Episode 256

What makes a well designed MVHR system? – with Tom Heywood

The show notes: www.houseplanninghelp.com/256

Tom: I was at uni studying architectural technology. It came to doing my dissertation and I wanted to do it on something different. And we'd not been taught anything in uni about efficient building, especially Passivhaus.

Then I found the Green Building Store and I started doing the dissertation based on Passivhaus principles and looking into that.

And then I was working as an architectural technologist but it was a bit boring. It was all set standards. Jaguar Land Rover; we knew exactly what we wanted.

Then I saw that a job had popped up at Green Building Store as an MVHR designer and I thought I might give it a go. I got the job and here I am.

Ben: Let's stick with basics. Why is ventilation important?

Tom: Particularly in airtight buildings, as we start to build more airtight, there's obviously no natural ventilation coming in through trickle vents or leaky building fabric.

So, you then start needing to introduce some kind of mechanical ventilation to provide enough fresh air for the occupants to keep CO_2 levels in the building down and prevent dangerous build-ups of volatile organic compounds and other indoor pollutants.

Ben: So, natural ventilation. It's something that we've lived with for quite a long time, but how does it compare to a mechanical system and when MVHR is designed well? What would you say are the differences between the two?

Tom: With natural ventilation, it's quite unreliable. So, on a still day, you might not get much ventilation at all. On a windy day, you'll be getting too much ventilation resulting in cold drafts around windows.

You might get more ventilation on one side of the building where the wind is hitting than the other side.

So, it's quite unreliable. You can't deliver a certain amount of air to each space depending on the use. Whereas with mechanical ventilation, combined with an airtight envelope, you can deliver a certain amount of air to each space depending on the uses. So, a double bedroom will get more supply air than a single bedroom. And you can be quite accurate with that when you come to the commissioning process.

And instead of extracting all the air and just dumping all the heat outside, it makes sense to recover as much heat as you can from the air so that you're in turn driving your heating load down.

Ben: As you get more and more airtight, at what point does it make sense to have mechanical ventilation? With Passivhaus it's easy because you're going the whole hog. But as you increase that airtightness?

Tom: As a rough guide, when you get to less than five air changes per hour, that's when you need to start introducing some kind of mechanical ventilation, whether it's MEV, which is just extracting, not supplying and not recovering any heat. So, as you're extracting, you're creating a negative pressure in the building which drives air in from outside. Again, the problem is cold drafts and cooling of the building.

MVHR starts to make sense when you get down to three air changes per hour because then there's not as much cooling going on with natural ventilation coming in. So, it makes sense to start recovering the heat and putting it back into the building. And MVHR is most optimal obviously the more airtight you get. So, down to Passivhaus levels is ideal.

Ben: What is an MVHR machine? We know it's a fan, but there's more to it than that?

Tom: Yes. So, you've got two fans, a supply and an extract, and a heat exchanger. So, as we extract air from bathrooms, shower rooms, utility rooms, kitchens, anywhere where there's stale, moist air being produced, we extract the air from there. It goes back to the heat exchanger, which is where the fans are, and the incoming air recovers the heat from that extract air. So, you get a nice, fresh air coming in, picking up that heat, and that is then supplied to the habitable rooms – living rooms and bedrooms.

That air is filtered usually through an F7 filter, that's a pollen-grade filter, so you get nice, fresh, clean air supplied to the rooms.

Ben: What's important? What do we need to know to get MVHR right?

Tom: The first thing is, the design is everything. People often focus mainly on the specification of components, which is right, but at the same time you can spend as much money as you want on the specification of components; if it's not designed right, they're not going to work anyway. You're going to have to turn it off because it will be too loud and it will be inefficient.

So, the key thing is getting it designed well, getting someone who can give you sound levels before you've installed the system; pressure loss data is always important. You know it's being designed properly then, if someone can provide you with that information.

Ben: How do you find a good designer or know that they're good at designing?

Tom: Asking key questions is always good. 'Can you provide me with sound data at design stage?' If they can, that's good. 'Can you provide me with pressure loss data at design stage?' If they can, that's good.

And rather than someone just drawing a schematic of some ducting on a piece of paper, you want someone who's going to look at your structure, design it around the structure to make sure when you get it to site it's actually going to go in, and you can pre-empt the number of bends and things that are needed in the design. So, again, you can calculate whether the air that you're supplying is actually going to make it all the way along this ducting route to that room at the end of the building. Because sometimes it won't do it.

Ben: Is this to do with pressure loss?

Tom: Yes.

Ben: What is pressure loss?

Tom: Basically, it's the resistance that the duct is putting into the airflow through it. So, it's the resistance that the duct is providing to that airflow.

