

# **Evolving a design driven ‘hybrid’ research approach to inform and advance sustainable outcomes in the built environment sector**

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## **Abstract**

A significant reduction in global greenhouse gas (GHG) emissions is a priority, and the preservation of existing building stock presents a significant opportunity to reduce the carbon footprint of our built environment. Within this ‘wicked’ problem context, and moving beyond the ad hoc and incremental performance improvements that have been made to date, collaborative and multidisciplinary efforts are required to find rapid and transformational solutions. Design has emerged as a strategic and redirective practice, and lessons can therefore be learned about transformation and potentially applied in the built environment. The purpose of this paper is to discuss a pragmatic and novel research approach for undertaking such applied design driven research. This paper begins with a discussion of key contributions from design science (rational) and action research (reflective) philosophies in creating an emerging methodological ‘hybrid design approach’. This research approach is then discussed in relation to its application to specific research exploring the processes, methods and lessons from design in heritage building retrofit projects. Drawing on both industry and academic knowledge to ensure relevance and rigour, it is anticipated that the hybrid design approach will be useful for others tackling such complex wicked problems that require context-specific solutions.

## **Keywords**

Multidisciplinary, transformation, hybrid design approach, design driven, sustainable development

Sustainable development literature from the ‘built environment’ field describes a need for a significant reduction in greenhouse gas (GHG) emissions on a global scale as a priority in a rapid response strategy (Smith, Hargroves, & Desha, 2010; Stern, 2006; Von Weizsäcker, Hargroves, Smith, Desha, & Stasinopoulos, 2009). Worldwide, a substantial proportion of GHG emissions are attributed to the built environment sector, with significant potential to achieve reductions in GHG contributions by targeting this sector (Built Environment Industry Innovation Council, 2012; Smith, et al., 2010). Much attention has been focused on new buildings and innovative projects that aim for best practice in green buildings, however retrofitting existing building stock has significant potential to reduce GHG emissions globally (Young, 2012). Considering the embodied carbon in existing buildings and other space and cost drivers, the preservation of existing building stock is emerging as a significant opportunity to reduce the carbon footprint of our built environment (Miller & Buys, 2008; Sustainable Built Environment National Research Centre, 2012).

Maintaining profitability in retrofit projects is an important factor in making such carbon reductions a reality; however such ‘decoupling’ of economic growth from environmental pressure is a well-known challenge and ‘wicked problem’ (Smith, et al., 2010). Progress to

date has had mixed success, with some incremental innovations delivering reductions in carbon emissions (such as maximising resource efficiency and decreasing energy use) and only a few examples of large scale change (Von Weizsäcker, et al., 2009). In overcoming the inertia for *ad hoc* and incremental performance improvement towards low carbon operations, many researchers have documented the need for collaborative and multidisciplinary efforts.

A integrated design process (IDP) (Larsson, 2004), or whole systems approach (Stasinopoulos, Smith, Hargroves, & Desha, 2009) is necessary in sustainable building projects in order to facilitate pollution avoidance, resource efficiency, lower costs, and healthy and productive workspaces. These approaches are regarded as optimal in that they consider the whole-building budget and are goal-driven, facilitated, structured, inclusive, collaborative, holistic, iterative (Zimmerman & Eng, 2006). It is clear that engagement with the full range of stakeholders that have the potential to contribute to the sustainability of buildings across the life cycle – from cradle to grave, is necessary (Watson, Mitchell, & Jones, 2004). In addition to this, retrofitting heritage buildings poses further challenges in acknowledging the cultural or historical value of the building. Social and legislative opportunities and constraints associated with the project, including possible ‘adaptive reuse’, underpin the importance of collaborative practice by stakeholders such as the architect, contractors and the owner in addressing stakeholder requirements (Bullen, 2007; Young, 2012).

