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## **THE BUILDING SERVICES BRIEF FOR THE FUTURE**

by Bill Bordass, William Bordass Associates

### **1 Background (Slides 1 to 19)**

- 1.1 In the 1960s we learned that narrow offices with lightweight cladding did not suit everybody and got too hot. In the 1970s we learned that deep air-conditioned open offices were not always the panacea, and new forms began to evolve, particularly after the energy crisis. In the 1980s manufacturers told us proudly that their equipment could come out of the computer room and work in an office environment, but not that it might sometimes strangle it with cables, pollute it with heat and noise, and make some buildings rapidly obsolete. The 1980s have also seen more sophistication, more diversity, more tenant and occupant power, and a new vocabulary: words like shell-and-core, high-tech, smart, intelligent and sick, the latter - so it seems - particularly affecting the more controlled environments.
- 1.2 None of the reactions described above were anticipated at the start of the three decades, except perhaps by a few visionaries and heretics. So what should I say about the building services brief for the future? Two things are pretty certain:
- i In hindsight, all predictions will turn out to be wrong
  - ii There will be no single "perfect" solution.

#### SWITCH TO OHP

- 1.3 Five things seem extremely likely (**OHP 1**):
- i The use of information technology will continue to grow, making organisations more dynamic and affecting both the office and its building services.
  - ii Communications requirements will grow.
  - iii Office buildings themselves will need to be more adaptable, accommodating a diverse range of spaces, functions and work patterns, and with an increasing proportion of "office work" happening outside, for example in the home and on the move.
  - iv Managers and users will become better-informed and more critical, and will demand better-performing, more cost-effective, and more adaptable buildings and building services.
  - v Fuel consumption and running costs will come increasingly under the spotlight.
- What does this mean for building services (**OHP 2**)? Will recent technological developments be future imperatives or not? Will the high-tech, intelligent, flexible, highly-serviced building be market leader or dinosaur? Will microchips look after our every need and save us energy to boot? Or will the technology move faster than our ability to handle it, loosening the demons that once inhabited our bank statements to tinker with our creature comforts?

### **2 A strategic approach to office design**

- 2.1 At handover, buildings are not "complete" but launched into an uncertain future where requirements are now changing rapidly (**OHP 3**). If the buildings cease to fit they need to adapt: If they can't there's something wrong.
- 2.2 How do we tackle the problem? Frank Duffy encourages us to think in terms of shell, services and scenery and to keep parts with different lifespans physically separate. The shell may last the typical 60 years (who knows why this figure rules!), main services 10-30 (and falling), and scenery 1-10. Within the scenery the sets - the detailed equipment, furnishings and layouts - can change from day to day. Modern office construction costs are typically 40% shell, 40% services, 20% scenery, so cumulatively over the years the more rapid replacement cycle makes the costs of services and scenery much higher than the shell.
- 2.3 The more tightly-designed the building the faster it will become obsolete: it is the 1960s offices that are coming down. The 1980s has seen the growth in shell-and-core developments but not necessarily with a unified approach. In designing the shell and making provision for the services, the architect and the client need to make allowances for uncertain and unpredictable change (**OHP 4**). One should repeatedly ask "what if", compare options, plan for alteration and replacement of less permanent parts, and pay as much attention to the invisible (functionally and operationally-related) as to the visible (physical) parts of the design. Preferred design solutions should be robust against a range of alternative scenarios and uncertainties, avoiding undesirable features and including desirable ones.

2.4 Nutt (1988) has identified five approaches to high uncertainty (**OHP 5**):

- 1 Loose fit, deliberately imprecise in its response to the brief.
- 2 Indeterminacy. Avoid exact briefs, clear goals, single strategies.
- 3 Flexibility. But often this exists only on paper, accommodating only foreseen detailed changes, often in an over-elaborate manner.
- 4 Contingency planning, most commonly through built-in oversizing of space, structure and services.
- 5 Least commitment, an incremental approach which avoids taking decisions today which can be faced later.

The approaches overlap, but share a common theme of change: leaving some things to be resolved by others at the appropriate time. Some decisions, like the building's location, shape, orientation, thermal and loadbearing capacity are irreversible and must be good to start with. Others - such as control and management of building services - already have to cope dynamically with unpredictable changes in weather, occupancy etc.. We must now bring this thinking further upstream into the physical provision and its management. We require a statistical approach to the brief.

