SECOND EDITION

An Essential Introduction to Maya Character Rigging

Cheryl Briggs

CRC Press
Taylor & Francis Group

An Essential Introduction to Maya Character Rigging

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

An Essential Introduction to Maya Character Rigging

Second edition

Cheryl Briggs

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

second edition published 2021
by CRC Press
6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742

and by CRC Press
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

First edition published 2008 by CRC Press

CRC Press is an imprint of Taylor & Francis Group, LLC

ISBN: 978-0-367-69406-7 (hbk)
ISBN: 978-1-138-77798-9 (pbk)
ISBN: 978-1-315-77140-3 (ebk)

Typeset in Myriad Pro
by Deanta Global Publishing Services, Chennai, India

Access the companion website *www.cherylcreates.com*

To my students

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

Contents

Preface ..... **xiii**
Acknowledgments ..... **xv**
About the Author ..... **xvii**

Introduction **1**
Overview of the Interface 1
Navigation 5
Keyboard with Highlighted Hotkeys 5
Setting Up Your Project Folder and Scene Files 7
Setting User Preferences 8

Chapter 1: Skeleton Setup **11**
Former Student Spotlight: David Bokser 12
Biography 12
Workflow 12
Introduction 12
Analyzing Motion 15
Identifying Pivot Points and Rotations 16
File Referencing [File > Create Reference…] 20
Changing the Referenced File [File > Reference Editor] 21
Setting Up Your Work Area 23
Working with Joints 26
The Joint Tool [Skeleton > Create Joints] 26
Display Size [Display > Animation > Joint Size…] 27
Local Rotational Axes 28
Placing Joints 33
Repositioning Joints 33
Moving Joints (also Known as – Translating Joints) 33
Rotating and Scaling Joints 34
Reorienting Joints [Skeleton > Orient Joint □] 35
Mirroring Joints [Skeleton > Mirror Joint □] 37
Additional Thoughts about Joint Placement 37
Summary 38

Chapter 2: Control Rig Setup **41**
Former Student Spotlight: Ryan Yokley 42
Biography 43
Workflow 44
Introduction 44
Kinematics 44
Forward Kinematics 47
Inverse Kinematics 48
Attribute Control 51

Rotation Order and Gimbal Lock....52
Connection Editor [Windows > General Editors > Connection Editor]....57
Expressions [Windows > Animation Editors > Expression Editor]....58
Set Driven Key [Key > Set Driven Key > Set...]....59
Constraints....61
Parent [Constrain > Parent]....62
Point [Constrain > Point]....63
Orient [Constrain > Orient]....63
Scale [Constrain > Scale]....64
Aim [Constrain > Aim]....65
Pole Vector [Constrain > Pole Vector]....65
Rivet [Constrain > Rivet]....65
Geometry [Constrain > Geometry]....65
Normal [Constrain > Normal]....66
Group Nodes or Null [Edit > Group]....68
Clusters [Deform > Clusters]....69
Combining Curves....69
Summary....73

Chapter 3: Bipedal Legs and Feet....75
Former Student Spotlight: Ben Willis....75
Biography....75
Workflow....76
Introduction....76
Joint Placement for the Leg and Foot Skeleton....76
Verifying the Joint Local Rotation Axis....79
Creating a Control System for the Leg and Foot Rig....81
Cleanup for the Legs and Feet....93
Simplifying the Foot Controls....95

Chapter 4: Bipedal Spine and Neck....103
Workflow....103
Introduction....103
Creating a Ribbon Spine for a Biped....103
Creating the Back Ribbon....105
Creating a Control System for the Ribbon....108
Cleanup for the Back Ribbon....114
Creating a Ribbon Neck for a Biped....115
Creating the Neck Ribbon....115
Creating a Control System for the Ribbon....120
Cleanup for the Neck Ribbon....124
Creating an IK Spline Spine and Neck for a Biped....125
Joint Placement for a Spine and Neck Skeleton....127
Verifying the Joint Local Rotation Axis....128
Creating a Control System for the IK Spline Spine and Neck....129

Cleanup for the Back IK Spline 136
Cleanup for the Neck IK Spline 140

Chapter 5: Bipedal Arms and Hands 143
Workflow 143
Joint Placement for the Arm Skeleton 143
Creating the Joints for the Arms and Clavicles 143
Verifying the Joint Local Rotation Axis 146
Control System for the Arm Rig 146
Creating a Control System for the Clavicle 146
Creating a Control System for the Arm 148
Cleanup for the Arm Setup 167
Joint Placement for the Hand Skeleton 168
Verifying the Joint Local Rotation Axis 172
Control System for the Hand Rig 175
Creating a Control System for the Finger Joints 175
Cleanup for the Hand Setup 185
Wings 186

Chapter 6: Quadruped Legs and Feet 193
Workflow 193
Introduction: Hoofs, Paws, and Claws 193
Joint Placement for the Leg and Paw Skeleton 193
Verifying the Joint Local Rotation Axis 198
Control System for the Leg and Paw Rig 200
Cleanup for the Leg and Paw Setup 213
Control System for the Leg and Claw Rig 215
Verifying the Joint Local Rotation Axis 218
Additional Functionality for the Talons and Toes 237
Verifying the Joint Local Rotation Axis 243
Cleanup for the Leg and Claw Setup 246
Control System for the Leg and Hoof Rig 248
Cleanup for the Leg and Hoof Setup 260

Chapter 7: Quadruped Spine and Neck 261
Former Student Spotlight: Dana Corrigan 261
Biography 262
Workflow 262
Introduction 262
Creating a Ribbon Spine for a Quadruped 264
Creating the Back Ribbon 264
Creating a Control System for the Ribbon 267
Cleanup for the Back Ribbon 272
Creating a Ribbon Neck for a Quadruped 275
Creating the Neck Ribbon 275
Creating a Control System for the Ribbon 278
Cleanup for the Neck Ribbon 283

Creating an FK Tail 284
Verifying the Joint Local Rotation Axis 286
Cleanup for the FK Tail Setup 289
Creating a Ribbon Tail 289
Creating the Tail Ribbon 289
Creating a Control System for the Ribbon 293
Cleanup for the Tail Ribbon 297
Adding a Scapula for a Quadruped 300
Joint Placement of the Scapula 300
Creating a Control System for the Scapula 300
Cleanup for the Scapula Setup 302

Chapter 8: Head 305
Workflow 305
Introduction 305
Joint Placement for the Biped Head 305
Creating the Joints for the Head, Hat, and Hair Skeleton 305
Verifying the Joint Local Rotation Axis 308
Control System for the Head, Hat, and Hair Skeleton 309
Cleanup for the Biped Head Setup 311
Joint Placement for the Quadruped Head 312
Creating the Joints for the Ears and Collar 312
Verifying the Joint Local Rotation Axis 313
Control System for the Head, Collar, and Ear Skeleton 314
Cleanup for the Ear Setup 317
Dynamic Joint Chains: Antennae 317
Creating the Joints for the Antennae 318
Verifying the Joint Local Rotation Axis 318
Creating a Control System for the Antennae 320
Cleanup for the Antenna Setup 332

Chapter 9: Facial Rigging 335
Workflow 335
Introduction 335
Blend Shapes as an Approach to Creating Facial Expressions 338
Tools Used for Modeling Blend Shapes 341
Soft Modification Tool [Deform > Soft Modification Tool □] 343
Sculpt Geometry Tool [Surfaces > Sculpt Geometry Tool □] 343
Add blend shapes [Deform > Create Blend Shape] 345
In-Between Blend Shapes 347
Update topology on blend shapes [Deform > Edit Blend Shape > Bake Topology To targets] 349
Deformation Order 350
Creating Facial Expression Blend Shapes 351
Flipping a Blend Shape Using the Shape Editor 354

Corrective Blend Shapes. 355
Joints as an Approach to Creating Facial Expressions 357
Creating a Control System for Facial Expressions 359
Creating the Jaw and Tongue. 366
Creating a Control System for the Jaw 366
Creating the Tongue Ribbon 368
Creating a Control System for the Ribbon. 371
Cleanup for the Tongue Ribbon 374
Creating the Eye Controls 375
Cleanup for the Eye Control 377
Summary. 377

Chapter 10: Props 379
Workflow. 379
Introduction. 380
Deformers. 380
Nonlinear Deformers [Deform > Nonlinear]. 381
Creating a Simple Basic Prop Rig 382
Creating a Prop Rig with Squash and Stretch. 387
Cleanup for the Prop Rig 389
Summary. 391

Chapter 11: Wrapping Up the Setup 393
Former Student Spotlight: Tim Keebler. 393
Biography 394
Workflow. 394
Introduction. 394
Cleaning Up the Scene File for Animation. 398
Preparing the Scene File for Skinning. 399
Creating a Bridge Shape 401
Creating Additional Tools for Animation. 402
Adding Squash and Stretch to the ikSpline Spine 404
Expression Solution for Squash and Stretch. 405
Utility Node Solution for Squash and Stretch. 408
Summary. 413

Chapter 12: Skinning Your Character 415
Former Student Spotlight: Tonya Payne 415
Biography 416
Workflow 416
Introduction. 416
Skinning Tools in Maya. 418
Creating the Skin Deformer [Skin > Bind Skin □] 418
Adding influences [Skin > Edit Influences > Add Influence] 419
The Component Editor [Window > General Editors > Component Editor] 420
Smooth Skin Weights [Skin > Smooth Skin Weights] 421

Paint weights – [Skin > Edit Smooth Skin > Paint Skin Weights Tool] 422
Mirror weights – [Skin > Mirror Skin Weights □] 422
Skinning a Character 423
Adding Influence Joints 425
Fixing Skin Weights Using the Component Editor 434
[Window > General Editors > Component Editor] 434
Fixing Skin Weights Using Smooth Skin Weights 435
[Skin > Smooth Skin Weights] 435
Fixing Skin Weights Using Paint Skin Weights 437
[Skin > Paint Skin Weights □] 437
Mirroring Skin Weights 440
[Skin > Mirror Skin Weights □] 440
Creating a geoLevel Switch for Polygonal Characters 440
Final Cleanup of the Scene File 443
Testing Rig Relocation 444
Making Geometry Unselectable 445
Colorizing the Controllers 446
Summary 447

Index **449**

Preface

When I began teaching 3D character animation almost twenty years ago, there were few resources available to help students learn and understand the fundamentals of the character rigging process. Because of this, I put my classroom materials together and presented them in the first edition of this book. That was thirteen years ago. Many techniques evolved and new practices emerged, but many of the foundations have remained the same.

This new edition is an almost complete rewrite. Most of the tools covered in the first edition remain updated along with their menu changes. I removed other tools that have phased out of the software and incorporated many of the new tools. Included in this edition are Quadruped rigging and Prop rigging since there is still little information available about these topics. This edition focuses only on rigging, taking feedback from the first edition to remove the design and modeling content. I also introduce some more advanced topics, such as MEL expressions and Node-based rigging solutions, giving just a taste to those who crave more than the basics.

Understanding these tools and procedures is a critical component of animation in the 3D environment. The technical vocabulary of rigging characters is necessary for animators to communicate their needs to technical artists. Still, this knowledge is also invaluable to anyone who may find themselves in a position where rigging becomes part of their job description. My goal is to provide a strong foundation in character rigging for anyone who wants to pursue 3D animation or more advanced rigging topics.

Essential tips and potential problems are in boxes throughout this book. However, because new issues come up with every student and version of the software, I have added a section to my website to support this book with FAQs and other postings along with resource files. Please make sure to visit and check things out: *www.cherylcreates.com*

For the best understanding of rigging in Maya, work through this book from beginning to end. If more information is necessary or if you have any further questions, please contact me via this form: *https://www.cherylcreates.com/contact*

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

Acknowledgments

Merci Gracias Mahalo Danke schön Grazie Yokoke Thank You …

I want to thank the following for their help during the long process of book writing. In reflecting on this process, I have realized I have been writing books steadily for the past 14 years. The next one will be a memoir.

Thank you, God, for Your continued guidance and the ability to live my life with strength and grace.

