 (Action Energy, 2003) which are based on actual energy performance data and take into account all energy uses in the completed and operating building.

Source Energy Performance of Non-Domestic Buildings: Closing the Credibility Gap
Bill Bordass, Robert Cohen, John Field,

<http://www.usablebuildings.co.uk/Pages/Unprotected/EnPerfNDBuildings.pdf>

What was actually specified to be built may have deviated from the design assumptions at the time the options were appraised and the estimates of energy use first made. For instance:

5. Client requirements may have changed, affecting the design and its energy use.

6. The insulation, ventilation, solar and daylight characteristics of the envelope may have changed.

7. The heat storage characteristics of the fabric may have changed.

8. The building services and the controls may have been altered.

But were their affects on the predicted energy use re-calculated, particularly if to do this would have meant having to pay people who had been thought to have completed their tasks (e.g. thermal modellers and BREEAM environmental certifiers), to come back and have another look?

The building may not be constructed as intended:

9. If tenders were high, cost savings may have been necessary. Cost cuts often affect thermal characteristics, building services and controls – things that aren't generally seen although they can be felt. Solar and glare control devices often suffer too. Increasingly such negotiations are between clients, project managers, contractors and suppliers and not under full control of the design team – who may sometimes not be involved at all, or only in commenting on the outcome.

10. Elements which include contractor-design (and often cost negotiations too) may not end up as anticipated. For example, it is not unusual for structures to cut into zones which had been intended for insulation, and to make air sealing measures very difficult to install; and for cladding systems not to be of the intended thermal integrity, especially at interfaces with foundations, eaves and other types of wall construction.

11. Building services equipment may have been substituted for that originally specified.

12. Build quality may not have been up to standard, e.g. with degraded insulation and airtightness.

13. Commissioning may not have been thorough. It is not uncommon to find energy-saving devices such as variable speed drives, heat recovery and “free cooling”, and plant sequencing systems working very poorly, if at all.

14. Services and controls may not work exactly as intended.

Once completed

- 15. The building may not be occupied quite as envisaged.
- 16. The fitout may change the building and its energy systems substantially and clash with some of the design intentions and installed systems.
- 17. The systems may never be fine-tuned to suit changing occupancies and seasons.
- 18. Operators and users may find it difficult to understand the control systems and to operate them effectively; and the systems may not always have been usable or manageable in the first place.
- 19. Maintenance and energy management may not be up to standard.
- 20. Systems and equipment may default-to-on unnecessarily; or because it is the only way to keep the level of complaints down, see figure 2. A similar example is shown in figure 19.2 of CIBSE Guide F (2004).
- 21. There may be emergent properties and unintended consequences, for example control systems which irritate the occupants and are therefore by-passed.
- 22. In rented – and particularly multi-tenanted - buildings, the split of responsibilities between landlord, tenants and building managers often inhibits investment and exacerbates the wasteful operation of systems.



The Woodland Trust
interior staircase



A LESSON FROM THE PAST

Experience gained from the post-occupancy evaluation of the National Trust's Heelis building have been fed into the design of The Woodland Trust's headquarters. The project team compares the in-use performance of both

By **Bill Bordass, Pete Burgon, Hester Brough, and Matt Vaudin**

To maintain the 'golden thread' from design intent to reality when creating the 2,727m² head office for The Woodland Trust, Max Fordham – and architect Feilden Clegg Bradley Studios – used post-occupancy findings from the Heelis building, in Swindon. The outcomes have now been studied, thanks to funding from Innovate UK – formerly the Technology Strategy Board – and its Building Performance Evaluation programme.

In 2002-04, the environmental engineer and architect formed part of a research team investigating the potential for soft landings¹, and discovered the importance of maintaining

the 'golden thread' – starting with inception and briefing, then managing expectations throughout the procurement process, building on initial aftercare, post-occupancy evaluation, and closing the feedback loop.

