The role of feedback in building design 1980–2018 and onwards

Article

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Review Paper

The role of feedback in building design 1980–2018 and onwards

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Abstract

This is a paper updating the paper I wrote on this topic for BSERT in issue 1 volume 1 in 1980. The original paper set out the causes of failure in building design as being due to various issues such as an inadequate brief, lack of data, poor communication, inadequate analysis or synthesis, quirks of human behaviour which could all contribute. Systematic appraisal – now referred to as post-occupancy evaluation – of buildings in use provides feedback which helps us to understand why theory and practice do not always agree and also gives evidence for improved building economics. It concluded that we have to involve users more in the design of buildings, and for the next generations, we need a much broader based education of building designers. This paper continues the theme by considering the latest methods of measurement and assessment which provide feedback data for sustainability but focusing more on health and wellbeing rating assessments.

Practical application: Our professions need more interaction across sectors and to foster a transdisciplinary approach. This means more communication with other professional kinsmen from the health and wellbeing sectors in order to make valuable interventions in the building design process. This paper updates the 1980 paper from the first edition of BSER&T that sets out the causes of failure in building design as being due to various issues such as an inadequate brief, lack of data, poor communication, inadequate analysis or synthesis, quirks of human behaviour which could all contribute. The paper determines that the need for feedback in order to improve building performance and provide data to develop existing guidelines, codes and standards is as valid now as it was in 1980 but the way we do this has changed.

Keywords

Building health, occupant feedback, post-occupancy evaluation

Introduction: The need for building appraisal

Today the life process of a building begins with the need for a space for living or working in and proceeds through design, construction and commissioning stages usually ending with maintenance throughout the life of the building. At each of these stages, iterative thinking and decision-making patterns follow the pathways usually described by analysis, or understanding the problem, synthesis, or producing a design solution and evaluation or performance appraisal of the solution. Evaluation provides a feedback link to the next analysis stage and may be carried out by using modelling, measurement or other techniques. Consider how the analysis stage begins. Data are amassed from the earliest client and building design team meetings, from standards and from previous experience. A young person may have little experience, an older person may have much experience but even within the same company experience too often remains isolated and personal so that similar problems and errors may continue simultaneously and successively within the same company.

The life process of a building involves five stages in its metamorphosis: design, construction, commissioning, appraisal in use and facilities management. Feedback is thus a systemised

learning process which fills gaps in existing knowledge besides updating it. It is essential because styles, preferences and human behaviour patterns change with time. Every building tells a story; all have some good, some bad features.

If a building design fails, four possibilities exist:

(a) the designers used the wrong criteria and these have been achieved in practice;

(b) the designers have used no criteria;

(c) the designers have used the correct criteria, but these have not been achieved in practice;

(d) the building structure and environmental services are incompatible so that no acceptable design criteria exist.

This last possibility is of great importance. Building structures enclose a chunk of space and create a natural background environment within it; the building has been referred to by some as a climatic moderator, although recent work by the Hong Kong architect James Law involves cybertecture in which digital devices are embedded in the structure, thus making the structure a communication channel also. By considering passive features like orientation, insulation, building mass and building form, this natural environment may produce acceptable working conditions.

However, this natural environment may have to be modified even further by the use of environmental services, so that it provides a suitable milieu for people to work in throughout all nature's seasons. If the building structure allows inside conditions to lag for only a short time behind external ones, then the environmental systems should be designed so that thermal energy can be quickly released or absorbed to or from the space. If these sort of considerations are not made at the outset of a design, then it is only good fortune which allows any design criteria to be satisfied for limited periods of time.

The causes of failure in building design are various and may each or all contribute as follows:
. an inadequate brief and specification;
. a genuine lack of data on certain aspects;
. poor communication between the client and the design team, and between the members of the design team themselves;
. inadequate analysis or synthesis of solutions;
. unpredictable quirks of human behaviour by users;
. poor selection of equipment, inadequate installation or facilities management.