I want to thank my students. This book is written for them. Thank you, Kenna Hornibrook, for the use of the Percy model that adorns many of the pages of this book. The work she did modeling all of the facial Blend Shapes saved me hours of work. Thanks to Ashley Luparriello, for the use of her Lucy model. To the following former students and friends in particular, for contributing their artwork and words of wisdom:

David Bokser, Bryan Colvin, Dana Corrigan, John Doromal, Jason Fronczek, Wesley Gordon, Noel Isham, Victoria Jones, Timothy Keebler, Judy Malloch, Drew Merrit, Sanne Methorste, Alina Morales, Tonya Payne, Crissy Peters, Ida McKenna Phillips, Genesis Rivera, Damian Thorn-Hauswirth, Charlie Tong, Haley Vallandingham, Marchand Venter, Ben Willis, and Ryan Yokley. And an extra special thanks to the BFA and BA students of the Character Animation and Visual Language degree programs at the University of Central Florida and all my former students from the Savannah College of Art and Design. Their hard work helped develop, test, and illustrate the many concepts covered in this book.

A special thanks to Sean Connelly, the Executive Editor at Taylor & Francis. Sean did not give up on my hectic schedule as a professor and understood the complications involved in working a full-time job, giving me confidence and motivation to keep going! Also, to Jessica Vega, editorial assistant, for working with me on a due date that I could finally meet.

Thank you to my husband, Robert, who has been so supportive and understanding, especially during the last two months of my writing non-stop during a pandemic while we were both working in the same room.

Thank you to my children, Alex, Taylor, Nathanael, and Ian, and my adopted niece, Heather, who give me a reason to wake up every morning and never give up. Thanks to my eldest son and my ex-husband, Michael Cabrera, for helping Nathanael survive and thrive in Algebra II Honors, which allowed me to focus my energy and efforts on completing this manuscript. A special thanks to Nathanael for the extra encouragement and hugs you gave me, especially toward the end, helping to see me through to the finish line.

A special thanks to all of my family and friends who have encouraged me throughout the years to pursue my dreams, including special recognition

of my teachers and mentors who have also instilled in me the curiosity of learning and fostered my ability to problem solve. An extra special thanks to Randy and Ann Asprodites, Marlene and Eugene Cookmeyer, Susan and Ben Eble, June and Bill Hackworth, Lucilla and Mark Hoshor, Lauren LaPointe and Dave Kaul, Sue Dee Lazzerini, Jeanna McCulla, Darlene Marr and Bob Owens, Tom Mavor, Hal and Nancy Miles, Heidi Poché, Chyrl Savoy, David Thibodaux, Dickie Wagner, Paul Werner.

Thank you to the faculty, staff, and administration of the School of Visual Arts and Design and the College of Arts and Humanities at the University of Central Florida, and the Florida Interactive Entertainment Academy. Extra special thanks to my colleagues and mentors, Dr. Rudy McDaniel, Ben Noel, John Rotolo, JoAnne Adams, Jason Burrell, Rich Grula, Darlene Hadrika, Waheeda Illasarie, Joe Muley, Ilenia Colon Mendoza, Wanda Raimundi-Ortiz Klotz, Phil Peters, Carla Poindexter, Dr. M.C. Santana, and Dr. Stella Sung.

About the Author

Cheryl Briggs (formerly Cabrera) is an award winning animated short film director who has advised and guided aspiring animators, game artists, and visual effects artists for 20 years. Since 2009, she has taught all aspects of animation production at the undergraduate and graduate levels in the School of Visual Arts and Design at the University of Central Florida. She has also taught as Professor of Animation at the Savannah College of Art and Design from 2001 to 2009. Her award-winning students have been featured in animation festivals worldwide, and many have gone on to work within the entertainment industry at studios such as Dreamworks, Disney, PIXAR, Blue Sky, Industrial Light and Magic (ILM), Moving Picture Company (MPC), Rhythm & Hues, Digital Domain, Blizzard, Epic, and Hi-Rez.

Cheryl is currently on the Board of Directors for the Animation Hall of Fame, a voting member of the International Animated Film Society (ASIFA-Hollywood), and a member of the Special Interest Group on Computer Graphics and Interactive Techniques (SIGGRAPH), Women in Animation, Women in Film and Television, and the Society for Animation Studies.

Cheryl holds a B.A. and M.Ed. in Education and an M.F.A. in Computer Art: 3D Animation from the Savannah College of Art and Design (2001). She is a native of New Orleans and is proud to bring her Cajun and Creole heritage with her wherever she goes by cooking up a gumbo and making pralines for all, happily sharing "Joie de Vivre" with the world.

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

Introduction

There is something to be said for learning from your mistakes. Throughout my twenty years as a professor of 3D character animation, I have seen many students make the same mistakes over and over again. I must say that much of what I have learned about Maya, I have learned because of the mistakes that my students or I have made. Hopefully, our loss will be your gain, and you will be able to avoid the same mistakes that we have previously made. I am going to show you a streamlined way of creating a character in Maya. The method that I am going to show you is an evolved and simplified process, and it is one that works for my students and me. It is one that has developed as an amalgamation of a variety of approaches that I have learned from different people and my own added techniques. It is not the only way to accomplish the end result. As with anything in Maya, there is more than one way to do the same task. There is no "right way" to achieve your goal. As an artist and a student, you should explore different approaches and assimilate what works best for you into your own approach.

The workflow, or production pipeline, is extremely important. There are some things that must occur before others and some things that can be done simultaneously throughout the production. Throughout each chapter, I will be listing the tasks that will be accomplished and specifying an order. You should pay close attention to the workflow because it will save you valuable time in the long run.

Overview of the Interface

There are many aspects to the Maya User Interface, and it can be pretty overwhelming for a new user. This book does not cover everything that Maya has to offer. If you want more information, make sure to utilize the Maya help files, which can be easily accessed by hitting **(F1)** on your keyboard. This book does assume that you understand 3D space and the XYZ coordinate system of establishing points in that space. This section explains some of the interface areas that we will frequently be using. Each section in the image below is outlined in white and numbered in red. The corresponding number that follows below describes that area of the interface. (Figure 0.1)

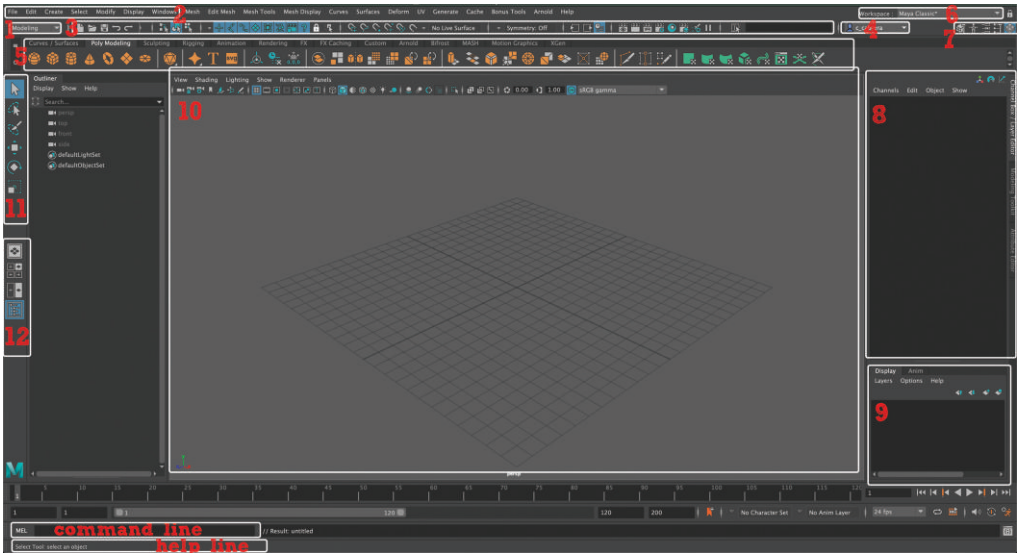

FIGURE 0.1 The Maya user interface.

1. ***Menu Sets.*** A dropdown to choose which menu you are currently working, corresponding with the following hotkeys on the keyboard:

   (F1) Help (Maya Help Files – Read through them when you have spare time)
   (F2) Modeling
   (F3) Rigging
   (F4) Animation
   (F5) FX
   (F6) Rendering

2. ***Menus.*** The Menu bar displays seven common dropdown menu items (File, Edit, Create, Select, Modify, Display, and Windows), and the remaining menu items change based on the current menu set. The current menu set can be changed using the hotkeys (above). Some tools in the menus have little boxes next to their name on the right. These are called option boxes, and clicking on one will open an options window where settings can be changed for that tool. As I refer to menu items, they will appear in brackets as follows: **[Menu > Submenu > Submenu – Option Box].** (Figure 0.2)
   Menu items can also be chosen from the **Hotbox**, which appears when you hold down the spacebar.
   The **Hotbox** is a quick method for accessing all menu items and tools wherever your cursor is located. Simply press and hold down the Space bar on the keyboard for it to appear. You can customize the Hotbox: press and hold the spacebar, press the **LMB**, and drag the mouse to the **Hotbox Controls** menu on the right. While still holding the **LMB** down (a marking menu will appear), drag your mouse to the option you want to enable or disable, such as SHOW ALL, then release the **LMB**. Show All will allow all menu systems to appear. The **Hotbox** saves time and frees up valuable

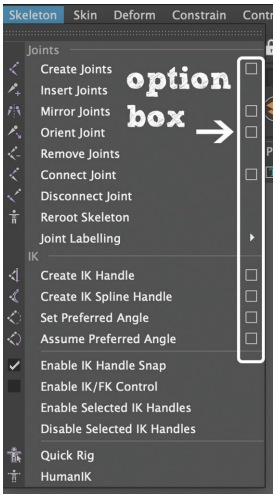

FIGURE 0.2 Menu items with option boxes to the right.

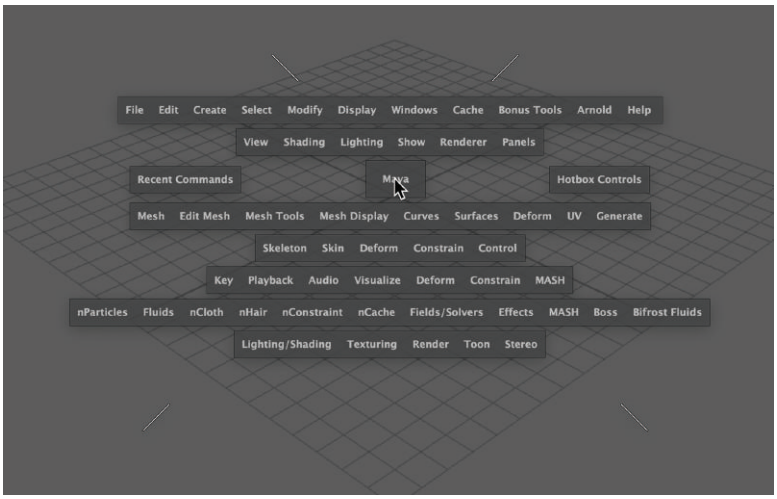

FIGURE 0.3 The Hotbox.

screen space if you hide the menu bar by customizing your settings/preferences, which will be done later in this section. (Figure 0.3)
The **Marking Menu** is a quick method for accessing a subset of menu choices of the most commonly used tools for a particular object. Simply place your cursor over an object, **RMB** and hold for the **Marking Menu** to appear. To select an option from a **Marking Menu**, while still holding the **RMB** down, drag your mouse to the option you want, and then release the **RMB**.

3. ***Status Line.*** The Status Line, or toolbar, contains shortcuts to many of the commonly used tools in Maya. We will be using the menu sets, selection masks, and sidebar buttons. There are small icon buttons for New Scene/Open/Save/Undo/Redo. This is followed by Selection Masks by Hierarchy/

Object/Component, which has a keyboard shortcut of **(F8)** that toggles between Object mode and Component mode. There are more tools on the status line, and I recommend reading the help files to learn more.

