

INVESTIGATING DESIGN AS RESEARCH: UNDERSTANDING R&D ACTIVITIES IN AUSTRALIAN ARCHITECTURAL PRACTICES

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Within the property and construction industry architectural design is generally seen as a problem solving activity which meets client needs. Through design, architects respond to a brief by using their design expertise to visualize and integrate together different building systems. However as buildings have become more complex architects are beginning to argue that design is not simply a problem solving activity in its own right. In this view, design is a research process which is unique. However, this view is quite different from accepted norms of what constitutes scientific research or research and development. Moreover in Australia very little is known about the R&D activities of architects and how these relate to the concept of design as research. Understanding how different practices undertake R&D and how much of this might be embedded in architectural design activities is important. Four case studies of architectural practices employing semi-structured interviews will be presented. The data gathered from these case studies were used to structure a broader online survey which was distributed to 1100 architects and received 92 responses. Architects conduct a range of what they identify as original research activities but few architects document or formalize these activities. For this reason identifying the research activities that architects conduct through the design and project delivery process is a first step in understanding how design activities drive construction innovation.

Keywords: architecture, design, research and development, research methods.

INTRODUCTION

Recent scholarship in architecture and architectural theory argues that architectural design is a research activity in its own right. Downton argues that design is a “way of enquiring a way of producing knowledge; this means it is a way of researching.” (Downton 2003). In this view, designing a building is regarded as a research project which generates new knowledge and innovations which are then constructed. As Radu asserts “The process of architectural design is close to the process of knowledge creation in the sciences” (Radu 2006: 345). In architectural schools, design based research has been given credence with the rise of design focused PhD programmes (Radu 2006, Melles 2009). As Short notes, amongst architects there has been a renewed interest in research in architecture as evidenced by the RIBA 2007 annual research symposium which focused on this issue (Short 2008). As Jane Rendell was to note at this Symposia “If, as some have argued, design is already a form of research, then we need to explore how we might distinguish between design-as-research and research-as-design, and question on what grounds and why such a distinction might

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matter. We should also pay attention to a relatively quiet but fascinating discussion around design research quality, and how excellence in this area is to be recognized. We can probably agree that not all excellent research is excellent design, but is all excellent design also excellent research?" (Rendell 2007). In February 2006, the National Education Council (NEC) of the AIA (then called the RAIA) convened a workshop to discuss how architectural research in Australia should be documented and how its impacts were to be understood in the discipline. The subsequent research policy recognized creative works, for example buildings or the design of buildings as constituting "the highest levels of achievement in architecture research" (AIA 2009). Despite this activity and theoretical debate, both in the UK and in Australia, very little empirical data has been gathered about the "design as research" or R&D activities in architectural firms.

The intent of this research is not simply to point to the ways in which Australian architects can gain R&D tax concessions. It goes deeper than that. Recent policy developments point to the need to begin to measure and benchmark R&D and its outcomes in architectural practices. Understanding how small professional consulting firms conduct R&D aids an understanding of how it might be conducted in other property and construction firms. Quantifying what might constitute R&D in Australian architectural firms is timely in light of the new tax credit which provides a 45 per cent refundable credit for firms with an annual turnover of less than \$20 million. This means that small firms, which encompasses most Australian architectural firms, will receive a tax refund which effectively doubles the current level of support for such firms (ATO 2010). Another aspect of this research surrounds the introduction of Excellence in Research for Australia initiative (ERA) metrics to measure research outputs in Australian Universities. For example, some industry practitioners who work in architectural schools demand that designing a building should be counted in university research metrics. Universities, however, want research publication outcomes that enhance their academic reputation.

Aims

Architectural design considered as research and development is obviously different to textual modes of research, or scientific research, because it encompasses a range of media—such as drawing and, more recently, computer modelling (Chi 2007). How might design research, as it has been termed, differ from what the construction management community regards as empirical research? If design is seen as a being akin to the process of knowledge creation in the sciences, how might it relate to peer contested methodologies and research methods? Given that R&D can in theory lead to innovative outcomes in construction, it is important to understand the architects' role in this; especially if architects are regarded as "systems integrators" with a significant role to play in leading processes of design and construction innovation (Gann 2000, Gann 2005). In theory, every design concept and its constructed realization in built form is the result of a unique process, a process that is the result of much knowledge based research activity. This suggests that it is correct to regard architects as "knowledge-intensive" professionals who often operate in project based situations of complexity and ambiguity (Lu and Sexton 2006). But Rylander, in an extensive study of the literature on design thinking as knowledge work, highlights that there are no case studies on knowledge intensive design firms (Rylander 2008). Hence, despite these theoretical claims very little is understood about the kinds of knowledge or innovations created within architectural firms. Nor is it clear how using design skills

to solve problems differs from traditional R&D activities that result in new product development or other innovations.

