Modern Building Design

Video Transcript

Week	1	**Step No.**	1.7
Session Title	Are Buildings Evil – Part 2		
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The post-occupancy evaluation of buildings is in its infancy. When it comes to energy, at its simplest, all that post-occupancy evaluation requires is an idea of the annual energy consumption and the floor area. From these, we get the annual energy use per metre squared of floor area. This value can then be compared to a table containing good, average, and poor values for similar buildings.

In essence, this is equivalent to the measured miles per gallon of a car, which accounts for the performance of the building and the performance of the operator. Most of us have an idea that for a car, 20 miles to the gallon is poor and that 70 is good. But how many of us know if 50 kilowatt hours per metre squared is good or bad for a house, school, or office?

I find it amazing that few in the building industry have ever calculated this number for the buildings they have built. All it takes is the annual energy bill and the desire to do it. Few CEOs know the answer for their buildings, even when their energy bills might run into millions of dollars.

In some countries, we are starting to see such figures being highlighted at the entrances of public buildings in the form of energy display certificates. But most of the public is still unaware of them. We can expect the use of such name and shame tactics by governments to increase. Whenever you go into a building, see if there is such a certificate on the wall, and whether you are in an A-rated building.

It is particularly fascinating that most architectural or engineering practises don't know the measured energy efficiency of buildings they have designed. Often, the excuse is given that there wasn't enough money in the budget to complete the post-occupancy evaluation. However, since a quick phone call to the facilities manager will provide all the information needed, this doesn't ring true.

With a decent post-occupancy evaluation, we can learn far more. We can see when the heating is coming on. If the daylight dimming that the client paid for is working. Where the energy is being spent. Whether the engineer's estimates of energy use and system sising were reasonable.

If you are paying for the building and don't bother to discover this, how will you know whether you should use the same architectural or engineering practise again? You could even use post-occupancy evaluation to discover if the occupants are happy. Now how radical would that be?

I strongly believe that without post-occupancy evaluation, we won't get very far on the low carbon road. The first step has to be finding out what works and what doesn't. Before I present some examples of low energy buildings that work, I'd like to take you on a quick tour of some building physics. I plan to do this via two questions.

Question one - why do we have heating systems and why do we heat buildings? This might seem a strange question, with an obvious answer - to keep us warm. However, we typically only heat up buildings to not much more than 22 degrees centigrade. Yet we are already at 37 degrees.

As the second law of thermodynamics indicates, heat flows from the hotter to the cooler body. So we heat our buildings, they don't heat us. This suggests that if the building needs little heat to stay warm, we might be able to use our body heat to maintain its temperature. All any heating system does is to make up for the losses from the building.

Unfortunately, we have spent many generations focusing on the heating or cooling system, not on the losses. This is just the same as what I call the madness of the philtre coffee pot. The coffee is hot when it first enters the glass pot. The only reason for the heating elements in the base is because the pot is uninsulated. This is poor design, and we need to see it as such - so stupid in design that it is displeasing.

Again, we need a new language to describe such inefficiency by design. We need to get angry at the stupidity of such thinking. We need to look at such objects - or buildings designed using much the same principle - and think of the harm they're doing to someone trying to grow enough to eat on a small patch of dust in sub-Saharan Africa. It doesn't even make good coffee.

An alternative that works just as well, and doesn't need electricity to keep warm, is the insulated flask. This is more than capable of keeping the coffee warm enough for the hour that it is drinkable. Such approaches to design are simple, clever, and elegance and need to be appreciated as such.

It also illustrates that it's ridiculous to heat hundreds of tonnes of building fabric to moderate the flow of heat between our skin and this fabric. Much of the time we simply need to add a layer of insulation to ourselves, not the walls. This insulation is called clothes, but it seems to be a forgotten technique.

The most ridiculous example being that in air-conditioned offices, it is common to cool them in summer to a lower temperature than that to which they are heated in winter.

But the big question we should be asking is whether buildings need to lose so much heat that we need a boiler to make them livable? The answer is that they don't.

Question two - why do we chill office buildings? It is tempting to think it is because they would get too hot otherwise. A building in a climate such as the UK doesn't get hot all by itself. It gets hot because of sunlight pouring through the highly glazed facade, the lights being on all the day, the mass of people, and the IT equipment.

All these should be considered as exciting engineering challenges, not shuffled into the "too difficult to think about" drawer. We need to ensure we don't use a ridiculous amount of glass, and that if overheating might be a problem, glass is shaded in summer. We need to ensure the lights are off when they can be, and make minimising energy the core of the IT purchasing and location strategy. Often a company would chill a server room, only to be heating the room next door with a gas boiler. This is madness.

It is worth doing some sums. Each one of us produces around 100 watts of heat. By the way, one watt is the output of a hummingbird in flight. So 30,000 hummingbirds is the output from a typical domestic boiler.

Modern low-energy houselights are about 10 watts per room. The TV another other 100 watts. A computer another 100 watts. A fridge and other items, maybe 200 watts. Light through the windows might provide 200 watts, averaged over the year.

So with three occupants, a house might naturally produce around 960 watts of heat. So is this enough to make up for the losses from a super insulated, well-designed house? A typical house might have a surface area of around 340 metres squared, of which 20 metres squared might be glass. A triple-glazed window loses 1 watt per metre squared for every 1 degree centigrade of temperature difference between the inside and the outside of the building. A super insulated wall, roof, or ground floor - 0.1 watts per metre squared.

