

How Practice Size Impacts on the Implementation and Dissemination of Post Occupancy Evaluation

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Abstract: There has been much research on the subject of environmentally sustainable design (ESD), with emerging techniques and technologies improving rapidly and informing sustainability higher education teaching to architects and prospective architects. By examining the success of sustainable designs using post occupancy evaluations, architectural practices might also increase their knowledge of sustainable building practice. Post occupancy evaluations could be useful for improving the designs of future buildings and the design processes that generated them. This paper aims to evaluate these claims by asking: "Do sustainable design practices use the feedback gained from post occupancy evaluations?," "How does the feedback refine the design process?," "How is the information gained in these evaluations absorbed within the firm's design practices?," and, "Does the size of a practice impact on its implementation and dissemination of POE?"

This paper investigates the questions posed above through the questioning of architectural practices that have gained a reputation for environmentally sustainable design by having a strong sustainable design philosophy and/or by being recognised for this by winning a sustainability design award. The interviewed practices will have provided some form of post occupancy evaluation as a service or employed them to add to their own knowledge.

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INTRODUCTION

Post Occupancy Evaluation (POE) evaluates a building and its components once in occupation. There has been much research citing the benefits of POE for the client, architect and the building industry (see, for example, (2001) (Zimmerman & Martin, 2001) (Preiser, 1995) (Way & Bordass, 2005). Much of this recognises that POE should become a standard stage in the design and building procurement process. In the design process, decisions are based on assumptions of how the owner/occupant will utilise the space, but standard architectural practice does not require the review of the design after the building has been handed over (Zimmerman & Martin, 2001). Zimmerman and Martin state (p.169); "without a feedback loop, every building is, to some extent, a prototype – spaces and systems put together in new ways, with potentially unpredictable outcomes."

Traditionally, POE has tested designs from a user's perspective - through surveys, questionnaires, walk-throughs of buildings and observations of user activities. The purpose of the POE is to evaluate how well the design fulfills user needs and the client brief. The evaluations have been developed over forty-five years to gauge the success of all aspects of a design; including the quality of lighting, ventilation, heating and cooling systems, materials, energy consumption and production. Zimring identifies POE as a tool for learning as well as fine-tuning (Zimring & Reitzenstein, 1980). Bordass and Leamann (2005, p. 371) fear that without POE "occupiers may never make the most of the design potential of their building, and large differences between expectations and outcomes can occur virtually unnoticed. Consequently, designers can continue to repeat flawed prescriptions, and may not even realise when they have success that should be replicated." Yet POEs are not commonly used for reasons that we shall now consider.

1. BARRIERS TO THE IMPLEMENTATION OF POST OCCUPANCY EVALUATIONS IN PRACTICE

According to Martin and Zimmermann (2001), the barriers to POE implementation stem from a lack of education. Indeed, according to many of the architects we interviewed, their client's lack of understanding of the advantages of POE was seen as a significant barrier to POE implementation. Bordass and Leaman (2005) see that many clients believe POE serves only to improve future projects and are therefore disinclined to pay for what they see as 'solving the problems of the construction industry.' Architects commonly express a reluctance to undertake evaluation activities that might uncover shortcomings in the building performance for which they could be seen as liable (Zimmerman & Martin, 2001). Identifying a possible solution to liability problems, Cooper (2001) suggests the use of POE during the defects liability period to allow the resolution of small problems within the normal framework of defects. Zimmerman sees the university education of architects in the use POEs as a way of improving their implementation (2001). Preiser attributes increased POE implementation in the United States to the requirement of the U.S. Architects' registration board that candidates show knowledge of POEs and demonstrate experience in their use (Preiser, 1995). Programs such as PROBE (Post-occupancy Review of Buildings and their Engineering) and that at www.usablebuildings.co.uk have also made POEs much more usable elsewhere.

