



**AUTODESK**  
Official Press



Introducing  
**Autodesk® Maya® 2015**

Dariush Derakhshani



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Introducing  
Autodesk<sup>®</sup> Maya<sup>®</sup> 2015



# Introducing Autodesk® Maya® 2015

DARIUSH DERAKHSHANI



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Dear Reader,

Thank you for choosing *Introducing Autodesk Maya 2015*. This book is part of a family of premium-quality Sybex books, all of which are written by outstanding authors who combine practical experience with a gift for teaching.

Sybex was founded in 1976. More than 30 years later, we're still committed to producing consistently exceptional books. With each of our titles, we're working hard to set a new standard for the industry. From the paper we print on, to the authors we work with, our goal is to bring you the best books available.

I hope you see all that reflected in these pages. I'd be very interested to hear your comments and get your feedback on how we're doing. Feel free to let me know what you think about this or any other Sybex book by sending me an email at [contactus@wiley.com](mailto:contactus@wiley.com). If you think you've found a technical error in this book, please visit <http://sybex.custhelp.com>. Customer feedback is critical to our efforts at Sybex.

Best regards,

A handwritten signature in black ink, appearing to read "Chris Webb". The signature is fluid and cursive, with a long horizontal stroke at the end.

Chris Webb  
Associate Publisher, Sybex

*To Mom*



# About the Author

---

*Dariush Derakhshani* is a VFX and CG supervisor and educator in Los Angeles, California. Dariush has been working in CG for more than 17 years and teaching classes in CG and effects production for close to 16. He is the best-selling author of a handful of books, including the popular *Introducing Maya* books. He is also co-creator of *Learning Autodesk Maya: A Video Introduction*, available from Wiley. You can find out information on this video series and more at [www.koosh3d.com](http://www.koosh3d.com).

Dariush started using the Autodesk® AutoCAD® software in his architecture days and 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, and working for a short while in Autodesk® 3ds Max® before moving on to Maya® jobs, Dariush has been using Autodesk animation software for the past 18 years.

He received an MFA in film, video, and computer animation in 1997 from USC. Dariush also holds a BA in architecture and theater from Lehigh University in Pennsylvania and worked at a New Jersey architecture firm before moving to Los Angeles for film school. He has worked on feature films, music videos, and countless commercials as a 3D animator and VFX supervisor, garnering honors from the London International Advertising Awards, the ADDY Awards, the Telly Awards, and a nomination from the Visual Effects Society Awards. He is bald and has flat feet.

# Acknowledgments

---

*As this book* goes into its 11th edition, I am thrilled that the *Introducing Maya* book is a favorite resource for students and teachers of the Autodesk® Maya® software. 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, just as important, you can remember those who have taught you. ■ I also 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 my 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 HP for its support and keeping me on the cutting edge of workstations and displays. ■ Thanks to my editors at Sybex and the folks at Autodesk for their support and help and for making this process fun. Thanks to the book team for bringing it all together: Mariann Barsolo, Stephanie Barton, Rebecca Anderson, and Kim Wimpsett. My appreciation also goes tenfold to technical editor Keith Reicher. ■ 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!



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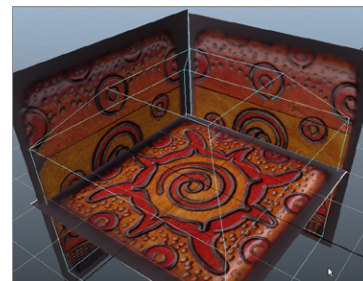
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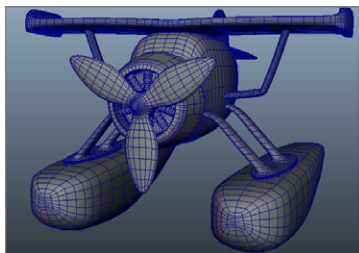
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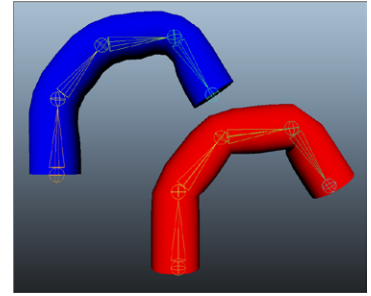
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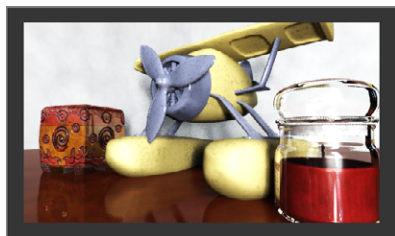
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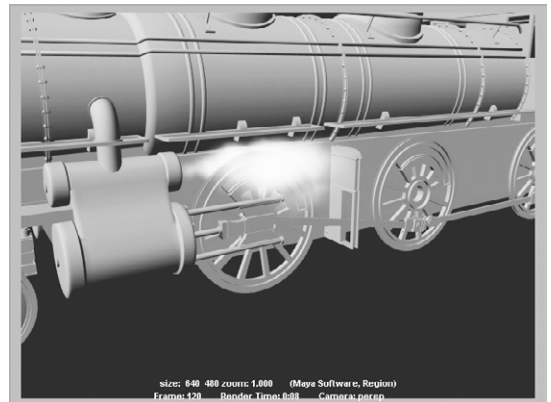