In recent years, ‘design’ has emerged as a potentially “redirective practice” in developing and deploying strategies for change (Fry, 2009, p. 55), providing “an unparalleled window of opportunity to address environmental objectives” and foster sustainable development (Carrillo-Hermosilla, del Río González, & Könnöla, 2009, p. 10). A key aspect in a design driven approach is the multidisciplinary and collaborative ‘co-development’ from start to finish, with internal and external stakeholder groups (Bucolo & Matthews, 2011; Manzini, 2007). Within this context, this paper draws on the theoretical context of ‘exaptation research’ - considering the phenomenon of solving of problems in one field using the knowledge base from another field (Gregor & Hevner, 2013) – to discuss an approach developed by the authors to distil learnings from design for the built environment sector. Through enquiring into processes, methods and lessons, the authors identify opportunities for rapidly transitioning the Australian built environment to low carbon operations.

The paper begins with a summary of theory that underpins the proposed research approach, and then details the ‘hybrid design approach’. The authors then provide an example application of the approach to consider what can be learned from the ‘design’ discipline about the processes and methods of design when retrofitting heritage buildings. It is anticipated that this paper will provide a possible design driven approach to delivering low carbon solutions in the built environment sector, fostering fresh thinking around tackling such complex wicked problems.

## **Processes, methods and lessons from design**

Design in its broadest sense is essentially about problem solving, and ranges from aesthetically based activities and the application of principles, to a process and strategic way of thinking (Baird, 2013). Despite the complexities of defining what design is, Archer (as cited in McKay, Marshall, & Hirschheim, 2012) conceptualises the practice of design as oscillation between conceptual and practical activities until a solution is refined (as shown below in Figure 1).

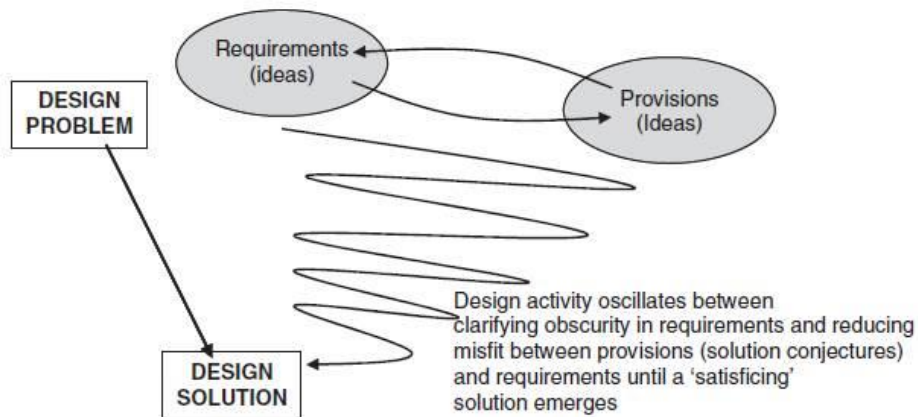


Figure 1: The oscillating nature of design problem solving (Archer as cited in McKay, et al., 2012).

'Design thinking' is described by Brown (2008, p. 86) as "a methodology that imbues the full spectrum of innovation activities with a human-centered design ethos". It is known as being particularly adept at addressing 'wicked problems' because it is transdisciplinary, integrative, and potentially transformative in exploring 'what could be' (Brown, Harris, & Russell, 2010). 'Wicked problems' were first described by Rittel (as cited in Buchanan, 1992, p. 15) as being "ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing". Given that the field of sustainable development itself could be considered to be a wicked problem (Peterson, 2009), and a broad range of stakeholders are involved in modifying the built environment, a design driven approach provides a potential vehicle to consider such problems.

The 'design methods movement' or 'design science decade' of the 1960s (specifically the inaugural Conference on Design Methods of 1962), is regarded as the period in which design methodology was formalised as a field of enquiry and began to be recognised as a valid research subject. As a result of the increased interest around design research, the Design Research Society was founded in 1966 and various design journals (such as Design Studies, Design Issues, and Journal of Engineering in Design) were established (Frankel & Racine, 2010).