Systematic appraisal of buildings or post occupancy evaluation (POE) in use can help to:

(a) establish if the design criteria have been achieved in practice and if not, why not?

(b) establish the validity of the existing criteria;

(c) establish criteria where none exist;

(d) account for unpredictable interactions that occur between physical and sociopsychological factors;

(e) establish the rank order of the various facets of environmental design in various building types;

(f) relate design criteria to work performance;

(g) classify user experience for future design;

(h) classify running cost data for buildings, environmental and utility services and thus help to remove the disastrous consequences of building design decisions being based on capital cost considerations alone.

The expansion of the building design team to include the human scientist

This need was stated in 1980 but is now recommended in the British Council for Offices (BCO) Report on Wellness Matters. **1,2** Buildings are for people so we need to understand how the environment affects health, wellbeing and ultimately human performance. Feedback gained from appraisal plays an important role to help us understand the human responses to the environment and this is now recognised as Stage 7 in the RIBA Plan of Work. **3** This then means better briefs can evolve. The Soft Landings Framework **4** is based on having a coherent feedback system in place for better briefing, design, handover and building performance in use.

There are two fundamental reasons why this appraisal role should be taken on by a human scientist, such as an ergonomist or a building psychologist. Firstly, appraisal involves assessing the subjective responses of people and correlating them with the physical parameters of the building design. And secondly, this process is carried out when the building has been used for at least six months to a year; it needs a neutral assessment by someone skilled in making this assessment rather than someone who practises design or construction and has a vested interest in the building. Some may be apprehensive about introducing another specialist in to the building design team, but the human scientist would simplify a lot of the problems because we have been working in ignorance for quite a few years regarding the place of the human being in the systems we are providing in buildings.

Since 1980, there are further reasons for using human scientists at intervention stages in the process of design. Health and wellbeing data are now prolific as measurement methods have advanced using wearable technology for example. So, intervention by health and wellbeing specialists can ensure the latest proven data are being used. Questionnaire design has become more refined too. The culture in 1980 was more about making workplaces functional and comfortable, but now they need to be much more than that by being expressive and providing flourishing environments in which people thrive. Users want to be able to express their views and improve conditions as we realise that the physical and social environments as well as management and the job itself all contribute to motivation.

Too often in society some product or some effect is only judged to have failed, or to be harmful, if sufficient complaints are received about them, but complaints are unreliable indicators of the degree of dissatisfaction because the process of complaining takes time and sometimes money. Certain individuals will express their complaints but most will not, and in some cases cannot. The process of complaining is often complicated although central and regional consumer groups since 1980 are well established. In the case of a building, unless

there is a structural failure, there is no focal point for complaints, and inaction is often the order of the day. The whole matter is complicated by only hazy notions of who is actually responsible for what. Too often it is assumed that people will adapt to almost any situation however unsatisfactory it may be. The truth is that one may attune to a given set of conditions in spite of the increased physiological or psychological stress they may impose on the human system especially when there is no alternative. Human scientists, human engineers or human technologists have for too long been excluded from the building design process.

Methods of measurement and assessment of human performance

We need to distinguish between methods which essentially deal with human performance as distinct from building performance. Well-known rating systems like BREEAM, LEED, Nabers, Green Star deal with the latter and were primarily intended for energy assessments but include some reference to health and wellbeing. The main focus of this paper is people, so I will concentrate here on methods which assess human performance.