Let's say you had a duct that was corrugated on the inside or even fluffy on the inside. The air isn't going to flow as freely through that as it would through a completely smooth, say, metal duct. So, it's kind of resisting the airflow through it.

If the pressure loss is too high, the fans are working too hard to try to drive the air down that duct. It's nice to have a low pressure loss so the fans are just trickling along.

Ben: And the second that you start increasing the fan power is when you increase noise as well.

Tom: Yes, exactly. It's always good to oversize the unit so it's not running too hard. Again, increasing the pressure will drive up the noise levels and the energy consumption.

It's kind of similar to when your filters get blocked. If you never change your filters, your fans are going to work harder and harder to drive the air through those filters because they're becoming blocked. So, they need to work harder to keep up that airflow.

Ben: And this ducting, I've got it on my own house, the rigid ducting. What do we need to know about it and why do you like this type of system?

Tom: We like the rigid systems because basically, it's easier to get a low pressure loss with careful sizing of ducts.

So, we can start off with a larger duct in larger houses. That might be a hundred-and-sixty mill. And then you start to branch off there with a hundred-and-twenty-five and a hundred mill.

A lot of people think that the radial system saves space, but if it's done properly, instead of having one one-hundred mill. duct to, say, a bedroom, you'd have two ninety mill. ducts. Because those ducts are carrying the same amount of air but they're smaller, so there needs to be more of them to compensate for that.

With the steel stuff, the rigid stuff, it is important to bear it in mind quite early and get the components on site in time. And often, a common mistake is for people to get the joists installed and then start trying to put rigid ducting through them. Which obviously, you can't feed it in. So, it's important that any ducts going through the joists are installed as the joists are erected.

Ben: You mentioned radial versus branch there for a second. Can we stop and look? Because there's a whole other way of doing it. I know that you don't specifically specialise in that but what is radial?

Tom: A good way to look at it is, it's also called an octopus system. So, you have a main manifold at the start of the system which is just a box with a lot of small spigots on it. You plug your semi-rigid plastic radial ducting into that, and then you go off to your rooms.

So, each room would have its own branch, or two or three branches, all the way from this manifold at the start of the system, all the way to the air valve in the room. Which is good at preventing any cross-talk sound travelling from room to room because the sound can't make it all the way along those ducts.

Radial systems do have their uses, especially in retrofit cases where you simply can't get the rigid stuff in; it's too big. But it's important to be careful and make sure it's getting designed properly.

Ben: I've seen one go in at Buckinghamshire Passivhaus and it seemed like the commissioning of that was a lot simpler because you do that at the unit. I know we're going to come on to this with the branch system. But can you explain how you'd commission a radial system?

Tom: Yes. It's similar to a rigid system really. You'd tell the unit what airflow you need – it obviously depends on units but a lot of units these days you just tell the unit what airflow you need for the supply, what airflow you need for the extract, on fan speeds one, two and three.

You'd then set that and go around each air valve in each room, measure the airflow coming out of it, and check it's right. If it's not, you'd adjust the airflow. So, each air valve has a damper built into it. You'd adjust that and then go around, measure the others, and it's kind of a balancing act. A lot of toing and froing until you've got the right amount of air going into each space.

So, it's not really self-balancing as such.

Ben: But the one that I saw – and I'm going to describe this really badly, I should think – they were doing it at the system and popping out little bits of plastic. As I said, I was going to describe it badly.

Tom: Yes, what that is, it's likely that they had dampers on each branch to each room. So, them popping out the plastic was them opening the damper further to allow more airflow along that branch which will in turn take some airflow from another branch. That is a way of commissioning radial systems, doing it via dampers at the beginning of the system.

The arguments for it, you're not having to go to each room, running from room to room adjusting things. It can all be done there at the unit.

Ben: Let's talk about the commissioning because I watched this. I imagine Steve from Green Building Store has done this so often that it's a quick process. But I've spoken to other people who say it can take forever to go from room to room. So, explain what you're doing at each specific point and how you're gradually balancing it.

Tom: Alright, well you're right, Steve's got it down to a fine art and it definitely keeps him fit running around those big London houses.

Basically, all we're doing, once we've told the unit what it's running at – so, if we say to the system we need three-hundred metres cubed per hour on fan speed two; then let's say we're supplying thirty-five metres cubed per hour in a master bedroom – we'd go into that bedroom. If we were getting forty-five metres cubed per hour, we'd screw the damper closed more so that you're not getting as much airflow coming through it.

The way we measure that airflow is we put an anemometer over the air valve and that has some kind of hot wires in it that measure how much air is coming out of it.

Once we've closed the damper down a bit, we'd take another measurement and hopefully get it to thirty-five. But as we close that damper down, that's driving the air from this air valve into another air valve somewhere else. So, we'd then have to go to the next room to see what we're getting out of there. Hopefully now that we've closed the one in the master bedroom, we're getting more air coming out of that one to the right level.

