

PowerEx Live
Park Plaza Hotel, London, 6 October 2021

HOW MUCH HEAT DO WE REALLY NEED?

Bill Bordass

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Current approaches to making large reductions in the heat used in buildings* ?

** or, predominantly, for the people in the buildings*

NEW BUILDINGS:

- A good thermal envelope can reduce demand massively.
- *BUT overheating will (and too often does) occur unless there is also good “passive” design (thermal capacity, solar control, ventilation ...).*
- Low-capacity H&V systems should then meet any remaining loads.

TODAY'S BUILDINGS *(the majority in 2050, by far):*

- Avoidable waste can often be tackled cheaply, *but frequently isn't.*
 - “Deep Retrofit”, approaching new building standards, *will be slow, expensive, carbon-intensive, and risky in many traditional buildings.*
 - *In many buildings, simple measures may be better - the 80/20 rule.*
 - Communal heating might help - *but too late for much in UK now?*
-

Nearly half a century of new building mistakes:

Cartoon by Louis Hellman on the cover of the RIBA Journal

Energy issue
Feb 1976

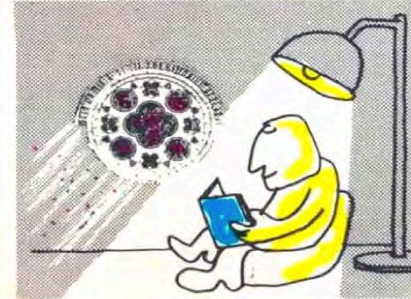
HOW WRONG CAN WE AFFORD TO BE ?



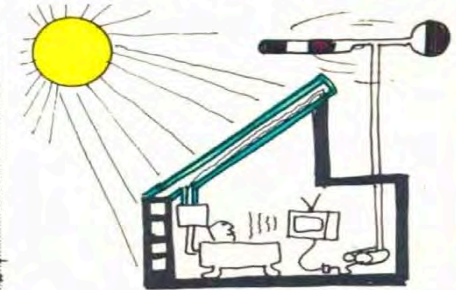
OLD BUILDINGS ARE HIGHLY FLEXIBLE IN USE, THEY CAN BE ADAPTED TO NEW FUNCTIONS CHEAPLY AND EASILY BY KNOCKING DOWN WALLS OR BY ADDING BATHROOMS OR STAIRCASES. IT HAS BEEN ESTIMATED THAT THE GREAT MAJORITY OF HUMAN ACTIVITIES CAN BE ACCOMMODATED IN A GEORGIAN TERRACE HOUSE.



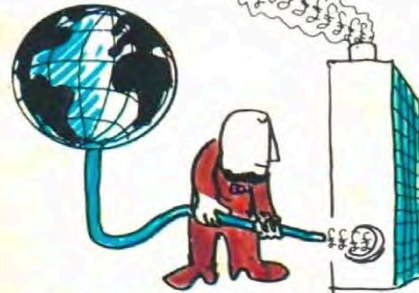
WHAT WE NEED IS A COMBINATION OF THE OLD EMPIRICAL EXPERTISE AND NEW TECHNIQUES TO PROVIDE REASONABLE BUILDINGS WITH THE MINIMUM COST AND ENERGY CONSUMPTION.



FOR EXAMPLE THE QUALITY OF DAYLIGHT IS MORE IMPORTANT THAN THE QUANTITY. SMALL WINDOWS FOR VIEWOUT CAN BE USED WITH ARTIFICIAL LIGHTING FOR WORK ETC.



MODERN MATERIALS CAN BE USED TO EXPLOIT SOLAR ENERGY MORE EFFICIENTLY TO HEAT WATER OR ROOMS, PLUS IMPROVED WINDMILLS TO DRIVE GENERATORS.



IT IS CLEAR THAT THE HIGHER THE BUILDING THE GREATER THE TECHNOLOGY REQUIRED TO COUNTERACT THE PROBLEMS CREATED BY BUILDING HIGH.



