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Medication for sick buildings

Better maintenance, a clearer recognition of contaminants and more guidance on ventilation need to be on the prescription. Geoffrey Brundrett* reports from the Healthy Buildings conference

Smelliness has been defined in Scandinavia. The 'olf', a subjective unit for strength of smell, is based on 'olfaction' and is equivalent to the smell coming from one adult Dane who bathes 0.7 times per day.

Not a silly subject, for the science of smelly products is important for comfort in the built environment. Smelly furnishings, poor building maintenance and inadequate ventilation reaching the people were the three major conclusions of the biggest European conference on Healthy Buildings ever held. Over 650 delegates analysed well over one hundred research papers, listened to almost thirty invited reviews, all of international status and still had time to argue in seventeen workshops. All in four days.

Bold policy

The Swedish initiative on sick buildings is one of long standing. Their bold national policy of aiming for a fixed annual energy consumption for the country means that they are more anxious than most to know if any of the consequences of lower energy living necessarily mean less healthy living. The answer appeared to be 'no'. However, more complex buildings did mean less healthy ones and often, particularly in offices, increased energy efficiency did mean more complex engineering solutions and hence a bigger likelihood of going wrong. A curiosity of the conference was the number of times old traditional building designs were shown to behave unexpectedly well because a simple design had been well developed empirically.

Surveys of office staff showed that very similar symptoms were reported by the occupants of air conditioned offices. The most prevalent was lethargy and it was common for well over half the occupants to experience it. Almost half reported a stuffy nose and a dry throat and over 40 per cent had headaches. These symptoms are now known as the 'sick building syndrome'.

There was a worrying discussion that if this proportion was brought down to 20 per cent the building could be passed as fit for work. This is based on the ASHRAE definition of thermal comfort which declared its standards of acceptability would satisfy 80 per cent of the occupants. While in general the engineers thought that this was the best that should be expected of them, the workshop discussions disagreed, presumably from the occupants' viewpoint.

Surveys of the physical conditions within air conditioned offices brought a universal but startling conclusion from Britain, Canada, the United States and Finland. The occupants were not getting the conditions the designers promised them. These surveys were usually declared anonymously and much was done to protect the guilty. A Finnish study found that the commissioning stage had been neglected, leaving a badly adjusted plant. The British study found that almost half of the air conditioning plants in a study of seven buildings were operating wrongly which resulted in environmental conditions at the edge of or beyond the conventional comfort envelope for the occupants.

The USA studies suggested a higher state of satisfactory buildings with percentages as high as 60 per cent or even 70 per cent of the buildings being acceptable. However, in one survey of over two hundred offices almost two thirds of them were found to have inadequate ventilation. Over a third had no fresh air supply whatsoever. It was expected that this was the result of an over-enthusiastic energy conservation plan. Another USA company reported that over half the troublesome buildings had inadequate temperature control. A Canadian study showed that the sick building syndrome symptoms increased with increasing temperature in measurements over 21°C–26°C. High temperatures also do tempt people to rest.

'Picknickers' are hired to report first impressions of smelliness when entering certain buildings.

Smelliness can now be quantified . . . in 'olfs'.

These bleak surveys set the foundation for the cure. How can the engineers create the right conditions? The first stage was to produce the right design. The second stage was to build it properly and then commission it. The last stage was to operate the plant and maintain it as the designer intended. The lack of respect between designers tended to lead to 'what do you expect from him?' Far from relieving the client this emphasised the non-professionalism of the practitioners. Britain seemed alone in favouring an architect-led team, particularly when engineering was not part of his training.

Owning up

Other countries, led by Sweden, favoured a real estate/owner-led team. The owner had the biggest interest in making the building a success: if a real estate agent then he may also have a long term view with leased buildings.