4. ***User Account menu.*** Here, you can log in to your Autodesk Account.
5. ***Shelves.*** The Shelves hold commonly used actions and tools, allowing them to be accessed by clicking an icon. If you double click on an icon, the options window will open. These can help save time if you are using the menu bar, but the Hotbox is usually faster. You can create a custom shelf by holding down old ⌘ (command) + shift (MAC), or ctrl + shift (PC), then select any menu item to add it to the shelf.
6. ***Workspace selector.*** Workspace layout option, which has great options for specialized screen layouts of different tasks to increase productivity. This book stays with Maya classic.
7. ***Sidebar icons.*** Buttons to quickly change between the following: Modeling Toolkit, HumanIK window (for use with Motion Capture Data Cleanup), Attribute Editor, and Tool Settings.
8. ***Channel Box.*** The Channel Box is usually the first tool for editing object attributes. The information displayed in the Channel Box changes depending on what kind of object or component you have selected. If nothing is selected, then the Channel Box is blank. Click in a field to type in attribute values, or you can click on a word and middle-mouse-button click and drag in the viewport area to change the value.
9. ***Layer Editor.*** The Layer Editor is useful for organizing your Maya scene file. We will be using display layers. Objects can be assigned to a layer that can then be labeled and set for display options. Referencing the layer allows an object to be viewed normally, but not selectable. Templating the layer allows the objects to be viewed as a wireframe, but not selectable. You can also turn the visibility of a layer on and off. Animation Layers are for adding changes to base animation.
10. ***View Panel (Viewport).*** This is the main Maya window where you work and see what you are working on in three dimensions. There are different camera views, and, by default, there is a top, front, side, and perspective view. If you tap the spacebar, with your cursor over the view panel, your view will change from all four to only the one where your cursor is located. There are Panel Toolbars that have the following menus: View, Shading, Lighting, Show, Renderer, Panels. The most commonly used menu items are on the Panel Toolbar, which is the series of icons.
11. ***Tool Box.*** The tools used to select and transform objects and components can be found here in a button format. These tools align with the QWERTY hotkeys: (q) Select (w) Move (w) Rotate (r) Scale (t) Show Manipulators (y) Last tool used.
12. ***Quick Layout/Outliner Buttons.*** These buttons give you quick access to the Perspective view, the four views, and the front/perspective two-panel layout. The bottom button shows or hides the Outliner.

There are more parts of the interface that align more with animation than with rigging. Please see the Maya help files for more information. Two more areas that may interest you for rigging are labeled in the image above and are:

FIGURE 0.4 Common Maya hotkeys used in this book.

Command Line. Area for entering MEL commands.
Help Line. Shows information if your cursor hovers over a button and also prompts with some steps for certain tools.

Navigation

To navigate in Maya, you need a three-button mouse. Holding down the **Alt/option** key and pressing the **LMB** in the perspective view panel will tumble your view. Holding down the **Alt/option** key and pressing the middle mouse button **(MMB)** in the view panel will track your view. Holding down the **Alt/option** key and pressing the right mouse button **(RMB)** in the view panel or viewport will dolly your view. The track and dolly movements also work in most Maya windows, such as the Node Editor and Graph Editor – not only in the view panels.

Keyboard with Highlighted Hotkeys

Maya is consistent across all platforms. The only difference is that when on a Macintosh a tool calls for using the Command key (⌘), on a Windows PC, the same would be the Control key (Ctrl). Be aware that Maya is case sensitive. This is particularly important when using hotkeys. Throughout this book, hotkeys, or keyboard shortcuts, will appear **bold** in parenthesis (). The following are the hotkeys that will be used in this book: (Figure 0.4)

F1 Help (Maya Help Files – Read through them when you have spare time)

F2 Modeling

F3 Rigging

F4 Animation

F5 FX

F6 Rendering

F8 toggles Object mode/Component mode

1 No Smooth Preview

2 Smooth Preview with Wireframe Cage

3 Smooth Preview

4 Wireframe Preview

5 Shaded Preview

6 Textured Preview

7 Light Preview

Q Select

W Move

E Rotate

R Scale

T Show Manipulators

Y Last tool used

P parent, **[shift+p]** unparent

A frame-all with the cursor over

D (hold) Move pivot **[ctrl+d]** duplicate selected

F frame selected with the cursor over

G repeats last command **[ctrl+G]** group or create Null

Z undo

X (hold) snap to grid

C (hold) snap to curve

V (hold) snap to point

B soft select toggle **B (hold)** change artisan brush size

_–decrease manipulator size

+ = increase manipulator size

{ [undo camera movement

}] redo camera movement

Spacebar (tap) display toggle changes Viewport when the cursor is over

Spacebar (hold) shows Hotbox

Insert/home toggle move pivot

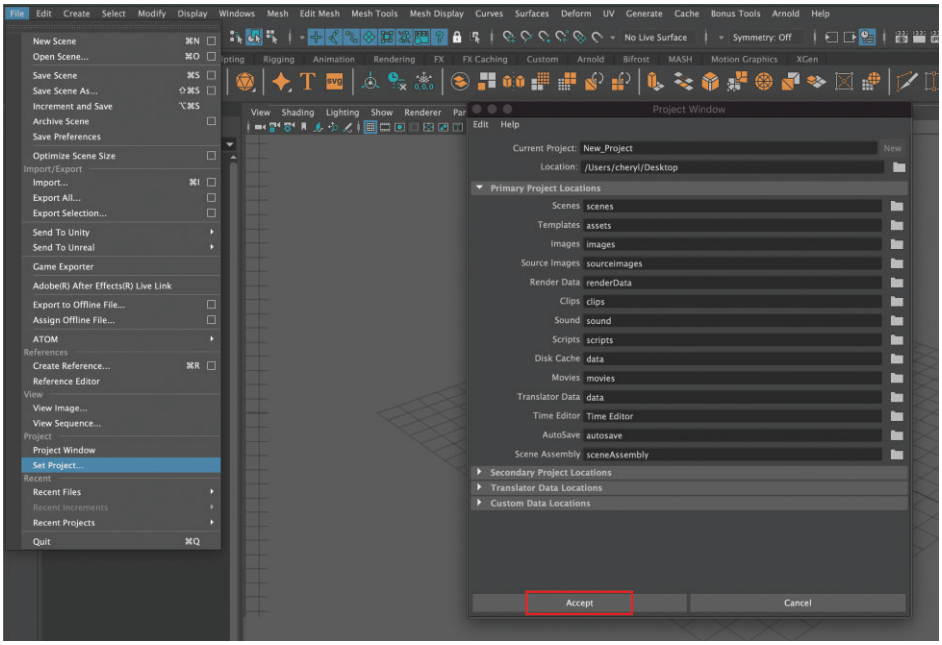

FIGURE 0.5 The Project Window.

Setting Up Your Project Folder and Scene Files

Before you begin working, it is best to develop a file system for storage and organization. Maya has a built-in folder system for storing different aspects of your project. If you are organized, you will save valuable time during the entire production process. This folder system must be the first thing you create when you begin a project. By placing all of your files and related resources into this folder and subfolders, you can be assured that Maya will be able to find your project assets.

To create a new project folder, do the following:

1. Once Maya is open, go to **[File > Project Window]**, the New Project window opens. (Figure 0.5)
2. Enter the name of the new project in the Name text box [a], for example, MayaCharacterRigging.
3. In the Location: text box, enter or browse to the directory that will contain the new project by clicking on the folder icon.
4. **Click** **Accept**.
5. Maya then creates a default folder structure for your project.

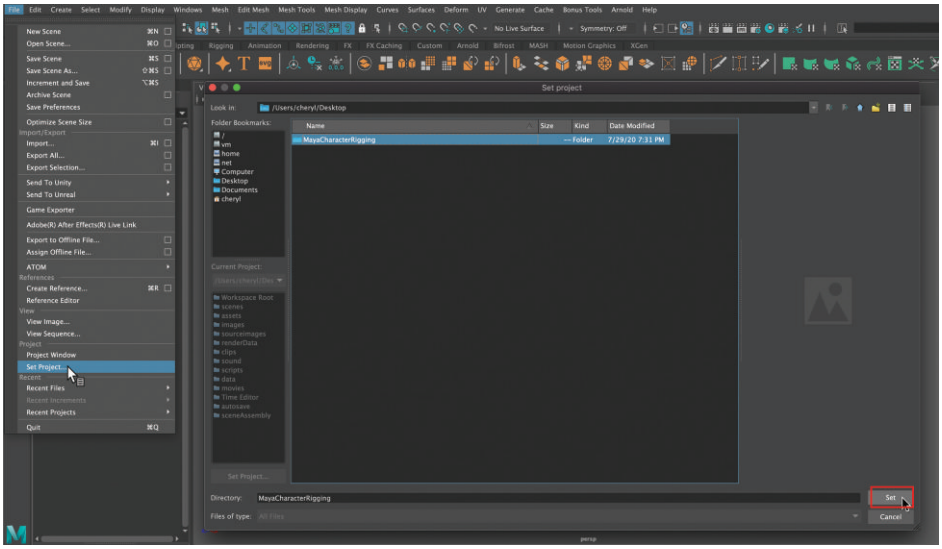

FIGURE 0.6 The Set Project window.

Next, you will want to tell Maya where the project folder is located by doing the following:

1. Go to **[File > Set Project…]**. The Set Project window opens. (Figure 0.6)
2. Browse to the folder on your computer.
3. **Click** **Set**.

Setting User Preferences

Preferences in Maya are, well, preferences. Everyone prefers to do things in a different way. The reason why Maya is such a powerful program is that it is fully customizable. You can configure the interface to your particular likes and dislikes. My suggestions are what works for me. I will be writing this book with these suggestions in place.

To change your settings/preferences:

1. With Maya open, go to **[Window > Settings/Preferences > Preferences]**.
2. Click on **Animation** and set the following:
   a. Default in tangent: choose "linear."
   b. Default out tangent: choose "linear" (these settings are best for rigging).
3. Click on **Undo** and set the following:
   a. Queue: choose "Infinite" (a must, unless you have a slow computer that crashes often).
   b. If you have a slow computer: choose "Finite" with a Queue size of 100.
4. **Click** **Save**. (Figure 0.7)

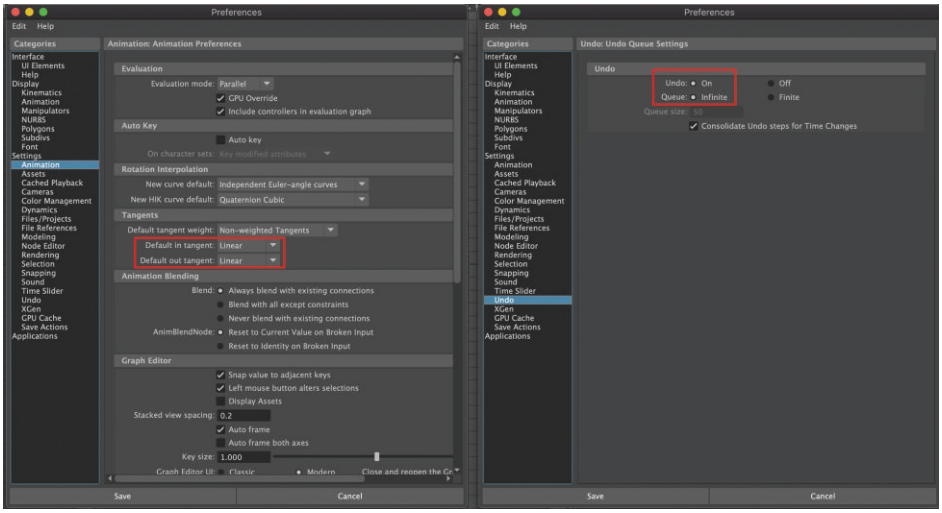

FIGURE 0.7 The Preferences window.

Taylor & Francis
Taylor & Francis Group
http://taylorandfrancis.com

Skeleton Setup

- **Former Student Spotlight: David Bokser**
- **Workflow**
- **Introduction**
- **Analyzing Motion**
- **File Referencing**
- **Setting Up Your Work Area**
- **Working with Joints**
- **Summary**

FIGURE 1.1 Power-up! Concept art illustration for Lucy Furr by Sanne Methorst, 2019.

Former Student Spotlight: David Bokser

Short films are tough. They always take way longer than expected and always require more work than planned for. No matter how small in scope, a short film is always a large collection of moving parts involving every aspect of CG production – from writing and concept to modeling, animation, lighting, and rendering. The rigger/tech artist is a bit of the unsung hero of the production phase. While modeling, animation, and lighting often get a lot of the love, the tech artist is often the one in the rafters making sure the scaffolding doesn't fall onto the stage and that the lights turn on.

