Lansdown Window System

Review Note

IN CONFIDENCE

Building Use Studies

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Introduction
The purpose of this paper is to examine proposals for the Lansdown Window System (hereafter LWS) and to develop some of the ideas for discussion. It has been written by Adrian Leaman of Building Use Studies in response to a request by David Lloyd-Jones.

Preamble
Building Use Studies' research shows that :

- people place a high value on the ability to control personal comfort in their offices;
- people are more likely to tolerate greater discomfort in environments over which they have more personal control;
- people have strong preferences for seats next to windows.

These findings are counter to trends in office planning and design in the 1970s and 1980s because:

- control has been systematically taken away from people, especially in air-conditioned buildings;
- services engineers continue to assume that designing to achieve tighter comfort tolerance ranges is better, in spite of peoples' subjective reactions against this;
- offices have become deeper in plan form, thereby denying window seats to a higher proportion of the office population.

As lack of control is in part a function of deep plan and because it has been linked to ill-health, especially in the poorer-managed, air-conditioned buildings, the inevitable response has been:

- to provide more control;
- to make buildings shallower or, at least, to compensate for the effects of deep plan;
- to think again about windows.

The argument goes that if windows could also help provide more controllability, and bring the benefits (comfort as well as cost) of natural ventilation to deeper-plan spaces, then this would be better all-round. Versions of this argument have been also applied to many other building elements and technologies (such as underfloor air systems or locally-controlled air-conditioning). Many such make claim to be both more environmentally friendly and better for human productivity.

Evidence from recent Building Use Studies research points in other directions. Many buildings are breaking down functionally because their managers cannot cope with the consequences of increasing complexity. Complexity often has its source in unwitting and seemingly innocuous decisions about individual technological systems, single building elements, control devices or local space layouts. Many offices are a "tyranny of small decisions" in the sense that the net effects of many sub-systems interacting and often conflicting with each other can often lead to the overall breakdown of the larger system. Adding more control devices in a piecemeal way adds to this complexity, and makes the effects much worse, not better, as many hope.

Also, comfort, control, tolerance and complexity are not well understood either as topics in their own right or in the ways they interact. The study of comfort has remained primarily about individual responses to controlled, laboratory-type conditions (it does not cover group decision-making or subjective responses or behaviour under stress or in poor conditions, for instance). There is no significant literature on control in buildings outside the specialist area of process control engineering (much of which is hard to understand for non-engineers anyway). Complexity in buildings is recognised, but not measured or systematically studied. The understanding of people's tolerance is almost completely anecdotal. Thus any attempts to improve comfort conditions through changing controls and building elements are operating in an information void.

Figure One
Hierarchical levels in buildings and organizations
Source: *User and Automated Control and Management in Buildings, Building Use Studies for Building Research Establishment, unpublished, June 1992.*

This diagram is included to show the potential complexity of system hierarchies in office buildings. There are potential conflicts between any or all of the seven levels and their respective services, controls and occupancy functions.

Level	Scale	Building	Occupancy	Services	Controls
i	Lot	Site	Cluster	Site services	Site or network
ii	Building	Building complex	Organization	Building services	Building
iii	Sub unit	Individual block	Tenant	Central plant	Central controls
iv	Physical part	Floor	Tenant or department	Local plant / distribution	Zone controls
v	Functional part	Area	Department	Local plant / distribution	Area controls
vi	Group space	Space	Working group	Terminal equipment	Room controls
vii	Individual space	Workstation	Individual	Local equipment	Individual controls

Buildings themselves are complex systems. They operate as systems both *hierarchically* in space and *periodically* over time. This complexity of hierarchic levels can be judged from Figure One.

Complexity comes from the intrinsic richness of the functions and operations within each of the levels in the hierarchy (and over periods of time), the relationships between them, the relatively high levels of organization that are required to make them function properly and gluts and famines of use over time (where the building changes from being relatively crowded to empty). When asked-for functions begin to outstrip the systems' abilities to organize and maintain themselves, then failures result and crises develop. This is happening in modern offices. More and more, functions are being demanded (in the form of improved performance) without the capability being necessarily available to organize or manage them. It thus becomes imperative to understand the *management consequences of physical design decisions*, because otherwise the building will inevitably become unmanageably complex, and therefore more dysfunctional.

