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Sensorial Design – A Collaborative Approach for Architects and Engineers

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Abstract. STUDENT PAPER: ***Post occupancy evaluations (POEs), allow the design team to see how well the initial design objectives have succeeded when in use. Current POE procedures gather data relating to its sustainability. They were largely developed throughout the sixties and seventies by academics and engineers [1] resulting in a legacy for POE procedures to focus on the technical performance of the materials and components. In this paper we propose the engineer has the skills to contribute even more to the aesthetics of a building design.***

Architects are naturally keen to know how the fabric and components of their designs are performing technically. Quantifiable data is often sought through collaboration with the design engineer, often using electronic devices to record performance data. There is limited input from occupants. Feedback on a building's 'aesthetics' remains scant, often focussing on the visual appearance of a building design and by reviewing an occupant's visceral response; commonly known as the 'wow factor'.

The first author has significant experience in the design of schools in South Wales, receiving the Eisteddfod Gold Medal Award for Architecture for a new school in South Wales on behalf of his employers in 2017. He has had many informal consultations with occupants who will reveal their sense of architectural delight by referring to their five common senses: sight, sound, smell, taste, and touch. Survival instincts have evolved these senses to respond to changes, resulting in the occupants' innate ability to sense changes in the built environment irrespective of how small the changes are. Architects and engineers can design for these changes and evaluate them post completion.

A mixed methodology is recommended for gathering data and knowledge from post occupancy evaluations, making the outcomes of more appealing to more readers, including the inhabitants.

Keywords: Architecture, Phenomenology, POE, Qualitative and Quantitative Methodologies, Sensory Response, Social Value and Wellbeing.

1 Introduction

This paper is the third publication by the same authors. In their previous papers [2] and [3] the authors established a context for multisensory design in architecture. This paper focusses on engineering design. Whilst the architect will remain the overall design lead, there are opportunities for the engineer to weave some sensory experiences into the overall architectural and spatial experience. The objective is to increase the experiential delight of new buildings, leading to an increase in the occupants' enjoyment and to the building's greater longevity in use.

As part of his professional doctorate studies, the first author proposes a paradigm shift in the evaluation methods of his employer's Post Occupancy Evaluation (POE) procedure. The proposed change will mean that completed schemes can be evaluated more from an *architectural design concept* position. He will be looking for feedback on the quality of spaces rather than the performance of components and materials. The journey, so far, has resulted in changing his research question from looking at the final stage of a design project to looking at the changes required to the initial stages of a design: the *design brief*. His research question still proposes a change in how POE is gathered, but it now encourages evaluations to take place after sufficient time for the initial visceral response to subside. The occupants can then reveal, through informal consultations, how they have settled into their new environment.

Meaningful evaluations require changes to the brief so that equal weighting is given to the aesthetic design of spaces, including various *design interventions* for the senses. Each '*sensory intervention'* can then be reviewed throughout the design development stages, ensuring they remain intact throughout the construction period. Post occupancy evaluation will then have a meaningful set of reference points to discuss and evaluate with the occupants when the building has been in use for some time. The objective will be to gather some phenomenological feedback to reinforce the engineered performance of the building's fabric and components.

In the first author's experience, design engineers *of all disciplines* enjoy the sense of good design. He is confident that engineers welcome the opportunity to contribute more to the experiential quality (the architectural delight) of a building. Good engineering design will inevitably influence the occupant's sensory experience, and their responses will be expressed with reference to their own sensory abilities. As lead designers, architects are encouraged to whole design team to incorporate some *sensory design interventions.* Engineering designs should contribute to the overall sensory experience when the building is in use.

The aesthetics of a building are not just visual. Consciously or otherwise, a new building will prompt occupants to respond with comments that rely on to their *common senses* of sight, sound, touch smell and taste. Nina Ricca [4] has argued the psychological benefits of good design and how it can influence the occupant's behaviour, health, and wellbeing through the reduction of stress, blood pressure, depression, and anxiety. There is a social value in this process and so there are good

reasons to encourage the *whole* design team to contribute to the fine-tuning of the overall designed experience.

