**On Research by Design**
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The notion of research by design is a recent mode of inquiry in the architectural discipline that aimed to employ the architectural skillset directly in the process of investigation. While the combination of design/research can be traced back to the 'design methods movement' of the late 1960 in Britain and America, the 1990s witnessed a different wave of inquiry about how to turn architectural design and practice into research. In its first issue in 1995, *arq* has started the design/research hare running in the journal. Later issues explored the uncertainty of the design/research question and its confusing position within its contemporaneous approved research culture as well in its relation with the RAE (Research Assessment Exercise). Since then, this mode of research gained more grounds, acceptance and capital in architectural academia. More schools of architecture adopted this mode of research, deploying design in a range of research methods. More writings in architectural academia started slowly to leave behind the shaky feet of '*Is it considered research or not?*' and to search how to secure it as a rigorous form of research. These developments led to an increasing confidence in the architectural field about the potential of this mode of inquiry to be a proper architecturally-based research method. However, the notion of design research in architecture is still broad, representing an arena of different ways of deploying design as a research method that also use a myriad of overlapping terminologies. This paper therefore aims to give an overall synthesis of the notion of research by design in architecture and untangle some of the most commonly used terminologies related to this topic. It builds on the works of many scholars that investigated this mode of research in the last 20 years or so to set a clearer definition of the notion of design research in architecture.

Research is conventionally defined as a formal, systematic, and rigorous process of inquiry directed towards new knowledge or understanding within the boundaries of a defined field. David Durling and Kristina Niedderer (2007) identified the categories of 'Research' with an uppercase 'R' and 'research' with a lowercase 'r'. 'Research' with an uppercase 'R' is associated with formal academic and public processes of inquiry that are often described as accessible and transferable. This type of research may be seen as highly systematic and aims to derive explicit knowledge from the world and disseminate it widely for other scholars. This knowledge should be original for the whole research community and not just for the individual researcher (Durling & Niedderer, 2007). On the other hand, 'research' with a lowercase 'r' is associated with more informal and personal processes of inquiry that may then lack the aspects of accessibility and transferability of knowledge. This category of research, Durling and Niedderer observe, may be found in professional practice where the process of gaining knowledge is assumed to benefit the individual practitioner but is not necessarily made widely available for scrutiny by others (Durling & Niedderer, 2007).

Persisting with Durling & Niedderer categories, both can be found in our

field. Scholars have conducted 'Research' into the history of architecture: the social and cultural role of buildings; theories of what it means to build and dwell in certain place and time; technical investigations into structure, lighting, thermal performance, air quality, acoustics; typological investigations into the qualities of building types; and so on (Lucas, 2016). The history of architectural production also has a long legacy of 'research' (with a lowercase 'r') involving the production and use of design-based knowledge (Grillner, 2013). Design-based knowledge is the kind of knowledge that designers develop in practice through their design activities to investigate everyday problems and gain knowledge about certain situations. However, turning 'design' or 'practice' 'research' into 'Research' is rarely straightforward. Such 'research' seldom has much currency or authority in 'Research' communities.

**By-design research and by-practice research**
A key issue with what is called by-design or by-practice research is the validity of developing grounded theory out of lowercase 'r' research. This has been attributed to the tacit nature of such research and the limitations to what reliable information may be extracted from it (Friedman, 2011). In other words, design and practice can involve some research activity, however, to make this knowledge-seeking process into 'Research', it needs to be explicit, openly communicated, and peer-reviewed (Verbeke, 2013). Thus, designing cannot be used as a research method without regard to the methodological framework within which it is set (Durling & Niedderer, 2007). This is exactly what 'by-design research' or 'by-practice research' involves. The advantage that by-design research seeks to pursue is a special access to the tacit knowledge of design practice.

 Nevertheless, while design could be considered the central feature distinguishing the 'Research' and 'research' fields of architecture, conventional methods drawn from other disciplinary backgrounds remain the norm in field. There are growing calls from within the architectural field – articulated clearly in the first issue of **arq** 21 years ago – to adopt more design-based research methods. They encourage the architectural field to tap into the knowledge held within its practice-based traditions (Verbeke, 2013). The key motor for this development is to incorporate design and the studio culture of practice, which are not well communicated in terms of knowledge transferability and accessibility, to inform its academic research practices (Verbeke, 2013). Conducting research-by-doing through architectural design has remained significant in practice and is increasingly important to architectural academe, representing an alternative to the production and consumption of traditional literatures about architecture (Lucas, 2016). Hence, blending the understanding of general principles of research with design as a mode of exploration gives both the practicing designer and academic researcher a background knowledge resource from which to draw (Friedman, 2011). However, as Fraser (2013) notes, compared to other practice-based fields of inquiry, the discourse around design research in architecture remains immature (Fraser, 2013).