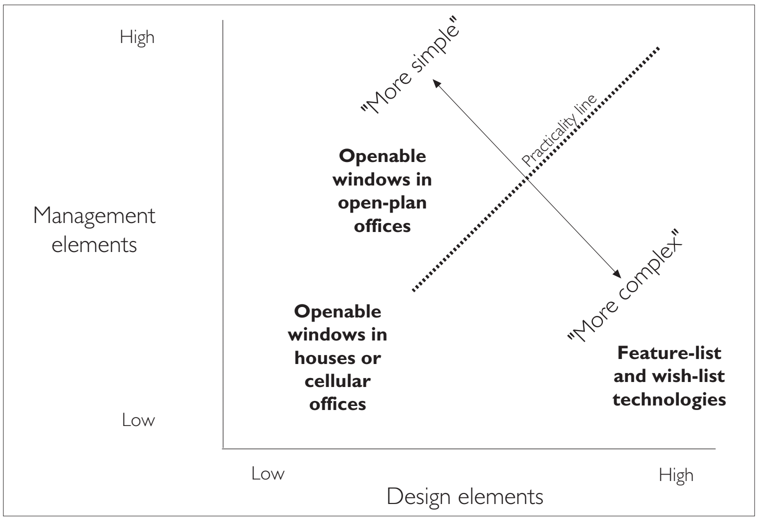

Figure Two
Simplicity and complexity in buildings
Source: Building Use Studies

The relationship between simplicity and complexity in buildings is to some extent counter-intuitive. The line shows the ideal relationship between design elements and management elements. Systems and technologies which are located close to the line will work efficiently and economically for the most part. As more and more design elements swamp management elements, systems appear to their users to be increasingly complex unless they are compensated for by more management or better knowledge. Conversely, systems appear over-simple if management elements outstrip design elements. For instance, an openable window located in a cellular office has relatively few design elements and relatively few management elements: hence it is close to the most practical relationship. The same window in an open-plan environment. carries a greater management "load" (it serves more people and is thus more likely not to work properly for everyone). As a result, in this conext it is more complex and seems less sophisticated, and can appear useful. Management then seek more sophistication, which can lead to feature-list thinking - that is, introducing many more design elements or "sophisticated" features without thinking through how they will work.

In general, perceived "complexity" in buildings is a symptom of design elements swamping management's ability to organize, understand or utilize the design. "Simplicity", on the other hand, is where management elements dominate design elements. A system which is too complex will have a relatively high number of design elements, with a relatively low number of management elements. A system which is too simple will have too few design elements in relation to the management input. Simplicity is often seen as a virtue in a designed object but as unsophisticated or naive in a management context. Also, designed objects tend to be assessed by absolute criteria which are often viewed independently of their working contexts, whereas management criteria are often relative and performance-based. This relationship between the context-free and context-dependent nature of designed objects is important in practice.

The relentless modern trend in offices is to add more and more technology to mitigate the consequences of complexity (like heat and larger floorplates). Technology, though, seems not to be achieving this. Offices are over-hot (increasingly so, temperature is normally at the top of the list of user's complaints in occupant surveys) and deep-plan forms are often associated with chronic occupant ill-health, as well as being much less energy-efficient. Creating offices which are comfortable *and* deep-plan *and* operate under local user control *and* avoid excessive use of air-conditioning *and* respond sensitively in a varied temperate climate is obstinately difficult to achieve.

The reason seems to be depth of space. As soon as a building goes deeper than the limits of natural cross-ventilation (which means that it gets gloomier as well as hotter and stuffier in the middle) the loss of natural light, outside awareness and fresh air cannot be fully compensated for by mechanical or artificial means. Depth of space, though, could be a spurious cause because, as buildings get deeper, the relationships between their control functions and their human activities also become much more complex. Improving the "fit" between control and human activities by a better-designed and managed controls environment may be just as beneficial as decreasing the depth. But going deeper involves irretrievable loss of amenity (less natural light and views out, for instance), and occupants who can be *less* tolerant of comfort failures in artificially-controlled, deep environments, so they tend to complain more, *even if the measurable conditions have actually improved*.

