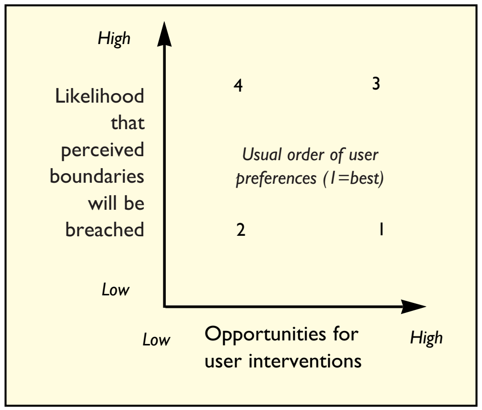
Usability in buildings: introduction

Ideally any building should be safe, comfortable and healthy. Other attributes like usability and fitness for purpose are also vital for excellence in overall performance. All are easily recognisable by occupants when they are absent, and usually taken for granted when present. People are soon aware if conditions become unsafe, uncomfortable or unhealthy, or if what they are doing is being thwarted by, eg, poorly functioning technology.

From the user/occupant's perspective, what happens when such boundaries are "crossed" is a vital part of their experience of buildings. People want conditions to be "good enough" more often than "just right". If not, they like plenty of opportunities to correct things in their favour. However, they do not want relatively trivial decisions and actions constantly intruding on what they are supposed to be doing, so there is a balance to be achieved between appropriate physical conditions (which need to be acceptable to them most of the time) and interventions when things need to be changed (which should be timely and effective).

This applies to user's perceptions of their comfort, health and safety, and to everyday use of technology. In general, the more people are forced to intervene to try to make things better for themselves, the less likely they are to perform tasks to their full satisfaction, capability and effectiveness. But if people cannot intervene to change things to their liking, they like it even less (see box, right)!



With buildings, users normally prefer:

1. situations where boundary conditions are breached only occasionally, so that there is a predictable "normal" or "default" state which they can utilise habitually, often as in the "background" to what they are actually doing;

2. opportunities to act quickly to make corrections or interventions if default states or boundary conditions alter;

3. the ability for individuals to carry out whatever they want to do quickly and effectively.

Usability is the satisfactory combination of all three to meet given functional objectives. However, usability is normally associated more with 3. than with 1. and 2. because more attention is given to how tasks and/or technologies are carried out in given, prescribed or assumed contexts.. That is, people tend to concentrate more on the functionality of the thing itself, rather than how it behaves in relation to its background.

People are adept at understanding their own contexts, but very poor at communicating context to others. For example, if people have a problem operating their computer, they often expect whoever they turn to for help to instantly understand what they are trying to do and the context of the problem they are working on without them needing to explain it - it is obvious to them.

Most tools and technologies are developed to be used in contexts which are relatively well-defined (eg cookers used in kitchens, bread knives on bread boards etc) and it is usually clear from the technology itself, or the instructions, in what circumstances they should be used. Objects have "affordances" - chairs are obviously for sitting on, knobs are for turning - which give strong clues for use. Affordances are reinforced by physical, cultural, semantic and logical constraints. Together constraints and affordances are exploited by designers to help improve usability.

Most published work on usability deals with level 3, rather than 1 or 2. This applies particularly to:

- human-computer interface usability and software design, for which there is an extensive literature [eg. References 1,2];

- the work of Donald Norman on the use of everyday objects [References 3.4].

Published work is most useful in dealing with the design and use of everyday objects, including software. It usually ignores things in the bigger contextual frame of the building designer. These are tackled at an introductory level in the next section: *Usability in buildings: contextual factors.*

For buildings, orders of priority are:

1. ***background* default states and boundary conditions must be appropriate for the task/s;**

2. ***rapid corrections* (manual or automatic) must adjust unwanted effects of changes to default states or boundary conditions;**

3. ***transparency of actions* so that people can carry out tasks effectively.**

[1] WINOGRAD T. (ed), Bringing Design to Software, New York: ACM press, 1996

[2] NIELSEN, J, Usability Engineering, Academic Press, 1993

[3] NORMAN, Donald A, The Psychology of Everyday Things, New York: Basic Books, 1988

[4] NORMAN Donald A., The Invisible Computer, MIT Press, 1998

Boundary conditions and defaults

Usability in buildings has three major components, of which default states and boundary conditions are one, and the most important

Usability is not just a question of how well a tool or technology works to help users achieve what they are trying to do. Just as important - often more so in buildings - is how the particular technology interacts with the context in which it is used. Three "levels" are relevant:

Level 1. The "background" itself, with the boundary conditions and default states in operation at any particular time.

