HOUSE PLANNING HELP

Episode 65

How Simple Design Decisions Can Impact on Energy Performance

The show notes: www.houseplanninghelp.com/65

Intro: You might not think that you need to know about the design of your house because you're not going to be doing that but I really feel that it helps to at least get your head around some of the important aspects.

That's why we're chatting to Alan Budden from Eco Design Consultants. I discussed with him what he thought might make a really good episode and he suggested just going over a few basics and trying to understand their impact.

So I started by asking him about his background.

Alan: Okay, I've been interested in buildings and architecture since I was a kid and trained on to be an architect quite early on. I've been very interested in housing and really trying to improve people's social wellbeing. Then I taught architecture in Sri Lanka for a little while and then I came back to the UK and did some light gauge steel. Again I was very interested in the environmental things, pushing forward things, became an eco homes assessor to start with and then that developed into the Code for Sustainable Homes. I became an associate at PRP Architects, developed a little bit more on the low energy housing stuff and designed one of the country's first 5-star houses down at the BRE Innovation Park.

Then after that, I set up my own practice - 5 years ago now - called Eco Design Consultants. We really did look much more at the building fabric as the first approach, potentially adding on renewals if necessary. I then came across the Passivhaus standard, ever since I came across it I've been hooked, and I think every person I speak to, it just makes so much sense.

Ben: I'm quite interested in our chat today to talk a little bit about design decisions that make a big difference, but you're also dealing with the client side of things as well. So it's going to be quite an interesting episode, I think, as we reflect on a few of those. So I

come to you as a client, what are the first steps that you'll be doing with the client?

Alan: The first step for the client really is to understand what they want, what their wishes are, I mean trying to get under their skin. Not necessarily just understanding how they live at the moment but how they would like to live, whether it's open plan, whether they have any particular interests or stuff. Maybe they've got dogs and outdoor life is very important to them so they need somewhere where the dog can sleep and can be washed without mucking up the whole house.

Or it could be laundry! We had one client where laundry was an important part of their lifestyle and the laundry room was to be in the centre of the house so that they could see anyone. [Alan laughs.]

Ben: Fantastic! Would they have a plot at this stage or does it just vary?

Alan: It varies. I mean hopefully they have got a plot because plots are incredibly difficult to find. Often our clients already have a house and it's often a retrofit so we'll be looking at whether, at that stage, they may be doing an energy improvement and also extending, and may be just making the house work for them because there may be bits of it that aren't very functional.

Ben: How often do you have to educate your clients or do they come well informed?

Alan: It's becoming less and less. I think we're getting quite a reputation for low energy housing and people come to us because we know Passivhaus and we can understand those things. But we do still really make sure, particularly at the later stages on-site and stuff, that they understand the details and they understand the need of attention to detail and making sure the airtightness works and the insulation is continuous. There's a lot of things like that that I think we help to . . . I suppose we push them, but at the end of the day we also respect the client's wishes. We're building for the client at the end of the day, not for us, so it is the client's wishes that we go for.

Ben: Quite often when you're looking for low energy and I am very much on this process. I'm open to learning and if I can be told something or educated just that little bit further and . . . That's why some of these things that we're going to bring up today, yes we've probably heard about them before but it might be interesting to go into a little

bit more depth and also because teaching is another element of what you do. Maybe you should explain that?

Alan: Yes, I should have said that earlier, really. I also teach the undergraduates in architecture up at Birmingham City University, teaching them about sustainability and the technology of low energy buildings. I think it's very important that now they will be building zero carbon houses, low carbon buildings when they graduate so they need to know from day one.

Some of the things that we look at is the building shape, the form factor. It's something that's not really, I don't think understood by general people - how the shape of the building really makes such a big difference to the energy [performance]. For instance, one of the exercises I do with the students is we look at U-values, the heat loss through and the fabric. Then we look at multiplying out those areas to a simple house, so we look at a $100m^2$ house that's two storeys. A square house, they discover as we go through the process, has a set amount of energy loss. We then look at an L-shaped house, same floor area as the square house but has 7.5% more heat loss just through the shape.

Ben: Okay, stop there for moment. We are saying because there's a bigger surface area of the exterior and that's just because it's no longer . . . sorry, I'm trying to work it out in my mind as a way of explaining it and going completely wrong . . .