Rigging and Tech Art is primarily about problem solving, not just putting joints into characters and painting skin weights. While working on personal short films and professional productions, the technical skills that I learned by starting with rigging have expanded to almost all other areas of production. I've had to write tools to help modelers convert meshes into dynamic hair curves, joint-based muscle systems because the rendering engine didn't support deformers, and back-end software that allowed artists to automatically check their work for errors as they send their assets through the pipeline. There are a million tiny cracks in CG production that a technical artist can fill throughout the course of their careers.

Making short films helps with getting your hands dirty in all of the details of a full CG production. It has helped me find those cracks that I could explore in parts of production that otherwise never held my interest, and it has helped me expand my knowledge and skill sets. If you do decide to make one, my suggestion would be to keep it simple. Don't try to create an epic with your first film; a 30–60 second short would be great. Try to use it as a learning process instead of "your great contribution to the art world." You might end up finding a niche that you didn't expect.

Biography

David Bokser graduated from the Savannah College of Art and Design with a BFA in Computer Art and a minor in Animation. His short films have been screened at numerous festivals including the SIGGRAPH Electronic Theater, the Palm Springs International Shorts Festival, and the SCAD Film Festival. He has animated and rigged on commercials for Coca-Cola, Apple, and AMC and has directed commercial and interactive media projects for Nintendo, PopCap, and Ubisoft. His interests are currently in VR experiences. His work can be seen at www.davidbokser.com (Figure 1.2).

Workflow

Figures 1.3 and 1.4

Introduction

The first character you choose to rig should be simple. Keep it SIMPLE. This rule applies to anything in life. You will encounter many obstacles while

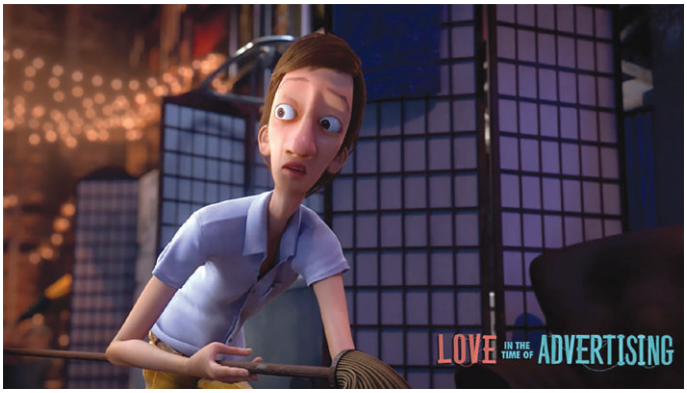

FIGURE 1.2 *Love in the Time of Advertising 2015*, directed by David Bokser.

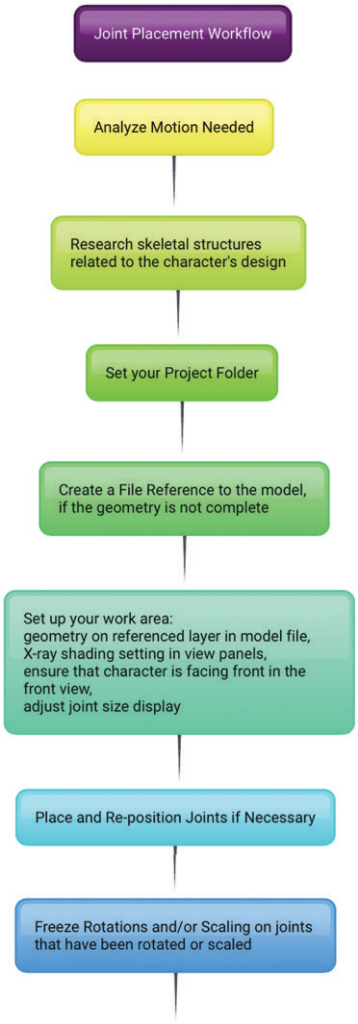

FIGURE 1.3 Joint Placement Workflow part 1.

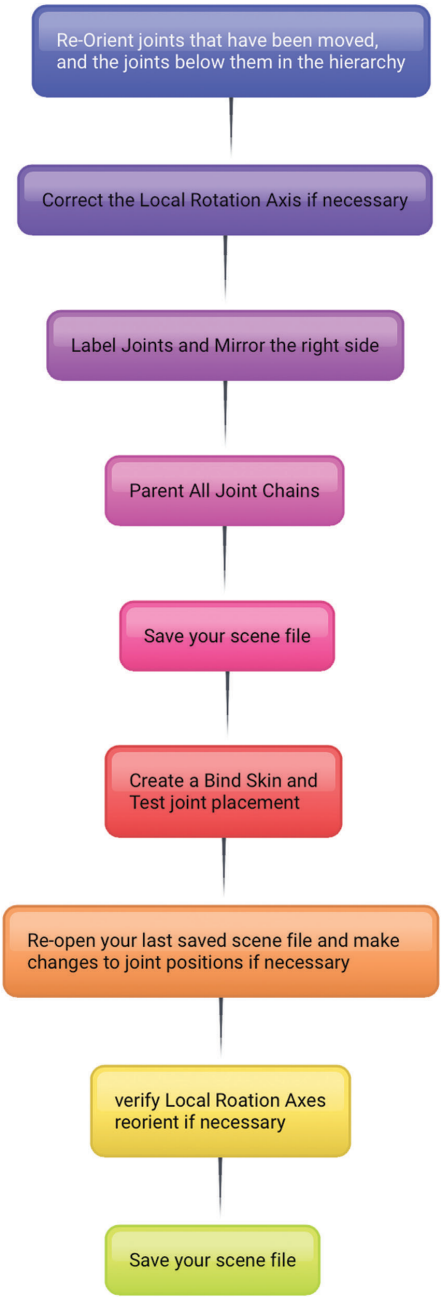

FIGURE 1.4 Joint Placement Workflow part 2.

learning, so why complicate the situation, unless, of course, you thrive on challenges and have no problem tackling these obstacles on your own. Generally, however, this leads to frustration and a strong desire to quit. Begin simple, then build on that knowledge with practice and add additional challenges later.

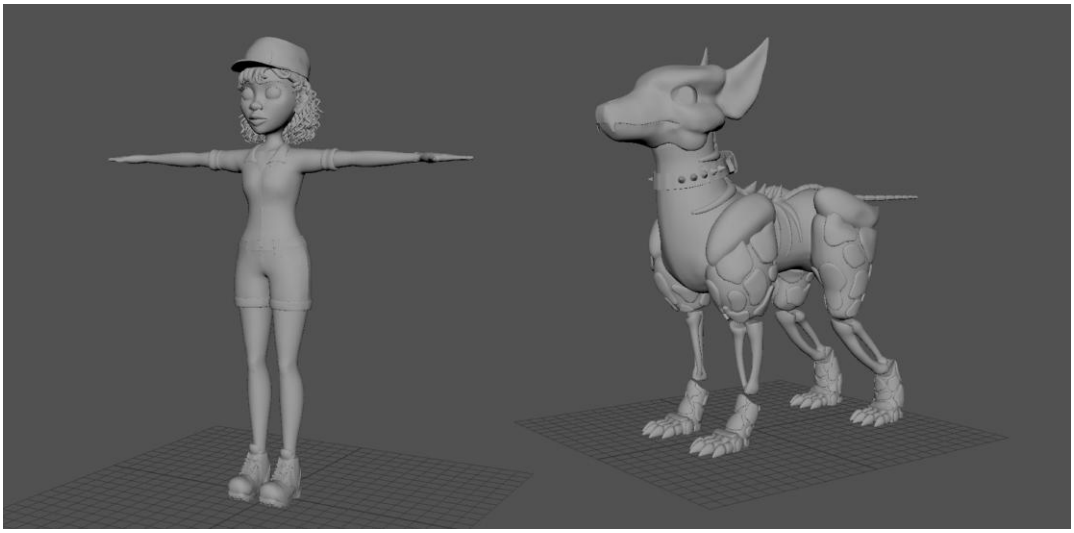

FIGURE 1.5 Biped model by Kenna Hornibrook, design by Crissy Peters, and Quadruped model by Ashley Lupariello, design by Alina Morales, 2019.

A **biped** is a great character for beginning riggers to start with because of the varied problems that will be addressed during the process. It is also one of the easiest of which to gather research since you are bipedal. When you have a question about how something moves, you simply have to study your own physical mechanics. Many of the rigging solutions that are used for a biped can be reused with other types of creatures and props.

A **quadruped** can be easier to rig because you may not have to necessarily worry about IK/FK switching, fingers, or other features that are needed for bipedal motion. It is important to stick to simple and stylized design ideas when learning. The more realistic and detailed the character becomes, the more difficult it is to set up for animation (Figure 1.5).

Analyzing Motion

The most important thing you need to remember about rigging is to analyze the character for the motion that will be necessary and create only the controls that are needed for movement. Too many people spend way too much time creating rigging features that are not needed or necessary for a particular character or prop.

The best way to go about analyzing the motion for a character is to create or acquire reference video to study. Of course, you then have to already know what action will be needed; otherwise, you have to consider all possible motions that a character can do and create a rig that can do everything, which could be a waste of time. On the flip side, you may miss adding something to a rig that is needed during production. In some cases, you can add these features later to a rig. This is a great example of why preproduction is necessary for whatever project you are working on. The more you plan,

FIGURE 1.6 Still frames from reference video can be used to analyze motion.

FIGURE 1.7 Still frames from reference video can be used to identify pivot points of rotation and movement.

the more you know what you will need, and the less time you will waste in all aspects of production (Figure 1.6).

Identifying Pivot Points and Rotations

After you acquire reference video, take a look at the motion of your reference actor. Reference video can be created or found. From this video, you can advance frame by frame and take notes about what is moving and what is staying still. Pay attention to where the **pivot** locations occur during rotational movements. Notice where the center of gravity is located during the motion (Figure 1.7).

Each character or prop will have a center of gravity from which all other parts radiate. This center of gravity becomes the root of our character. We can compartmentalize a character or prop into specific independent rigs that are eventually connected together during the animation process. This way, we can break apart complicated movements into smaller, more manageable sections. Every bipedal human has a center of gravity that usually exists in the pelvic area. From here, we can radiate outwards and list the sections that need to be created. Going up: torso, neck, head, clavicles, arms, and hands. Going down: hips, legs, and feet.

It is helpful to begin with a drawing of the character, like the character model sheet, so that you can make notations of where pivot points are located for the necessary rotations. This information becomes extremely helpful when creating the underlying skeleton. A screen-capture of the geometry can also work well for this (Figures 1.8 and 1.9).

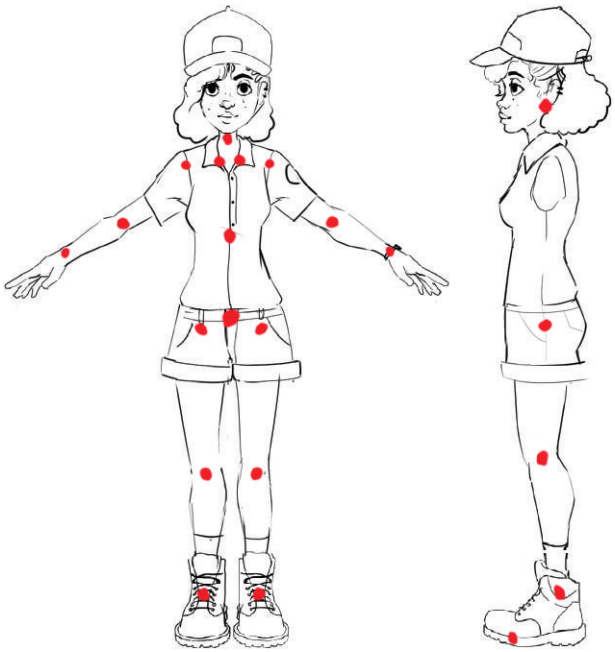

FIGURE 1.8 Character Model Sheets can be used for initially marking major pivot locations. Character Model Sheet for Persephone by Crissy Peters, 2019.

