

Leeds University Business School – Research and Innovation Podcast

Episode 31: The importance of good ventilation

Speakers: Dr Matthew Davis, Professor Cath Noakes and Professor Simon Rees

Matthew Davis: Welcome to the Research and Innovation Podcast. On today's episode we're going to be talking about ventilation and fresh air, and the role this plays in healthy building design and offices. So, I'm Matt Davis, I'm an associate professor in organisational psychology at the Business School, and I'm joined today by two experts: Professor Cath Noakes and Professor Simon Rees.

Cath Noakes: So, my name is Cath Noakes, I'm a professor of environmental engineering for buildings at the University of Leeds. I'm a member of the steering group for this project and I've been very involved with supporting the COVID response since April 2020. I've been on the SAGE committee.

Simon Rees: Hi, I'm Simon Rees. I'm in the school of civil engineering at the University of Leeds, I'm professor of building energy systems, and I work on the adapting offices project as an engineer and commenting, really, on what are the implications in terms of how people want to adopt working patterns and how they use offices and what all that means in terms of building design and building infrastructure.

Matthew Davis: Fantastic. Thank you both so much for joining us today. As Simon mentioned, this podcast is related to our adapting offices project. Simon, do you want to maybe give us an introduction to why fresh air and ventilation is so important?

Simon Rees: So, we want to talk about why fresh air is so important and what organisations need to consider about ventilation instead of thinking about returning to office buildings... adapting office spaces. So, we're going to talk about some of the particular things that need to be thought about for spaces that have air conditioning and how that might be different when we're thinking about rooms that have natural ventilation.

So, we know, research tells us, one of the benefits of good ventilation, so I thought it would be helpful also to think about going forward, how should we be dealing with the challenges of ventilation and what some of the benefits of good ventilation... Early in the pandemic, we got used to this UK government slogan, "Hands, face, space," and organisations made a big

effort to adapt operations using those basic ideas. So, however, more recently, people in organisations have been asked to adopt, “Hands, face, space and fresh air,” so then I ask Cath, can you tell us about the fresh air part of that got added and how ventilation became recognised as an important element of managing the risk of infection?

Cath Noakes: Over the past year we’ve seen more evidence come through which explains how this virus transmits, and we now know that it’s in respiratory particles, the small aerosols and droplets that we breathe out. But we now know it’s in some of the very smallest ones of those which can stay in the air for long periods of time and can build up in the air... if the air in a room is poorly ventilated. And there is some evidence from outbreaks that show that very poorly ventilated spaces can enable transmission infection. So, as we’ve learned that over the past year, it’s become more important to recognise that we need to mitigate that mode of transmission and that means understanding ventilation and changing the ventilation in many of our buildings.

Simon Rees: So, many larger office buildings were designed with some sort of air conditioning system that also delivers a certain amount of fresh air, that does the basic ventilation function. So, organisations might not have thought about the quality of ventilation, it’s pretty much been taken for granted if you’ve got air conditioning in your office then you’ve got proper ventilation. Often occupants don’t need to worry about... have a lot of control over how things work in any case. So, now we need to be a bit more mindful about what is happening in terms of ventilation. Can you tell us some of the things we need to be thinking about and what might need to be reviewed when we get back to office buildings that have air conditioning?

Cath Noakes: So, it will depend very much on the building and its ventilation system, and it is quite hard to give a single, one size fits all answer. Many buildings, particularly more modern buildings, should meet current building regulation standards and, as long as that ventilation system is checked and that it’s been well maintained, it’s quite likely that that provides enough fresh air. But particularly older buildings, buildings that have been retrofitted, or those which haven’t got such clearly designed ventilation systems, they may need to be reviewed for whether they’ve got low ventilation rates.