If we were then to go into a living room and tweak that air valve, we'd then again have to go back to the master bedroom and check that again because it's all one system. So, if you alter one, it alters all of them.

Ben: We're going to have a video on that in the Hub at some point, but it's probably a few months off. Let's talk about those air valves that come out in the different rooms. Why are they different? What do they do?

Tom: The supply valves, again let's just say in a bedroom, a ceiling mounted supply valve, it has a kind of plate over the front of it, so that the air rather than just blowing out of the front of the air valve down into the room, it blows across using what's called the Coandă effect, where the air will stick to the ceiling, travel across the room, hit the walls and go down the walls.

The extract valves don't have a plate on them because there's no need to. We're only extracting. So, they have a damper that kind of screws into the body of the valve.

It's important when you design a system to make sure that the valve isn't too far closed because then it will become clogged up with dust. So, it's nice to have it open by a good few millimetres. Similarly, with the supply ones. If we close that plate on the front which is a damper too tight, there's a chance that the air could start whistling out of it. Which obviously you don't want in a bedroom.

In the kitchen, we'd put a filter in that air valve so that it's not taking any remaining airborne grease and clogging up the system. So, we always try and get a filter in there.

Ben: This is a question that has been on my mind as I look at ours. How easy is it to adjust them? If the cleaner is coming around and giving them a quick onceover, should I be worried?

Tom: They are easy to adjust. What should be done after commissioning, once it's complete, the commissioning engineer should lock off the air valves. There are different ways of doing that on different air valves. Most of them it's quite simple. You just put a nut on each end and tighten it really tight.

Yes, if you went up and really, really wanted to adjust it, you could do. But kids aren't going to be able to adjust it, the cleaner's not going to knock it around with a feather duster.

Ben: So, I've no excuse for all that dust now, trying to keep them away! What about the design principles for external vents?

Tom: One of the good things to look at is trying to get the intake and exhaust ducts on the north elevation, particularly the intake. That way it's in a shaded area in the peak of the day in summer. So, the summer bypass is more efficient because you're bringing in the cooler shaded air.

It's nice not to have them blowing right next to a window or into a neighbour's garden or somewhere where you might sit in summer and eat your dinner. Because it is going to be blowing quite hard, it's likely to be audible. Even with a silencer, it's still likely to be audible.

And you don't want it too close to the ground because if it is too close to the ground, it will blow up and leaves and debris and animal hairs and the intake duct will then bring that in which blocks up your filters quicker. So, it's nice to get it above one-point-five metres above the floor level really.

Ben: One of our neighbours had a bonfire that just hung in the air. There was no wind at all, and we noticed that the house filled up with smoke quite quickly. I did a quick 'what should I do' on Twitter. So, you can control these units. Is it the best idea to just take the flow rate down to absolute minimum if something like that happens and you start to think, 'this is weird'?

Tom: Yes, maybe in that case you could set the unit to unoccupied. It would mean you're getting very little ventilation, but for the time that it takes for that smoke to clear, it'd probably be alright.

We have a problem where if someone lives quite rurally and there's a lot of people with log burners, that the smell becomes permanent rather than just the neighbour's having a bonfire. It becomes all through the winter. You can get active carbon filters that will take out that smoke, take out that smell and filter the air down even better than an F7 filter to make sure there's less remaining pollutants in that air.

Ben: A couple more things then. The actual controls for this. You always try to keep them simple. I like it because when someone comes in, I can say, 'we basically just leave it alone.' That's the control. Unless you want more ventilation, when you press up, and as you say, if you're not there, you go down to the unoccupied.

Tom: Yes. Basically, we like to keep it as simple as possible. That way the end user always knows how to use it, there's less to go wrong mechanically. Some people like the intelligent controls, the app on the phone, humidity sensors, but basically we say to just leave the unit running on fan speed two and that will provide you with enough ventilation.

If you leave the house, you could put it on unoccupied, you could set it on fan speed one, but there's no real need to unless you're leaving for a long time, because the energy consumption shouldn't be that high.

Maybe if you're cooking or if it's, say, Christmas and you've got a lot of people round, you can boost the system which will increase the ventilation rates for a set time, usually forty-five minutes, and then it will automatically drop back down to fan speed two. The reason we say forty-five minutes is because that's, let's say, an average time to cook a meal. The German's also call it the party button because we use it when there's a lot more people around.

But yes, keep it as basic as possible really.

Ben: What are those controls and how many can you have? My house, it's just one on the wall. But are there any other options that you have?

Tom: Yes, there are. The basic thing to do is to have one main controller which you put in your kitchen so that when you're cooking you can easily boost. The other option is to put that somewhere else and have remote boost switches in your kitchen.

