How Intelligent Should your Office be?

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1 Introduction

1.1 At office automation and computerisation advances, the office building is changing from a edifice into a piece of plant, and one which is constantly being re-configured. This creates additional requirements, different and more exacting standards and a new approach to the building's design, engineering and management.

1.2 As a technological solution, people are talking about "smart" and "intelligent" buildings. There is a lot of argument about definitions and some doubt whether any intelligent buildings yet exist. Today I do not wish to add to the semantic argument but will adopt David Lush of Ove Arup Partnership's definition (1987) of an intelligent building as a flexible and adaptable one, with:

- advanced communications networks,
- air conditioning,
- an electronic building management system, and
- a climatically-responsive facade.

1.3 I would now like to explore the potential and the actuality, the reality and the hype, in each of these. It seems to me that different organisations require - and feel comfortable with - different levels of technology and that over-reaching oneself can be just as damaging as falling-short of the business' needs. I hope this outline may help you to judge your own requirements

2 Advanced communication networks: the vision

2.1 An office contains a variety of systems, particularly:

i Office automation.
ii Telecommunications
iii Building services.
iv Security and alarm.
v Facilities management

2.2 Increasingly all these systems are becoming electronic networks which share the common features of computer systems: input, output, transmission, storage and processing. As technologies converge, elements can be shared. For example:

i Increasingly, devices are becoming multifunctional, and are told rather than made to do different tasks. For example, most of today's building energy management systems now run on standard PCs and we are now seeing the one-piece desk-top phone, fax, photocopier and answering machine: this already contains most of the components to become a computer scanner and laser printer as well.
ii A single communications network can potentially carry a wide range of information: voice, data, fire safety, security controls etc., etc..

2.3 One can therefore foresee standard information networks becoming as normal a building service as electrical distribution. Once the network is in place, it can be coupled-up to all sorts of electronic goodies: it can monitor and control the environment, allow the building to admit or reject daylight and sunlight, know where everybody is, warn us of danger and take the appropriate evasive action, keep tabs on furniture and equipment, draw office plans on demand: the list is endless. So if the building can collect, process and act on information, then presumably it could be called intelligent.

3 Advanced communication networks: the reality

3.1 The reality is somewhat more prosaic. American experience of offering speculative buildings complete with integrated communication networks has been disappointing: the tenants have usually wanted something different! The universal communication network is not yet with us and in many offices several different systems coexist. Although strong customer pressure is now creating rapid development towards unified standards, they are not quite with us yet.

3.2 So how far can (and should) we go today? Is full integration such a good idea until fail-safe standard communications are commonplace: one's new building could well be equipped with yesterdays technology on a grand scale! There is also quite a lot to be said for keeping business, telecommunications, building/facilities management, safety and security systems largely separate: they tend to be different areas of management and contractual responsibility, with fairly narrow areas of intercommunication. Physical segregation also limits the scope for disasters, for example relocating a telephone and inadvertently disconnecting the fire alarm re-setting the air-conditioning controls and corrupting a business file?

3.3 So for the time being I'm afraid the intelligent building will need facilities for a range of cable systems. The important thing is to identify the simplest and most flexible ways of meeting your needs, get on top of cable management, and have the ability to accommodate both long and short-term change. Cable congestion is likely to get worse before it gets better, but with luck things will start improving within the next five years.

4 Air conditioning: the vision

4.1 The received wisdom is that air-conditioning is essential: if not for prestige and as a defence against the external environment, then to cope with the high heat output from office equipment and to maintain comfortable conditions whatever is thrown at it.

5 Air conditioning: the reality

5.1 The reality is rather different: air-conditioning systems don't necessarily provide a satisfactory environment and happy staff, and there are growing concerns about environmental and health risks.

5.2 And how much heat does electronic office equipment really put out? Developers & clients bid up the internal gains: is it 30 W/m^2, 60, 100, 200? And how are the figures reached? Many people seem to read the labels on the back and double them for future growth. In fact, the labels indicate the maximum power drawn: in normal use consumption is frequently - but not always - much less (Leary & Herridge, 1987). The greatest discrepancy reported to me to date was for a computer company, where measured annual energy use by office equipment overall was one-twentieth of their design requirement!. On the other hand, we all have heard of instances where the design requirement was exceeded.