**Design research in architecture**
The significance of design research in architecture is perhaps that the intrinsic

component of its investigations remains dependent on the creative dimensions of architectural endeavour (Fraser, 2013). Architectural design research can hence be described as the processes, and outcomes of investigations, in which architecture researchers use the creative process and its products, or broader contributions towards design thinking, for critical inquiry in which design is a central component of the process of research (Fraser, 2013; Verbeke, 2013). It involves the process of making original investigations through generative and propositional modes of producing works that open-up opportunites to be reflected upon (Schön, 1985; Schön, 2017). Thereby, architectural design research combines a design element with other research activities and methodologies, operating together in an interactive manner (Fraser, 2013).

Architectural design research involves the use of the tools of architectural design as the medium for conducting the research. In a way, architects have already been deploying a combination of modes of expression like drawing, writing, testing, verifying, debating, disseminating, performing, and so on for a rather long time in their training and practice. Hence, the method of research by design is an opportunity to put these significant processes into the realm of architectural research (Forty, 2004; Fraser, 2013). This type of research makes explicit the possibilities for drawing, diagramming, notation, cartography and other graphic representations in the research process. By doing so, it brings the process of research closer to the design process. This is often expressed by the idea of '*thinking by doing*' (Frayling, 1994; Lucas, 2016). It then becomes a research that is distinctively architectural in nature which investigates architecture through architecture instead of just being a research 'on' architecture (Verbeke, 2013). An important aspect of this process is that it takes into account the problem of the irreducible complexity of the architectural design knowledge (Jonas, 2011). Thereby, this mode of research is considered according to Simon Grand and Wolfgang Jonas as the second-generation methodology, which could be one of the most important conversational mediums for the generating of new design knowledge in architecture (Grand, 2011; Jonas, 2011).

**Characteristics of Design Research in Architecture**
Key characteristics of design research include: its saturation with tacit architectural knowledge; the iterative nature of its processes; and a commitment to reflexivity on the part of the researcher.

To observers from outside the field, architectural design can appear to be unsystematic, dependent on individuality, and reliant on processes that remain largely invisible. As such, it is hard to see in it a form of cumulative knowledge base (Fraser, 2013). The knowledge revealed in design outcomes is often tacit and experiential. Tacit knowledge is a kind of knowing that is not separable from the perception, judgement or skill which the knowledge informs (Archer, 2011). While often straightforwardly 'read' by other designers, it usually remains unclear to those external to the discipline (Fraser, 2013; Polanyi, 2009). Architectural projects – be they a building, artefact or speculative proposal – contain embodied knowledge that draws on prior experiences and legacies of architectural training, and are hence visible to those with the training. However, long-established academic disciplines

habitually consider this kind of immediate experience as less objective when compared to factual and theoretical knowledge (Friedman, 2011). Therefore, in Fraser's account, much of the contemporary discourse in architectural research is directed towards theoretical concerns unrelated to the actuality of the design process. Even when directed to that process, researchers often retrospectively analyse the outcome rather than account for what actually has taken place (Fraser, 2013). It is often difficult to discern the tacit knowledge and the cumulative experiences that a design outcome adds to the discipline. However, design research offers a significant opportunity to articulate this kind of situated knowledge which is tacitly communicated between practitioners (Fraser, 2013).

Moreover, design – as a continuous non-linear iterative process of investigation – is central to the process of architectural design research. Its characteristics revolve around experiments into a research topic via design as a mode of inquiry. Rather than placing the emphasis only on the productive outcome, such experimental design processes can examine the inputs and contextual framework in which design takes place (Fraser, 2013). Experimentation becomes a responsive form of research in which each experiment suggests the next step in the research work. The primary benefit of this process is that the results of these experiments are unpredictable, opening the possibility of surprising the researcher with the outcomes achieved. This allows the researcher to design the next experiment to ask more specific research questions (Lucas, 2016). Nevertheless, while experimental method is well established in the sciences, it has only occasionally been employed within architecture. Therefore, architectural design research exploits the iterative process of experimentation to become a methodology for defining and interrogating research questions (Lucas, 2016).