Nicholson, N. (1989) has argued there is a clear evolutionary basis for many psychological and physiological human responses to building designs [5]. Most human beings are effectively 'hardwired' to their survival instincts. They are always alert to sensorial change; the senses often being fatigued after constant exposure to the same stimuli. Whilst these changes can only be evaluated post completion, they are an essential part of the initial design concept, making feedback from POE an essential part of the initial design process. This paper explores an approach to building design that encourages both the engineer and architect to collaborate in design opportunities that allow for a range of sensory experiences. It sets out a methodology for gaining knowledge of how the occupants perceive and respond to the built environment. Ultimately, a multisensory design approach will inspire similar approaches in the development of landscape design and urban spaces, leading to the improvements in the inhabitants' social, cognitive, and emotional wellbeing.

2 Aesthetics

In this study the authors are referring to the wider meaning of aesthetics, derived from from the Greek word for '*perceiver*' or '*sensitive*'. In the first author's experience, the occupants will convey their feelings about spaces by describing their cognitive understanding of the way things *look and feel*. The way a space looks is both important to the designer and to the user but, as Holl [6] points out: '*the way it feels, the smell and sound of a place'* also contributes to a '*complete experience of a place'.* This is essentially the occupant's feeling of delight when using a building and they are very much a part of the 'aesthetic' design of the architecture, including the significant design input by engineers. The engineers' designs will also have an impact on the overall appreciation of a building. Good design requires more than just the minimum. All it requires is for the design team to vary from the minimum statutory and regulatory requirements by incorporating their own design flair and ingenuity.

Designers are encouraged to do more than simply satisfying an industry recognised metric that can be measured easily post-occupation. The author's change proposal requires the designers to use their imagination, ingenuity, and initiative to maximise the sensory opportunities. Below are some aesthetic design opportunities for both the architect and the engineer to consider. The intention is to provide an indication of the opportunities rather than be an exhaustive list of possibilities.

Thermal Aesthetics: This is not a new concept. Half a century ago, Lisa Heschong had been exploring the thermal delight in architecture [7]. She noted that food is as fundamental to survival as our thermal environment. Whilst it is theoretically and physiologically possible to provide for all nutritional needs with a few pills and an injection, it would lack the essential desire for eating to be a social event. There is human need for food and drink to have taste, smell texture, temperature, and colour, and there a need to allow for detectable changes in terms of temperature, colour, smell and taste. Similarly, thermal designs can be designed for variation. Lisa Heschong

[ibid] has noted that comfort zones for occupants vary widely: in Britain it can be between 14°C and 21°C whereas in America the range is between 20°C to 26°C. The difference is possibly affected by the range of latitudes over which the data is drawn. A later study found that residents in the UK set their central heating to allow for internal temperatures between 17–23 °C which links average indoor temperature to the mild outdoor conditions of west central Kenya or the Ethiopian highlands where human life is first thought to have evolved [8]. Each assessment appears to have a range of about 6°C and so there is a range of sensory design opportunities for engineers to vary the heating intensity by considering a variation in the way heating is transferred either by radiation, conduction, and convection or as a combination of the three.

Aesthetics of sight: Building orientation has a major influence on the access to daylight within a building and is one of the important sustainable considerations in design. Daylighting and artificial lighting will influence the visual appreciation of both the materials and the spaces created. Lighting levels are often specified in a design brief, but there are opportunities to allow for variation. Light and shade will inform the impact of what can be seen. The intensity of light can reveal the visual patterns created in colour, shape and form will influence how we respond to the visual appearance of the built environment. Internal spaces should avoid being painted white throughout, relying on signage to help guide and direct the inhabitants to various destinations. Diurnal changes can be incorporated to enhance circadian expectations. Visual impairment rarely means there is no perception of light. Designs that allow for visual impairment will also increase spatial enjoyment for all other occupants.

Aesthetics of sound: There are opportunities for the acoustician to include sensorial changes in the absorption and reflection of sound. Once the technical requirements of the building fabric and spaces have been resolved, the acoustic engineer could consider some creative changes in the design; not only to increase the delight in use, but also to provide wayfinding information and acoustic interest. Textural changes in the surface of material can be introduced in collaboration with the architect to provide both visual and acoustic changes that will enrich the occupant's sensory interest, both in the design of internal and in the design of external spaces. Delight can be achieved when the two are designed as a continuous transition from outside to inside, linking as many of the sensory aesthetics in a seamless manner.

