

# Contents

Preface	v
Acknowledgements	x
List of Figures	xv
List of Tables	xx
List of Color Plates	xxii
Introduction	1
1 The Shape of Cities: Geometry, Morphology, Complexity and Form	7
1.1 Understanding Cities	7
1.2 Ancient and Traditional Conceptions of Space	10
1.3 The New Science of Space and Time	14
1.4 The City of Pure Geometry	18
1.5 The Organic City	28
1.6 Morphology: Growth and Form, Form and Function	42
1.7 Urban Hierarchies	47
1.8 A New Geometry	55
2 Size and Shape, Scale and Dimension	58
2.1 Scale, Hierarchy and Self-Similarity	58
2.2 The Geometry of the Koch Curve	61
2.3 Length, Area and Fractal Dimension	65
2.4 The Basic Mathematical Relations of Fractal Geometry	68
2.5 More Idealized Geometries: Space-Filling Curves and Fractal Dusts	71
2.6 Trees and Hierarchies	75
2.7 Fractal Attractors: Generation by Transformation	83
2.8 Fractals as Iterated Function Systems	85
2.9 Idealized Models of Urban Growth and Form	91
3 Simulating Cities as Fractal Picturescapes	96
3.1 The Quest for Visual Realism	96
3.2 Randomness and Self-Similarity	100
3.3 Fractional Brownian Motion	107
3.4 Fractal Planetscapes and Terrain	110

3.5	Simulating Brownian Motion by Midpoint Displacement	115
3.6	Fractal Terrain Using the Midpoint Displacement: the 'Earthrise' Sequence	118
3.7	Elementary Models of Urban Structure	122
3.8	Fractal Cityscapes: the 'London' Sequence	126
4	Laboratories for Visualizing Urban Form	130
4.1	Experimentation as Visualization	130
4.2	Exploring Urban Forms in the Space of All Cities	135
4.3	Hierarchical Urban Structure	140
4.4	Discrete Choice Models of Urban Structure	142
4.5	Estimation Methods for the Multinomial Logit Model	143
4.6	Determinants of Spatial Structure: the Data Base	146
4.7	Model Selection and Estimation	149
4.8	Fractal Simulation of House Type and Location in London	159
4.9	Extending the Laboratory for Experimentation and Visualization	162
5	Urban Boundaries and Edges	164
5.1	At the Edge of the City	164
5.2	Cartographic Representation and Generalization of Geographical Boundaries	167
5.3	The Basic Scaling Relations for a Fractal Line	170
5.4	Estimating the Fractal Dimension: the Urban Boundary of Cardiff	173
5.5	Form and Process: Cardiff's Changing Urban Edge	179
5.6	Fractal Measurement Methods Compared I: the Structured Walk	185
5.7	Fractal Measurement Methods Compared II. Equipaced Polygon, Hybrid Walk and Cell-Count Methods	190
5.8	Beyond Lines to Areas	195
6	The Morphology of Urban Land Use	199
6.1	Inside the Fabric of the City	199
6.2	Area-Perimeter Relations and Scale Dependence	201
6.3	Areas and Perimeters: the Fractal Geometry of Urban Land Use	204
6.4	Perimeters and Scale: Constructing Long Threads from Land Use Parcel Boundaries	210
6.5	Refining the Perimeter-Scale Relations for the Aggregated Land Use Boundaries	218
6.6	Fractal Dimensions of Individual Land Parcels	221
6.7	The Problem of Measurement	226
7	Urban Growth and Form	228
7.1	Cities in Evolution	228
7.2	The Basic Scaling Relations of the Fractal City	230
7.3	Preliminary Evidence for a Theory of the Fractal City	234

7.4	A Scaling Model of Urban Growth	244
7.5	The Process of Diffusion-Limited Aggregation	247
7.6	The Statistical Measurement of DLA Clusters	250
7.7	Space-Time Histories and Accounts	252
7.8	Theoretical Simulations: I. Statics	255
7.9	Theoretical Simulations: II. Dynamics	262
7.10	An Empirical Test: The Urban Growth of Taunton	266
7.11	Extending the Growth Model	272
8	Generating and Growing the Fractal City	274
8.1	Simulating Growth	274
8.2	Diffusion-Limited Aggregation and Dielectric Breakdown	277
8.3	Analogies and Solutions	281
8.4	Form and Dimension of the Baseline Model	285
8.5	The Effect of Randomness on Form and Dimension	291
8.6	Physical Constraints on the Simulation	295
8.7	Generating the Continuum of Urban Forms	297
8.8	Measuring and Simulating Urban Form in Medium-Sized Towns: Applications to Cardiff	300
8.9	Towards More Realistic Models	306
9	Form Follows Function: Reformulating Population Density Functions	308
9.1	Cities as Population Density Functions	308
9.2	Exponential Functions of Urban Density	311
9.3	Power Functions of Urban Density	314
9.4	Urban Allometry, Density and Dimension	318
9.5	The Basic Scaling Relations Revisited	320
9.6	Methods of Parameter Estimation	321
9.7	Applications to Large Cities: the Seoul Data Base	324
9.8	The Density Model Estimates	326
9.9	Fractals and City Size	332
10	Extending the Geometry to Systems of Fractal Cities	335
10.1	Articulating Systems of Cities	335
10.2	Scaling Relations for City Size Distributions	339
10.3	The Representation of Urban Areas	342
10.4	Initial Analysis of the Norfolk Settlement Pattern	344
10.5	Estimates of Allometric and Fractal Dimension in Norfolk	347
10.6	Constraining Urban Form Through Green Belts	353
10.7	The Impact of Green Belts Using Scaling Relations	357
10.8	An Unfinished Agenda	364
	Conclusions	369
	Bibliography	373
	Author Index	385
	Subject Index	389