Gathering data

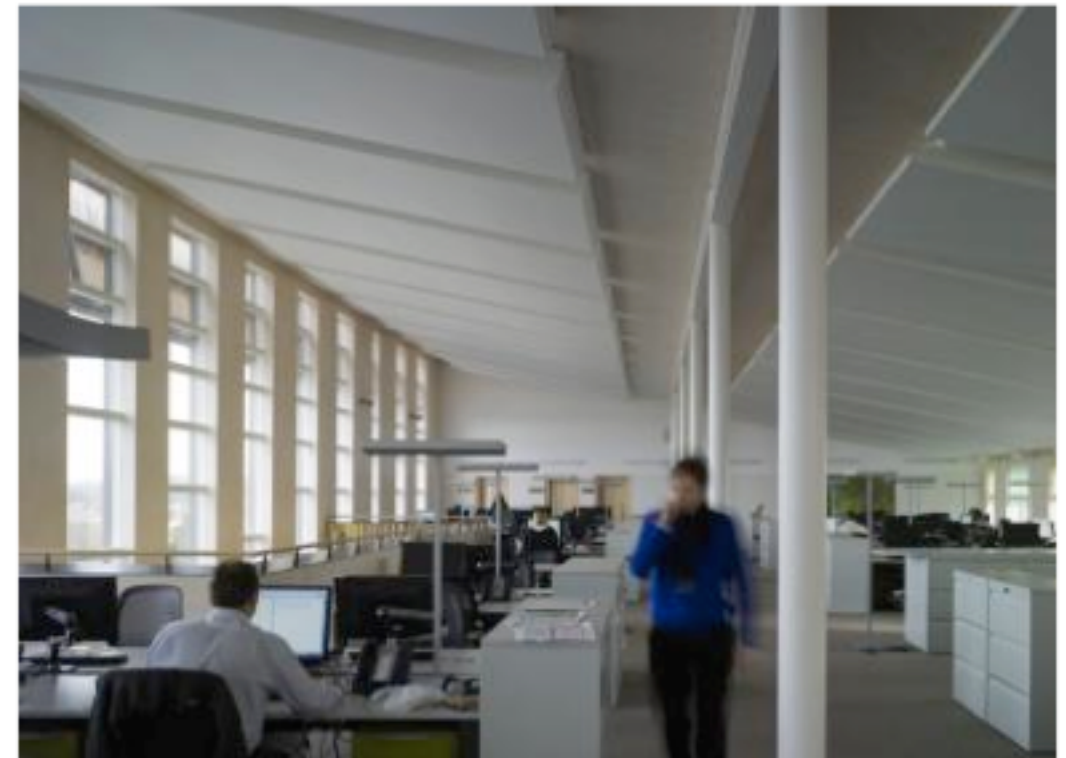
At that time, Max Fordham and Feilden Clegg Bradley Studios were working together on Heelis, the National Trust's 7,605m² (gross) head office in Swindon. The project followed a strong sustainability agenda, though this was somewhat softened by the requirements of the developer, which procured the building after the scheme design had been agreed with the client.

As part of the reality checking advocated by soft landings, a matrix was developed by Feilden Clegg Bradley Studios and Max Fordham, to allow design ambitions for sustainability to be reviewed at project

National Trust Swindon



Woodland Trust Grantham



ARCHITECTS: Feilden Clegg Bradley Studios, ENVIRONMENTAL ENGINEERS: Max Fordham.

... supporting www.sustainable.com

2006-07 Mini-Probe at Heelis

National Trust Headquarters, Swindon

Offices, catering facilities for staff & public, central IT server, shop.

Client and design intent for a sustainable building, including:

- Deep plan (with courtyards) for good communications.
- Low rise (2 storey) with rooflights for natural light and ventilation.
- Automatic natural ventilation with low energy mechanical backup.
- Large photovoltaic array.
- Expectations managed using a matrix of features vs. aspirations.

