PLEA 2017 EDINBURGH
Design to Thrive

Embedding building performance evaluation in UK architectural practice and beyond

Fionn Stevenson
School of Architecture, The University of Sheffield, Sheffield, United Kingdom,
f.stevenson@sheffield.ac.uk

Despite repeated efforts to foreground Post-occupancy evaluation (POE) in many countries, few have any policy or legislation in place to mandate this process. Large scale voluntary efforts have also failed to provide successful templates through which to mainstream broader Building performance Evaluation (BPE) activity within which POE sits. This paper reviews various programmes and initiatives in the UK which have attempted to embed first POE, then BPE over the last twenty years within a global context, using a practice-based approach based on the author's experience of working in the field over this period. Key findings are: a failure of government to systemically follow through on BPE initiatives, stakeholders operating independently of eachother, a lack of institutional engagement in the education sector as a key driver for BPE, and the potential for interdisciplinary models to embrace all members of the design team as well as the client. The paper then examines the means by which BPE has been successfully embedded into practice directly, through deep organisational learning and knowledge exchange activities. Recommendations for these models to be replicated through professional institutions, other learning organisations and regulatory frameworks in the UK are put forward in the Conclusion as a way forward.

Keywords: building evaluation; learning; practice; knowledge exchange

Introduction - why has BPE not taken root in practice in the UK?

In his paper 'Post-occupancy evaluation – where are you?, Ian Cooper (Cooper) spoke of 'almost 40 years of continued neglect of POE…'. POE is defined here as the 'process of evaluating an asset/facility after it has been completed and is in use, to understand its actual performance against that required and to capture lessons learned' according to the British Standard, BSI_BS_8536_1_2015. For the purpose of this paper, it is proposed that a POE study must include a minimum of four activity areas as set out by Leaman, Stevenson and Bordass (2010): a documentary review, a walkthrough, a user survey and a resource audit of energy use. Studies which only consider some of these areas are described as research associated with POE, rather than as complete POE. One helpful

development has been the incorporation of POE as a subset within the wider concept and process of Building Performance Evaluation (BPE) defined in 2005 by Wolfgang Preiser as a systematic and rigorous approach encompassing a number of activities including research, measurement, comparison, evaluation, and feedback that takes place through *every* phase of a building's lifecycle (Preiser, & Vischer, 2005). It is now widely recognised that effective BPE must include activities which encompass interrelated feedback from people as well as the buildings they are inhabiting (Cole, Robinson, Brown, & Shea, 2008; Janda, 2011; Lowe, Chiu, & Oreszczyn, 2017).

Nearly two decades on from Cooper, however, there is still relatively little progress in mainstreaming this BPE activity in architecture. Only 9% of architecture practices registered with the Royal Institute of British Architecture (RIBA) in the UK offered POE as a fee paying service as part of their annual RIBA practice statement, with no take up of this offer, in 2015 (Hay, Samuel, Watson, & Bradbury, 2017). This is despite extensive BPE programmes being funded by government at a national level (Cohen, Standeven, Bordass, & Leaman, 2001; "Digital Catapult: Building Data Exchange," ; Gupta, Gregg, Passmore, & Stevens, 2015) and BPE projects being consistently carried out during this period (Agha-Hossein, El-Jouzi, Elmualim, Ellis, & Williams, 2013; Bordass, Cohen, Standeven, & Leaman, 2001; Bordass & Leaman, 2005; Gill, Tierney, Pegg, & Allan, 2011; Gupta & Gregg, 2016; Lawrence & Keime, 2016).

The twin origins of POE can be traced back to environmental psychology in the 1960's, with its emphasis on the inhabitant experience (Hall, 1969; Sommer, 1969), and the use of building science to monitor the physical performance of buildings in the 1970's (Markus, Whyman, Morgan, Whitton, & Maver, 1972). However, with the discrediting in the 1980's of environmental determinism (Franck, 1984), it was left to the newly emerging discipline of facilities management to pick up the reputation and work of POE (Cooper, 2001). As a professional response, the RIBA strategically recognised the need for gathering and disseminating information and experience on user requirements and the study of buildings in use as early as 1962. This was then endorsed in 1965 by the insertion of a new final work stage (M: Feedback), in the 'RIBA Plan of Work' guide, which proposed that architects should inspect buildings two or three years after final completion as the most cost effective way of improving service to future clients. Unfortunately this type of work was dropped by the RIBA in 1973 primarily because it was never aligned with a fixed payment mechanism and architects were reluctant to undertake POE studies without this financial commitment from the profession (Cooper, 2001). The POE aspect of Part M was finally reinstated as the RIBA 'Plan of Work Stage 7: In Use', forty years later, but still without a specific mandatory fee attached to it (RIBA, 2013) (Figure 1).

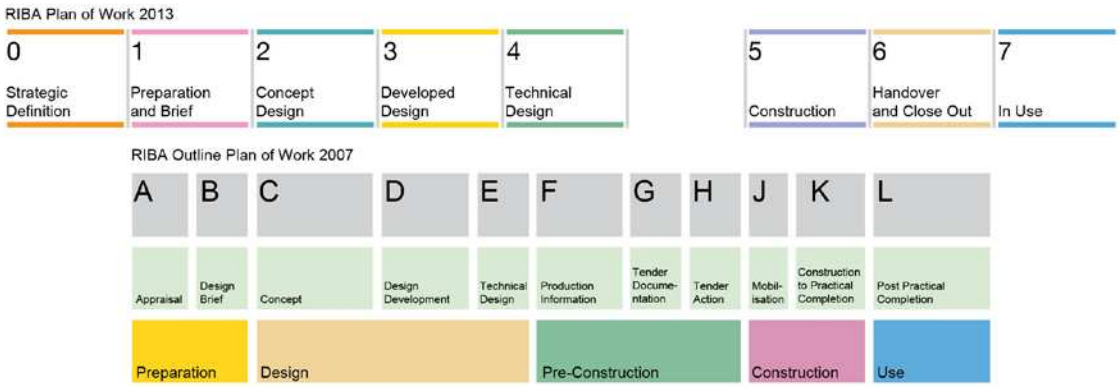

Figure 1: RIBA Plan of Work 2013 related to earlier 2007 version

Another crucial omission by the RIBA at that stage was the failure to fully embed POE into the overall work programme as a required part of a strategic definition or project brief, which would have completed the broader BPE feedback loop. More recent attempts by the RIBA to foreground POE as a recommended 'follow up' part of the BPE process now include greater emphasis on planning POE in from the beginning (RIBA, 2016; RIBA et al., 2017). Nevertheless, lack of leadership, collaboration and cost remain key reasons why BPE and its subsidiary component, POE, remain unembedded in general design practice in the UK and why the practice of BPE more generally remains so disaggregated between different sectors (Figure 2) (Hadjri & Crozier, 2009; Hay et al., 2017). But is it any better elsewhere and are there other reasons why BPE is still not mainstream? What can be done about this today?