To assess if the design has been successful, various POEs can be used, but they need to consider the impact of the environment on economic performance in terms of days absent, presenteeism, medical conditions and self-assessed productivity besides personal data from wearable sensors worn by occupants and who may be willing to share some of these data in order to provide feedback to aid understanding and help to detect weak links between people and their environmental setting which could if acted on lead to improvements in building performance. Now with the use of wearable sensors, we can assess the physiological state of people. **5** Together with questionnaires and sometimes interviews, we can obtain a complete picture of how the environment affects the state of being of a person at any one place in time. This is a major advancement since 1980 and continues to evolve. **16**

The Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) originated in the Warwick University Medical School and is one of the POE methods that has been used in the UK. The shortened form of WEMWBS is a good way to find out about feelings and thoughts in different environmental settings which can act as a background indicator to see if the environment is a contributory factor to negative or positive wellbeing. **6, 16**

Other methods include BUS – which was used in the Probe studies – and the Leesman Index. BUS relies more on satisfaction scales. The Leesman Index is derived from a massive data bank collected online and indicates the priorities that people attribute to a wide range of working conditions not all specifically to do with the physical environment.

Currently, the WELL version 2 launched in 2018 is now beginning to be used in the UK but could undergo modifications as most POE approaches do and other rating approaches can be used like Fitwel and Flourish which are all described in the BCO Report Wellness Matters.

Technology has led us in more recent times into numerate assessments of situations and yet verbal language is, and will probably remain so, the principal mode of people expressing their ideas and thoughts either to themselves or in communication with others. People communicate mainly by written or spoken words. Verbal descriptions greatly aid the understanding of human behaviour patterns and may be obtained by indirect or direct observation of people, the use of structured or unstructured views and, or questionnaires. These are common tools in the social sciences.

Skilled interviewers can assess the appropriate verbal dimensions for particular user–building relationships by informal discussion and noting the key adjectival phrases spoken by the user; this requires a minimum intrusion of the personality of the interviewer upon the subject. Having assessed the verbal dimensions and their elements, there remains the problem of quantifying the information. Words often have different grades of meaning from person to person; besides, judgements vary from time to time so that any analytical approach must allow for this range of variations in space-time. Semantic differential scales like hot–cold or sad–happy allow different grades of meaning to be judged on a continuum.

In any one dimension, several semantic differentials will be used and so judgement range variations tend to cancel out. The results are then derived from the data using statistical techniques, such as principal component analysis. There will be regions of overlap between the verbal dimensions, e.g. a differential like gloomy-bright may form an element in the verbal dimension of pleasantness and also that of friendliness; this is useful in evaluating the importance of environmental interactions on judgements.

Questionnaires require careful preparation, and it is important to refer to the work in occupational psychology and social science. They must be easily understood by the subject, non-ambiguous and not elicit unfelt responses from the subject. Physical features in the environment enhance the expectancy of first impressions; a distinction should be made between opinions stated which are based on first impressions and those based on long-term experience. Extreme judgements may also occur due to contrast when different stimuli are viewed sequentially, i.e. the pleasure of an agreeable experience is heightened if preceded by a disagreeable one. It is useful to include an open question to let subjects cover any relevant aspect not on the questionnaire.

In order to investigate the building–user relationship, the following questions need to be answered: Have the design criteria been met? Are the operating costs as predicted? Are the energy demand patterns as predicted? Are the environmental services satisfactory? Are the utility services satisfactory? Are there any significant changes in productivity, staff turnover, absenteeism or presenteeism? Are there any distinctive features in the social or organisational environment?

There are then questions about the physical environment which can be measured with a range of familiar instrumentation. Physical measurements of properties are needed concerning the energy sources, energy distribution (e.g. fluid velocity, pressure distributions, duct/pipe surface temperatures, fluid temperature), the occupancy space (e.g. indoor air quality, air and globe temperatures, air velocity patterns, relative humidity sound levels, lighting levels) and the external environment (e.g. dry-bulb temperature, wet-bulb temperature, external sound levels, lighting conditions). Sufficient readings are needed to show daily and seasonal variations.

Now with the use of wearable sensors, we can assess the physiological state of people. Together with questionnaires, this means we can get a complete picture of how the environment is affecting the state of being of the person at any one place in time. This is a major advancement since the 1980s.