Alan: Yes, that's exactly it. [Alan and Ben laugh.] It is very much about the shape. Basically you're losing heat out of any external wall so if you have less external wall you'll lose less heat from the building. So the simplest shape is probably a sphere but we can't live in a sphere because that would be incredibly difficult. So the next, the most practical shape is probably a cube. That has the best floor area to surface ratio. That would be the optimum in terms of heat losses.

What's interesting as well is when we start looking at it with clients it's not just about heat loss it's about building costs. The most expensive part of your building is the outside envelope. So if you make the outside envelope smaller, then you reduce your costs as well.

Ben: Are there any other shapes that we should be avoiding or do we just think every time it gets more complicated the percentage will alter?

Alan: Yeah, I mean, it is. Anything that you add on, dormer windows and things like that. Anything that sticks out will increase your heat losses. It also probably increases the complexity of the build. You'll find that the details around dormer cheeks and at the sides are additional details that potentially could be cold bridgings, that could potentially be the areas where air could be leaking out. So it does all complicate things as well as adding it onto the cost.

It does want to be quite a simple shape but saying that, I'm sure you're thinking now it's going to be really boring. [Alan laughs.] I think you can through materials and through adding different bits to the facade, you can still make quite an interesting building.

Ben: I know that my wife is always very critical of things when they look blocky and square, and that's why she has this love for older buildings because they do have lots of little extra bits on it. Where is the balance and how can we almost keep that shape but add on the exciting bits? If that's a good enough question!

Alan: Yeah, it is. At the end of the day the building has got to be something that gives delight and is for the people. If it doesn't succeed in its function and give delight then the building has really failed its sustainability credits anyway.

One of the things I quite like doing is, the house I mentioned before down at the BRE, Oxford Brookes University did some monitoring of the house. They had a family that lived in there for two weeks every season and there was a report done at the end of it, how they found it, when they got hot and all the rest of it. One of the interesting findings from there was not about the energy side of it that I found really fascinating was the young daughter who had one of the front bedrooms, it was the first time she could see out of her bedroom window because she was obviously fairly short and couldn't see out but this window went down to the floor. That really struck a nerve with me so from then onwards I've actually thought about that and at Howe Park Passivhaus in the top bedrooms we had a slit window, which went down to the ground. It was very interesting on the open day we'd just often find little kids sitting there, looking out.

The interest on that window, we looked at the energy losses and gains of that window and it was actually losing more heat than it was gaining so really in energy terms we probably shouldn't have had that window but it provided delight and it provided interest so it's about having the tools to decide which way you want to go. That is the key.

Ben: And that's going to be my next question as where is this balance? Or is that down to the designer? Perhaps it's not. Perhaps it's even more down to the client?

Alan: I think we work with the client. One of the things that we do is we often put the building into the Passive House Planning Package and from that we produce an options report which has a number of graphs and stuff, so that you can really kind of understand exactly where the losses are so you can start to balance things up. In your mind you can see, okay, that extra dormer window which is fantastic and nice, okay, that might lose 5% extra heat loss. Is that something that you want to maybe increase the insulation elsewhere to have and still have the dormer? That's the sort of questions that we'd look with you. Dormers are lovely. I know we shouldn't necessarily not have them but it's understanding the overall picture.

Ben: And I suppose that is it, isn't it, if you don't want one, something that's a feature you have to make up for it somewhere else?

Alan: Yeah, that's right. It's understanding that loss. I don't think people do necessarily understand the shape and other things do have a cost and knock-on effect.

Ben: Another aspect, our houses need windows but there is some interesting statistics, aren't there . . . which I'm just going to let you explain. [Ben laughs.]

Alan: Windows are really really important. Probably the least heat loss would be a house with no windows at all, which would be absolutely horrible. We need windows for daylight and for delight and for well-being but the way we design the windows is crucial. We don't want it too big because it will overheat, we don't want it too small because we won't have enough daylight.

The way the window works is also important because the window frame is probably the weakest point in the whole building. Your U-value through the external wall could be as low as 0.1, the U-value through the window frame is probably 1 so it's possibly about 10 times worse.

