

Air conditioning may have economic and health disadvantages, but it does provide protection against future change in functional requirements of buildings, says Professor Patrick O'Sullivan. It will continue to be essential in high density urban areas, but there will be many cases where there is no clear distinction as to the which mode of environmental control, natural or mechanical, should be adopted

Health and future prosperity

AIR CONDITIONED buildings have received considerable negative publicity as a result of their potential detrimental impact on health and comfort. The results of the Building Use Studies report in 1987 have been reported as showing that the majority of the unhealthy buildings, in its large sample, were air conditioned and that it was not unreasonable to conclude that there was something inherent in air conditioning that generated the symptoms. This was not however borne out in the following studies.

In 1994 the Welsh School of Architecture and the Bartlett, with financial support from the Science and Engineer-

ing Research Council and the Department of Trade and Industry, set out to determine what it was about hvac systems and their operation that accounted for the noted ill health of occupants in air conditioned office buildings. Nine buildings were selected for detailed monitoring from nearly one hundred offered for study. The buildings which were selected were considered either to represent good current practice and freedom from obvious design faults or offered the potential for important lessons for the future. All the buildings had been reported to the survey by the building owners as having potential health related problems.

The detailed study of each building

included an investigation into the following:

- a detailed examination of the hvac systems
- a survey of the occupants' utilisation of space
- monitoring of the workspace environmental conditions throughout the building over a period of at least one week in the summer and winter.
- a questionnaire survey of over 2,190 occupants and the completion of daily diaries to determine the occupants' health, comfort, detailed occupation and overall attitudes and behaviours at work.

The final report of the study concluded the following about the eight monitored buildings:

- The range of Building Sickness Scores encountered in the study suggest there is nothing inherently unhealthy about air conditioned buildings.

The age of the hvac system was not a major determinant of occupant health in the study buildings when properly maintained and controlled. However, poor maintenance of older systems was implicated in occupant ill health.

Simple zone by zone control systems in open plan buildings can be just as effective as sophisticated BMS controls. It was shown that where the central control is sufficient to maintain conditions in open plan areas the perceived lack of

The 12 screen Cineworld cinema in Stevenage is serviced by an integrated air conditioning and ventilation system installed by Kershaw Mechanical Services. The 37,000 sq ft building can seat up to 2,000 people



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control by individual occupants does not necessarily lead to high symptom reporting.

A higher level of knowledge and proactive management of the building facilities was a characteristic of the healthiest buildings monitored.

Hvac systems need to be designed to cope with high levels of cellularisation, frequent changes to the location of full height partitions, and the ability to give individual control within cellular spaces.

There is no single phenomenon that merits the term Sick Building Syndrome. Clusters of occupants within a building may be sick but it is not necessarily a building wide phenomenon. Therefore, interpreting local sickness data on a building wide basis may in fact substantially distort the overall health picture.

On average the building monitored had high internal temperatures and considerable variations in internal air velocities. Although perceived thermal conditions are frequently implicated in symptom reporting, the issues which promote symptom reporting can vary from building to building and from location to location within a building.

Women reported themselves significantly more unhealthy than men, as did smokers and allergy sufferers. They also took significantly more sick leave.

Workers who reported their jobs as being dull and repetitive or felt social isolation and unhappiness at work or performed self contained tasks independently of other workers reported a higher incidence of nasal related health symptoms such as runny nose, blocked nose, flu like symptoms, lethargy dry throats or headaches, than other occupants.

Some 70% of health complaints could not be attributed to the physical or organisational environment within the monitored building.

The measured pollutant levels both gaseous and particulate, including dust mite faeces, were within the levels recommended in international standards. Pollutant levels were not found to significantly correlate with health reporting and so pollutants did not appear to play a significant role in symptom generation.

Whilst some of the above conclusions may be true for all buildings it is important to realise that they are based on an assessment of a particular subset of buildings, i.e. 8 out of almost 100 offered as being sick. In particular buildings which had obvious flaws in their design e.g. air intake from a car park were exempt from the study.

Future environmental control

■ *The following potential disadvantages of full air conditioning have been well argued over the past ten years:*

They are expensive to operate and maintain. Energy costs in air conditioned buildings are typically double that of naturally ventilated buildings and the life-

Staff of the Royal Insurance company in Liverpool are benefitting from a Fujitsu air conditioning system with reverse heat pumps. Seventeen ASY30RSC wall-mounted units were installed by AMB Environmental Air Conditioning each to deliver 8kW of cooling and 8.8kW of heating

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time cost of maintenance and operation is greater than the initial capital costs of the hvac plant.

Comfort and health problems, associated with poorly maintained and operated air conditioned buildings can result in high levels of complaint in buildings where occupants feel powerless to control their own environment.

