

Contents

Preface, xvii

SECTION I **Procedural Generation**

CHAPTER 1 ■ When and Why to Use Procedural Generation 3

DARREN GREY

PLANNING WHEN TO USE PROCEDURAL GENERATION	3
Integral	3
Drafting Content	4
Modal	5
Segmented	5
WHEN PCG IS A BAD IDEA	5
Quality Assurance	6
Time Restrictions	6
Authored Experience	7
Multiplayer	7
Just Random	8
Overreliance on PCG	8
WHY USE PROCEDURAL GENERATION?	8
Utilitarian	8
Unique	10

CHAPTER 2 ■ Managing Output: Boredom versus Chaos 13

KENNY BACKUS

CHAPTER 3 ■ Aesthetics in Procedural Generation 23

LIAM WELTON

ATMOSPHERE IN <i>SUNLESS SEA</i>	24
ESTABLISHING THE RULES	25
BLURRING THE BOUNDARIES	26
THE RESULT	27

CHAPTER 4 ■ Designing for Modularity 29

JASON GRINBLAT

MODULES AND GESTALTS	29
ASSEMBLY MECHANISMS AND GESTALT SPACES	30
ENABLING PLAY	33
Mechanics as Shared Substrates	33
Orthogonality	35
Equivalence of Impact	37
PLOTTING DESIRABLE GESTALTS	38
INSERTING MEMORABLE ASYMMETRY	40
REFERENCE	41

CHAPTER 5 ■ Ethical Procedural Generation 43

DR. MICHAEL COOK

TALKING IN CODE	44
THE BIG WIDE WORLD	46
YOU ARE WHAT YOU EAT	50
TALKING THE TALK	51
THE FUTURE	54

SECTION II Procedural Content

CHAPTER 6 ■ Level Design I: Case Study 57

CHRIS CHUNG

OVERVIEW	58
THE RULES	59

HOW IT WORKS	60
CONCLUSION	62
CHAPTER 7 ■ Level Design II: Handcrafted Integration	63
<hr/>	
JIM SHEPARD	
STANDARD DUNGEONS	63
CRYPT GENERATION	66
BEST PRACTICES	68
<i>DUNGEONMANS DUNGEON GENERATION PSEUDOCODE</i>	69
<i>DUNGEONMANS CRYPT GENERATION PSEUDOCODE</i>	70
CHAPTER 8 ■ Level Design III: Architecture and Destruction	73
<hr/>	
EVAN HAHN	
ARCHITECTURE GENERATION	74
Step 1: Calculate the Bounding Box	75
Step 2: Split the Box into Regions	75
Step 3: Skim Perimeter Regions	76
Step 4: Place Connections	78
Step 5: Assign Region Types	80
Step 6: Make Adjustments	81
Step 7: Generate the Regions	81
DISCUSSION	82
CHAPTER 9 ■ Cyclic Generation	83
<hr/>	
DR. JORIS DORMANS	
CYCLES	84
USING GRAPHS TO EXPRESS CYCLES	84
PATTERNS	89
IMPLEMENTATION	89
ASIDE: LOCK-AND-KEY ATTRIBUTES	91
Locks Might Be Conditional, Dangerous, or Uncertain	91
Locks Are Permanent, Reversible, Temporary, or Collapsing	92
Locks Might Be Valves or Asymmetrical	92
Locks and Keys Can Be Safe or Unsafe	92

Keys Can Be Single Purpose or Multipurpose	92
Keys Are Particular or Nonparticular	93
Keys Might Be Consumed or Persistent	93
Keys Might Be Fixed in Place	93
TILEMAPS	93
DISCUSSION	95
 CHAPTER 10 ■ Worlds	 97
<hr/>	
DR. MARK R. JOHNSON	
BRIEF HISTORY OF WORLD GENERATION	98
WHY MAKE WORLDS?	101
Exploration	101
Expansive or Complex Worlds	102
Gameplay Variation	103
QUALITATIVE PROCEDURAL GENERATION	103
 CHAPTER 11 ■ Puzzles	 107
<hr/>	
DANNY DAY	
PROCEDURALLY GENERATING PUZZLES	107
Puzzle-Spaces	108
Desired Outputs	108
PUZZLE GENERATION APPROACHES	109
Random Start State	109
Backward from Goal State	110
Heuristics	110
Extra Bonus: Permutations	111
DESKTOP DUNGEONS, THE PUZZLE ROGUELIKE	112
More Puzzle than Roguelike?	112
More Roguelike than Puzzle?	112
PLAYER HOPE AS A RESOURCE	113
Guaranteeing Solvability	114
Generating Hope	115
CONCLUSION	117

