Introducing Maya® 2008

DARIUSH DERAKHSHANI
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Best regards,

Neil Edde
Vice President and Publisher
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As this book goes into its fifth edition, I am thrilled that Introducing Maya 2008 is finding a growing audience of students and teachers. I have always thought that education is the foundation for a happy life, and with that in mind I’d like to thank the outstanding teachers from whom I have had the privilege to learn. You can remember what you’ve been taught or, more important, you can remember those who have taught you. And of course I want to thank my students, who have taught me as much as they have learned themselves. Juan Gutierrez, Victor J. Garza, Robert Jauregui, and Peter Gend deserve special thanks for helping me complete the models and images for this book.

Thanks to the student artists who contributed to the color insert, and, of course, thanks to my bosses, colleagues, and friends at work for showing me everything I’ve learned and making it interesting to be in the effects business.

Special thanks to Dell for their support and keeping me in the cutting edge of workstations.

Thanks kindly to my editors at Sybex and the folks at Autodesk for their support and help and for making this process fun. (Mariann, Laurene, Debbie, Kathy: I’m looking in your direction.) My appreciation also goes to technical editor Keith Reicher. And special mad props to my friends Bill, Mark, Frank, Terry, and Brett.

Thank you to my mom and brothers for your strength, wisdom, and love throughout.

And a special thank you to my lovely wife, Randi, and our son Max Henry, for putting up with the long nights at the keyboard, the grumpy, sleep-deprived mornings, and the blinking and buzzing of all my machines in our apartment. Family is where it’s at, man!
About the Author

Dariush Derakhshani is a Creative Director and FX Supervisor with Radium|Santa Monica, a creative and design studio in Dallas, Texas; San Francisco, California; and Santa Monica, California. Dariush has been working in CG for over eleven years and teaching classes in CG and effects production for close to nine, and is the best-selling author of a handful of books, including the popular 3D for Beginners series.

Dariush started using CAD software in his architecture days, then migrated to using 3D programs when his firm’s principal architects needed to show their clients design work on the computer. Starting with Alias PowerAnimator version 6, which he encountered when he enrolled in the University of Southern California Film School’s Animation program, Dariush has been using Alias animation software for the past twelve years.

He received an M.F.A. in Film, Video, and Computer Animation in 1997 from USC. Dariush also holds a B.A. in Architecture and Theatre from Lehigh University in Pennsylvania and worked at a New Jersey architecture firm before moving to L.A. for film school. He has worked on feature films, music videos, and countless commercials as a 3D animator, CG lead, and sometimes compositor. He is bald and has flat feet.
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Introduction

Welcome to *Introducing Maya 2008* and the world of computer-generated imagery (CGI). Whether you are new to 3D graphics or venturing into Autodesk’s powerhouse animation software from another 3D application, you’ll find this book a perfect primer. It introduces you to Maya and shows how you can work with Maya to create your art, whether it is animated or static in design.

This book is part of the Maya Press series, a collaboration between Sybex and Autodesk to create books dedicated to teaching artists all over the world how to use Maya.

Written originally out of the author’s frustration from the lack of solid, comprehensive, and yet open-ended teaching material on Maya for his classes, this book exposes you to all the facets of Maya by introducing and explaining its tools and functions to help you understand how Maya operates. In addition, you’ll find hands-on examples and tutorials that give you firsthand experience with the toolsets. Working through these will help you develop skills as well as knowledge. These tutorials expose you to various ways of accomplishing tasks with this intricate and comprehensive artistic tool.

Finally, this book explains workflow—not only how specific tasks are accomplished but why—that is, how they fit into the larger process of producing 3D animation. By doing that, these chapters should give you the confidence to venture deeper into Maya’s feature set on your own or using any of Maya’s other learning tools and books as a guide.

It can be frustrating to learn a powerful tool such as Maya, so it’s important to remember to pace yourself. The number one complaint of readers of books like this is a sense that either the pace is too fast or the steps are too complicated or overwhelming. That’s a tough nut to crack, to be sure, and no two readers are the same. But this book offers the chance to run things at your own pace. The exercises and steps may seem confusing at times, but keep in mind that the more you try, even the more you fail at some attempts, the more you learn how to operate Maya. Experience is key to learning workflows in any software program, and with experience comes failure and aggravation. But try and try again, and you will see that further attempts will always be easier and more fruitful.

