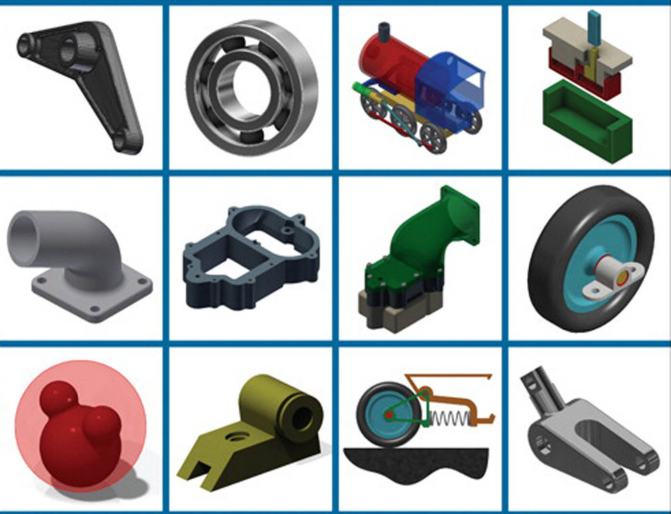
3D Printing with Autodesk

Create and Print 3D Objects with 123D, AutoCAD and Inventor



John Biehler
Bill Fane

que

FREE SAMPLE CHAPTER

SHARE WITH OTHERS

3D PRINTING WITH AUTODESK® 123D®

CREATE AND PRINT 3D OBJECTS WITH 123D, AUTOCAD, AND INVENTOR

John Biehler
Bill Fane

que®

800 East 96th Street,
Indianapolis, Indiana 46240 USA

3D PRINTING WITH AUTODESK® 123D®

Copyright © 2014 by Que Publishing

All rights reserved. No part of this book shall be reproduced, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without written permission from the publisher. No patent liability is assumed with respect to the use of the information contained herein. Although every precaution has been taken in the preparation of this book, the publisher and author assume no responsibility for errors or omissions. Nor is any liability assumed for damages resulting from the use of the information contained herein.

ISBN-13: 978-0-7897-5328-1
ISBN-10: 0-7897-5328-6

Library of Congress Control Number: 2014938539

Printed in the United States of America

First printing May 2014

Trademarks

All terms mentioned in this book that are known to be trademarks or service marks have been appropriately capitalized. Que Publishing cannot attest to the accuracy of this information. Use of a term in this book should not be regarded as affecting the validity of any trademark or service mark.

Autodesk, the Autodesk logo, 123D, and AutoCAD are registered trademarks or trademarks of Autodesk, Inc., and/or its subsidiaries and/or affiliates in the USA and/or other countries.

This book is independent of Autodesk, Inc., and is not authorized by, endorsed by, sponsored by, affiliated with, or otherwise approved by Autodesk, Inc.

Warning and Disclaimer

Every effort has been made to make this book as complete and as accurate as possible, but no warranty or fitness is implied. The information provided is on an "as is" basis. The authors and the publisher shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this book.

Special Sales

For information about buying this title in bulk quantities, or for special sales opportunities (which may include electronic versions; custom cover designs; and content particular to your business, training goals, marketing focus, or branding interests), please contact our corporate sales department at corpsales@pearsoned.com or (800) 382-3419.

For government sales inquiries, please contact governmentsales@pearsoned.com.

For questions about sales outside the U.S., please contact international@pearsoned.com.

Editor-in-Chief
Greg Wiegand

Executive Editor
Rick Kughen

Development Editor
Sondra Scott

Managing Editor
Sandra Schroeder

Project Editor
Seth Kerney

Copy Editor
Megan Wade-Taxter

Indexer
Lisa Stumpf

Proofreader
Kathy Ruiz

Technical Editor
Ralph Grabowski

Publishing Coordinator
Kristen Watterson

Cover and Interior Designer
Mark Shirar

Compositor
Mary Sudul

Contents at a Glance

PART I **GETTING STARTED WITH 3D PRINTING**

CHAPTER 1 The Rise of 3D Printing 1

CHAPTER 2 Basic Principles of 3D Printing 5

PART II **USING 123D IN A 3D PRINTING WORLD**

CHAPTER 3 123D Creature for iPad 25

CHAPTER 4 Creating 3D Objects with Cameras and 123D Catch 51

CHAPTER 5 Introducing 123D Design for iPad 63

CHAPTER 6 123D Design Exercises for iPad 87

CHAPTER 7 Workspace Basics of 123D Design for Mac and PC 107

CHAPTER 8 123D Design Exercises for Mac and PC 121

CHAPTER 9 Preparing 3D Models for Printing 151

PART III **3D PRINTING FOR AUTOCAD AND INVENTOR USERS**

CHAPTER 10 The Difference Between Surface and Solid Models 163

CHAPTER 11 Why and How to Use 3D Printing 173

CHAPTER 12 Designing Easy-to-Print Parts 185

CHAPTER 13 Designing Multipart Models to Print Preassembled 199

CHAPTER 14 Exporting Models to a 3D Printer 213

PART IV **EXPORTING MODELS TO THIRD-PARTY 3D PRINTING SERVICES**

CHAPTER 15 Using Inventor to Print Directly to Third-Party 3D Printing Services 229

