

Sick building syndrome - what seems to be the matter?

by Brian M Roberts *FCIBSE MASHRAE MIP MASPE

Building sickness, or sick building syndrome, is a recently-coined term used to describe varying degrees of discomfort and real or imagined poor working conditions reported by occupants of office buildings, both air conditioned and non-conditioned. Common complaints are irritation of the nose, throat and eyes, lethargy and headaches. Conditions such as dry skin, breathing difficulties, bronchial asthma hypersensitivity and nausea have also been attributed to it. It has been suggested, perhaps unkindly, that 'office work syndrome' might be a more appropriate term since sufferers say the symptoms are experienced during the time they are at work and cease shortly afterwards.

Office work sickness is not just the concern of the air conditioning engineer. It involves the clients who commission office buildings, the architects who design them, the employers who choose the surroundings and determine how the office work and maintenance is organised and above all, it concerns the people who work in them.

This article reviews the factors in the equation and largely leaves it to the reader to draw his or her own conclusions (with a little help) as to whether sick building syndrome is fact or fiction.

The recently-published Building Use Studies Ltd, report (May 1987) indicates that there is a statistical if somewhat tenuous link between air conditioning and most of the common symptoms of building sickness in the 46 offices covered by the study, those people being most prone being lower grade and female staff (Fig 1). This has caused some alarm both in the air conditioning industry and to the owners and users of offices. As yet, other types of building appear relatively immune.

Comfort air conditioning only began on any scale in the USA in the 1920s and in the UK, office block air conditioning started seriously in the early 1960s. Since office air conditioning is not new, the answer to discovering the cause of office sickness may be in discovering what has changed. Is it the people and their attitudes or expectations, or is it the buildings, or is it the air conditioning systems?

Psychological research has shown that the motivation to work efficiently depends primarily on achievement, recognition, work interest and responsibility, ie, job satisfaction. Working conditions come a poor ninth.

Since the 1960s, most office workers are more mobile, and they are generally more outspoken and demanding. The growth of the electronic office with its rows of VDUs has also shaped work responsibilities and people's attitudes. Some are bored. Many appear to find the stress of modern office

Is it catching?

As far as is known, building or office work sickness is not an infection and should not be confused with other building-related problems which include legionnaires disease, humidifier fever or toxic poisoning from building materials.

Legionnaires disease is a rare form of pneumonia caused by a bacterium which thrives in warm stagnant water and becomes a source of infection only when conveyed in minute water droplets which are inhaled by a susceptible person. Most outbreaks have been associated with hot and cold water distribution systems in hospitals or hotels.

Humidifier fever is a respiratory infection associated with the inhalation of organisms which have colonised the water in poorly maintained humidifying apparatus. It can occur in both warm-air ventilation and air conditioning installations.

Taking away the probable source of infection, the warm stagnant water, has led to a sharp decline in the number of air conditioning installations using water-cooled refrigerating plant with cooling towers. Air-cooled equipment is now largely the order of the day.

Humidifiers using recirculating water sprays or water-storage tanks are rarely incorporated into new office-block air conditioning systems. Instead, the electrode-steam humidifier is being used, in which sterile steam is generated directly from mains water.

life too high. Most people's expectations have increased. In all these circumstances is office sickness physical or mental and is air conditioning just a convenient scape-goat?