Aesthetics of touch: Touch is the first sense to develop in human beings. In the Eyes of the Skin, Pallasmaa determined that all mammals perceive touch through physical pressure, temperature, light touch, vibration, pain etc. often in combination with another sense [9]. It is therefore important to the wellbeing of building occupants, especially for those with visual impairment [10]. Touch is often our first sense of a building, making the approach and contact with a main entrance an important feature of the architecture. The choice of materials for the handle can have a lasting impact on the impressions made in this first contact. Heating and cooling are both sensed by the skin and so the choice of heating system will influence the sensory responses of occupants.

Aesthetics of smell: Smell is omnidirectional. It is more difficult to avoid than sight, but good spatial design can help to control its movement. Every space has its own characteristic smell which can have a lasting and emotional effect. Mehta [11] noted this could possibly have a stronger and longer lasting influence on the architectural

experience than sight. The way that internal air moves around internal spaces can affect the intensity and flow of smells. There is a tendency for design solutions to eradicate smells but there are opportunities to enhance smells through air displacement. The smell of baking at the supermarket entrance is a positive displacement of smell within a food store can heighten awareness of freshness. In schools there are a range of activities that will have their own intrinsic smells. These could be designed in a positive way to assist with wayfinding particularly for the visually impaired.

Aesthetics of taste: The sensation of taste is closely related to smell. Taste is more often experienced when all other senses perceive it is safe to taste. There are design opportunities in the appreciation of taste. Whilst it is not actually encouraged to taste a building, Forster [12] and Yi Hsuan [32] have shown that colours and sound can generate oral sensations related to taste. Even so, Eberhard [14] found that a restaurant can influence a customer's 'conditioned response' to the taste of the food through lighting, colour, and comfort.

A final note: Sensory designs can activate all senses to varying degrees of intensity or concentration; both in the delivery and in the reception of a sensory response. In 2014, Spence et al revealed that the intensity of senses might be better limited to two senses in order not to confuse. This was reported in a study into 'Store Atmospherics' when it was found that there appears to be an optimal level of stimulation leading to a risk of sensory overload [15]

3 Proposed Research Methodology

The first author is seeking to support the fabric performance data with a complementary methodology that can gather feedback for the conceptual stages of building design. He is seeking a methodology that involves the occupants because he believes that feedback relating to the occupant's experience and perceptions of spaces will inform future designs and possibly lead to a more complete sensorial experience of a building. His research is seeking a methodology that will gather some of the less quantifiable responses from the users. He aims to develop a qualitative approach to evaluating buildings in use. The objective will be to capture some feedback and data based on the user's feelings and their lived experience and this can only be gathered by meeting with the occupants.

Current evaluation methodologies tend to focus on collecting the more tangible (quantitative) data that can confirm whether the design team has met the performance targets set within the original design brief. This approach to evaluation satisfies the current requirements set out in Stage M of the Royal Institute of British Architect's (RIBA) Plan of Work 2020 [16], the aim of which is to record the sustainability measures when the building is in use. These metrics are all quantifiable and so the current methodology aims to gather valuable knowledge for a Building Performance Evaluation (BPE). Comparative studies can be made with respect to industry benchmarks on performance and any disparities between the *designed* performance and the as-built performance can be assessed. The sustainability parameters sought by Part M of the Plan of Work are often achieved by meeting the quantifiable metrics currently

benchmarked and assessed by the engineering industry. Data can be collected '*post occupancy'* without any input by the inhabitants, the real-time users of the spaces. The ontological position of this paper is that Post Occupancy Evaluations *(POEs)*, should also include an evaluation of the design with the building users. The aim is to increase the architect's *knowledge and understanding* of *why and how* things are perceived to be the way they are in the real world. Gaining knowledge in this way would be based on a *qualitative methodology* that aims to discover why the occupants are doing what they have been observed as doing.

As Bryman [17] says, a qualitative methodology can involve either '*semi-structured interviews'* to reveal views on a particular topic, or '*in-depth interviews'* to gather knowledge on the occupant's personal (*phenomenological*) experience. The first author favours the latter approach as it will allow the participants to talk freely about their experiences and it will allow the facilitator to interpret the feedback as part of the recording of data.

