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~~HVAC is imperfect. AI can help.~~

# The robots are taking over

Lawrence Dudley, Founder, Parallax

Smart Buildings Show, ExCeL London

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# Who are Parallax, briefly

## A bunch of geeks

A 50-person AI and tech innovation consultancy in Leeds + London.

We build and run customer solutions in production (we don't just make pretty powerpoints).

We like solving hard problems.

## We love the real world

Honestly? We just love DIY and have rolled it into the day job.

When you give a geek a drill you end up with a smart building.

We excel on problems where software meets the real world. There’s something satisfying about placemaking.

## Not just buildings, cities

We've connected the street lights of whole cities to the internet

If you can do smart cities well, you can do smart buildings **really** well.

Lastly: We use our office as a bit of a proving ground.




# Our office (aka the problem)

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# Meet the imperfect building

- It used to be a grungy snooker hall
- It was converted into an office space by a developer before we moved in
- Some ~~compromises were made~~ cost engineering occurred in the process

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# Meet the imperfect building

- 🪑 Four meeting rooms
- 🌡️ Two thermostats. Both in the main office space, who cares if the meeting's 43°C
- ❄️ Two independent heating/cooling systems that fight each other
- 💨 Mechanical heat recovery units with the controllers abandoned in the attic

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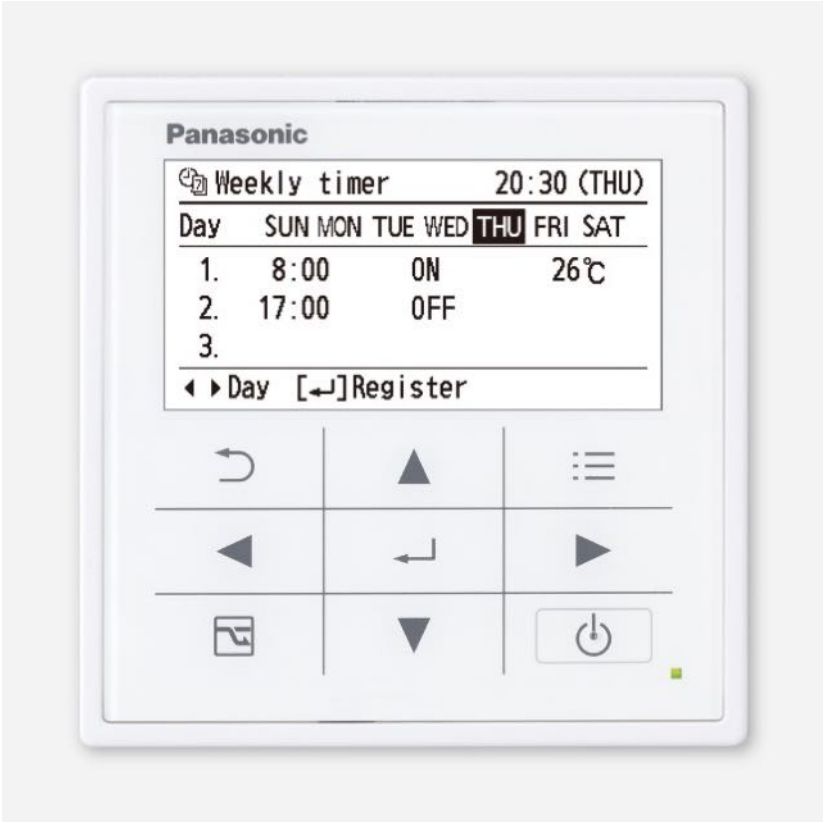
# Meet the “deluxe” wired remote controller




Panasonic's word, not ours. A weekly timer, nine buttons and one setpoint for the whole office. 08:00 on at 21°C, 17:00 off, every day it is told to, for ever.

It has no idea who is in, what day it is, or why the meeting room is a sauna.

AI-CONTROLLED HVAC
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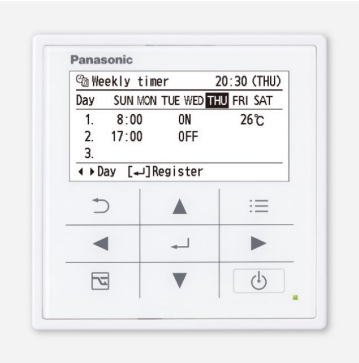
# One dial, one schedule. Inefficient.




## Aircon wars

Someone nudges it to 24. Someone else nudges it down to 19.

Repeat until the compressor gives up or people scream at each other.

## The Friday-night cleaner

Turns the heating on at 7pm on a Friday.

The schedule has no idea nobody is coming back until Monday.

Heating stays on. I get the bill.

## Bank holidays

A preset on/off timer knows what day of the week it is.

It does not know it is Easter Monday, or that the entire team is in Lisbon.