CHAPTER 16 Using a Third-Party 3D Printing Service Bureau 241

CHAPTER 17 The Future of 3D Printing 253

Index 257

Table of Contents

Chapter 1 The Rise of 3D Printing 1

3D Printing Will Change the World 2

Chapter 2 Basic Principles of 3D Printing 5

How 3D Printing Works 5

Layered Approach to 3D Printing 5

Printing Time for Layers 17

A More Realistic 3D Printing Example 18

Two Basic Types of Printers 20

Deposition—Deposit This... 20

Fusion—Take This Material And Stick It... 20

Stacking Up: The Third Type of 3D Printing Process 21

Pros and Cons of 3D Printing Processes 21

Pros and Cons of Deposition Printers 21

Pros and Cons of Fusion Printers 24

Summary 24

Chapter 3 123D Creature for iPad 25

Creating a Creature 26

Adding Bones and Joints 30

Moving the Model 31

Sculpting Your Creature 32

Working with Control Options 34

Sharing Your Creature 45

Summary 50

Chapter 4 Creating 3D Objects with Cameras and 123D Catch 51

Photographing Objects 52

Correcting the Model 56

Orienting the Model 59

Repairing the Model 60

Summary 62

Chapter 5 Introducing 123D Design for iPad 63

123D Design Interface 65

Primitives Parts 66

Parts Kit Library 68
Rotate Tool 70
Scale Tool 70
Adjust 71
Combine Tools 74
Reshape Tools 76
Take a Picture Option 80
Object Editing Tools 80
Project/File Menu Options 82
Projects and Galleries 83
Additional Support 83
Saving to the Cloud 84
Camera View 85
Summary 85
Chapter 6 123D Design Exercises for iPad 87
Creating New Projects 87
Scaling and Smoothing Edges 91
Using the Chamfer Tool 94
Manipulating Existing Projects 96
Aligning the Model 100
Finishing the Model 103
Sending a File to a 3D Printer 105
Summary 106
Chapter 7 Workspace Basics of 123D Design for Mac and PC 107
123D Design Templates 108
Starting a New Project 109
Toolbar Controls 111
Menu Options 113
Summary 120
Chapter 8 123D Design Exercises for Mac and PC 121
Exercise: Create a Coffee Mug 122
Making the Mug Handle 129
Exercise: Create a Business Card Holder 140
Summary 149

Chapter 9 Preparing 3D Models for Printing 151
Code Used for Printing a 3D Model 152
Scale and Dimension 155
Manifold Geometry 156
Orientation 158
Adding Support Material 159
Place Good Side of Model Against Print Bed 160
Consider Print Orientation 160
Summary 161
Chapter 10 The Difference Between Surface and Solid Models 163
The Solid Facts About CAD 163
Animated 3D CAD Models 166
Show Me Some Skin Models 168
AutoCAD Versus Inventor 171
Summary 172
Chapter 11 Why and How to Use 3D Printing 173
What Can Possibly Go Wrong, Go Wrong, Go Wrong... 173
Using 3D Prototypes to Verify Designs 176
Manufacturing Small Quantities with 3D Printing 181
Creating Metal Parts with 3D Printing 182
Allowing for Shrinkage 183
Using 3D Printing for Large Parts 184
Summary 184
Chapter 12 Designing Easy-to-Print Parts 185
Design Versus Make—Know the Process 185
We Can Do This the Hard Way... 187
...Or We Can Do This the Easy Way 189
Helpful Hints to Minimize Problems 191
Size of the Little Details Matters 192
No Visible Means of Support 192
Fusion-Type Printers 194
Deposition-Type Printers 194
Creating Usable 3D-Printable Threads 196
Solutions to 3D Printing Large Objects 197
Summary 198

Chapter 13 Designing Multipart Models to Print Preassembled 199

Effects of Printer Resolution on Parts 199

Using Derived Part Functionality 200

Resolving Interference Problems 203

Problems Unique to AutoCAD 203

Issues with Ball and Roller Bearings 203

Ball and Bearing Solutions 205

Considerations Before Using 3D Printing for Parts 208

When Not to Use 3D Printing 209

Summary 211

Chapter 14 Exporting Models to a 3D Printer 213

Exporting STL Files 213

Using Inventor to Export Files 213

Using AutoCAD to Export Files 215

Scale 216

Optional Extras 217

Resolution Setting Options 219

Assemblies as Separate Files Option 219

Viewing STL Parts 220

Inventor 2013 Users, Do NOT Try This at Home 220

Inventor 2014's Own File Naming Quirk 221

Using STL Files to Translate CAD Models 222

Something Completely Nerdy 222

The STL File Format Explained 222

The Three Sides of STL Files 224

G-Code Used to Send STL Files 225

Summary 227

Chapter 15 Using Inventor to Print Directly to Third-Party 3D Printing Services 229

Connecting to a Third-Party Print Service 229

Options for 3D Printing 232

More Inventor STL Export Options 232

3D Print Preview Button Bar Options 234

Using the Assembly One File Option 237

Summary 239

Chapter 16 Using a Third-Party 3D Printing Service Bureau 241

Reasons to Use a Third-Party Service Bureau 241

Capability of Service Bureau Machines 242

Players in the Third-Party Service Arena 242

Uploading 3D Projects to Third-Party Services 242

Ordering a 3D Print 242

Using the Edit Details Tab 247

Pricing and Materials Options 249

Checkout Options 252

Summary 252

Chapter 17 The Future of 3D Printing 253

The Future According to Bill 253

The Future According to John 255

Index 257

About the Authors

John Biehler has been writing online about technology since 1999. An avid photographer and generally curious geek, he discovered 3D printing a number of years ago and built his first 3D printer shortly thereafter. Since then, he has been actively sharing his knowledge about the technology with thousands of people at various events and conferences in Western Canada and the Pacific Northwest, on television and radio, as well as online through his website. He cofounded a Vancouver-area group of 3D printer builders and enthusiasts that has grown exponentially since it started and as the technology heads toward the mainstream.

