Landscape Architecture and Digital Technologies

RE-CONCEPTUALISING DESIGN AND MAKING

JILLIAN WALLISS AND HEIKE RAHMANN

Landscape Architecture and Digital Technologies

Re-conceptualising design and making

Jillian Walliss and Heike Rahmann

MIX
Paper from
responsible sources
FSC
www.fsc.org   FSC® C011748

Landscape Architecture and Digital Technologies

Landscape Architecture and Digital Technologies explores how digital technologies are reshaping design and making in landscape architecture. While the potential of digital technologies is well documented within landscape planning and visualisation, its application within design practice is far less understood. This book highlights the role of the digital model in encouraging a new design logic that moves from the privileging of the visual to a focus on processes of formation, bridging the interface of the conceptual and material, the virtual and the physical.

Drawing on interviews and projects from a range of international designers, including Snøhetta, Arup, Gustafson Porter, ASPECT Studios, Grant Associates, Catherine Mosbach, Philippe Rahm, PARKKIM, LAAC and PEG office of landscape + architecture among others, the authors explore the influence of parametric modelling, scripting, real-time data, simulation, prototyping, fabrication and Building Information Modelling on the design and construction of contemporary landscapes. This engagement with practice is expanded through critical reflection from academics involved in landscape architecture programs around the world that are reshaping their research and pedagogy to reflect an expanded digital realm.

Crossing critical theory, technology and contemporary design, the book constructs a picture of an emerging twenty-first-century practice of landscape architecture premised on complexity and performance. It also highlights the disciplinary demands and challenges in engaging with a rapidly evolving digital context within practice and education. The book is of immense value to professionals and researchers, and is a key publication for digital landscape courses at all levels.

Jillian Walliss has over 15 years' experience as a landscape architecture academic in Australia and New Zealand. She works in the Landscape Architecture program at the University of Melbourne where she teaches landscape theory and design studios. Jillian's research focuses on the relationship between theory, culture and contemporary design practice. Her most recent work investigates the potential of digital technologies to produce a new generation of urban open spaces, which feature the explicit manipulation of climatic phenomena.

Heike Rahmann is a landscape architect at RMIT University and has worked with various practices within the fields of landscape architecture and urban design in Germany, Japan and Australia. Her research explores the intersection of landscape, technology and contemporary urbanism with focus on design practice and theory. Her publications include the co-authored book *Tokyo Void: Possibilities in Absence* (Jovis, 2014), which examines notions of vacancy and transformation processes in one of the largest urban areas in the world.

Preface

There has never been an easier time for designers to engage with the digital realm. Designers can now explore the creative potential of computational design, with minimal mathematical knowledge, aided by more accessible programming languages that transform designers into 'toolmakers' to customise software for their own needs. Hardware advancements offer designers autonomy to define and gather their own data, fabrication techniques such as 3D printing and CNC routing can now be accessed at minimal cost, while the emergence of open source resources offers unprecedented access to a collaborative community in which to exchange and share ideas.

In comparison to architecture, these digitally driven design opportunities have been slow to influence landscape architecture. This disparity in adoption is reflected in the projects featured in the 2012 publication *Digital Landscape Architecture Now*, where almost half of the profiled firms are architectural or art practices.[1] This observation led us to ask why is it that landscape architecture has been so hesitant to engage with a digital design practice? In asking this question, we also became inspired to look more closely for evidence of change.

For the past 3 years we have been working with leading international landscape architects and urban designers, practitioners and academics to construct a record of an emerging digital design practice of landscape architecture. This book highlights how designers apply a range of digital technologies and associated operative techniques in the conceptualisation, design, and construction of form, materiality and systems. We see the book as a work in progress, rather than a manifesto, presenting a snapshot of contemporary developments which we encourage students, academics and practitioners to analyse and debate. Crossing theory, technology and practice, the book uncovers a contemporary design practice embracing complexity and performance, well positioned to engage with the pressing challenges of the twenty-first century such as climate change and intense urban growth.

Importantly, we offer a new generation of landscape architects already engaged with digital technologies (often self-taught) much needed direction in how to meaningfully apply digital techniques and tools within the distinctive disciplinary

framework and concerns of landscape architecture. For more experienced practitioners, we provide an outlook on where practice and design opportunities may develop in the next decade, offering direction for implementing and embedding the digital realm within design practice and pedagogy. And, finally, we offer suggestions on how these two generational positions may engage each other's strengths to advance and shape the discipline.