Level 2. Corrections or changes, predictable or otherwise, to 1.

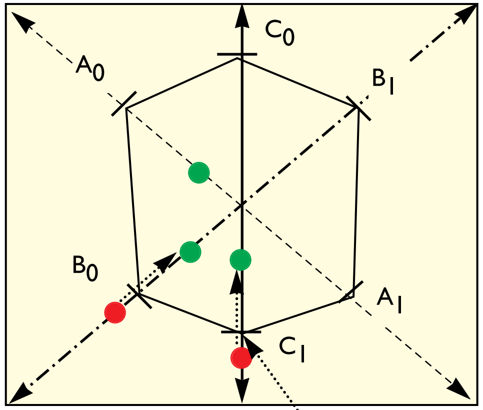
Level 3. How well a given technology performs as a means towards the end required by the user, given the context and working dynamics of 1 and 2.

Level 1: Background

The background has:

- *boundary conditions* (Figures 1-3), within which users and occupants may work comfortably and safely - these are defined by upper and lower tolerance thresholds of temperature, luminance, noise, ventilation, attributes such as cleanliness, and a host of other factors such as eg slipperiness of floor surfaces, ergonomics, etc;
- *default states* (Figure 4) of activity settings, such as normal day-time use, changeover in mornings and evenings, and night-time patterns. Weekly, monthly, seasonal and organisational (eg year end) variations all contribute, as do changing activities.

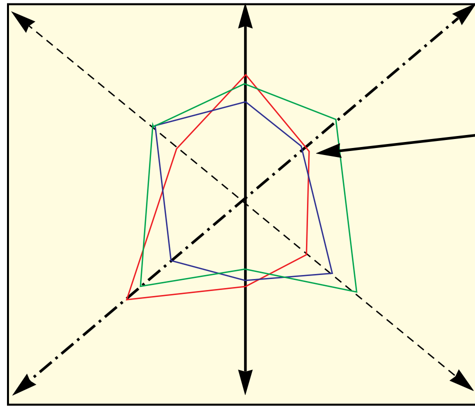
Figure 1



Individuals will usually be comfortable, satisfied, healthy etc if their experience of conditions remain within the bands of upper (eg A_1) and lower (eg A_0) tolerance of eg temperature, relative humidity, lighting levels, noise levels etc.

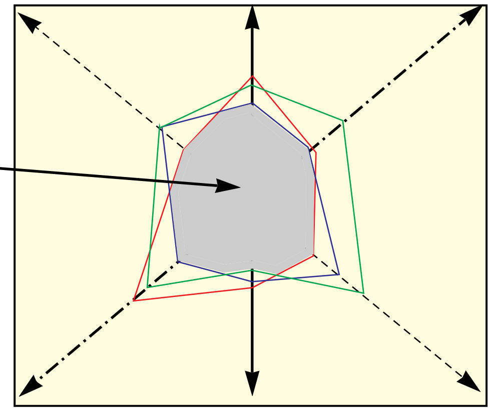
If experience of conditions exceeds a threshold for a particular variable (red dot C_0-C_1, people will usually try to improve conditions for themselves (ie either by trying to move the system across the boundary towards the green dot by intervening with eg controls, or trying to change their limits of tolerance by eg trade-offs or compromises).