The benefit of POE in innovation testing and in learning from success and failure can be realised only if there are adequate knowledge management processes to transform feedback into information that architects can use in practice. Yet there is a lack of research on knowledge management by architectural practices. Bordass and Leamann suggest that, to avoid bias in POE, they should ideally be undertaken by a party independent of but in close association with the architect (2005). The feedback should then, to have the most impact on decision-making, be processed by a design-architect. Zimring has examined the processes of large client organisations that perform POEs, such as The Disney Corporation and the U.S. Courts (Zimring, 2001). The Disney Corporation has created electronic databases that catalogue projects and POE feedback, while the U.S. Courts have developed design guides from returned information. It has also been found that even when evaluations are carried out and the feedback is documented, the knowledge gained is often not used to inform future designs because project teams often have no access to this knowledge. Zimring concludes by stating that theories on the implementation of POE feedback can only be developed further if organisations “create appropriate conditions for the potential to learn,” and that this requires a variety of staff to have access to the information in a readily useable format (Zimring, 2001, p. 16).

Zimring’s research on the implementation of POE information is restricted to large commercial organisations with sizeable building programs. There is little research, however, on POE feedback implementation in architectural practices. This paper, aims to redress this shortfall and to ask three questions. Firstly, how are architects learning from POE feedback? Secondly, how is POE feedback absorbed into architectural practices’ knowledge and design practices? Lastly, if the information gained from POEs is not being carried forward into future designs, then why not?

2. METHOD

2.1. Participants

The Royal Australian Institute of Architects (RAIA) has attempted to advance sustainable architecture by honouring built designs in their annual awards. The awards increase awareness of sustainable techniques and promote practitioners whose designs minimise their impact on the environment. Although there is some debate surrounding the validity of the awards and the “green” credentials of the buildings they have honoured, Owen stresses that they play an important role in promoting the green movement and are a powerful influence in architecture (Owen, 2003 p.25). It was important that the architects included in our sample held a clear design philosophy of sustainability and thus all participating practices were sustainability award winners. One was from the U.K and the others were from Melbourne, Australia, or its neighbouring regions in Victoria. The RAIA awards were used to refine the scope of our research sample such that our initial search for Australia-based participants was limited to practices with RAIA chapter awards for sustainable architecture. The U.K. practice is a RIBA national Sustainability Award winner and was included in the sample to add to the external validity of the study by providing comparative results. Due to a lack of practices that had both used POE and had won an RAIA sustainability award, our search was widened to include the winners of other notable sustainability awards. Prospective practices received an invitation to participate with an abstract explaining the issues that a questionnaire would discuss. Nine practices responded positively and nine questionnaires were returned, with five practices participating in subsequent telephone interviews. Whilst only three of the eight Australian practices that agreed to take part had won RAIA sustainability awards, all of the remaining five had been honoured by some other national or international sustainability award (for instance, there were winners of a National Green Building Award, a Interior Design - Environmentally Sustainable Design - Category Award, an HIA Award for Most Energy Efficient Home, a HIA National Greensmart Award, and a UN World Environment Day, Sustainable Buildings Award). The various sizes of the practices - from a sole-practitioner to a practice with offices nationwide - allowed us to see if practice-size, as well as the types of projects they commonly were engaged in, influenced the use of POE and how feedback informed future design. The practices were comprised of the following:

- A large renowned U.K. firm (Practice 1) with a long history of using POE. Two architects from the practice completed the questionnaire and one took part in an interview.
- A large national practice (Practice 2) that advertises life cycle analysis as a service. The director completed the questionnaire and took part in an interview.
- Two firms who designed and built their own offices and evaluated the success of these designs. One is a small office (Practice 3) whose principal designer completed the questionnaire and the other is a medium sized collaborative consultancy firm with a subsidiary architecture practice (Practice 4). The director of the subsidiary architecture practice completed the questionnaire and took part in an interview.
- Three more practices that use systems of building analysis and monitoring of designs. One is a large national practice (Practice 5) whose principle director completed the questionnaire. The second was a sole practitioner with a strong focus on sustainable design (Practice 6) who contributed by completing the questionnaire and an interview. The third firm was a small regional practice who describes their services as having a “primary ecologically sustainable design focus” (Practice 7). The director of the regional practice completed the questionnaire and an interview.
- Two well-known medium-sized Melbourne practices. One has received an award for their design of a renowned environmentally friendly building (Practice 8), and the director of this firm completed the questionnaire. The other practice has a recognised focus on “green” architecture and the director was interviewed but did not complete the questionnaire.

