RIBA

Royal Institute of British Architects

Architects and research-based knowledge:

A literature review

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RIBA

Contents

Foreword

The RIBA recognises the intimate relationship between research and design innovation. This is why becoming the hub for knowledge, innovation, research and debate on the built environment[1] is one of the Institute's key priorities.

This literature review is part of a suite of key documents, *Architects and Research*, for the RIBA. It summarises the current understanding of the profession's information practices, as found within the academic literature. The other publications look at the current state of housing research in architectural practices (*Home Improvements*), the use of research-based knowledge in practices large and small (*How Architects Use Research*), as well as giving architects guidance on how to engage more with, and benefit financially from, the research that is an integral part of their working lives (*Research in Practice Guide*). With SCHOSA (the Standing Conference of Heads Of Schools of Architecture) we have also developed a resource – currently an interactive pdf, but intended to become an online database linked to *Find an Architect*[2] – so that practising architects can more easily find academics with relevant research interests with whom they might work *(RIBA/SCHOSA Review of University Research 2013*).

While architects' workloads appear to be recovering,[3] the current economic climate remains challenging. Practices that offer 'additional' professional services (as *How Architects Use Research* shows, research is integral to practice, but clients are not always aware of this) will not only have a competitive advantage, but will also be more able to access alternative funding streams, such as research funding. For example Ash Sakula, Satellite Architects and Urbed won research funding from the Arts and Humanities Research Council (AHRC) through the *Home Improvements* project.[4]

But research is more than just a potential source of revenue: it goes right to the heart of what it means to be a professional[5] and, for the RIBA, is at the heart of what it means to be a learned institute. That is why this review is just an early step in a journey with many fellow travellers. For example, *Design Research in Architecture – An Overview*,[6] of which I was privileged to be the editor, is the first in a major series of books by Ashgate that look at the role of design research in the creation of insights and knowledge by architects. The RIBA's Research and Innovation Group is building upon the *Research in Practice Guide* to look in more detail at methods of investigation that architects can employ – which will also form a future book giving younger architects solid, practical guidance on how to do, and benefit from, research.

The RIBA, of course, also continues to support and celebrate research in numerous other ways: through its research symposia,[7] research funding,[8] awards,[9,10] public programmes,[11] events such as "Research Matters" and, of course, the various social media platforms with which it engages, for example RIBA Knowledge Communities.[12]

This document will help the RIBA to refine its strategy for communicating research, but is also a useful resource for practices who might be wanting to, for example, encourage knowledge sharing between their staff members. Some readers will only want to read the executive summary, others may want to explore the full review: for example to see how Arup take advantage of architects' preference for peer-to-peer knowledge exchange. However you engage with the review, we hope you find it an intriguing insight into research and information exchange in our profession.

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1. RIBA, 2012. *Leading architecture: The RIBA's strategy 2012-2016*, [pdf] London: Royal Institute of British Architects.

2. RIBA (n.d.) *Find an architect*. [online]

3. RIBA (n.d.) *Future Trends survey*. [online]

4. University of Sheffield (nd.) *AHRC Home Improvements - Home Improvements - Home Research Projects - Home - Research at SSoA - School of Architecture - The University of Sheffield*. [online]

5. (2013) *Building Research & Information* **41**(1) [online]

6. Fraser, M. ed. (2013) *Design Research in Architecture*, Farnham: Ashgate.

7. RIBA (n.d.) *Research Symposium 2013*. [online]

8. RIBA (n.d.) *Research Funding*. [online]

9. RIBA (n.d.) *RIBA President's Awards for Research*. [online]

10. RIBA (n.d.) *RIBA President's Medals*. [online]

11. RIBA (n.d.) *RIBA Public Programme*. [online]

12. RIBA (n.d.) *RIBA Communities*. [online]

Executive summary

Part of a series of RIBA publications on research – *Architects and Research* – this desktop study, undertaken for the RIBA by the Research Information Network, looks at published academic research on information practices in architecture and the built environment. The study is intended to help the RIBA to refine its strategy for communicating research, but is also a useful resource for practices who may be wanting to, for example, encourage the sharing of knowledge between their staff members. It demonstrates the importance of understanding research cultures across the built environment sector for those, such as the RIBA, seeking to encourage closer relationships between researchers across practice and academia, and more effective knowledge transfer.

While there are different understandings of research…

There is a plurality of understanding about what activities constitute research. In particular, practicing architects may not recognise their design research as research, and consequently fail to maximise value from the knowledge gained through the design process.

…the value of research is widely recognised, but there remain significant barriers to research in practice.

There is wide recognition from practitioners of the potential benefits of engaging with research, in particularly Post-Occupancy Evaluation, and its importance to the work of practices. However there is a rift between intention and practice.

Post-Occupancy Evaluation was identified as a key method to improve design quality and reduce the 'performance gap', but there are a number of barriers – some of which are misconceptions – to wider uptake, including:

- A perception from clients (particularly one-off clients) that value accrues to the architect's next client, rather than to themselves
- Concerns regarding legal or financial liability
- A belief that evaluation is expensive, and a resulting unwillingness to meet costs – whereas costs may actually be as low as 0.25% of construction costs.

Because of difficulties in obtaining funding for project-related research many studies called for resources to be built in at the start of any project, for example through the Soft Landings process.

Reliable and unbiased knowledge about client requirements, along with user needs and behaviour, are also important in improving design quality and performance. A structured process (i.e. a research process) is most effective in gaining this knowledge.

There are different knowledge cultures in practice and academia…

Many problems that architects face in accessing and using research appear to arise from differing cultural norms, knowledge practices and knowledge bases within the profession and academia. Other built environment professions and the construction industry more widely also have differing knowledge cultures.