### 3 The enemies of a strategic approach (OHP 6)

- 3.1 Servicing is a difficult area because the range of provision has become so wide, with some activities having very modest needs and others packing in people, machines and cables. Not enough is known quantitatively, and people sometimes jump to conclusions about their requirements, rather than thinking them through.
- 3.2 Too many buildings now meet the paper requirements but not the functional ones: they have all the buzzwords: VAV, BMS, raised floors.... but do not actually deliver. For example, in a recently-completed building let to a computer company:
  - the air-conditioning could not cope with fairly modest local heat gains
  - floor, ceiling and window grids did not coincide, making sensible partitioning impossible without major change.
  - the open-top trunking had limited cable capacity and ludicrously small entries to the risers: raised floors had to be laid over it at the ends and new risers cut through the slabs.
- 3.3 In addition to the technical challenges, some established rules must change. All parties involved must think about buildings over their whole life, rather than different aspects being dealt with if not by different organisations with different interests than at best from different pockets.
- 3.4 For example, net lettable space excludes plant rooms and risers, so developers and their architects try to minimise "waste space", and this in turn restricts flexibility. But if one thinks of a building as plant rather than lettable area "occupiers might well prefer 10 good floors to 11 third rate ones". By moving to a concept of "gross lettable space", there might be more interchangeability between plant and occupied area. With a suitable strategic plan, organisations could have more or less plant, and plant space, to suit their individual requirements.

### 4 A strategic approach to office services

- 4.1 A strategic approach to services is illustrated schematically in **OHP 7**, which represents a section through part of a building. The slot up the middle represents one primary services distribution route: it could be for pipes, ducts, cables; it doesn't matter. Here it looks like an internal riser but the thinking applies equally to perimeter risers and to horizontal routes. A "nett lettable area" approach often leads to these things being stuffed into tight and inaccessible corners, linked through pinch points to plant areas and secondary distribution systems. The strategic approach doesn't necessarily ask for more space for services, but it does ask for space to be potentially available, for extensions or additions to risers, for more or less plant both centrally and locally, and for making connections. If servicing requirements are modest, the space allocated can contract; if intensive, it can expand: think of walls as pistons rather than bastions!
- 4.2 The approach has some interesting detailed implications. For instance, if a communications riser is sandwiched between the back of the WCs and a main corridor (as often happens), there is little room for manoeuvre. If it abuts a main office area, it is easy enough to add to it by enclosing additional space or by bringing in extra free-standing cabinets for distribution frames, patch panels, fibre-optic/copper interface units etc.. Similarly, if extra air-conditioning is required you can put the additional plant in strategic positions with access to the necessary services and/or the outside air. In all instances the strategic provision isn't "waste": if you don't need it for services now you can use it for something else.

- 4.3 Strategic thinking of course applies also to secondary distributions (usually horizontal on the floors) and tertiary (the final connections to the occupied space and workstations). For these, ideally, where change is anticipated, it should be possible to move, add, subtract or reconfigure outlets and terminals connected to the secondary systems without closing the systems, down, and as far as possible by unspecialised people using relocatable items with flexible connections and/or plugs and-sockets. This is of course already familiar for electrical systems, is on its way for communications systems, but is as yet in its infancy for HVAC systems.
- 4.4 Individual solutions developed using these principles should be tested against potentially worthwhile options for future growth and change. Once the building and systems are in use, the potential for growth and change should be kept under regular review to make sure that day-to-day revisions are maintaining, rather than blocking, any inherent flexibility. For instance, in one building we left empty riser space for future office air-conditioning, only to find it occupied by a duct then the client wanted to use it. It had been opportunistically used by one of the shops below, with the encouragement of the letting agent. Unfortunately, such problems are not uncommon with spare space for services, and illustrate the "Olympic Principle": the first there takes the most direct route!
- 4.5 Enough of strategy. I'll now move a bit closer to the nuts and bolts.

## 5 The nature of the building services problem

- 5.1 I expect the main problems for services in the 1990s to be (**OHP 8**):
- i more office automation and its consequences for power supplies, cable systems, heat removal, and the associated plant and horizontal and vertical distribution systems
  - ii an increasing diversity in use and the related services requirements
  - iii increasing user expectations of quality, economy and performance, including occupant comfort and energy efficiency
  - iv minimising the disruptiveness and cost of change
  - v minimising cost in use, including first cost and subsequent alteration, energy and maintenance costs.
- All this in an industry which is already very short of skilled manpower.
- 5.2 So where do we go? There is a lot of talk about the high-tech building, with air conditioning, unified computer controls, and an adaptive facade which reacts to the weather. The argument goes that because the technology is available one has to use it: air conditioning is essential because of equipment heat gains and user expectations, and the rest follows.
- 5.3 But does this stand up to examination? I am currently involved in a study of energy efficiency in offices for the Building Research Station, and am visiting a number of offices to serve as potential case studies.