Figure 2: The disaggregated sectors of BPE

This paper provides a brief international overview of recent POE studies and associated research carried out in all continents, in relation to legislation, to provide some context. There follows a review of various programmes and initiatives in the UK which have attempted to embed first POE, then BPE, in non-domestic and domestic development processes over the last twenty years. This based on a practice perspective drawing on the author's direct experience over the same period. The paper then examines the role that architectural education plays in relation to BPE progress before proposing an alternative method of embedding BPE in practice through interdisciplinary knowledge transfer partnerships and deep learning, with some conclusive recommendations for taking BPE forward.

POE in practice - current international context

In Europe, there is a general understanding that POE studies are vital in terms of improving occupancy performance and reducing environmental impact. However, uptake is still extremely low, with only some local authorities or agencies mandating POE, such as Stockholm County in Sweden (on all projects over 3 million SEK - about 330 000 EUR) and the National Health Service in Scotland (SCI-Network, 2012). Key factors for this include: low priority in terms of revenue v capital expenditure; localised cost cutting due to a disconnection between: procurement, provision and occupation; time constraints; no requirement from senior level; disconnection between projects preventing comparisons; and fear of poor performance (SCI-Network, 2012). Despite this, there have been numerous POE studies in various countries such as: Sweden (Rohdin, Molin, & Moshfegh, 2014), Germany (Krupper, 2015), The Netherlands (Balvers et al., 2012) and Denmark (Gram-Hanssen, 2010; Vlasova & Gram-Hanssen, 2014). A number of key research institutions are also undertaking POE studies in the USA, (Choi, Loftness, & Aziz, 2012; Collinge, Landis, Jones, Schaefer, & Bilec, 2014; Loftness et al., 2009; Schiano-Phan, 2012). There is, however, still no legislative requirement at either Federal or State level, despite an extensive survey of POE practice carried out by the Federal Facilities Council (FFC, 2002). The General Service Administration, responsible for overseeing all 500,000 Federal buildings is committed to carrying out POE studies to validate best practice, but only on a sample basis (Fowler, Rauch, Henderson, & Kora, 2011).

In the Middle East, various countries are now also developing research which draws significantly on POE methods (Attia, 2017; Hassanain, Mathar, & Aker, 2016; Omari & Woodcock, 2012). There is no requirement for mandatory POE as part of national regulatory processes in this global region. The story is similar in Australia and New Zealand, where despite having an excellent building performance rating system based on real data (NABERS; Residovic, 2017) administered by the national government, participation remains voluntary apart from a mandatory energy use disclosure for commercial buildings over 1,000 sqm as of 1st July 2017 in Australia. Again, there is excellent research work in this region of the world drawing on POE methods (Deuble & De Dear, 2014; Miller, Buys, & Bell, 2012; Moore, Ridley, Strengers, Maller, & Horne, 2017; Moore, Strengers, & Maller, 2016; Williamson, Soebarto, & Radford, 2010) and developing new BPE methods (Candido, Kim, De

Dear, & Thomas, 2016; Cohen et al., 2017). There are various research initiatives concerning POE on other continents including: Russia (Strelets et al., 2016) China (Li, Ng, & Skitmore, 2018; Zhu & Wu, 2013) Brazil (Ornstein, Villa, & Ono, 2011;. Ornstein & Ono, 2010) Africa (Adewunmi, Omirin, Famuyiwa, & Farinloye, 2011) and India (Steemers & Manchanda, 2010; Thomas, 2017). But again there are no mandatory requirements in these continents for doing a POE once a building is completed.

Although plenty of voluntary studies have been identified whilst conducting research for this paper, it would appear that there is still no national mandatory requirement for POE, anywhere. It is, however, slowly becoming more mainstream as an optional part of established international green building assessment tools, such LEED and BREEAM, and as promoted by the Green Building Council. Before exploring more deeply why POE and BPE remain relatively unembedded in practice, and how this might be improved, it is worth briefly recapping on its development in the UK, as one country that has led on the development of a national BPE agenda.

BPE in the UK 1995-2017

The government funded *PROBE* (Post-occupancy Review of Buildings and their Engineering) studies, which ran from 1995-2002, are generally recognised as the first systematic attempt to document the performance of new non-domestic buildings in the UK (Derbyshire, 2001). The twenty case studies relied on four combined POE activities – a preliminary questionnaire for the building manager, a walkthrough visit, an occupant survey and an energy assessment – sometimes supplemented with an air tightness test (Cohen et al., 2001). In 2005, the Building Research Establishment (BRE) set up an *Innovation Park* which demonstrated the first commercial zero carbon homes in the UK. One of these homes was evaluated using a combination of new inhabitant-centred BPE methods, including inhabitants' videoing their own use of technologies, observation and evaluation of the handover process and the associated home user guide (Stevenson & Rijal, 2010). Further BPE studies took place in the £17 million government funded *Retrofit for the Future* programme which ran from 2009 to 2013 to demonstrate and test the deep retrofitting of 86 existing homes. This was the first systematic national BPE programme for housing retrofit prototyping in the UK and demonstrated a significant energy performance gap (Gupta et al., 2015). The BRE continued with the £6.4 million industry-led *AIM-C4* research project on innovative housing and product design (2010-14), extensively informed by a BPE approach developed by the author which included new 'customer usability focus groups' to physically pre-test windows, heating and ventilations systems. These BPE findings substantially influenced three of the largest house builders in the UK in terms of improving their house types (Gaze, 2014). Key actors, including the author, concurrently lobbied the UK government for another £8 million to fund the first national *BPE programme* (2010-15). The findings of over 100 domestic and non-domestic BPE studies, and the overall lessons learnt, were openly published via the UK government's 'Digital Catapult' platform ("Digital Catapult: Building Data Exchange,").

All of this suggests a steady stream of government sponsored BPE activity in the UK, although this covers only a small fraction of the hundreds of thousands of buildings being delivered each year in this country (Higgins, 2017). However, there has been no systemic government follow up to date, with the initiative once again delegated to voluntary BPE activity by other stakeholders in the built environment.

Currently, there are various industry and government attempts to connect BPE activity to the new field of Building Information Modelling (BIM), with the promise of linking up design input directly with facilities management feedback via object- related building performance information and geographic information systems (Göçer, Hua, & Göçer, 2015). 'Soft Landings' involves a careful proof testing with support at every stage of the building development to improve design, construction and handover, as well as POE for at least two years after completion to fine tune performance and learn lessons for the next cycle (Way & Bordass, 2005). This BPE process is supposed to be linked to Level 2 BIM, where all parties use their own 3D CAD models, but are not necessarily working on a single, shared model, with design information shared through a common file format. This is to ensure that value is achieved in the operational lifecycle of an asset according to recently enhanced British Standards (BSI, 2015, 2016). However, the UK Government's own 'mandated' Soft Landings initiative appears to be somewhat stalled, with little evidence of any results (Gough, 2016). This is largely due to a lack of resource allocation by the government for managing this activity and no identifiable 'champions' within the relevant government departments, despite the RIBA lobbying for more government leadership in relation to embedding POE nationally (RIBA, 2017). Meanwhile, there are at least two fledging groups aiming to establish a national NGO to promote BPE in the UK – 'Building Performance Experts' (https://www.linkedin.com/groups/8465321), stemming from the initial government BPE programme, and 'Building Performance Network'(https://building-performance.network/), coming more from industry. Neither have government support at the moment, and BPE remains without a national champion. At the same time, the RIBA have produced a short POE 'Primer' document as part of their new POE guidance resource, which shows good intent, but again, without any requirement for POE to be carried out by its members (Williams, Humphries, & Tait, 2016).