Bill Fane was a product engineer and then product engineering manager for Weiser Lock in Vancouver, British Columbia, for 27 years and holds 12 U.S. patents. He has been using AutoCAD for design work since Version 2.17g (1986) and Inventor since version 1.0 beta (1996). He is a retired Professional Engineer and an Autodesk Authorized Training Centre (ATC) certified instructor. He began teaching mechanical design in 1996 at the British Columbia Institute of Technology (BCIT) in Vancouver, including such courses as AutoCAD, Mechanical Desktop, Inventor, SolidWorks, machine design, term projects, manufacturing processes, and design procedures. He retired from this position in 2008. He has lectured on a wide range of AutoCAD and Inventor subjects at Autodesk University since 1995 and at Destination Desktop since 2003. He was the AUGI CAD Camp National Team instructor for the manufacturing track. He has written more than 220 "The Learning Curve" AutoCAD tutorial columns for *CADalyst* magazine since 1986. He is the current author of the book *AutoCAD for Dummies*. He also writes software product reviews for *CADalyst*, *Design Product News*, and *Machine Design*. He is an active member of the Vancouver AutoCAD Users Society, "the world's oldest and most dangerous." In his spare time he skis, water skis, windsurfs, scuba dives, sails a Hobie Cat, rides an off-road motorcycle, drives his '37 Rolls Royce limousine or his wife's '89 Bentley Turbo R, travels extensively with his wife, and plays with his grandchildren.

Dedication

John Biehler: I want to dedicate this book to Kelli Smith, who watched patiently as I built my first 3D printer on my dining room table and has supported my efforts in 3D printing ever since my first printed object came off the printer.

Bill Fane: To my wife Bev, who still manages to tolerate me after being married for 48 years.

Acknowledgments

John Biehler: I want to acknowledge and thank friends and members of 3D604.org, the Vancouver Hackspace, and Metrix Create:Space in Seattle. Without their help, friendship, and willingness to share their knowledge, my participation in this book would not have been possible.

We Want to Hear from You!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

We welcome your comments. You can email or write to let us know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that we cannot help you with technical problems related to the topic of this book.

When you write, please be sure to include this book's title and author as well as your name and email address. We will carefully review your comments and share them with the author and editors who worked on the book.

Email: feedback@quepublishing.com

Mail: Que Publishing
ATTN: Reader Feedback
800 East 96th Street
Indianapolis, IN 46240 USA

Reader Services

Visit our website and register this book at quepublishing.com/register for convenient access to any updates, downloads, or errata that might be available for this book.

This page intentionally left blank

4

Creating 3D Objects with Cameras and 123D Catch

Autodesk has a free service called 123D Catch that allows you to scan objects in 3D of just about anything, including people or buildings, using a regular digital camera—even with the one in your smartphone or tablet.

NOTE

You will need to set up an Autodesk account (it's free) before you can start. The process is quick and only requires a valid email address. It can be done via the application directly or via the website at http://123dapp.com.

There are a couple of ways to use 123D Catch. In this chapter, we cover the use of the iOS and web versions of the software. Both require that you take multiple photos of your object, from every angle possible. Then you submit those photos to the 123D servers either from within the Apple iOS app or via your browser.

NOTE

123D Catch is not currently available for Android devices but works with any mobile iOS device from Apple that has a camera such as an iPhone, iPad (see Figure 4.1), or iPod Touch.

The 123D website then processes those images and presents you a 3D model of the object. We go over some tips to ensure the best possible success in capturing your model.

FIGURE 4.1 Launching 123D Catch application on iPad.

NOTE

123D Catch doesn't require the use of an Apple device. You can use any camera and upload the photos using the website version of the application. The same tips apply when using your own camera. The iOS app just saves you the step of having to manually upload the photos.

Photographing Objects

Let's start with a handmade ceramic cactus that was purchased at a street market in Mexico about 20 years ago. The scanning process works best with objects that aren't shiny because reflections can cause problems while processing the model.

TIP

If you have an object with a shiny or reflective surface, you can apply something such as cornstarch, flour, or a similar powder to make that surface less reflective. The same applies if you are scanning people. Dark hair doesn't register as well as lighter hair. Applying a white powder (such as cornstarch) to dark hair will assist in bringing out the details in the model when scanning.

Using an iPad and the 123D Catch app, approximately 30 photos of the cactus were taken from every angle of it (see Figure 4.2).

NOTE

The 123D Catch app is free from the Apple App Store. Visit http://123Dapp.com/ for more information.