Procured as a pre-let:

- Scheme design by Feilden Clegg Bradley (FCBS, architects), Max Fordham (building services), Adams Kara Taylor (structural).
- After RIBA Stage D, design team novated to: Aim Investments (investor), Kier Ventures (developer), Moss (contractor).

Awards 2006: BCO Innovation, Civic Trust Sustainability, RIBA Sustainability.

FCBS spent the RIBA prize money on the POE, plus a bit for a party!

Heelis office interior



Heelis POE 2006-7: some conclusions

- DAYLIGHT: design should take account of indoor appearance, not just desktop illuminance. *Added wall washing would save lighting energy.*
- SPECIAL AREAS: Energy in server room and kitchen accounted for more than half the CO₂ emissions. *Need more design & management attention.*
- METERING & MONITORING: More attention needed. *Automated in 2012.*
- HEATING & HOT WATER: *Performance disappointing.*
- ENERGY MANAGEMENT. Improved in 2007, deteriorated 2008-2012, now improving. *Scope for more savings, including reduced night loads.*
- SUMMER COMFORT. Occupant survey shows satisfaction improved in 2007, owing to cooler weather, better control and management. *Reportedly better still now, after control upgrades in 2012-13*
- WINTER COMFORT. Improved: window controls were fine-tuned in 2007. *The control system was replaced in 2012, allowing individual adjustment.*
- OCCUPANT SATISFACTION: Heelis (2007) had the best overall score in the BUS database for “green” buildings with deep floorplates (*but simpler, shallower buildings tend to perform better, with better perceived control*).

Feeding forward from Heelis to the Woodland Trust HQ, Grantham

Followed in the footsteps of Heelis, with FCBS, Max Fordham, *and the CEO of Woodland Trust who joined from the National Trust.*

SOME LESSONS INCORPORATED IN THE DESIGN (2008):

- Make it simpler: *controls, shallow plan, naturally ventilated*
- Task-ambient lighting in main offices.
- More energy-efficient ICT, *with thin clients.*
- Rudiments of Soft Landings, *though not rigorously adopted.*
- Early appointment of Facilities Manager.
- Managed move-in process, *with newsletters from the FM.*
- Follow-through, *with successful bid to TSB for evaluation.*