SHOW SLIDES 20 - 29

**OHP 9** shows preliminary results (in kWh/sq ft nett per year) for seventeen buildings we have recently looked at (**discuss**), all of which are claimed to have low-energy features. **OHP 10** shows the same thing in money terms.

- 5.4 The general pattern is as follows:
- i Improved thermal insulation, better plant and controls gives the more modern buildings a modest heat requirement. Since heating energy typically costs less than one-third of full-rate electricity, heating costs in many offices are much less than electricity costs.
  - ii In air-conditioned buildings, fan power usually costs considerably more than refrigeration.
  - iii Computer suites have a major impact on energy consumption & costs.
  - iv The energy used by lighting is highly variable.
  - v The energy consumed by office equipment only just shows, and is on average much lower than the lighting load.

### 5.5 Overall, our findings to date suggest (**OHP 11**):

- Heat gains from office equipment are often lower than people expect, and at their present levels can often be dealt with by good envelope design and a combination of natural and mechanical ventilation. These findings are also supported by recent work by Jim Leary and others at the Electricity Council.
- Some sophisticated electronic control systems have been abandoned or downgraded owing to a lack of design, installation, operation & maintenance skills; others are not working properly or effectively
- Offices with complex adaptive systems don't necessarily use less energy than those with much simpler systems, and often cost more to operate and maintain.

So I don't think there is any need for an organisation to have any more technology than it wants and is happy with. Some firms may regard a high-tech solution as an excellent piece of advertising - and so it may be. But others do not have to emulate it unless they want to.

### 5.6 GENERAL PRINCIPLES (**OHP 12**):

- KISS: Use the simplest and most cost-effective technology which is appropriate for you and your organisation.
- Don't install more capacity than you really need (but don't box yourself into a corner either).
- Control what you've got effectively.
- Only then think about the bolt-on goodies.
- Don't overkill. Don't give yourself a maintenance or management burden out of proportion to the technical benefits.

## 6 Individual services

To be discussed below. But not much about controls, EMS and cables in order not to steal the other speakers' thunder.

## 7 Heating and hot water

Are heated and naturally-ventilated buildings obsolete? Discuss.

Heated-only buildings can be built to a wide range of insulation standards and heating systems. With good insulation, buildings tend to become sluggish in their thermal response as their thermal capacity becomes large in relation to their rate of heat loss. A greater proportion of the daily space heating energy consumption is then used in getting the building up to temperature before occupancy, especially if during the occupied period there are large internal heat gains from people, equipment, lights etc..

The Electricity Council now claims that if one builds to walls and floors 0.35, roof 0.25, windows 2.0, has well-controlled ventilation and infiltration, and protects from solar overheating it is possible to make a well-controlled electric heating system cost-effective in relation to wet systems. The proposed new building regs are 0.45 roofs, walls and floors, with a maximum of 35% single glazing. However, the majority of offices being built today are already double glazed. Night storage heaters are not required: simple electric panel heaters can be operated on the off-peak rate for preheating.

Additional temperature stability from exposed soffits.

Gas systems, condensing boilers etc.

Hot water - decentralise (can then also be submetered). Special requirements for restaurant kitchens.

## 8 Ventilation

Ventilation typically accounts for about half the overall heat loss from modern, well-insulated buildings. With current concerns about air quality and health, recommended quantities of outside air may well increase: heat recovery systems can allow this to happen without increasing running costs. More care will also need to be taken in the location of fresh air intakes. Mechanical ventilation can allow greater use to be made of the building's thermal capacity.

## 9 Lighting

In the past decade lamps have got smaller and more efficient, more light gets out of the fitting, lamp control gear is better, and new techniques such as uplighting have become available. Controls, both manual and electronic, have got better, and the problem of VDU screen visibility has caused more attention to be given to glare and a reduction in typical design service illuminance levels from around 1000 lux to under 500. The result is that while a typical office lighting system of the 1970s might have consumed 30-40 W/m<sup>2</sup>, these days it is more likely to be 10-20 W/m<sup>2</sup>. This not only reduces electrical consumption but also the associated heat gains, and there are many examples where air-conditioning systems and electrical supplies, struggling to meet the additional power supply and cooling requirements of new office equipment, have been given a new lease of life by programmes to improve the energy efficiency of the lighting.