One possibility for by-passing the financial cost of institutional, industry and government support for POE, lies in direct occupant feedback via social media. One research study, which the author was part of, explored how two different resident Facebook sites developed this type of feedback for effective social learning and collective problem-solving. However, there is a danger that such self-reporting can fail to take account of critical issues such indoor air quality unless there is expert knowledge within the group concerned (Baborska-Narozny, Stirling, & Stevenson, 2017). As such, there will always be a need for well supported POE expert evaluation of buildings, alongside, or within, any social media initiative like this.

It is clear from the above, that although a number of disaggregated BPE initiatives are still underway in the UK, there is still no embedded mainstream activity going on, with various stakeholders operating independently of each other, no single

national body to promote BPE and relatively little systemic government support. The situation, unfortunately, is little better in education, which is examined next.

BPE in UK Education

Arguably, BPE should be introduced at an early stage in design education to help familiarise students with the idea that it is a routine investigatory activity which is part of the overall design process (Markus, Whyman, Morgan, Whitton, Maver, et al., 1972; Moore, 1983). This is certainly something that colleagues in the USA aimed to do with their seminal 'Vital Signs' national education project (funded from 1992-98). By 2001, 18 progressive schools of architecture in the USA had provided approximately 50 case studies (Kwok & Grondzik, 2001). The follow-on 'Agents of Change' project (2000 - 2005) aimed to embed this process still further and delivered training to 170 staff from over 50 architecture programmes. It led onto the delivery of annual intensive POE workshops (http://www.sbse.org/retreats/tool-day-2017) for practitioners known as 'Tool Days' (Kwok, Grondzik, & Hagland, 2011). POE subsequently became a required part of the live architectural design and build curriculum for the pioneering 'Ecomod' project in the University of Virginia, which ran for many years and included detailed building performance as well as occupant feedback into the design process (Quale, 2012; Stawitz, MeGehee, Devlin, Tan, & Wong, 2008). The Society of Building Science Educators (SBSE) is also a lively international platform for architecture and associated disciplines, hosted in the USA, which has been discussing and promoting POE methods in teaching since its inception in 1995 (http://www.sbse.org/) . There is also a history of various localised and individual research-led teaching projects using POE methods in many other countries, as evidenced in numerous Passive and Low Energy Architecture international conference presentations, often based in Masters level programmes (Gupta & Chandiwala, 2009; Hernandez- Martinez, Bedoya, Garcia-Santos, Neila, & Caamano, 2011; Takata, Taniguchi, & Hoyano, 2017). Despite this evidence of POE methods being used internationally in architectural education, the author is unaware of any explicit professional institutional requirements to teach POE or BPE as an integral part of a pedagogical methodology for architectural design.

In the UK, the author was involved with others in introducing POE activities to students in the second and third year of their architectural studies at Oxford Brookes University from 2007-11, which subsequently informed their design thinking, as this technology element was integrated within the studio programme. However, the pedagogy of BPE still operates only in small and fragmented parts of the UK architectural education sector, despite having been taught by enthusiasts for well over a decade in establishments such as Oxford Brookes University (Gupta, 2007). In 2008, several UK academics initiated a series of three national workshops for all Schools of Architecture called 'Designs on the Planet' in recognition of the need to re-visit the technology curriculum within architectural education and provide better and shared investigative tools for students. The author led the organisation of the first of these and the overall curation of the series. The workshops included participants from 34 out of the 41 Schools of Architecture in the UK at that time. It was generally concluded after discussion with all participants concerning their current curricula that '…there is a real

need for evidence-based design approaches in education in order to improve building performance and lower their carbon emissions', with promises by all attending to continue developing these approaches (Stevenson, Roberts, & Altomonte, 2009). What followed over the next decade did not fulfil what was anticipated in these workshops in terms of promoting BPE and POE in architectural higher education in Europe and the UK, as described next.

From 2009 to 2012, a larger European Union programme, Environmental Design in University Curricula and Architectural Training in Europe, ("EDUCATE,"), built on the initial work of 'Designs on the Planet'. It had a budget of 1.65 million Euros and examined sustainable design in higher education through a consortium of seven leading European Universities. It also received the support of the Chambers of Architects, international building professionals and associations of educators and practitioners, in all the participating countries. However, an examination of its outputs (Altomonte, 2012) shows little evidence of aiming to embed BPE in the curriculum as a holistic activity. Instead the BPE process is fragmented, being broken down into two separated aspects: monitoring and evaluation. POE as an overall educational topic is deeply buried within EDUCATE's section entitled 'Tools: Onsite Surveys and Measurements'. The POE 'tool' provided is overly simplistic when compared with definition of POE offered at the start of this paper. Another recent EU project, *Adapting Architectural Education to the New Situation in Europe* (Cabrera i Fausto, 2017) concluded that: "Studio projects that involve intervention to existing environments should be designed to "close the circle", that is, to bring the results of the design back to the starting point by means of a reflection on the impact of the proposal". However, there is no mention that this might be linked to understanding or using BPE processes to inform design in the studio. Instead the authors refer simply to the traditional use of case study precedents for students to learn from, and these rarely have BPE studies associated with them.

In an effort to re-stimulate a broader evidence-based design agenda in education, the author initiated and led the organising of a national conference, *Beyond Building Performance: architectural research, practice and education*, under the auspices of The Standing Conference of Heads of Schools of Architecture in the UK (SCHOSA, 2015). 44 Schools of Architecture in UK – virtually all – sent over 100 representatives to attend the event. The culmination of the day was a manifesto forwarded to the RIBA Education Committee which stated:

> This conference believes that integrating BPE within education is essential in order to: fulfil our responsibility to society, exploit the potential for collaboration between academia, users, research, disciplines and professional practice in expanding the evidence base for affordable, biodiverse rich, healthy, resource efficient building and urban design, supportive of communities.

To obtain unanimous consensus from so many representatives from Schools of Architecture is unusual, in the author's opinion, and the hope was that the professional educational criteria would be revised at a national level. Three years on, however, there

is very little change evident; the RIBA Validation Criteria remain silent on the need for either BPE or POE competencies in graduates, with only vague overarching statements about graduates needing to understand '…the needs and aspirations of building users' (Criteria GC5.1) and '…the impact of buildings on the environment, and the precepts of sustainable design'(Criteria GC5.2) (RIBA, 2014). Few architecture programmes in the UK teach POE or BPE techniques routinely at undergraduate level, in the author's experience of reviewing studio and technology programmes, and as revealed by participants at the national SCHOSA conference in 2015, described above. One alternative for embedding BPE lies in research-based practice initiatives that involve deeper and more iterative learning through knowledge exchange partnerships, as discussed next.