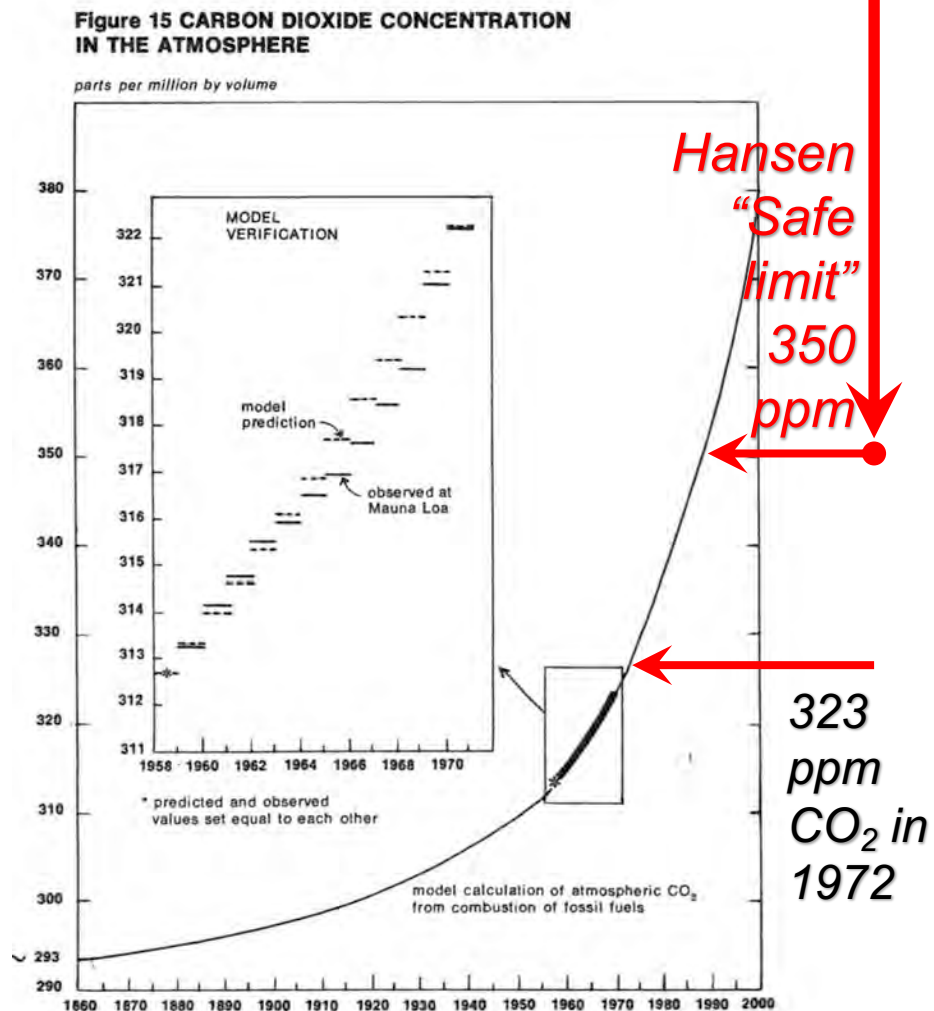
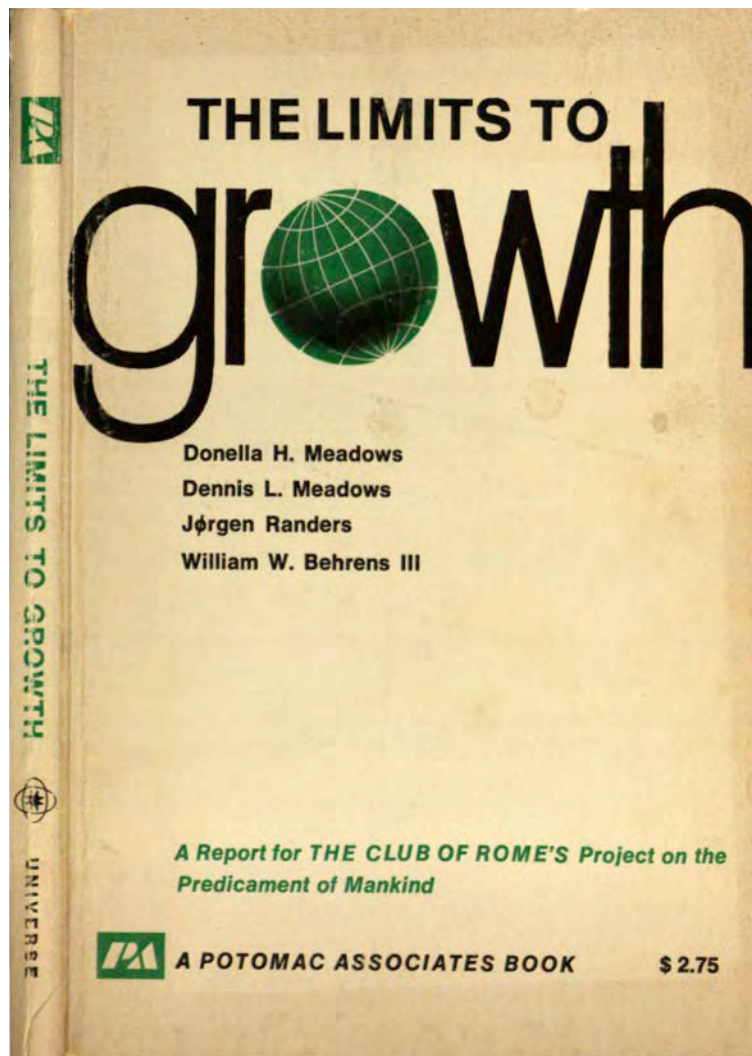
ENVIRONMENTAL DESIGN IS NOT AN EXACT SCIENCE - WE CAN NEVER BE RIGHT, THE QUESTION IS...



HOW WRONG CAN WE AFFORD TO BE ?

Hellman

In 1972, the message was *slow down*:
Now, 50 years later: *get back down there!*



Every little helps: *use multiplier effects to save energy and carbon quickly*

ENGAGE PEOPLE to start with, **AND** for example ...

BE LEAN - Halve the demand

Review standards, reduce losses, avoid waste.

times

BE MEAN - Double the efficiency

Buy efficient equipment, use it effectively, minimise system losses, tune it up.

times

BE GREEN - Halve the carbon in the supplies

With on-and off-site measures

equals

You're down to one-eighth of the CO₂

BEING LEAN: CHEAPEST, FASTEST-ACTING

Are our comfort standards appropriate?

*“Evening out fluctuations has become
an egalitarian enterprise which it is heresy to question.”*

MICHAEL YOUNG, *The Metronomic Society* (1988).

“What we’ve got used to, we’re not entitled to”

RODERIC BUNN

*“A constrained world cannot afford the rich *”*

GEORGE MONBIOT

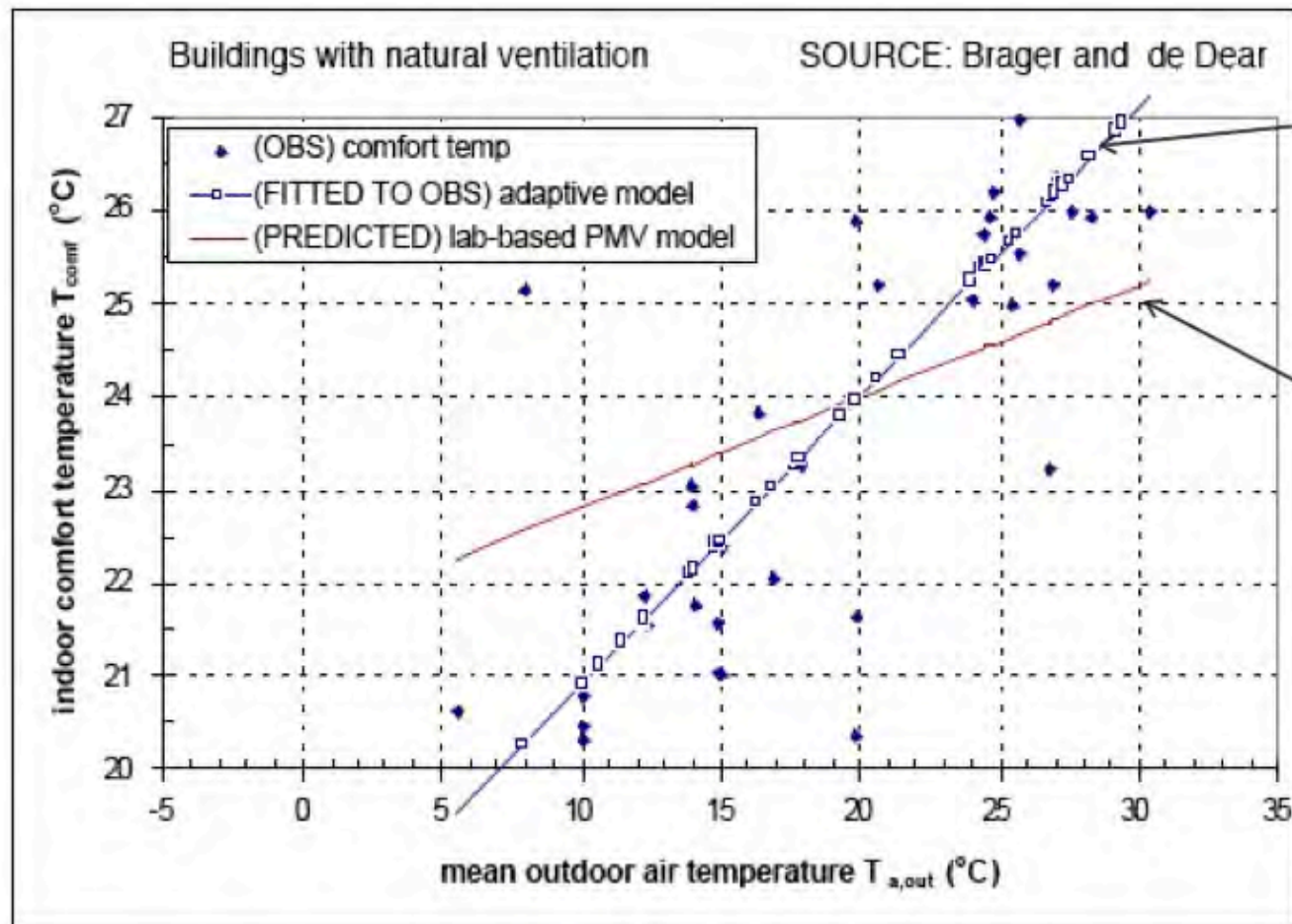
**HOW MUCH HEATING AND COOLING IS JUST AND
JUSTIFIABLE, IN OUR CLIMATE EMERGENCY ?**