In this book, this digitally driven design practice is positioned relative to theoretical developments within landscape architecture as well as in relation to a longer theoretical and technical history of the allied design disciplines of architecture, urban design and engineering. This wider positioning recognises that changes to landscape architecture are due to internal (e.g. design discourse and precedents) and external influences such as developments in construction and in software and hardware technologies. For example, the construction industry is currently undergoing significant transformation following the introduction of BIM (Building Information Modelling), which revises construction processes into new models of collaboration conceived to offer efficiencies, cost-savings and simulation of post-construction management processes. BIM is slowly being mandated for major projects across the world, requiring design firms to adapt and revise their work practices.

We present a significant departure from the dominant manner in which landscape architecture currently engages with digital technologies as an advanced representational toolbox. We aim to shift discussions of digital technology from questions of representation and visualisation to a critical reflection on the design possibilities emerging from a digitally driven design practice of landscape architecture. There is no question that these developments will fundamentally reshape the design and construction practices of landscape architecture over the next decade, in a manner already witnessed in architecture. As Antoine Picon, Professor of the History of Architecture and Technology at Harvard's Graduate School of Design (GSD), notes:

> One can safely wager that the contrast between the respective degrees of permeation by computer culture of landscape architecture and architecture will fade in the years to come, as digital tools are about to transform the former as profoundly as they have already changed the later.[2]

So what is meant by the term digital technologies? At the most basic level, the term describes the application of digital resources crossing digital media, programming tools and software applications in the design and construction process. Two distinct concepts emerge in this context – 'computerisation' and 'computation'. Computerisation refers to applications where digital technologies form a 'virtual' drafting board', while computation 'allows designers to extend their abilities to deal with highly complex situations'.[3]

This book concentrates on the definition of 'computation', introduced in two major ways. First, we focus on the concept of modelling, in particular parametric modelling (also known as relational or associative modelling). Accordingly, design shifts from an emphasis on the compositional or visual to a more procedural or rules-based approach.

Second, we introduce the role of digital tools. Through the use of proprietary software or by writing their own code or script (instructions understood by the computer), designers use computational power to apply and explore operations such as spatial modelling or the testing of particular phenomena and conditions represented by data within their design processes.

In addition, we outline how developments in hardware such as sensors, terrestrial laser scanners and fabrication techniques support new means for recording, analysing and modelling site conditions and systems, facilitate the design of 'intelligence' into constructed projects and allow for the construction of complex forms and infrastructures.

The book's structure

We have drawn extensively on the experience of landscape architects and urban designers engaging with digital technologies within their design practice. Through over 80 hours of interviews and detailed analysis of selected projects, we explore how software and hardware, applied within new theoretical framings, transform design processes, workflows, collaborative relationships and construction processes. These projects, crossing large-scale infrastructure, parks, urban squares, river edge and memorials, have mostly been designed in the past 5 years, with over half constructed or in the process of being constructed.

The practices have been strategically chosen to reflect a diversity of sizes and international contexts, encompassing some of the largest landscape architectural practices in the world (up to 100 employees) through to practices of fewer than ten people.

Snøhetta (Oslo), LDA Design (London), Arup (London) and HASSELL (Melbourne) offer the experience of large-scale internationally operating practices, some of which are multidisciplinary. ASPECT Studios (Melbourne), Gustafson Porter (London) and Grant Associates (Bath) provide examples of large landscape-architecture focused offices. Catherine Mosbach (Paris), PARKKIM (Seoul), ecoLogicStudio (London), LAAC (Innsbruck) and PEG office of landscape + architecture (Philadelphia) represent smaller design firms.

This engagement with practice is expanded through critical reflection from academics involved in landscape architecture programs that are reshaping their research and pedagogy to reflect an expanded digital realm; namely Harvard's GSD, the University of Pennsylvania's Department of Landscape Architecture, the University of Virginia's Department of Landscape Architecture and the Master of

Advanced Studies in Landscape Architecture (MAS LA) at ETH, Zurich. And, finally, these perspectives are further widened through the consideration of speciality research labs such as the University of Toronto's GRIT Lab and the University of Southern California's Landscape Morphologies Lab, together with input from the research and development-driven practices of OLIN Studio, Kieran Timberlake and CASE.