Lack of effective systems to support knowledge gathering and exchange in practice means that many practices – particularly small ones – are failing to learn not only from peers and colleagues, but are also not benefitting from knowledge created in their own projects.

Architects, more than any other profession, appear to accept the primacy of 'knowing-in-practice': while they create an 'immense' body of knowledge it is largely shared informally, and rarely codified into organisational or industry memory. Attitudes to research and knowledge exchange appear to be rooted in architectural education, learning styles and preferred communication methods, which are primarily visual and peer-to-peer.

…which compound barriers to knowledge exchange in practice.

Project-based working (including forms of appointment) and resource constraints appear to further militate against the recording and sharing of knowledge in practices. Project pressures create practices which are 'good enough' for immediate needs but do not support effective longer term knowledge sharing, with most insights from project-based research not being formally recorded.

New tools and frameworks intended to facilitate knowledge transfer may inadvertently reinforce existing behaviours and knowledge culture differences. Further, tools that do not work with existing behaviours and patterns of thinking (and cannot change them) will tend to be unsuccessful, for example practice-based WIKIs, or will be used for other purposes. Some practices are responding to this by trying to adopt facilitated knowledge exchanges processes that work in harmony with user preferences and ways of working.

The benefits for practicing architects of engaging with academic research do not appear to have been addressed in the literature, but this does not imply that academic research does not have value for architects, and the evolving discourse around academic impact will address this gap in the literature in the future. Nonetheless barriers to wider engagement of academic research remain, including a preference for academic knowledge exchange to take place via scholarly communication and journal articles (although academic architects are challenging the academic community to be more accepting of design), and a suggestion that the primary drivers for academic research are not related to the profession.

Funding for collaborative research is seen as a way to bridge the divide between practice and academia, but has not been widely embraced.

What the RIBA is doing…

Building lasting relationships between practice and academia is an important part of meeting the RIBA's aims to become a hub for knowledge, innovation, research and debate on the built environment. The importance of research informs much of the RIBA's work, from education (RIBA Validation criteria emphasis that '*part 2 will be awarded to students who have… …critical understanding of how knowledge is advanced through research to produce clear, logically argued and original written work relating to architectural culture, theory and design*') through to public programmes (the popular *Perspectives on Architecture* series). These supplement the RIBA's support for, and celebration of, research through its research symposia, research funding, awards, events such as "Research Matters" and, of course, the various social media platforms with which it engages, for example RIBA Knowledge Communities. In particular the RIBA has:

- Incorporated research activities into the RIBA Plan of Work 2013, supporting architects in making the case for fees related to their research work;
- Sought a better understanding of exactly how practicing architects make use of research in their practice through *Home Improvements: Housing Research in Practice* and *How Architects Use Research* to supplement the sparse literature on the subject.
- Commenced a programme of work to support architects wanting to engage with research through the *Research in Practice Guide* and a forthcoming book *Research in Commercial Practice*.

Introduction

In 2012 the RIBA started a number of projects looking at the role of research in the life of the profession, and encouraging its further development. This literature review, undertaken for the RIBA by the Research Information Network (RIN),[13] is a key part of the series, seeking to understand how architects find, create and share research-based knowledge: to investigate their **knowledge practices**. Other publications in the series include *Research In Practice Guide*[14] and *Home Improvements: housing research in practice*[15] as well as the forthcoming *How Architects Use Research* and the *RIBA/SCHOSA review*. The RIBA/SCHOSA review of academic architectural research will provide practising architects with a single point through which to find academic research experience in their field of interest – a task which has been particularly difficult to date.

Since the beginning of architecture the foundations of architects' knowledge has been the activities of past generations. For the builders of Gothic cathedrals knowledge had a mystical and secret status, but skipping forward to the twentieth century we see the architects of functionalist modernism embracing research more openly. Le Corbusier was one of the first to realise the propaganda value of facts and figures, although in reality their impact on his work was minimal. In the UK it was through the work of Sir Leslie Martin in the early 1960s that research-based practice received new impetus.[16]

It was at roughly this time that there was a close relationship between the social sciences and architecture – albeit short-lived – particularly in housing, as sociologists studied (and sometimes found wanting) architectural experiments in the field. The development of feminist practices, such as Matrix[17], led to a call for an architecture based on real need, an impetus that continues to this day through the more socially-driven work of architecture schools such as the University of Sheffield.

In 1980s USA – at a point when architecture was revolting against functionalism – Roger Ulrich began a series of experiments showing the relationship between access to views of nature and the reduced use of drugs in hospitals,[18] and so the beginnings of what has come to be known as Evidence-based Design, advanced in the UK principally through the work of Bryan Lawson.[19]

13. RIN (2012) *Research Information Network*. [online]

14. RIBA, Coucill, L., Samuel, F., Dye, A., Tait, A. and Crosby, M. (2013) *RIBA Research in Practice Guide*. [online pdf]

15. Samuel, F., Coucill, L., Dye, A. and Tait, A. (2013) *Home Improvements: Housing Research in Practice*. [online pdf]

16. Dutoit, A., Odgers, J. and Sharr, A. eds. (2010) *Quality out of control: Standards for measuring architecture*. London: Routledge.

17. Spatial Agency (n.d.) *Matrix Feminist Design Co-operative*. [online]

18. For example see:

Ulrich, R.S. (1981) 'Natural Versus Urban Scenes Some Psychophysiological Effects.' *Environment and Behavior*, [online] **13**(5), pp.523–556.

Ulrich, R.S. (1984) 'View through a window may influence recovery from surgery.' *Science*, [online] **224**(4647), pp.420–421.