CHAPTER 12 ■ Procedural Logic 119

BEN KANE

BACKGROUND	119
USUAL APPROACH TO PROCEDURAL GENERATION	120
A DIFFERENT APPLICATION: PROCEDURAL LOGIC	121
HOW THE RULE LOGIC IS GENERATED	122
Trivial Case	122
Countable Problems	123
Not So Trivial: Procedural Logic	124
Generating Rules	125
<i>Queries: Asking Questions</i>	125
<i>Solutions: Taking Action</i>	126
IMPROVING THE PROCESS	127
Better Queries	127
<i>Compound Queries</i>	127
<i>Query Contexts</i>	127
Better Solutions	128
RIGGING THE DECK: RANDOM THAT FEELS GOOD	129
Dealing with Degenerates	129
Avoiding the Impossible	130
PUTTING IT ALL TOGETHER	131
CONCLUSION	132

CHAPTER 13 ■ Artificial Intelligence 133

DR. MARK R. JOHNSON

UNPREDICTABILITY AND ARTIFICIAL INTELLIGENCE	134
MOVEMENT AND COMBAT	135
AMBIENT BEHAVIOR	137
EMERGENT PHENOMENA	137
CONVERSATIONS	138
Dialects	138
Conversation System	140
CONCLUSION	141

CHAPTER 14 ■ Procedural Enemy Waves	143
<hr/>	
WYATT CHENG	
METHOD 1: SPAWN BY TIMER	144
Spawn by Timer Pseudocode	144
Commentary	144
Key Characteristics	146
METHOD 2: SPAWN ON COMPLETION	146
Spawn on Completion Pseudocode	146
Commentary	147
Key Characteristics	147
METHOD 3: CONTINUOUSLY ESCALATING TOTAL	148
Continuously Escalating Total Pseudocode	148
Commentary	149
Key Characteristics	150
METHOD 4: HITPOINT PROGRESSION	150
Hitpoint Progression Pseudocode	150
Commentary	151
Key Characteristics	151
CONCLUSION	152
CHAPTER 15 ■ Generative Artwork	153
<hr/>	
LOREN SCHMIDT	
TECHNIQUES	154
PERCEPTION OF INTENT	158
CHAPTER 16 ■ Generative Art Toys	161
<hr/>	
KATE COMPTON	
BUILDING ART TOYS, FOR EXPERTS AND NOVICES	161
EXPERIENCE OF ART TOYS	163
TRADING CONTROL FOR POWER	164
DESIGN AND CONSTRUCTION OF ART TOYS	166
Inputs	166
Data and Transformations	168

<i>Points and Rotations</i>	168
<i>Connectivity and Meshes</i>	168
<i>Gestural Curves</i>	168
<i>Forces and Acceleration</i>	169
<i>Rendering</i>	169
OUTSIDE THE GENERATOR: JUDGMENT, SHARING, AND CURATION	172
CONCLUSIONS: CREATIVITY FOR ANYONE	173
 CHAPTER 17 ■ Audio and Composition	175
<hr/>	
BRONSON ZGEB	
PROCEDURAL AUDIO IN SKIPPING STONES	175
Sampling	175
Pitch	176
<i>Implementation</i>	177
PROCEDURAL COMPOSITION IN SKIPPING STONES	177
Beat	178
Scale	179
<i>Steps</i>	179
Chords	181
Motif and Repetition	181
CONCLUSION	183
 SECTION III Procedural Narrative	
 CHAPTER 18 ■ Story and Plot Generation	187
<hr/>	
BEN KYBARTAS	
GRAMMARS AND STORY GRAMMARS	188
GAME WORLD	190
STORY MODEL	191
RULE DESIGN	192
SECONDARY REWRITE RULES	194
GAME WORLD SIMULATION	195