Above all, this book aims to inspire you to use Maya as a creative tool to achieve and explore your own artistic vision.
What You Will Learn from This Book

Introducing Maya 2008 will show you how Maya works and introduce you to every part of the toolset to give you a glimpse of the possibilities available with Maya.

You’ll learn the basic concepts underlying animation and 3D and how to work with the Maya interface. You’ll then learn the basic methods of modeling—creating objects and characters that appear to exist in three-dimensional space and that can be animated. You’ll also explore shading and texturing—the techniques of applying surfaces to the objects you create—and you’ll learn how to create lights and shadows in a scene. Animation is an enormously rich topic, but the practice and theory provided here will give you a solid footing. Then you’ll learn how to control the process of rendering, turning your images into files that can be viewed. Perhaps Maya’s most dazzling capability is its dynamics engine, software that allows you to make objects behave as if controlled by the real-world laws of physics.

Once you’ve finished this book and its exercises, you will have some experience in almost everything Maya offers, giving you a solid foundation on which to base the rest of your Maya and CGI experience.

The goal of this book is to get you familiar enough with all the parts of Maya to get you working on your own and to start a long, healthy education in a powerful and flexible tool.

You will, however, learn the most from yourself.

Who Should Read This Book

Anyone who is curious about learning Maya or who is migrating from another 3D software package can learn something from this book. Even if you are highly experienced in other 3D packages such as Lightwave or XSI, you will find this book helpful in showing you how Maya operates, so you can migrate your existing skill set quickly and efficiently. By being exposed to everything Maya has to offer, you will better understand how you can use its toolset to create or improve on your art and work.

If you already have a cursory or even an intermediate experience with Maya, culled from time spent learning at home, you can fill many holes with the information in this book as well as expand your experience. Self-education is a powerful tool, and the more you expose yourself to different sources, opinions, and methods, the better educated you will be.
In addition, this book is invaluable for teachers in the CG field. This book was written to cater to those who wish to pick up the fundamentals of Maya as well as for those who wish to teach classes based around a solid body of course material. You will not find a better basis for a class when you combine this book with your own curriculum.

**How to Use This Book**

*Introducing Maya 2008* approaches the subject in a linear fashion that tracks how most animation productions are undertaken. But the book has numerous cross-references to make sure the chapters make sense in any order you might want to tackle them. You may open this book to any chapter and work through the tutorials and examples laid out for the Maya task being covered. Feel free to browse the chapters and jump into anything that strikes your fancy. However, if you are completely new to CG, then perhaps taking the book on chronologically is best.

Although you can learn a lot just by reading the explanations and studying the illustrations, it is best to read this book while you are using Maya 2008 (Complete or Unlimited) or Maya Personal Learning Edition so that you can try the exercises for yourself as you read them. This book also includes a CD that contains all the example files and support files you’ll need for the tutorials in the text, which is quite valuable as an educational aid. You can use these example files to check the progress of your own work, or you can use them as a starting point if you want to skip ahead within an exercise, which could save the more experienced reader tons of time. You’ll also find it valuable to examine these files in depth to see how scenes are set up and how some of the concepts introduced in the book are implemented. Because Maya is a complex, professional software application, the tutorials are both realistically ambitious and simple enough for new users to complete. Take them one step at a time and find your own pace, accepting aggravations and failures as part of the process. Take your time; you’re not working on deadline—yet.

**How This Book Is Organized**

Chapter 1, “Introduction to Computer Graphics and 3D,” introduces you to the common computer graphics terms and concepts to give you a basic overview of how CG happens and how Maya relates to the overall process. This chapter explores the basics of CG creation and its core concepts. In addition, it describes the process of CG production and discusses how to establish a commonly used workflow.
Chapter 2, “The Maya 2008 Interface,” presents the entire Maya interface and shows you how it is used in production. Beginning with a roadmap of the screen, this chapter also explains how Maya defines and organizes objects in a scene.