Another factor that characterises design research in architecture is the clear influence of the reflexive position of the researcher. This reflexive position establishes a bi-directional relation between the researcher and the topic under investigation in which neither can be assigned as causes or effects. Reflexivity is a common attribute in researches in the humanities, arts and social sciences. These fields involve the acquisition of an ideological framework that enables the researcher to make coherent sense of disconnected theories, experiences, and values arising in different aspects of life. In such contexts, it is the duty of scholars to make clear the viewpoint from which they operate (Archer, 2011). The field of architecture – while not sitting comfortably within art, humanities, social science, or science – shares some aspects with each. Thus, an act of architectural research inevitably begins from a certain ideological position, which it responsible researchers must declare. Indeed, architectural design processes allude to the personality of the designer within the design. Design as creative act thus implicates the designer with object being designed. Therefore, the researcher in design research is nearly always a participant observer who remains inseparable from the research. Design research thus touches on autobiographical and ethnographical research traditions. And the researcher must remain open to the autobiographical aspects of the work and their encounters with everyday practice (Lucas, 2016).

**The Reflective Practitioner**

Design research in architecture is commonly labelled research by design, research by creative practice, research through design, practice-led research, and practice-based research. Generally, these different designations respond to Donald Schön's idea of 'the reflective practitioner' (Verbeke, 2013). Schön's book *The Reflective Practitioner: How Professionals Think in Action* introduced the importance of reflective thinking in the development of understanding and knowledge in creative disciplines (Schön, 2017). He called for a model of practice whereby practitioners are constantly critiquing and reflecting upon their own actions as they are undertaken, changing their behaviours as appropriate (Schön, 2017).

In Schön's account, methodologies of reflective practice comprise two modes of reflection: 'reflection in action' and 'reflection on action'. Reflection in action can be described as the ability of practitioners to 'think on their feet' (Schön, 2017). It revolves around the idea that, when faced with a professional issue, practitioners usually connect with their feelings, emotions and prior experiences to attend to the situation. On the other hand, reflection on action is the idea that, after the experience, practitioners analyse their reaction to the situation and explore the reasons around, and the consequences of, their actions. In research terms, these reflections are usually conducted through a documentary reflection on the situation. This model of the 'reflective practitioner' thus centres on the idea of life-long learning, where a practitioner analyses experiences in order to comprehend them. It involves paying critical attention to the practical values and theories that inform everyday actions, by examining practice reflectively and reflexively (Schön, 2017).

In this sense, reflective practice methodologies refer to the researcher's actions continuously through the process of research. Afterwards, they stop to reflect-on-action and analyse their in-action decisions, exploring the consequences at work on the research. Accordingly, researchers can reflect on the situation in a different way to someone who simply pursues a more conventional theoretical or practical study. This continuous loop of reflective acting and thinking is a foundational way of marking the method of research by design in architecture (Lucas, 2016).

**Research 'for', 'into', and 'through' Design**
Along with the concept of 'reflection in/on action' in design research, Christopher Frayling famously envisaged a complex tripartite model of relationships between design and research; research 'for', 'into', and 'through' design (Frayling, 1994). These categories bear different expectations about the relationship between a design outcome (whether product, prototype, architectural project, building, urban development scenario, planning document and so on) and the process of knowledge creation (Grillner, 2013; Fraser, 2013).
Frayling proposed that research 'for' design tends to involve investigations conducted with a design application in mind (Frayling, 1994), enabling design to occur (Fraser, 2013). It refers to a process of exploration, discovery and fact-finding which makes possible the production of a particular architectural work (Frayling, 1994; Grillner, 2013). An example of this might be a series of investigations into architectural precedents relevant to the project being designed (Fraser, 2013). Ranulph Glanville summarises research 'for' design as research where the observer is outside, looking outward (Glanville, 1997; Jonas, 2011).