Ulrich, R.S. (1991) 'Effects of interior design on wellness: theory and recent scientific research.' *Journal of health care interior design: proceedings from the ... Symposium on Health Care Interior Design. Symposium on Health Care Interior Design*, 3, pp.97–109.

19. See publication list here: (n.d.) *ResearchGate - Bryan R Lawson*. [online]

UK universities have become engines of academic architectural research, particularly under the influence of first the Research Assessment Exercise (RAE) and now the Research Excellence Framework (REF). But as the RIBA/University of Sheffield *Home Improvements: housing research in practice* report has shown, this has had very little impact on practices. While "*...architecture's bias towards the tacit weakens the dependability of the knowledge base and leaves the field open to colonisation...*"[20] there is an opportunity for architects to take back lost ground and to disseminate the insights they uncover through their research practice in a more authoritative way.[21]

The body of literature on architecture and the built environment knowledge practices is not particularly extensive, unlike the body of literature on architectural and built environment research itself, which is considerable.[22] Of the literature on knowledge practices reviewed by the RIN, much focuses on issues such as post-occupancy evaluation (POE) or Building Information Modelling (BIM).

While the barriers to undertaking POE, and other related forms of research, paint a rather gloomy picture, these are being eroded by opening up discussions and demystifying the issues. The Bridge the Gap campaign from the Architects Journal raises the profile of POE and building performance by sponsoring debates, providing guidance on metrics and joining forces with institutes and their awards programmes. This leadership for the industry places architects as the key providers of post occupancy services, now given their own stage in the RIBA Plan of Work 2013.

This study helps to demonstrate the importance of guidance and support for architects to help them begin to engage with research and to raise the profile of practice-based research.

20. Owen, C. and Dovey, K. (2008) Fields of sustainable architecture. *The Journal of Architecture*, [online] **13**(1), pp.9–21.

21. Hamilton, D.K. and Watkins, D.H., 2009. *Evidence-based design for multiple building types*. Hoboken, N.J.: John Wiley & Sons.

22. To get an idea of the scale of the body of knowledge see the Architectural Publications Index (API) which at present consists of around 480,000 index records, to which around 10,000 new records are added annually. See RIBA (n.d.) *About the online catalogue*. [online]

Findings

1. Understanding 'research'

The literature suggests that while the term 'research' was not widely used by most architects – but note that this view may now have become outdated, as the later publication in this series *How architects use research* shows – many of them undertake activities that can be seen as research, even if they might not consider it so themselves.[23] The review identified two broad categories of research that architects might engage with:

- Design Research: research that is undertaken by architects and their collaborators in the course of a project; and
- Research Projects: research that is done by architects and others, in practice and academia, outside the scope of architectural projects.

Design Research – research during the course of a project – can be broken down into two further categories:

- research activity carried out specifically to inform or evaluate a building/project, for example during the client briefing process or POE; and
- a broader category of research that encompasses all the work done to gather, evaluate, interpret and share information in the course of the design and construction process.

The RIBA Validation criteria for schools of architecture, emphasises that 'part 2 will be awarded to students who have… …critical understanding of how knowledge is advanced through research to produce clear, logically argued and original written work relating to architectural culture, theory and design'.[24] This enforces the need for understanding of the first type of design research however the literature in this review suggests that the second, broader, research is less likely to be recognised by architects themselves as research activity; nonetheless interactions with the design team and others involved with the project, and even the design process itself, are processes which involve the collation and organisation of knowledge to reach new understandings – in other words: research. A key aspect of research, as defined regarding the UK's Research Excellence Framework (REF), is that new insights should be effectively shared.[25] Clearly the outputs from these processes could – if recorded, managed and shared – be used to inform future work.

Research done outside the scope of individual architectural projects might be done by academics in schools of architecture and other university departments (for example engineering, history of art, materials science, environmental science, social science and so on), in R&D departments of larger architectural firms or by specialist research consultancies. There is a plurality of understanding of what constitutes research in this context, and it is clear that a wide gulf remains between academics and practitioners.

The *RIBA Plan of Work 2013*[26] places considerable emphasis upon information, and information outputs. Two 'task bars' are dedicated to Information Exchange, one relating to project stakeholders and the other to UK Government information requirements. Post-Occupancy Evaluation is not only an explicit part of the new Stage 7 (along with a review of project performance, project outcome and research and development) but the review of the findings from previous projects is included in Stage 0, with the intention of closing the feedback loop, and binding research more tightly into project processes.

What will become clear, however, from the rest of this paper is that many of the problems which architects face in accessing and using research arise, not from limitations within a specific project, but from wider cultural norms within the profession and industry.

23. Jenkins, P., Smith, H. and Garcia-Ferrari, S. (2005) *Architecture, research and the profession in Scotland.* [pdf] Edinburgh: RIAS

24. RIBA (2012) *RIBA procedures for validation and validation criteria for UK and international courses and examinations in architecture.* [pdf] London: RIBA, p.54

25. REF 2014 (2011) *Assessment framework and guidance on submissions (updated to include addendum published in January 2012).* [pdf] Bristol: REF, p. 48

26. Sinclair, D. ed. (2013) *RIBA Plan Of Work 2013.* [online]

2. The value of research-based knowledge

The literature suggests two main benefits for architects who incorporate research – in particular evaluation-type research – into their practice: efficiency gains (changing the way they practice) and innovation gains (changing what they do in practice). In contrast the question of the benefits to architects in engaging with academic research does not appear to have been addressed in the literature. The lack of explicit reference to the value of academic research in this context certainly does not imply that such research lacks value. Rather it may reflect the fact that the evolving discourse regarding academic impact – being assessed for the first time in the 2014 REF – has not yet reached published status; or that the value that academic research confers is rarely commented on and may be difficult to trace over time and across other publications that it has influenced (such as building regulations, design guidance, standards or codes of practice).

