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Review article

Post-positivist microclimatic urban design research: A review

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HIGHLIGHTS

- Research Through Designing (RTD) is needed in landscape architecture and urban design.
- RTD can generate design relevant knowledge: design guidelines and prototypes.
- Urban microclimate responsive design is often studied with post-positivist RTD.
- In post-positivist RTD complexity is reduced to different degrees, independent of scale.
- Post-positivist RTD tests design results through physical or numerical modelling.

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ABSTRACT

'Research Through Designing' (RTD) is a research method that is based on the active employment of designing in the research process. Often, RTD is necessary to generate knowledge that is relevant for design such as design guidelines or prototypes. A broad range of RTD methods can be used to produce such results: post-positivist, constructivist, participatory and pragmatist approaches. The aim of this paper is to elucidate the post-positivist RTD methods through the discussion of examples. The examples represent microclimate responsive design research and were derived from an extensive literature review. The typical issues to be dealt with in such studies are discussed: complexity, scale, testing methods and their mutual relations. A distinction is made between RTD methods and other design research for microclimatic improvement. Three studies occurred to be RTD in the literal sense and they provide a methodological model for further research to generate evidence that supports urban microclimate responsive design.

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1. Introduction

Landscape architecture has been transitioning into an evidence-based profession (Brown & Corry, 2011) and faculty at universities are publishing more research than ever before (Milburn & Brown, 2016). Yet much of the information that is being provided through academic research is not what professional landscape architects report that they want or need (Milburn & Brown, 2016). Evidence is often published in academic journals that are not readily available to practitioners, and the information is often in a form that is not directly usable in design. There is a gap between what is known and the applicability to design (Eliasson, 2000; Lenzholzer, 2010). The relationship between research and design has been the subject of many publications (e.g. Cross, 2007; Deming & Swaffield, 2011; Groat & Wang, 2002; Milburn & Brown, 2003; Rodgers & Yee, 2015).

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New knowledge generated through research can form the *evidence* that design can be based upon (Brown & Corry, 2011) and it can be used to develop design guidelines, recommendations or prototypes (Stappers, Visser, & Keller, 2015; Wensveen & Matthews, 2015). This article gives an overview of a set of design research methods to generate such evidence. It focuses on quantitative methods, using examples from microclimate design studies. There are many different interpretations of 'research' and 'design' but in this article the following definitions were used. 'Research' is considered an academic, rigorous activity to generate new knowledge. This new knowledge can take many different forms (e.g. qualitative, quantitative, etc., see Creswell, 2009). 'Designing' is the activity of giving three- dimensional shape to landscape or urban environments (Glanville, 2015) which differs from spatial planning that focuses on governance and management.

Frayling (1993) described different relationships between research and design. He made distinctions through the use of prepositions such as 'into', 'for' and 'through' to link 'research' and 'design' and these categories have influenced much of the subsequent discourse on the relationship between design and research. The first category described by Frayling was research *into* design which was later also coined as research *on* or *about* design. In this category, design is used as a noun and the research examines the finished design product. Very typical for such research is the *reflection on* or the *analysis of* the design products *post hoc* such as case studies (e.g. Francis, 2001). These reflections can be objective, but also represent philosophical or aesthetic viewpoints. Much of this research is not conducted by the design disciplines themselves, but by members of other disciplines. In the field of landscape architecture and urban design many studies are done by historians, geographers, environmental psychologists or social scientists. The second category pertains to research *for* design. This category covers all types of research that supports the making of a design product or the design process itself. In research *for* design both the design process and the design product benefit from research activities that precede the design process. Research for design can be conceived of as the creation of substantive knowledge through the generation of scientific data to eventually create 'evidence based' designs (Brown & Corry, 2011; Deming & Swaffield, 2011). The third category described by Frayling, research *through* design, also termed 'designing as research' or 'research *by* design' later covers research processes that employ the act of designing (de Jong & van der Voordt, 2002b). Research *through* design requires the involvement of design experts and is often conducted in cooperation with other disciplines. Accordingly, Willis (2007, p. 271) illuminated the role of design in research concisely: "Design is research in many... fields... Industrial design, architecture, art, graphic design, most fields of engineering, some fields of agriculture, areas in business such as marketing, many specialties in health care, computer science, commercial art, and several areas of communication and journalism all focus on design. Design may involve anything from the creation of a coffee pot or the design of a work environment to the building of software. Outside the traditional ... sciences, design is a critical outcome of scholarship in many different disciplines."

