PREFACE

This book imparts a working knowledge of procedural approaches in texturing, modeling, shading, and animation and demonstrates their use in high-quality offline and real-time applications. These include two-dimensional and solid texturing, hypertextures, volume density functions, and fractals. Readers are provided with the details often omitted from technical papers, enabling them to explore how the procedures are designed to produce realistic imagery. This book also contains many useful procedures and descriptions of how these procedures were developed. Readers will gain not only a powerful toolbox of procedures upon which to build a library of procedural textures and objects, but also a better understanding of how these functions work and how to design them. With procedures like noise[1] and *turbulence* and an understanding of procedural design techniques, readers will be able to design more complex procedures to produce realistic textures, gases, hypertextures, landscapes, and planets. The procedural techniques are explained not by people who have read some technical papers and tried to decipher them, but by the people who develop the techniques, wrote the seminal papers in the area, and have worked with procedural design for more than 10 years.

THE UBIQUITY OF PROCEDURAL TECHNIQUES IN COMPUTER GRAPHICS

Procedural modeling, texturing, and shading are ubiquitous, vital tools for creating realistic graphics and animation in applications ranging from movie special effects to computer games. Procedural techniques were originally introduced to produce textures for objects. With the introduction of three-dimensional texturing techniques (solid texturing) by Ken Perlin, Darwyn Peachey, and Geoffrey Gardner in 1985, the use of procedural techniques exploded. Realistic images containing marble, wood, stone, and clouds were now possible. Procedural techniques became an area of

1. Ken Perlin won a Technical Achievement Award from the Academy of Motion Picture Arts and Sciences in 1997 for the development of his noise function.

active research in computer graphics. Many programmers and researchers developed their own procedures to simulate natural materials and natural phenomena. What was lacking, however, was a clear understanding of the design of procedural techniques and of the primitive stochastic functions that were used to produce these amazing images. Since the mid-1980s, the use of procedural techniques has grown rapidly, and they can now be used to actually define the geometry of objects such as water, fire, gases, planets, and tribbles.

The use of procedural techniques is not limited to still images; they have been used successfully for animation and the simulation of natural phenomena such as fog, fire, water, and atmospheric patterns. The animation of procedural models requires knowledge of both animation principles and the characteristics of the procedural model. Procedural animation is a powerful technique for producing complex, realistic motion.

With the advent of low-cost programmable graphics processors, procedural techniques have become vital to creating high-quality effects in interactive entertainment and computer games. As of late 2002, it is now possible to implement most of the techniques presented in this book as controllable, interactive procedures that can harness the power of programmable PC graphics to run at real-time rates.

OUR OBJECTIVE

The objective of this book is to provide readers with an understanding and working knowledge of procedural techniques in texturing, modeling, and animation. This book describes the current state of procedural techniques and provides readers with the challenge and information necessary to extend the state of the art. Readers will gain the following from the book:

- A thorough understanding of procedural techniques for solid texturing
- An insight into different design approaches used by the authors in designing procedures
- A toolbox of procedures and basic primitive functions (noise, turbulence, etc.) to produce realistic images
- An understanding of several advanced procedural approaches for modeling object geometry (hypertextures, gases, fractals)
- An introduction to animating these procedural objects and textures
- An understanding of how to adapt these techniques to commodity graphics hardware

DEVELOPMENT OF THIS BOOK

At SIGGRAPH '91, Darwyn Peachey and David Ebert first discussed the need for a course to explain how texture and modeling procedures are designed to create impressive images of wood and marble objects, gases, landscapes, and planets. There were some classic papers on these topics, but they were lacking in several respects. First of all, not enough detail was given to enable readers to reproduce the results in most of the papers. Second, if an image could be reproduced, readers still didn't know how to modify the procedure to get a different effect. Finally, the reason why a procedure produced a given image was unclear. There seemed to be some "magic" behind the development of these procedures. From this discussion, our course at SIGGRAPH '92 arose. There was great demand for the course at both SIGGRAPH '92 and SIGGRAPH '93. We have received useful feedback, thanks, and requests for more material on this topic from the attendees of these courses.

With the success of these courses, we decided to produce the first edition of this book. It was similar in nature to our course notes, but greatly expanded and revised. The second edition contained new chapters discussing work from 1994 to 1998.

There were two motivations for the third edition. First, we wanted to expand, update, and, in essence, complete this book to be *the* reference and source for procedural techniques in computer graphics. Second, we wanted to describe the developments that have been made in procedural techniques in the past five years and the applications of these techniques to games and other real-time graphics applications. Two authors, William Mark and John Hart, have been added to more completely cover interactive procedural techniques.

SOURCE CODE

All of the source code for the examples in this book is available on the Web site for the book at *www.mkp.com/tm3*.

ACKNOWLEDGMENTS

We wish to thank the reviewers of our book proposal, who made valuable suggestions to improve this book. We also wish to thank the attendees of our SIGGRAPH courses, and our students, for feedback and suggestions that led to its development. Susan Ebert, Judy Peachey, and Rick Sayre were of immeasurable help in reviewing

parts of this book. Holly Rushmeier helped with figure creation. Larry Gritz provided RenderMan translations for Ken Musgrave's code and coauthored Chapter 18. Nikolai Svakhine and Joe Kniss contributed to Chapter 10. Tom Deering helped Darwyn Peachey with his Illustrator figures, and Benjamin Zhu, Xue Dong Wong, Rajesh Raichoudhury, and Ron Espiritu helped Ken Perlin in the preparation of his chapters. Bill Mark thanks Pat Hanrahan for sharing his knowledge and advice, and for providing him with the opportunity to spend time writing his chapter. We also wish to thank our families, friends, and coworkers for support during the development of this book. Finally, we wish to thank the staff at Morgan Kaufmann for producing this third edition.

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