Comfort is a subjective concept

*“People are the best measuring instruments, they’re just harder to calibrate” – GARY RAW **

- A lot depends on what we are doing.
- We can accept a wide range of conditions ... *if we have the opportunity and willingness to adapt by ourselves.*
- So recognise the climate, don’t exclude it.
- Naturally-conditioned buildings can be less energy-dependent and therefore more resilient.
- Research also suggests that thermal uniformity may be less healthy than responding to fluctuating environments.

PEOPLE ADAPT: *Results from laboratories and comfort-controlled buildings don't tell the whole story*



The curve is steeper (i.e. has a greater range of comfort conditions) in real (observed) situations than in the predictions from laboratory experiments.

This means that people are more likely to be tolerant when they have more control, **even if the conditions themselves are not measurably better!**

Comfort in context *on a simplified scale*

- Medical problems (*e.g. heat stress, frostbite*)
- Discomfort and stress (*too much of a good thing*)
- Delight (*exhilarating differences: theatre, holiday*)
- Comfortably unbalanced (*e.g. comfortably warm or cool*)
- **Neutral** (*comfortable*) - sensory deprivation?
- Slightly uncomfortable (*boiled frog*)

CRISIS OF DISCOMFORT (*comes sooner with no control*)

- Irritably uncomfortable
 - Increasing discomfort, until ...
 - Medical problems (*e.g. heat stroke, hypothermia*)
-

Comfort itself is not very important ...

BUT You need to avoid ***Crises of discomfort*** *

HOW?

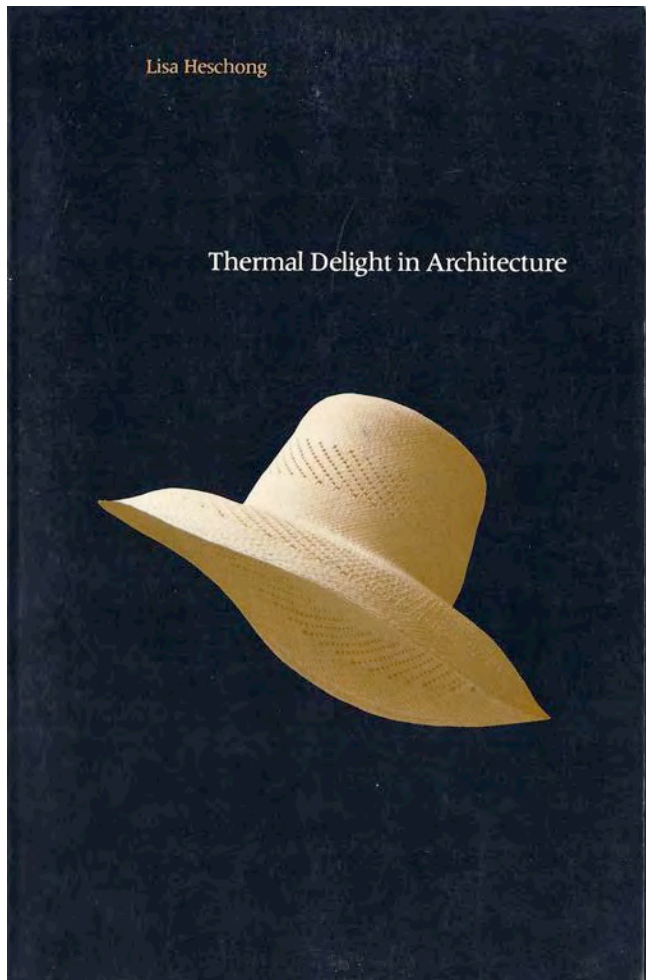
Using perceived control & adaptive opportunity, e.g:

- Adjust a passive system (*windows, blinds etc*).
- Adjust M&E services (*central, local or task*).
- Contact the manager (*rapid response needed*).
- Adjust posture, clothing, activity etc.
- Move about, or go somewhere else (*possible at home, in some modern work environments, in Australia! ...*).
- Eat or drink (*hot or cold*), take a shower, feet in bucket ...

Loose control with adaptive opportunity can give greater occupant satisfaction with less energy dependency ...

BUT achieving consensus in shared spaces can be tricky.

Thermal delight arises when one is recovering from a less comfortable state



Alliesthesia

Can satisfaction with non-uniform personal comfort conditions exceed that of the neutral uniform conditions traditionally considered ideal?

The topic was re-introduced by Richard deDear* in Australia ten years ago. It is now receiving considerable research attention.

Personally-controlled variations may well save a lot of energy.

* R deDear, *Revisiting an old hypothesis of human thermal perception: alliesthesia*, Building Research & Information 39(2), 108–117 (2011) and subsequent papers.