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# Introduction

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*Welcome to* *Introducing Autodesk® Maya® 2015* and the world of computer-generated imagery (CGI). Whether you're 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 the Autodesk® Maya® software and shows how you can work with Maya to create your art, whether it's animated or static in design.

The first edition of this book was written out of the author's desire for solid, comprehensive, and yet open-ended teaching material about 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. You'll learn 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 the Maya feature set on your own or by using any of the other Maya 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 you the chance to run things at your own pace. The exercises and steps may seem challenging at times, but keep in mind that the more you try—even the more you fail at some attempts—the more you'll learn about how to operate Maya. Experience is the key to learning workflows in any software program, and with experience comes failure and aggravation. Nevertheless, try and try again, and you'll see that further attempts will 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'll Learn from This Book

*Introducing Autodesk® Maya® 2015* 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. Next, you'll learn how to control the process of rendering, turning your images into files that can be viewed. Perhaps the most dazzling capability of Maya is its dynamics engine, software that allows you to make objects behave as if controlled by the real-world laws of physics.

After you've finished this book and its exercises, you'll have 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 that you can work on your own and 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're highly experienced in another 3D package such as the open source Blender or Autodesk® 3ds Max® or Softimage®, you'll 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'll better understand how you can use its toolset to create or improve on your art and work.

If you already have cursory or even 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'll be.

In addition, this book is invaluable for teachers in the CG field. This book was written to cater to those who want to pick up the fundamentals of Maya as well as those who want

to teach classes based on a solid body of course material. You won't find a better basis for a class when you combine this book with your own curriculum.

## How to Use This Book

To begin reading this book, open it to some page, and read.

*Introducing Autodesk® Maya® 2015* 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 no matter in which order you want to tackle them. You can 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're completely new to CG, you may want to take the chapters in order.

Although you can learn a lot just by reading the explanations and studying the illustrations, it's best to read this book while you're using Maya 2015 so that you can try the exercises for yourself as you read them. If you don't already have Maya, you can download an educational license if you are a qualifying student or faculty member at [www.students.autodesk.com/](http://www.students.autodesk.com/) or a 30-day trial version of the software at [www.autodesk.com/maya](http://www.autodesk.com/maya). This book refers to a companion web page ([www.sybex.com/go/introducingmaya2015](http://www.sybex.com/go/introducingmaya2015)), containing all the example and support files you'll need for the exercises in the text as well as some videos to help you through some of the tutorials, which is a valuable educational aid. These videos will be updated over time, so make sure to check back in now and then for more material. You can use the example files to check the progress of your work, or you can use them as a starting point if you want to skip ahead within an exercise. The latter can 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 exercises 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 common computer graphics concepts to give you a basic overview of how CG happens and how Maya

relates to the overall process. In addition, it describes basic animation concepts to better build a foundation for further study.

Chapter 2, “Jumping into Basic Animation Headfirst,” creates a simple animation to introduce you to the Maya interface and workflow and give you a taste of how things work right away. By animating the planets in our solar system, you’ll learn basic concepts of creating and animating in Maya and how to use its powerful object structure.

Chapter 3, “The Autodesk® Maya® 2015 Interface,” presents the entire Maya interface and shows you how it’s used in production. Beginning with a roadmap of the screen, this chapter also explains how Maya defines and organizes objects in a scene while you are set to the task of building a decorative box model.

Chapter 4, “Beginning Polygonal Modeling,” is an introduction to modeling concepts and workflows. It shows you how to start modeling using polygonal geometry to create various objects, from a cartoon hand to a catapult, using some of the new tools incorporated into Autodesk Maya 2015.