If the inside of the house is at 20 degrees centigrade and the garden is at zero, then we have a 20 degree temperature difference. And the house will be losing 1,040 watts. This leaves an energy gap of only around 80 watts, or about three candles. So we can definitely throw the boiler out, together with all those ugly radiators.

So yes, we can in theory build a house such that the losses are so small that they can be compensated for with little more than the gains from other sources. We just have to build it well and using the best materials.

Luckily, these materials are cheap. With commercial buildings it should be even easier, as the gains from people and equipment are normally much higher and the ratio of the wall area to floor area smaller.

Some of you may have spotted that I haven't supplied the occupants with any air to breathe. This can be done in winter with a very simple mechanical system that transfers the heat from the expelled air into the fresh incoming air. The savings from not needing the normal array of radiators and pipes will roughly pay for the capital cost of such a system. For most of the year, though, we can simply open the windows to provide all the air we need.

Over 40,000 such buildings have been built around the world, from Norway to Australia, from homes, to offices, to schools and factories. Measured data indicates that a typical house built using this approach costs, on average, £50 a year to heat. The increase in build cost is around 6%. So assuming the house and the land has a cost of £200,000, of which the building represents half, the increase is around £6,000 to almost remove the heating bill forever.

Those who have built a lot of such buildings claim to have reduced the uplift and cost to zero. The city of Frankfurt has declared that they can't afford to build any other form of social housing. Their analysis is likely to be true for many landlords that pay for the energy use in their buildings.

For example, universities and commercial landlords. Or those that have some form of responsibility for fuel poverty or rates of hypothermia. It is now the only form of new build allowed in the greater Brussels area.

It is also possible, though difficult, to refurbish older buildings to almost the same standard. We still need some energy input for the lighting etc. Although with good controls, the lights will only be on at night. A small photovoltaic system on the roof should be able to provide this. And solar hot water panels provide much of the water for showers etc.

If all the windows are left open for an extensive period, the extremely modest heating system that is typically fitted in the air ducts will not be able to keep up and the occupant will have learned a lesson, but a less harsh lesson then those surviving against climate change are learning today.

The photographs show examples of buildings built using these techniques. I encourage you to visit such a building in winter. You will notice that the benefits go far beyond energy savings. They are simply much nicer places to be. There are no cold walls and no draughts and every part of the building feels warm. In short, they fulfil one of the main requirements of a building - to provide shelter. Whereas for generations, we've got used to heat and cooling from fossil fuels providing the shelter, with the building being little more than a box to put such services in.

I would now like to return to the question of evil. We've already successfully changed many things in our buildings and in our societies over the last few decades. As one example, it is worth considering Pirelli-like calendars and similar items from the 1970s.

At the time, these would have been typical items on the walls of many workshops on campus or canteens in offices. Not so now.

Why is this? Although part of the answer is that society's views about such items and the values they represent have changed, it's also true that they were removed because it was easy to do so. Because they weren't holding the roof up.

Most elements of poorly-performing buildings cannot be removed so easily or so cheaply. Given the reality of climate change and its impact on the poorest peoples, the acres of glass and poorly insulated walls, and the miles of heating and cooling ducts with which we surround ourselves can all be seen as direct statements about our morals.

If nothing else, we need to future-proof our decisions about new buildings and not get stuck with the equivalent of sexist calendars we cannot afford to remove. If we can give up slavery and still survive economically, we can put insulation in our walls without economic collapse. We need to make sure we aren't constructing liabilities that will reflect badly on us for a long time to come, and that will leave us with high costs when we are forced by change of heart or by change of law to upgrade them.

And we will be forced to do so, as the UK and many developed countries are aiming for an 80% cut in carbon emissions. I believe that the public will start to recognise what in architecture is profligate. What is unacceptable? That they will see all that glass or the presence of a big fat boiler as plain wrong and will not want to be associated with it.

In the past, we've seen people throwing red paint at those shops selling certain types of fur. Consumers withdrawing their custom from businesses seen as immoral. And those with better moral profiles finding it easier to employ higher quality staff. Thus a building that is energy-hungry - or even looks energy-hungry - could haunt an organisation for a very long time.

As I've said, in many countries, you will find energy display certificates - or the equivalent - placed by law in the lobby of larger buildings. These are designed to encourage change amongst building owners and those commissioning new buildings. They are placed in the lobby for a reason - to make occupants and visitors aware.

The question is, how as customers, employees, and occupants we should react if these indicate high levels of climate-changing emissions. But we don't always need a certificate to tell us when a building is profligate with our future. We just need to look at a building and work out for ourselves whether we think it is well-insulated and being used in a sensible or moral way.

Here is another image - fair trade coffee being sold in a highly-glazed, poorly-insulated building with the lights on. How's that going to help an Ethiopian coffee grower as the planet warms?

Returning to our definition of evil. Well, we know our buildings are the single greatest cause of climate change. We know climate change is likely to be catastrophic for some of the poorest people on the planet. And we know how to build buildings that use almost no energy. But we stubbornly refuse to build such buildings. This means we can tick the destructiveness, harm others, and consciousness boxes in the definition.

So look around you as you walk past and through buildings, and rank them as evil or not. And if you design or purchase buildings, rank yourself.