The methods of designing as research in other disciplines such as product design or architecture have been broadly discussed (e.g. Burdick, 2003; Dilnot, 1998; Rodgers & Yee, 2015; Zeisel, 2006). However in landscape architecture the act of designing has not been considered a research method until fairly recently (Klaasen, 2007; Lenzholzer, Duchhart, & Koh, 2013; Nijhuis & Bobbink, 2012). Landscape architecture and urban design are disciplines that can transform the earth's surface and human living conditions. In this constantly changing environment, academically sound knowledge on how to design the landscape is needed and knowledge production often requires inclusion of design in the research process. Knowledge that is more readily applied to design (Kapper & Chenoweth, 2000) is needed and design as research has the potential to generate such knowledge (Jonas, 2015; Lenzholzer, 2010).

In architecture, de Jong and van der Voordt (2002b) and Klaasen (2004) developed ideas about 'research by design' and Jonas (2007) about 'research through design'. It is not clear from these articles how design can be research in the context of scholarly research criteria. Lenzholzer et al. (2013) proposed that *designing* can be research when it complies with procedures and values of academic research. They based their proposition on Creswell (2009) who identified four approaches to research: post-positivist, constructivist participatory and pragmatist. Lenzholzer et al. (2013) extended this to propose four different types of 'research through designing' (RTD) for landscape architecture. They consciously used the gerund form of the verb 'design' in this term to emphasize that design activity is an integral part of the research. This differs from the use of a product of designing – the 'design' – in research. Classic post-positivist RTD uses quantitative evaluations to test designs. Typical constructivist RTD entails assessment of designs according to their cultural, aesthetic or ethical values. Participatory RTD involves citizens or other stakeholders in the production of evidence and pragmatic RTD combines the three aforementioned methods.

The idea of design as research has changed over time but generally had a post-positivist tenor. Simon (in Dorst, 1997 p. 50) proposed that "design science could ... become a body of intellectually tough, analytic, formalizable, partly empirical, and teachable doctrine about the design process". Empirical methods were added by Hillier, Musgrove, and O'Sullivan (1972), the term 'hypotheses' was replaced by 'conjectures', and the 'analysis – synthesis' design model was replaced with 'conjecture – test' models (Bamford, 2002; Cross, Naughton, & Walker, 1981; Zeisel, 2006). de Jong and van der Voordt (2002a, p. 455) suggested research by design was "the development of knowledge by designing, studying the effects of this design, changing the design itself or its context, and studying the effects of the transformations. The 'TOTE model' from systems analysis may be recognized in this: Test → Operate → Test → Exit.". Breen (2002, p. 137) extended this to "(t)he most 'scientific' approach would be one whereby targets and course of action are clearly specified beforehand, allowing for systematic evaluation of outcomes and the drawing up of unambiguous conclusions."

As proposed by Creswell (2009), the post-positivist approaches rely on reductionism. This involves identifying clear *cause and effect* relationships and based on these, making hypotheses or conjectures that are tested. When these parameters are transposed into post-positivist RTD, a reduced set of design criteria or aims is clearly defined. This means that the high complexity that urban and landscape design usually involves needs to be reduced to a smaller set of parameters. Designs that respond to this set of parameters can be considered hypotheses that are tested (also see Zeisel, 2006). The testing of the design hypotheses is conducted with well-established methods from empirical sciences. The 'design' in this case is an interim product of the design process and can be a full scale mock-up, scale model, but also drawn projections such as plans, sections and 3D models. In a complex design process so-called 'wicked problems' (Rittel & Webber, 1973) can occur and require continuous compromising, and the outcomes of the testing and refining cycles cannot be 'optimal', but rather 'satisficing' (Simon, 1996). Larger degrees of complexity and scale therefore need to be addressed through several iterations in the design process. Essentially, the design products and hypotheses are tested and optimized in an iterative process in RTD.

Within post-positivist methods, empirical observation and measurement can be used to test hypotheses. Translated to RTD this means that the testing of designs should involve such empirical observation and measurement methods. Predictive models are