Definitions and design frameworks

The OECD states that "Research and Development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. R&D is a term covering three activities: basic research, applied research, and experimental development" (OECD 2008). The definitions described under Australian Commonwealth legislation are a useful starting point to understand how R&D might be defined in an architectural firm. R&D is described in terms of activities, as compared to theoretical concepts or intentions, on a project basis. Hence, an R&D project is "a set of co-ordinated and controlled activities with a start and finish date, undertaken to achieve an objective." Under Australian law, all R&D projects must contain at least one "systematic, investigative and experimental" activity (ATO 2010).

Indeed, as suggested above in recent architectural theory the concept of design as research has been linked to a tradition of architectural experimentation. It has been suggested that "architectural experimentation requires a rigorous feedback between design and research" and this "has been at play in design pedagogy since at least the 1960s" (Furján 2007: 62). As has been noted, architectural design as research has increasingly been regarded as a unique activity because "all architects ever do is design and build prototypes" (Kieran 2007: 27). Lawson notes that architectural design processes are complex and need to be distinguished from engineering definitions of optimized design. But he argues that many of the maps or descriptions of the design process tend to be overly theoretical or prescriptive and thus tend to place a value on linear descriptions of the design process sometimes ignoring the iterative design process that take place within a particular design exercise (Lawson, 1980: 29). To complicate things further, Lawson argues that, amongst other things, design knowledge is based on precedent and this is a central feature of the design process (Lawson, 2004: 93).

Approach

The hypothesis of this research is to begin to test the proposition that: architects undertake original design research and this is distinct from the other modes of design or R&D that architects undertake in their firms. Having identified these distinctions the research quantified the percentage of time architects typically spend on research in different sized practices. The above hypothesis was tested by asking the following primary questions: How much time do architects spend on creating new design knowledge in each phase of the practice lifecycle? Are some projects, such as competition entries, used to develop new design knowledge within the firm? Do different types of practices conduct different types of original design research? What kinds of other research activities do architects conduct in their practices? What kind of innovations does this activity produce? This extends my previous research and the definitions I have already developed (Raisbeck 2006, 2008).

In order to begin to pinpoint both explicit and implicit R&D practices in architectural firms a two stage or phase approach was chosen. In the first phase, in-depth series of firm case studies were developed. Structured interviews were undertaken with four Australian architectural firms. A pilot interview was undertaken in order to clarify and test the survey instrument questions. This interview is not included in the results as it

did not capture the same qualitative data. The results of the interviews are set out in Tables 1 to 4.

The aim of the interviews was to ascertain what kinds of activities the architects took in relation to R&D and design by research. A diverse range of practices were selected in an attempt ensure a broad range of so-called design research practices were examined. Another selection consideration was the aim of investigating practices of different size and years in business. Five practices were approached and interviewed. These ranged from a small practice with five staff to firms with up to 50 staff. Most of the in-depth interviews were undertaken with either directors or senior members of staff. All of the practices interviewed affirmed that original design research, as we had defined it, was a significant part of designing across the practice lifecycle.

The survey questions were structured by the typical project stages in which architectural offices have traditionally been organized. These stages were: briefing and feasibility up to and including concept and schematic design (SD), design development (DD), contract documentation (CD), and contract administration (CA). Both the structured interview surveys and the online survey made the distinction between design orientated tasks and those tasks devoted to original design research. Architects do not spend all of their time designing and within any particular stage of the practice lifecycle they will need to spend time assessing briefing information, organizing workflows, meeting with clients and co-ordinating consultants and other non-design administrative tasks.

RESULTS

Structured interview results

Practice A is a national firm based in Melbourne with around 50 staff. It has completed apartment buildings, museums, art galleries and university buildings. The practice is involved in furniture manufacturing business which allows it to quickly prototype models. It has received a number of state and national AIA awards for these projects. Within the office, design information is transferred across the office by “creative” staff meetings once a week.

Practice B is also a national firm based in Melbourne. R&D in the practice is market driven in that the firms formal R&D efforts are an effort by the practice to anticipate how it might gain future competitive advantage and new revenue streams. This practice had 50 staff in Melbourne and 20 in Sydney plus a small office in Hanoi. In addition there is a 15 to 20 person research group devoted to research into systematized housing construction and bushfire resistant housing. The firms R&D efforts are formalized and a taxation concession is claimed. This group has a number of patents but little of its output has been commercialized.