In some cases, you could do it in your bathrooms. We wouldn't suggest that because then if someone gets up in the night or early in the morning and boosts the system whilst showering, it can become audible in the bedrooms and disturb those occupants. We design the fan speed two flow rates to remove enough moisture whilst showering without the need to boost.

Other controls – a lot of the newer units now, you can use apps on smartphones or tablets, or you can control it via a web portal. Which might be a good idea for social housing because you can see from your web portal in the office what the unit is doing, if the pressure loss has gone right up, if filters need changing or someone's blocked an air valve up. That would give you a warning then to go out and check that.

Ben: And maintenance. What do we need to think about? Is it just filters?

Tom: Yes, providing you keep on top of your filter changes, there should be very little maintenance. Your filters are likely to need changing every three to six months depending on outdoor air quality, indoor air quality, if you've got a lot of pets or children running around.

The other maintenance, maybe after five years, unscrew the air valves in the bathrooms and have a wipe around in there. Because they are extracting white dust and towel lint so, that could collect over time.

Depending on the MVHR unit specified, the extract fan may need cleaning very carefully, ideally by someone who's done it before. Because there might not be a filter before that to collect any dust and it hits the fan first rather than the filter first. So, that can block up.

Ben: I've got a couple of other little bits and pieces. One is about if things haven't been done well, is there a risk of mould growth in the ducts?

Tom: Mould growth in the ducts – yes, there is. It would have to be done really badly for that to happen. Basically, if you turn the unit off for a long period of time, let's say, more than two or three days, then there is a chance of mould growing. Because those ducts are carrying moist air, as is the heat exchanger. And if your heat exchanger starts to go mouldy, you're looking at quite a cost to replace it.

There shouldn't really be any danger of mould growing in the ducts if the system is left on and each branch to each room basically has got air flowing through it. It's just if the unit is turned off.

Ben: One of our Hub members has been investigating decentralised MVHR. What is that and is it an alternative? I think the angle that she's coming from is that she's actually not that keen on all the ducting and is worried about things like mould growth. Can you explain a little bit about it and could it have a use in a new-build home?

Tom: Decentralised is MVHR but what you'd have in most cases is each room would have its own unit built into an external wall to outside or ducted to outside.

The problem is that each room then has a fan in it which can create sound problems in that room. A lot of them will say they're down at fifteen decibels. How accurate that is, I don't know. I've never seen one in practice actually.

In new-builds, I'd always suggest having one central unit. It's less grills on the outside of the building. With decentralised, if you've got four rooms each with a decentralised unit, then that's four external grills which isn't going to look great. And with the cost, it's unlikely to come out cheaper.

So, with a new-build, if you can design the ducting into the building, which you can at new-build stage, then it's worth going for a ducted system.

Ben: Just thinking about my own system – Alan designed this; we've done a podcast on that, that we'll probably link up – but what work do you do once you've got designs from someone like Alan?

Tom: When we've got them from someone like Alan, there's very little to do. We've worked with Alan a lot in the past. So, we know that he knows what's going on really. He knows what he's doing.

Basically, we just model it in our 3D modelling package, double check things such as pressure losses, sound levels, we chat to Alan on that basis and check he's happy with everything. Then basically we can do a bill of materials then off our model, to get a full list of parts, making supply much easier and more efficient.

Ben: When you've got all these pieces, how competent are the main contractors in doing a good job on site and is there anything they need to be told?

Tom: Usually we've got a main contractor who, even building down to passive levels, is very keen and has got a good attention to detail. So, he's quite happy to install an MVHR system with good installation drawings.

If you've got a system where every part is labelled and the parts come to site to suit those drawings, then there's little really that can go wrong. As long as you stick to those drawings, any amendments that need to be made on site, just communicate them with us so we can check they're going to be alright.

There always will be tweaks that are needed on site because we can sit there in the office and look at the drawings and say, 'you need to do this and go around that steel.' But things always change on site, don't they? Unexpected things crop up.

Self-builders, again if you've got a self-builder with good practical knowledge, they're good installers as well. They pay close attention to it. They know how much work has gone into the design so, they want to do it right. No shortcuts are taken.

Ben: And finally, is there anything else we should be thinking about or anything else that you don't think we've mentioned that we should just crowbar in at the end?

Tom: No, I don't think so. Again, there can't be enough stress put on the design stage. It's essential really. Thinking early on in your building project what size ducts do I need, where do I need to run them, what size joists will I need to accommodate these ducts.

Even as soon as the architects or engineers start doing the building drawings, it's worth then getting your plans submitted to a designer and getting their opinion on unit location and duct sizing.

So, the design is key every time.

Ben: Tom, thank you very much.

Tom: No problem. Thank you.