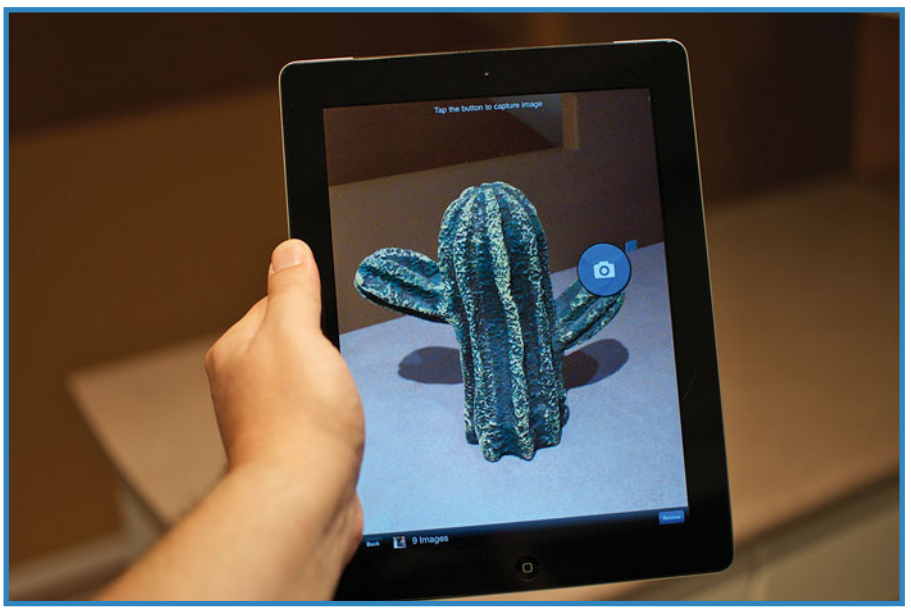


FIGURE 4.2 Using an iPad to photograph the cactus.

Start at one side of the object, and work your way around it, keeping the object fully in the frame, approximately the same distance for each photo. Alternatively, you can set up your camera in a fixed position and rotate the object you're photographing. It's better to have some overlap of the object in each photo than not because the software will figure out where to stitch the images together better.

TIP

Ideally, the background in the photos should be high contrast or complex compared to your object. Scanning a solid red object on a red table for example will lead to a poor scan. Simply using a sheet of (black-and-white) newspaper underneath your object can greatly improve your scanning results. This contrast helps the software separate your object from the background in the photos.

You can review what you've captured by pressing the Review button, as shown in Figure 4.3. You can delete images or retake specific angles if they didn't turn out simply by tapping on the photo.

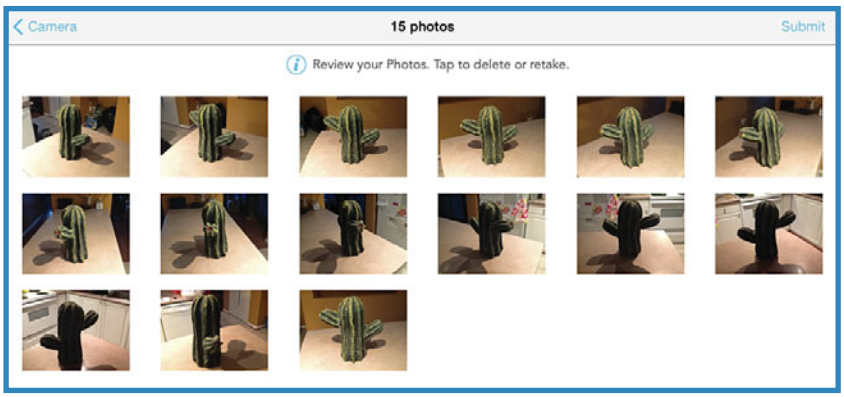


FIGURE 4.3 Gallery of captured images for review.

If you touch the screen on the iPad with one finger, you can rotate the model. Using two fingers at the same time, you can pinch and zoom to adjust your view of the model. The model also can appear upside-down depending on the orientation of the camera used to capture it.

When you're happy with the results, press the Finish Capture button, which takes you back to the Captures tab. Press the Tap to Process button to begin the process of uploading the photos to the Autodesk servers and begin converting the images into your 3D model.

NOTE

This process can vary in length depending on how busy the servers are and how complex your model is, but it usually takes only a few minutes.

When the software finished processing the model, it gave me the 3D model of the cactus (see Figure 4.4).

FIGURE 4.4 Reviewing the 3D model output from 123D Catch on the iPad.

FIGURE 4.5 Overhead view of 3D model.

Correcting the Model

There are a few issues with the model that need to be corrected; we walk through them here.

You'll notice that the top of the surface on which your object was sitting may also be included in the model. Shortly, we'll go through the steps to trim that off, leaving only the desired object behind as your 3D model.

After saving the model to your Autodesk account, you then can manipulate it further using the other Autodesk applications. We cover these in later chapters. Your model should appear in the Captures tab of 123D Catch on the iPad and in the My Projects section online after you log in to 123D Catch (see Figure 4.6).