Practice C is a 10 year old practice which has completed a number of award winning projects up to \$30M dollars in value. The firm’s philosophy is to approach design as a research activity which encompasses form making, computer modelling and programming, alongside social and cultural conditions. It has around five staff depending on workloads. Both directors of the firm have strong connections with a university. The firm considers that research is a core activity and each project is approached as a unique set of circumstances.

Founded in 1983, Practice D has an office in Melbourne with four staff and a second small office in central London with two staff. The firms focus is on client based research and prototyping. It employs four staff and has adopted a research consulting

model to specialize in retail and work environments. In the early stages of each project, the firm undertakes a number of research orientated methods including “think tank” and concept sessions, scenario planning and spatial prototyping (building physical mock-ups of spaces). Whilst the practice does document each project in terms of the research outcomes, such as prototypes, it has no formal R&D procedures in place.

Table 1: Practice A

Practice A	SD	DD	CD	CA
Research undertaken:	Client context and disciplinary language of clients (e.g. biosciences) Local building systems and methods New materials Historic precedents Climatic design	Workplace research	Materials and systems research Non-standard details and products	Minimal design research or R&D
Time allocation:	60-90% in this stage allocated to design 20% of this would be original design research.	50-60% allocated to design. 6-15% project specific research	Not quantified	Minimal design research or R&D

Table 2: Practice B

Practice B	SD	DD	CD	CA
Research undertaken:	Compilation of base information. Climatic research	Discussion with external consultants Material research.	Resolution of details Construction methods and supply chain logistics	Minimal design research or R&D as a result of on site changes.
Time allocation:	60% on design Original design research varies as it is project specific.	85% allocated to design. (50/50 between design and presentation). Original design research 30%	15-20% allocated to design Original design research would be 15-20%	Minimal design research or R&D

Table 3: Practice C

Practice C	SD	DD	CD	CA
Research undertaken:	Project specific	Incorporating technical information and project constraints.		Minimal design research or R&D
Time allocation:	50 to 60% allocated to design. Half or 30% of this time allocated to original design research and innovation.	70% devoted to design. Original design research 50%	20-30% devoted to design. A third or 10% of total time in this stage devoted to original R&D	Minimal design research or R&D

Table 4: Practice D

Practice D	CD	DD	CD	CA
Research undertaken:	Interviews Client workshops Data collection	Scenario development	Technological research.	
Time allocation:	30% devoted to original R&D. 30% of time spent on design	30% devoted to original R&D prototyping	30% devoted to original R and D	30% devoted to original R and D

Online survey

The case study data was reviewed in order to develop the online survey. The online survey was designed to be much shorter and relatively quick to complete. Eleven hundred and thirty two Australian architectural offices were approached via an online survey tool and there were 91 respondents. The online survey form established the research profile of the company in terms of numbers employed in the company and if the company had a formal R&D programme, any links with research centres and how many people in the practice worked specifically on R&D. The next section of the online survey ascertained how research, if any, was documented in the office. This was a key question to ascertain the level of research documentation and what procedures were in place to verify this. Respondents were asked to consider this in relation to the largest project in their office.

For each practice stage the respondents were asked what percentage of time was allocated to design in each stage. This question was asked with the assumption that design activities continue even after the architect has created the initial or concept design. In order to distinguish between normative and routine design tasks, respondents were then asked about the total amount of time spent on design in each stage. Following this, respondents were asked what percentage of this time was allocated to original design research. In other words the amount of time spent on conjectural design tasks such as researching products or materials, building systems or non-standard details. Such tasks, in practice, may mean iteratively designing by trial and error a new detail for a building element that brings together existing products and materials in an entirely new way. In addition this element may be part of a building design that is itself a response to a unique brief, site context and budget.

Online survey results

Most of the practices surveyed were small practices. Eleven hundred surveys were sent out using an online survey tool and 95 completed. They would fall under the category of SMEs but most were what might be regarded as micro-businesses with less than five staff. Eighty-six percent of these were incorporated as companies under Australian law. Fifty-seven percent of those surveyed had between one and five employees, 23% had between six and ten employees and 23% had more than ten employees. Eight percent of respondents had more than 30 people employed. Eighty-nine percent of practices reported that they did not have a formal R&D programme in place and only 8% said that they had links with a university or co-operative research centre. Nevertheless, 37% of survey respondents indicated that their practice had staff who worked specifically on R&D and 68% indicated that they had an informal R&D programme in their firm.