METRIC-GUIDED GENERATION	196
CONCLUSIONS	197
CHAPTER 19 ■ Emergent Narratives and Story Volumes	199
JASON GRINBLAT	
MOTIVATION	199
THE VOICE IN THE MACHINE	201
FIASCO: A CASE STUDY	203
UNPACKING YOUR THEMES	205
GRIST FOR THE NARRATIVE MILL	207
CHAPTER 20 ■ Poetry Generation	209
HARRY TUFFS	
CHAPTER 21 ■ Characters and Personalities	215
EMILY SHORT	
INTRODUCTION	215
SOURCE MATERIAL	216
REALIZATION	217
Selecting Dialogue	217
Layering Dialogue Features	218
Character and World Interaction	220
CREATION	220
Orthogonal	221
Mechanically Significant	221
Easy to Communicate	222
Meaningful in Combination	222
RECURRING STRATEGIES	223
Combining Output from Several Layers of Simulation or Gameplay	223
Bringing Character into Every Interaction	223
Juxtaposing Events and Interpretation	224
Callbacks to Earlier Events	225

PITFALLS	225
Overgeneralization	225
Overrealism	226
Untamed Simulation	227

SECTION IV **The Procedural Future**

CHAPTER 22 ■ Understanding the Generated	231
--	-----

GILLIAN SMITH

EXPRESSIVE RANGE AND GENERATIVE SPACES	232
QUALITIES OF THE GENERATED	232
Types of Qualities	232
<i>Example</i>	233
Formalizing Qualities into Metrics	235
<i>Example</i>	235
Metrics versus Requirements	237
QUALITIES OF THE GENERATOR	238
VISUALIZING EXPRESSIVE RANGE	239
Histograms	239
<i>Example</i>	240
Distance-Based Clustering	242
CONCLUSION	243
REFERENCES	243

CHAPTER 23 ■ Content Tools Case Study	245
---------------------------------------	-----

KEPA AUWAE

SYSTEM OVERVIEW	247
EXAMPLE ROOM	248

CHAPTER 24 ■ Automated Game Tuning	251
------------------------------------	-----

AARON ISAKSEN

STEP 1: SET PARAMETERS	253
STEP 2: GENERATE THE GAME LEVEL	255

STEP 3: SIMULATE THE GAME	255
STEP 4: ANALYZE THE DATA	258
STEP 5: VISUALIZE THE DATA AND MAKE ADJUSTMENTS	261
CONCLUSION	263
ACKNOWLEDGMENTS	264
 CHAPTER 25 ■ Generating Rules	 265
<hr/>	
DR. MICHAEL COOK	
MIX AND MATCH	266
GAME DESIGN 101	267
THROWING OUT THE RULEBOOK	269
 CHAPTER 26 ■ Algorithms and Approaches	 271
<hr/>	
BRIAN BUCKLEW	
RANDOM NUMBERS	271
Pseudorandom Number Generators	271
Making Use of Repeatable Series	272
Seeds and Hashing	273
Rolling Dice	274
Normal Distributions	275
Weighted Distributions	277
HEIGHTMAPS	279
Box Linear Filters	279
Midpoint Displacement	280
Perlin and Simplex Noise	281
SEQUENCE GENERATION	283
Lindenmayer Systems (L-Systems)	283
Markov Chains	284
FILLING SPACE	286
Random Walks	286
<i>One-Dimensional Random Walks</i>	286
<i>Two-Dimensional Random Walks</i>	287

Cellular Automata	288
Settling	291
Wang Tiles	291
PARTITIONING SPACE	293
Binary Space Partition	293
Voronoi Diagrams	295
Dijkstra Maps	296
Tree Mapping	297
PUTTING IT ALL TOGETHER	298
CHAPTER 27 ■ Meaning	301
<hr/>	
DR. MARK R. JOHNSON	
MEANING IN GAMES	302
MEANINGLESSNESS IN GAMES	304
DESIGNER AND PLAYER MEANING	306
MEANING IN QUALITATIVE PROCEDURAL GENERATION	308
CONCLUSION	311
INDEX, 313	