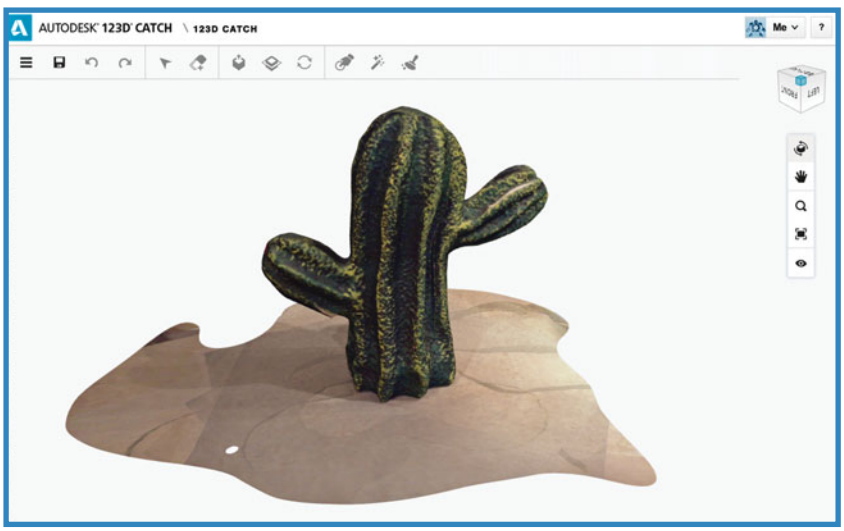


FIGURE 4.6 Reviewing the finished output 3D model of the cactus in the online version of 123D Catch.

As mentioned, the bottom of the model contains the surface on which the object was sitting when you captured the images. We're going to use the Plane Cut tool to trim off the bottom of the model, leaving behind only the cactus object, as shown in Figure 4.7.

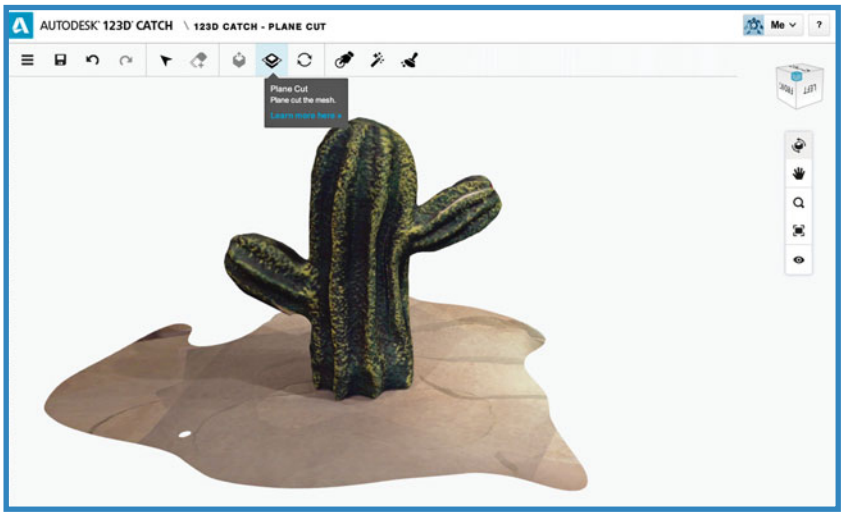


FIGURE 4.7 Plane Cut tool.

Select the Plane Cut tool from the toolbar. A set of controls should appear on your model with an arrow pointing along the Z axis. The bottom of this arrow represents the bottom of the model and direction the cut will occur. A circular control on both the X and Y axis lets you rotate the cutting surface and align it with the bottom of your model.

In Figure 4.8, the arrow is pointing down. It should be pointing up; otherwise the top of the cactus would get cut off. Click and drag your mouse on either the X or Y circle (below the purple line in Figure 4.8) to rotate the cut line. It should snap at the 45° and 90° positions to help with alignment.

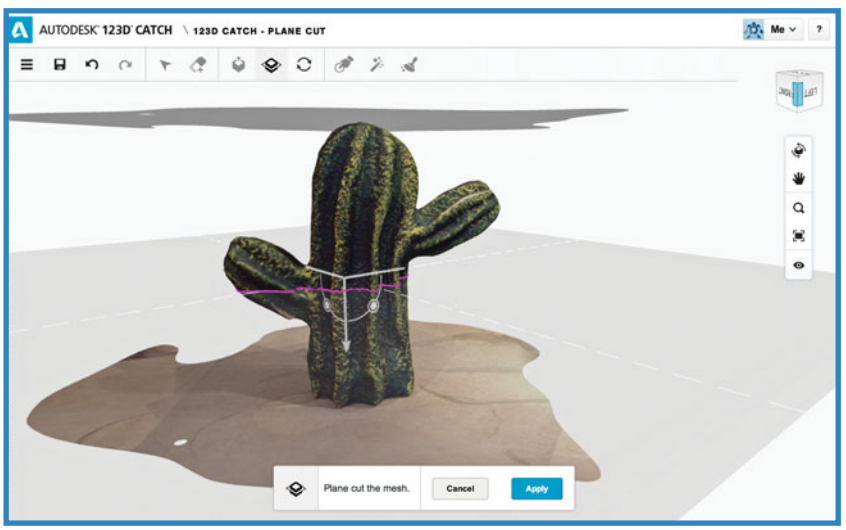


FIGURE 4.8 Ensure the arrow is pointing in the correct direction of the desired cut.

When the arrow is orientated correctly, you can then click and drag it to move the cutting plane up and down your model (see Figure 4.9). In this example, you want to see only the purple line along the bottom of the cactus which means that the cut will discard the countertop surface.