Secondly, research 'into', or 'about', design is perhaps the most straightforward of Frayling's categories. Here the researcher has a clear outsider's perspective through making an investigation into art, design practice, architecture or a particular dimension of its practices or outcomes (Grillner, 2013). Research 'into' design seeks the advancement of new scholarship about a design discipline through a variety of historical, aesthetic, and theoretical perspectives on art and design that may cover a variety of social, economic, political, ethical, cultural, technical, material, and structural concerns (Frayling, 1994). This type of research often refers to established research methodologies drawn from the humanities, social sciences or natural sciences (Fraser, 2013). In this approach, the act of knowledge development is considered to be explicit, and is thus expected to be clearly articulated during the course of the research process (Grillner, 2013). In this sense, this kind of research is being a broad concept whose processes do not involve design *per se*. However, design can be specifically deployed in research 'into' design through two distinctive approaches. The first states what design practice could be and then sets out to develop methods to achieve it. This was seen in the 'design methods' movement that flourished in architecture and beyond in the 1960s and 70s, investigating how to diagram design process, often as a singular entity, and define explicit stages within it (Broadbent et al., 1969; Jonas, 2011). The second approach investigates the circumstances where design is undertaken, seeking to improve or refine the observed activity (Fraser, 2013). Examples include Dana Cuff and Robert Gutman's anthropological studies of architectural practice and practitioners (Cuff, 1992; Gutman, 1988; Fraser, 2013). Glanville explains research into/about design as research where the observer is outside, looking inwards (Glanville, 1997; Jonas, 2011).

Meanwhile, Frayling defines research 'through' design as research where design processes constitute the research methodology itself (Frayling, 1994). This category involves a process of knowledge production that provides possibilities for interrogating, extending, and critiquing the discipline through conceptual designs (Frayling, 1994; Jonas, 2011). The 'through' component of design research is hard to examine other than by the designer who is undertaking the design. In this sense, research questions emerge through the design process in an iterative rather than linear way. To make knowledge outcomes transferable, this method involves critical reflection on the process as it is being undertaken, where design knowledge can be transferred and made available to others. Glanville describes the research 'through' design as a research where the observer is inside, looking outwards (Glanville, 1997; Jonas, 2011).

**Practice-Based/Led Research**
Moreover, research 'through' design is often associated with the notions of 'practice-based research', and 'practice-led research' (Jonas, 2011). The use of the terms practice-based and practice-led research have become widespread in different fields — most often found in design, health, creative arts, and education disciplines. However, these terms do not have an agreed definition across these various fields of research. (Candy, 2006; Niedderer and Roworth-Stokes, 2007). As Linda Candy defines it, practice-based research is an original investigation set out for the purpose

of gaining new knowledge by means of practice and its creative outcomes. In this type of research, the focus on creative practice aims to develop new understanding and insight through deliberate research inquiry that involves a design process or outcome (Candy, 2006). This research process involves the critical framing of design practices through larger theoretical or philosophical concerns (Fraser, 2013). On the other hand, practice-led research is concerned with the advance of knowledge about practice, or to advance knowledge within practice. Its deliberate inquiry focuses on the nature of practice and leads to new knowledge that has operational significance for that practice. Generally, if a creative process or artefact is the basis of the contribution to knowledge, the research is practice-based, whereas if the research leads primarily to new understandings about practice, it is practice-led (Candy, 2006; Frayling, 1994).

*Research by Design – Synthesis*
In conclusion, research-by-design is a relatively new approach in architectural research that exploits the tools and methods of thinking used in practice to generate knowledge that is transferable and original. Architectural research by design is not a single approach; the term incorporates an umbrella of different ways of deploying design as a range of research methods which operate under Schön's widely acknowledged concept of 'the reflective practitioner'. The notion of 'the reflective practitioner' can be described as the ability of the architectural practitioner to reflect through the process of design using both factual and explicit knowledge; as well as situated, experience-based, and intuitive knowledge. This process of reflection is employed through two simultaneous and/or sequential steps: reflection in action and on action. Reflection in action is described as the ability of practitioners to connect with their feelings, knowledge and prior experiences to attend directly to a professional issue. Whilst reflection on action is the idea that, after the experience, practitioners analyse their reaction to the situation and explores the reasons around, and the consequences of, their actions.

On the other hand, there are multiple methods for deploying design in research. For many authors, the key text underpinning the categorisation of such methods is Frayling's article: 'Research in Art and Design' (Frayling, 1994). Those methods are: research 'for', 'into', and 'through' design. The method of research 'through' design is commonly a foundational part of research by creative practice. This method is often associated with notions of 'practice-based research' and 'practice-led research' (Candy, 2006; Frayling, 1994; Jonas, 2011) Nonetheless, research by design is not a clear-cut method of research. Katja Grillner argued that long time after Frayling's essay, the existing portfolio of design-driven, or practice-led, MPhil or PhD researches sit between the 'through' and 'for' positions. Moreover, she argued that the researcher often practices in both categories, not necessarily always being able to distinguish between them (Grillner, 2013). Hence, these are not definite categories, but they are useful means for understanding and allocating the application of design work within the research. Design-driven research could be a mix of two or more of these methods that commonly would fall under the notion of creative practice research.

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