Seeking to rationalise the design process, this early discourse by design researchers such as Bruce Archer and Herbert Simon was focused on documenting the 'science of design' and developing "a body of intellectually tough, analytic, partly formalisable, partly empirical, teachable doctrine about the design process" (Cross, 2007, p. 1; Simon, 1996). This 'design science' paradigm was later criticised by some design researchers such as John Chris Jones, Christopher Alexander, Donald Schön and Nigel Cross who rejected the notion that the design process followed a logical, systematic, sequential, structured framework. Instead, a 'constructivist' paradigm was proposed as a more appropriate alternative for understanding complex and wicked problems and coping with the unique circumstances of each practice (Alexander, 1964). This 'second generation' of design research was more pragmatic, action-oriented and participatory, where designers were urged to co-create solutions with the problem 'owners' (clients, customers, users, the community), and 'reflect-in-action' – adjusting the design process in practice in response to each unique situation (Cross, 2001; Frankel & Racine, 2010; Schön, 1983).

According to Archer (1995), the various styles of scientific research range from creating generalised theoretical knowledge to specific practical knowledge, and generally categorised as being either: fundamental, strategic, applied, action, or option in nature.

Similarly, and more specifically applicable to design research, Buchanan (2001) believes that there are three types of design research that contribute to new design knowledge: basic, clinical, and applied. Basic research about design is generally theoretical in nature and explores the fundamental problems and principles that explain the phenomena being studied. Clinical research for design usually focuses on gathering information about a particular, individual problem and designing a solution specifically suited to the case study. Applied research through design involves hypothesising or attempting to explain the phenomena being studied based on information drawn from many individual case studies and theory (Frankel & Racine, 2010; Lenzholzer, Duchhart, & Koh, 2013).

This 'applied' perspective was conceptualised by Owen (1998) who claims that, in the field of design – which is described as being neither a science nor an art - the building of new knowledge must involve both analytic discovery (from the realm of theory) and synthetic invention (from the realm of practice). As shown below in Figure 2, design is viewed as an iterative process of knowledge development that moves between theory and practice.

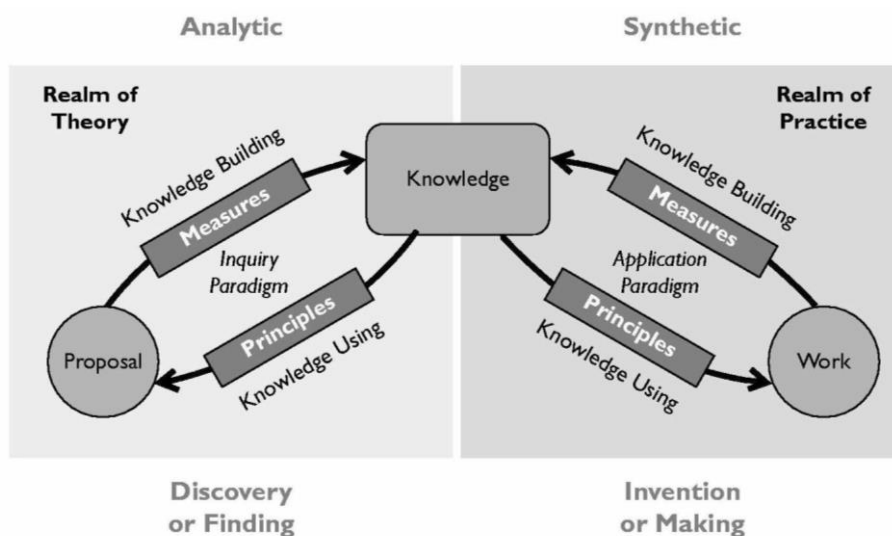


Figure 2: Building and using knowledge in design research (Owen, 1998 as reproduced in Beckman & Barry, 2007)

Comparable to the relationship between a research methodology and research methods, it is understood that the design process is distinct from design methods in that it is an overarching approach or framework, while design methods are the techniques or tools by which design is practised.