It's quite hard to check this but one way you can do it is to use carbon dioxide meters, and that allows you to look at how much fresh air is in the space compared to how much gets recirculated in there. Some of this can be done locally by an in-house team, so your estates team or facilities management, but sometimes it might mean that you need to get professional advice in to support this. There is also a huge amount of guidance now available, so the Health and Safety Executive, their website has a really good set of information now on ventilation and using carbon dioxide meters, and the Chartered Institute of Building Services Engineers provides really detailed guidance that allows you to understand ventilation and think about what you can do under different settings.

Matthew Davis: That's really interesting, Cath, I just wonder, listening to you talk there, we're talking about air conditioning as a way of circulating air in buildings, are there other kind of ventilation systems we need to be thinking about here as well, and what's the implication of those?

Cath Noakes: Buildings can be ventilated in many different ways. There are essentially basically two ways, one is a mechanical ventilation, and that uses ducts and fans that bring air in and distribute it in the building, and the other way is that you can use natural ventilation which usually means opening windows or other vents that just allow air to move in naturally. Air conditioning is slightly different in that air conditioning is about how we cool and heat the air in a building, and sometimes the air conditioning is combined with the ventilation so it's all part of the same system, but sometimes it's separate, and many of us are very familiar with those separate systems, you know, the white box on the wall or on the ceiling that recirculates the air. Those are the ones that we have to watch out for, because they are the ones that don't necessarily bring in new fresh air, they just cool you down and make you think that the air is good.

Simon Rees: So, organisations are giving a lot of thought to how they might actually change the spaces in their office buildings to suit new, sort of, styles of working and working patterns. And that means that there might be some effects in relation to the existing air conditioning system. Can you give us some thoughts about what things need to be thought about in terms of, you know, if people want to set up new partitions, move things around, change the concentration of people in different parts of the building.

Cath Noakes:

So, I think it's very important to think about the ventilation in conjunction with how you're laying out a space. One of the risks with, for example, partitions is that although people perceive they can be useful for blocking transmission, and if you are very close to somebody, they can block those large droplets, for example like in a shop at a counter, putting them in an office can actually block the airflow if we're not careful, so we have to be careful that doesn't happen, you can almost, like, create zones where you've got higher concentrations of virus, and we want to make sure that the air flow is quite well distributed in a space. One of the other things is we should think about that activities that people are doing.

So, we know that people generate more virus particles, or more aerosols generally, when they are more active. So, if they're talking loudly and talking for continuous amounts of time, that might put more virus into the air than when people are sat passively at desks. And then then the other thing that we might have to consider is if we have a naturally ventilated office and we need to open the windows a little bit more, that might make things a bit cooler in the winter, so we might want to adjust position of desks and things, so people aren't sat quite as close to those windows. We also might want to move desks and furniture to allow people to actually get access to the windows to open them more readily, because one of the barriers to people opening windows is often that they are hard to reach and they are hard to get to.

Matthew Davis:

That's interesting, Cath. It makes me just wonder whether actually there is a question around what we're doing... what people do when they come back to the office, then, if we're looking to keep things as safe as possible. So, I think there might be a tension, then, from what you were saying between the pull to come back to the office, to be part of meetings and lots of face to face talking and interaction, and what you were saying around that potentially being riskier in terms of generating more particles, more aerosols and so on. I wonder whether we're in a position where we're saying that actually meetings are better done virtually, on your own or elsewhere rather than, kind of, coming in for that kind of activity and whether things like call centre work, lots of kind of work on telephones where you're talking continuously, whether this is something we should be

thinking about being less of an office based activity in the future. Any thoughts?

Cath Noakes: Yes, so these are quite... yes, interesting challenges, and I think there is that balance between what's the benefits in terms of mental health and productivity from people being in an office versus what's the additional risks. And I do think that is going to vary over time, so it will depend on things like the prevalence of the virus, but I think what's probably quite important is that organisations think about this when they're doing risk assessments, and rather than doing top down risk assessments that just, you know, put numbers on spaces and this is what you must or must not do, I think it's more important to think carefully through the activities that people do and involve the people that are in that office in that discussion so we can identify things that might be higher risk that we could adapt in a slightly different way, or things that actually are relatively low risk and therefore we can continue doing in a similar way to which we did before.

