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VISUAL EFFECTS
WITH DIRECT3D®

PETER WALSH

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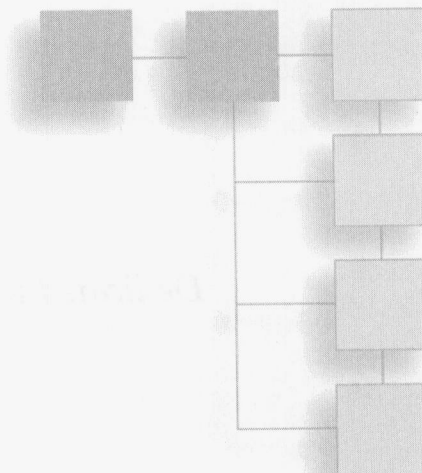**Cover Designer:**
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Dedicated to Lisa, my beautiful wife.

ACKNOWLEDGMENTS

First up, I would like to thank my wife, Lisa, whom I will love forever, for putting up with me for the past year while I wrote this book. Lisa stood by me all the way through the book, and I couldn't have finished it without her.
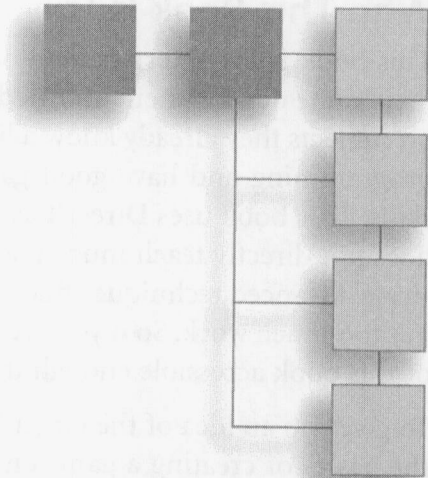
I'd like to thank Emi Smith for talking me into writing another book. A big thank you to my project editor, Karen Gill, without whom this book would only be useful as a doorstop. I think she'd make a great programmer one day if she ever decides to get out of the publishing industry!

Thanks to all my friends who provided support along the way. Our many nights out helped take my mind off 18 hours a day of programming at work and this book! In particular, I'd like to thank my brother David for his help with optimizing advanced particle systems. Mike Andrews and Mark Robb were a huge help with the chapters on pixel and vertex shaders. Jordana Gold and Catriona McLaren were a great source of inspiration for the chapters on vertex skinned animation and Catmull-Rom splines.

And, of course, I'd like to thank you, the reader of this book. I hope this book is useful to you and that it takes you to the next level of your game development career.

About the Author

Peter Walsh has more than five years of experience writing educational material on interactive entertainment software development. This book is his fifth published title. He has worked for some of the largest and smallest game development and entertainment companies in the world directly and indirectly, including Microsoft Gaming Studios, Activision, Real Time Worlds, Visual Sciences, Nicely Crafted Entertainment, Disney, Warner Bros, and others. He has developed games on the PC, PlayStation, PlayStation 2, GameCube, Xbox, Xbox 360, and numerous handheld devices. Peter currently works as a software engineer for Real Time Worlds in Dundee, Scotland, creating next-generation games for the Xbox 360.

INTRODUCTION

This book is designed to fill a large gap in the computer games market. Plenty of books out there cover introductory material on how to learn game development and how to learn particular APIs. Many books also teach extremely advanced material packed full of complicated language, mathematical algorithms, and so on. This book includes a wide range of exciting, advanced material written in an accessible way.

I'll be taking you on an incredible journey through the world of advanced game development, showing you production-quality and optimized code all the way. You'll learn some of the hottest topics and newest techniques to make your games a step above the rest. And unlike some other books, I'm not going to obfuscate and over-complicate these topics just to make myself look good.

This book is all about the subjects that you are required to know in the game industry. It's a step above the API level and deals with many subjects that every developer should know but for which there are no decent sources of information. It includes subjects like how to implement HLSL shaders into an engine, how to write an advanced particle system, how to develop advanced vertex skinned animations, and how to write exporters for popular 3D programs like Maya. Volumetric shadowing, terrain generation, developing on the PC with an Xbox 360 controller, Catmull-Rom spline systems, scripting, and so on are all advanced topics that you will be asked to implement one day if you are in the industry. If you are not yet in the industry, expect these topics to be asked at your interview. By the end of this book, you'll be unstoppable!

Who This Book Is For

This book is for intermediate to advanced programmers who want to expand their game development knowledge, learn new topics, or just sharpen their skills on subjects they already know a little about. You should be confident about C++ programming and have good game development and graphical programming skills. This book uses DirectX as its API; however, apart from shaders, this book does not directly teach much about DirectX. Instead, I use Direct3D to demonstrate advanced techniques that can be implemented with other languages without too much work. So if you are an OpenGL programmer, you should find most of this book accessible enough if you have cursory DirectX knowledge.

To give you an idea of the target level of this book, I don't spend time discussing the basics of creating a game engine, color channels, the Windows API, and so on. Instead, you'll find a wide range of hot game development topics explained without the jargon. If you can take that kind of pace, this is the book for you.