So you really want to limit the amount of window frame as far as you can. It's one of the exercises that I do with my students. We look at a simple window 1m by 1m, so we have this nice square window. Then we look at, okay, we split that 1m by 1m window into

one opening and a fixed light so just a vertical mullion down the middle. That increases the energy performance by 16%, it's 16% worse than the other one, just purely because it's got more frame so that's losing more heat and also it's allowing less sunlight in so it's not giving you any solar gain.

Then if you look at the traditional English window where you have the window divided in half with the central mullion and you also have a little opening light to let the ventilation in, that is even worse, it goes up to 28% worse than the square windows. So just simple things like that can make quite a difference.

Ben: Over the course of the design is it a case of going back and thinking, oh well actually I want my opening window and this upright slat but I'm making up for it somewhere else. Is it the same thing?

Alan: Yeah, it is very much you work with the client and if you understand those things they can make decisions. What I think often, I suppose other architects as well don't necessarily understand the decisions they're making in terms of the heat losses and energy, they don't necessarily understand the whole picture. It's trying to explain those that can really make quite a difference.

Ben: And how do you decide how many windows you do put in or how large those windows are?

Alan: With that we can do things called a daylight factor so we can actually calculate the amount of window size to the size of the room to make sure that it is the appropriate amount. There's various rules of thumb that we can use as well, but it's one of those things that people do like a lot of glass and a lot of windows, which is great, but it's about getting that right balance and that's one of the things that we help them with.

Ben: Airtightness, I know, is another one on your list. Again we've covered it extensively on the podcast, but coming into this as a client, are they normally clued up on airtightness?

Alan: Not always, to be honest. Airtightness is a real passion of mine and I think it's not necessarily understood. I know when we did Howe Park Passivhaus that when the in-laws came to the opening day they were quite concerned, I think, of going into this plastic bag covered building and they were going to suffocate and it was going to be horrible. [Alan laughs.] I think they were quite pleasantly surprised. They realised actually what I'd been saying to them for quite a while was not a problem. Airtightness is not an issue. It

reminds me a lot of the very old Everest Windows adverts where the guy would be standing at the window and it would be really windy outside and he'd close the window and drop a feather. And really with airtightness we're talking about reduction in draughts. It's not this plastic bag that sometimes it gets thought of.

Ben: And go through your stats of if you were just doing this to the building regulations and how the dramatic change we're talking about design decisions. Well, if you say it doesn't matter too much but it will really make a difference.

Alan: Yeah, I did some interesting calculations on the Howe Park one. If we'd have met Passivhaus which has an airtightness of 0.6 and the specific heat demand of 15kWh per m^2 (per annum). If, keeping at that energy, that low energy rate in terms of insulation we reduced, which we did on that building, reduce our airtightness down to 0.07, that actually improved our energy performance by 17%.

Controversially if we'd gone to an airtightness of 3, which is thought of in the building industry as a good airtightness, that would have actually increased the heat losses of the house by 86%. And if we'd gone to 10, which is what building regulations is, that would be 355% more heat losses which is absolutely staggering.

You think about airtightness and it's so important. Even with a building regulation house now built to fairly good standards, not quite to Passivhaus, but pretty good, if you had an airtightness of 10 you'd be losing as much heat through draughts as you would through the insulation. I think most people don't understand that. It's so important and it's relatively easy to put right.

Ben: Are there any other key points that we should be looking at? We've talked a little bit about daylighting, form factor, windows, airtightness. What is going to make a huge difference?

Alan: I think it's the quality of the build and I think that's one of the things that the more Passivhaus stuff I do the more I realise how attention to detail it is. Having an airtightness test at the end of the day means that the builder is going to do things properly. Everybody on-site is going to make sure there is attention to detail. The insulation is going to be continuous, it's not going to have any gaps in it, the airtightness membrane is going to be there, it's going to work, and the knock-on effects to that is also interesting. The fact that the building is not going to have any moisture going through the wall, it's not going to have moisture build-up inside the fabric which can cause damage and long-term decay and other things.

It's quite interesting on Howe Park there was one outbuilding above a little car port that wasn't built to Passivhaus standard because it was going to be a drum room and on the snagging after the first six months most of the things to be put right were on that room, which was kind of built by the same guys but it was just the attention to detail and the quality of the materials and things. It wasn't quite as good. That sums up, I think, some of the extra benefits that you get from it that you don't think of to start with.