Using Knowledge Exchange to embed BPE in practice

As BPE is not taught routinely in higher education, it remains for practitioners to learn about BPE from others in the best way possible, and knowledge exchange (KE) can be a key means to this (Stevenson & Baborska-Narozny, 2017). One way of enabling and embedding KE is through a Community of practice (CoP) with members who are bound together through mutual engagement to develop a shared repertoire of communal resources over time (Wenger, 2000). CoPs can operate at the level of an individual architectural practice, or across many such practices, or by linking other CoPs across disciplines and countries. The recently formed architectural 'Practice Leads' network in the UK is an example of an emergent national CoP supporting KE and research in architectural practices (Samuel, 2017). CoPs often work using tacit practice-based knowledge based on the experience of the CoP members, as well as articulated knowledge that may be more formalised. Informal and formal face to face meetings are often seen as most important for searching, consultation and verification of ideas and concepts (Sapsed, Gann, Marshall, & Salter, 2005). The development of KE through and across architectural CoPs is aided through the use of human 'brokers' who can translate, co-ordinate and align perspectives between these CoPs using various tools and techniques. These can often be external researchers and consultants, institutional agents, or champions within a practice. Such brokers always need enough credibility built up in the first place in order to be able to influence the development of a practice. They also need to be able to link practices by facilitating transactions between them and by introducing elements of practices to each other to enable learning (Wenger, 2004). One example of this brokering is where an academic and institutional researcher translated between practice-based terminology ('aims', 'context', 'approach', 'lessons') and formal research terminology ('aims', 'research context', 'methodology' and 'findings') using an edited book of practice-based research case studies as the translation tool. This helped to 'demystify' and translate the formal notion of 'research' to other CoPs situated within architecture practice in the UK (Samuel, 2017).

According to Nicolaides and McCallum (2013), embedding effective BPE learning within an organisation can enable individual architectural practices not only to improve their performance (single loop learning) but to question their assumptions (double loop learning) and open themselves up to intuitive new ways of being, knowing

and doing (triple loop learning), starting with the highest leadership level. This requires BPE practice champions to either be practice directors or to work with them directly, using (1) intuition, intention, and attention; (2) critical and strategic thinking; (3) vigilant and meaningful actions; and (4) impacts, outcomes, and feedback.

One example of this type of activity enabled a full-time Graduate Associate engineer, with back up from two senior architecture academics (one being the author), to act as a BPE 'broker' when this team undertook a two year Innovate UK Knowledge Transfer Partnership BPE project in collaboration with Architype Architects, a leading sustainable design practice in the UK, from 2010-11 (Pasquale, Hancock, & Stevenson, 2011). The 'brokering' worked here because the Graduate Associate was able to work with the most senior figure in the practice, the Managing Director, who provided the necessary leadership as the overall BPE practice 'champion', as well as with key individual 'champions' in different areas of the practice. This project resulted in ten iterative BPE studies of Schools and other buildings that the practice had designed and delivered with contractors and more importantly, in vital co-learning between the Senior Academics, the Graduate Associate and the key practice 'champions'. Over time, the Graduate Associate was able to build up significant credibility and trust as a BPE 'broker' for the practice, challenging them not only to improve their performance but also to question the tacit design assumptions and work procedures within their two offices, in order to improve the performance of their buildings. This resulted in the practice developing new ways of thinking about their design work. Together with the Graduate Associate and others, they developed new learning tools and processes for deeply embedding BPE in every aspect of the practice's approach to producing architecture. This included an internal knowledge-sharing website using an open source mediawiki framework with multiple plug-ins, as well as internal continuous professional development presentations.

As result of this positive BPE experience, Architype Architects went onto secure EU funding for a second Knowledge Exchange project in 2014 to carry out further monitoring studies on five further Schools they had completed, working this time with Coventry and Wolverhampton Universities (Hines & Thoua, 2016). The practice now has BPE as part of its DNA as a CoP, and uses multiple loop learning to feedback as well as feed forward their findings from their post-occupancy studies to improve all their design work, using the 'Soft Landings' approach for each project. Thus, BPE is now a routine work stage activity in this example of best practice. They are now working towards a target date of 2020 for guaranteeing the performance of all their buildings. Critically, Architype Architect now build in BPE costs from the outset of any project, recognising the payback for the practice over time in terms of troubleshooting and resolving any performance issues quickly and timeously (http://www.architype.co.uk/working-with-us/).

Another example of this type of BPE practice 'brokering' occurred when a well-known interdisciplinary practice, Buro Happold Consulting Engineers, decided to collaborate with academics to develop a unique industry-based engineering doctorate programme, which the practice sponsored. An engineering PhD student on this programme went on to undertake an in depth POE study while working in their

Sustainability and Alternatives Technology (SAT) department in their London offices. The focus of the study was on the impact of occupant behaviour on the real-life performance of aspiring low energy/carbon buildings in the UK (Gill et al., 2011). Importantly, Buro Happold refine their design practice through this type of process (https://www.burohappold.com/what-we-do/specialisms/delivering-building-performance/).

Ideally, if BPE is to be fully embedded within broader practice, interdisciplinary models could be developed which embrace *all* members of the design team as well as the client. While embedded KE partnerships and industry-based PhD studentships offer two ways forward for deeply embedding learning, a third model is proposed that could potentially transcend traditional professional boundaries associated with these two routes. The nascent BPE NGOs referred to earlier are both interested in promoting BPE consultants to work directly with clients. However, this does not necessarily develop the long term relationship that is necessary to change practice for good. A variation on this could be to promote a BPE *service* that embeds interdisciplinary consultants (e.g jointly qualified architect/engineers) for several years within a client organisation to allow the necessary trust for 'brokering' BPE and embedding it through multiple loop learning. This service could be financed by the practice, as exemplified by Architype Architects above. This would also tie in with the latest British Standard which demands that POE is embedded in the initial briefing for any project and carried out annually for three years (BSI, 2015). This third interdisciplinary 'consultancy' BPE learning model could help to transcend the evidently different approaches towards BPE that come from architecture as a more qualitative and improvisational culture (Hay et al., 2017) and engineering as a culture that values what is typically more quantitative and replicable (Gerrish, Ruikar, Cook, Johnson, & Phillip, 2017) and allow the best of both worlds. All three models of KE described here offer different ways to embed BPE in practice (Figure 3). Over time, an ongoing BPE programme can help to reduce the risk of liability for unforeseen defects, as well as gain client trust, as Architype Architects discovered (Hines & Thoua, 2016) (http://www.architype.co.uk/working-with-us/).