If you're feeling like you might be able to get the material for this book but are worried it's too advanced, don't forget that I'm on hand to help. If you get stuck anywhere along the way, find a bug, or need some clarification, drop me a line at mrzen@msn.com.

How This Book Is Organized

This book is divided into 15 chapters covering exciting topics in game development. I take you from the beginnings of adding HLSL shader support to your engine all the way to creating the most impressive effects with shaders, with many other topics in between. Here's a short summary of the chapters you'll find in this book.

Chapter 1, "The New World," covers everything you need to know about the code I'll be developing throughout this book. You'll get a quick overview of how the skeleton engine I developed works so that you can understand the code later on. You'll also see how to set up your development environment with the latest version of DirectX and see the settings used to set up Direct3D for rendering.

Chapter 2, "The Programmable Pipeline," introduces you to the terminology of shaders, including vertex shaders, pixel shaders, HLSL, effect files, and more. You'll also learn how data is passed between CPU and GPU. In addition, this chapter has a brief overview of DirectInput so that you can move around the 3D world.

Chapter 3, "Pimp My Engine," demonstrates how to take shaders and effects into the real world. An extensible shader manager, library, and associated code automatically load all the shader effect files from your chosen directory, allowing you to easily and instantly associate a particular shader with a renderable object. You'll also see how to create a visual resource manager and learn how to load and render models using shaders.

Chapter 4, "Particle Systems Part 1—Coding and Optimization Techniques," introduces you to the exciting world of particle systems. You'll learn all about how particle systems work. This chapter has massive coverage of topics like cache alignment for optimization, billboarding, configuring particle systems from text files, and much more.

Chapter 5, "Particle Systems Part 2—Implementation," is all about taking the theory from Chapter 1 and putting it to use in an incredibly advanced configurable particle system. You'll learn how to create incredibly fast particles, particle systems, and a particle system manager and library. You'll learn how to control a particle's velocities, colors, sizes, textures, effect files, and much more.

Chapter 6, "Alias Maya API Model Exporters," covers how to write a C++ plug-in model exporter for the incredibly popular 3D authoring package Alias|Maya. You'll learn everything necessary to write a Maya plug-in using the Maya API. The code allows you to export any Maya model to the DirectX X File format. The code is general enough for you to write the data to any format you wish.

Chapter 7, "Applied HLSL—Water," teaches you about how to put HLSL and shaders to use to create a realistic water effect. You'll learn about using multiple textures in a shader, dynamically modifying texture coordinates, and cubic environment mapping.

Chapter 8, "Introduction to Vertex Skinned Animation," shows you how to build a powerful vertex skinned animation library using D3DX. You'll learn all about bones, joints, skeletons, weights, and animation sets. By the end of this chapter, you'll have an advanced system that's capable of smoothly interpolating and rendering seamless 3D animations.

Chapter 9, "Advanced Animation Techniques," builds on the previous chapter to include advanced animation topics like spawning multiple instances of an animation and playing multiple animation sequences. You'll also see how to seamlessly blend between different animations and how to create an advanced extensible animation system manager.

Chapter 10, "Implementing Scripting," deals with the incredibly important but scarcely covered topic of scripting. This chapter shows how to use the popular Lua scripting language, found in many of the best-selling games, to add advanced scripting support to your game engine. You'll learn all about glue code, passing data to the script, and retrieving it.

Chapter 11, "Volumetric Shadowing with Stencil Buffers," shows you how to render advanced shadows using the technique known as *volumetric shadowing*. You'll see how to use shaders to tell which vertices of a model are in shadow, how to create an extruded shadow model, how to utilize stencil buffers to isolate shadowed regions, and how to use multipass rendering to finalize the shadow onscreen.

Chapter 12, "Environment Generation," shows you how to use shaders with a heightmap terrain generation engine to create perfectly blended and seamless texture coverage. You'll also learn about sky boxes and using spherical environment mapping to create incredibly realistic effects.

Chapter 13, "Advanced Spline and Route Systems," demonstrates how to use linear and Catmull-Rom algorithms to create splines that can control the camera, provide routes for models to follow, or even allow particle systems to fly around. You'll learn about the various interpolation techniques and how to create a file format to represent your splines on disk. Finally, you'll see how to create a route manager to manage all your routes.

Chapter 14, "Xbox 360 Controllers on the PC and Video Playback," shows off two very different but nonetheless useful techniques. The Xbox 360 controller is fully compatible with the PC, and the latest version of the DirectX SDK provides the XInput API for you to use. The first half of this chapter shows you how to set up and control up to four Xbox 360 controllers simultaneously. You'll also learn how to control the rumble motors in the controller. The second half of this chapter demonstrates how to render videos in your game using the DirectShow API. You'll learn how DirectShow uses components and the concept of pins to create a rendering graph capable of loading, decompressing, and playing back your videos with audio.

Chapter 15, "Putting It All Together," discusses a sample application to bring together as many of the book's topics as possible to show off all the techniques learned. It includes seamless generated terrain, animated 3D models, particle systems, volumetric shadows, spline routes, and more. The end result is incredible.

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