Chapter 3, “Your First Maya Animation,” creates a simple animation to introduce you to Maya workflow and give you a taste of how things work. By animating the planets in our solar system, you will learn basic concepts of creating and animating in Maya and how to use its object structure.

Chapter 4, “Modeling with Polygons,” is an introduction to modeling concepts and workflows in general and shows you how to model using polygonal geometry to create various objects, from a human hand to a complex locomotive engine.

Chapter 5, “Modeling with NURBS,” will take your lesson in polygonal modeling a step further by showing you how to model with NURBS and patches by modeling an intricate toy rocket and another aspect of the locomotive to bridge the gap.

Chapter 6, “Further Modeling Topics: Deformers and Subdivision Surfaces,” will round out your modeling lessons by showing you how to use lattices to model your objects. In this chapter, you’ll learn how to model a starfish and a teakettle using subdivision surfaces.

Chapter 7, “Maya Shading and Texturing,” shows how to assign textures and shaders to your models. Using the toy rocket you created in Chapter 5, you’ll learn how to texture it to look like the real toy rocket. You’ll also learn how to take advantage of Maya 2008’s ability to work with layered Photoshop files and the basics of working with polygonal UVs.

Chapter 8, “Introduction to Animation,” covers the basics of how to animate a bouncing ball using keyframes and moves on to creating more complex animation—throwing an axe and firing a catapult. You will also learn how to import objects into an existing animation and transfer animation from one object to another, a common exercise in professional productions. In addition, you’ll learn how to use the Graph Editor to edit and finesse your animation as well as animate objects along paths.

Chapter 9, “Further Animation Practices,” expands on Chapter 8 to show you how to use Maya’s skeleton and kinematics system to create a simple walk cycle. Also covered is how to animate objects by using relationships between them. A thrilling exercise shows you how to rig your locomotive model from Chapter 4 for automated animation, one of Maya’s most productive uses.
Chapter 10, “Maya Lighting,” begins by showing you how to light a 3D scene as you learn how to light the rocket created earlier in the book and shows you how to use the tools to create and edit Maya lights for illumination, shadows, and special lighting effects. mental ray for Maya’s Global Illumination is explored in this chapter as an introduction to some sophisticated techniques for mental ray lighting as you learn to light an interior living room scene.

Chapter 11, “Maya Rendering,” explains how to create image files from your Maya scene and how to achieve the best look for your animation by using proper cameras and rendering settings. You’ll also learn about the Maya renderer, the Vector renderer, and Final Gather using mental ray for Maya, as well as raytracing and motion blur. You will have a chance to render the rocket to round out your skills.

Chapter 12, “Maya Dynamics,” introduces you to Maya’s powerful dynamics animation system. You will animate pool balls colliding with each other using rigid body dynamics, and using particle animation, you will create steam to add to your locomotive scene from Chapter 4. This chapter also introduces you to Maya’s amazing Paint Effects module and shows how to use Paint Effects to create animated flowers and grass within minutes.

An appendix offers a glossary of key terms used throughout the book and also describes the contents of the companion CD-ROM.

Hardware and Software Considerations
Because computer hardware is a quickly moving target, and Maya 2008 now runs on three distinct operating systems (Windows 2000/XP/Vista, Linux, and Mac OS X), specifying which hardware components will work with Maya is something of a challenge. Fortunately, Autodesk has a “qualified hardware” page on its website that describes the latest hardware to be qualified to work with Maya for each operating system. Go to:

www.autodesk.com/maya

for the most up-to-date information.

Although you can find specific hardware recommendations on these web pages, some general statements can be made about what constitutes a good platform on which to run Maya. First, be sure to get a fast processor; Maya eats through CPU cycles like crazy, so a fast processor is important. Second, you need lots of RAM (memory) to run Maya; 1GB is
a minimum, but 2GB is a good amount to have, especially if you are working with large scene files. Third, if you expect to interact well with your Maya scenes, a powerful video card is a must—although Maya will mosey along with a poor graphics card, screen redraws will be slow with complex scenes, which gets frustrating quickly. You might want to consider a “workstation graphics card” for the best compatibility (rather than a consumer-grade gaming video card). Several companies make entry-level through top-performing workstation cards to fit any budget. A large hard disk is also important, but most computers these days come with huge drives anyway. Some suggested setups might be as follows (current at the time of writing):