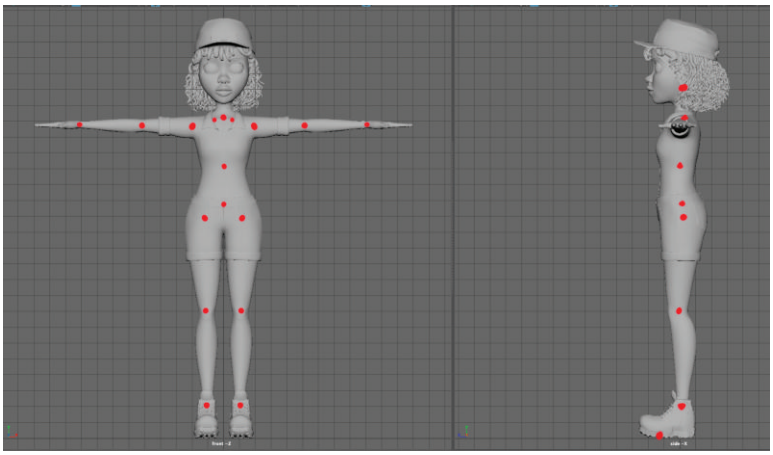

FIGURE 1.9 Screen captures of the model can be used to mark major pivot locations. Persephone biped model by Kenna Hornibrook, design by Crissy Peters, 2019.

A character modeled in the T-pose is the easiest to rig. As a beginner rigger, it is recommended to only work with characters modeled in a T-pose. The reason for this is because the rigging tools were programmed to assume perpendicular and parallel grid systems. A-pose characters are more difficult and require additional steps.

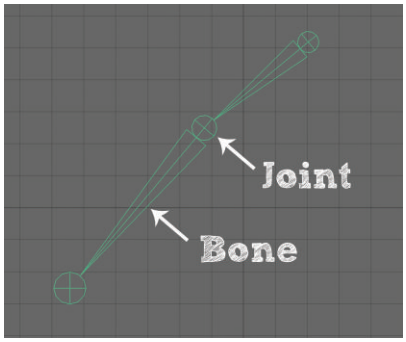

FIGURE 1.10 Joints are connected visually with a bone.

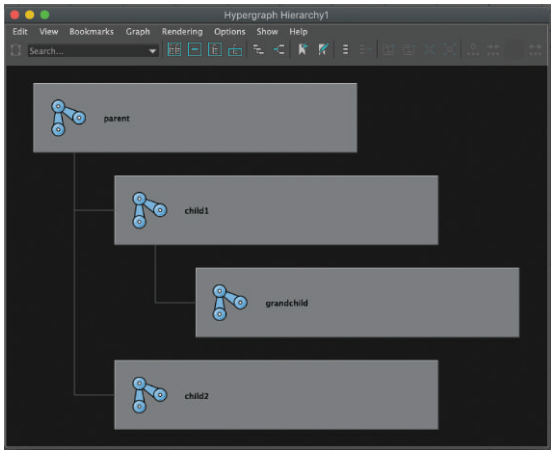

FIGURE 1.11 The hierarchy of a joint chain as seen in the Hypergraph.

A skeletal structure is the support system for our bodies, and the same type of structure is needed for our digital characters. This structure is built in Maya using joints. Joints are connected visually with bones, but bones do not physically exist as objects in Maya. They are simply a visual connection from one joint to the next. If you **select** a bone, you are **selecting** the joint above that bone in the **hierarchy** (Figure 1.10).

As joints are created, each subsequent joint is automatically connected as part of a hierarchy (unless you hit **enter**, which ends the joint chain). This hierarchical system looks much like your family tree. The main difference is that there are only single parents in the Maya environment. While a joint can have many children, the children, however, can only have one parent. When you create two joints, the first joint is considered the parent, and the second joint is considered the child of that parent. Each additional joint created becomes a child to the preceding joint. A series of connected joints is called a joint chain (Figures 1.11 and 1.12).

The hierarchical system is present in Maya in other ways as well, not just with the joint chains. For example, when objects are grouped, the group node that is created becomes the parent of all the objects in that group.

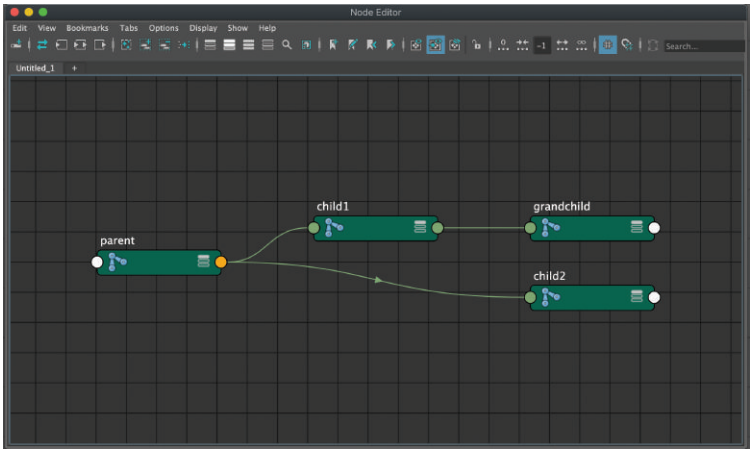

FIGURE 1.12 The hierarchy of a joint chain as seen in the Node Editor.

FIGURE 1.13 Human and canine skeletons.

Before creating your joint chains, your character geometry should be as finished as possible. It is unnecessary to complete fine details in the geometry, but the main proportions of the character should be in place before beginning the joint placement process. If modeling with polygons, it is important not to smooth the finished model at this point in the rigging process as this will create extra geometry which will slow down the entire process of rigging and skinning.

When placing joints in your character's geometry, it is important to study the physical shape of the character that you will be rigging. Depending on the type of character design for which you are creating controls, the first place to start would be to research the skeletal structure to ensure proper joint placement. For a biped character, this is a simple process since you are sitting in the best research available, which is your skeleton. If you need to know how something moves or bends, you simply have to look at yourself (Figure 1.13).

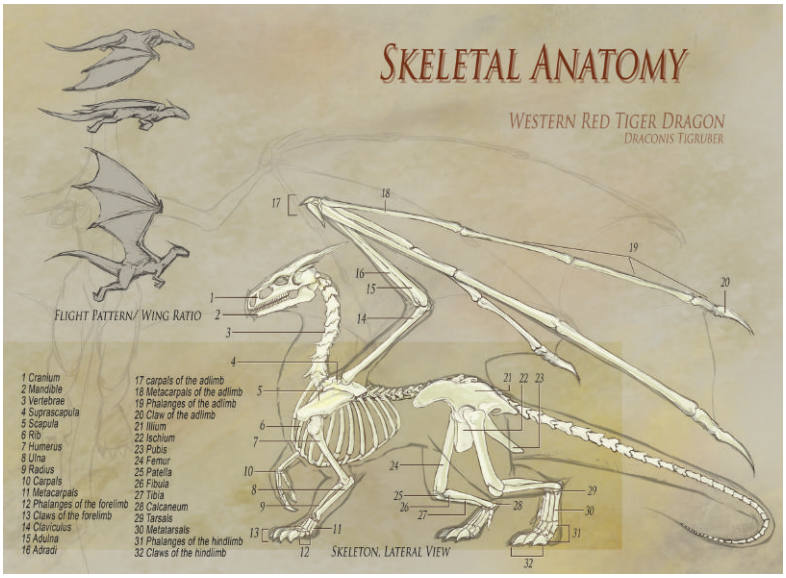

FIGURE 1.14 Dragon skeleton illustration by Drew Merritt. Skeletal influences from reptile, bats, and birds are clearly defined.

If the character is a creature or something that may not exist in real life, it sometimes takes multiple existing animal parts to create a skeletal structure that may work for the creature that you are setting up. For example, a dragon is part reptile, bat, and bird, so you may want to study the skeletal structures of all three to create a basis for the dragon (Figure 1.14).

When you are placing joints in your character, think about each appendage as an individual joint chain. Create separate chains for each leg, arm, finger, torso, and head. These will all be connected as a single skeletal structure. You can also add chains for other body parts such as ears, tails, or antennae. You can even add joints and joint chains for articles of clothing or props, such as neckties or skirts, for better control when animating.

File Referencing [File > Create Reference...]

File Referencing can be found in all menu sets under the File menu.

Many times during the production process, the geometry for a character is not finished when it is time to begin the rigging process. Perhaps the textures are not completed or the blend shapes have not been modeled yet. In my classroom, the students have only 15 short weeks to learn how to create a character. Once their character geometry is finished, we begin the rigging process in class, while outside of class they work on retopologizing their character models, UVing, and creating their blend shapes and textures. Because of the overlapping workflow, file referencing is utilized, so that the latest version of the character model can easily be updated in the rig file.

Creating a "File Reference" does not make the file data part of the current scene. Referencing files only point Maya to a different file by creating a path and saving the path information. When your current scene file is saved, it is not including any data from the referenced file. It just tells Maya where to look when you open the file again. This reference can easily be removed or replaced as you are working. It can even be imported into the scene, so that it eventually does become part of the scene file. File referencing can be used during the creation of assets (we will be using it during rigging and skinning), but it can also be used when animating.

If your character model scene file is large (2000 KB), your rig scene files can be very small in size, sometimes under 100 KB, if *file referencing* is used. This can be helpful if your disk space is limited and you are following the practice of saving versions of your files as you work. Instead of resaving the geometry every time you **save**, the only thing Maya is saving is the rig information.

It is extremely important to always work in a structured and organized way to avoid time-consuming problems later. A project folder should be used to organize your files and create relative paths within your project folder. A relative path points to a folder or file within the project folder. This allows the ability to move a project folder from one computer to another and still maintain a working path structure. Before creating a reference file, be sure to have a project folder created and set your project. Go to **[File > Set Project…]** and browse to the created project folder.

To create a referenced file, open a new scene in Maya and go to **[File > Create Reference**...☐**]** In the option box under "**Namespace Options**," make sure there is a checkmark ☑ in the box next to **"Use Namespaces."** This will ensure that the names of the nodes of the referenced file will not conflict with any that already exist in the current file, which is extremely important when creating a reference for several characters in your animation file. It is good to get in the habit of using namespaces. Maya will use a colon **(:)** in front of the node name to signify that the node is from another file. The default setting is to use the filename. So, if you are referencing a file named **"model.ma"** and there is a node called **"Left_Arm,"** the referenced name will look like **"model:Left_Arm."** If you set **"Use selected namespace as parent and add new namespace string:"** you can type something inside of the available box instead of using the lengthy name of a file. This also allows you to create references to multiple versions of the same file. It is a good idea to keep your filenames short, otherwise, the namespaces become very confusing (Figure 1.15).

Keep filenames short, especially when using a file for file referencing.

Changing the Referenced File [File > Reference Editor]

If you make changes to your model and need to replace the referenced file, go to **[File > Reference Editor]**. A dialog box will appear. **Click** on the filename to highlight it, then go to **[Reference > Replace Reference]**. This will open a dialog box that will allow you to browse for a new file, temporarily

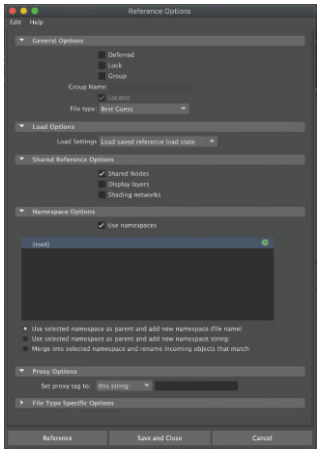

FIGURE 1.15 Create Reference can be found under the File menu. The Create Reference options window.