2.1. Efficiency

Architects who evaluate their work can use the information and insights gained to improve their business processes and designs in the future.

A major piece of research[27] evaluated a number of POE techniques in practice (in collaboration with a number of architects). Almost all of the participating architects recognised the benefits to practice of undertaking POE, and in some cases, the improvement actually benefitted the project being evaluated, while in most the value was more likely to be realised on future projects. As well as informing architects about problems that might otherwise have been carried forward to future work, the evaluation process allowed architects to identify parts of their projects that had been challenging, but which had not conferred significant benefit to the building's users.

In contrast, the evaluation process can also help architects to identify project success which can then influence future projects; failure to identify project successes can lead to a situation where designers reinvent solutions to design-challenges that they have already addressed.[28] Lawson *et al.*[29] note that:

> *We have found that even with organisations that construct similar projects, there may be little transfer of knowledge even with elaborate procedures in place.* (p 331)

Efficiency gains occur only where the results of evaluations are used; having a procedure in place to promote the use or the results is not necessarily the same as actually ensuring use: the authors talk about this as the difference between intention and practice. Jenkins *et al.*[31] stress that the lack of systems to support knowledge gathering and exchange means that many practices – particularly small ones – are "*reinventing the wheel*": failing to learn not only from their peers and colleagues, but also from their own experiences.

Where the RIBA seeks to widen the debate is to discuss how knowledge practices in architectural practice might be supported, accepting that the economic climate remains challenging and activities not immediately involved with fee-earning will necessarily become a low priority.

27. Bordass, B. and Leaman, A. (2005a) 'Making feedback and post-occupancy evaluation routine 3: Case studies of the use of techniques in the feedback portfolio.' *Building Research & Information*, [online] **33**(4), pp.361–375.

28. Bordass, B. (2004) 'Learning from what we build.' In: S. Macmillan, ed., *Designing Better Buildings: Quality and Value in the Built Environment*. London: Spon, pp.21–32.

29. Lawson, B., Bassanino, M., Phiri, M. and Worthington, J. (2003) 'Intentions, practices and aspirations: Understanding learning in design.' *Design Studies*, [online] 24(4), pp.327–339.

30. Jenkins *et al.*, *op. cit.*

2.2. Innovation

Many buildings contain innovative elements and designs – indeed Bill Bordass suggests that:[31]

> *Every new piece of construction is to some extent a hypothesis and its performance in practice is the experiment.* (p29)

The literature contains several examples of innovative buildings (particularly with regard to energy efficiency) which – when evaluated – proved not to have worked as effectively in use as was hoped. This "performance gap" may occur because the building (and its innovative features) were not used by occupants in the way the designers envisaged – either because systems were complex, or because they conflicted with user behaviours. In other cases, different systems can interact in unanticipated ways to lower the overall efficiency of the building.[32] Bill Bordass notes that, in general, architects will not hear about these types of issues unless they are specifically asked to investigate them, so they often remain unaware of the actual impact – both positive and negative – of the innovations they introduce.[33]

Positive impacts of post-occupancy evaluation and feedback are not limited to projects that contain innovative elements: in more routine projects it can help ensure consistent quality.[34]

3. Research and practice: the two cultures

A key aim of this study was to investigate the relationship between academic research and practicing architects. The literature confirms the anecdotal assertion that there is a disconnect between information practices in Schools of Architecture and those in architectural practice, with one Head of School being concerned about the creation of a '*two-tier society – the teacher architects and the maker architects*', and suggesting that students have to choose just one path at the end of their training.[35] Murray believes that '*excellent*' research produced by some research students is discarded as soon as the students enter the profession, because research-based knowledge is not valued in practice.[36]

A professional education does not finish at the point of attaining a professional qualification but should be considered as lifelong learning through post-qualification CPD and practice-based learning. We must therefore review an architect's education both in schools of architecture and in practice to identify the source of the disconnection between knowledge acquired in academia, and that developed from professional activity.

3.1. Learning, design and the foundations for practitioners' attitudes towards research.

Several studies stress the importance of 'learning through doing' for architects. Heylighen *et al.*[37] highlight the distinction made within professional training between the 'knowledge base' (formally codified knowledge) and 'knowing-in-practice', and they suggest that architects, more than any other profession, accept the primacy of 'knowing-in-practice'. This continues into professional practice, where knowledge and learning from projects are rarely codified into organisational memory – into the knowledge base. This is reflected in the views of an academic, who, when responding to a student's reasonable request for '*the undergraduate textbook on architecture*' noted that '*there isn't such a textbook… you just have to learn it for yourself!*'[38]

31. Bordass, *op. cit.*

32. Bordass & Leaman. (2005a) *op. cit.*

33. op. cit.

34. Bordass & Leaman (2005a) *op. cit.*

35. Murray, G. (2002) 'Teaching, research and practice establishing a productive balance.' *arq: Architectural Research Quarterly*, [online] **6**(04), pp.297–299.

36. *ibid.*

37. Heylighen, A., Neuckermans, H., Casaer, M. and Dewulf, G.P.M. (2007) 'Building memories.' *Building Research & Information*, [online] **35**(1), pp.90–100.

38. Lawson, B. (2002) 'The subject that won't go away But perhaps we are ahead of the game. Design as research.' *arq: Architectural Research Quarterly*, [online] **6**(02), pp.109–114.