Metrics

The World Green Building Council (WGBC) Report 2014 **7** in respect of offices suggests:

. Economic metrics covering absenteeism, staff turnover and retention, medical costs, medical and physical complaints, revenue breakdown;
. Perceptual – feelings assessed by self-reported attitudes via questionnaires, interviews;
. Physical design and operation by direct environmental measurements and also measuring people's physiological responses using various forms of wearable sensor technology.
The UK Green Building Council (UKGBC) Report 2018 **8** describes a Retail Metrics Framework which is based on the:
. Environment – lighting, air quality, thermal factors, sound, layout look and feel, inclusive design, biophilia, amenities and community space.
. Experience of employers and customers as they perceive them.

. Economics – the costs to the employers like absenteeism and presenteeism as in WGBC 2014 and value issues like the sales, dwell time, return customers.

Such frameworks let clients and designers check the real issues using authoritative sources and encourage an integrated visionary approach. They also encourage the users to be involved and collect data using various evolving technologies and environmental mapping approaches which will help to improve and understand how design needs to move forward for harnessing a healthy wellbeing culture in architecture.

McGraw Hill Construction (2014) Report 'The Drive to Toward Healthier Buildings' **9** states that Metric and Benefits for Healthier Buildings in ranked order as judged by owners and managing directors of companies are:

. Self-assessed productivity
. Lower absenteeism
. Reduced healthcare costs
. Improved employee satisfaction
. Improved employee engagement
. Improved ability to attract new talent.

Self-assessed productivity and satisfaction can be measured using subjective scales like the BUS surveys **10** as done by Leaman and Bordass, but the other factors can show quantitative data. The Leesman Index **11** is another satisfaction survey approach but over a very broad range of priority issues based on online surveys. In time, we will advance the metrics and measures, for example by the increased use of wearables (embedded wireless sensors in clothing or accessories) and more comprehensive feedback will lead to enhanced POE.

Sivunen et al. **12** state that building owners and tenants can financially benefit from sustainability and improved indoor environmental quality via:

. Reduced life-cycle costs
. Extended building and equipment life span
. Longer tenant occupancy and lease renewals
. Reduced churn costs
. Reduced insurance costs
. Reduced liability risks
. Brand value

In practice, investors, developers and clients often agree that sustainable healthy buildings are desirable but want quantified economic evidence to persuade them to finance such projects. This is also now true of the health and wellbeing debate. Social awareness is changing about the need for sustainable buildings which are healthy and promote wellbeing. The US Green Building Council published a report in 2003 entitled Making the Business Case for High Performance Green Buildings **13** and some of the conclusions included:

. higher capital costs are recoverable in a comparatively short time
. integrated design lowers operating costs
. better buildings equate to better employee productivity
. new appropriate technologies may enhance health and wellbeing
. healthier buildings can reduce liability
. tenants' costs can be significantly reduced
. property value will increase
. communities will notice your efforts
. using best practices yields more predictable results, but remember that occupancy behaviour affects the performance
. respect the landscape and open space near the building.

From the Reports by the UKGBC on offices, retail and homes we can derive eight main feedback metrics:

. Absenteeism and presenteeism rates
. Staff retention rates
. Revenue breakdown
. Medical costs
. Medical complaints
. User feedback
. Physical complaints
. Perception of conditions determined by a survey

Interactive architecture and the environment

Digital and built environments combine to offer personal interaction in the workplace setting. As embedded sensory technology develops and its benefits realised, personalisation is set to remain and the connectivity of building occupants with their surroundings will intensify. Wearable sensors are likely to be part of a personalisation family together with various Apps and forms of augmented reality. Sensors can be embedded into clothing, accessories; attached in the form of a thin film to the skin. Sensors can be embedded in the body even but more practically in surrounding objects and structures.