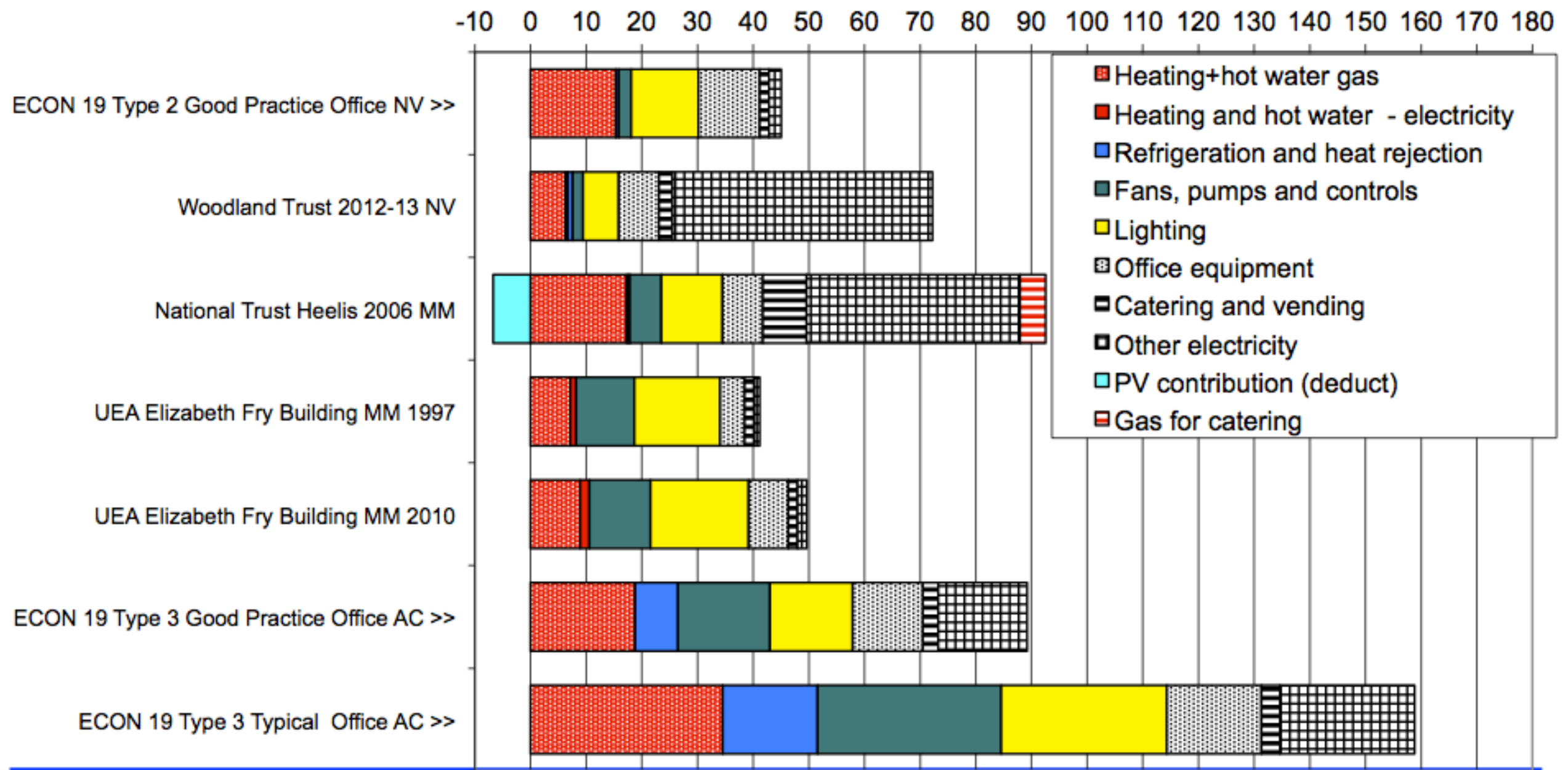




Woodland Trust energy performance *expressed as annual CO₂ emissions*

Annual CO₂ emissions comparison

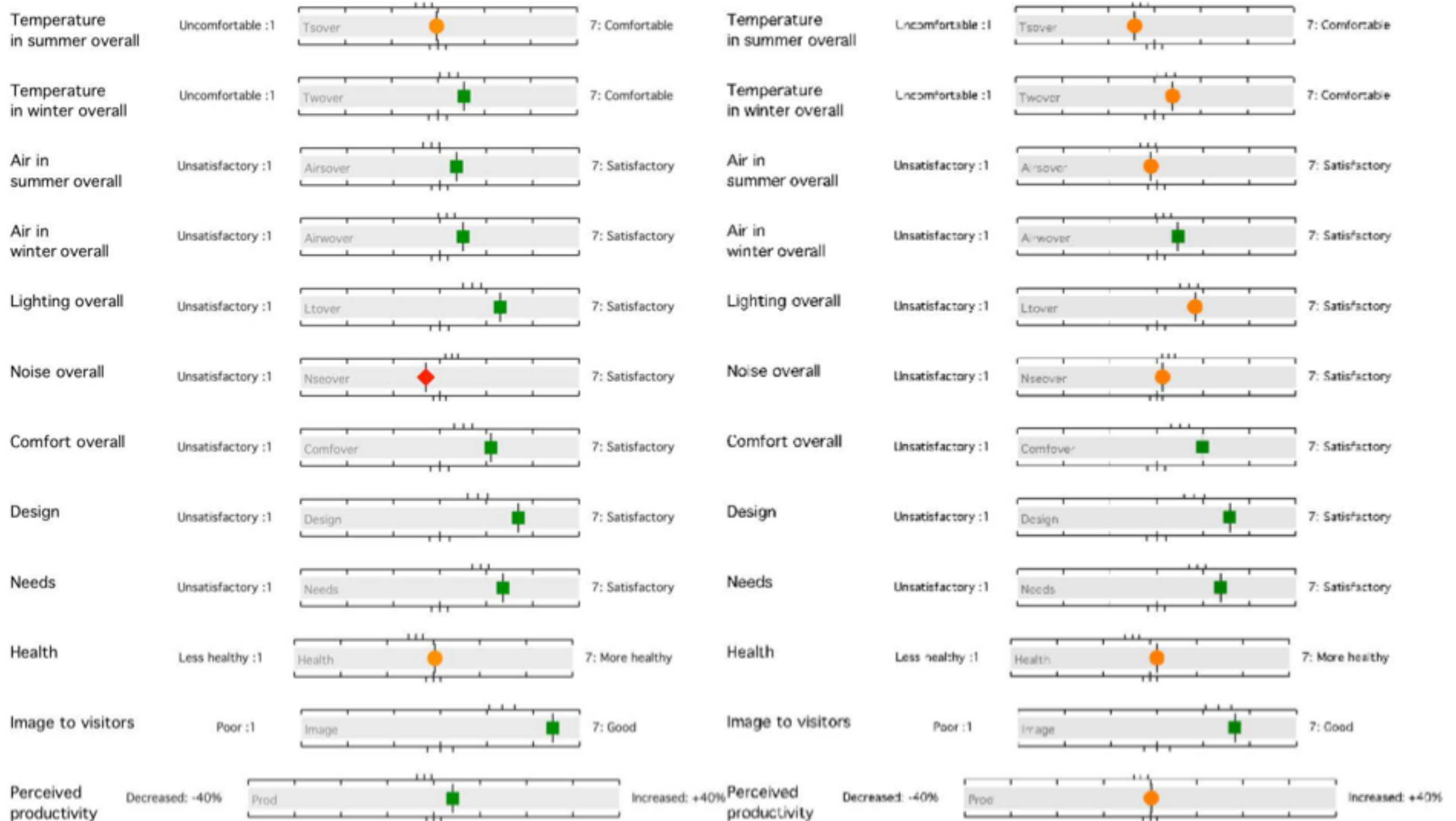
kg/m² Treated Floor Area at UK CO₂ factors of 0.194 for gas and 0.55 for electricity



BUS Occupant survey results

Woodland Trust 2012

Heelis 2006



Some things that have been learnt *from Heelis and the Woodland Trust*

- SIMPLER BUILDINGS and KIT: Considerable potential, but still needs care.
- FINE TUNING IN THE FIRST YEAR OF OCCUPATION. Needs very different priorities from normal practices during the defects liability period.
- NATURAL LIGHTING: Good, but glare can come from unexpected places.
- ELECTRIC LIGHTING: Task-ambient strategy successful. Would benefit from more finesse in control, together with more efficient lighting generally.
- HEATING: Woodland Trust uses much less gas. Further improvements planned. Hot water generation probably best separated from heating.
- CONTROLS AND BMS: Still in need of much more attention to detail.
- WINTER VENTILATION: Tricky to introduce controlled quantities in winter at the Woodland Trust. Mixed mode at Heelis may be more robust.
- SUMMER VENTILATION AND COOLING. Optimisation required at the Woodland Trust, owing to control issues and security concerns.
- WORKSTATION PLANNING: Needs flexibility. One size doesn't fit all.
- ICT SYSTEMS: In spite of major efforts, ICT and the associated HVAC still dominates electricity use. Some tuning now happening, with specialist advice.