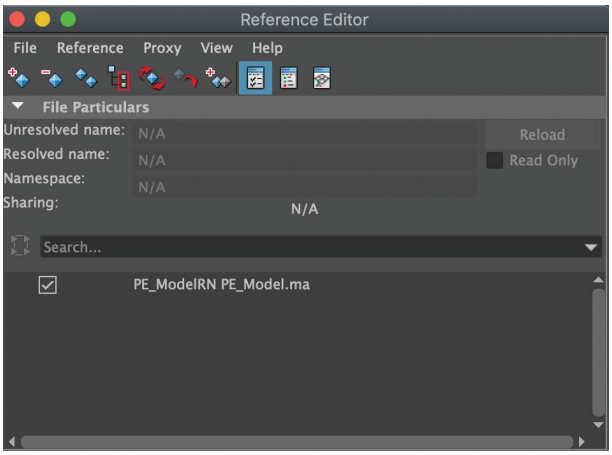

FIGURE 1.16 The reference editor.

remove the reference from your scene, and then reload the new referenced file into the scene. By clicking **[Reference > Remove Reference],** you can *permanently* remove the reference from your scene. By clicking **[File > Import Objects from Reference],** you can *permanently* import the reference file into your scene. Be sure to delete construction history, once the objects are imported. You can also adjust the path if it is necessary to change an absolute path to a relative one (Figure 1.16).

The proper way to start Maya is to set your project before you begin working for the day. You should never double-click directly on a scene file to open Maya, as this will change the relative paths to absolute paths when saving your files. An absolute path looks for the specific computer on which it was created. This will cause problems, especially with larger scene files and in larger productions, when moving a project from one computer to the next, or placing a file onto a renderfarm.

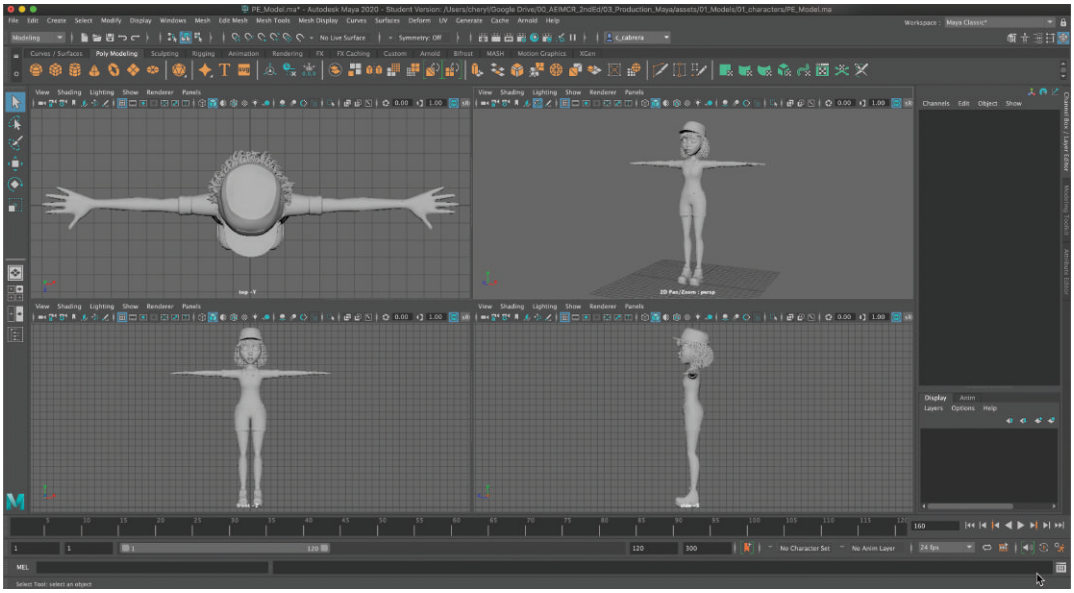

FIGURE 1.17 Proper character placement for rigging. Persephone biped model by Kenna Hornibrook, design by Crissy Peters, 2019.

Setting Up Your Work Area

Before placing joints, make sure your character is facing front in the front view; in the top view, he should be facing down. This may sound obvious, but it is my experience that some students do not pay attention to the direction their character is facing. The tools in Maya were created with the assumption that the character is facing forward in the front view, in other words, toward the positive Z-axis in three-dimensional space. If for some reason, your character is not facing forward in the front view panel, you will need to rotate the geometry. You will need to make a group of your geometry if your character is made up of multiple pieces of geometry before being able to rotate them together. This should be done in the model file, not in the rig file, when the geometry is file referenced. Remember, all changes to the geometry should be done in the model file. If you are working on a team, you should communicate this with the modeler (Figure 1.17).

The scale of your character is another important consideration. One square on the Maya grid is 1 cm by default. I have had students model their entire character to fit inside a single 1 cm grid square. Many of the tools used in Maya are based on mathematical calculations. The problem with keeping your character so small is that these tools must calculate results using fractions in the thousandths or smaller. This creates a greater margin for error. My general rule is to keep the character arm span the width of the entire grid in the perspective window, at a minimum. If, for some reason, your character does not have an arm span that is the width of the perspective window grid, you will need to scale the geometry. Again, you will need to make a group of your geometry if your character is made up of multiple pieces of geometry

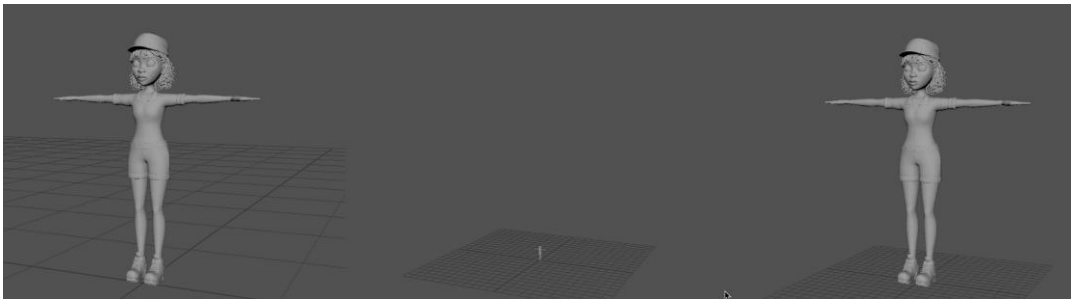

FIGURE 1.18 The image of the character on the left looks similar in scale to the image of the character on the right. However, on a closer look, the character on the left is the scale of the image in the middle. Make sure that your character is not too small, as it will cause problems with some tools and when rigging and animating. Persephone biped model by Kenna Hornibrook, design by Crissy Peters, 2019.

before being able to scale them together. (If you had to group them for rotational purposes, you can scale the same group, another group is not necessary.) Again, this should be done in the model file. It is important to note that once skeletal placement and rigging begins, any changes to the scale of the character should happen *after* the rigging is completed. A good rig is scalable and allows a character to be scaled to match the environment in which it will exist. It is also a good idea to *freeze transformations* on all geometry or groups in your model scene file at this point (Figure 1.18).

It is a good idea to delete the construction history on your geometry before you place any joints or bring in your model file as a reference, if you are still working on the geometry. This will ensure that the geometry is free of extra and unnecessary information that slows the scene file down. Once the geometry construction history has been deleted, open your Outliner or Hypergraph, and take the time to label everything in your scene file. You can also group body geometry if you have multiple pieces. Keeping your scene file organized and clean always saves time later.

DO NOT parent geometry pieces to other geometry pieces unless you have done so to create the blend shapes for the face, which I do not recommend because it creates some irritating problems that make it difficult to achieve desirable results. Parenting geometry pieces to other geometry pieces causes double transformations after the skinning process.

Remember that when your character is facing you, his left side is your right side. This is important so that as you label all of your joints, you label the left and right sides correctly. Make sure to label all joints as this will make an organized and clean workflow and save time later. As you work, **save** versions of your work and **save** often.

When using a tool in Maya, always open the Option Box and reset the tool when using it for the first time that day. This ensures that the tool is working appropriately and is not based on the tool settings when it was last used.

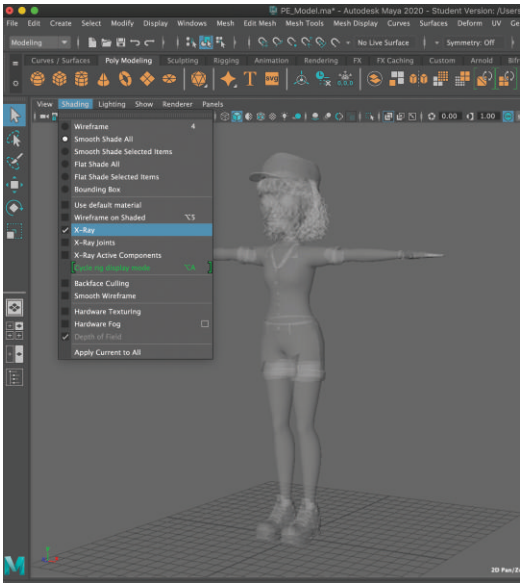

FIGURE 1.19 Shading set to X-Ray. Persephone biped model by Kenna Hornibrook, design by Crissy Peters, 2019.

It is a good idea to place the geometry for your character on a display layer. Set the layer to reference, so that you are unable to **select** the geometry by mistake when working. Again, this should be done in the model file. I recommend working with shading options set to X-Ray so that you can still see your geometry volume. This is a personal preference, as others like working in wireframe (Figure 1.19).

- The model should be constructed of quadrilateral polygons with good edge flow.
- Avoid non-manifold geometry, T-intersections, n-gons, concave polygons, double vertices, back-facing polygons, and hidden polygons.
- Character faces should be built with concentric edge flow around the eyes and mouth. The character should be in the classic T-pose, ready for rigging.
- The arms should be aligned with the X-axis.
- The feet should be toes forward with feet apart.
- Arms should be modeled palms down with fingers spread.

Below is a quick checklist that can be used on the model file to prepare it for rigging (before you create a File Reference). Remember, once you hand your model off to someone else or reference in your file to begin rigging, do not freeze transformations or scale the model.

Model file checklist:

- Delete construction history on the geometry (with the geometry selected, go to **[Edit > Delete by type > History]**).

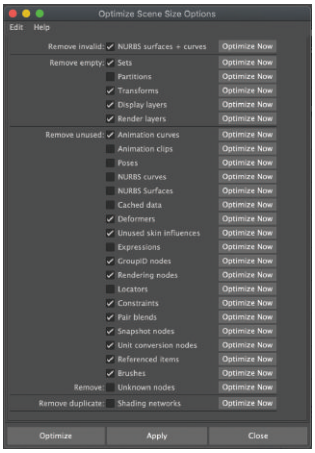

FIGURE 1.20 Optimize Scene Size Options.

- Run **[Mesh > Cleanup…]** (operation: select matching polygons: faces with more than 4 sides; Lamina faces; non-manifold geometry: geometry only).
- Fix any problems selected; delete construction history again; repeat and continue until problems solved. Sometimes you must change the operation to **Cleanup matching polygons** to remove all problems.
- Make sure your Normals face outward (conform if necessary, then reverse).
- Delete construction history again on the geometry. With the geometry selected, go to **[Edit > Delete by type > History]**.
- Clean your OUTLINER – delete any unnecessary or extra nodes.
- **Rename** all nodes remaining in the OUTLINER so that the nodes make sense.
- Freeze transformations on your geometry to return Translations and Rotations to 0 and Scale to 1. With the geometry selected, go to **[Modify>Freeze Transformation]**.
- Optimize scene size. Go to **[File> Optimize Scene Size ☐]** box, CHECK ☑ everything and **click Optimize.**
- Be sure that there is only one node remaining in the OUTLINER. Select all the geometry, **[ctrl+g]** to group them, and **rename** the group (Figure 1.20).

Working with Joints

The Joint Tool [Skeleton > Create Joints]

The Joint Tool can be found in the Animation menu set (F4) under the Skeleton menu.

The joint tool allows you to create joints by clicking on a grid. For this reason, you should always use the orthographic view panel (front, side, or top) when

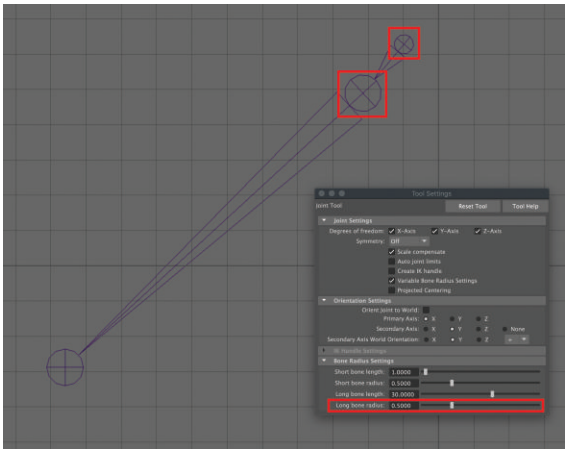

FIGURE 1.21 The long bone radius changes the size of the joint based on the distance it is from the following joint. Changing the long bone radius to 0.5 will prevent this.

placing your joints. You can create a joint by moving your mouse cursor where you would like to position the joint and clicking with the **LMB** (left mouse button). A single joint appears as a circle with a crosshair in the center. A new joint is created every time you click the mouse. Subsequent joints are connected with bones, which look like a triangle with a line down the center pointing toward the new joint. To complete a chain of joints, simply hit the **(enter or return)** key on your keyboard. If you would like to create another chain, **select** the joint tool again by **pressing** the **(y)** key.