5.3 I have recently monitored a range of office equipment: power consumption overall averages about one-third of the nameplate value when they are on, but not everything is on all the time. Similar factors have recently been reported for some (but not all) dealing rooms, both here and in the USA (Kershaw, 1989). And although there will be future growth in the short term, later on saturation in numbers is likely to be reached while equipment continues to get more efficient

5.4 I am certainly not telling you to go away, divide your estimates by three and ditch your air-conditioning. But we do need a more intelligent and professional approach to defining the real requirements before grasping at a watts/sq ft figure, perhaps through short tests of the proposed equipment. By designing to a guesstimated average one can simultaneously end up with:

- central plant which is far too big
- insufficient local capacity to meet peak requirements
- inefficient operation out-of-hours, where the local tail of demand wags the central plant dog.

5.5 We have not yet come to terms with thinking probabilistically. While it would be expensive and probably unnecessary to provide services which can instantly cope with all foreseeable conditions anywhere in the building simultaneously, it would be intelligent to have one with the capacity to deal with the likely aggregate of requirements and to be easily reconfigured to suit changing local needs. For example, terminal units could be designed for 90 percentile power loadings, but capable of easy upgrading. Alternatively, a primary system (say VAV) could be installed for baseload cooling and ventilation requirements, and supplementary sensible cooling systems (say DX, fan coils or unit heat pumps) added where necessary.

5.6 People tend to think in terms of full air-conditioning versus natural ventilation. However, there is also a neglected middle way which may be appropriate on out-of-town sites and in quiet areas of cities (eg: pedestrian squares). These "mixed mode" buildings use a combination of natural and mechanical systems. Sectional forms tend to be of the traditional width of 40 to 50 feet, allowing more external perimeter(for light, air and view) and a combination of cellular and open offices though often with a courtyard (slide...), atrium or "street" plan to give compact internal circulation. Background mechanical ventilation provides the necessary minimum amount of fresh air, additional ventilation and cooling is available through openable windows, and mechanical cooling can be brought in when and where required. *Show slides of Hereford-Worcester, NFU, Refuge.* The lesson from these is that quality can be on a par with prestige air-conditioned buildings, occupant satisfaction is high, but capital and running costs are lower, and the use of mechanical cooling systems is often less than predicted.

6 Electronic building management: the vision

6.1 Electronic building management allows one to:

- Control plant more precisely and in an integrated manner.
- React rapidly to changing requirements.
- Optimise plant operation in order to reduce energy and maintenance costs.
- Monitor centrally, to be aware of problems and respond rapidly & appropriately.
- Collect and process facilities management information.

6.2 Building services controls are evolving from dedicated single-purpose devices to programmable multifunctional controllers (Slide....). Over the last decade, development has been rapid, starting with cumbersome central systems (slide..) via distributed systems (slide..) to networking systems (slide). Each advance has taken processing power closer to the individual item of plant, increasing whole system reliability and reducing wiring and commissioning costs, and we are entering a era of linked pocket-calculators rather than hand-configured mainframes. (discuss further).

6.3 The costs of conventional controls and building management controls are now similar, at least for the larger building, and we are now rapidly approaching the point where each item of plant - and perhaps each light fitting -will come with its own dedicated controller, which can either stand-alone, respond to local signals, or be linked into supervisory and command systems which will be able to gather information, adjust settings and optimise performance. This modular network approach can greatly simplify installation and commissioning, as each item of plant will be factory-commissioned to run "by the seat of its pants", and its performance can then be progressively upgraded on site by linking it in to the central system. However, we are not quite there yet owing to a lack of agreed communications standards.

6.4 Building management systems are also evolving from the prescriptive to the responsive: lighting can adapt automatically to occupancy and to prevailing natural light levels, ventilation systems in meeting rooms need operate only when the room is occupied, central plant need only operate when there is a local demand for it.

6.5 However, people usually know better than automatic systems when they require a service: what they are not good at is controlling it economically and switching it off afterwards. So, where possible, manual ON auto OFF is a good principle. For example, in a meeting room where traditional time controls ran the ventilation for 45 hours a week, monitored occupancy control reduced running times to 26 hours and "on-demand" push-buttons to three!