■ *There has, however, been less media coverage of the following potential advantages:*

Extensive protection against future change. For example air conditioning can provide: flexibility in allowable occupant density, flexibility in partitioning of buildings, flexibility to cope with global warming, flexibility to cope with what might happen to adjacent buildings.

Improved health and comfort particularly in urban sites polluted with noise

and poor air quality.

The future will see a blurring in the boundaries between different environmental control systems and also a less clear definition of when one particular design strategy should be adopted over another.

High density urban areas will undoubtedly carry on attracting air conditioned buildings and buildings in less dense rural locations will be naturally ventilated. The future will continue to see the design of high quality air conditioned and naturally ventilated buildings, but there will be many more opportunities for mixed mode ventilation strategies. There will however be an increasing number of design situations where it is unclear which strategy the designer should opt for. This may in fact be the typical rather than atypical situation. It is essential that mechanisms are put in place, both in the training and practice of building professionals, to deal with the uncertainty over strategy and future change.

**Professor O'Sullivan OBE is head of the Bartlett School and is dean of the Faculty of the Built Environment at University College, London.*

Win the space race

■ Fully integrated building design has hugely valuable implications for developers particularly in terms of usable space, according to Geoff Harwood, who is strongly in favour of a truly multi-disciplinary approach to extract maximum benefit from air conditioning.

Inevitably pressure on engineering design to compensate for cost or design driven extremes continues. Building services have freed building design from the normal pragmatic human restraints, allowing multistorey, high density spaces, but it was air conditioning which allowed deeper spaces and lower ceiling heights, extending the building depth beyond the limitations of window ventilation and minimising the reservoir of

▲ The Ecos mobile air conditioning unit from Rapid Heat & Building Equipment has a cooling capacity of 8,000 Btu/hr, and is designed for emergency and longer term needs

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space available for heat stratification. Soft insulating carpets and false ceilings compounded the situation. If there is, rightly, a tendency towards passive or mixed mode philosophies for building design they should not be regarded as simply another way to economise on capital costs, whilst retaining the very cost advantages of deep plan buildings and shallow spaces with the same soft insulation to floor and ceiling that were only allowed by full air conditioning. Basically, less air conditioning equals more expensive building envelopes and less efficient space planning with consequent effects on building value. These are functions of real integration. Too often, engineers are prepared to dodge such issues primarily to avoid aggravating the architect/client for fear of risking the next appointment with unpalatable truths.

The design of displacement cooling demonstrates this principle as it can be demonstrated that, as the system relies on stratification, by calculation it can be seen that there is a correlation between the amount of air necessary to cool the space and its height - the higher the building, the more stratification, the less air is needed to cool it, hence less plant and less distribution space, and the less it will cost in terms of engineering. It has to be recognised however that the building envelope will cost more in conse-



▲ The CA180 Compact is a slimline unit with a cooling capacity of 2.2kW. It is the latest addition to the Heatbusters range and is made by Rowenta

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quence.

The rationalisation and simplification of design elements into fewer by use of the multi-functionality of those elements gives scope for creative integration. Among early examples, was perhaps the combination of light fittings and extract grilles where not only were extract grilles avoided in the ceilings but we also had the simple spin-off of tracking the air out through the light fitting which conducted

significant heat from the room. A more dramatic example was demonstrated at Stanstead Airport where structural modules were designed to encapsulate the air conditioning distribution, the uplighting and much of the signage and information functions. Currently stretching most peoples' imagination is the integration of large grille terminals for displacement cooling with very little scope for concealment. The need to make them appear to serve other functions such as structure or furniture, is an interesting area.

The derivation of the cost plan should be based on the measured sketch designs and not elemental yardstick allocations that inhibit innovation or integration and perpetuate preconceptions discouraging financial redistribution when appropriate to the development of integration ideas.

Services engineers tend to have to validate decisions by capital or operating costs appraisals, whereas architects or designers seldom have to justify design decisions for enhanced appearance high cost components on the basis of payback. So there is a mismatch of logic through the team for budget allocation, aesthetic design decisions on quality for its own sake and engineering decisions on straight minimum capital cost or perhaps on payback.

The perennial integration issue of ser-

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A COOL WORKPLACE... AT A COOL COST

“Packaged plant can increase building value”

vices in buildings is their spatial impact. This is a strategic issue having architectural design, programme and cost implications. Architectural integration is clearly a blend of understanding of the design objectives, the future development objective and sheer creativity. Strategic sketch diagrams crystallise ideas and achieve appreciation to illicit contribution from the rest of the team.

Further considerations are planning constraints. Planning authorities have different policies for the treatment of plant rooms. The issue is the impact of plant and distribution space on the planning gross area on the site, such that if plant is counted as part of the planning area the, in effect, net area is lost and hence investment value of the site is lost. Some planning authorities however will make some exceptions.

Unusable

Planners are always concerned with space created that could be converted later to useable space, hence if plant is in a basement, i.e. the floor level is lower than 1.2 metres (Building Regulations) then such space is seen as unusable.