2.2. Questionnaire

The questionnaire is in two parts, with the first composed of twenty-one questions using a Likert scale of 1 – 5, where 1 is strongly agree and 5 is to strongly disagree (see Table 1). The second part contains multiple-choice and qualitative questions asking how POEs are used, what is learned from them and how feedback has influenced the design process. The questions were devised to reveal similarities and contrasts in views between practices and sought to answer such questions as; is there a common way of implementing POEs and using the information from them to influence design? Are there common lessons learned from the evaluations? If POEs are not being utilised, is there a reason why the practices find them to be ineffectual or difficult to implement?

Table 1: Combined results from quantitative section of questionnaire. The numbers correspond to the practice numbers defined in section 2.1 (i.e. 1 = Practice 1, 2 = Practice 2 etc.)

QUESTIONS	1	2	3	4	5
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Post Occupancy Evaluations (POEs) are appropriate for all projects	1,4,5	6,8	2,3,7		
2. POEs are appropriate for only certain project types	2	3,4	7	1,5,6,7,8	
3. The feedback from POEs is documented formally within the Practice		1,4	2,3	5,6,7,8	
4. The feedback from POEs is often reviewed/accessed once the project has finished	5	1,2,3,4,6,7,8			
5. The feedback from POEs and the consequences on design is discussed widely within the practice		1,2,3,4,5,6	7,8		
6. The feedback from POEs is often reviewed in relation to future projects		2,3,4,5,6,8	1,7		
7. The feedback from POEs is not relevant to future projects.				1,2,4,6,7,8	3,5
8. The knowledge gained from POEs is important to our design work	2,4,5	1,3,6,7,8			
9. Information gained from POEs is usually used in the initial stages of the design process	2	1,3,4,5,6,7,8			
10. Information gained from POEs becomes a part of the practice body of knowledge.	2,4	1,3,5,6,7	8		
11. Information gained from POEs is not referenced formally for future designs.			4,7,8	1,2,3,6	5
12. Information gained from POEs is not referenced at all for future designs.			7	1,3,4,8	2,5,6
13. Information gained from POEs is used continually throughout the design process.	2	3,5,6,8	1,4	7	
14. Information gained from POEs is used only at certain points in the design process.		1,4,7	3	2,5,6,8	
15. POEs are useful	2,4,5	1,3,6,7,8			
16. POEs are easily implemented.		2,3,4,5	1	6,7,8	
17. Generally, clients want a POE implemented		2	1,3	5,6,7,8	
18. Measuring the performance of a building can be done accurately once it is in occupation	5	1,2,3,4	6,7	8	
19. A building's performance can only be measured once it is in occupation	5,8	1,2,3,4,6,7			
20. Certain techniques and technologies are avoided in future designs because of feedback gained from POEs	5,8	1,2,3,4,6,7			
21. Evaluating the performance of a building is important	1,2,5,8	3,4,6,7			

3. RESULTS & DISCUSSION

3.1. General Opinions

It is important to understand the preconceptions of POE held by the participating practices because such opinions influence the manner in which future POEs are conducted and how the feedback gained from them is used (see Zimmerman & Martin, 2001)). POE was highly regarded in our sample, for all practices either agreed or strongly agreed with statement 15 that "POEs are useful," as well as with statement 21 that "evaluating the performance of a building is important." However, for statement 16 – "POEs are easily implemented" - four practices agreed, three disagreed and one practice was undecided. Two of the three practices that felt POEs were not easily implemented were small firms and the

other was medium-sized. These three practices, like the majority of the participants, execute POEs in-house. However, unlike the other practices, these three practices perform their evaluations informally; obtaining feedback merely through conversation and observation with clients as they found their limited resources made it difficult to perform a formal POE. Practice 1 was undecided about the usefulness of POE. This opinion reflected a long-term experience of performing POE both in informal and formal settings that had revealed the need for more structured, formal POEs, to ease their implementation and improve the usefulness of the information revealed.