Figure 2



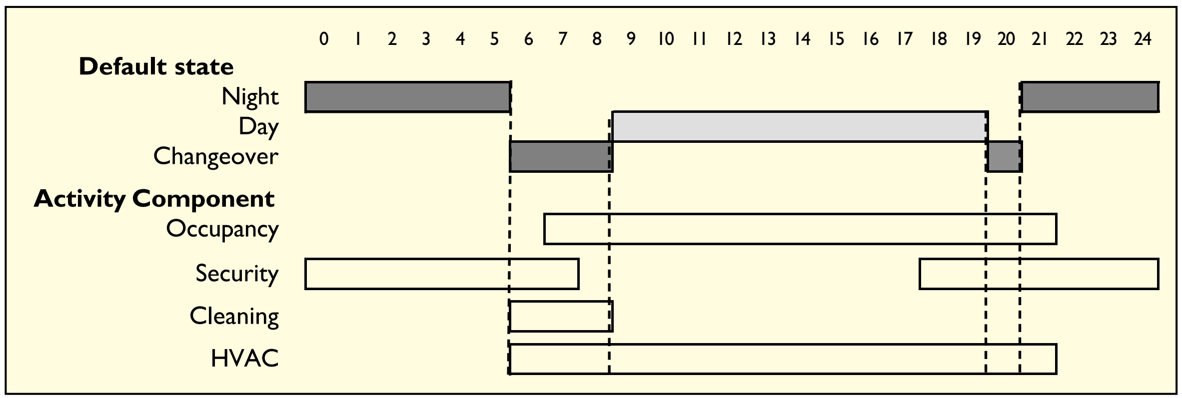
Boundaries differ between individuals and individuals' own thresholds change with circumstances.

Figure 3



Given individual requirements in changing circumstances, in theory there will be a common set of conditions (shaded area, right) which will satisfy everyone. Designers often concentrate their efforts on this area. However, real situations are much more complex with many more ruling factors, so often there is no definable zone of satisfaction. As complexity increases, the likelihood of achieving satisfactory zones diminishes, so alleviation or compensation strategies become more important than just provision.

Figure 4



Over a 24-hour period, buildings change default states (dashed vertical lines). In this oversimplified example, there are four default states (night, day and changeover 1 and changeover 2) and four activity components (occupancy etc). Note the potential complexity of changeover states, especially with a larger number of activity components.

Changing conditions and states

Given that buildings always have default states and boundary conditions, successful usability depends on anticipating how these work in reality. Yet many designers :

- make unrealistic assumptions, usually by oversimplifying use patterns;
- concentrate too much on *provision* (of eg comfort and safety within performance "envelopes") at the expense of *alleviation* (eg giving users strategies for coping with discomfort when things become uncomfortable);
- underestimate effects of additional complexity over and above design intent (eg resulting from higher-than-planned occupant densities or changed space layouts), so that it becomes even harder to achieve optimum or even satisfactory outcomes;
- do not fully account for out-of-range differences between people, needs, activities and uses, preferring to design to norms or averages, or within regulatory limits;
- do not second-guess or risk-assess consequences of unusual or rare events unless obvious risks are involved (eg fire or structural safety will be thought about but excess capacities probably won't).

For building users, greatest frustration arises when they are:

- prevented from intervening to change physical settings from an undesirable existing state to a preferred new one;
- subjected to arbitrary changes in conditions which they perceive and are affected by but cannot themselves over-ride ;
- working in an unfamiliar setting which may require intervention to make things habitable or comfortable (eg in the evening or at weekends when the heating is switched off);
- required to act quickly and/or in stressful circumstances, eg in an emergency;
- unable to achieve speedy or effective response from other people who may control settings which affect them (eg facilities management contractors running the building management system);
- are prevented from making trade-offs of their own choosing between lesser evils (eg in the summer, preferring to block out external noise in the morning and let the building heat up, but open the windows in the afternoon and be disturbed by noise from outside).

Most of these are connected with the way systems move from one default state to the next - failing to properly take into account the needs of the user in the process, or from arbitrary changes in boundary conditions and the way automatic systems, users or managers can intervene to correct things.

Default state changeovers
Buildings tend to be designed to operate in only one default state - their normal daytime use. Operation of eg HVAC automatic control and cleaning then tends to be built around a standard occupancy pattern eg 08:00 - 18:00. During this period, major office services, eg helpdesk, reception, vending, stationery and IT support, will usually be operational. Occupancy patterns, however, are now less clearcut, especially in offices, with longer operating hours, flexitime, more part-time and contract staff and less predictability in eg lunch breaks. To this can now be added (although less common), shared desks, teleworking and other space and time-saving strategies. What was once a fixed temporal cycle of use (eg with everyone leaving the building between 17:30 and 18:00) has now become more diffuse (eg with fewer staff at their desks at any one time and with more people in the building in the evening and at weekends). Although this may present greater operational flexibility, it introduces new usability and manageability dysfunctions. For example, staff working in the evenings, at night and at weekends often expect "normal" levels of servicing for eg vending, car parking and personal security, as well as fully operational computers, telephones and office service like fax and photocopiers. For staff working at night, new requirements arise for environmental control - eg they may perceive themselves to be colder as blood sugar levels decline during the night, and also may want less ambient light than normal daytime settings. If they have no control over heating/cooling/lighting levels and the vending/restaurant services are not operating at that time of night, then they will be adversely affected.