For these reasons it is probably only worth trying to design a window which extends the limits of natural ventilation by a metre or two (as the LWS seems to do) if *none* of the other amenity variables (such as views out and controllability) are affected. I doubt whether this is practically possible. It is better to concentrate on solving the main problem - offices which overheat - by designing a window which overcomes management and practical obstacles to summertime, night-time cooling, and retains as many of the other "traditional" window virtues as possible.

Following the criteria developed above, this means developing a window which is as *manageable as possible*, delivering *rapid response* across *all* hierarchic levels (not simply for individuals) and which is *ultra-sensitive* to changing occupancy and climatic conditions.

Windows

Windows are a good example of a context-dependent building element which are now being designed and specified as if they are context-free (that is, they are chosen out of catalogues). Occupants expect that windows should be controllable, give views out, allow available daylight in most of the time and thus keep down the demand for artificial light, give fast, if not instantaneous, response to personal comfort requests for fresh air or cooling, look good, and give weather-proofing and thermal and acoustic performance of a high standard. All of these, except perhaps the aesthetic one, are context-dependent: some greatly so. There are also few other technologies (of any type) which have to offer so many functions, many of which potentially clash with each other as the context changes (like the need to keep daytime traffic noise out but allow fresh air in).

The first requirement of any kind of modular window system must therefore be the ability to fine-tune it for the context: that is, *improve its context-dependency*. The context will have two main forms: first, physical, and, secondly, behavioural. Almost invariably, the physical will receive most of the attention; the second hardly any.

Switching and control behaviour

The basic reason why people use switches and controls is to alter the state of their environment from an existing state to a new state that they perceive to be improved, more comfortable, and/or more functional. They usually do this is response to random, external events - like the sudden noise of a pneumatic drill or police siren in the street, or a change from sunlight to gloom - or more predictable events, like twilight. They are likely to make the decision to use the switch or control only after the event has prompted them to do so (rather than in advance of it), and they will often overcompensate for its effect (like completely closing all the windows in a railway carriage when it rains to keep out a few spots of rain, in spite of creating a much hotter and more humid environment for everyone inside). People use controls and switches to alleviate obvious discomfort (Too dark? Switch the lights on. Too glary? Pull the blinds down. Too hot? Open the window). They tend not to behave by optimizing comfort requirements with energy efficiency, nor anticipating change for the worse.

Having made the decision to switch, people will often as not leave the system in the switched state, rather than alter it back again later. This tendency to take the ON decision, but ignore the

OFF, means that many buildings adopt inertial states in which their systems are left enabled or running unnecessarily. Not only is this inefficient for energy consumption, but it is also often quickly degrades the comfort conditions. These inefficient and uncomfortable inertial states usually occur in open-plan environments where it is frequently difficult or tedious for people to arrive at OFF decisions because of the complexity of the decision-making processes involved.

The normal inertial state for windows in office buildings is CLOSED. At night-time, all windows will be locked shut by the security staff or the cleaners. They will usually remain closed until altered by occupants during the day. In many open-plan office spaces, the opening of even a single window may cause conflict - either because of genuine differences in comfort needs between people, or because of disagreements whose origins may be outside environmental controls, but which spill over and affect their use (often irrationally so, and sometimes bewildering so to the outside observer).

Ideally, a window is required which is openable on demand during the day as normal, but with an upper part which may also be automatically or manually opened during the evening or night to satisfy cooling demands. This element should adjust or shut again when the cooling requirement has been met, so that the building is not left too cool (as can happen when windows are opened overnight in hot weather and conditions change for the worse during the night). In this way, cooling through cross-ventilation is carried out when occupants are not normally present, and it is not critical that air-movement may be high and cross-flow noticeable. The "night-time" element could be an upper hopper and the day-time element a vertical sash, as with the LWS, or, perhaps better, it could be a motorised upper sash (for automatic night-time use) with a local over-ride control for day-time adjustment and perhaps also an alternative manual option for day-time as well.