Matthew Davis: That's music to my ears, Cath, and I think as a psychologist, some of the discussion that we've had around adapting offices and thinking about effective office design more generally, we've been talking much more around understanding if an activity and nature and task that people engage in as part of their job design as well... I think this is another extension of this in terms of thinking about that same process and how that contributes towards risk mapping as you were saying and thinking about the infection risk in space too. So, that's really interesting, thank you.

Cath Noakes: I think just to follow on from that, it's also really important that we don't just think about the office as the engineering and the physical environment, it's that interface between the physical environment and human behaviour, and, you know, there are an awful lot of things that we can already do to make our environments better, which come down to giving people a little bit better information about how to manage their building, about how to interact in that building, and about giving them responsibility for making sure that place is safer for themselves and for all their colleagues.

Simon Rees: I'd like to ask a little bit more about these situations where we have to deal with opening windows. So, summertime, you know, it's quite easy to throw the windows open and control overheating and get loads of fresh air in the process. Winter, it gets more difficult, some of us have been through these difficult

situations where you have to put up with the freezing cold because the windows have to be open, but that's not the only way of dealing with winter ventilation, there are some other ideas, aren't there?

Cath Noakes:

Yes. So, just simply opening a window is a very crude measure and actually ventilation in a naturally ventilated office is a lot more complex than that. So, the amount of ventilation will depend on the weather, so the windier it is, you will get more ventilation, and actually the colder it is, you'll get more ventilation, because the bigger the temperature difference between indoors and outdoors the more ventilation you get.

So, this means that you can adapt what you do through the year. That means, if it's windy and cold, you only need really quite small gaps to be able to get good ventilation, whereas if it's hot and still you need much bigger openings to get that ventilation through. There are also some other tricks you can play, so many buildings have openings at different heights, sometimes they will have them low down, sometimes they will have them high up. In the hot weather, if you can open both and low and high, you can get a nice air circulation because the air will come in low and go out at the high one. In cold weather, what you can do is close the lower one and just open top windows and then the cooler air comes in, mixes with the air in the room and it makes it more comfortable for you, you don't get such cold draughts in that way. One of the real challenges here though is to do with the quality of windows in offices, and a lot of offices, particularly those higher level windows, don't operate very well, they're badly maintained, they've been painted shut, and actually finding ways we can reopen those and give people the means to open them might be the solution we need to make sure our buildings are better ventilated.

Simon Rees:

So, there are quite a lot of situations, particularly in older and smaller buildings where some sort of air conditioning has been retrofitted, and this is often the, sort of, white boxes you referred to earlier, but that's not quite the same as ventilation, it provides a heating and cooling. There is often a bit of a misunderstanding about whether that solves their ventilation problem.

Cath Noakes:

Yes, there is, and therefore that's why we really need to check that there is sufficient fresh air in a building. As I said earlier, carbon dioxide meters can be one of the easiest ways to do that. And, you know, there's not a magic number that means you are

safe or not safe but looking at all of the evidence from around the world it does seem that if you can keep your carbon dioxide concentrations below about 800 parts per million that shows you've got reasonably good ventilation. But if it's going above 1500 parts per million on a regular basis that really is telling you you need to do something about it and improve that environment. And some environments are straightforward, you know, we can just change the flow rates on a system, or we can open the windows a bit more, some are really hard and particularly some of these ones that have been retrofitted, and there we might need different strategies.

So, we might need to think about changing the occupancy of those spaces or we might need to think about putting in new technologies like air cleaning devices which can remove the virus from the air, but they obviously don't change the ventilation in the building.

Matthew Davis: So, Cath, you were saying about levels of, kind of... quality of air here, are there any links to broader health and wellbeing or other things that might be implications of having poor air within a building?