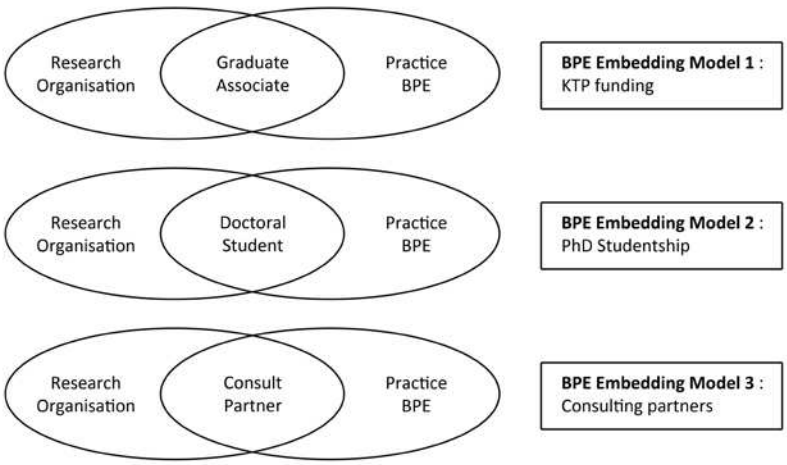

Figure 3: BPE deep learning models

An interesting institutional initiative, from the UK Royal Academy of Engineering, has been the promotion of Centres for Excellence in Sustainable Design which has successfully engaged both architecture and engineering educational departments to develop a mutual understanding between these disciplines. This has enabled interdisciplinary courses to be developed which teach evidence-based design related to building physics and performance evaluation (King, MacCombie, & Arnold, 2012; RAEng, 2013). It may well be that a future joint initiative like this could embrace the BPE agenda which individual UK schools of architecture have collectively failed to grasp, as well as to bring the currently disaggregated efforts by professional institutes of architecture and engineering more closely together in relation to promoting and embedding BPE in practice, through interdisciplinary educational change over time. In addition to using single, double and triple learning loops to break down current institutional barriers in the built environment, such an interdisciplinary initiative would have to pay close attention to the political context within which it operates and the need to address stakeholder viewpoints which contradict each other, by attending to the different modes of presentation that may be required for different audiences. Explicit attention also needs to be paid to how institutional and political considerations affect knowledge perception and evaluation of the value of BPE across different types of audience (Young, Corriveau, Nguyen, Cooke, & Hinch, 2016) .

Conclusion

Frank Duffy has outlined one underlying structural reason for a lack of integrated user feedback in design:

> However, unlike medicine which, despite its many specializations has always held together and has always maintained the tradition of linking practice, research and teaching, architecture and the other professions in the construction, design and urban planning, with few exceptions, have not developed a tradition of practice-based, user research, preferring to outsource both user research and teaching almost entirely to the universities.
>
> (Duffy, 2008 p. 657).

In theory, BPE could provide a way to make this vital linkage. However, from the overview presented in this paper, it appears that BPE remains relatively invisible in architectural professional education criteria, taught in a fragmented manner in UK higher education institutions, and generally unembedded in architectural practice, despite numerous government and educational initiatives. Deep ‘triple loop’ learning is thus proposed with a process to challenge the status quo in existing practice at a more fundamental level; firstly to provide BPE skills and improve performance, secondly to question institutionalised and regulated assumptions, and finally to free up current embedded thinking in practice using knowledge exchange processes. Three different KE models have been presented to show how such learning could be embedded over time through different KE relationships to introduce and build new BPE CoPS within practice.

There also is a clear need to go beyond continuous practice development (CPD) training in BPE methods, in order to help professional practices understand the real value of BPE over the long term. Any training has to be deeply embedded within a design practice using 'champions' and 'brokers' who stay around long enough to ensure that a genuine and structural culture change takes place from within. This process takes several years, usually, and requires translation through BPE carried out on projects that are live in the office. Without this change towards embedding BPE as integrated and iterative practice-based learning processes, the BPE process can be easily lost when any BPE 'champion' or 'broker' leaves.

Establishing the underlying value of BPE in practice remains a key area of challenge at a national level in the UK, and similar 'champions' are required at a senior level in built environment professional institutions. One positive step in this direction lies in the RIBA appointment of a Vice President of Research for the first time in 2017, who is actively promoting POE and BPE within the institution, and, crucially, through practice-based research (Hay et al., 2017; Samuel, 2017). For this to be effective, however, there firstly needs to be a stronger educational mandate from the *all* built environment professional bodies in terms of revising their CPD training and validation criteria to make knowledge and skills in BPE a much more explicit requirement. Utilising the deep learning models proposed in this paper could perhaps help with this. At the same time, BPE needs to be presented in a politically astute manner with its 'champions' engaging with different audiences on their own terms, while at the same time challenging them to move beyond current boundaries towards a new professionalism, and new professionals (Hartenberger, Lorenz, & Lützkendorf, 2013), that fully embed BPE interdisciplinarity between architecture and engineering.

It is also not enough for there to be tacit assumption that learning about BPE is contained within 'understanding the needs of the user' as stated in the RIBA validation criteria. Students in the built environment need to learn the concept of feedback from year one and this needs to be iterated throughout their learning programme using 'triple loop' learning which questions assumptions and encourages fresh thinking in relation to a co-design process which empowers clients and occupants. Design feedback should include how buildings really perform, and not simply rely on how students and staff think they should perform. This is best provided through supportive modelling, field measurements and social evaluations of any built case study used to inform design propositions. Where this information is not available, students can usually undertake very basic POE on the case studies themselves, as part of understanding BPE as an integral part of the design process.

At the same time, it is doubtful that POE and BPE will become mainstream, given the past 60 years of its neglect in history, without governments mandating BPE as a routine activity within a regulatory framework. Whoever heard of running a car without a mandatory MOT? Regulation could also help to ensure that the service costs are built in by the client in the first place as a matter of compliance. Such regulation needs to be light touch and incisive, with the flexibility that comes with using performance based methods rather than settling on approved methods which need continuous updating. This could ensure that regulation allows BPE to continuously

develop over time as new understandings unfold. Until BPE is mandatory, however, the costs for BPE learning and design improvement will likely remain with the design team, and based on this review, will not be carried out routinely.

It is hoped that this review, the KE models proposed, and the recommendations above may help to at least partly address the question by Cooper 'POE – where are you?'

References:

Adewunmi, Y., Omirin, M., Famuyiwa, F., & Farinloye, O. (2011). Post- occupancy evaluation of postgraduate hostel facilities. *Facilities, 29*(3/4), 149-168. doi:10.1108/02632771111109270

Agha-Hossein, M. M., El-Jouzi, S., Elmualim, A. A., Ellis, J., & Williams, M. (2013). Post-occupancy studies of an office environment: Energy performance and occupants' satisfaction. *Building and Environment, 69*, 121-130. doi:10.1016/j.buildenv.2013.08.003

Altomonte, S. (2012). *Educate for Sustainable Environmental Design: The EDUCATE project: Summary of Results*. Retrieved from Nottingham, UK: http://www.educate-sustainability.eu/results-summary

Attia, S. (2017). Evaluation of adaptive facades: The case study of Al Bahr Towers in the UAE. *QScience Connect, 2017*(6). doi:10.5339/connect.2017.qgbc.6

Baborska-Narozny, M., Stirling, E., & Stevenson, F. (2017). Exploring the Efficacy of Facebook Groups for Collective Occupant Learning About Using Their Homes.