The surprise from the case studies is that although one can find exemplary installations at 10 W/m<sup>2</sup> or less (**SLIDES 1 & 2 - PHH**) there are not very many of them: the majority of recent completions are still around twice this. And why do you need this much light in a corridor? (**SLIDE 3 - PSI**) So the first rule is to get the installed load down. If you can manage on 10 W/m<sup>2</sup> rather than 20 you have already halved your costs before you move on to a fancy lighting control system.

But controls need to be good too: gone are the days when a single contactor or a bank of switches by the door (if you were lucky; in some hidden position if not) would do, but too many offices still have them. There are lots of options, from the humble, user-friendly local light switch, to systems involving a combination of local and central control. When starting afresh, electronic controls may be more cost-effective than you think: for instance one developer recently claimed that, by saving the cost of switch drops, the remote infra-red controlled-lighting was cheaper than a conventional system. As controls get built into fittings as standard, costs will get lower still.

The golden rules for lighting controls

- Keep them reasonably simple.
- Use them to switch lights off, use people to switch lights on.
- Don't use them to excess: OFF in mid-morning OFF if daylight levels are good, at lunchtime, and shortly after the end of the normal working day will do.
- Retain some background pilot lighting at night.

Typical savings from daylight linking 25-30%, occupancy linking 10-30%.

## 10 Electronic office equipment

10.1 Electronic office equipment is the big scare, bringing cables, lighting demands, heat gains in its wake. The reaction has been more and deeper raised floors, and more and more air conditioning. Developers & clients bid up the internal gains: is it 30 W/m<sup>2</sup>, 60, 100, 200? And what does the figure measure: electrical supply capacity, total connected load, average power requirement, peak or the average air conditioning load, for an individual room or for the plant as a whole? Seldom does anybody tell you and never mind: the bigger the better!

10.2 And how are the figures reached? If not by guess, I suspect as follows:

- Select the most intensively-serviced area of office you can find.
- Add up the nameplate power consumptions of all office equipment.
- Add a bit for luck.
- Double it for future growth.
- Round up to the nearest convenient figure.

You often end up with an overestimate. The greatest reported to me to date was for a computer company, where the measured annual energy use by the office equipment was one-twentieth of what they had expected! Be warned. Nobody likes to be caught short but unnecessary extravagance also has its pitfalls. We need more precision, not only with regard to the average figure, but also to the range of variation and how it should be accommodated.

10.3 Of course things are changing rapidly, and we need to take account of it in our designs. But more facts are needed. Through measurements in a number of offices, Leary & Herridge of the Electricity Council have thrown some light on the subject of diversity factors. They find that a typical electrical maximum demand from office equipment is about 12 and is seldom more than 20 W/m<sup>2</sup>, rising to some 50-80 W/m<sup>2</sup> in dealing rooms, while many provincial offices run at as little as 2-3 W/m<sup>2</sup>. The typical air conditioning load is much less than this, as usually the maximum demand doesn't persist for very long and the thermal response of the building gives a buffering effect. But recent published statements by others would lead us to think that

- 10.4 Unfortunately, about these averages there are large local variations in individual rooms. It is therefore worth thinking of installing terminal units designed for a typical small power loading of 10-15 W/m<sup>2</sup>, but capable of easy upgrading to two or three times this. Alternatively, a primary system could be installed for the baseload cooling and ventilation requirements, and a secondary sensible cooling system installed in specialised areas at a later date. One possibility would be to have a VAV main system plus a water-based supplementary system (either fan coil or unitary heat pumps), with water available both at core positions and to perimeter terminal units.

## 11 Air conditioning and comfort cooling

So you really do need mechanical cooling: how can you get the best out of it? Note that many commercial air conditioning systems use more fan power than fridge power, so efficient cooling may save less than you expect. Possibilities:

- Keep the fan power down
- Zoning
- Free cooling - fresh air, strainercycle, airblast
- Efficient chilling
- Heat recovery: remember the simple measures!!
- Cool storage (common in USA), eg Cristopia. Peak pruning.

It is not economical to install VAV systems for large heat loads or 24-hour loads: wet systems should be used

## 12 Halfway houses (MULTIMODE & USE THERMAL CAPACITY FOR PASSIVE COOLING)

Some buildings can cope without full air conditioning, particularly if on quiet sites with normal occupancy patterns, as they can recover from heat inputs overnight and at weekends. Examples: Worcester, NFU. Buildings need not be permanently sealed: discuss merits of background mechanical ventilation plus openable windows.