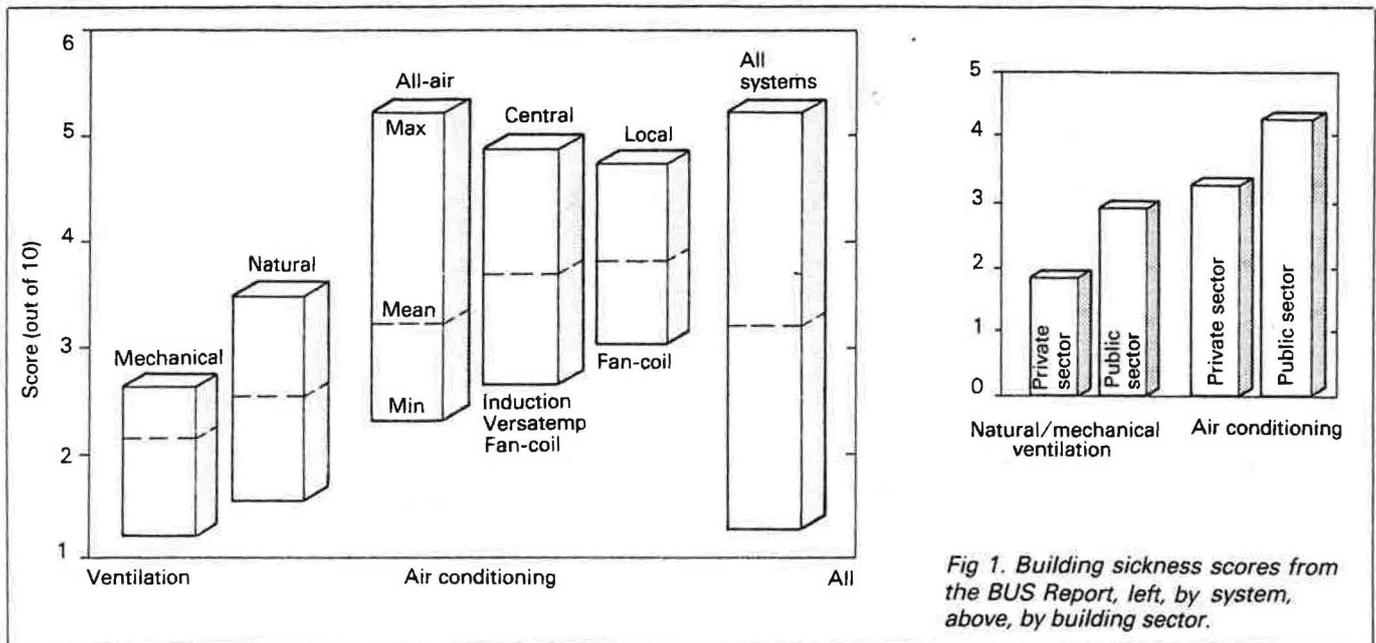
Building changes

In the early 1960s the current fashion in new office blocks was curtain wall construction with about 50% glass in the external facade (Fig 2). All occupants had a view out of a window and most buildings, with a few notable exceptions, were ten storeys or lower and probably below 10000m² floor area, often being less than 5000m². Many were for owner-occupiers and standards were often relatively high. Air conditioning was generally straightforward with few problems of plant accommodation or distribution or control.

Then came the trend for the open plan office with a large proportion of internal zones. Many people disliked the loss of small individual offices because of lack of acoustic and visual privacy and perceived loss of status. With hindsight some of these may have been the sick buildings of their day. Into the 1970s offices became much larger, often up to 30 storeys, and internal zones became more common. The buildings were often speculative, with financial pressures to install minimum-cost air conditioning in under-sized plant rooms and distribution spaces, with a view to achieving maximum office rentals.

Then came the oil crisis bringing well-insulated buildings and small windows and some effort towards energy conservation. The 1980s brought hi-tech building

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designs, more speculative ventures, the atrium lobby, the refurbishment boom, and a return to the landscaped but now electronic office.

The building developers and many occupiers have certainly changed their ideas on what constitutes a satisfactory building:

Air conditioning changes

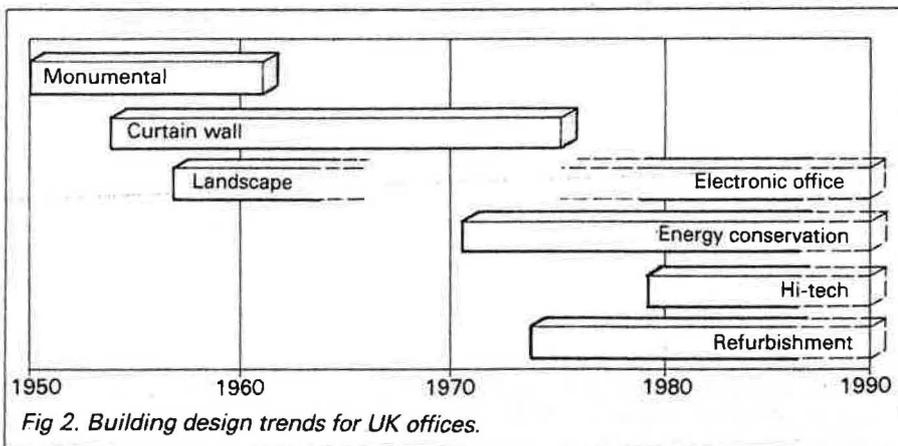
Prior to the late 1950s, comfort air conditioning systems for offices were generally of the low velocity all-air type, the conditioned air being distributed through ductwork at air speeds below 10 m/s (Fig 3). Fans operated at pressures below 750 Pa. The early 1960s saw the

introduction of high velocity, high pressure all-air systems with duct air velocities up to 25 m/s and fans operating at pressures up to 2500 Pa.

Most of these systems had twin supply air ducts, one carrying hot air and the other cold, to provide a constant volume variable temperature air supply. In another type, both the supply air volume and temperature were varied. These systems were expensive to install and operate and occupied considerable building space.

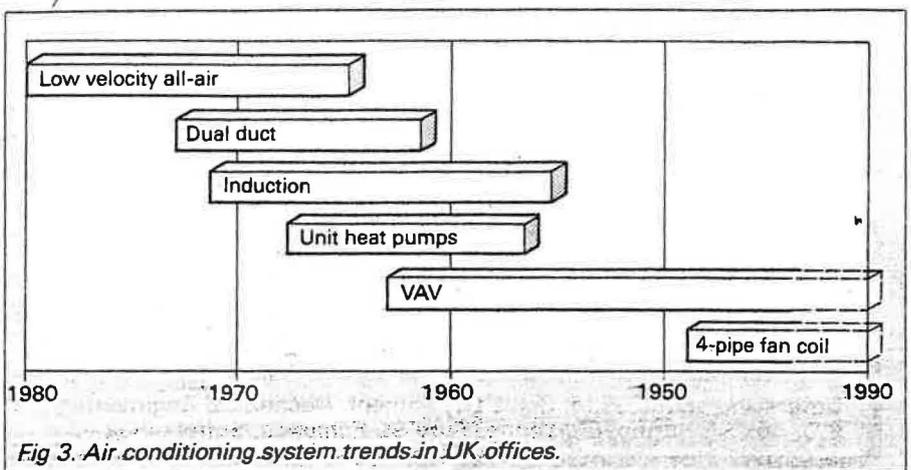
To overcome these problems the induction unit system was introduced. A central plant supplies conditioned fresh air, just sufficient for ventilation purposes, at high pressure through nozzles in a room unit to induce up to five times that volume of room air across a water coil. The early systems were of the 'change-over' type where hot or chilled water from a central plant is circulated through the room coil to control room temperature.

The problem of changeover in the changeable UK climate was overcome by



The office blocks typical of the 1960s with their shoe box shape and repetitive interior layout, are distinctive, if unimaginative..... But it is not just aesthetics that make these buildings unsuitable for today's businesses. Their flaws go deeper.....It is now either economically unviable or practically impossible to adapt the services in these buildings to the standards required by modern commercial and financial sector companies — 'The Ageing Office' (Property Director, Autumn 1987).

Is it the stress and the strains of using older offices for tasks to which the buildings and its services are totally unsuited that is the cause of office work sickness?



the 'non-changeover' system, using chilled water all year around with the central air progressively reheated in cold weather. This solution was wasteful of energy and maintenance costs were high.

To overcome these criticisms the variable air volume (VAV) system was reintroduced with supply (and return) air volume being varied according to load. Under peak summer conditions the VAV systems generally worked well but at light loads, some of the earlier systems had problems. It is a feature of office buildings that the sensible cooling loads (due to heat from solar gains, outdoor temperature, people, lights and equipment) vary on both a daily and an annual basis, while the latent cooling load (due to moisture from occupants) remains substantially constant. The VAV system, varying air volume in response to temperature demands, also changes the system's capability to absorb moisture gains.