Balvers, J., Bogers, R., Jongeneel, R., Van Kamp, I., Boerstra, A., & Van Dijken, F. (2012). Mechanical ventilation in recently built Dutch homes: technical shortcomings, possibilities for improvement, perceived indoor environment and health effects. *Architectural Science Review, 55*(1), 4-14. doi:10.1080/00038628.2011.641736

Bordass, B., Cohen, R., Standeven, M., & Leaman, A. (2001). Assessing building performance in use 2: technical performance of the Probe buildings. *Build. Res. Informat., 29*(2), 103-113.

Bordass, B., & Leaman, A. (2005). Making feedback and post- occupancy evaluation routine 3: Case studies of the use of techniques in the feedback portfolio. *Building Research & Information, 33*(4), 361-375. doi:10.1080/09613210500162032

BSI. (2015). BS 8536-1: 2015 Briefing for design and construction. Code of practice for facilities management (Buildings infrastructure). In (pp. i-iv,1-88). London: British Standards Institution.

BSI. (2016). BS 8536-2:2016 Briefing for design and construction. Code of practice for asset management (Linear and geographical infrastructure). In (pp. i-iv,1-98). London, UK: British Standards Institution.

Cabrera i Fausto, I. (2017). *Final Report: Confronting Wicked Problems: Adapting Architectural Education to the New Situation in Europe*. Retrieved from Oslo: http://www.eaae.be/wp-content/uploads/2017/04/Erasmus-Project_CWP_00_Final-Report-1.pdf

Candido, C., Kim, J., De Dear, R., & Thomas, L. (2016). BOSSA: A multidimensional post-occupancy evaluation tool. *Building Research and Information, 44*(2), 214-228. doi:10.1080/09613218.2015.1072298

Choi, J.-H., Loftness, V., & Aziz, A. (2012). Post-occupancy evaluation of 20 office buildings as basis for future IEQ standards and guidelines. *Energy & Buildings, 46*, 167-175. doi:10.1016/j.enbuild.2011.08.009

Cohen, R., Austin, B., Bannister, P., Bordass, B., Bunn, R., & Dwyer, T. (2017). How the commitment to disclose in- use performance can transform energy outcomes for new buildings. *Building Services Engineering Research & Technology, 38*(6), 711-727. doi:10.1177/0143624417711343

Cohen, R., Standeven, M., Bordass, B., & Leaman, A. (2001). Assessing building performance in use 1: the Probe process. *Building Research & Information, 29*(2), 85-102. doi:10.1080/09613210010008018

Cole, R. J., Robinson, J., Brown, Z., & Shea, M. (2008). Re-contextualizing the notion of comfort. *Building Research & Information, 36*(4), 323-336. doi:10.1080/09613210802076328

Collinge, W. O., Landis, A. E., Jones, A. K., Schaefer, L. A., & Bilec, M. M. (2014). Productivity metrics in dynamic LCA for whole buildings: Using a post- occupancy evaluation of energy and indoor environmental quality tradeoffs. *Building and Environment, 82*, 339-348. doi:10.1016/j.buildenv.2014.08.032

Cooper, I. (2001). Post-occupancy evaluation - where are you? *Building Research & Information, 29*(2), 158-163. doi:10.1080/09613210010016820

Derbyshire, A. (2001). Probe in the UK context. *Building Research & Information, 29*(2), 79-84. doi:10.1080/09613210010016839

Deuble, M. P., & De Dear, R. J. (2014). Is it hot in here or is it just me? Validating the post-occupancy evaluation. *Intelligent Buildings International, 6*(2), 112-134. doi:10.1080/17508975.2014.883299

Digital Catapult: Building Data Exchange. Retrieved 28th January 2018 http://www.buildingdataexchange.org.uk/

Duffy, F. (2008). Forum Linking theory back to practice. *Building Research & Information, 36*(6), 655-658. doi:10.1080/09613210802381017

EDUCATE. Retrieved from www.educate-sustainability.eu/home

FFC. (2002). *Learning from Our Buildings: A State-of-the-Practice Summary of Post-occupancy Evaluation.* Retrieved from Washington, DC: https://www.nap.edu/read/10288/chapter/1

Fowler, K., Rauch, E., Henderson, J., & Kora, A. (2011). *Re-assessing Green Building Performance: a Post-occupancy Evaluation of 22 GSA buildings*. Retrieved from Richland, Washington: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-19369.pdf

Franck, K. A. (1984). Exorcising the Ghost of Physical Determinism. *Environment and Behavior, 16*(4), 411-435. doi:10.1177/0013916584164001

Gaze, C. (2014). *Information Paper: Lessons from AIMC4 for cost-effective, low-energy, fabric-first housing: Part 5: As-built performance and Post-occupancy Evaluation*. Retrieved from Watford, UK: http://www.aimc4.com/filelibrary/files/AIMC4-Briefing-Paper-5_final.pdf

Gerrish, T., Ruikar, K., Cook, M., Johnson, M., & Phillip, M. (2017). Analysis of basic building performance data for identification of performance issues. *Facilities, 35*(13-14), 801-817. doi:10.1108/F-01-2016-0003

Gill, Z. M., Tierney, M. J., Pegg, I. M., & Allan, N. (2011). Measured energy and water performance of an aspiring low energy/carbon affordable housing site in the UK. *Energy & Buildings, 43*(1), 117-125. doi:10.1016/j.enbuild.2010.08.025

Gough, T. (2016). Will it be a hard landing for government soft landings? Retrieved from http://www.bimplus.co.uk/management/will-be-ha5rd-land3ing-gove2rnment-soft-landings/

Gram-Hanssen, K. (2010). Residential heat comfort practices: understanding users. *Building Research & Information, 38*(2), 175-186. doi:10.1080/09613210903541527

Gupta, R. (2007). *Leading by example: post-occupancy evaluation studies of city council-owned non-domestic buildings in Oxford to assess the potential for reducing CO2 emissions*. Paper presented at the Proceedings of the 24th International Conference on Passive and Low Energy Architecture (PLEA), Singapore.

Gupta, R., & Chandiwala, S. (2009). *A Student-Centred POE Approach to Provide Evidence Based Feedback on the Sustainability Performance of Buildings*. Paper presented at the Proceedings of the 26th Conference on Passive Low Energy Architecture, Quebec. http://www.plea2009.arc.ulaval.ca/Papers/1.CHALLENGE/1.3%20Education/ORAL/1-3-09-PLEA2009Quebec.pdf

Gupta, R., & Gregg, M. (2016). Empirical evaluation of the energy and environmental performance of a sustainably-designed but under-utilised institutional building in the UK. *Energy & Buildings, 128*, 68-80. doi:10.1016/j.enbuild.2016.06.081

Gupta, R., Gregg, M., Passmore, S., & Stevens, G. (2015). Intent and outcomes from the Retrofit for the Future programme: key lessons. *Building Research & Information, 43*(4), 435-451. doi:10.1080/09613218.2015.1024042

Göçer, Ö., Hua, Y., & Göçer, K. (2015). Completing the missing link in building design process: Enhancing post-occupancy evaluation method for effective feedback for building performance. *Building and Environment, 89*, 14-27. doi:10.1016/j.buildenv.2015.02.011

Hadjri, K., & Crozier, C. (2009). Post-occupancy evaluation: purpose, benefits and barriers. *Facilities, 27*(1/2), 21-33. doi:10.1108/02632770910923063

Hall, E. T. (1969). *The hidden dimension : man's use of space in public and private*. London: Bodley Head.