Although the majority of the participants agreed and strongly agreed with statement 18 – “measuring the performance of a building can be done accurately once it is in occupation” - two practices were undecided and one disagreed. The same three practices disagreed with statement 16 – “POEs are easily implemented” - which may elucidate why the three practices do not implement a formal POE. In contrast, the practices that use a formal method of POE feel that measuring the performance of a building in occupation is accurate. In response to statement 7 – “the feedback from POEs is not relevant to future projects” - all practices either disagreed or strongly disagreed. Participants echoed this opinion when they all strongly agreed or agreed with statement 8 – “the knowledge gained from POEs is important to our design work.” This acknowledgement of the relevance and importance of POE feedback to future designs indicates that it is seemingly worthwhile overcoming barriers of POE implementation and resolving the difficulties of managing the knowledge gained from them.

3.2. Implementation of Post Occupancy Evaluations

The manner in which a POE is performed and the reasons for its implementation determine the type and usefulness of the information that will be returned and influences too if and how that feedback will be used in future design processes. All the participating practices stated that they perform POE to improve the internal knowledge of the practice. Practice 8 also sees the implementation of a POE as a service to clients, for POE ensures that the practice does “not repeat mistakes or poor outcomes from previous projects. More importantly it assists in adding further operational, strategic and sustainable value for clients in future designs.” This claim is supported by the large firm Practice 5, who describe POE “as a way of improving design service,” and by Practice 4 who perform them to improve the “customer service” of the practice. In the qualitative section of the questionnaire, all practices claim that POEs are important to their design processes and positively influence their design outcomes. Practice 7 believes POE allows for a greater understanding of how the buildings and the products used within them perform, and Practice 1 describes POE as a “fundamental design tool.”

The interviews and qualitative questionnaires revealed how POEs are performed and why the issues they address are determined by the size of the practice and the type of clients and projects they undertake. Thus, as discussed above, the small Practices 6, 7 and 8 perform POE in an informal manner via conversation and observation. These practices disagree that “generally, clients want a POE implemented.” Practice 7 relies on clients informing them during the defects liability period about a building’s problems or successes. As a small practice, with mostly residential work, Practice 7 believed that a formal POE would be of no use or would be impractical because clients do not see the purpose of an evaluation or do not have time to complete one. Practice 7 considered formal evaluation as an “academic exercise,” a view that reflects the opinions discussed by Bordass and Leamann (2005). The large Practice 1, who has implemented POE both formally and informally, refutes such a view. Furthermore, Practice 7 felt that measuring energy use on a project-to-project basis was impractical, as the behaviour of dissimilar clients had to be accounted for. In contrast, the large Practice 2 viewed understanding client energy-consumption as beneficial because they felt that a building is not always used how the designer expects. Practice 6 is a sole practitioner and revealed that, although he had considered technically evaluating his built designs, his practice was too small to carry out such evaluations. Instead, he uses computer-modelling programs to test designs before they are built.

Practice 8, which is medium-sized, performs evaluations to assess the outcomes of the building relative to that predicted at concept design phases. The director states that POE assists to ensure that mistakes or poor outcomes are not repeated and thus gives “operational, strategic and sustainable value” to future clients. The small firm Practice 3 is dedicated to sustainable building. Their clients understand and expect, from the practice name and website to the reputation of its principle designer who has advised the government on sustainable issues and lectured on behalf of the Australian Greenhouse Office, that the designs of practice 3 will have a “green” focus. Although many clients of this practice do not understand the advantages of POE, an ignorance often seen by Bordass and Leamann (2005), the practice often persuades them through education to implement POE. This has enabled the practice to analyse owner-occupiers’ energy use and how this usage affects a building’s thermal performance. For practice 3, client education is important and plays an important role in improving the usefulness of POE.