The closer the device is to the general occupant, the easier it should be to understand, the more straightforward the technology involved, and the more robust its construction and controls. It is imperative that the control devices used must give direct and unambiguous feedback. The device should *plead* with the occupant to be used, rather than put people off. Thus sliding sashes, for instance, especially upper ones, must be easily reachable (especially for women), and have no tendency to trap fingers, damage nails or leave dirt on the hands (all of which discourage subsequent use).

Sash windows are admirable for users because:

- they allow a wide range of adjustment, from a tiny crack to half open;
- people understand what they are for, how to use them and how they work;
- users can monitor their state and performance easily (you can see that they are open from a distance);
- they give instant, perceivable responses and feedback;
- they are relatively easy (but not the best) to clean and maintain;
- they can be combined straightforwardly with many other internal and external control blinds and devices for solar and glare control;
- they fit the vertical plane of the building;
- they have many glazing options;
- they can be fitted with supplementary controls for sun and glare.

Drawbacks are often greater for the designer and specifier than the users. They include:

- perceived higher maintenance costs, especially for wooden systems;
- inefficient mechanisms, making windows difficult to open, in aluminium systems;
- higher cost.

Lansdown Window System

Given the considerations set out above, the present LWS sets out to solve too many problems - noise reduction and increased depth of space on top of everything else, and it is not really clear what problem is being addressed. Although the noise baffles and louvres and light shelves seem to be optional components, they have more prominence and give the window its novel character. The important feature - the upper window element for summertime overnight cooling - appears much less prominently.

Given the existing proposal, my preference is that the system should have the following characteristics.:

- There should be two major elements only - upper and lower sashes - because this is simpler.
- The lower sash should be the major "daytime" component- that is it would be adjusted by occupants frequently on demand

mostly for localised fresh air - because this is how people normally use them.

- The upper sash should be the major "night-time" component - with the capability to be either motorised or manually-operated or, preferably, both, rather like a motor-car sunroof. This would be adjusted by occupants on demand during the day, and operate under automatic, semi-automatic or manual control during the night (and other unoccupied periods). Given that the windows are restrained while open, this will be relatively secure, especially if only the upper part is open. The system could also be calibrated locally so that some areas are more fully ventilated and/or cooled than others.

- Refinements for control of solar gain, glare and noise should not be part of the system itself (these are often difficult to solve with one universal technology, they are highly localised, especially affecting the people who do not sit directly next to the window, but are affected by it by glare and draught, for example).

- The system should be compatible with standard security and cleaning procedures, because these are the people who often set the state of the building for subsequent daytime operation.

- The system should allow window-opening under automatic BEMs-type control to operate in response to outside conditions. Automatic opening and closing should normally happen when the building is unoccupied.

- All automatic operations should be capable of being over-ridden locally.

- The system should encourage habitual behaviours with occupants. For instance, on a hot summer's night occupants should expect that upper windows will be relatively wide open and in a cooling mode. They will expect to close the windows thereafter. On cool summer nights the windows may be in a ventilating mode, and occupants will expect to open windows progressively during the day.

- The window system should set a spring/summer/autumn inertial state which is partially or fully OPEN.

- This system must be designed so that it does not conflict with the use and operation of blinds, which will be used increasingly commonly in office buildings.

- The inertial night-time state of the blinds - internal or external - should be UP

- The system should be designed to encourage a change in habitual behaviours of occupants, so that default settings *always* favour the optimum use of outside conditions. This means that the *defaults will be context-dependent,* and change from one set of circumstances to another. These defaults will differ according to the complexity of the control technology on the skin of the building. For instance, on buildings with external solar blinds, the default settings on a sunny, windy day in summer will be external blinds UP, internal blinds partially DOWN (depending on orientation, contrast and internal illuminance levels), windows partially OPEN with blinds DOWN (for fresh air) and fully OPEN with blinds UP (for cooling).

- Some of the window devices and blinds could also be interlocked in the manner of railway points and signals, so that at least two upper windows may be simultaneously fully OPEN for cross-ventilation at certain periods during the day in hot weather conditions.