The Electricity Council has recently been advocating a scheme where, using mechanical ventilation, well-insulated buildings can cope economically with a wider range of internal gain conditions using mechanical ventilation plus:

- i Heat recovery from exhaust air.
- ii Thermal storage of excess heat gains in the building mass.
- iii Off peak thermal storage in the building mass.

NB: CIBSE 2(a) allows credit for casual gains up to 10W/m<sup>2</sup> only, while 2(b) allows the lot.

El Cncl figures tested at intl gains (ex pp) of 5, 10 and 20 W/m<sup>2</sup>.

Value of thermal capacity, eg: 100 mm concrete internally insulated stores 2 Wh/m<sup>2</sup>K, externally insulated 50 Wh/m<sup>2</sup>K. Floor slabs major stores - useful if soffits exposed - otherwise can also put in heat via embedded ducts (Termodeck) for next morning's preheat - under microprocessor control (over 100 examples on mainland Europe). Ducts can also be used for night cooling or heat storage. Electric panels retained for local trim and draught protection.

## 13 Controls

## 14 Commissioning

## 15 Management

## 16 User reaction

Sick buildings. people are spending a lot longer than they used to in buildings and in controlled environments, and they are getting more critical. Although many sick buildings are just plain bad, or badly-maintained buildings, it also seems that people are increasingly sensitive to other environmental variables. But people's higher criteria are not currently matched by the industry's products, which seem to be getting increasingly agricultural.

## 17 Measure your energy!

**18 Cable distribution**

Need to see office buildings as plant: downtime is expensive! Need a proper IT infrastructure and a life cycle approach to cabling, otherwise very wasteful. Designing in redundancy can give fast payback times, when typical costs of cable moves £ 80- 800 a time, and many organisations have annual churn rates of 30-100%.

Cabling should be seen as a utility: need strategic thinking, not "don't worry, the user can sort it out". Leave enough space and redundancy: professional should stop client settling for too little. Think ahead and keep good records.

Increasing need for 3 power supplies: ordinary, clean, UPS. Keep communications risers separate from electrical risers. 2 risers/service for security?

Cable mess: computer companies like their own systems as it helps keep consumers captive; communications people looking for common system: ultimately they will win through as users are looking for compatibility. Forecasts suggest workstations will require 2-5 Mbaud by 1992; some products already allow 100 Mb.

Increased tendency to high speed fibre optic backbone and risers, plus copper runouts on floors, and also interfacing (FDDI: Fibre Distributed Data Interface - includes protocol converters) between lower-speed LANs. This will help give a future-proof building. Need physically flexible cables - floor boxes a bit of a nuisance, trailing cables better?

Cable chaos will probably increase for next five years, and then decrease as communications systems become more standardised. Uniform socket market already approx £ 10 m p.a..

Void spaces: for blue chips 150 mm clear, 350-500 mm if A/C.

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**SLIDE LIST**

- 1 BLANK
- 2 Euston Tower
- 3 Bristow-oven
- 4 Hoechst
- 5 WF&D
- 6 Hillingdon
- 7 Hillingdon plan
- 8 Oil wells
- 9 Save it
- 10 Welwyn Hatfield
- 11 Microchip
- 12 Cables
- 13 Fridge Plant
- 14 Boston-anything goes
- 15 Hearts of oak - obsolescent
- 16 Cooling towers
- 17 Bristow - people reactions
- 18 Chatham - fresh air
- 19 BLANK - Switch to OHPs 1 to 10
- 20 BRE LEO
- 21 Heslington Hall
- 22 PSI
- 23 PSI atrium
- 24 1 Finsbury Avenue
- 25 Briarclif House
- 26 Becket House
- 27 BLANK - Switch to OHPs 11 & 12
- 28 HEATING
- 29 BLANK
- 30 Old boilers
- 31 Econoflame
- 32 Modulares
- 33 Separate HWS
- 34 LIGHTING
- 35 BLANK
- 36 PSI -daylight
- 37 Bakers Court - sunlight
- 38 Improve lights or controls?
- 39 Reading
- 40 PHH
- 41 Silverlight
- 42 PHH dimmers
- 43 EQUIPMENT
- 44 Office equipment
- 45 BLANK
- 46 Computer rooms
- 47 BLANK
- 48 NFU Elevation
- 49 NFU model
- 50 NFU section
- 51 NFU office
- 52 NFU pool
- 53 BLANK
- 54 Keep it simple
- 55 Beware technology traps
- 56 Remember the people
- 57 Ask or it
- 58 BLANK