ENERGY SUFFICIENCY:

Getting reasonable comfort with much less energy

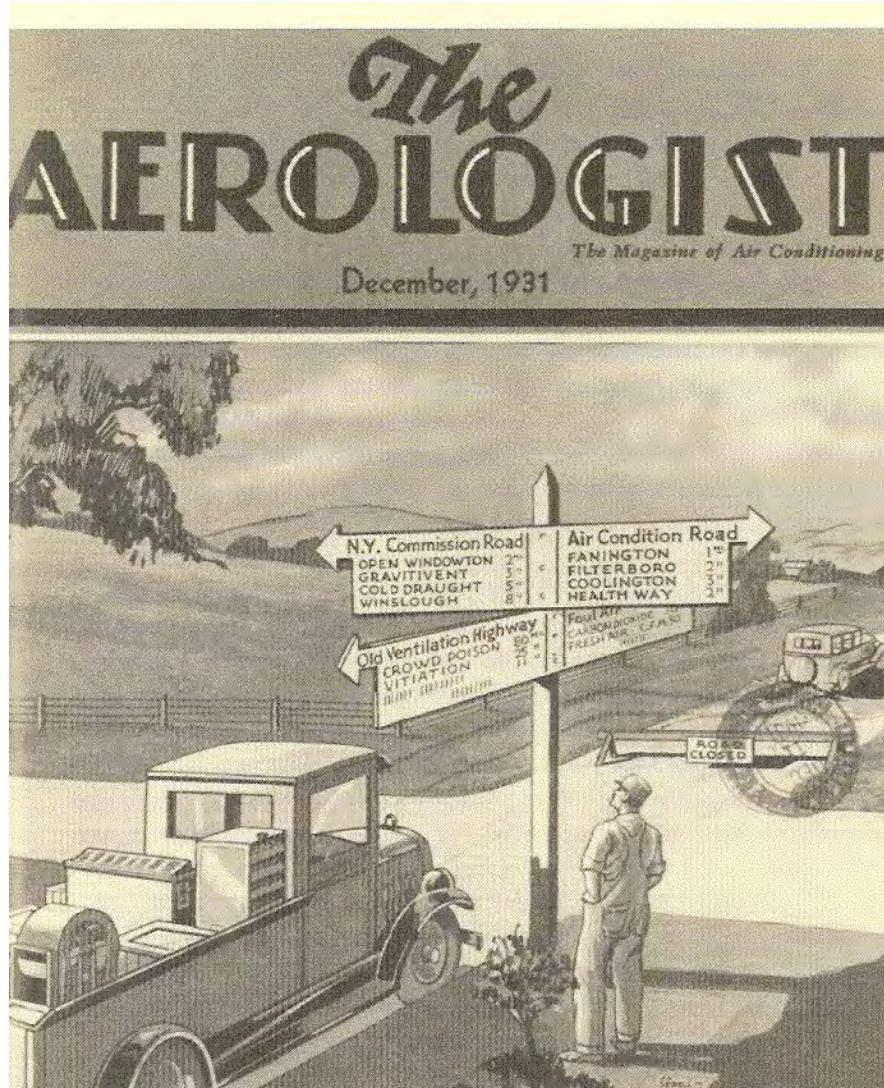
MAIN METHODS:

1. Review appropriate standards
2. Control draughts and radiant heat losses
3. Wear the right clothing
4. Consider local and personal heating
5. Have responsive user-friendly controls
6. AND Consider thermal refuges as a last resort – *both local and communal*



"He gets so dramatic when I lower the thermostat."

1. COMFORT STANDARDS became marketable commodities nearly 100 years ago



"In 1922, the New York State Commission ... advocated natural ventilation ... The engineering community seriously opposed ...

"The AeroLogist journal ... argued physicians were stepping outside their [professional] boundaries.

*"When natural climate was the ideal, mechanical systems were found wanting, but **when quantitative standards ... became the measure, natural climate was found wanting.** When no town could deliver an ideal climate, all towns became potential markets."*

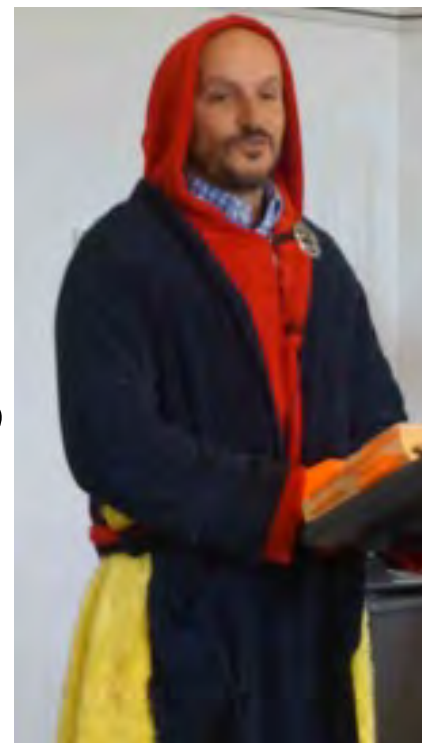
BUT COMFORT STANDARDS *are also socially and culturally determined*

“If current understandings of comfort underpin escalating levels of energy demand, why persist with them?”

People’s needs... have social histories of their own ... The [mistaken] distinction between technology ... and behaviour.

“Sociology ... repeatedly demonstrates the extent to which things ... ‘script’ what people do

“[while] dominant paradigms remain ... there are fewer references to non-technical barriers and more to sociotechnical change, and ... practices not behaviours.”