Table 5: No. of firms (92 in total) allocating time to design and original design research by stage

% time allocation	Briefing to Schematic Design		Design Development		Contract Documentation		Contract Administration	
	Firms allocating this % of Design time	Firms allocating this % of time for Original Design Research	Firms allocating this % of time for Design	Firms allocating this % of time for Original Design Research	Firms allocating this % of time for Design	Firms allocating this % of time for Original Design Research	Firms allocating this % of time for Design	Firms allocating this % of time for Original Design Research
0-20%	8	34	9	31	23	43	65	72
20-30%	9	26	12	25	24	28	18	12
31-40%	19	16	12	12	18	6	3	1
41-50%	10	9	15	13	9	6	1	2
51-60%	14	4	13	5	8	4	2	2
61-70%	18	2	13	3	5	3	1	0
71-80%	9	0	14	1	5	1	1	0
Greater than 80%	5	1	4	1	0	1	0	1

There was little documentation of the research activities in the offices surveyed. Seventy-two percent of respondents had no formal procedure for the collection of design data in their offices and yet 56% indicated that for each project they had a separate section or directory file devoted to research. Sixty-eight percent of respondents indicated that timesheets were the principal method by which research was accounted for. Only 13% of offices wrote research reports on the information they had collected and yet 89% of practices stated that the research information they might collect on a project is used on other projects.

Almost all of the responding 92 firms allocated time to design throughout the lifecycle. The schematic design and design development appear to be the most intensive in terms of design time. In the initial design phase, 46 of the 92 firms allocated more than 51% of their time to design. In terms of original design research, it can be seen that eight firms claimed in the survey to have devoted more than 51% of their time to this during the schematic design phase. However, 51 of the 92 firms reported that they had spent at least 20% to 50% of their time involved in original design research during this stage. In the next stage, design development, 44 of the

firms reported having allocated more than 51% of their time to design and 39 firms reported having allocated between 21% and 30% of their time to design. By the contract administration stage, normally the time when the project is under construction, the majority of firms are spending less than 20% of their time on original design research.

DISCUSSION

The results confirm that architects regard themselves as being engaged with the process of creating original design knowledge throughout the project lifecycle. The responses all affirmed that design activities, and what was termed original design research, continued through each stage of the practice lifecycle. Once a project was in the construction phase, this tended to diminish. This research is limited in as much as it did not try and quantify the amount of time devoted to these activities in detail via an inspection of logs or time sheets or observation. However, it still points to the idea that architects are producing original design knowledge customized and intended for particular site conditions, briefs, budgets and clients. In theory, the design of every building is different and even those buildings that are repetitive or made from standard elements arguably may still require a degree of original design research. Surprisingly, a majority of practices indicated that the research information that they gathered on one project might be used on other projects and yet few practices mentioned the role of competitions and unbuilt projects in their responses.

Only one practice (practice B) had formal R&D procedures in place in order to claim the R&D taxation concession. This practice had grown to the point where it had formed a separated related company whose purpose was to conduct research, develop patents and commercialize this work. This practice had developed a number of patents in the area of prefabrication and had a formal programme in place. The other three companies, whilst all claiming to be interested in the idea that practice based design research and research and development were important, did not have formal programmes. Of these practices, only one had developed procedures for managing and documenting the original design outcomes, client workshops and prototyping that were the result of their research endeavours. It would appear that most original design research in architect's offices was stored in files, either in physical files or in digital form. Nonetheless, this points to the fact that this knowledge is largely implicit within the firm and rarely is it made explicit through systematic documentation in order to strategically direct design processes in order to gain taxation R&D concessions or commercialization via patents.

CONCLUSION

Architects appear to devote a great deal of design time to solving unique and original problems across the practice lifecycle. The study points to the range of design activities that architects undertake in order to realize project designs. These activities include a range of problem solving and design related research activities such as data collection, workshops, internet searching and drawing. In addition, it demonstrates the degree to which they research historic precedents, climatic issues, construction methods, products and materials. Arguably, few other construction professionals would actively have this broad range of skills and expertise at their disposal. It also points to the emergence of new skills amongst architects related to the scripting of programmes, 3D digital modelling and prototyping. Clearly, further research could quantify how much time was spent conducting these design related activities on different projects and then quantify how the design knowledge from these activities

was captured and used on further projects. More importantly, further research might begin to look at how this design knowledge drives construction innovation in the construction and project delivery phase and how the benefits of this knowledge are transferred to other parties such as other consultants, contractors, sub-contractors and even clients also involved in the project delivery process.

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