Wearable devices are being developed beyond health monitoring into everyday practicalities such as paying bills. Fitbits can monitor steps and stairs walked; besides, they also have calorie inputs and outputs which can be refined with a sugar App for example. These applications can encourage attention to improving fitness and nourishment regimes. **5** Physiological measures include heart rate, blood pressure, cortisol and glucose levels, brain waves, respiratory rates and muscle tension.

Advantages of wearables

Increased awareness of health and fitness.
Learn how one's body and mind respond in various conditions.
Online data connect with doctor so save appointment times.
Early diagnosis, so help prevention better than cure.
Devices can be integrated into clothing as well as wristbands and other accessories.
Weak spots in the office environment can be detected.

Disadvantages of wearables

Privacy – see Data sharing section More data and information, so need big data analytic solutions
Market open to gimmicks
Like computers and smart phones, devices need regular updating

Data sharing

There are choices.

No data sharing
Selective data sharing – for example, share one's health data with your doctor
Open data sharing – for example wearable air quality monitors provide valuable data helping towards establishing improved air quality and everyone gains making this a case of sharing for the common good.

Conclusions

The need for feedback in order to improve building performance and provide data to develop existing guidelines, codes and standards is as valid now as it was in 1980, but the way we do this has changed. Measurement, methods, questionnaire design, metrics for design have become more detailed, refined and sophisticated. Above all, we see the priority now given to health and wellbeing across society as we move from a comfort objective of 1980 towards designing for flourishing environments in which people thrive mentally, socially as well as physically.

In 2017, the UK and their construction industry experienced the pain of the Grenfell tragedy and 72 people lost their lives. How could this happen in this century? We have to question the way we do things. It is likely that there were fault lines at every stage of decision making. In her book, the Silo effect **14** Gillian Tett describes the conclusion about the fire in the Bronx area of New York that took place in 2011 in which three people died. A principal cause was found to be the Silo effect that happens when different departments and agencies do not communicate with each other. This paralyses the connectivity and flow of information.

The environment affects our physical, mental and social wellbeing. This is a holistic notion and needs to be dealt with in that way. Society has to change to recognise this and to find an interpretation of what is required; regulations and law do not provide complete answers.

The evolving frameworks like WELL and Flourish described in Wellness Matters are examples of fruitful avenues to consider and suggest a more user centric design approach.

Further, we need to use a transdisciplinary approach. The great biologist EO Wilson in his book, The Origins of Creativity **15** published in 2017, when he was 95, argues we should bring the social sciences, the arts and natural sciences closer together if we really want to enrich our understanding.

This leads to another thought namely the industry needs a much broader based education to generate creative building designers. Sir Ove Arup read philosophy for his first degree and yet his reputation is in architectural engineering. **8**

If we still go on and educate ourselves basically as engineers and architects, instead of perhaps as people concerned with building design which must involve human beings, then it seems that we are divorcing the real reason of building design, which is to design for people, from the technical and economic issues that abound in our work.

Our professions need more interaction across sectors and to foster a transdisciplinary approach. This means more communication with other professional kinsmen from the health and wellbeing sectors in order to make valuable interventions in the building design process.

Field testing and commissioning too often show that many products do not provide the specified performance when installed. Many of the British Standards tests are inadequate firstly because they do not take into account human factors, and secondly the tests are often for elements alone rather than elements within a total system.

Changes in society at all levels are indeed if we are not going to continue to bathe in our own ignorance and that foisted upon us by politicians which can mislead institutions along false short-term avenues. A capital cost-only economy is false because in the long term, energy is wasted, materials are wasted, and human resources are wasted; in the short-term, human needs are sacrificed for short term financial gains. We need to nurture a value-driven outlook.

The BCO itself is a transdisciplinary body and their report on Wellness Matters espouses many of the beliefs expressed in these conclusions. The intelligent collection and use of feedback can help us to unlock the corroded beliefs of the past but leaving the golden values that can help to drive architecture and engineering onwards along more humanistic pathways together with valuable interventions by health and wellbeing specialists so that we are always aware of the latest state of knowledge.

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