Cath Noakes: Yes, there are. And there is actually quite a lot of evidence of this going back many years. So, there are studies which show that if you have better ventilation in your bedroom you sleep better and you perform better the next day. There are plenty of studies in offices and in schools which show that your productivity and performance is related to the ventilation, so the better the ventilation, the better you perform. There are also relationships between ventilation and sickness absence, so shows that particularly around respiratory symptoms people are less likely to take time off. And I think it's worth thinking about, you know, why would a company invest? Well, when we start looking at the consequences of poor ventilation, the numbers are huge.

So, if you just look in the UK alone, in 2019 there were over five million sick days lost because of respiratory infections. There was a study from Denmark which looked at indoor air quality and associated poor indoor air quality with up to a nine percent drop in productivity, you know. That's almost half a day a week, imagine putting that across an entire organisation. And then we can go back nearly 30 years and find studies from the United States which estimate that their annual cost of poor air quality in

offices is around about \$40 billion a year. So, you know, these are huge numbers and actually it makes a lot of sense to improve ventilation for health and for the performance of an organisation.

Simon Rees: So, we've already talked a little bit about CO2 and how that can help us understand whether we've got good ventilation or bad ventilation. And you can see new products have come out even that help you monitor this sort of thing at home. It's not so common in offices, although many buildings may have CO2 sensors, but we just don't realise that that data is already there. Can you tell us a bit more about how you think some of this monitoring technology could be used to, sort of, monitor things in an ongoing way but also to figure out where we've got bad ventilation?

Carol Noakes: Yes, so, I mean, sort of, on a practical basis, if you're the office manager and you're trying to think, well what do I do now? Obviously the first step is to do a quick sanity check of your ventilation: can you see how the air gets in and out? Have you got systems? Do you know what they are? Are they working, know? Have you even got simple things like bathroom extractor fans? Do they work? And if you do have mechanical ventilation, do you have a record of its maintenance and how it is being used? But then when it comes to using CO2 monitors, I think they are a really practical tool. So, these are available, they are about... between about £70-200 depending on what you buy, and you should always look for something called an NDIR monitor, which gives you a much better reading than some of the others for carbon dioxide.

Essentially the reason we measure carbon dioxide is because it's in our breath when we breathe out, so it's a marker of how much of the air in a space is from other people's breath. And you can use them in two different ways, so you can put them in a space for a short period of time, watch what they do as people interact in that space and understand... use that to say, do we know that the ventilation is good enough? And if it's good enough, particularly mechanical ventilation, you can take the monitor out and on you go, you're comfortable you've measured it and checked. There are other spaces, particularly the naturally ventilated spaces where you can use them to actively manage the space, so what you can do is put the meter there for people to be able to see, with some guidance and people can open and

close windows and vents depending upon the reading on that meter.

Obviously, they're not a magic bullet, they're not infallible, so, you know, they will... the readings will vary, and we shouldn't be, sort of, a slave to the numbers on them, we need to be thinking about using them for broad ideas and a broad indicator of the ventilation rather than to suddenly go, "Oh, it's spiked a bit therefore it must be dangerous," it doesn't work quite like that. But those are the really practical tools that people can use. I think an awful lot of this is about how we educate people about how they use their buildings in a better way.

Matthew Davis: Wonderful. I think that's a really good place to leave this, Cath, I think you've illustrated, again, I think with all of the topics around this idea of the future workplace and adapting offices, about that mix between the engineering, the design and the behaviour, and the need to think about all of these things together. Well, that's fascinating, thank you so much Cath and Simon for sharing your thoughts on this topic and really showing how good ventilation goes beyond just thinking about tackling COVID-19 and creating safe spaces. So, thanks very much for joining us today.

Cath Noakes: You're very welcome.

Simon Rees: Thanks for having us, thank you.

Matthew Davis: So, if you're interested in finding out more about this project or about this topic in general, you can check our web pages; the link is in the show notes. Thank you very much.