Ben: It's funny how often you hear attention to detail. Now before we completely change things for the end of the podcast and I have another question for you to answer, retrofit. When we apply all of these things, say our form factor, you can't really change anything on a retrofit?

Alan: No, often we find you can. We often find that clients that come to us for a retrofit, maybe to EnerPHit or somewhere, they're usually doing something else to the building as well. They are looking for an extension, they are looking maybe to going up into the loft and other things, so in those areas you can.

Other fairly obvious things which happens on most houses actually we look at is things like they may have their front door slightly recessed into the building. That recess has three sides to it, the two sides and the top which is areas where you're losing heat. They are usually also those areas that aren't particularly well insulated. I know one property that we looked at where literally it was just a piece of hardboard and a bit of plaster on the other and that was it. By moving that door forward into the front of the building we find that that can make up to 5% or 10% improvement on the total energy losses.

So simple things like that, even with a retrofit where we can change the form can really make a difference.

Ben: And windows?

Alan: Yeah again, if you can take out the mullions and things then that again can improve it. We may look at reducing some of the window sizes or increasing some of the window sizes as well, depending on the orientation, how much sun's coming in, whether it's been shaded, various factors, we can look to optimise the windows. Also we can potentially make them bigger because of that lovely view.

Ben: Right, let's move this along. It's a question that I'm sure a lot of us will have thought if we're wanting to move into, let's say, a draught-free house, we're thinking about airtightness. In this situation one day the MVHR breaks down and we're in the house, are we in danger? Is this a dangerous situation? Take me through your detailed calculations?

Alan: Yeah, I must admit when we first did that house at Howe Park I was a little bit concerned because it was so airtight. It's the most airtight in the UK, maybe in the world? I think there's one German building that's better so far but on that I did some quick calculations. Basically it's not the lack of oxygen that's going to damage you it's the CO_2 build-up.

Ben: Why, why?

Alan: It's a poison basically CO_2 so it will harm you and give you headaches.

Ben: So we breathe in the oxygen and then breathe out the CO_2?

Alan: Exactly. The CO_2 level will slowly build up. So what I did basically is look to see what would happen if we were producing lots of CO_2 and the worse case scenario would be exercising. If you're exercising you give out the most CO_2, if you're sleeping it's the smallest amount.

So I looked at the occupancy of the house, which is a big five-bedroom house, would be a maximum of nine people. If those nine people were in the house and they were exercising and the MVHR had broken, for some reason they hadn't noticed and the windows are all closed and they were exercising, they'd have to be exercising for 24 hours before it got to 1.7% CO_2 level and that would be the first time it would become noticeable.

It wouldn't be until it got to 2 days and 22 hours, and up to 5% that it starts to become toxic and potentially a risk and you might be having headaches and dizziness and stuff. But I'd guess they may have wanted to open a window by then!

Ben: I was just about to say that when something gets like that you think, oh God. You do that at the moment with ventilation. If something's not good and in here this room is stuffy that's the first thing that you do, isn't it?

Alan: It is. And people must remember that in a Passivhaus you can open the window. The myth of not opening windows is still out there but . . .

Ben: It will continue to be out there. [Alan laughs.] We'll say it again at some point. Also, what we're not taking into account here is you're talking about people exercising continuously, not leaving the house. Whenever you do that the fresh air is going to come in and that will reset all of these and you'd have to be exercising again.

Alan: That's exactly it. [Alan laughs.] It's never going to happen to be honest.

Ben: You're talking about a bigger house but how would that scale down to something that's a lot smaller?

Alan: Yeah, it would be quicker but you'd have to have a lot of people in a very small space and again it would just become uncomfortable. It would become hot more than anything else and you'd want to open the window. [Alan laughs.]

Ben: That would be interesting if you got hot first. Well, excellent, I've really enjoyed this, Alan. Thank you very much. Is there a closing thought on anything that we've been talking about today?

Alan: I think just some comments from some of the clients is, why isn't everybody doing this? I mean the only downside of the Passivhaus from the clients we've had so far is they don't like leaving their house and going to stay with relatives and stuff! They find now going to visit relatives kind of uncomfortable and they want to come home soon.

Ben: Alan, thank you.

Alan: Thank you very much.