Chapter 5, “Modeling with NURBS Surfaces and Deformers,” takes your lesson in modeling a step further. It shows you how to model with deformers and surfacing techniques, using NURBS to create a glass candle jar to later light and render in a scene. You’ll also learn how to create NURBS surfaces directly into polygon meshes easily.

Chapter 6, “Practical Experience!,” rounds out your modeling lessons with a comprehensive exercise showing you how to model a child’s toy airplane using polygons. The chapter also exposes you to the powerful File Referencing workflow available in Maya.

Chapter 7, “Autodesk® Maya® Shading and Texturing,” shows you how to assign textures and shaders to your models. Using a toy wagon model, you’ll learn how to texture it to look like a real toy wagon as well as lay out its UVs for proper texture placement. Then, you’ll create detailed photo-realistic textures based on photos for the decorative box and toy plane models. You’ll also learn how to use toon shading to achieve a cartoon look for your renders.

Chapter 8, “Introduction to Animation,” covers the basics of how to animate a bouncing ball using keyframes and then moves on to creating and coordinating more complex animation—throwing an axe and firing a catapult. You’ll 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, “More Animation!” expands on Chapter 8 to show you how to use the Maya skeleton and kinematics system to create a simple walk cycle. This chapter also covers how to animate objects by using relationships between them. A thrilling exercise shows you how to rig a hand for easier animation and then a locomotive model for automated animation, some of the most productive uses of Maya.

Chapter 10, “Autodesk® Maya® Lighting,” begins by showing you how to light a 3D scene as you learn how to light the toy plane and box that you modeled and textured earlier in the book. It also shows you how to use the tools to create and edit Maya lights for illumination, shadows, and special lighting effects. The mental ray for Maya Physical Sun and Sky feature is explored in this chapter as an introduction to some sophisticated techniques for mental ray lighting.

Chapter 11, “Autodesk® Maya® Rendering,” explains how to create image files from your Maya scene and how to achieve the best look for your animation using proper cameras and rendering settings. You’ll work with displacement maps to create details in a model. You’ll also learn about the Maya renderer, the Vector renderer, and Final Gather using HDRI and image-based lighting through mental ray for Maya, as well as raytracing, motion blur, and depth of field. You’ll have a chance to render the table lamp and decorative box to round out your skills.

Chapter 12, “Autodesk® Maya® Dynamics and Effects,” introduces you to the powerful Maya dynamics animation system as well as nParticle technology. You’ll animate pool balls colliding with one another using rigid body dynamics, and you’ll fire the catapult. Using nParticle animation, you’ll also create steam to add to your locomotive scene. You will then be exposed to nCloth to create a tablecloth and a flag. This chapter also shows you how to use Paint Effects to create animated flowers and grass within minutes.

## Hardware and Software Considerations

Because computer hardware is a quickly moving target and Maya now runs on three distinct operating systems (Windows 7/8, 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, as well as whether you’re running the 32-bit or 64-bit version. Go to the following site for the most up-to-date information on system requirements:

[www.autodesk.com/maya](http://www.autodesk.com/maya)

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—at least 4 GB, but 8 GB or more is better to have, especially if you’re working with large scene files and are on a 64-bit system. 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 can quickly become frustrating. You may 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—most computers these days come with huge drives anyway.

Fortunately, computer hardware is so fast 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 won’t be able to get technical support if your system doesn’t meet the company’s qualifications.

## **Writing this Book with the zBook 14**

As you consider the hardware requirements for running Autodesk Maya 2015, it’s interesting to note that a good portion of this book was written and accomplished on an ultrabook sized laptop workstation from HP, the zBook 14 (Figure FM.1). This little laptop has been a powerful ally in working on the scenes used throughout this book, as well as the actual writing of the book.

With a strong Intel i7 2.1Ghz CPU, 16 GB of memory and an HD resolution 14” LED display, I was able to write this book and work on the scene files for the exercises anywhere I went, even crushed in a coach class airplane seat. The ultrabook’s AMD FirePro M4100 adeptly powered the graphics and even ran a second 24” display without a hiccup.

This is the first thin and light ultrabook form factor I’ve seen that is capable of workstation graphics, and I’m grateful to HP for allowing me the pleasure of using the zBook 14 while writing this book. It allowed me to have the stability and power I need without having to be chained to my desk, or toting around a much heavier 15” or 17” mobile workstation.