Throughout the book we introduce five conceptual framings for conceiving of a digital design practice of landscape architecture. In our Introduction we explore some disciplinary attitudes that have so far limited landscape architecture's engagement with digital technology, before introducing the defining characteristics of a digital design practice. This discussion highlights the primacy of the digital model. In Chapter 1 Topographic surface we focus on the emergence of the digital model, introduced through a discussion of the theoretical and technical influences on architectural design during the 1990s, highlighting the three influential concepts of topology, parametric modelling and performance. In parallel, we discuss advancements in hardware and software sourced from the automobile, aviation and film industries. This is followed by an examination of how landscape architects and urban designers (LAAC, PARKKIM, ASPECT Studios and Snøhetta) interpret theoretical developments and utilise software in the production of precise spatial geometries and a parametric rule-based approach to topography.

The concept of parametric design is discussed in more detail in Chapter 2 Performative systems. We explore how landscape architects apply computational design, guided by a performative theoretical framing, as operative techniques for investigating relationships between form, phenomena and systems. We begin with a discussion of performative design, introduced through Catherine Mosbach and Philippe Rahm's winning scheme for the Taichung Gateway Park competition held' in Taiwan in 2011. This is followed by a more detailed interrogation of parametric modelling and scripting explored through the work of PEG office of landscape + architecture and master's-level design studios held at Harvard's GSD and the University of Pennsylvania (2014–13). The chapter concludes with a discussion on the potential of parametric modelling in offering a new approach to landscape planning.

This exploration of parametric modelling is extended in Chapter 3 Simulating systems where we introduce the emergence of environmental modelling, prototyping and robotics in the simulation of systems. Beginning with the *Gardens by the Bay* in Singapore and PARKKIM's proposal for *Danginri Thermal City* in Seoul, we demonstrate the value of embedding simulation modelling within design processes to test for performance and offer evidence-based metrics such as achieving thermal comfort levels. The possibilities of real-time data together with recording technologies such as small unmanned aerial vehicles (UAV) drones and inexpensive site sensors are then discussed as techniques for gathering and modelling site data; conducting evidence-based research on constructed designs, as well as contributing to the development of intelligent design systems. We conclude the chapter

with an examination of design studios and research labs that explore physical and digital prototyping of systems such as water and material flow as part of their design processes, effectively shifting the conceptualisation of the design studio into the design laboratory.

We continue the focus on prototyping in Chapter 4 Materiality and fabrication, where we examine how material explorations and 'file to fabrication' techniques can extend landscape architecture practice into the design of components that have traditionally been considered as 'off the shelf' items. We begin by introducing the impact of 3D Global Navigation Satellite Systems in creating an automated construction process increasingly applied to large-scale projects. The 'materials first' design practice of Brian Osborn at the University of Virginia, PEG office of landscape + architecture and ecoLogic Studio is then discussed, before concluding with a detailed account of the innovative digital design and fabrication processes critical to the construction of Gustafson Porter's *Diana, Princess of Wales Memorial*.

The theme of construction continues into Chapter 5 Collaboration, where we introduce the 'data' inspired BIM construction environment that is currently reshaping the design and construction processes of the United Kingdom, Asia and the Middle East. We explore the experience of Arup, LDA Design, ASPECT Studios, HÅSSELL and Snøhetta as they negotiate an emerging collaborative data-driven construction process, which challenges the workflows, design, and construction practices of landscape architecture. And, finally, in Future directions we summarise the opportunities presented by a digital design practice of landscape architecture, combined with strategies for transitioning practice and pedagogy into an era inclusive of digital technologies.

This book is dedicated to Ada Lovelace and Grace Hopper – the brilliant women who could see beyond the hardware to imagine the true potential of digital technologies.