## A pragmatic and novel research approach

Within research design theory, Guba (1990) explains that the research paradigm is characterised by the ontological (the nature of reality) and epistemological (the nature of knowledge) view. A relativist ontological approach where reality is an individual representation of what exists based on our own perceptions, experience and values. Epistemologically, a subjectivist view is adopted where knowledge is viewed as a constructed reality that is internally constructed and interpreted by individuals (Mehay, 2012). Collectively, with these underpinnings, the philosophical approach upon which this inquiry is based is described as 'constructivist' in that reality and knowledge are constructed beliefs (Guba, 1990).

Based on an exploration of literature around design process theory, the design process – fundamentally balancing convergent and divergent thinking, and iterative in nature – can

be rationalised to some degree and follows some logic. We argue that the selection of appropriate design methods as a means of engaging in these process phases, however, is a more intuitive endeavour where context dictates what techniques are most suitable to the specific circumstances. This design research is therefore characterised as being primarily within a *constructivist* paradigm and *applied* in nature. This research will, however, draw on and apply both the rational and theoretical research *about* design (with regards to the design process), and the intuitive and specific research *for* design (with regards to design methods) to construct new knowledge *through* design (Dalsgaard, 2010; Frankel & Racine, 2010).

Given the requirement for human and contextual insight, it is clear that a pragmatic and novel methodological approach is necessary in constructing this new knowledge. Drawing on experiences with the foundational and multi-method, qualitative work focused on sustainability in the built environment undertaken by The Natural Edge Project research group over the last decade, it is proposed that several layers of inquiry form an emerging methodological hybrid approach appropriate for this research (Reeve, Desha, Hargroves, Newman, & Hargreaves, 2012; Sustainable Built Environment National Research Centre, 2012). Exploratory and largely qualitative in nature, this inquiry adopts a design driven, hybrid research approach that is underpinned by a convergence of design science (rational) and action research (reflective) philosophies as discussed in the following paragraphs.

### ***The contributing role of Design Science theory***

The design science research paradigm is commonly used in the Information Systems (IS) discipline which is described as being “at the confluence of people, organizations and technology” (Hevner, March, Park, & Ram, 2004, p. 75). Both exploratory and explanatory in nature, a design science research approach ensures that proposed solutions are relevant and rigorous by drawing in and systematically combining information on the environment (contextual data) with the knowledge base (theoretical foundations). With aspects of behavioural science and design science paradigms, the information systems research framework is characterised by the inherent ‘relevance’ and ‘rigor’ research cycles (Hevner, 2007) (as shown below in Figure 3). Design science is considered to be highly appropriate for multidisciplinary research that requires contextual understanding in addressing complex problems and developing feasible solutions.

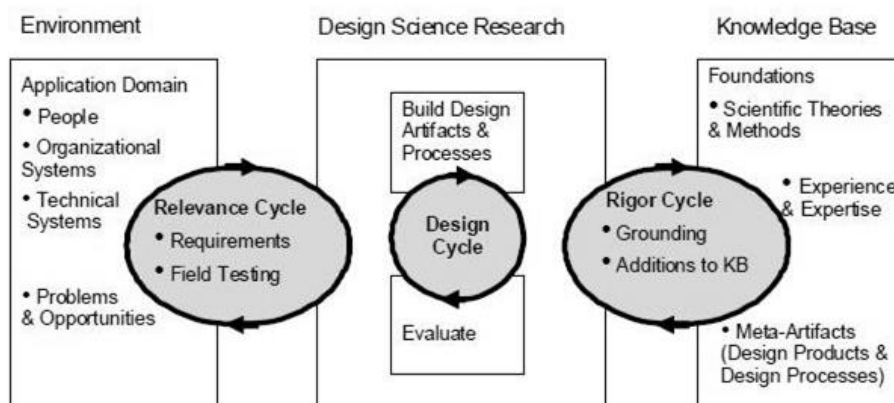


Figure 3: The information systems research framework showing the inherent research cycles (Hevner, 2007).