Figure F.1  
The HP zBook 14  
was a great little  
machine to run  
Maya while travel-  
ing around!

## Free Autodesk Software for Students and Educators

The Autodesk Education Community is an online resource with more than five million members that enables educators and students to download—for free (see website for terms and conditions)—the same software used by professionals worldwide. You can also access additional tools and materials to help you design, visualize, and simulate ideas. Connect with other learners to stay current with the latest industry trends and get the most out of your designs. Get started today at [www.autodesk.com/joinedu](http://www.autodesk.com/joinedu).

## The Next Step

By the time you finish *Introducing Autodesk® Maya® 2015*, 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 books from Sybex at [www.sybex.com](http://www.sybex.com) and additional resources at [www.koosh3d.com](http://www.koosh3d.com).

You can contact the author through [www.koosh3d.com](http://www.koosh3d.com) and Facebook at [www.facebook.com/IntroMaya](http://www.facebook.com/IntroMaya). You may also go to the book's web page for the project files and video tutorials from the book at [www.sybex.com/go/introducingmaya2015](http://www.sybex.com/go/introducingmaya2015).



# Introduction to Computer Graphics and 3D

---

*This book will introduce you* to the workings of 3D animation, also called *computer graphics* (CG), with one of the most popular programs on the market, the Autodesk® Maya® software. It will introduce you to many of the features and capabilities of Maya with the intent of energizing you to study further.

The best way to succeed at anything is to practice. Go through the exercises in this book (more than once if you care to), and also think of exercises and projects that can take you further in your learning process.

This is not to say you can't be a casual visitor to working in CG—far from it. Playing around and seeing what you can create in this medium is just flat-out fun. Understanding your own learning pace is important.

Throughout this book, you'll learn how to work with Maya tools and techniques at a pace you set for yourself. When you're learning how to work with Maya, the most important concept is discovering how you work as an artist.

**Learning Outcomes:** In this chapter, you will be able to

- Develop an appreciation for the CG process
- Discern between different types of digital image files
- Recognize key terms and principles in film and animation

## A Preview of the CG Process

Try not to view this experience as learning a software package but as learning a way of working to an end. It's hard to relax when you're trying to cram so much information into your brain. You should try not to make this experience about how a software program works but about how you work with the software. Maya is only your tool; you're the boss.

CG and CGI are the abbreviations for *computer graphics* and *computer graphics imagery*, respectively, and are often used interchangeably.

The process of creating in CG requires that you either model or arrange prebuilt objects in a scene, give them color and light, and render them through a virtual camera to make an image. It's a lot like directing a live-action production but without any actor tantrums.

A large community on the Web provides free and for-pay models that you can use in your scenes. Sites such as [www.turbosquid.com](http://www.turbosquid.com), [www.cgtextures.com](http://www.cgtextures.com), [doschdesign.com](http://doschdesign.com), and [www.archive3d.net](http://www.archive3d.net) can cut out a lot of the time you might spend creating all the models or textures for a scene.

After 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.

The CG animation industry inherited a workflow from the film industry 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 rehearse, the 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; and visual effects may also be added.

Preproduction for a CG animation means gathering reference materials, motion tests, layout drawings, model sketches, and such to make the actual CG production as straightforward as possible. Production begins when you start creating models of characters, sets, and props from the storyboards, model sheets, and concept art. Then these *assets* are animated, and finally, shots are then lit and ready for rendering. Postproduction for a CG project is where all of a CG film's elements are brought together and assembled into the final form through editing, adding sound, and so on.

## The CG Production Workflow

Modeling almost always begins the CG process, which then can lead into texturing and then to animation (or animation and then texturing). Lighting should follow, with

rendering pulling up the rear as it must. (Of course, the process isn't completely linear; you'll often go back and forth adjusting models, lights, and textures along the way.)

Modeling, the topic of Chapters 4 through 6, is usually the first step in creating CG. Downloading or purchasing models from the Internet can often cut down the amount of time you spend on your project, if you don't prefer modeling or texturing.

Knowing how an object is used in a scene gives you its criteria for modeling. Creating a highly detailed model for a faraway shot will waste your time and expand rendering times needlessly.

Because your computer stores everything in the scene as vector math as opposed to pixels (called *raster*), the term *geometry* refers to all the surfaces and models in a scene.

When the models are complete, it's a good idea to begin *texturing* and *shading*, the process of applying colors and material textures to an object to make it renderable. In Figure 1.1, an elephant model is shown, with textures applied to its lower body.