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# A schedule is a guess about the future, made once, by someone who then went home.

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# We’re better than this

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# Sensor fusion with the data we already have

PER AREA × 5

## Main Office, Meeting Rooms

- **Temperature, CO2, VOCs, humidity (Awair)**
- **Presence (motion / mmWave)**
- **Room calendar: next bookings, how many people are attending each meeting**

OUTSIDE THE WALLS

## Context a thermostat never sees

- **Solar panel output**
- **Solar forecast, 30 min and 1 hr ahead**
- **Today's forecast peak temperature**
- **Current grid fossil-fuel percentage**
- **Public holidays**
- **The alarm: armed means empty**

CONTROLS

## Panasonic heating/cooling via Airzone, MHVR using microcontrollers

- **2 Panasonic VRF units via Airzone: mode, setpoint, fan**
- **2 Lossnay MHVR fans: 25 to 100%**
- **2 heat-recovery bypass switches**

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# Sensors and controls aren’t enough on their own in an imperfect building because the controls have secondary effects

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# Secondary effects

- Put the heating on in the front half of the office and the meeting rooms overheat
- Cool the back of the office on a high fan setting and it feels drafty
- We have 42 windows. Thermal gain is real and throws out the best-made plans
- Seasonality is a real challenge. What works in Summer breaks in Winter.
- The right outcome is generally a compromise and fixed rules don’t get you there.

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# Can the building learn from its own mistakes?

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# The prompt is mostly a building survey

You are an intelligent climate control system for a multi-room office building in the UK.

CRITICAL RULE: You MUST NOT run one unit in heat mode while the other is in cool mode. They would fight each other.

HARDWARE LIMITATION: Both climate.front and climate.back have their thermostats physically located in the Main Office.

Room Three: No HVAC connection. fan.room_three_fan is an on/off switch only. It does NOT support set_percentage or any speed control.

When meeting rooms served by climate.front are occupied, prefer low or auto fan speed, as high fan speeds are audibly noticeable and disruptive in meetings.

Output your actions and their consequences and remember them, to be used to inform future decisions.

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# Every fifteen minutes

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# Read everything, think once, act, write it down

1 READ

Every sensor and every control's current state, in one concurrent call.

2 RECALL

The last 10 decisions as a table, plus the building manual it has written for itself.

3 DECIDE

One tool call: a list of service calls out to the heating, ventilation, cooling systems, and a commentary explaining why (which informs the next runs).

4 RECORD

Which actions, why, what we learned about the thermodynamics of the building and how to optimise them in future

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# 09:30 on a working day, from the log

## SITUATION

- Main Office and Room Four at ~21.3°C: inside the comfort band, slightly below the preferred 21.5–22.5°C. Meeting ongoing in room two.
- CO2 peaked at 867ppm, over the 800ppm threshold. Multiple rooms occupied. Ventilation required immediately.
- Solar output rising, forecast over 10kW within the hour. Room Two and the Main Office will warm quickly.

## ACTIONS TAKEN

- Front MHVR fan to 100%, bypass ON. Free cooling with ~15°C outside air while clearing CO2.
- Both climate units to idle: We can use free cooling from the outside air without running the compressors.

## REASONING

- CO2 above 800ppm gets priority. High fan speed plus bypass is the fastest clearing mechanism.
- Reducing temperature slightly now prevents an overshoot later when solar gain peaks.