Kelly *et al.*[39] suggest that there is a fundamental incompatibility between the ways that many architects learn and the way that research-based feedback mechanisms operate: both in terms of the content, which tends to focus on technical, rather than design, issues; and in terms of the methods of communicating the feedback, which is usually formal and written. Some practices are trying to adapt processes so that research-based feedback mechanisms work more harmoniously with architects' preferred communication methods. For example, Arup's briefing notes – written by their R&D department – include contact details of relevant staff involved with the briefing, encouraging peer-to-peer knowledge transfer.[40]

Where knowledge must be codified in some way architects have a strong preference for visual over written communication: Raisbeck and Tang[41] suggest that architects codify their design knowledge through drawings and models, which are as important as documentation in this respect. A practical element to this preference for the visual was posited by Kelly *et al.*,[42] as it is often the quickest way to summarise and absorb information. This preference can be traced back to how architects are taught and assessed during their training,[43] and is echoed in academic approaches to design as research.[44]

Design is increasingly recognised as a research process and output in its own right, in both academia and practice: '*…a form of research can be seen to take place in the drawing offices of design practices as much as in the laboratories and studios of our schools of design*'.[45] Lawson et al. tracked the changes in how design has been viewed over time, and note that most classifications of the design process are an attempt to understand (and, for some, to control) 'creative and chaotic melange'.[46]

An important characteristic highlighted by most studies was of the importance of originality in design, a view that may be traced back to an architect's training: architect teachers, interviewed for a study in 2007, were divided on the desirability of students using previous designs as background to their own work,[47] although architects are positioned within an architectural tradition and are influenced by previous work in creating their designs.[48]

39. Kelly, G., Schmidt III, R., Dainty, A. & Story, V. (2011) 'Improving the design process for adaptability: linking feedback and architectural values.' In: *Proc 27th Annual ARCOM Conference*. [online] 27th Annual ARCOM Conference. Bristol: Association of Researchers in Construction Management, pp.43–52.

40. Bordass & Leaman (2005a) *op. cit.*

41. Raisbeck, P. and 'Tang, L.C.M. (2009) Humanistic and scientific knowledge management: a comparison of design practice between architects and engineers.' In: A. Dainty, ed., *Proc 25th Annual ARCOM Conference*. [online] 25th Annual ARCOM Conference. Association of Researchers in Construction Management, pp.729–737.

42. Kelly *et al., op. cit.*

43. *ibid.*

44. Lawson *op. cit.*

45. *ibid.*

46. Lawson *et al., op. cit.*

47. Heylighen *et al., op. cit.*

48. Lawson *op. cit.*

3.2. Academia: crossing the cultural divide

Architects in academia are working with an academic culture as well as architectural one, and the tension between these is evident in the literature. While the 2008 Research Assessment Exercise (RAE) found that integration between architectural practice and academia was very good overall, offering '*a model of best practice in this regard*'[49] they also reported that there was '*scope for improvement… …in developing a contribution to knowledge through practice-based research*'[50]. Further architectural research outputs submitted to the RAE were of higher quality in academic creative design research, and theory and history than practice-based outputs.[51]

While architects are challenging the academic community to be more accepting of design as a research output[53] - and making progress on this front[54] - they are very like traditional academics in other senses, and this can tend to cut them off from the profession. Jenkins *et al.*[55] suggest that most architects do not consider consulting academic research as a source of knowledge when seeking to understand new issues or find information; the level of knowledge about what research was being undertaken in academia (both in architectural schools and in wider built environment and social research), was extremely low[56] and this may be the root of the perception that very little academic research would be relevant to practice.[57]

The literature suggests that the focus of academic research is not driven by practice and practical issues, but rather academic success is driven by influences internal to a University department.[58] Bill Bordass suggests that this more theoretical academic focus may actually be detrimental to an organisation citing the '*wish to develop theory at the expense of practical opportunities for improvement*' may have been a factor in the closure of the Building Performance Research Unit (BPRU) in the 1970s by distancing the BPRU from the '*designers, clients, operators and users it has intended to serve*'.[59]

Collaborative research funding might be seen as a way to bridge the divide between practice and academia, however Pringle ascribes the failure of some collaborations to practices (who understand the real world) not really wanting to do research, while the academics want to do research but are '*not (always) in touch with real world requirements!*'[60] Further, the funding mechanisms for academic research can appear very obscure to practices, limiting their ability to participate and give academic research a more practice angle.[61] This is a problem that the RIBA is beginning to address through its publication the RIBA *Research in Practice Guide* 2013.

The difference between academic and practice culture is particularly evident in the way they prefer to communicate. As we have discussed, practicing architects appear to communicate visually and are used to codifying their knowledge through drawings and models, and to transferring knowledge through peer-to-peer conversations. Academics are comfortable with scholarly communications and publish the findings of much of their research in journal articles. Several authors recognised this, commenting that this represents a considerable challenge for anybody trying to bridge the gap between academia and practice, suggesting that academics need to find a more commercial way to disseminate their work so that it reaches architects in practice.[62] This is a challenge – to cross the cultural divide – which academics from all disciplines have to address, especially given the context of the impact element of the Research Excellence Framework.

49. RAE (2008) *RAE2008, Sub-panel H30: Architecture and the built environment subject overview report - 12/11/2008*. RAE2008 subject overview reports. [pdf] RAE, pp.1–11.

50. *ibid.*

51. *ibid.*

53. Lawson *op. cit.*

54. The Research Excellence Framework will accept design as a research output. See: REF (2013) *Output information requirements (updated May 2013)*. [online]

55. Jenkins *et al., op. cit.*

56. *ibid.*

57. *ibid.*

58. Glasser, D.E., 2000. Reflections on Architectural Education. *Journal of Architectural Education*, [online] **53**(4), pp.250–252.