Open spaces with screened plant clearly can never be occupied and hence do not count against planning. Hence, for example, although packaged boiler rooms may carry a cost premium there would be a major gain in terms of building value if they were used.

e.g. In a 100,000 sq ft city building boiler plant space was measured as 75 sq m. The value of saving 75 sq m is about £800,000.

Whilst speculative buildings have clearly been seen primarily as financial assets more non-property corporate clients see them as balance sheet assets, having to obey the same investment rules as speculative buildings. Hence it is not only developers buildings that need to be treated as marketable developments. It is this aspect mainly that drives the critical assessment of service spatial allocation.

Clearly, while plant rooms and shaft space needs to be adequate for practical installation, servicing and future requirements, excessive allocation brings needless pressure on the overall cost plan and

is hence a sensitive integration issue.

In broad terms the value of a building is derived from the rent level and the 'yield', e.g. a 100,000 sq ft building in the city today would have a yield of about 5% and a rental level of about £50 per square foot, giving an investment value of about £100m. Hence, if the plant rooms and distribution space erodes the lettable space by 10% the effect on the building value is about £10m, i.e. every square foot used needlessly reduces the value of the building by £1000, i.e. if 10% of plant/distribution space could be saved then a £1m gain to the value of the building is achieved.

Of similar interest are the construction costs. Plant rooms probably cost about £40-£50 per sq ft to construct so in our example above services space costs would be some £450,000 premium to the project. Ceiling depths likewise are another example of objective cost premium considering the example above 100,000 sq ft building, for each 100m of depth over say 10 floors costs about £100,000.

The management of integration can be achieved by a multi-disciplinary design practice being organised on the principles of client centred project teams, situated in their own area of the office so that multi-disciplinary team members work alongside each other to reinforce constant communication and full team ownership of the project.

The architects and engineers act as a single group with a single point of contact and a single point of responsibility in the interests of the project. At the start of the project a project co-ordinator is nominated, as appropriate to the project, e.g.

- Office Building Architect
- Multi Storey Car Park
 Structural Engineer
- Process Building . Services Engineer
- Fit-Outs Interior Designer

This project co-ordinator is then totally responsible for every aspect of the project, including:

- Ensuring that everyone understands the objectives
- Deliverable Schedules
- Resource Requirements scheduling for all disciplines
- Strategic Design
- Design Progress Control
- Point of Contact and Leadership for all disciplines
- Mobilisation of staff
- Present project for design reviews
- Sign-off all documents and drawings for issue

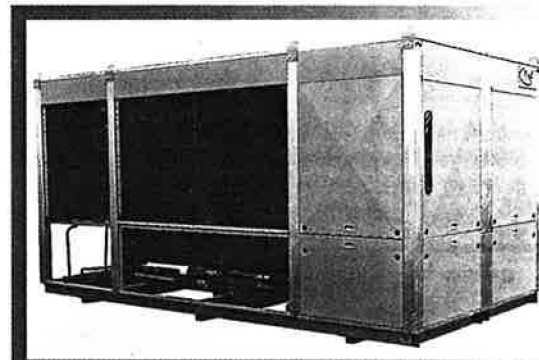
The computer system is totally networked so that disciplines always have access to the latest issues of drawings, specifications, reports and letters, within reason. It is not possible for people to

access out of date material

The very first concept sketches of projects are done as a multidisciplinary group so that idea contributions from all the disciplines involved are brought to bear at that critical stage with the objective to obviate future problem solving and minimise future co-ordination difficulties by strong integrated concepts.

Education

Architectural schools continue to include course elements on Environmental Science, (covering thermal, acoustics & light) and building services. Indeed, several schools combined whole year modules so that the architectural, structural and services engineers learnt together. Other schools arranged collaborations through different periods of their courses. Clearly there was an attempt to get students to understand the work of other disciplines, the success or otherwise of this approach may be questioned but the objective was clear. It is less clear why engineering courses have



A Debrae has introduced packaged liquid chillers which incorporate a water or air cooled condenser and screw compressors.

The new models incorporate features of a semi-hermetic compressor. The company also adds that the direct motor drive eliminates the need for gearing down so cutting out some motor cost.

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not seriously attempted to include a strong element of aesthetic design so that engineers can understand and anticipate the designer's objectives. As more enlightened companies concentrate on staff training, perhaps an oversight can be remedied with inter-company, architects and engineers, collaboration arrangements. Maybe with the knowledge and understanding, successful integration of building design will be achieved. ■

** Geoff Harwood is a board director of Aukett Associates. Both he and Prof. O'Sullivan were speaking at the 'Air Conditioning Ten Years On' conference organised by Mid Career College. The full proceedings from the conference are available from Mid Career College, PO Box 20, Cambridge. CB1 5DG*

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