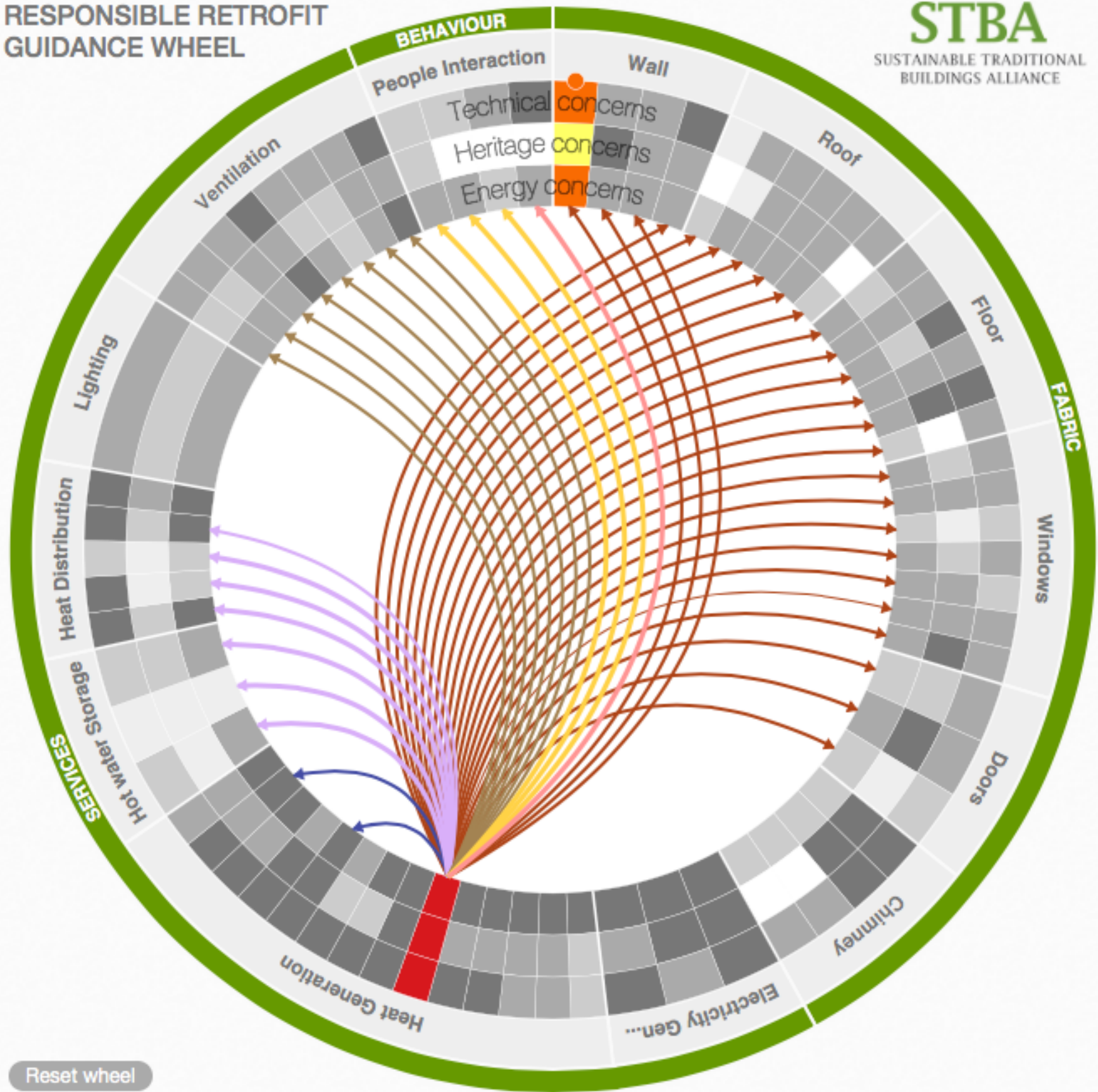
Soft Landings: *Everybody can win*

- Better communication, proper expectations management, *fewer nasty surprises*.
- More effective building readiness. *Less rework*.
- Teams can develop reputations for customer service and performance delivery, *building relationships, retaining customers, commercial advantage*.
- Vital for rapid progress towards more sustainable, low-energy, low-carbon, well-liked buildings and refurbishments, *closing the performance gaps*.
- Will save capital costs, *leaving the bling out and focusing on what really matters*.