7 Electronic building management: the reality

7.1 In spite of all the potential, I have seen building management systems disconnected, under-used, or running wild. There are two main reasons for this:

i The electronic system has not been properly integrated into the overall management structure. It must be seen a management tool and not something which will somehow look after itself. Inappropriate staffing and divisions of responsibility between occupier and maintenance contractor can be problem areas.

ii The costs of operation and maintenance of the system are out of proportion to the benefits. It is easy to go over the top and provide facilities which it is not cost-effective to maintain, though things are becoming easier with modern systems where low level controls are given greater local autonomy, while central supervisory systems are becoming much more user-friendly.

7.2 So, as managers, think carefully about what you really need and how you are going to use it. Ultimately, the only justification for a building management system is to improves overall performance and efficiency and reduce overall costs.

8 Adaptive facades: the vision

8.1 Another part of the intelligent building vision is a facade that adapts to the climate: not in the conventional way of opening and closing windows, shutters and blinds, but by automatically changing its light and heat transmission characteristics, preferably using electronic systems with no moving parts.

9 Adaptive facades: the reality

9.1 Although some of the necessary technologies exist on a small scale, they are generally not available with the size, scale, durability and life span suitable for buildings, and certainly not at an acceptable cost, so for the time being we will have to put up with electromechanical systems.

9.2 But the degree to which electromechanical systems are desirable is also limited. Modern, well-insulated buildings with low-emissivity glass don't lose much heat anyway and so variable insulation would only be cost-effective if heating costs were to rise substantially. With a good modern office costing about 10 pence per sq ft nett to heat, and with say a ratio of window: floor area of say 20%, a halving in total heating costs (a generous estimate) with a 4 year payback criterion would only make available about £ 1/sq ft for a long-life maintenance-free device: not an awful lot

9.3 There may be more scope for saving on lighting and cooling costs with variable transmission and reflection glasses, though if experience with motorised blinds is anything to go by, many occupants dislike automatic control and prefer to make adjustments to suit their individual requirements.

10 Flexibility and adaptability: the vision

10.1 Ideally, one would like a building to be flexible enough to take everything one can throw at it without flinching. In actuality, there are lots of problems:

- One may be buying a lot of things one never uses.
- Unanticipated demands will always arise and undermine the system.
- Underutilised systems my well operate inefficiently.
- It will all cost too much.

So I would prefer to see a design with the flexibility to meet known short-term needs and the adaptability to accommodate longer-term change. The more tightly-designed the building the faster it will become obsolete: it is the 1960s offices that are coming down.

10.2 How do we crack this 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 - 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 life costs of services and scenery much higher than the shell.

10.3 Preferred design solutions should be robust against a range of alternative scenarios and uncertainties. Nutt (1988) has identified five overlapping approaches to deal with change and uncertainty **(OHP....)**:

1 Loose fit, A deliberately imprecise response to specified requirements.
2 Indeterminacy. A brief which deliberately avoids exact briefs, clear goals, single strategies.
3 Flexibility. But not one which only exists 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 share a common theme of leaving some things to be resolved by others at the appropriate time. But this is not a soft option: it means a more statistical approach to problem definition:

- Some decisions, like the building's location, shape, orientation, thermal and loadbearing capacity are irreversible and must be good and precise to start with.
- Others - such as control and management of building services - already have to cope dynamically with unpredictable changes in weather, occupancy etc., but are now subject to larger variations in internal requirements and pressures than before.

10.4 We must now bring this thinking further upstream into the physical provision and its management and 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 then at best from different pockets.

10.5 For example, net lettable space excludes plant rooms and risers, so one tries to minimise "waste space", in turn restricting 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.

11 A strategic approach to office services

11.1 A strategic approach to services is illustrated schematically in **OHP....**, 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!

11.2 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.

11.3 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.

11.4 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 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. When the client wanted to use it, it had been opportunistically filled with a duct from a shop below, installed with the encouragement of the client's 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!

12 Conclusions

12.1 So, returning to the checklist (OHP.....), I see the key feature of an intelligent building as an intelligent approach to flexibility and adaptability. On the technology side:

- Communication systems will become more integrated and while I would encourage you to ask for such integration, but be cautious of what is offered.
- Air conditioning may not always be essential for all purposes: think carefully about your requirements and get your architects and engineers to think equally carefully about the solution.
- Electronic building management is with us already, but make sure you get something that suits your system of management.
- Until the sealed building we always had adaptive facades, with openable windows and closable curtains and shutters. Many people would like to have these back, but the degree that they should be electronic and automated is debatable.

In conclusion, keep it all as simple as you can and make sure that you get the flexibility and adaptability you want, but don't pay for more equipment than you need.

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