## ***The contributing role of Action Research***

Action research allows for collaborative ‘construction’ through ‘transformational enquiry’ - the process is cyclical, where researching, learning, putting what is learnt into practice, evaluating, and refining or adjusting occurs repetitiously (Boog, Keune, & Tromp, 2003; Heron & Reason, 1997; List, 2006). It is a participatory style of research – with several opportunities for reflection and ‘reperception’ (List, 2006, p. 673) and is generally undertaken in an ‘action-reflection’ cycle where the researcher: observes, reflects, acts, evaluates, and modifies to move in a new direction (McNiff & Whitehead, 2011). Like adaptive theory, the emergence of novel theory (iteratively evolving theory), incorporates and absorbs elements of prior theory and standing concepts, and is augmented by further data collection and analysis (Layder, 1998). The cyclic nature of this action-reflection cycle is shown below in Figure 4.

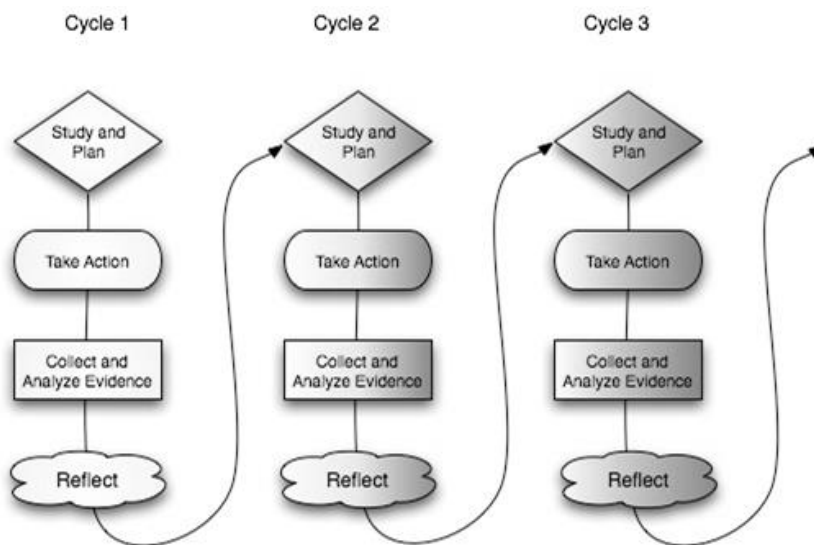


Figure 4: The cyclic nature of action research (Riel, 2010)

## ***Emergence of a methodological hybrid design approach***

Drawing on design science and action research philosophies, an emerging methodological hybrid creates a new space for enquiry to address wicked problems. Balancing the tension and flexibility afforded by these approaches, this *Hybrid Design Approach* provides a holistic and iterative paradigm through which this research may be considered. As shown below in Figure 5, triangulation of data pertaining to discourse, people, and projects in this inquiry will illuminate the emergent consensus and ensure the relevant (contextually appropriate for the context) application of knowledge (demonstrating rigour). A solution to the research problem will be cyclically ‘built’ and evaluated as a result of further information gathered and synthesised through a range of appropriate research methods.

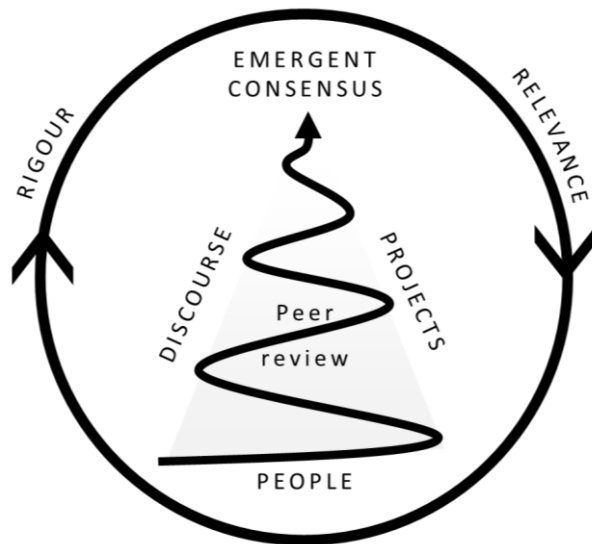


Figure 5: An illustration of the emerging Hybrid Design Approach.