Practice 4 is medium sized and performs POE in the form of structured reviews with clients. The POEs are implemented for projects identified by the practice as needing evaluation, such as large-scale buildings, and examine building performance in terms of sustainability. The practice believes that the perception of good service advanced by POE influences not only client satisfaction but also design outcomes. Their evaluations look, therefore, at not only building performance but also at the success of the design process and at the performance in the client’s view of the practice’s employees. The interviewed director felt that structured evaluations are key to the success of their practice and inform not only future designs but also the manner in which the office runs and how project teams are developed. The size of this practice and its role as part of a larger national company enables the evaluation process to take a far broader appraisal of design to include its process as well as its product in the form of a built design.

The large national Practice 5 also sees POE as crucial to good client service as well as to practice education. The practice uses a consultancy firm for evaluations, using what the director describes as a “pre and post approach” to assess designs in terms of “critical success factors” that are established at the start of the project. For this practice, a POE enables them to understand the physical and psychological implications of design decisions.

Practice 2 is also a large national practice and undertakes many sizeable government and tertiary education buildings commissioned by repeat clients. POEs are performed by them in both an informal and formal manner, depending on the nature and scale of project. Normally, close relationships with clients enable feedback and anecdotal information to be collected. However, the practice director recognises that anecdotal feedback is not always accurate, especially in public

projects when the client is not the user of a building. In instances where innovative or ambitious goals have been set, the practice will commit funds and time for a consultant to perform a structured, formal POE. Formal POEs are also usually performed for repeat clients who have a constant building program – such as universities – and for those who request an evaluation. The practice has performed POE as proof of building performance for clients who had precise environmental demands, and has also used POE as a tool to inform the retrofit or fine-tuning of buildings.

The large firm of Practice 1 uses consultants for POE that is used to inform future designs and verify designs during construction. They evaluate buildings in terms of energy consumption, occupant satisfaction and environmental control. Their clients tend not to demand POE unless they specifically indicate that sustainability is a prime aim. When discussing the influence of the scale of projects, large Practice 1 reflects the opinion of large Practice 2 on the problems of acquiring client feedback. Namely, that for bigger projects, evaluation is made difficult by the fact that there are many end users who often are not their clients, especially when compared to smaller residential projects when the user is normally the client. Thus, the smaller the project the easier it is to get clear and reliable feedback. Practice 1 finds that lines of questioning must be project specific if feedback is to be useful for future design.

To sum up our findings on POE implementation; the smaller practices in our sample tended to perform POE informally due to their limited resources and their consequential need to make evaluations appropriate to the scale of their projects and fees. They normally found that it is possible to evaluate built designs directly from client feedback because their clients tend to be the end users of their designs. This finding is in line with the research of Cooper (2001), who advises that such informal POEs can generally be performed during the defects liability period when small problems can be unearthed. The implementation of POE in the medium-sized practices of our sample occurred in a more structured manner and took place in-house. The scope of their POE varied according to their priorities and the scale of their projects. For the large practices in our sample, POE was project specific. For smaller projects, the large practices implemented evaluations in-house, while for larger projects consultants performed evaluations. The large Practices 1 and 2 revealed that clients with a continuing building program routinely demanded a POE and expected feedback to inform subsequent projects. In common with Martin and Zimmerman (2001), Practice 1 cites the feedback loop of POE as important to improving the status of POEs in the construction industry.

All practices in our sample perform POE for the improvement of their expertise. Only two practices stated that they have implemented POE purely because of a demand for this service from clients. Three of the nine participating practices did not specifically assess the energy use of buildings and other measures of “sustainability” in their POE. Two of these practices are small and claimed that targeting “sustainability” performance in POE would require unfeasible resources.” Clearly, the size of the practices seems here to have an influence on how POE is implemented and what questions are asked. As a result, we might expect practice size to also impact on how feedback is managed and used to inform practice.