59. Bordass *op. cit.*, p23.

60. Pringle, P. 2002. 'Research and the RIBA. Lea's Pottery: The call to arms answered.' *Architectural Research Quarterly*, [online] **6**(3), pp 197-199

61. Jenkins *et al., op. cit.*

62. Pringle *op. cit.*

3.3. Using research-based knowledge in practice; the practicalities

The literature also addressed a number of issues regarding how research-based knowledge is used, which are summarised in the following sections. They include issues specifically related to design projects as well as wider topics, such as collaboration and new technologies.

3.3.1. Project-based working: project evaluation and POE

A project-based working pattern has a significant impact on practices' use of research-based knowledge, with many practical reasons why lessons learned on one project may not be taken up and used in the next.

The transience of projects is one major problem. Architects collaborate with a wide range of individuals and organisations, with relationships waxing and waning (depending on the project stage) and often ending when the project concludes. This means that many architects do not have long-term collaborations with colleagues with whom they can evaluate success or failure over a number of projects.[63]

Even within a practice, knowledge gained on one project may not be codified for use in the future and – even if it is recorded – it may not be used.[64] It has been observed that in practices '*little resource lies outside the project teams which could be used to transfer learning from one project to another*'[65] making it difficult for architects to devote significant time to improving organisational learning.

Funding, or lack thereof, for the evaluation of project outcomes is an important issue. Financial support for an evaluation process, perhaps two or three years after the completion, is rarely identified in initial project finances.[66] For this reason Bordass and Leaman,[67] amongst others, stress that resources for feedback and evaluation must be built in at the start of the project; this also helps to increase buy-in by team members and to ensure that evaluation is considered at every stage of the building process. This approach is embedded in the Soft Landings[68] process which begins at project inception and continues for three years after handover. Bringing designers and contractors together on-site during the handover process itself generates important knowledge, and the three year POE period monitors building use and energy performance.[69]

Finally, several studies suggest that clients themselves may militate against successful project evaluation. For example the procurement teams in large client bodies turn their attention to the next project, and are uninterested in thorough evaluation and engagement with users.[70] A potential solution is to evaluate relevant previous projects at the start of each new project, but this would increase the length of the design process which is also counter to many clients' requirements.[71]

63. Heylighen *et al., op. cit.*

64. Kelly *et al., op. cit.*

65. Lawson *et al., op. cit.*

66. Andreu, I.C. and Oreszczyn, T. 2005. 'Architects need environmental feedback.' *Building Research & Information* [online] **32**(4), pp313-328.

67. Bordass, B. and Leaman, A. 2005b. 'Making feedback and post-occupancy evaluation routine 3: case studies of the use of techniques in the feedback portfolio.' *Building Research & Information* [online] **33**(4), pp361-375.

68. Useable Buildings Trust, n.d. *Usable Buildings: feedback and strategy for better buildings* [online]

69. 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*, [online] **33**(4), pp 353-360.

70. Bordass & Leaman (2005a) *op. cit.*

71. Lawson *et al., op. cit.*

3.3.2. Promoting good research habits

Habit is a powerful driver of everyday information practices in practice and in academia. Behaviours that are 'good enough' for a particular project – perhaps undertaken under strict time and resource pressures – become accepted and maintained, even though they may not allow (and in some cases may actively prevent) better information sharing which could lead to longer-term benefits.

Tools and frameworks intended to facilitate and manage information and knowledge may instead reinforce existing behaviours. For example, one study found that different members of design teams use Building Information Modelling (BIM) tools in very different ways, depending on their profession, and that behaviour change was difficult to achieve.[72] Other studies reinforce this relationship between tools and habits, with Bordass and Leaman finding little capacity for implementing broad-reaching feedback systems, and that tools had to be built to fit the way that people already work.[73]

Even frameworks that are not directly related to information management can impact on the way that practitioners handle research-based knowledge. For example standard appointments do not include POE, which is a barrier to project evaluation becoming routine.[74] Nonetheless some initiatives do support better knowledge sharing: one study found that the International Council on Monuments and Sites (ICOMOS) framework[75] for knowledge management in building conservation works effectively, helping project participants from very different backgrounds to share their knowledge.

The most common barrier to the effective sharing of insights is that most are not formally recorded. As Murray says, an '*immense amount of data is collected and analysed by a significant number of practices*' in the course of their work, but this information is not systematically documented or shared, so others cannot benefit from it.[76] Instead architects tend to communicate informally – conversationally – which does not allow knowledge to be captured or disseminated more widely, or for systematic analysis of lessons learned.[77] It is vital for the profession, and the industry more widely, that insights from practice are shared beyond the originating organisation,[78] and while there is enthusiasm for mechanisms which would support wider dissemination or practice-based experience[79] this has not, in the main, been acted on.

3.3.3.Collaboration

Not only do different collaborators have different knowledge cultures but knowledge bases. This – through the very large number of parties involved in construction – brings a complexity that can mean that it is difficult to capture all the relevant information when undertaking design or research.[80] This appears to be particularly significant in terms of designers' relationships with the end users of buildings – who may not be the client. Several studies highlighted limited relationships with end users,[81] suggesting that while architects feel "that they can themselves represent the users' view. This is probably a result of architects frequently having little access to actual users and becoming used to assuming that as building users themselves they have similar wishes and needs."[82] For example, where a novel ventilation strategy for a school was based upon keeping the classroom doors closed the building failed to perform when occupied because for the teachers a closed classroom door signalled an out-of-control class.[83] While failures to understand user expectations and behaviour will result in a building not performing as expected there are nonetheless examples in the literature of successful processes where end users and designers worked together.[84]

72. Neff, G. Fiore-Silfvast, B. & Sturts Dossick, C. 2010 'A case study of the failure of digital communications to cross knowledge boundaries in virtual construction.' *Information, Communication & Society,* [online] **13**(4), pp 556-573.