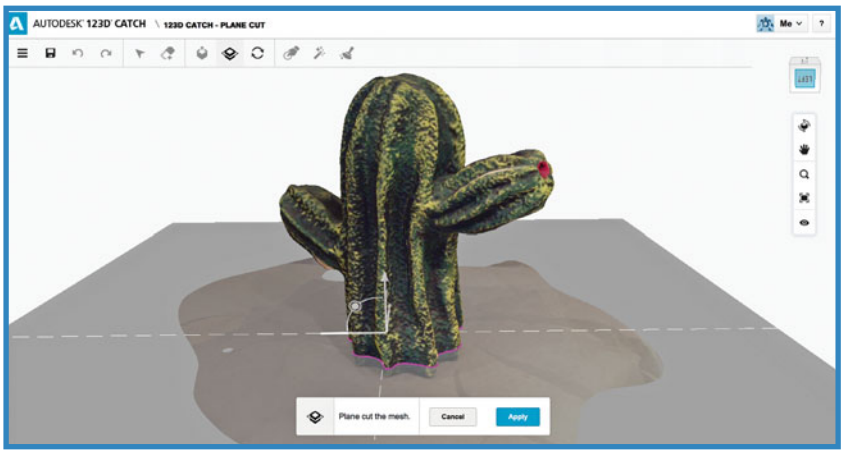


FIGURE 4.9 Moving the cutting plane.

Use the X- and Y-axis circles again to pivot the model along the plane until it's level. The purple line represents the new bottom of the model. Press the Apply button when you're happy with the position of the purple cutting line.

In Figure 4.10, you can see that the bottom of the model has been cut and the countertop surface has been removed from the model.

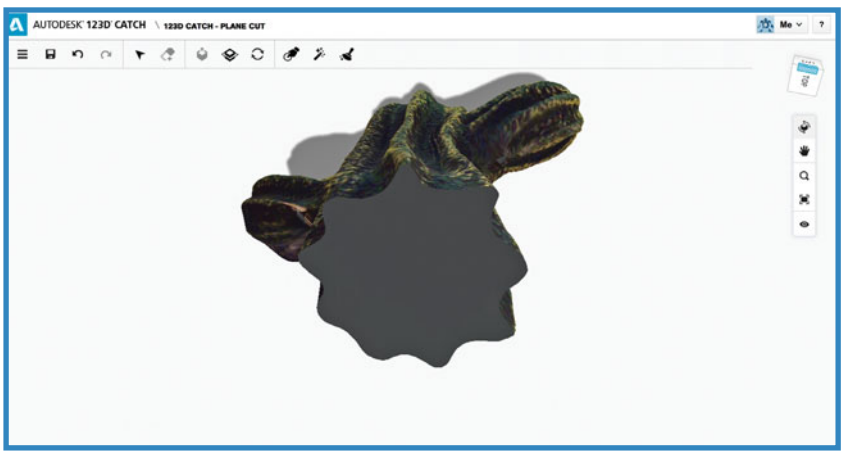


FIGURE 4.10 Cutting complete.

Orienting the Model

One last thing that you might need to do is orient the model so that it is upright for printing. You'll notice in Figure 4.11 that in the upper-right corner of the screen the orientation box is upside-down.

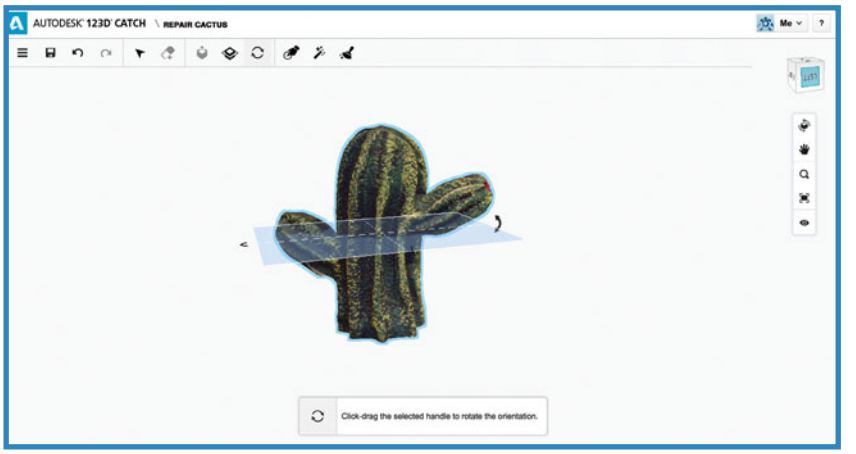


FIGURE 4.11 Orienting the model.

To correct this, press the Orientate button from the menu; a blue plane appears on the model. Clicking the arrow enables you to rotate the model and correct the orientation (see Figure 4.12). In this example you need to rotate the model 180°.