3.3. The Management and Dissemination of POE Knowledge

All the interviewed practices stated verbally that the information gained from POE is used to inform future projects. This is verified in their questionnaires, where seven practices agreed and one strongly agreed that “the feedback from POEs is often reviewed/accessed once the project has finished.” Six of the practices agreed with statement 5 that “the feedback from POEs and the consequences on design is discussed widely within the practice,” while two were unsure that this occurred. Exactly the same responses were given by the same practices for statement 6 - “the feedback from POEs is often reviewed in relation to future projects.” For statement 12 - “information gained from POEs is not referenced at all for future designs” - only three practices strongly disagreed, four disagreed and one was undecided. Thus it would appear that most of our sample agree with Zimring that the longer-term benefits of implementing POE can only be realised if the information gained is managed to make it easily accessible by staff and readily usable therefore in future design (Zimring, 2001).

Practice 7, however, responded undecided to all three statements on POE knowledge management. The small size of the practice and their responses to questions on the nature and scope of their evaluations would suggest that their failure to advance a POE feedback loop is related to the informality of their POE process. This likelihood is reinforced by the responses of the medium-sized Practice 8, which was undecided about whether feedback was reviewed in relation to future designs in their office, and in discussions revealed that, although feedback is becoming more formally documented in their office, it currently circulates ad hoc. In the small Practices 6 and 7, where evaluations are carried out informally with clients, the POE feedback loop takes place merely via casual conversation and office meetings. In Practice 7, more formal feedback management systems, such as office standards, are being developed as the practice grows. The two small Practices 6 and 7 both found that most POE confirms early computer simulation and the intuitive understanding that their architects have of building energy performance. POE has, however, fine-tuned for them their understanding of passive lighting techniques, materials properties and water conserving systems.

Practice 3 is also a small practice, yet handles the dissemination of POE information in a formal manner via staff meetings and an office design-standards manual. As the practice focuses POE on the technical performance of their buildings, the POE information is too specific to be distributed informally. Their design process also includes discussions of POE feedback as early as the sketch stage because they have found this feedback to refine early ideas. Regular design reviews amongst their staff disseminate POE knowledge from past projects to inform design decisions and to improve sustainable building techniques.

As a medium-sized firm with a large number of staff, Practice 8 recognises that in order to be sure that design teams use POE feedback to influence future designs, the feedback loop must be formalised. Thus, the practice is now formalising dissemination by circulating POE via office meetings and a design-standards manual. The medium-sized Practice 4 also has a formalised POE feedback loop. The directors of Practice have regular meetings with their “Development Manager” whose responsibility it is to implement POE and then disperse the feedback to project teams via meetings and office design-standards. Moreover, their design process includes structured reviews that provide the opportunity to test designs against the POE feedback of past projects. The practice recognises that its large design teams need access to POE feedback via both formal and informal systems that encourage them to inform and test designs using the feedback.

Like some of the smaller practices in our sample, the large national Practice 2 disseminates POE feedback via casual conversation, meetings, and the inclusion of information in an office design-standards manual. The practice also engages in in-house training sessions and slide presentations where previous POEs are reviewed. These workshops are held at the commencement of projects to determine how past POE can inform their design.

Two of the large practices, Practice 5 and Practice 1, use an intranet to disseminate POE feedback. In Practice 5, the POE feedback loop is encouraged by the combination of this intranet with regular design workshops where people from within and outside the firm contribute. The use of an intranet as both a formal database and a communication tool between offices in Practice 5 enables all staff to learn from the POE of many past projects. The workshops are structured to facilitate the ready exchange of POE to inform future designs. Practice 1 uses the intranet to upload to a knowledge-management database key recommendations and summary documents collected from POE. Like practice 5, workshops and design reviews are used by Practice 1 to formally present POE conclusions to project teams, to research groups within the practice and to engineering consultants (who collaborate with the practice's architects on the implementation of its sustainability agenda and environmental management strategies). The practice also encourages staff to attend professional development seminars to disseminate and advance expertise informed by POE. These dissemination initiatives highlight to design team members the importance of learning from others and from past projects in order to improve future design. Despite these initiatives, Practice 1 is undecided about statement 6 – "the feedback from POEs is often reviewed in relation to future projects" - for the practice feels the inclusion of POE feedback in its design processes needs even greater formalisation. The practice is therefore presently trying to systemise feedback implementation in the form of a checklist for each fee stage. The practice sees that, although their current POE dissemination methods could be improved, they have however informed practice. For instance, POE has shaped environmental management strategies that seek to avoid the dangers of overcomplicating Building Management Systems and have illuminated unexpected energy loads in buildings due to occupancy behaviour. POEs have also enabled the practice to recognise the importance of engaging from early design stages engineering consultants with sustainable building expertise. In our sample, the degree of formality of POE dissemination is very much related to practice size. The larger practices have been able, due to economies of scale, and been compelled, due the complexity and size of the collaborative structures of their design teams, to develop formal electronic systems of documenting POE feedback that are reinforced with design workshops and reviews. Such a combination of dissemination methods also allows for the different learning styles of staff. Currently, for most of the practices POE dissemination is structured to largely inform only the initial stages of the design process when perhaps systems could be implemented to ensure POE feedback is used at all stages of design.