However, the prize of clarity, management

and success went to the Norwegian approach. Fifteen years ago the Norwegians produced North Sea Oil Rigs designed to withstand very heavy seas and to provide a complex set of services. They required even more thought than ships because they were not intended to be brought back to land for repair. The designers pioneered Quality Assurance. This recognised that most mistakes occur at the interfaces between the specialists. In practice everyone plays down these differences and hopes the gaps will not show. In Quality Assurance these interfaces are exaggerated and highlighted so that clarity is achieved. The system is now working well and has already spread to buildings. It has had one unexpected effect. It has created a new consultancy team of Project Managers, always engineers, never accountants. These new specialists are hired by the owner to control the construction of buildings and provided the Quality Assurance System is

Samples were placed in jars for testing. Air conditioning components can stink themselves.

operating, they can and do make sure the building works.

This approach is even better than the present British solution of offering an independent commissioning contract which reports directly back to the building owner not the contractor. The Scandinavians believe that this is too late and too expensive to remedy serious problems. The Quality Assurance approach is preventative, not curative.

The maintenance and the operational side was, with rare exceptions, not done well. The highest satisfaction with offices came from the Japanese who declared that they have for many years, required a qualified plant operator to supervise the boiler and air conditioning services. The new kind of specialist now appearing in the USA and just entering Europe, is the building 'doctor'. He provides an appraisal service with emphasis on hygiene and microbiology. At the moment this tends to be an expensive service used only by those with troublesome buildings. However, in the discussions the concept of an MOT type test for buildings was highly regarded. It worked for cars and it could provide a low-cost check list for all buildings. Britain, through its CIBSE HVCA and Air Conditioning Approvals Board, is in the lead.

In a stink

The science of smelly products has now centred on Scandinavia. The practical difficulty of defining the source strength of a smell has been resolved by defining the previously mentioned subjective unit—the 'olf'. The local odour created by this smell is defined as a 'decipol' which is the dilution which 10 litres/sec outdoor air creates in a chamber containing one 'olf'. Much work remains to be done on the additivity of smells and on the adaptation to a smell but a new way of approaching smells is now established.

This simple but profound step had two important implications. The first is that the 'smelliness' of common materials can be quantified. The second is that we will in future ventilate for the materials as well as the people. Several laboratories are working towards a standard appraisal technique and the simplest method, that of sniffing a jar containing the product, is gaining ground as the front runner. It is also the lowest cost. It will not be long now before the manufacturers will have to provide a smell factor for their product and soon afterwards, I expect some indication of the potential dangers of the volatiles emitted. The enterprising Danish Technical Laboratory arranged a novel 'olf bar' where they could mix cocktails of different materials and assess the offensiveness of the combined smell.

Basic samples of burnt cigarette stub and dirty carpet were all too familiar, but the surprises came when a sample of brand new air filter materials was sniffed and was very offensive. Even more surprising was the jar full of small samples of galvanised iron ducting. Does galvanised metal smell or was it the lubricating oil traces used during manufacture?

Detection of traces of organic compounds is now possible, thanks to sensitive gas chromotography. These techiques have been applied to real buildings to show the many hundreds of compounds now present in our office environment. The science is showing the speed of decay of smells and the

The Danish Technical Laboratory has an 'olf bar' where smells can be mixed like cocktails to assess their pungency

complexity of this process. While fresh paint can lose its smell in days, urea formaldehyde wall insulation may take several years for its smell to decline to half strength. However, while we know a great deal about a few common contaminants and have some knowledge about another small number of contaminants, we know little about most contaminants emitted from building materials, finishes and cleaning compounds.

Once the knowledge becomes recognised then manufacturers will look more carefully at the ingredients of their products and perhaps change the formulation. Architects, armed with the new knowledge, will be able to select less offensive products. Contractors may be able to develop techniques to precondition materials before application. The recent trend in plastic packaging often means that the product retains its odour within the package and the decay of volatiles does not begin until the products are unwrapped. Finally, it may become desirable to condition materials in place in new buildings well before the occupants move in.

Bad odour

Air conditioning ductwork itself was the last source of smell. In general there was agreement that the fresh air supply ducts were usually clean but there were exceptions when the inlet filtration was too coarse or badly executed. Damp conditions inside ductwork also created musty mould odours which were unhealthy and unpleasant. Several cleaning companies offer sophisticated duct cleaning services using robotic cleaners combined with vacuum cleaning.