Acknowledgements

Introduction

Landscape architecture has a proud connection to the earliest explorations of digital applications for spatial analysis. The publication of this book coincides with the 50-year anniversary of the establishment of Harvard's Laboratory of Computer Graphics, which was influential in the advancement of automated mapping technology, which later evolved into spatial analysis and Geographical Information Systems (GIS). Despite this history of earlier adoption, landscape architecture today demonstrates a more tentative engagement with the possibilities of digital technologies. In this introduction we discuss some of the reasons behind this hesitancy, before introducing the importance of grounding an emerging digital design practice of landscape architecture within a theoretical framing.

We begin by acknowledging the innovative work of landscape architects, who over a half century ago began to explore the potential of burgeoning technologies for informing better decisions about the planning of our cities and the environment.

Funded by a grant from the Ford Foundation, Harvard's Laboratory of Computer Graphics was established in 1965 under the guidance of Howard Fisher. The Laboratory was developed to explore the potential of computer graphics in addressing the urban, social and spatial issues of the American city. Research focused on the development of modelling tools such as SYMAP (a vector model and a punch card system) that could spatialise demographic, social and ecological data into 2D digital format thematic maps. SYMAP is recognised as the first widely distributed computer package that could support geographical data.[1] Early applications of SYMAP included Carl Steinitz's 1967 design studio at Harvard's Graduate School of Design (GSD), which mapped and analysed the urban development and natural systems of the Delmava Peninsular.[2]

In 1965, Ian McHarg (also supported by the Ford Foundation) established the Regional Planning Program at the University of Pennsylvania, and in 1967 visited the Laboratory, to experience first-hand the potential of SYMAP to his emerging methods of spatial analysis. In the following year he began his extensive regional planning study of the Delaware River Basin, followed by the publication of his seminal text *Design with Nature* in 1969. During this period, McHarg tried to introduce a computer system to the program, however, students were reluctant

to engage with the time-consuming punch card system.[3] At the same time, Jack Dangermond left Harvard's Laboratory to co-found Esri (Environmental Systems Research Institute), now considered the largest supplier of GIS software in the world. In a common pattern in the history of software development, research originating from universities offered the basis for commercially viable software, with Esri releasing ARC/INFO software in 1982 (including a PC version in 1986, followed by ArcView in 1991).[4]

Encouraged by the availability of ARC/INFO software, McHarg argued for the reintroduction of computers at the University of Pennsylvania in 1984, leading to the purchase of Intergraph computer system, which included three Intergraph Workstations (to the value of $500,000).[5] Dr John Radke, a visiting professor from the Department of Geography who helped McHarg to establish the computer system commented on the 'immense' analytical capabilities of the computers, stating:

> This Intergraph computer will enable us to do the type of 'McHargian' ecological land-use sustainability analysis that has, in the past, taken much longer to do with a much wider margin of error. You will be amazed at how quickly you can draw features of the landscape, move them around, and actually view, in three dimensions, a variety of design alternatives with the push of a button.[6]

Throughout the 1980s and 1990s, GIS spread across universities and practices as a digital application for integrating environmental knowledge into planning, promoted by the increasingly accessible software and guided by the academic writings of McHarg, Carl Steinitz, Stephen M. Ervin and Dana C. Tomlin.

However, the exploration of GIS within landscape architecture has weakened considerably in the early twenty-first century, considered by many designers to be too constrained within scientific positivist methodologies weighted towards inventory and analysis for land suitability. Aimed at addressing this acknowledged limitation, Esri has more recently proposed a further iteration of landscape planning known as 'Geodesign'. Geodesign is broadly considered 'design in geographic space'.[7] But techniques for integrating design practice with the geographic sciences currently remain ill-defined and ambiguous, ranging from the development of 'sketching' capabilities, either by the application of hand drawings or the ability to sketch within specific software, through to the development of collaborative processes inclusive of designers.

These proposals share conceptual difficulties in conceiving design logic or techniques for bridging design generation, data and the considerable power of the computer. But foremost, this discussion is occurring in isolation from the theories and ideas that drive a designer's adoption of digital technologies. The challenge of inserting design into Geodesign is therefore multifaceted, encompassing ideas, generative techniques, imagination and theories. It is our ambition in writing this

book to show how the considerable powers of a computational approach (including the capabilities of GIS), can be applied within a creative and generative practice, and to demonstrate how these techniques can help landscape architects to explore the ideas and concerns core to landscape architecture in the twenty-first century such as designing with ecological systems, working with systems in flux or engaging with the extreme weather events caused by climate change.