There is no disputing that both BPEs and POEs are appropriate methodologies for gaining knowledge of how a building is performing in use, but a combination of the data from each approach could provide a clearer picture. A combination of the two methodologies could aim to clarify and enrich the knowledge gained from each of the methodologies. As Bryman has noted, the two methodologies can address both the 'what' (quantitative and qualitative) questions and the 'how' or 'why' (qualitative) questions [ibid]. This approach to reporting on POE findings moves away from the assumption of building performance is paramount. Instead, there is the opportunity to juxtapose the 'lived experience' from the occupants with the performance data of the building fabric. There is also the opportunity to triangulate the feedback to better understand different interpretations of a view (or views) of the feedback, making the combined report far more meaningful to a reader [18].

4 The Pilot Study – about to commence

A pilot study has been developed to capture the occupants' sensorial responses to the built environment. It focusses in on school design which is a specialism of the first author. Schools can be seen as a microcosm of the outside world in the sense that all the subjects and activities taught within a school are represented in the world outside school. Knowledge, social skills, trades, and professions are all learned through the initial years at a school.

The first author's research assumptions are based on his personal and professional experience of feedback from occupants in the schools he has designed. Irrespective of any sensory deficiencies, all occupants will 'sense' their environment; both in a conscious and in a subconscious way [19]. Whilst an occupant's feelings and perceptions will differ in many ways, often varying in intensity, most will make references to their five common senses of sight sound touch smell and taste. Some might combine more than one sense by presenting mixed modal responses.

The pilot study will involve focus groups, consisting only of the teaching staff. It will be based on a set of five questions that are aimed to start a conversation with the

participants. The objective is to record, *after at least one year in use*, how the occupants *feel* about their school throughout the day. It is assumed that their responses will be less that visceral and hopefully more robust for later evaluation and assessment.

The research methodology will assume a *constructivist* approach to interviewing participants, as this will allow for a *continual review* of the participants responses within different interview settings, both in terms of time and location. Clarity in feedback may be affected by the participants mood at the time of the research study. It might also be affected by the research context and by the presence of the researcher. For these reasons, the recording of the feedback will inevitably require some degree of *interpretation*.

5 The Questionnaire

This research encourages the whole design team to introduce *experiential changes* in the built environment, deliberately designed to stimulate the occupants' senses as they move about the spaces. An objective is to see if the occupants can help to calibrate a range of experiences within the built environment.

A questionnaire has been developed to help start an informal dialogue with the school's staff. We are seeking to capture their perception and experience of the designed spaces with respect to time of the day. We are seeking feedback on how the participants feel about their designed spaces: whether they are enjoyable to use or disliked. By adding the time of day, we can evaluate the effect circadian rhythms.

Records will be grouped according to how the occupants have related their experience with respect their five common senses of sight, sound touch, taste, and smell. The interviews will be transcribed and then coded within an analysis program (ENVIVO) under the five common the senses. Future coding might include gender, age and ethnicity as these parameters might show variations in responses, but there will be a need for a further ethics application to analyse such data in this way.

As the methodology is intended for architects, there is a risk that participants may focus on what they see as an architect's remit, the *visual aesthetics*. Hopefully, participants can be steered to comment on their perception of the four other common senses, even if this could be seen as guiding the respondents. The five questions are as follows:

Q1: On entering the school grounds, please describe any feelings you may have on the route from the school gate to the point of entering the school building? Include any preferred routes across the external spaces and explain why you use a particular entrance or door. *This will record the occupant's expectations and preferred experiences upon arrival to the school. It will discuss how occupants might enter the school, which points of access are used, and their choice of route within the school ground to arrive at their first place of use.*

Q2: Turning to your morning break times, please talk about some of the preferred locations where you like to take a break from your normal workspace, noting why you prefer these locations. It will also be useful to note any places that are less preferred, including any external spaces. *This will record the occupant's capability of*

acclimatising to the building, identifying their preferred use of spaces. There may be preferred routes that the occupant takes to feel comfortable.

Q3: Lunchtime is an opportunity to move away from your workplace. Please describe your favoured or usual place to meet, eat and refresh, ready for the afternoon's session. Some of the spaces you may be using, such as the dining room, may be less favourable than you would wish. Please also note about any places that are less preferred, including any external spaces. *This will aim to discover if there are any preferred areas within the building where occupants wish to take a short break away from the daily tasks, recharging their energy levels to complete the day.* We will recognize there is the socially driven aspect of people wishing to meet colleagues irrespective of whether they like the space where they agreed to meet.