It is accepted that “rigor has no meaning in the absence of relevance” (Kock, 2007, p. 92), and a combination of industry and academic knowledge is therefore required to ensure the outcomes are not only usable and desirable, but also feasible and viable (Stanford University Institute of Design, 2013). Additionally, it is understood that a multi-method research approach enables qualitative researchers to obtain a more complete picture of the comprehensive whole. A combination of complementary research methods are typically conducted to answer specific sub-questions and the results of each inform the emerging conceptual understanding of the overall research problem (Morse as cited in Tashakkori & Teddlie, 2003).

## Application of the Hybrid Design Approach to a heritage building retrofit

In undertaking this research into retrofitting heritage buildings, the proposed research methods comprise of a literature review on the key theoretical constructs, a series of semi-structured interviews with selected participants, and case study observation of a single case study. The research project (2013-2015) has commenced, and an initial literature review has been undertaken in order to address the first research question. The research methods were selected with methodological congruence (refer to the Hybrid Design Approach shown above in Figure 5), and considered in relation to my design research position.

The overall research question is:

*How can additional processes and methods of design be used in heritage building retrofit projects to achieve low carbon outcomes?*

To address this gap in the research, the research methods were selected to answer each of the four research sub-questions as follows:

1. Literature review ('Discourse'):
 

*In the field of design, what processes (and methods) of design are emerging as opportunities for delivering sustainable outcomes?*
2. Semi-structured interviews ('People'), and Case study observation ('Projects'):

*What can be learned about the methods (and processes) of design that are currently used in building retrofit projects?*

3. Literature review ('Discourse'), and Semi-structured interviews ('People'):  
*What additional processes and methods of design could be embraced in heritage building retrofit projects to achieve greater carbon reductions?*
4. Semi-structured interviews ('People'):  
*What are the skills, knowledge and new competencies that are needed to support more effective processes and methods of design in heritage building retrofit projects to achieve greater carbon reductions?*

The literature review, semi-structured interviews, and case study observation research methods provide a robust and rigorous approach to considering the research sub-questions and create a platform for triangulating the qualitative data and key findings. The rigour of the approach is further augmented through several opportunities for peer review in the process. The approach provides a structure that still allows for creativity and the emergence of new knowledge. Based on a convergence of the methodological approaches discussed above, the methods oscillate between the expertise and experience from the knowledge base and insights around the problems and opportunities specific to the environment, and are discussed further below.

### ***Exploring the extent and nature of expertise ('Discourse')***

It is hypothesised that the built environment can learn transformational lessons from the field of design to achieve significant and systemic carbon reductions. With a focus on building expertise based on existing discourse (refer to the Hybrid Design Approach shown above in Figure 5), the first research sub-question proposed is:

*In the field of design, what processes (and methods) of design are emerging as opportunities for delivering sustainable outcomes?*

Beginning from a theoretical perspective and in gathering existing knowledge, a critical review of pertinent literature is undertaken (Silverman, 2000). An initial literature review of existing 'orienting or background concepts' serves to stimulate further theoretical elaboration (Layder, 1998). The aim of the initial literature review is to distil the key characteristics of the central theoretical construct as a foundation of understanding. In exploring the known expertise within the field of design, an initial literature review was undertaken as a means of understanding the notion of design innovation and transformation. A more targeted literature review was subsequently undertaken on the processes and methods of design.

