

Landscape Modeling

Digital Techniques for Landscape Visualization

GIFT OF
THE ASIA FOUNDATION
NOT FOR RE-SALE

Stephen M. Ervin
Hope H. Hasbrouck

ĐẠI HỌC QUỐC GIA HÀ NỘI
TRUNG TÂM THÔNG TIN THƯ VIỆN

A - 00 / 3702

McGraw-Hill
New York Chicago San Francisco Lisbon London Madrid Mexico City Milan
New Delhi San Juan Seoul Singapore Sydney Toronto

Contents

Preface	xii
Acknowledgments	xiii

Chapter 1: Landscape Modeling

1.1 Introduction to Landscape Modeling	1
1.1.1 Reasons for Modeling	3
1.1.2 Dimensions of Modeling	8
1.1.3 Techniques for Digital Modeling	11
1.2 Two-Dimensional Models	12
1.2.1 Coordinate Systems	12
1.2.2 Map Coordinates	13
1.2.3 Pixels and Color Space	15
1.2.4 Points, Lines, Polygons, and Curves	16
1.3 Three-Dimensional Models	18
1.3.1 Surfaces	18
1.3.2 Solid Models	19
1.4 Operations in 3D Modeling	20
1.4.1 Organization: Repetition, Combination, et al.	20
1.4.2 Boolean Operations: Intersection, Difference, Union, et al.	21
1.4.3 Procedural Operations and Scripting	22
1.5 Rendering	23
1.5.1 Ray-tracing	23
1.5.2 Multichannel Textures	24
1.5.3 Procedural Textures	26
1.6 Presentation	26
1.6.1 Lighting and Shadows	26
1.6.2 Camera Frame and Viewpoint	28
1.7 Calculations from 2D and 3D Models	28
1.7.1 Database Models	28
1.7.2 GIS-Based Analysis	29
1.8 Dynamics: 4D Models	30
1.8.1 Generation	30
1.8.2 Movement Through	31
1.8.3 Movement Of	32
1.8.4 Interaction With	33
1.9 A Brief History of Computer Graphics in Landscape Modeling	34
1.10 Summary	36
References	37

Chapter 2: Landform

2.1 Introduction	39
2.2 Two-Dimensional Representations	42
2.2.1 Spot Elevations	42
2.2.2 Contours	46
2.2.3 Cross Sections	48
2.3 Three-Dimensional Terrain	49
2.3.1 Surfaces	49
2.3.1.1 Simple Planes	50
2.3.1.2 Grid Mesh	51
2.3.1.3 Ruled Surface	55
Tutorial: Ruled Surface	58
2.3.1.4 TIN – Triangulated Irregular Network	60
Tutorial: TIN	64
2.3.1.5 Parametric Surfaces: Patches and NURB Surfaces	67
Tutorial: NURB Surface	68
2.3.2 Three-Dimensional Solid Terrain	72
2.3.2.1 Parametric Solids	72
Tutorial: Parametric Solids	74
2.3.2.2 Stepped Contours ("Pancake" Models)	77
Tutorial: Solid Stepped Contour Model	78
2.3.2.3 Boolean Operations	79
Tutorial: Boolean Operations	80
2.3.2.4 Rocks	83
2.4 Operations on Terrain: Space Forming, Design Approaches	84
2.5 Textures on Landform	85
2.5.1 Simple Color	86
2.5.2 Multichannel Textures, Including Photographic-Based Textures	86
2.5.3 Draped 2D Image Maps	88
2.5.4 Geospecific Textures	89
2.5.5 Geotypical Textures	91
Tutorial: Draping an Image Map	92
2.6 Terrain Visualization	95
2.6.1 Tiling of Texture Maps	95
2.6.2 Levels of Detail	96
2.6.3 Lights and Shadows on Landform	99
2.7 Calculations on Terrain: Analytic Models	100
2.7.1 Cut and Fill Volume Calculations	101
2.7.2 GIS-Based Elevation, Slope, and Aspect Analysis	102
2.8 Dynamics – Procedural Models and Representations	102
2.8.1 Generation	104
2.8.1.1 Fractal Terrain	105
2.8.1.2 Terraforming	106
2.8.2 Movement through Terrain	109
2.8.3 Movement of Terrain	111
Tutorial: Morphing Terrain	