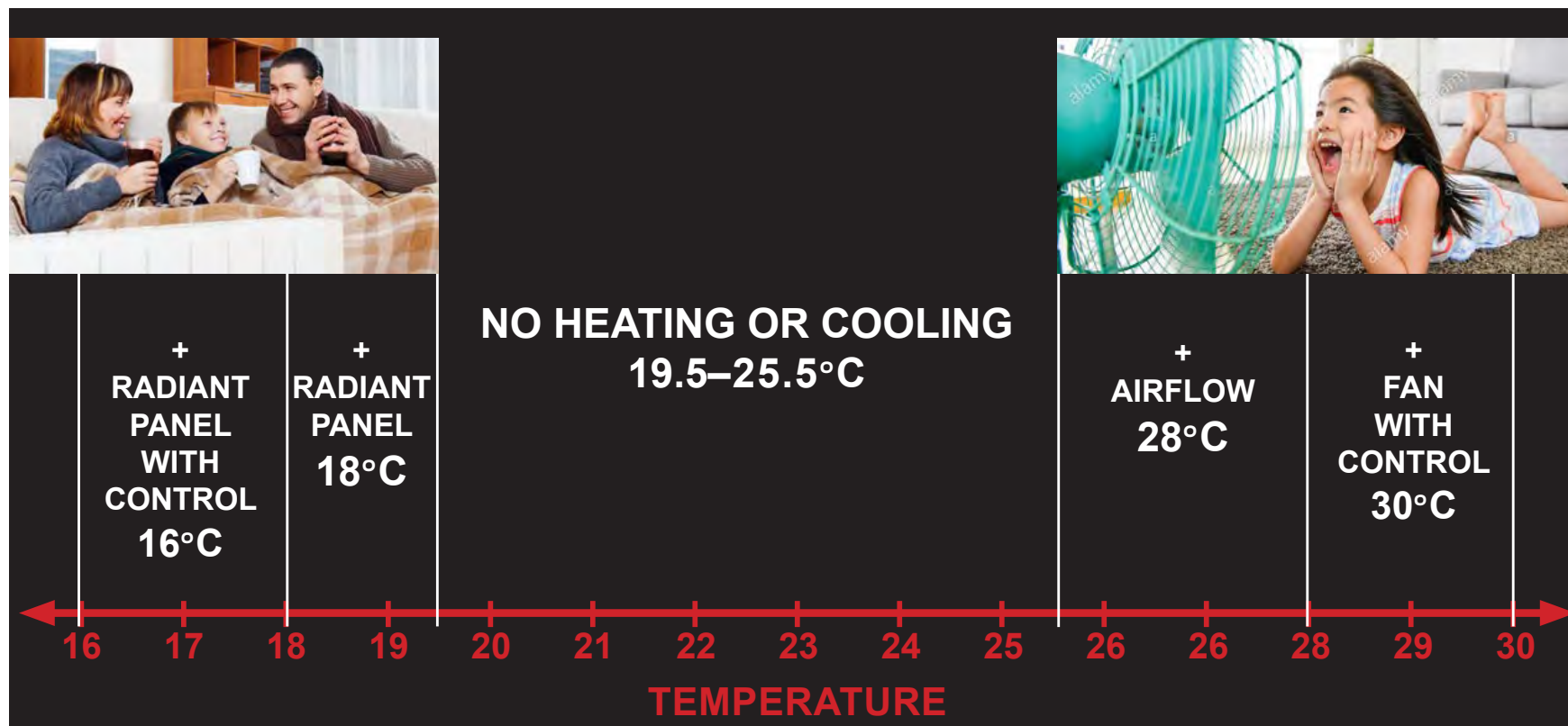


Clothes like this would more than halve space heat demand



SO ARE OUR STANDARDS FIT FOR TODAY?

Do we really need to heat to 21°C or so?



What about the recommended minimum 18°C Health requirement?

In its Minimum Home Temperature Thresholds review (2014) Public Health England says it is a “*weak recommendation*” with little robust support, but *may be beneficial to the over-65s and those with pre-existing medical conditions.*

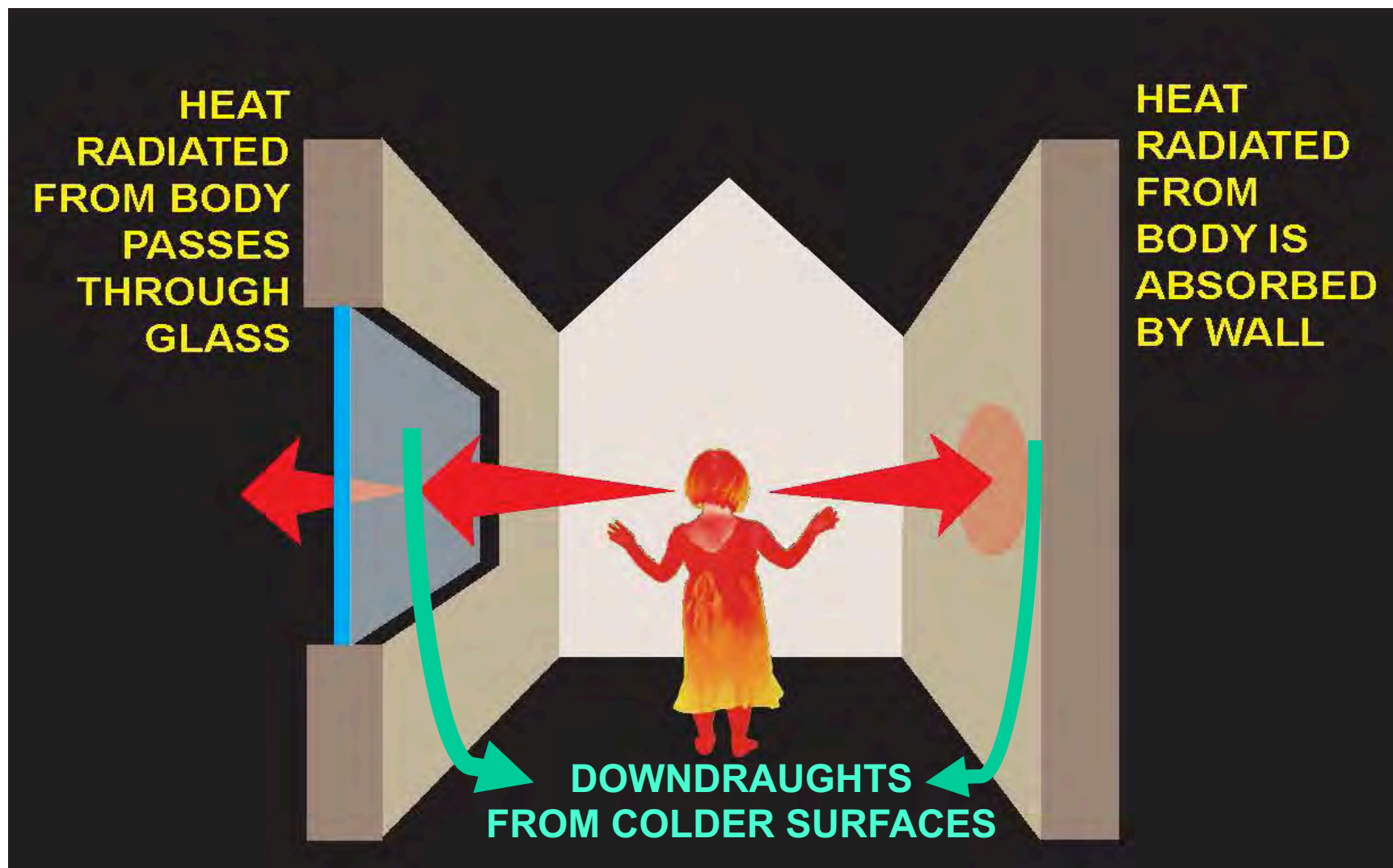
Where looser control works and occupants report better conditions

- Design intent is made clear to occupants, and where possible is intuitively obvious.
- Controls are clear to the user and manager, and give good feedback on what to do and what is happening.
- Facilities management is adequately resourced, respects users and responds rapidly and effectively to their needs.
- Default states are restored manually or automatically, to avoid unnecessary stress and/or energy waste.
- Organisations monitor performance in use, and make an effort to ensure that things are working and occupants are informed.