Q4: Mid-afternoon is when there is often a feeling that the day is almost done. Please describe any feelings about the spaces you use in the school to complete the day. This could include classrooms, workspaces, study areas or physical activity areas, as well as any internal or external spaces that are less preferred. *This will record the difference in perception of school when the day is nearly complete. Do occupants use alternative spaces to relax in the afternoon? Will changes in daylight and artificial light and location of the sun influence their choices? Will occupants display a change in their tolerance in things they are unhappy with in the building (or vice versa), wishing they could be elsewhere.*

Q5: It is the end of the school day, and you may be looking forward to getting back home. Please could you describe your return journey away from your workspace and through the school, including leaving the site? *This might reveal how occupants feel about leaving the school buildings. Some may have a strong desire to leave and forget about the building they must occupy for significant parts of their waking day.*

6 Discussion

Human survival has evolved a arrange of sensory responses that can be incorporated into the design for buildings. Occupants are always alert to sensorial changes. Post occupancy evaluations provide the ideal opportunity for designers to discover how selected design interventions are performing in use. Good architecture requires feedback on the occupants' real-life experiences. POE cannot be based solely on the fabric's performance data as this usually collected without meeting the occupants who are the real-life users of the building. Quantitative POE data provides excellent feedback on how the building fabric is performing, but buildings are for people to use and to enjoy. Qualitative feedback is therefore equally important. Qualitative research involves direct contact with the public whose permission to participate must be sought well in advance. Data recording must be carried out with respect to potential ethical concerns that could arise over the course of the pilot study, and to any subsequent relationship with the participants [20].

A mixed-methodology approach to reporting on post occupancy evaluations is recommended so that knowledge gained from the fabric's performance can be coupled with knowledge gained from the occupants' real-life experience. Feedback can then be

presented in a clear and collective manner that will appeal to more readers. The objective is to provide an opportunity for architects to fine-tune the design intent and for the inhabitants to maximise the social value of their own environment.

Research data collection requires approval from the university's Research Ethics Committee. A formal application has been approved for a pilot study and this includes precise details on how the data will be collected and from whom it will be collected. Following an initial meeting with the headteacher, a formal request to participate in the pilot study will be sent out as a letter to all staff members. This will be the first contact with the teachers and so it will help to gauge initial interest. School staff are extremely busy throughout the day and so the formal request for participation will include full details on the time required for meeting staff, the potential for sensitivity in the outcomes and the need for confidentiality. Clear assurances on data control and compliance with General Data Protection Regulations (GDPR) is essential. Data will only be used as agreed and raw data will not be shared with anyone.

The first author has significant experience of consulting with school staff and sometimes with pupils who can be supervised by a responsible member of staff. He has CRB (now known as the DBS) Enhanced Disclosure certificate that covers access to schools. Even so, the ethics committee has raised concern about *vulnerable persons*: such as children under the age of 18. This is a shame because the first author's research is specifically related to the design of school buildings where about 90% of the occupancy will be pupils. Schools will also have children with special educational needs (SEN). Some of these pupils can have a heightened sensitivity to their environment, making them more likely to say how they feel about the spaces they use. In many ways, SEN pupils would be ideal participants in a survey on sensitivity. Alas, they fall well within the category of *vulnerable persons*.

7 Conclusions

Architects desire feedback on the how the occupants feel about the spaces they have designed. This requires the designers to evaluate their designs when the occupants have had enough time to settle in after the building is completed. Connecting with the inhabitants is an essential part of the objective to gather meaningful feedback.

Engineers should be encouraged to heighten the sensory experience of all occupants. A collaborative approach to multisensory design would include a *variety* of sensory design interventions from each of the engineering disciplines, all of whom can enrich the occupant's experience and *aesthetic* appreciation of a new school design. Changes in intensity can be introduced, but possibly prioritising on the intensity in just two sensory responses at any one time [14]. Variation is a key objective.

A mixed methodology combines knowledge gained from the occupants with the data recorded in the technical evaluation. There is a triangulation data. The aim is to provide a clearer picture of what has been found, making the report more meaningful to the reader. The output should then seek to attract a broader use and understanding of the feedback process, resulting in a far more useful set of POE findings for the whole design team and for the inhabitants. It is time for a change.

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