CONCLUSION

This paper has aimed to explore the use of POEs in architectural practice, how architects learn from POE, and has asked - if the information gained from POE is not used to inform future designs, then why?

Post occupancy evaluations are used in all the participating practices, however the method by which they are implemented and the type and usefulness of the information revealed is largely determined by the size of the practice and hence the scale of projects they undertake. Practice size also determines the way feedback is documented and disseminated.

Two of the three smaller practices found that feedback from informal reviews with clients was less useful for future design than they had hoped due to the unspecific nature of such POE. The feedback was used, however, to confirm software simulation accuracy and fine-tune understandings of design and material/construction system decisions. These small practices believe that formal evaluations are not appropriate and too difficult to implement for small-scale projects. Feedback in these practices tends to be distributed via casual conversation as necessary. The third small practice, however, desired to put to more effective use what they learned from past projects and felt that POE was informative for developing sustainable building techniques. When the clients of this practice were not eager for POE, the practice attempted to educate them of the benefits of POE and generally performed some form of design evaluation for the education of the practice even when clients refused to fund POE.

In the medium-sized practices, POEs were always performed in-house – as occurred in the smaller practices too. However, POE tended to be more structured for the medium-sized practices and able to evaluate a wider variety of design influences and decisions - including practice structure and technical building performance data. Although these medium-sized practices had key principle designers, they have larger teams than the small practices and their processes of design are therefore much more collaborative. As a result, it is important that their teams have access to POE via both formal and informal systems and follow a design process that encourages and allows the implementation of the knowledge informed by POE.

The directors and principle designers of all the practices had direct access to information from POE. This was because they were either involved in carrying out the evaluation or, where consultants were used, they were the first receivers of returned information. These principle designers were able, therefore, to implement feedback in future designs. In the bigger practices, large project teams usually carry out design and it is important therefore to structure the dissemination of POE feedback throughout the office. The larger practices have also been compelled to implement a variety of dissemination systems to cater for the different learning preferences of those who make up the firm. Some may find conversation between colleagues the ideal way of learning, while others gain more from an intranet or database of information. For these larger practices, structured design reviews have proven the most used and successful method for integrating POE into the design process.

All the participating practices that perform a formal POE have found the feedback to be informative for future design and for improving their understanding of sustainable building techniques and technologies. It is notable that in our assembly of "green" practices, six out of the nine have used POE to specifically evaluate sustainable building techniques and technologies and that the other three practices were all small in size. Two of these three small practices stated that to evaluate the sustainability of their buildings via POE would be too difficult because they did not have the resources to do

so. The large Practice 5 has established an intranet research database for sustainability investigations. This practice recognises, however, that POE is not being used by them to its full potential and agrees, as has also been recognised by both Martin and Zimmerman (2001) and Preiser (1995), that there is a need for education of architects in the implementation and dissemination of POE. As Zimmerman and Martin state (2001), to ensure that sustainability objectives are realised, POE is needed to close the loop between intention and reality. To enable this, medium and larger scale practices need to structure their design process to ensure that the dissemination of POE and the use of it to inform future design are scheduled duties of its architects. For smaller practices, there is the need to educate owner/occupiers of the effect on them of the buildings that they occupy and of how POEs are critical to understanding and shaping that effect.

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