2. DRAUGHTS & “COLD” RADIATION: *Mediaeval hangings weren't just decorative*



2. DRAUGHTS & “COLD” RADIATION: Effects of colder surfaces

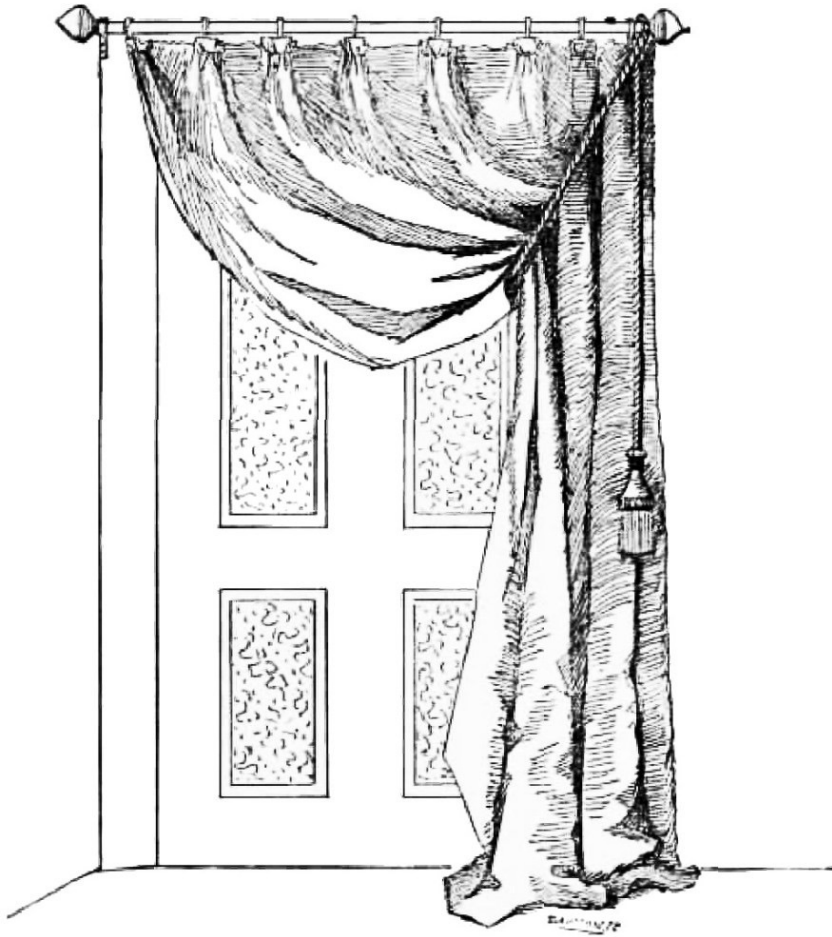


2. DRAUGHTS & “COLD” RADIATION: *Rich and poor could both have wall hangings*

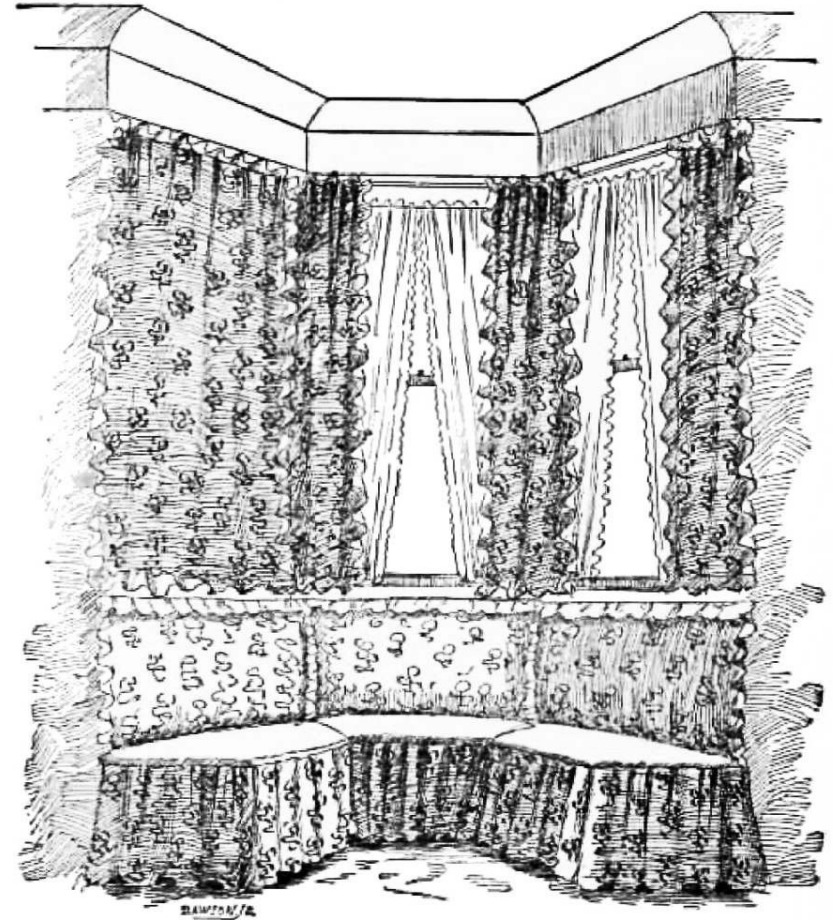


SOURCE: Robyn Pender, Historic England, *Lecture to the Rumford Club* (20 Feb 2020).

The Victorians added many soft furnishings, partly for thermal reasons



“This [cord] allows the curtain being dropped in one moment should more warmth be desired.”



“[the male architect]... too many windows ... and almost ruins us in blinds and curtains”

3. CLOTHING: Back to the Future *in a chateau*



Modern winter layers – awkward indoors and ultimately not warm enough



An Erasmus-style hat is comfortable and warm



Late medieval Burgundian coats – finally warm enough!