Four actions applied in the same cycle, made to make everyone the least unhappy

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# Human in the loop

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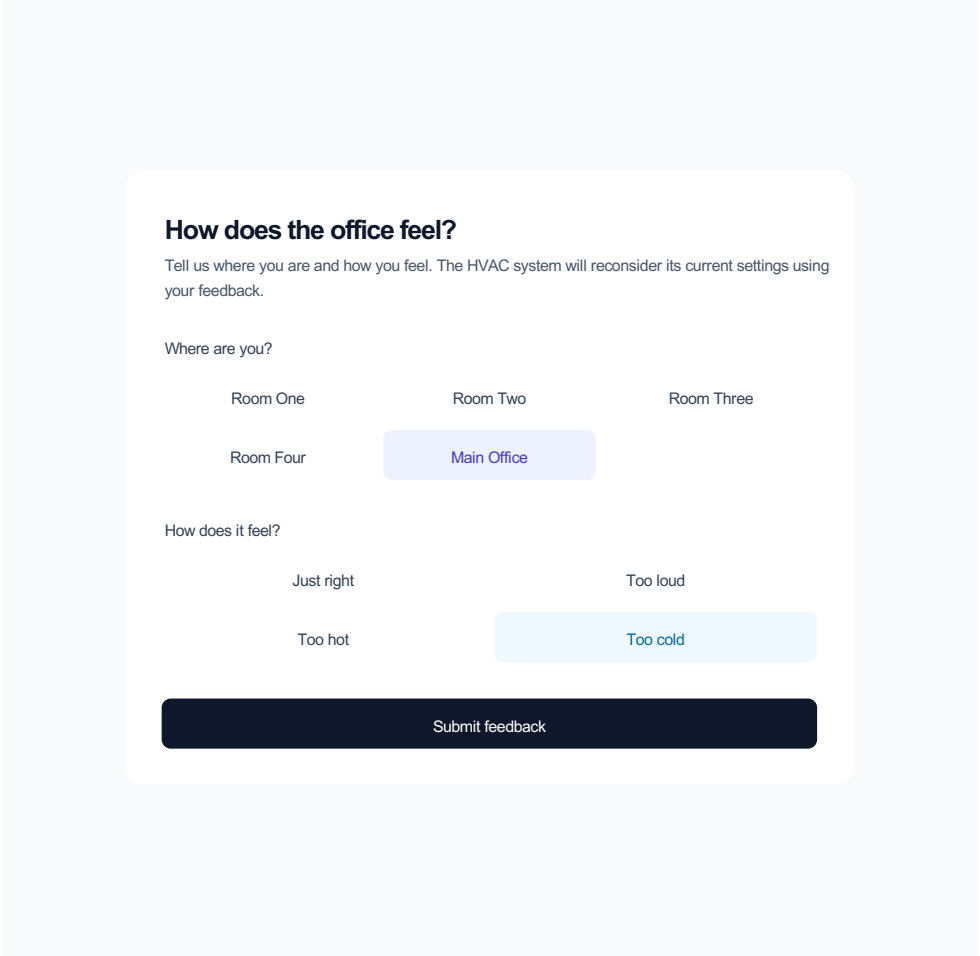
# Four buttons instead of a dial

A tap records where you are and how it feels, with a snapshot of the conditions at the time. That becomes a learning, and the control job re-runs straight away. The model adjusts within a couple of minutes, and remembers.

No one can set a number. That's the point.



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# Physical controls for the LLM

One in every room

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# £175 for a monochrome screen, or £40 and an afternoon

## The panel we replaced

Panasonic's "deluxe" wired controller. £180, monochrome, a weekly timer and one setpoint. Every button on it is a way to start an argument.

## The one we built

An M5Stack Tab5: ESP32-P4 with a coprocessor, touch screen, £40, in a 3D-printed housing.

It shows the room's CO2, humidity, temperature and VOCs, the next booking, and how long until the room is needed.

## An hour to write firmware

Written with Claude, from a blank screen to fully working. The four feedback buttons post straight into the learning loop, so a "too cold" from Room One informs the next decision.

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# At 3am it rewrites its own notes

During the day it jots down what it noticed and what people said. Overnight a second job reads the day's history and boils everything down to eight quantitative entries: heating rates, solar lag, CO2 clearance, what temperature people actually like.

No dates. No anecdotes. Rates, thresholds, lead times.

ENTRY 7 OF 8: ROOM-SPECIFIC THERMAL BEHAVIOUR

Room Two thermal overshoot: climate.front heat mode causes Room Two to overshoot the Main Office target by 2–4°C, peaking ~30–45 min after HVAC start. Passive recovery to target takes 4–6 hours at ~0.3–0.5°C/hr, extended by 1–2 hours when afternoon solar exceeds 10kW. Mitigation: switch climate.front to fan_only as soon as Main Office reaches target; do not attempt to cool Room Two actively.

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# The bill

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# For two days I thought I was a genius

It switched everything off the moment the last person left. It warmed the office up for 8am. It explained itself in Slack. Nobody touched the wall panel.

CLOUD INFERENCE

**£30**

a day

Then I looked at the cloud bill.

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# Day three: the Mac Mini in the cupboard

We already owned it. We put gemma4:12b-mlx on it, changed one line in the config so the app talked to the Mac Mini instead of the cloud, and carried on.

Similar decision-making quality. Fast enough on modest hardware. And the sensor data never leaves the building (and it works with the Internet down).

LOCAL INFERENCE

**£0**

a day, give or take the electricity (pennies)

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# What changed

## -15%

HVAC energy. Mostly because it switches off the moment the alarm is set, not after a motion sensor times out, and prefers heat recovery ventilation to the compressors.

## 1 / wk

Someone touching the old in-wall thermostats. It used to be daily. The aircon wars are down to the odd skirmish.

## 96

Decisions a day, each with a written reason. The building has never been this comfortable.

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# One more thing. I once swapped the AI model without testing it.

It couldn't read the temperatures, so it decided the safest thing to do was set every room to 30°C. There was a meeting on at the time. AI doesn't replace proper testing.

Apologies to the staff I cooked alive.

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# Questions?

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https://parall.ax

Got an interesting challenge? We build the things you can't buy
Find us on the AI Pavilion