73. Bordass & Leaman (2005a) *op. cit.*

74. Bordass *op. cit.*

75. ICOMOS (n.d.) *ICOMOS documentation centre.* [online]

76. Murray *op. cit.*

77. Kelly *et al., op. cit.*

78. Bordass & Leaman (2005b) *op. cit.*

79. Jenkins *et al., op. cit.*

80. Bordass & Leaman (2005a) *op. cit.*

81. Andreu & Oreszczyn *op. cit.*

82. Lawson *et al., op. cit.* p329

83. Bordass & Leaman (2005b) *op. cit.*

84. Le Dantec C.A. and Do, E.Y-L. 2010 'The mechanisms of value transfer in design meetings' *Design Studies* [online] **30**(2), pp11-137

The literature also posited a link between a lack of communication between consultants involved in projects and a failure to utilise research-based knowledge effectively. For example, one study of architects working on conservation and heritage projects – which inevitably involves a number of specialists – found that there was little connection between suppliers and end users of information, meaning that information supplied was often not fit for purpose. On another project building services subcontractors used BIM tools for detailed design, but failed to communicate this to the architects and engineers, who therefore failed to take account of the proposed designs – leaving the subcontractors feeling frustrated by organisational separation from the design team.[85] Kelly *et al.*[86] suggest that not only do architects feel they lose control over projects during construction and post completion, but that this impacts on feedback data they can access and their enthusiasm for post-occupancy evaluation processes.

Architects are not the only profession to have particular cultural attitudes and approaches towards information and knowledge. Raisbeck & Tang[87] found that architects and engineers communicate in different ways: engineers are '*linear and sequential*' while architects are '*generative and chaotic*'. Differing approaches also affect the way that collaborators use the tools that are supposed to ease communication: each group uses tools such as BIM in their own way rather than changing their behaviours to get the most out of the tools, which means that knowledge is not shared effectively.[88] These tools cannot, according to Bogers *et al.*, replace direct communication between architects and their clients, noting that architects seek "*to establish a direct dialogue with users and clients, even though they are not supposed to do so in some projects*"[89] While face-to-face meetings are an opportunity to share information if it is not recorded or documented in a systematic way knowledge can be lost.

3.3.4.New technologies and techniques

In recent years architects, like other professionals, have engaged with new communication technologies; powerful computers and the rise of the internet have opened up opportunities for easier communication, especially between large, disparate and dispersed groups of people. Nonetheless there are examples in the literature where newer tools and techniques have not been successfully implemented.

One practice unsuccessfully attempted to introduce a set of WIKIs to allow staff to share knowledge.[90] Other studies look at the failure of BIM systems and post-occupancy evaluation, while Lawson *et al.* note that they "*found that even with organisations that construct similar projects, there may be little transfer of knowledge even with elaborate procedures in place, sometimes supported by sophisticated information technology.*"[91]

Heylighen *et al.* conclude that new tools often fail because they do not change attitudes towards learning and sharing knowledge.[92] They cite the example of the Dynamic Architectural Memory On-line (DYNAMO)[93] tool which sought to connect architectural learning across fields, practices and projects. Architects in practice very quickly repurposed it as a mechanism for showcasing their firm's projects; they were reluctant to use it in a more meaningful way to share knowledge.

BriefBuilder[94] is another example of a tool failing because it does not fit with designers' existing knowledge habits. The Dutch tool seeks to streamline the briefing process through an interactive digital model, however architects continue to print parts of the model as they are more used to working with paper-based information.[95]

85. Neff *et al., op. cit.*

86. Kelly *et al., op. cit.*

87. Raisbeck & Tang *op. cit.*

88. Neff *et al., op. cit.*

89. Bogers, T., van Meel, J.J., and van der Voordt, T.J.M. 2008. 'Architects about briefing: recommendations to improve communication between clients and architects.' *Facilities* [online] **26**(3/4), pp 109-116.

90. Raisbeck & Tang *op. cit.*

91. Lawson *et al., op. cit.*

92. Heylighen *et al., op. cit.*

93. DYNAMO, n.d. *DYNAMO – Dynamic Architectural Memory Online*. [online]

94. ICOP, n.d. *Home*. [online]

95. Bogers *et al., op. cit.*

96. Neff *et al., op. cit.* line 313-323

97. Bordass *op. cit.*

98. Bordass & Leaman (2005a) *op. cit.*

99. Bordass *op. cit.*

100. Bogers *et al., op. cit.*

101. Although note the project-long involvement of processes such as Soft Landings.

102. Bordass & Leaman (2005a) *op. cit.*

103. Lawson *et al., op. cit.*

104. Bordass *op. cit.*

There are cases where a reluctance to engage with new tools cannot easily be attributed to a failure to change knowledge habits but rather to the properties of the tool itself. For example one study found that:

> "*Interpretive flexibility – or the ability for multiple people to draw their own interpretation from the plans – is important within the design process. He [the interviewee] continued,*
>
> > *'You can do this in 2D really well, just draw what you want. It doesn't matter if it's really correct or it's coordinated to anything, because at this point you don't want that to be that way. You're trying to communicate design intent not accuracy. Because you're just formulating idea, so you're trying to keep things vague. It's an important part of the design and workflow. But when you're doing the BIM model there's no room for that anymore' (architect interview)*
>
> *"This tension between the precision of what is presented digitally and the need to keep some negotiations open and vague strikes to the core of the collaborative challenge that BIM faces in implementation.*"[96]