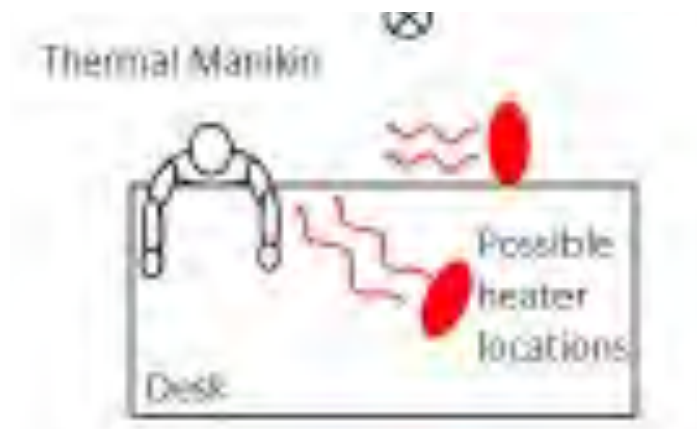
Cone-shaped mediaeval garments proved to be the warmest and most controllable

Heating one 40 m² room to 10-15°C using a log fire needed less than 5% of the fuel required to heat the whole building to the high teens using modern wood burning stoves.

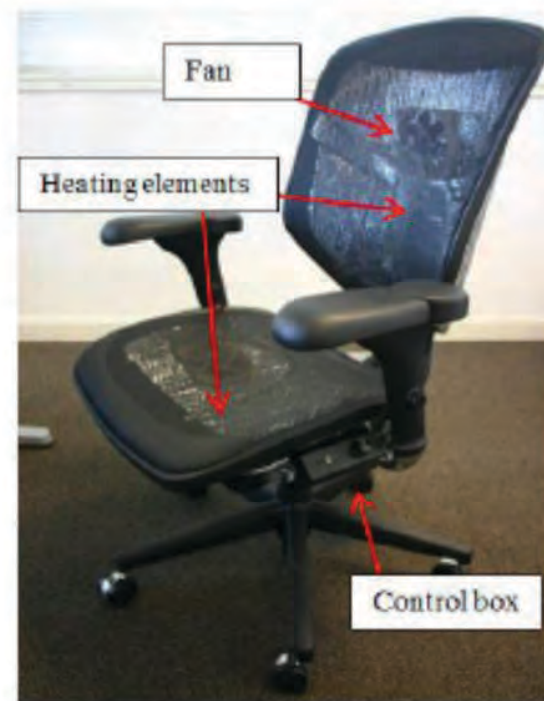
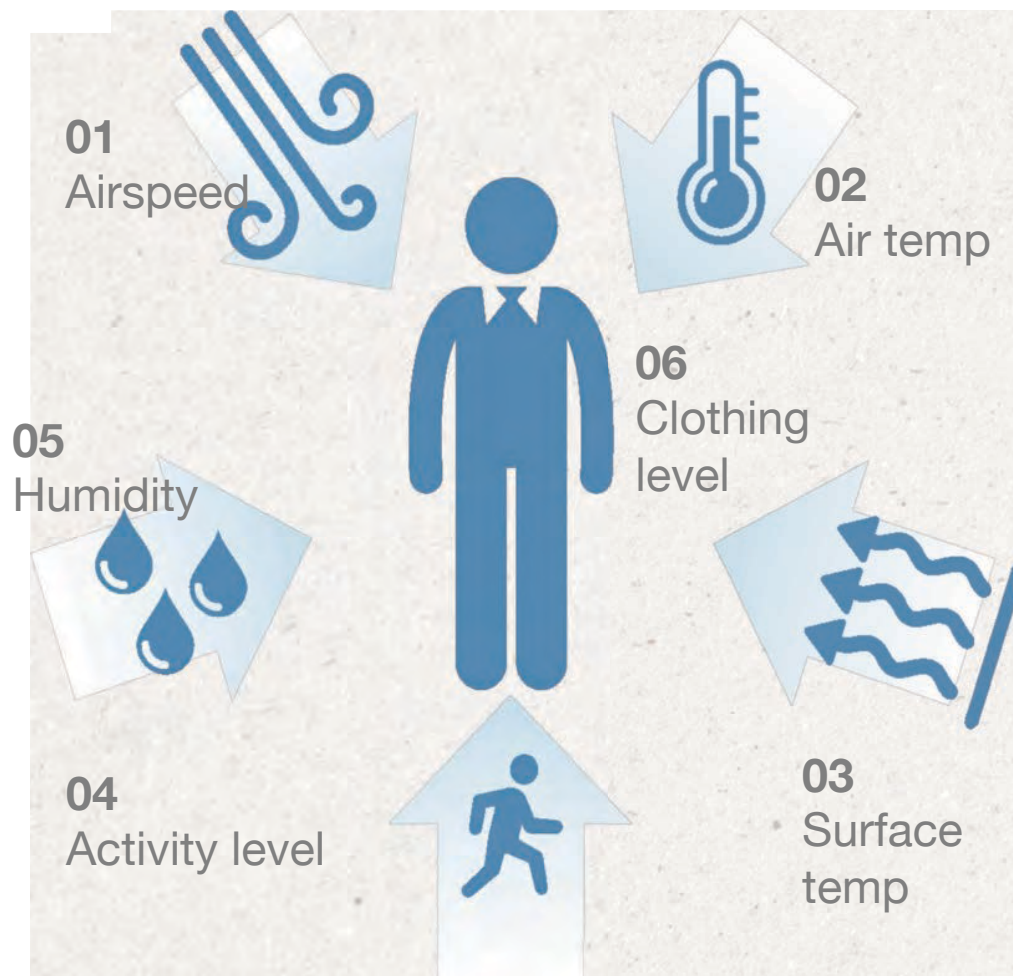
4. LOCAL AND PERSONAL HEATING: *Experiments with 16-zone thermal manikin*

Indicative Watts to increase personal comfort by 1°C:

250	Local convector heater
100	Local radiant panel
35	Local foot warming mat
<10	Heated chair or cushion



Battery-powered heated & cooled Hyperchair: *At RMI Innovation Centre, Basalt, Colorado*



Max heating power 14 W
Max cooling power 3.6 W

5. USER-FRIENDLY CONTROLS

“In a Machine for Living, I want to be in the driving seat” – OCCUPIER

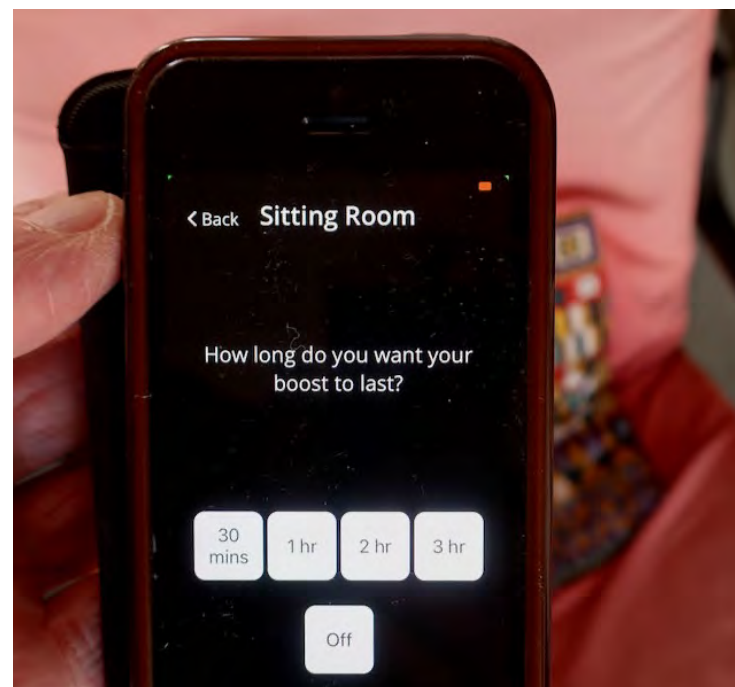
“We sell dreams and install nightmares” – CONTROLS MANUFACTURER

