This book describes a unique way of measuring, analysing and comparing buildings using fractal dimensions. A fractal dimension is a mathematical determination of the typical or characteristic level of complexity in an image or object. Thus, fractal dimensions provide a rigorous measure of the extent to which an object, say a building, is relatively simple, plain or smooth at one extreme, or complex, jagged and rough at the other.

After introducing the method for calculating fractal dimensions in Part I of the book, Part II presents the results of a major study of the plans and elevations of eighty-five canonical houses designed or constructed between 1901 and 2007. The houses include works by Le Corbusier, Eileen Gray, Mies van der Rohe, Frank Lloyd Wright, Robert Venturi, Denise Scott Brown, Frank Gehry, Peter Eisenman, John Hejduk, Richard Meier, Kazuyo Sejima, Ryue Nishizawa, Yoshiharu Tsukamoto, Momoyo Kajima, Glenn Murcutt and Peter Stutchbury. The eighty-five houses are measured to examine trends in individual designer’s works, across different stylistic movements and over more than a century of shifting social patterns and aesthetic tastes. These trends are encapsulated in a series of three hypotheses which are proposed in the introduction and examined in the book’s conclusion.

In addition to the results of this overarching study, five specific arguments about architecture are also tested using mathematical evidence. The first of these is concerned with the way the formal expression of modernist architecture is allegedly shaped in response to its orientation and address. The second examines claims about the changing visual experience of walking through one of Frank Lloyd Wright’s houses and the third is about the extent to which façade permeability (the presence of windows and doors) shapes the formal expression of a building. The fourth of these studies examines arguments about frontality and rotation in the early domestic architecture of Eisenman, Hejduk and Meier. The fifth and final study investigates the degree to which Murcutt’s architecture is shaped by either literal or phenomenal transparency. These secondary studies all use variants of the fractal analysis method that are attuned to testing specific architectural properties.
As a result of this combined approach—a primary overarching study and five secondary studies—this book does not possess a neat, singular conclusion about architecture that can be summarised in a paragraph. Instead, the newly developed measures are used to illuminate a large number of beliefs about design, including arguments pertaining to changing trends in planning and expression and the extent to which different stylistic movements are visually differentiable from each other. Furthermore, the data are used to distinguish between diverse approaches to spatial planning, form-making and architectural expression. Thus, the majority of the results of this research are presented sequentially, at the end of specific sections and chapters.

To give some context to the research, this book has been written for people with backgrounds in architecture, urban design, interior design and design computing. It has also been written and framed in such a way that it is accessible to postgraduate students, as well as to professionals and academics. For this reason, the level of mathematics used is relatively general and only basic statistical methods are employed. This descriptive approach has been taken to the data because, with no detailed inferences being drawn from it about the relationship between the designs studied here and the larger body of domestic architecture produced in the same period, there is no need for more complex statistical analysis. For the same reason, the mathematical results are typically analysed using the critical-interpretative techniques of design theorists and historians. Thus, a common approach in this book is to use numbers, charts and simple statistical measures (average, median, standard deviation) in parallel with scholarly arguments, to reach a reasoned conclusion about an issue. More mathematically inclined readers are invited to undertake their own analysis of the data or follow links to our other publications which contain more detailed results. Similarly, design theorists and historians are free to interpret the results in their own terms or read our papers, cited in the text, which offer a more intricate interpretation of the philosophical basis for some of this material.

At this juncture, it is also useful to provide a note about authorship and how we will refer to our past research. For much of the last ten years, we—Michael Ostwald and Josephine Vaughan—have jointly published our research into applications of computational fractal analysis in design. Across twenty-five co-authored papers and chapters, we have gradually developed and refined the theory and practice of fractal analysis for architectural and urban applications. The intellectual content of the present book is shaped by these publications, a few of which have been substantially revised and expanded for inclusion here. However, prior to this time Michael Ostwald separately published a large body of research on philosophical, theoretical and historical connections between architecture, non-linear mathematics and fractal geometry. Furthermore, he also worked closely with several other co-authors on this early research. For this reason, throughout the present book we will refer to past research published by Michael alone, or in partnership with other colleagues, in the third person. In contrast, we will tend to refer to our joint research in the first person, and in this way hope to remain clear about authorship.
The software used for the majority of the calculations in this book is called ArchImage. We developed and refined this software with the support of colleagues from computer science and software engineering at the University of Newcastle (see the Acknowledgments section for full details). ArchImage’s basic properties are described in Chap. 6 and it is available for download through the authors’ websites.

In this book, we present the results of our mathematical analysis of more than 625 reconstructed architectural plans and elevations and over 200 specially prepared views of famous buildings. Using software that has been specially authored for this project, over five million separate pieces of data were extracted from these images and subjected to over 9000 mathematical operations to measure the dimensional properties of eighty-five designs. To the best of our knowledge, this is the largest mathematical study ever undertaken into architectural design and the largest single application of fractal analysis in any field. We hope that through this research the reader will be inspired to think about architecture—its history, theory and analysis—in a new way.

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