> Remember, a bone does not exist in Maya. It is simply a visual connection of one joint to the next.

You will notice that the closer you click the joints to each other, the smaller the joints appear. The further away the joints are from each other, the larger the joints appear. This can cause visual clutter in your scene file. This setting can be changed by opening the OPTION BOX on the tool and changing the long bone radius to 0.5000. By changing the long bone radius to equal the short bone radius, all of the joints will be created as the same display size (Figure 1.21).

Display Size [Display > Animation > Joint Size. . .]

Display Size can be found in all menu sets under the Display menu.

As you are drawing your joints, you might notice that they are small or large compared to the size of your character model. You can change the display size of the joints to see what you are doing more clearly. First, you may want to click out a few joints in one of the orthographic view panels. Then after opening in the joint display scale window, you can enter any numeric value or use the adjustable slider to interactively change the size of the joints.

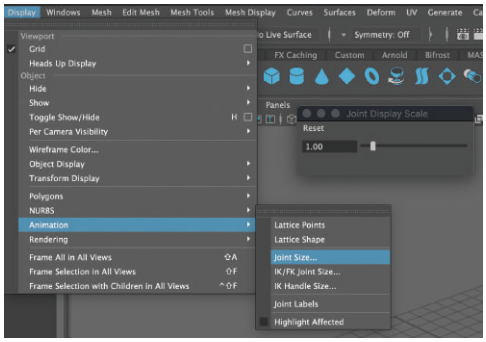

FIGURE 1.22 Display > Animation > Joint Size.

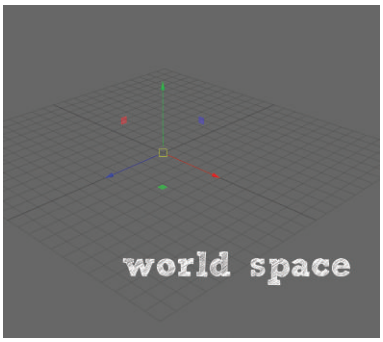

FIGURE 1.23 The Cartesian coordinate system and its point of origin.

Adjusting the display size of the joint will not affect how the joint works. You will notice that the position of the center point of the joint does not change regardless of the display size (Figure 1.22).

Local Rotational Axes

To understand the **local rotation axis**, it is important to understand the 3D coordinate system and the differences between world space, object space, and local space. It is time to think back to math class when you were first introduced to the Cartesian coordinate system. In the Cartesian coordinate system, there are three intersecting perpendicular lines called axes. A point in the coordinate system is defined by three **real numbers** (an infinite decimal representation) and each number reveals the position of the point on each axis, X, Y, and Z. The point of their intersection is referred to as the origin, and it is at the position of 0 0 0.

In Maya, we use a right-handed Cartesian coordinate system, where the X-axis points left to right on your screen, the Y-axis points up and down, and the Z-axis points forward and backward. This coordinate system is considered **world space** (Figure 1.23).

If you create an object in Maya, such as a sphere, it is placed in world space at the origin. Imagine the XYZ axes lines sticking to the sphere (Figure 1.24).

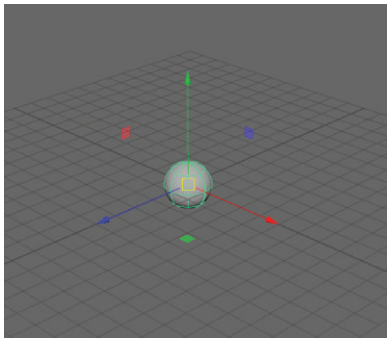

FIGURE 1.24 A sphere that has been created at the origin and is in World space.

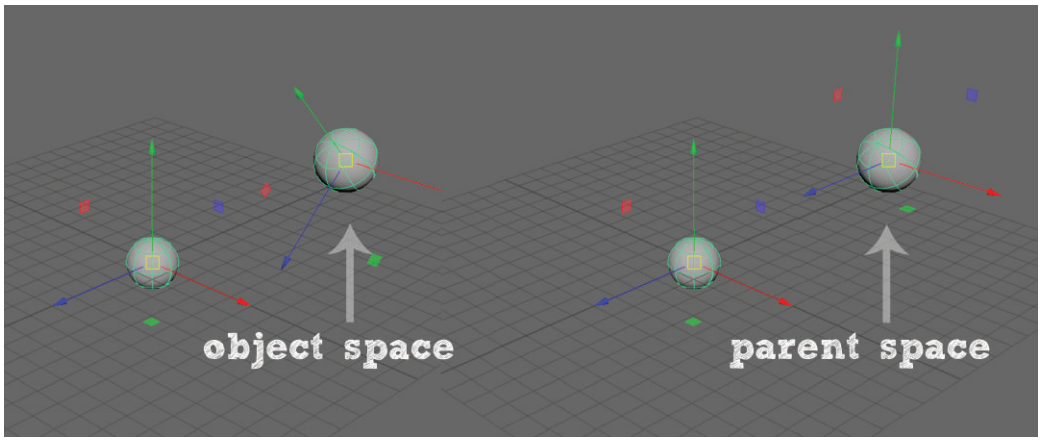

FIGURE 1.25 A sphere (left) that has been moved from the origin and rotated with its parent shows a different coordinate system called Object space. The same sphere (right) showing Parent space.

Now imagine the sphere is moved away from the world space origin and rotated. The XYZ axes of the object (sphere) would be pointing in a different direction and no longer aligning with the world. This coordinate system is referred to as object space. The origin is at the object's pivot point (currently at the center of the sphere), and its axes are rotated with the object. The origin can be moved by using the move pivot mode (**select** the move tool **(w)** and then **press** the **(insert)** or **(d)** key). **Object space** changes for each object in Maya, based on its rotation and translation values.

If the object's transformations are frozen, the axes will return to align with world space, but the origin remains where it is currently located, still in object space. If an object is the child of another and its parent is transformed, the object uses the origin and axes of its parent for its position in **parent space**. This is especially important for translation values, as you can move an object based on its object, parent, or world space, and it is particularly noticeable if the object has been rotated separately from its parent (Figure 1.25).

The local rotation axis is a separate coordinate system for joints. The local rotation axis of a joint is determined by the position of its child. If a joint does

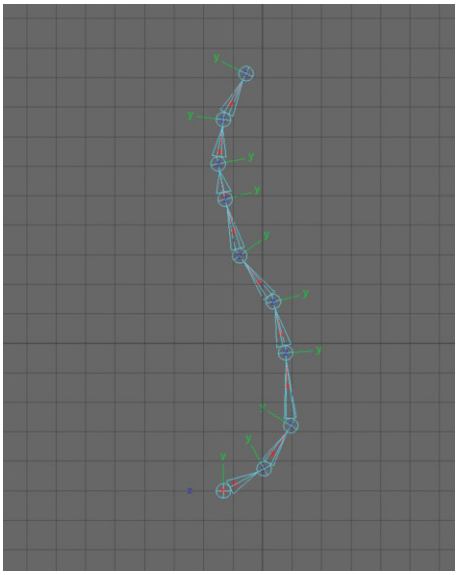

FIGURE 1.26 Local rotation axis set to XYZ on a vertical joint chain, where the axis does not line up from one joint to the next.

not have a child, its local rotation axis aligns with world space. If a joint has a child, by default its X-axis points toward that child and the Y-axis will point upward (or as close to up as it can, based on its relationship to the X-axis). We do have to be concerned when the joint chain is vertical or semi-vertical because the X-axis points toward up or down (depending on the direction of the children), therefore the Y-axis cannot point up at the same time. Maya will arbitrarily point the Y in any direction, and the joint chain does not have the same local rotation axis throughout (Figure 1.26).

When do you worry about the local rotation axis? To ensure that joints rotate uniformly and predictably when using IK (**inverse kinematics**, will be covered in Chapter 2), any joint chain created should be oriented properly for IK. This means that the X-axis should be pointing toward the child joint, and the Y and Z-axes are the same throughout the chain. This ensures that the IK tools will work as the creators defined them (Figure 1.27).

However, to ensure that joints rotate correctly using FK, (**forward kinematics**, will also be covered in Chapter 2) the joint orientation must align closely to world space. For the arms, we can achieve this alignment when drawing out the joints, but for the spine, neck, and head, we will run into trouble (and for the ankles and feet, but we will not be setting up FK in the legs for this rig). It is impossible to have the X and Y-axes pointing in the same direction. This means that the Y-axis should be pointing toward the child (up in the spine), and the Z-axis should be pointing forward. To solve this problem, we create multiple joint chains for the different types of control systems needed and switch between the two. We must reorient the FK chain to match world axis (Figure 1.28).

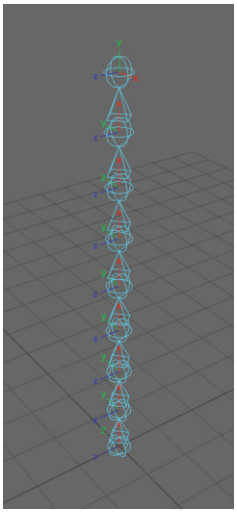

FIGURE 1.27 A spine chain prepared for Inverse Kinematic control.

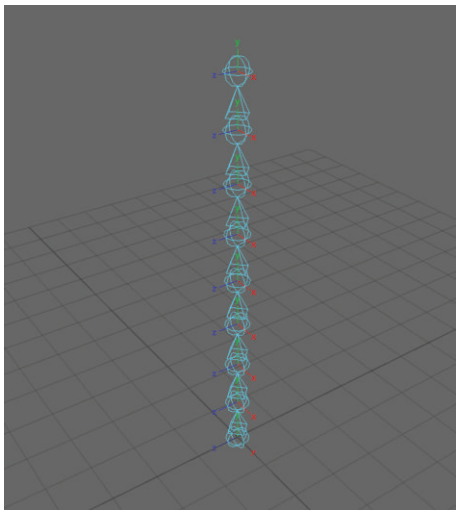

FIGURE 1.28 A spine chain prepared for Forward Kinematic control.

The last joint of any chain will not rotate; therefore, the local rotation axis position does not matter for that joint.

Placing joints with the default orientation set to primary axis X, secondary axis Y, and secondary axis world orientation to Y + will always ensure the X-axis points toward the child joint, but the direction of the Y-axis depends on the direction of the child joint, especially in vertical or semi-vertical chains. If the X-axis is going up or down, then the Y-axis is unable to do so as well. This confuses Maya, and it is not sure which direction to place the Y. Sometimes the Y-axis will be flipped in different directions. You will need

to ensure that they are all pointing in the same direction so that the joints are aligned. To solve this unpredictable behavior, change the tool settings whenever creating vertical joint chains so that the joints are created with the primary axis orientation as X and secondary axis orientation is Z. Secondary Axis World Orientation would also be Z +. (You could also reorient the joints after positioning them.)

Use this handy guide to help you choose the proper settings when drawing joint chains:

Joint chains that will be controlled by IK:

draw on the:	Primary Axis	Secondary Axis / Secondary Axis World Orientation
X-axis (horizontal: left to right)	X	Y or Z
Y-axis (vertical)	X	Z
Z-axis (horizontal: front to back)	X	Y

Joint chains that will be controlled by FK (Figure 1.29):

draw on the:	Primary Axis	Secondary Axis / Secondary Axis World Orientation
X-axis (horizontal: left to right)	X	Y or Z
Y-axis (vertical)	Y	X or Z
Z-axis (horizontal: front to back)	Z	X or Y

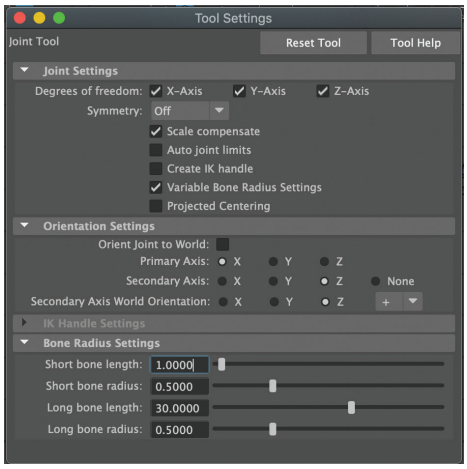

FIGURE 1.29 Joint Tool Options set for vertical IK chain creation.