Changes in boundary conditions
If conditions move outside preferred parameters of comfort, health and safety people will usually try to do something about it, either by changing things if they can (eg using lighting controls, or adjusting settings on equipment) or modifying their normal behaviour (eg staying at home in icy or foggy weather, going home early in a building they perceive to be unhealthy or avoiding places perceived to be unsafe). Everyday behaviour is often habitual, with people using tried-and-tested routines. Habit is one way of coping with the complexity of life, more so in the modern world and especially for people with very active lives. Even though people are habit -driven they still like to perceive that they are in control, or at least think they are part of a control loop or involved in any decision-making which affects them. Whenever an intervention is required they like it to be as simple and with as little fuss and interruption as possible. Thus anything other than straightforward actions, quickly carried out, will usually be ignored (people may try it once). Anything which involves effort or skill (eg any kind of programming with telephones, computers, videos etc) will usually be abandoned by all but the most persevering or technically-minded.

User needs

Given how buildings work, there should be:

- clearly defined operating modes, the base rules for which are understood by all classes of users, with unambiguous changeovers from one period to the next;
- potential for rapid response to any type of change in default or boundary conditions.

With these in the "background", needs of building users can then be addressed. There are two main considerations:

1. usability;
2. side-effects.

Technologies which are best liked by users tend to "invite" them to share the problem and help them participate creatively in solutions without a sense of alienation or making them look silly. Details work so well that they are not normally noticed by the user. They become, as Schon has said, "invisible" to them. They will have unobtrusive cues about which user actions will be appropriate, and guide people quickly through the most appropriate courses of action. In many cases, user actions will be nearly obvious or intuitive, as with doors and door handles, light switches, taps, and control knobs on cookers, radios and televisions, for instance.

With many of these devices, a de facto standard has arisen, sometimes with a "natural" mapping of the control action onto the physical layout, eg door knobs turn left and/or right with pull or push; taps turn anticlockwise for on, clockwise for off with hot tap on the left of the basin; light switches toggle up for off, down for on; volume controls turn clockwise to increase volume; low settings are to the left, high to the right, etc.

However, as Donald Norman shows in *The Design of Everyday Things,* familiar conventions and mappings are tending to disappear, so things can be more confusing to use eg taps and showers, as conventions change from device to device; light switches, as later devices supersede familiar toggle switches, and newer controls, such as thermostats, imply one function (ie volume control via a dial) and deliver another (altering temperature set points) thus offering potential for confusion and misuse.

Can intended user behaviour be achieved in practice? A device should:

- be easy to understand and preferably intuitively obvious without undue recourse to instructions;
- be easy to use, otherwise people may take an easier or more convenient route;
- operate and be effective as close to the point of need as possible, which may vary with time and the user;
- work effectively, with sufficient fine control to give the required level of adjustment;
- give immediate tangible feedback (eg a click) to indicate to the user that the device has operated;
- give immediate feedback to show that the intended effect has occurred;
- take into account that facilities may be used only occasionally, so that people may forget basic actions (eg phone diversion).

Often, features triumph over functions because point of sale considerations (eg proliferation of features) trump usability issues. This leads to products - notably some computer software - which have many more functions than any normal user ever requires (eg Microsoft Word version 8 has over 1300 functions). A further consequence is software "bloat" - programs which are much larger than strictly necessary.

In buildings, usability issues do not only apply to individuals operating devices, but the consequences and side effects of some of these operations. These include;

- noise (eg keyboard, telephone and computer operations);
- misuse and breakdown (eg attempted remedial action on photocopiers by untrained staff);
- tampering and vandalism (eg often the result of frustration because the intended effect cannot be achieved eg door entry systems)