THE RUNBACK TIMER:

The most neglected control?



perhaps no longer ... ?



PEOPLE ARE THE BEST JUDGES OF WHAT THEY WANT ... BUT
YOU CAN NEVER HAVE TOO MUCH OF A GOOD THING

5. USER-FRIENDLY CONTROLS

A few principles

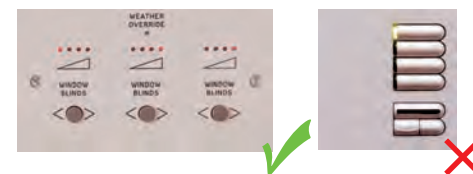
- Easy to reach
from the point of need
- Easy to use and understand,
preferably intuitively obvious
- Acknowledge interventions, so
you know things will happen
- Default to off, safe or standby,
so energy isn't wasted.

PLUS Rapid system response:
Widens thresholds as it lessens any anxiety conditions might deteriorate



Controls for End Users

a guide for good design and implementation



by Bill Bordass, Adrian Leaman and Roderic Bunn

Compiled for the BCIA by



Supported by



Heating and cooling on-demand proved very economic in these offices in Sydney

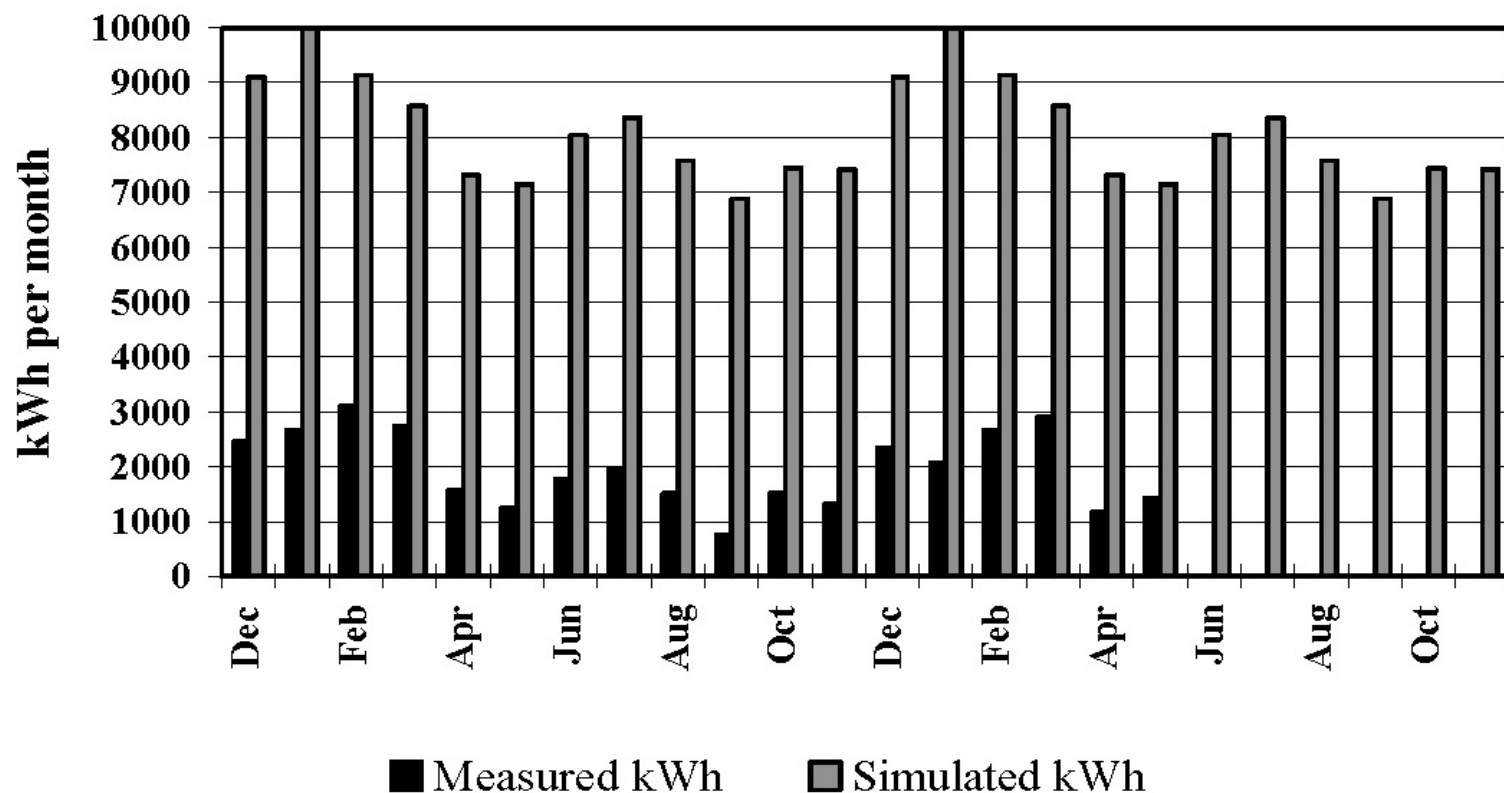


Figure 10. Actual month by month energy consumption used by the supplementary cooling and heating system in the study area compared with estimates from a simulation model of a conventional air conditioning system.

6. REFUGES – A LAST RESORT? *both individual and communal*



SUMMARY:

Changing mindsets for the Climate Emergency

1. Challenge standards
2. Control draughts and radiant losses
3. Effective warm clothing, *made fashionable too*
4. Local and personal heating
5. Responsive, user-friendly controls, *default to off or safe*
6. Thermal refuges, *both local and communal*

“We can't solve problems by using the same kind of thinking we used when we created them” - EINSTEIN



*'Faster! The lights
are dimming'*

MATT

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