### ***Uncovering the problem context ('People' and 'Projects')***

To understand the barriers and challenges in the environment, semi-structured interviews with people and case study observation of a project (refer to the Hybrid Design Approach shown above in Figure 5) will illuminate a number of insights based on the following research sub-question:

*What can be learned about the methods (and processes) of design that are currently used in building retrofit projects?*

It is understood that an array of challenges prevent the integration of alternative options into mainstream practice, and it is therefore necessary to consider the perspectives of all



the stakeholders in order to understand the problem with respect to the whole system. It is acknowledged that cases must be viewed in the context of the specific circumstances in which they presented, and key actors should be directly engaged for critical reflection (Reeve, et al., 2012). Semi-structured interviews will therefore be undertaken with design and built environment professionals who have worked on at least one heritage or green building retrofit project in the last five years. Participants will be selected across the various lifecycle phases of a building project ('design', 'as built', and 'performance') to gain insights around the problems associated with current practice from the perspectives of these various stakeholder groups. Participants will include architects and interiors designers ('design'), project managers ('as built'), and owners, occupants and tenants ('performance').

A single case study (an actual heritage retrofit building project that has not yet begun) which will be observed as it progresses from start to finish to capture the actual processes and methods of design used (beyond the bias of what people reported in the preceding interviews).

### ***Learning from experience ('Discourse' and 'People')***

Building on the lessons learned from previous projects, semi-structured interviews supported by further literature (refer to the Hybrid Design Approach shown above in Figure 5) enables an exploration of additional processes and methods of design that may potentially apply to the context and is based on the following research sub-question:

*What additional processes and methods of design could be embraced in heritage building retrofit projects to achieve carbon reductions?*

Bringing together the insights gained from discourse ('expertise') and from the semi-structured interviews and case study observation ('problems'), potential additional processes and methods of design will be proposed based on literature and discussed with selected participants in semi-structured interviews. These methods will enable the validation of appropriateness and feasibility of proposed additions.

### ***Identifying opportunities ('People')***

In reaching an emerging consensus and arriving at a research outcome, a final research sub-question guiding the development of recommendations is as follows:

*What are the skills, knowledge and new competencies that are needed to support more effective processes and methods of design in heritage building retrofit projects to achieve greater carbon reductions?*

This question will be addressed in conjunction with selected participants through semi-structured interviews which identify emergent challenges and opportunities for capacity building (i.e. through higher education and continuing professional development), ensuring that an expanded range of processes and methods of design can be enabled in an effort to transform the built environment. It is anticipated that this suite of recommendations will be developed for government, industry and academia as a means of preparing them for engaging in an expanded range of processes and methods of design in future projects.

## Conclusion

This paper has identified a need for new collaborative processes to inform a transition to low carbon solutions in the built environment sector, and a potential opportunity to learn from the design profession. A 'hybrid design approach' has been described and an example of applying this approach to a heritage building retrofit project has been discussed. This approach to qualitative enquiry provides an option for other foundational and multidisciplinary research that seeks to apply learnings from design to solve a complex, wicked, context-specific problem. The targeted and iterative use of several methods in this approach helps to ensure the research is both relevant and rigorous. The process of arriving at a research outcome is well considered as the build and evaluate loop is consistently validated through peer review. A combination of exploratory and explanatory inquiry, this multi-method qualitative style of research draws together industry and academic knowledge.

Through the example provided, it is evident that the *Hybrid Design Approach* creates opportunity for layers and 'lessons of wisdom' to add to the depth of understanding of the problem and potential solutions. The example also provides additional considerations for others considering similar enquiry. As the research continues, the authors intend for additional insights and considerations to inform the emerging research approach and future refinements, including a suite of refined recommendations enabling more effective strategies for retrofitting heritage buildings. The implications for systematically incorporating design process considerations within the built environment sector are potentially broad-reaching, providing new opportunities for innovative thinking towards substantial sustainability outcomes. Furthermore, this approach could be considered in other contexts where new thinking or processes are being sought to move beyond *ad hoc* or incremental outcomes.

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