Hartenberger, U., Lorenz, D., & Lützkendorf, T. (2013). A shared built environment professional identity through education and training. *Building Research & Information, 41*(1), 60-76. doi:10.1080/09613218.2013.736202

Hassanain, M. A., Mathar, H., & Aker, A. (2016). Post- occupancy evaluation of a university student cafeteria. *Architectural Engineering and Design Management, 12*(1), 67-77. doi:10.1080/17452007.2015.1092941

Hay, R., Samuel, F., Watson, K. J., & Bradbury, S. (2017). Post- occupancy evaluation in architecture: experiences and perspectives from UK practice. *Building Research & Information*, 1-13. doi:10.1080/09613218.2017.1314692

Hernandez- Martinez, M. C., Bedoya, C., Garcia- Santos, A., Neila, J., & Caamano, E. (2011). *A Prototype from the Solar Decathalon Competition becomes an Educational Building in Sustainable Architecture*. Paper presented at the 27th Conference on Passive Low Energy Architecture, Louvain-la-Neuve, Belgium. https://books.google.be/books?id=KKZMp2kotAEC&printsec=frontcover&hl=fr&source=gbs_atb#v=onepage&q&f=false

Higgins, N. (2017). *Housing supply; net additional dwellings, England: 2016-17*. Retrieved from London, UK: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/659529/Housing_Supply_England_2016-17.pdf

Hines, J., & Thoua, C. (2016). Post-occupancy evaluation of five schools by Architype. *Architects Journal.* Retrieved from https://www.architectsjournal.co.uk/buildings/post-occupancy-evaluationof-five-schools-by-architype/10004526.article?blocktitle=Buildings&contentID=13630

Janda, K. B. (2011). Buildings don't use energy: people do. *Architectural Science Review, 54*(1), 15-22. doi:10.3763/asre.2009.0050

King, D., MacCombie, P., & Arnold, S. (2012). *The Case for Centres of Excellence in Sustainable Design*. Retrieved from London: https://www.raeng.org.uk/publications/reports/the-case-for-centres-of-excellence-in-sustainable

Krupper, D. (2015). Nutzerbasierte Bewertung von Büroimmobilien. *Zeitschrift für Immobilienökonomie, 1*(1), 5-33. doi:10.1365/s41056-015-0001-y

Kwok, A., & Grondzik, W. (2001). *Taking the Vital Signs of a Building: Understanding Building Performance by Taking a Building's Vital Signs*. Paper presented at the Buildings VIII. http://web.ornl.gov/sci/buildings/conf-archive/2001%20B8%20papers/149_Kwok.pdf

Kwok, A., Grondzik, W., & Hagland, B. (2011). *Academic Advocacy: Teaching Outside the Academy.* Paper presented at the Conference Proceedings of the 27th International Conference on Passive and Low Energy Architecture, Louvain, Belgium.

Lawrence, R., & Keime, C. (2016). Bridging the gap between energy and comfort: Post-occupancy evaluation of two higher- education buildings in Sheffield. *Energy and Buildings, 130*, 651-666. doi:10.1016/j.enbuild.2016.09.001

Li, H., Ng, S. T., & Skitmore, M. (2018). Stakeholder impact analysis during post- occupancy evaluation of green buildings – A Chinese context. *Building and Environment, 128*, 89-95. doi:10.1016/j.buildenv.2017.11.014

Loftness, V., Aziz, A., Choi, J., Kampschroer, K., Powell, K., Atkinson, M., & Heerwagen, J. (2009). The value of post- occupancy evaluation for building occupants and facility managers. *Intelligent Buildings International, 1*(4), 249-268. doi:10.3763/inbi.2009.SI04

Lowe, R., Chiu, L. F., & Oreszczyn, T. (2017). Socio-technical case study method in building performance evaluation. *Building Research & Information*, 1-16. doi:10.1080/09613218.2017.1361275

Markus, T. A., Whyman, P., Morgan, J., Whitton, D., & Maver, T. (1972). *Building Performance*. New York, USA: Wiley.

Markus, T. A., Whyman, P., Morgan, J., Whitton, D., Maver, T., Canter, D., & Fleming, J. (1972). *Building Performance*. London: Applied science publishers.

Miller, W., Buys, L., & Bell, J. (2012). Performance evaluation of eight contemporary passive solar homes in subtropical Australia. *Building and Environment, 56*, 57-68. doi:10.1016/j.buildenv.2012.02.023

Moore, G. T. (1983). Teaching design evaluation, with results from case studies of playgrounds, schools, and housing for the elderly. *Design Studies, 4*(2), 100-114. doi:10.1016/0142-694X(83)90040-6

Moore, T., Ridley, I., Strengers, Y., Maller, C., & Horne, R. (2017). Dwelling performance and adaptive summer comfort in low- income Australian households. *Building Research and Information, 45*(4), 443-456. doi:10.1080/09613218.2016.1139906

Moore, T., Strengers, Y., & Maller, C. (2016). Utilising Mixed Methods Research to Inform Low- carbon Social Housing Performance Policy. *Urban Policy and Research, 34*(3), 240-255. doi:10.1080/08111146.2015.1077805

NABERS. National Australian Built Environment Rating System (NABERS). Retrieved from https://nabers.gov.au/public/webpages/home.aspx

Nicolaides, A., & McCallum, D. C. (2013). Inquiry in Action for Leadership in Turbulent Times. *Journal of Transformative Education, 11*(4), 246-260. doi:10.1177/1541344614540333

Omari, S., & Woodcock, A. (2012). Post occupancy evaluation of primary schools in Saudi Arabia. *Work, 41*, 881-887. doi:10.3233/WOR-2012-0258-881

Ornstein, S., Villa, S., & Ono, R. (2011). Residential high-rise buildings in São Paulo: aspects related to the adequacy to the occupant's needs. *Journal of Housing and the Built Environment, 26*(1), 73-84. doi:10.1007/s10901-010-9200-y

Ornstein, S. W., & Ono, R. (2010). Post-Occupancy Evaluation and Design Quality in Brazil: Concepts, Approaches and an Example of Application. *Architectural Engineering and Design Management, 6*(1), 48-67. doi:10.3763/aedm.2009.0102

Pasquale, L., Hancock, M., & Stevenson, F. (2011). *Embedding building performance evaluation in a medium-sized architectural practice: A soft landings approach.* Paper presented at the Conference Proceedings of the 27th International Conference on Passive and Low Energy Architecture. pp 17-22, Louvain, Belgium.

Preiser, W. F. E., Vischer, J., Preiser, W., & Vischer, J. C. (2005). *Assessing building performance*. Amsterdam ; London: Amsterdam ; London : Elsevier Butterworth-Heinemann, 2005.

Quale, J. D. (2012). *Sustainable, affordable, prefab : the ecoMOD Project*. Charlottesville: University of Virginia Press.