- Windows or Linux
  - AMD Athlon XP 3000+, 2GB RAM, ATI FireGL V5000, 250GB hard disk
  - Intel Pentium Core 2 Duo, 2GB RAM, nVidia Quadro FX1400, 250GB 7200rpm hard disk
  - Portable system such as the Dell M6300 with Intel Core 2 Duo CPU, 1Gb RAM, Nvidia Quadro FX 1600M Graphics, 80Gb hard disk
- Mac OS X
  - Mac Pro Intel Xeon CPU, 2GB RAM, Nvidia GeForce 7300GT, 250GB hard disk, third-party three-button mouse

Fortunately, computer hardware is so fast these days that even laptop computers can now run Maya well. Additionally, even hardware that is not officially supported by Autodesk can often run Maya—just remember that you will not be able to get technical support if your system does not meet their qualifications.

The Next Step

By the time you finish Introducing Maya 2008, you’ll have some solid skills for using Maya. When you’re ready to move on to another level, be sure to check out other Maya titles from Sybex at www.sybex.com.

You can contact the author at koosh3d.com.
Introduction to Computer Graphics and 3D

This book is intended to introduce you to the workings of 3D animation (called computer graphics, or CG) with one of the most popular programs on the market, Autodesk’s Maya. It will introduce you to a lot of the features and capabilities with the hope of energizing you to further study. The best way to study for almost anything is to practice. Prepare to go through exercises in this book, but also try to think of exercises and projects that can take you further in the learning process. A book or class or video can take you only so far; the rest is up to you. Imagination and exploration will serve you well.

Throughout this book you’ll learn how to work with Maya tools and techniques. This chapter will prepare you for the hands-on study that follows by introducing the most important CG concepts and the roles they will play in your Maya work. The most important concept when you are learning how to work with Maya is learning how you work as an artist. If you have a basic understanding of the methodology and terms of computer art and CG, you can skip this chapter and jump right into working with Maya.

Topics in this chapter include:

- Embrace the Art
- Computer Graphics
- The Stages of Production
- The CG Production Workflow
- Core Concepts
- Basic Film Concepts
Embrace the Art

Art, in many instances, requires transcendence of its medium; it speaks of its own accord. Learning to look past what you’re working with and seeing what you’re working for is key to learning CG art. So don’t view this as learning a software package but as learning a way of working. As you begin learning 3D with Maya, you acquire a new language, a new form of communication. Keep in mind that the techniques you acquire should remain only a means to the end of expression. In short, relax and enjoy yourself.

Computer tools are based on logic and numbers; your exploration of Maya, however, need not be limited to such a logical path. Your exploration is about learning what you can do and not what the software can do. Don’t make this a lesson in how to make a software program work; make it about how you work with the software.

CG studios hiring professional 3D artists look primarily for a strong artistic sense, whether in a traditional portfolio or a CG reel. It is paramount, then, to fortify the artist in yourself and practice traditional art such as life drawing, photography, painting, or sculpture as you learn CG, beginning with the core principles introduced in this first chapter. Keep in mind that the computer you’ll be using for 3D work is nothing more than a tool. You run it; it does not run you.

3D is quickly becoming a part of the daily visual lexicon. With the availability of cheap and fast computers, everyone can create their own CG projects. An increasing number of artists, no matter what medium they typically use, are adding the language of CG to their skill set. So before you start learning a particular CG tool—Maya—make sure you have a grasp of the fundamental issues underlying CG. It’s important.

Computer Graphics

CG is the abbreviation for computer graphics imagery, also known as CGI. CG literally refers to any picture or series of pictures that is generated with the aid of a computer. However, the industry convention is to use the terms CG and CGI to refer to 3D graphics and not to images created using 2D image or paint programs such as Photoshop. Most 2D graphics software is bitmap based, and all 3D software is vector based. Bitmap software creates an image as a mosaic of pixels, filled in one at a time. Vector software creates an image as a series of mathematical instructions from one calculated or graphed point to another. This much more powerful method for creating graphics is behind all the impressive CG images you’ve seen—and the ones you’ll soon create with Maya. You’ll learn more about vectors and bitmaps in the section “Computer Graphics Concepts” later in this chapter.