Chapter 2: Landform – continued

2.8.4 GIS-Based Erosion and Other Dynamic Models	113
2.9 Summary	116
References	117

Chapter 3: Vegetation

3.1 Introduction	119
3.2 2D Models of Vegetation	122
3.2.1 Photographs for Collage and Drawing	123
3.2.2 Paraline/Orthographic Drawings	124
3.2.2.1 Planting Plans	124
3.2.2.2 Plan Symbols	125
3.2.2.3 Elevation and Section Symbols	125
3.3 3D Vegetation Models	127
3.3.1 Surfaces	127
3.3.1.1 Billboards	128
3.3.1.2 Silhouette	129
Tutorial: Billboard	130
Tutorial: Silhouette	132
3.3.1.3 Layered Canopy	134
Tutorial: Layered Canopy	135
3.3.2 Solid Representations	138
3.3.2.1 Simple Parametric Solids – Cones, Cylinders	138
3.3.2.2 Cylinder-based Hand-built Models	138
Tutorial: Parametric Solids – Simple	139
3.3.3 Hybrid (3D and 2D) Plant Forms	142
Tutorial: Hybrid Models	143
3.3.3.1 Parametric 3D Models	148
Tutorial: Procedural Models	149
3.3.3.2 Special Trees – Palms, Others	148
3.3.4 Plant Structures: Groves and Allees	151
3.4 Textures on Plant Material	152
3.4.1 Maps on Solids	152
3.4.2 Simple Color	153
3.4.3 Bump Maps and Other Compound Textures	153
3.4.4 Photograph-based Textures	154
Tutorial: Textured Tree Bark	155
3.4.5 Procedural Textures	158
3.4.6 Grass and Groundcovers	158
3.5 Visualization Concerns	160
3.5.1 Transparency	161
3.5.2 Lighting	162
3.5.3 Shadows	164
3.5.4 Levels of Detail	166
3.5.4.1 Forest Models	166

Chapter 3: Vegetation – Continued

3.6 Plant Dynamics	168
3.6.1 Generation	168
3.6.1.1 Recursive Plant Forms	168
3.6.1.2 Other Plant-Generation Codes	171
3.6.1.3 Growth, Change, and Seasons	172
3.6.2 Movement through Vegetation	175
3.6.2.1 Vegetation Walk-throughs	175
3.6.3 Movement of Vegetation	176
3.6.3.1 Physics-based Kinetic Systems	176
3.6.3.1.1 Blowing in the Wind	176
3.6.3.2 Forest Growth Models	177
3.7 Summary	178
References	179

Chapter 4: Water

4.1 Introduction	181
4.2 2D Models of Water	184
4.2.1 Paralinear/Orthographic Drawings	184
4.2.2 Hypsography	184
4.3 3D Models of Water	185
4.3.1 Surfaces	185
4.3.1.1 Flat Planes	185
4.3.1.2 Rippled Surfaces	185
4.3.1.3 Lakes and Ponds	186
4.3.2 Solid Representations	187
4.3.2.1 Simple Parametric Solids – Prisms	187
4.3.2.2 Falling Water	188
4.3.2.3 Spray, Mist, Drops	189
4.4 Textures for Water	190
4.4.1 Simple Color	190
4.4.1.1 Transparency	191
4.4.1.2 Reflectivity	192
4.4.1.3 Refractivity	193
4.4.2 Multichannel Textures	194
4.4.3 Underwater Effects	196
4.4.4 Wet Objects	197
4.4.5 Puddles	197
4.4.6 Snow and Ice	198
4.5 GIS-based Hydrologic Models	201
4.6 Water Dynamics	201
4.6.1 Movement through Water	203
4.6.2 Movement of Water	204
4.6.2.1 Ripples and Waves	206
4.6.2.2 Waterfalls	206

Chapter 4: Water – continued

4.6.2.3 Fountains	207
<i>Tutorial: Making a Waterfall or Fountain</i>	208
4.6.3 Multimedia – Sound	213
4.7 Summary	214
References	215

Chapter 5: Atmosphere

5.1 Introduction	217
5.2 Illumination	218
5.2.1 Sunlight	220
5.2.2 Moonlight	221
5.2.3 Night Lighting	222
5.3 Shadows	223
5.4 The Sky	226
5.5 Clouds	227
5.6 Weather	230
5.6.1 Haze and Fog	230
5.6.2 Rain	231
5.7 Colors in the Landscape	232
5.8 Atmospheric Dynamics	234
5.8.1 Solar Motion	234
5.8.2 Wind	235
5.9 Summary	236
References	237

Chapter 6: Synthesis

6.1 Introduction – Putting It All Together	239
6.1.1 Structures, Vegetation, and Water on Landform	240
6.1.2 People and Other Animals	242
6.2 Professional Practice	244
6.2.1 Accuracy, Precision, and Conversion	246
6.2.2 Digital Modeling Project Management	248
6.3 Presentation and Output Media	248
6.3.1 Camera and Viewpoint	249
6.3.1.1 Plan View	250
6.3.1.2 Plan Oblique	251
6.3.1.3 Eye-level Perspective	252
6.3.1.4 Animation Cameras and Viewpoints	253
6.3.2 Media	253
6.3.2.1 On-screen	254
6.3.2.2 Printed Output	254
6.3.2.3 35 mm Slides or Photographs	254

Chapter 6: Synthesis – continued

6.3.2.4 World Wide Web	255
6.3.2.5 Animations	255
6.3.2.6 Video	256
6.3.2.7 QTVR	256
6.3.2.8 VRML	257
6.3.2.9 Immersion	257
6.4 Data Sources	258
6.4.1 USGS, GIS Agencies	258
6.4.2 Surveyors	260
6.4.3 Digitizing	261
6.5 Ethical and Representational Concerns	262
6.6 Final Thoughts; Next Steps	264
6.7 Summary	266
References	267
 Appendix 1: Software	 269
 Appendix 2: Glossary	 273
 Index	 283
 About the CD-ROM	 287

GIFT OF
THE ASIA FOUNDATION
NOT FOR RE-SALE