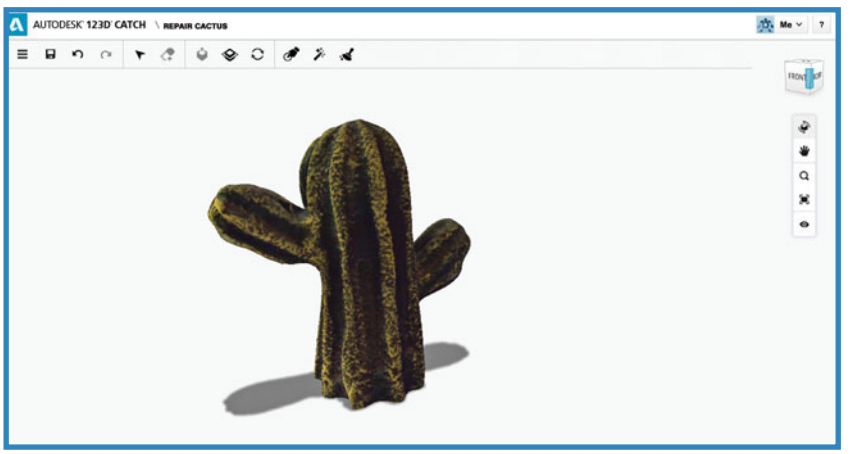


FIGURE 4.12 Model orientated correctly.

Note that the upper-right box is now upright. You'll need to save the model before you proceed to the next and final steps of repairing the model.

Repairing the Model

It's not uncommon for scans to result in some holes or rough spots due to the software misinterpreting your source photos. This can be caused by a number of reasons, but usually it's due to areas of the source object being in shadow or too similar to surrounding areas.

Fortunately, 123D Catch has some repair options included that will analyze the finished model. You can manually do some spot repairs to the model using the Smooth tool for rough areas and holes. Automatic repairs can be done using the Heal Mesh and Auto-Cleanup tools from the menu.

The Smooth tool is used to smooth out any rough points in the model that might not have been processed as accurately as desired. You can adjust the brush size using the slider on the bottom as well as the strength of the effect.

Start with small brush Size and low Strength; then work your way up (see Figure 4.13). You don't want to apply too strong of an effect because it will look obvious on the model. Also, be sure you rotate around the model to smooth all sides of the model.

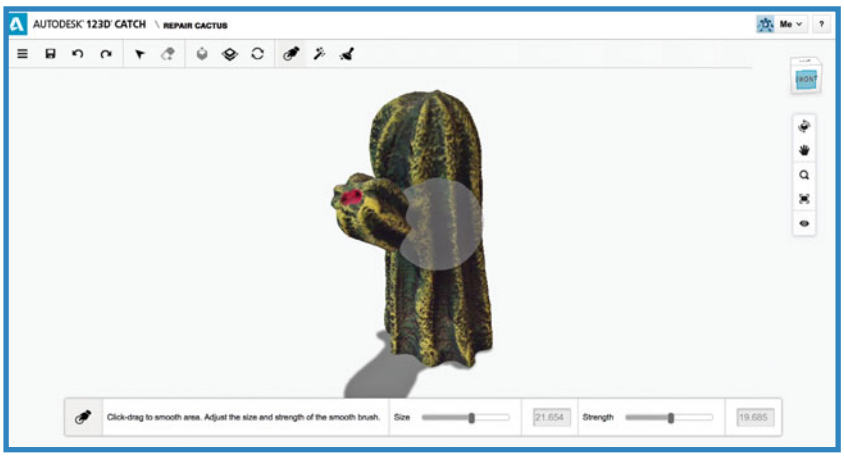


FIGURE 4.13 Smoothing the model.

The Heal Mesh tool detects any holes in the model and repairs them. Inspect the model after applying this to ensure it doesn't close openings that you intended to be open (see Figure 4.14).

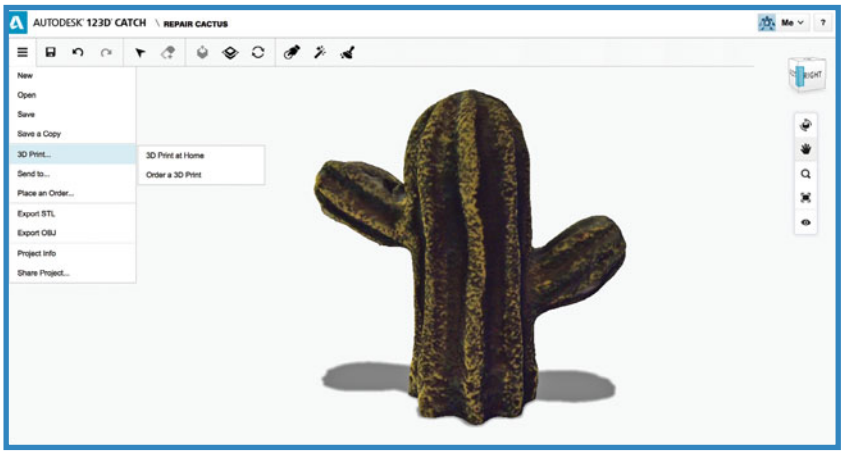


FIGURE 4.14 Getting ready to 3D print the model.

The Auto-Cleanup option magically fixes the model and removes any of the detached parts of the object. This is the last step you should apply. Again, inspect the model from all sides to ensure it didn't over-repair any parts of the model unnecessarily. Use the Undo option if you aren't happy with the results.

Finally, you can choose to preview the model for your 3D printer software or send it to a printing service (see Figure 4.15).