If you’re familiar with 2D graphics software such as Adobe Illustrator or Macromedia Flash, you already know something about vectors. What Maya and other 3D graphics
tools add are calculations of depth. Instead of being drawn on a flat plane, objects are defined in three-dimensional space. This makes the artist’s job fairly cerebral and very different than it is with 2D art; in 3D there is more of a dialogue between the left and right sides of the brain. When working in 3D, you get a better sense of working with and manipulating objects, as opposed to working with the lines, shapes, and colors used to create 2D images.

A Preview of the 3D Process

The process of creating in 3D requires that you either model or arrange pre-built objects in a scene, give them color and light, and render them through a virtual camera to make an image. In essence, you create a scene that tells the computer what objects are where, what colors and textures they have, what lighting there is, and what camera to use. It’s a lot like directing a live-action production, but without all the actor tantrums over bottled water.

Instead of a canvas on which to paint or copy and paste images, you have a 3D space—an open area in which you define your objects, set their colors and textures, and position lights as if you were setting up for a real photo shoot. CG is actually remarkably analogous to the art and practice of photography and filmmaking.

Photographers lay out a scene by placing the subjects to form the frame. They light the area for a specific mood and account for the film stock and lens they use and for the colors of the scene. They choose the camera, film, and lenses according to their desired result. They snap a picture, develop the negative, and print it to paper. Through this process, a photo is born.

Once you build your scene in 3D using models, lights, and a camera, the computer renders the scene, converting it to a 2D image. Through setup and rendering, CGI is born—and with a little luck, a CG artist is also born.

Rendering is the process of calculating lights and shadows, the placement of textures and colors on models, the movement of animated objects, and so on to give you a sequence of 2D pictures that effectively “shoot” your virtual scene. Instead of an envelope of 4 × 6 glossy prints, you get a sequence of 2D computer images (or a movie file like a QuickTime or AVI [Audio Video Interleave] file) that sit on your hard drive waiting to be seen, and invariably commented on, by your know-it-all friends.
That, in a nutshell, is the CG process. It requires planning and patience, because CG follows conventions that are very different than those for painting programs and image editors. Its workflow is entirely based on building, arrangement, and relationships. But it is an easy workflow to pick up and eventually master, and it can be learned by anyone with the desire and the patience to give it a try.

You can already see CG as a bigger part of the everyday computing environment, as shown by the popularity of image editors and digital-video editing software. The more familiar you are with CG, whether with Autodesk Maya or another package, the greater your part will be in the computing future. The day will soon be on us when we can custom-make our own environments for our 3D Windows desktops.

**Animation**

Although Maya can be used to produce remarkably lifelike 3D still images, most Maya artists also work with a fourth dimension: time. Most CG art is animated; short films, cartoons, etc. *Animation is change over time.* In other words, animation involves understanding the simulation of something changing over a period of time, whether it is its position or size as it moves or grows, or even its color or shape.

All animation, from paper flipbooks to film to Maya, is based on the principle that when we see a series of rapidly changing images, we perceive the changing of the image as continuous motion. If you have a chance to pause and step through an animated film frame by frame on your DVD player or DVR, you can begin to see how animation comes together.

In creating CG animation yourself, you have to create scene files with objects that exhibit some sort of change, whether through movement, color shift, growth, or other behavior. But just as with flipbooks and film animation, the change you are animating occurs between static images, called *frames*, a term carried over from film. You define the object’s animation using a *timeline* measured in these single frames.

You’ll learn more in the section “Basic Animation Concepts” later in this chapter.

**The Stages of Production**

The CG animation industry has inherited from the film industry a workflow (also called a *pipeline*) that consists of three broad stages: preproduction, production, and postproduction. In film, *preproduction* is the process in which the script and storyboards are written, costumes and sets are designed and built, actors are cast and rehearsed, a crew is hired, and the equipment is rented and set up. In the *production* phase, scenes are taped or filmed in the most efficient order. *Postproduction* (often simply called *post*) describes everything that happens afterward: The scenes are edited into a story; a musical score, sound effects, and additional dialogue are added; special visual effects may also be added.
(In a film that has special effects or animation, the actual CG creation is usually completed in postproduction but may start in the preproduction phases of the film or project itself.) Although the work performed at each stage is radically different, this is a useful framework for understanding the process of creating CG as well.