Indeed the tension between a need for structure and a need for flexibility is evident in many of the studies cited in this review. The key seems to be achieving a structured way of providing information while allowing flexibility in the process of recording knowledge. For example, when the Federal Facilities Council in the USA reviewed post-occupancy evaluation processes in 2001 they found that a standard methodology or definition for the process was not desirable.[97] Feedback systems (e.g. POE) need to be flexible to allow the various different stakeholders (design teams, clients, end users) to specify what they would like to know, and are capable of finding out.[98] However in order to do this they need very structured information on what range of POE techniques are available – what they offer, how much they cost and how to access them.[99] A similar need for clear information is evident in the Bogers *et al.* study into the briefing process: architects find that many briefs contain a lot of irrelevant information, and would prefer a clearer structure that would allow them to identify the client's main ambitions separately from, for example, lists of technical standards.[100]

3.3.5. The cost, value and ownership of research activity

Many of the studies in this review were concerned with post-occupancy evaluation, but raise a number of issues about practical constraints that may have relevance to architectural and built environment research more widely. At the heart of many of these issues is a reluctance to recognise the value of POE and similar research, on the part of both architects and clients. Clients, although broadly interested in POE, see the primary benefit accruing to the architect's next client rather than to their own project, which would most likely be complete by the time evaluation takes place.[101,102]

Designers however perceive a risk that problems with the building, that might otherwise go undetected,[103] and for which they may have financial or legal liability, will be identified (and that this may impact on their ability to get insurance for future projects). Bordass[104] recognises that these concerns may be more perceived than real, and suggests that in many cases establishing a procedure for POE can help to keep the lines of communication between designers and clients, and prevent potential conflict.

These various concerns led to some reluctance on the part of both clients and designers to pay for POE, and there is also relatively little knowledge about POE procedures and costs among key potential stakeholders. Because of the perception that POE will benefit a future, rather than the current client, clients are often reluctant to pay for POE, and this reluctance can be particularly evident among occasional clients.[105] Architects on the other hand rarely have the time, financial resources or mandate to undertake POE, and believe – probably correctly – that it will be difficult to justify the costs of POE to clients.[106]

The costs, however, of POE are not necessarily high, with the costs to an architect (on a full-scope appointment) of Soft Landings estimated as around 0.25% of construction costs.[107] Way and Bordass stress that not only is the extra cost not high, but it should be balanced against net gains from less rework and fewer snagging visits – along with the future commercial advantage gained from understanding the data and the probability of better client references.[108]

Even where an architect is convinced that evaluation would be valuable it can be a struggle to convince clients to participate.[109] The reluctance to undertake evaluation of projects means that assembling useful benchmarking datasets can be very difficult.[110] These datasets, if more routinely populated (for example the energy information collected on the CarbonBuzz[111] website) would be of vital importance in improving the performance of buildings.

Because practices rarely access funding for research as a separate activity most practices do not have the financial resources or staff time to undertake research outside the scope of their projects.[112] As a result "*most practices rely on relatively accessible, already packaged, sources of information – generally focused on the immediate problem only – as well as their own experience, more than they might otherwise want to depend.*"[113]

Finally, there is a significant question about who should undertake research. Several studies suggest that, for post-occupancy evaluation, the best results might not arise from consultants undertaking evaluations of their own buildings – due to a conflict of interest.[114] Regardless of one's views on this issue, effective evaluation does need the participation from the project teams and a building's users.[115] An effective solution appears to be for external researchers to work with the project team, but for the researchers to analyse their findings independently.[116]

105. *ibid.*

106. Kelly *et al., op. cit.*

107. Way & Bordass *op. cit.*

108. *ibid.*

109. Bordass & Leaman (2005b) *op. cit.*

110. Bordass *op. cit.*

111. CarbonBuzz, n.d. *CarbonBuzz :: RIBA | CIBSE Platform*. [online]

112. Jenkins *et al., op. cit.*

113. *ibid.*

114. Andreu & Oreszczyn *op. cit.*

115. Bordass & Leaman (2005b) *op. cit.*

116. *ibid.*

Methodology

The review explores existing research on architects' use of research resources, and ability to find, share and communicate knowledge within, and outside, their practices. A search on the Scopus database was undertaken using combinations of search terms as in table 1.

The body of literature on **architecture and built environment knowledge practices** was not particularly extensive; after reviewing the abstracts around a dozen relevant articles were identified, and citation chaining[118] was used to identify around a dozen more.

Table 1: Scopus database search terms

Item	Activity	Group
Information	Management	Architect
Research	Access	Engineer
Knowledge	Availability	Built environment
Data	Sharing	
	Retrieval	
	Communication	

117. **Scopus** – online abstract and citation database, www.scopus.com, covering >20,500 titles, 49 million records and >5.3 million conference papers.

118. **Citation chaining** – following article citations backward (searching for items the article's author(s) cited) or forward (pieces of work that have citied the article) to, for example, access additional research or to track the development of ideas. It is related to other methods such as Citation Chain Aggregation. See:

Cribbin, T., 2011. "Citation Chain Aggregation: an interaction model to support citation cycling" *Proceedings of the 20th ACM Conference on Information and Knowledge Management, CIKM 2011,* Glasgow, United Kingdom, October 24-28, 2011 [online]

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Bordass, B. and Leaman, A. 2005a. 'Making feedback and post-occupancy evaluation routine 1: a portfolio of feedback techniques.' *Building Research and Information* **33**(4), pp347-352. Available at: <http://www.tandfonline.com/doi/pdf/10.1080/09613210500162016> [Accessed 23 May 2013]

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Heylighen, A. Neuckermans, H. Caeser, M. and Dewulf, G.P.M. 2007. 'Building memories.' *Building Research & Information* **35**(1), pp90-100. Available through: Taylor and Francis Online <www.tandfonline.com>

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