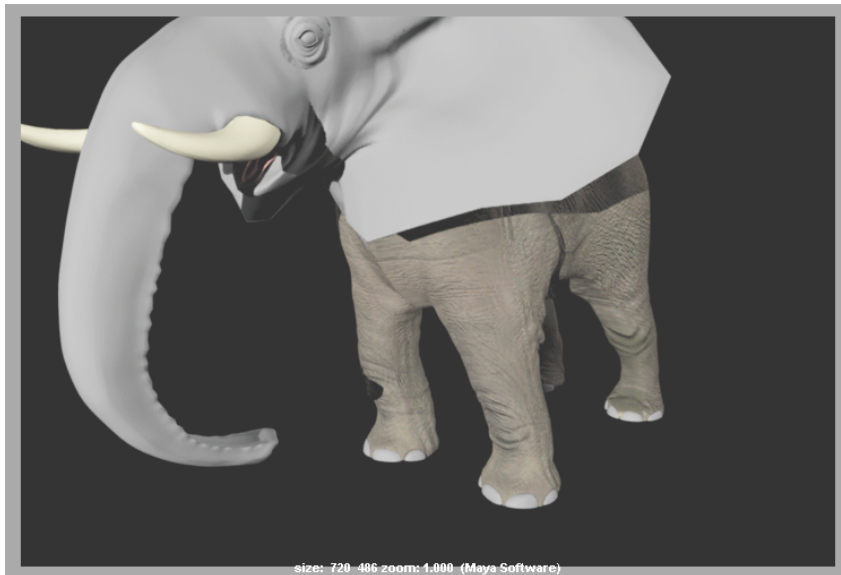


Figure 1.1  
Texturing adds detail to an otherwise flat model.

Because the textures may look different after animating and lighting the scene, it's wise to leave the final adjustments for later. You'll learn more about texturing and shading in Chapter 7, "Autodesk Maya Shading and Texturing."

Next comes the process of animating. *Animation* shows *change over time*. All animation, from paper flipbooks to film to Maya, is based on the principle of *persistence of vision* that when we see a series of rapidly changing images (called *frames*), we perceive the changing of the image to be in continuous motion.

You know when something doesn't look right, and so will the people watching your animation. So, to animate something properly, you may need to do quite a lot of setup beyond just modeling and texturing. In character animation, for example, you'll need to create and attach an *armature*, or skeleton, to manipulate the character and to make it move like a puppet. I cover animation techniques in Maya in Chapter 8, "Introduction to Animation," and Chapter 9, "More Animation!"

Next there is lighting. *CG is fundamentally all about light*. Without light, we wouldn't see anything; simulating light is the one of the most influential steps in CG. During the lighting step, you set up virtual lights in your scene to illuminate your objects and action, as you'll learn in Chapter 10, "Autodesk Maya Lighting." Before long, you'll start modeling and texturing differently—that is, working with the final lighting of the scene in mind.

When you're done lighting, you move to rendering; your computer takes your scene and makes all the computations it needs to render your scene into images. Rendering time depends on how much geometry is used in the scene as well as on the number of lights, the size of your textures, and the quality and size of your output: the more efficient your scene, the shorter the rendering times. The more experience you gain, the more efficient your eye will become.

## Digital Images

When you're finished with your animation, you'll probably want as many people as possible to see it (and like it!). Here is a primer on the types of digital images and how they are discerned.

As mentioned, each image file holds the color information in *channels*. All color images have red, green, and blue color channels. Some images have a fourth channel called the *alpha* channel (a.k.a. *matte* channel), which defines what portions of the image are transparent or opaque (solid). You can read more about alpha channels in Chapter 7.

First, an image file stores the color of each pixel as three values representing red, green, and blue. The image type depends on how much storage is allotted to each pixel (the *color depth*).

**Grayscale** The image is black and white with varying degrees of gray (typically 256 shades). These are good for use as texture maps such as bump and displacement maps.

**8-Bit Image File (a.k.a. 24-Bit Color Display)** Each color channel is given 8 bits for a range of 256 shades of each red, green, and blue channel, for a total of 16 million colors in the image.

**16-Bit Image** Used in television and film work with such file types as TIFF16, a 16-bit image file holds 16 bits of information for each color channel, resulting in an impressive number of color levels and ranges.

**32-Bit Image** 32-bit image files, such as the OpenEXR format, give you an incredible amount of range in each color channel.