RAEng. (2013). Royal Academy of Engineering Centres of Excellence in Sustainable Building Design. Retrieved from https://www.cibse.org/raeng-centres-of-excellence-in-sustainable-buildin/about-cesbd

Residovic, C. (2017). The New NABERS Indoor Environment tool – the Next Frontier for Australian Buildings. *Procedia Engineering, 180*, 303-310. doi:10.1016/j.proeng.2017.04.189

RIBA. (2013). RIBA Plan of Work 2013. Retrieved from https://www.ribaplanofwork.com/

RIBA. (2014). *RIBA procedures for validation and validation criteria for UK and international courses and examinations in architecture*. Retrieved from London: https://www.architecture.com/-/media/gathercontent/validation-procedures-and-criteria/additional-documents/validationprocedures2011secondrevision2may2014pdf.pdf

RIBA. (2016). *What Clients think of Architects Feedback from the 'Working with Architects' Client Survey 2016*. Retrieved from https://www.architecture.com/-/media/gathercontent/working-with-architects-survey/additional-documents/ribaclientsurveyfinalscreenwithoutappendixpdf.pdf

RIBA. (2017). Post Occupancy Evaluations: How the government can get most out of capital funding programmes. Retrieved from https://www.architecture.com/-/media/gathercontent/post-occupancy-evaluations/additional-documents/ribapoepolicypaperpdf.pdf

RIBA, Hay, R., Bradbury, S., Dixon, D., Martindale, K., Samuel, F., & Tait, A. (2017). *Pathways to POE*. Retrieved from https://www.architecture.com/-/media/gathercontent/post-occupancy-evaluation/additional-documents/buildingknowledgepathwaystopoepdf.pdf

Rohdin, P., Molin, A., & Moshfegh, B. (2014). Experiences from nine passive houses in Sweden – Indoor thermal environment and energy use. *Building and Environment, 71*, 176-185. doi:10.1016/j.buildenv.2013.09.017

Samuel, F. (2017). Supporting Research in Practice. *The Journal of Architecture, 22*(1), 4-10. doi:10.1080/13602365.2017.1280288

Sapsed, J., Gann, D., Marshall, N., & Salter, A. (2005). From here to eternity?: The practice of knowledge transfer in dispersed and co-located project organizations. *European Planning Studies, 13*(6), 831-851. doi:10.1080/09654310500187938

Schiano-Phan, R. (2012). Post- occupancy evaluation of non- domestic buildings using passive downdraught evaporative cooling in south- west USA. *Architectural Science Review, 55*(4), 320-340. doi:10.1080/00038628.2012.725535

SCHOSA. (2015). SCHOSA Conference: Beyond Building Performance: architectural research, practice and education. Retrieved from http://www.schosa.org.uk/docs

SCI-Network. (2012). *Post Occupancy Evaluation: An insight into current POE-related policies and practices by European public authorities to drive sustainable construction and innovation*. Retrieved from http://www.sci-network.eu/fileadmin/templates/sci-network/files/Resource_Centre/Reports/SCIN_POE_final_report_-_June_2012.pdf

Sommer, R. (1969). *Personal Space: The Behavioral Basis of Design* (16th printed edition ed.). Englewoods Cliffs, New Jersey: Prentice-Hall (Spectrum).

Stawitz, C. C., MeGehee, H. S., Devlin, C. M., Tan, F., & Wong, S. (2008). *Increasing awareness of residential energy consumption: Data analysis and presentation for ecoMOD, a sustainable housing initiative.* Paper presented at the Proceedings of the 2008 IEEE Systems and Information Engineering Design Symposium, SIEDS 2008.

Steemers, K., & Manchanda, S. (2010). Energy efficient design and occupant well- being: Case studies in the UK and India. *Building and Environment, 45*(2), 270-278. doi:10.1016/j.buildenv.2009.08.025

Stevenson, F., & Baborska-Narozny, M. (2017). Housing performance evaluation: challenges for international knowledge exchange. *Building Research & Information*, 1-12. doi:10.1080/09613218.2017.1357095

Stevenson, F., & Rijal, H. B. (2010). Developing occupancy feedback from a prototype to improve housing production. *Building Research and Information, 38*(5), 549-563. doi:Pii 926025671 10.1080/09613218.2010.496182

Stevenson, F., Roberts, A., & Altomonte, S. (2009). *Designs on the Planet: a workshop series on architectural education and the challenges of climate change* Paper presented at the Proceedings of the 26th International Conference on Passive and Low Energy Architecture, Quebec, 22-24 t^{h} June, Quebec. http://www.plea2009.arc.ulaval.ca/En/Proceedings.html

Strelets, K., Perlova, E., Platonova, M., Pankova, A., Romero, M., & Al-Shabab, M. S. (2016). Post Occupancy Evaluation (POE) and Energy Conservation Opportunities (ECOs) Study for Three Facilities in SPbPU in Saint Petersburg. *Procedia Engineering, 165*, 1568-1578. doi:10.1016/j.proeng.2016.11.895

Takata, M., Taniguchi, S., & Hoyano, A. (2017). *Redesign your previous design studio work according to the environment! - Learn principles of environmental design from famous architect's houses and taking your own field measurements-*. Paper presented at the Proceedings of the 33rd International Passive Low Energy Architecture, Edinburgh. https://plea2017.net/

Thomas, L. E. (2017). Combating overheating: mixed-mode conditioning for workplace comfort. *Building Research & Information, 45*(1-2), 176-194. doi:10.1080/09613218.2017.1252617

Vlasova, L., & Gram-Hanssen, K. (2014). Incorporating inhabitants' everyday practices into domestic retrofits. *Building Research & Information, 42*(4), 512-524. doi:10.1080/09613218.2014.907682

Way, M., & Bordass, B. (2005). Making feedback and post-occupancy evaluation routine 2: Soft landings – involving design and building teams in improving performance. *Building Research & Information, 33*(4), 353-360. doi:10.1080/09613210500162008

Wenger, E. (2000). Communities of practice and social learning systems. *Organization, 7*(2), 225-246. doi:10.1177/135050840072002

Wenger, E. (2004). *Communities of practice : learning, meaning, and identity*. Cambridge ; New York: Cambridge University Press.

Williams, J., Humphries, B., & Tait, A. (2016). *Post Occupancy Evaluation and Building Performance Evaluation Primer*. Retrieved from London, UK: https://www.architecture.com/-/media/gathercontent/post-occupancy-evaluation/additional-documents/ribapoebpeprimerpdf.pdf

Williamson, T., Soebarto, V., & Radford, A. (2010). Comfort and energy use in five Australian award- winning houses: regulated, measured and perceived. *Building Research & Information, 38*(5), 509-529. doi:10.1080/09613218.2010.494890

Young, N., Corriveau, M., Nguyen, V. M., Cooke, S. J., & Hinch, S. G. (2016). How do potential knowledge users evaluate new claims about a contested resource? Problems of power and politics in knowledge exchange and mobilization. *Journal of Environmental Management, 184*, 380-388. doi:10.1016/j.jenvman.2016.10.006

Zhu, X. L., & Wu, S. X. (2013). Progress, challenges, and prospects of POE in China. *Intelligent Buildings International, 5*(3), 181-191. doi:10.1080/17508975.2012.748643