Conceiving a digital design practice

Many landscape architects have difficulties in conceptualising digital technology as a creative medium. This attitude can be traced to three issues: the conceptualisation of creativity as a human endeavour; the assumption that an unmediated connection between hand and the brain evident in the act of drawing provides the most valuable insights for design; and that technology distances the designer from the real world. Underlying all of these attitudes is the problematic conflation of a tool with technique.[8] For example a pencil is no less a tool than a computer, with neither offering non-mediated technique. These attitudes are equally prevalent in practice and academia.

For instance, a 2003 survey of members of the ASLA (American Society of Landscape Architects) concluded that 'the predominant response was that computers were not intuitive and design is intuitive'.[9] The computer 'was not perceived to have significantly impacted the artistic or creative aspects of design practice', with few practitioners believing that 'the computer can improve these aspects of the profession'.[10] Even a decade later, a survey of 427 ASLA-registered landscape architects continues to highlight the attitude that technology negatively influences creativity, with design conceived as requiring 'human creativity' and 'human spontaneity'.[11]

These attitudes are mirrored within academia. Numerous publications and essays have emerged since 2000 that link creativity with hand drawing, reinforcing the association of design as a distinctly 'human' endeavour. Most prominent are Marc Treib's edited collections *Drawing/Thinking: Confronting an Electronic Age* (2008) and *Representing Landscape* (2008).[12] Such writing produced predominantly from a generation of scholars and designers educated within a non-digital era, expresses anxiety over the assumed loss of particular qualitative attributes and skills, if hand drawing is replaced by digital technologies.

These positions tend to be formed from a limited understanding of the potential of digital technologies, reducing its value to that of a 'virtual drawing board' to replicate analogue modes of representations. This perspective, observes architectural historian Mario Carpo, is aligned with historic patterns of technological change, where 'new and potentially disruptive technologies' are used to 'emulate pre-existing ones'.[13] As Karen M'Closkey states: 'If digital media are believed to be

deficient, this is only because they are used to replicate hand-drawn techniques, rather than explored for the medium's inherent capabilities.'[14]

In this light, a more valuable discussion focuses upon what techniques such as drawing type, operative technique or analytical process – whether analogue or digital – might offer the designer. There is no argument that hand drawing will always have a valuable place in any designer's skills. Equally, computational design offers landscape architects analytical power and new generative capabilities that cannot be replicated through drawing. Therefore in this book we avoid the binary discussion of an either/or approach to analogue and digital techniques. Instead we focus on the areas where digital technologies demonstrate the capability to *expand* the design practice of landscape architecture.

Presently, there are few publications or essays that discuss the design potential of digital technologies to landscape architecture within practice or pedagogy. This absence is reinforced by the manner in which design projects are discussed, which emphasises the representational quality of the image and often diminishes the role of digital technologies in the generative design process, keeping such practices 'back of house' observes Charles Waldheim.[15] Anecdotal evidence suggests it not unusual for landscape architects to hand draw over digitally generated designs to present more 'pleasing' images for the client. Even when considerable technological innovation has shaped a project, there can be a tendency to privilege a particular 'artistic' framing, as is demonstrated in the manner in which the *Diana, Princess of Wales Memorial*, designed by Gustafson Porter is generally understood by the discipline.

Jane Amidon's 2005 monograph on Gustafson Porter, for example, included minimal discussion of the innovative digital scanning, 3D modelling, physical prototyping, and advanced stone fabrication techniques integral to the realisation of the memorial, beyond the scant reference to 'advanced 3-D digital imaging and stone cutting technology'.[16] This project not only utilised technologies *ahead* of architecture, but also could not be achieved without them.[17] As we explore in Chapter 4, the subsequent design development and fabrication processes of this memorial allowed the granite 'necklace' to be designed and manufactured in just 26 weeks.

How is it that such digital innovation is so quietly put aside? It is inconceivable that Jørn Utzon's design of the iconic Sydney Opera House would be discussed without referring to his collaboration with engineer Ove Arup in the design and construction of the monumental concrete shells. Yet, too often landscape architecture

I.2a–c
Plan image and clay model from Gustafson Porter's winning competition entry for *Diana, Princess of Wales Memorial*.