**Preproduction**

Preproduction for a CG animation means gathering reference materials, motion tests, layout drawings, model sketches, and such together to make the actual CG production as straightforward as possible.

Because the CG artist is responsible for defining his or her 3D scenes from the ground up, it’s essential to have a succinct plan of attack for a well-organized production. The more time spent planning and organizing for CG, the better. Whether you are working on a small job or a complex film, entering into production without a good plan of attack is not only going to cause you trouble, but it will stunt the growth of your project.

In the real world, preproduction is part of every CG animation project. For the tutorial projects in this book, the sketches and other files supplied on the accompanying CD are your preproduction. Even for these tutorials, however, you should try to gather as much information as you can about the objects you’ll create, going beyond what is presented to you. Having different perspectives on a subject is key to understanding it. Disappointing movies often are the product of terribly flawed preproduction stages; likewise, a poorly thought-out CG production will invariably end in headaches and your wasted time.

**The Script**

To tell a story, CG or not, you should put it in words. A story doesn’t need to contain dialogue for it to benefit from a script. Even abstract animations benefit from a highly detailed explanation of timings and colors laid out in a script. The script serves as the initial blueprint for the animation, a place where you lay out the all-important intent.

**The Storyboard**

A storyboard is a further definition of the script. Even a rudimentary storyboard with stick figures on notebook paper will be useful to a production. You break the script into scenes, and then you break those scenes into shots. Then you sketch out each shot in a panel of a storyboard. The panels are laid out in order according to the script to give a visual and linear explanation of the story. Storyboards are useful for planning camera angles (framing a shot), position of characters, lighting, mood, and so on.

**The Conceptual Art**

*Conceptuals* are the design elements that you might need for the CG production. Typically, characters are drawn into character sheets in three different neutral poses: from the
front, from the side, and from an angle called a 3⁄4 view. You can also create color art for
the various sets, props, and characters to better visualize the colors, textures, and lighting
that will be needed. Props and sets are identified from the script and boards, and then
sketched out into model sheets. The better you visualize the conceptual art, the easier it
will be to model, texture, and light everything in CG.

**Production**

Production begins when you start creating models from the boards, model sheets, and
concept art. You model the characters, the sets, and the props, and you assign textures
(colors, patterns). The animators take the models and animate everything according to the
boards and script. The sequences are rendered in low quality for dailies and checked for
accuracy and content.

A CG production phase can involve a variety of steps. The specific steps are defined by
the needs of the production. Most of the CG techniques you’ll learn in this book are part
of the production phase.

We’ll peer into 3D workflow in the next section, but to make a long story short, 3D
scenes are created, lit, and animated in the production phase.

**Postproduction**

Once all the scenes have been set up with props and characters and everything is ani-
mated, postproduction can begin. Postproduction for a CG project is similar to postpro-
duction for a film. This is where all of a CG film’s elements are brought together and
assembled into final form.

**Rendering**

All CG scenes need to be rendered into their final image or movie files. Rendering is the
process by which the computer calculates how everything in the scene should look and
displays it. As you’ll learn throughout this book, the decisions you make in creating the
objects in a scene can make a big difference in how the rest of the process goes.

Rendering makes great processing demands on your computer, usually requiring the
full attention of your PC, and it can take a good amount of time. You can render one
scene while another scene is in production, but ordering a computer that is rendering to
multitask is not advisable unless you’re using a dual-processor machine with plenty of
memory.

When everything is rendered properly, the final images are sorted and the assembly of
the CG project begins. Rendering is discussed more fully in Chapter 11, “Maya Rendering.”

We’ll take a quick look at three more postproduction activities: compositing, editing,
and adding sound. These are advanced topics, beyond the scope of *Introducing Maya*;
however, a multitude of books on these topics are available for further study.