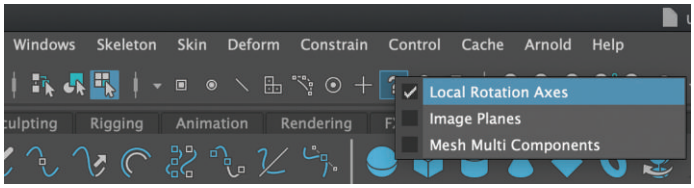

FIGURE 1.30 Display the Local Rotation Axes in Component Mode by right-mouse clicking over the question mark. Be sure to select the root of the joint hierarchy before switching to Component Mode (F8) to display the Local Rotation Axes for that hierarchy.

There are two ways to check the directions of the local rotation axes in your character's joints:

1. Component mode: **press** (**F8**) to change to component mode or **click** on the component mode button. In the selection mask toolbar, place your cursor over the "?" button, **RMB** (right mouse button) **click** and hold, then **select** Local Rotation Axes from the pop-up menu that appears. In the perspective view panel, **select** the root of the chain you would like to display. Every joint in the selected hierarchy will display its local rotation axis (Figure 1.30).
2. Object mode: **select** the joints you would like to display then go to **[Display > Transform Display > Local Rotation Axes]**. I do not recommend displaying the LRA this way for beginners. It can be frustrating because to hide them again you have to reselect the same joints and repeat the command. Any joints you accidentally add to this selection will display the LRA when the others are hidden. This can become what seems to be a never-ending cycle of frustration.

Placing Joints

The joint transforms around the position of its center point. It is important to make sure that the joint is positioned in the exact place to control your character appropriately. As you begin to place joints, you may find that you have misplaced them in the process. You can **[Edit > Undo]** or **press (z)** and continue to recreate joints. While placing joints, you can **click** and hold the **LMB** (left mouse button), then drag the joint into the correct position.

Repositioning Joints

Once you place joints in one of the orthographic views, such as the side, front, or top, it is important to look at the perspective view panel to ensure correct and proper placement in 3D space. You may notice that the joints are not in the proper place and need to be repositioned. Repositioning the joints can be done by using the move, rotate, or scale tools.

Moving Joints (also Known as – Translating Joints)

The move tool – keyboard shortcut **(w)** – will move the selected joint and any joints below it in the hierarchy. If the selected joint is the first chain in the

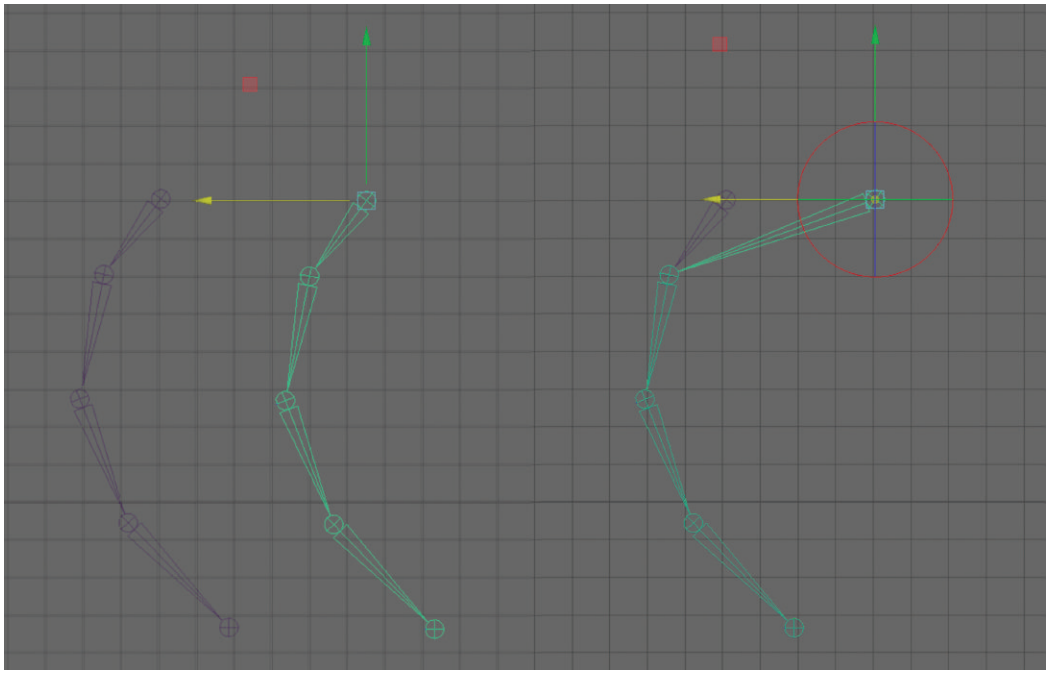

FIGURE 1.31 Moving a joint into place will also move any joints below it in the hierarchy (left), unless the move pivot mode is toggled on by pressing the *Insert* key (right).

hierarchy, then the entire chain will move. To move an individual joint, you must first **select** the move tool by **pressing (w)** and then **press** the **(insert)** key to toggle into the move pivot mode. The move pivot mode will allow you to move only the selected joint (Figure 1.31).

If you use the move tool to move joints into position, the local rotation axis of the translated joint stays at the orientation in which it was created. This means that it will no longer be aligned with the child joint. If you must move a joint, make sure to reorient the joints.

Rotating and Scaling Joints

The rotate tool – keyboard shortcut **(e)** – and the scale tool – keyboard shortcut **(r)** – can be used to rotate or scale a joint into place. If a joint is rotated or scaled, you MUST freeze transformations on the joint to reset rotation values back to zero and scale values back to one. To do this, **select** the top joint of the hierarchy and go to **[Modify > Freeze Transformations]** (Figure 1.32).

Translate values will not freeze on joints. There will always be a value in one or all translation channels for a joint. Maya must have translation

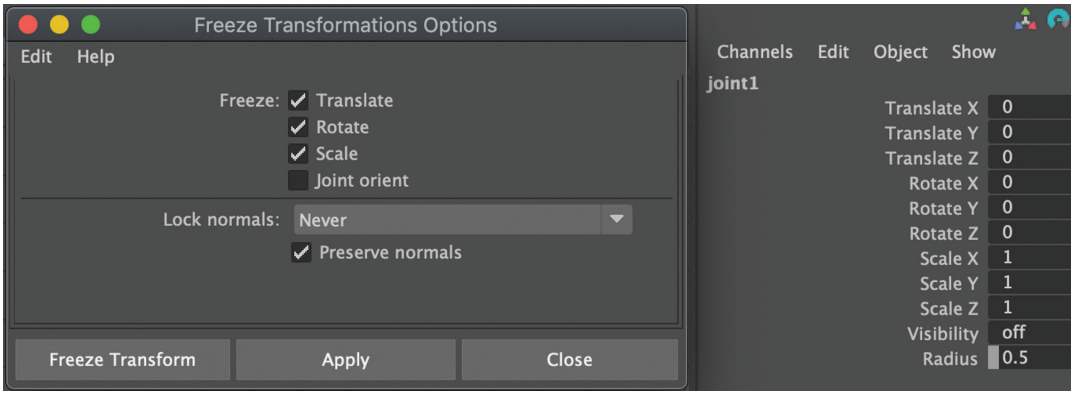

FIGURE 1.32 Rotating or scaling joints into place requires the Freeze Transformation command to reset the values to Rotate: 0 and Scale: 1. Joints always retain translation information.

FIGURE 1.33 Warning signs for non-zero rotations appear during the reorientation process if the joint's transformations have not been frozen.

values for a joint so that it knows where that joint is located in world space or in relation to its parent joint.

Reorienting Joints [Skeleton > Orient Joint □]

After you have finished placing your joints, I recommend displaying your local rotational axes and reorienting them if necessary. There will be special circumstances (such as the thumb joints) that will require rotating the local rotational axis into position. Also, if you used the move tool to reposition the joints into place, the local rotational axis of the translated joint is no longer aligned with its child. If you must move a joint, make sure to reorient them.

It is not necessary to reorient a joint if the entire joint chain was moved.

Remember, if you rotated a joint into place, you must first freeze transformation **[Modify > Freeze Transformations]** on that joint before you reorient. Omitting this step will result in an error message during some commands "Warning: Cannot perform joint orientation," and sometimes the joint will be skipped when trying to reorient (Figure 1.33).

To reorient a joint or joint chain, **select** the joint in object mode OR **select** the axis in component mode and go to **[Skeleton > Orient Joint □]**. UNCHECK □ Hierarchy to orient only one joint, or CHECK ☑ Hierarchy to orient that joint and ALL child joints (this option only affects the entire hierarchy in object mode; in component mode, you must **shift-select** each joint axis that needs to be reoriented). Choose the orient joint

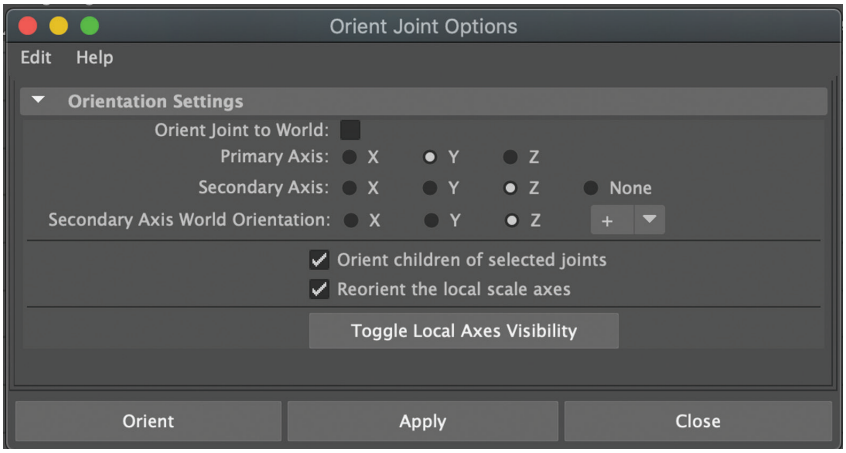

FIGURE 1.34 Orient joint OPTION BOX.

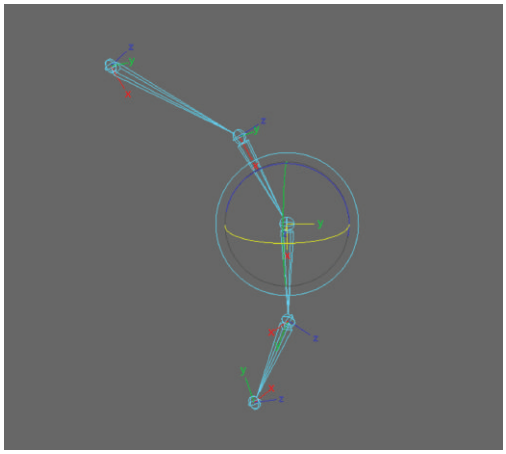

FIGURE 1.35 Manual rotation of a joint's Local Rotation Axis is possible for fine-tuning joint rotation.

options and then choose the second axis orientation. **Click Apply.** If you are in component mode, make sure to **press (F8)** to change back to object mode or **click** on the component mode button in the Status Line (Figure 1.34).

If necessary, you can manually rotate the local rotational axis into position when you are in component mode. **Select** the desired axis with the rotate tool by **pressing** the **(e)** and adjust in place. When finished, **press (F8)** to change back to object mode or **click** on the component mode button (Figure 1.35).

You can also change the rotational axis by **MEL** (Maya Embedded Language) command. In component mode, **select** the desired axis and **enter** in the Command Line the following command (change the numbers and axis as necessary)