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!*

Dissemination



► Colour key

► Building context

Heat Generation

Biomass boilers

Installation of large scale biomass boiler (woodchip, woodlogs or pellets) to provide heating and hot water.

ADD TO LIST

CLOSE MEASURE

► Advantages

▼ 7 Technical Concerns

- Space limitations (major)
- Handover to user/s (major)
- Complex installation (major)
- Complex operation (major)
- Maintenance interval and complexity (major)
- Relation to Building Thermal Performance (high)
- Personal capacity/Right opportunity (high)

▼ 4 Heritage Concerns

- Planning consent within conservation area (major)
- Original internal detail lost (high)
- Detail for Access to services (high)
- Detail retains character? (medium)

▼ 5 Energy Concerns

- Product quality (major)

Conclusion

- Understand what is needed *strategic briefing*
- Be clear what is wanted, and communicate it plainly *strategic design, leadership*
- Be ambitious, but realistic *question all assumptions, understand users*
- Follow things right through *e.g. using **Soft Landings** procedures*
- Review what they are doing *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 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 *reflective practice, sharing of experiences*

KEEP THINGS AS SIMPLE AS PRACTICABLE AND DO THEM BETTER
Only make things complicated where it is really necessary.

Further material

What next ...?

Case studies?

Misunderstanding 1: General, theoretical (context-independent) knowledge is more valuable than concrete, practical (context-dependent) knowledge.

Misunderstanding 2: One cannot generalize on the basis of an individual case; therefore, the case study cannot contribute to scientific development.

Misunderstanding 3: The case study is most useful for generating hypotheses; that is, in the first stage of a total research process, whereas other methods are more suitable for hypotheses testing and theory building.

Misunderstanding 4: The case study contains a bias toward verification, that is, a tendency to confirm the researcher's preconceived notions.

Misunderstanding 5: It is often difficult to summarize and develop general propositions and theories on the basis of specific case studies.

Five Misunderstandings About Case-Study Research

Bent Flyvbjerg

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Individual cases and outliers can be bellweathers.

A portfolio of approaches is best.

Yes! Especially if not done independently.

Five Misunderstandings About Case-Study Research

Bent Flyvbjerg

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What next...?

Case studies?

Misunderstanding 1: General, theoretical (context-independent) knowledge is more valuable than concrete, practical (context-dependent) knowledge.
Too much emphasis on statistics and benchmarking.

Misunderstanding 2: One cannot generalize on the basis of an individual case; therefore, the case study cannot contribute to scientific development.
Individual cases and outliers can be bellweathers.

Misunderstanding 3: The case study is most useful for generating hypotheses; that is, in the first stage of a total research process, whereas other methods are more suitable for hypotheses testing and theory building.
A portfolio of approaches is best.

Misunderstanding 4: The case study contains a bias toward confirmation, that is, a tendency to confirm the researcher's preconceived notions.
Yes! Especially if not done independently.

Misunderstanding 5: It is often difficult to summarize and develop general propositions and theories on the basis of specific case studies.
But coherent strategies for the future are what's required not theories.

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What next...?

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Too much emphasis on statistics and benchmarking.

Individual cases and outliers can be bellweathers.

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Too much emphasis on 'proof'.

But coherent strategies for the future are what's required not theories.

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Five misunderstandings about case study research

1. General, theoretical knowledge is more valuable than concrete (context-dependent) practical knowledge.
***NO:** They complement each other.*
2. One cannot generalise on the basis of an individual case.
***NO:** Individual cases and outliers can be bellwethers.*
3. The case study is most useful for hypothesis generation.
***NO:** They can also test hypotheses, using multiple methods.*
4. Case studies contain a bias to verifying preconceptions.
***NO:** They can often provide new and richer insights,
BUT they need to be done with a degree of independence.*
5. Case studies do not let one develop general propositions.
***BUT:** They help us develop coherent strategies for the future.*

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