In many early systems the fresh air was not separately controlled. When the supply air volume was reduced to 20% of maximum so was the fresh air, irrespective of the fact that office occupancy was substantially constant throughout the year. This produced a lack of fresh air ventilation and in turn led to problems of humidity control, ineffective removal of odours and tobacco smoke, and difficulties with air distribution.

These problems were largely due to system designers not analysing part-load operation. Even today such analyses are often overlooked.

It may be significant that the early low velocity systems, the dual-duct systems and the induction-unit systems did not have this inherent problem with part-load humidity and fresh air control. This view, is to some extent, supported by the Building Use Studies Report (page 5) which notes that building sickness has

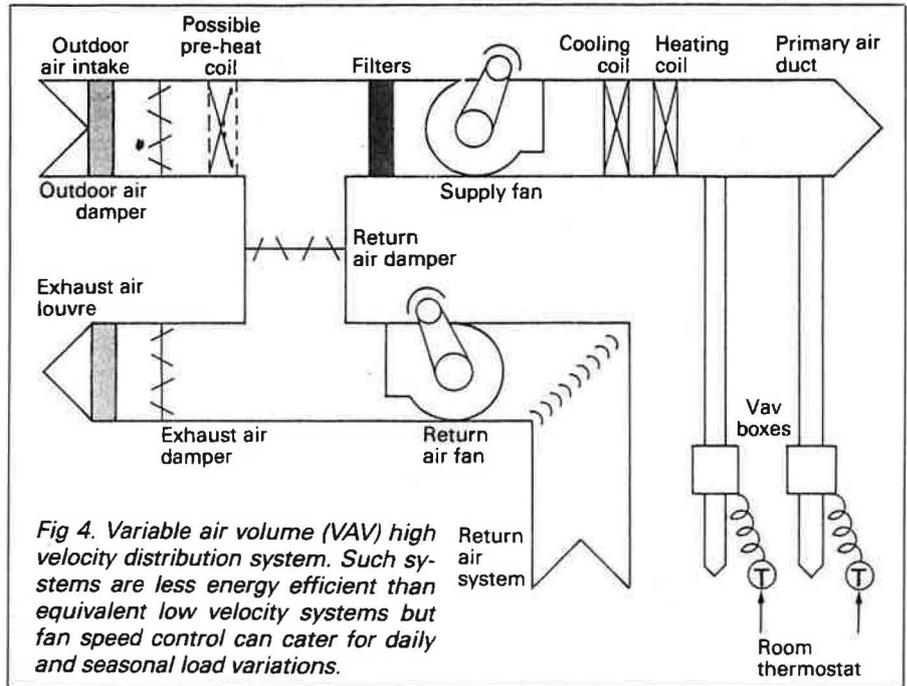


Fig 4. Variable air volume (VAV) high velocity distribution system. Such systems are less energy efficient than equivalent low velocity systems but fan speed control can cater for daily and seasonal load variations.

been reported in most West European countries, in the United States and in Canada, but not in Singapore, Hong Kong and the southern United States. In the former countries, part-load cooling and heating operation is usual, but in the latter the air conditioning operates on near maximum cooling throughout the year. It may also be noted that the four-pipe fan coil unit system, where a constant volume primary air system controls ventilation rate and relative humidity, is now being widely adopted for UK office block applications.

Some conclusions

Air conditioning has been successfully used in offices for over half a century without problems of office sickness. In the UK, during the past 20 years, office block design and use has changed considerably,

more so in the last five years with the introduction of the electronic office. People's expectations and changing attitudes, coupled with the stress of coping with new ways of working, has undoubtedly created some form of social reaction.

Financial pressures from developers and landlords, to minimise the capital and running costs of air conditioning, has not helped. Inadequate analyses of part-load operation of air conditioning systems at the design stage, coupled with poor standards of maintenance, appear to have compounded the problems. Fortunately, competent design and proper maintenance should be able to correct any complaints which may result from the air conditioning. That leaves the building, all the other mechanical and electrical services, and the people. Further studies may provide the answer.

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