Adequate ventilation was the final research

Professor Ole Fanger (l.), president of SCANVAC, and award winner Professor Thomas Lindvall (r.) have both been involved in research into smelliness. SCANVAC is the federation of Nordic heating, air conditioning and sanitary engineering societies.

area. Four topics were discussed. The first was a review of why we need ventilation. Originally all the pollutants were assumed to come from the occupants themselves, and ventilation rates were chosen on the basis of occupancy. Now that many other contaminants have been recognised, the ventilation quantities will have to be increased and the operating pattern of the system changed. Energy conserving building managers have often preheated the building before occupancy with fully recycled air. This will have to be changed so that the building is purged of its self-generated contaminants. The night flush has become essential.

The second topic was casual infiltration. Mechanical ventilation systems reinforce the casual infiltration. In practice buildings have become progressively tighter over the years and the unplanned infiltration is becoming less and less. Infiltration rates in Danish offices have, in recent years, reduced from around 0.8 air changes per hour down to 0.3 ac/h today. If the total ventilation rate is to remain constant then the mechanically ventilated flow will need to be higher.

Critical supply

The third and most critical topic was the effectiveness of the ventilation systems. The professional guidelines all specify how much air should be supplied to the occupied room. None yet request that it reaches the occupants. This serious shortcoming is now getting the attention it deserves and ASHRAE are planning a standard with urgency. This will mean a complete repraisal of guidelines on conventional air diffusers. Much criticism was levelled at today's manufacturers because their research appears to have stopped twenty years ago. New systems were proposed and claims are being made for some degree of personal control. The personalised desk with eyeball car-type air inlets have been abandoned because, while giving spot cooling and relief for short periods, they become too intense for long exposure. The new trend is towards a plenum floor. The driving incentive for this floor has been the growing number of services now required within the office and the need for these service points to be flexible. The logical extension was to make the floor pressure tight and supply it with conditioned air. Local ventilation units provide a personal air supply at low velocity in the vicinity of the individual desks.

The final topic was draughtiness, a subject closely linked with unsatisfactory offices. The latest research has shown that the turbulence within the air stream has a much stronger effect on the heat transfer rate than the mean velocity itself. Most air from mechanical systems arrives highly turbulent and therefore has a much more powerful cooling effect than the simple velocity measurement suggests.

Shock tactics

The Americans lead in these areas. The proposed changes in ventilation standards recommends tripling the minimum rate from 2.5 litres/s/person to 7.5 litres/s/person. Their new standard on ventilation effectiveness will shock grille manufacturers.

How can we overcome these problems? There were five recommendations

- Get the ventilation rate right. Allow for smelly materials or avoid them, operate at night to purge the building before occupancy and make allowances for the ineffectiveness of the ventilation system.
- Introduce Quality Assurance which at its lowest level, defines responsibility and when working well, enables a new breed of consultant to act for the client. This is the Project Manager.
- Provide training for the operational staff and encourage proper handbooks for buildings.
- Give serious management time to the maintenance of the building services, using risk analysis to highlight sensitive areas. If the cooling tower becomes accidentally contaminated with Legionella, for example, will such contamination reach the air inlet or ground level areas where there could be crowds of people.
- Introduce a simple MOT type test for the building services. This is the management feedback to demonstrate that all is well.

Britain led on hygiene studies perhaps because indoor mould problems are termed the 'British disease' and we were well represented in the poster session. Dr Peter Charlesworth from the Air Infiltration and Ventilation Centre at Bracknell, won the poster prize for clear presentation on measurement techniques for infiltration. Prof P O'Sullivan, UMIST, gave the keynote address, warning us of the problems of complexity in modern design. Mr Chris Saunders, BRE Scotland, summarised the techniques to avoid condensation while Dr Peter Warren, BRE England, highlighted the factors needed to make a building healthy

Full technical papers are now available. Volume 1 is a collection of the state of the art reviews. Volume 2 deals with planning physics and climate Volume 3 covers systems, materials and policies. There will be a fourth volume collating the practical recommendations. This will be out early next year. They cost approximately £15 each. Make sure your library has a set and that you at them. They are available from Svensk Bygqtanjaust 7853, S-10399 Stockholm, Sweden

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