→ *For more information on how to send your model to a 3D printing service, go to Chapter 16, "Using a Third-Party 3D Printing Service Bureau."*

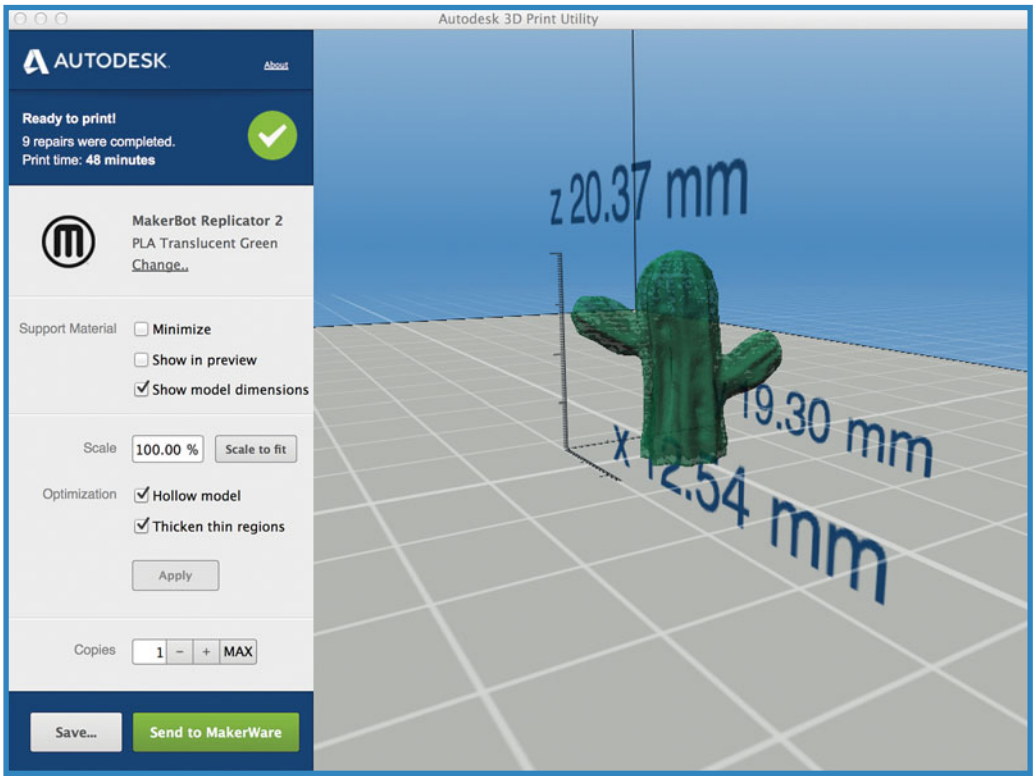


FIGURE 4.15 Autodesk Print Utility preview of the finished model for printing on a MakerBot.

Summary

In this chapter, we used an iPad to photograph a physical object and create a 3D model from those photographs. Then, using a number of built-in tools, we cleaned up and repaired the model, getting it ready to send to a 3D printer.

In the next chapter, we dive into creating models from scratch using your iPad and 123D Design.

Index

Symbols

3D CAD models
animated, 166-168
skin models, 168-171
surface models, 168-170
3D CAD solids, 163-166
3D models
code for printing, 152-155
orientation, 158-159
printing, placing good side of model against print bed, 160
3D-printable threads, creating, 196-197
3D printers, sending files to (123D Design for iPad), 105-106
3D printing, 5
considerations for parts, 208
future of, 2-3, 253-256
large objects, 197-198
large parts, 184
layered approach, 5-17
examples, 18-19
printing time, 17
metal parts, creating, 182-183
options in Inventor, 232
small quantities, 181-182
third-party service bureaus. *See* third-party service bureaus
when not to use, 209-210
3D Print Preview (Inventor), 233-234
button bar options, 234-237
3D prints, ordering from third-party services, 242-249
3D projects, uploading to third-party services, 242
ordering 3D prints, 242-249
3D prototypes
cost, 180
design verification, 176-180
123D Catch, 5
Android devices, 51
correcting models, 56-58
launching on iPad, 52
orienting models, 59
photographing objects, 52-54
repairing models, 60-61
123D Creature, 25
control options, 34-44
sharing your creature, 45-49
creating creatures, 26-27
adding bones and joints, 30-31
sculpting creatures, 32-33
moving models, 31
skeleton controls, 36
123D Design for iPad, 63-64
Chamfer tool, 94-96
creating new projects, 87-90
interface, 65-66
object editing tools, 80-81
Parts Kit Library, 68-80
Primitives, 66-68
manipulating existing projects, 96-100
aligning models, 100-103
finishing models, 103-105
Project/File menu, 82
additional support, 83

Camera view, 85
Projects and Galleries section, 83
saving to the cloud, 84
scaling and smoothing edges, 91-93
sending files to 3D printers, 105-106
123D Design for Mac and PC, 107
exercises
creating a business card holder, 140-148
creating a coffee mug, 122-129
creating a coffee mug, making the handle, 129-139
Gallery, 109
starting new projects, 109-111
menu options, 113-119
toolbar controls, 111-112
templates, 108-109

A

accounts, setting up, 51
adding
bones and joints to creatures, 30-31
support material when printing, 159-160
additive manufacturing, 181-182
aligning models, 123D Design for iPad, 100-103
Align tool, Parts Kit Library, 72
Android devices, 123D Catch, 51
animated 3D CAD models, 166-168
Assemblies as Separate Files, exporting STL files, 219-220
Assembly One File option, STL export options, 237-238
AutoCAD
interference problems, 203
versus Inventor, 171
STL files, exporting, 215-216
AutoCAD meshes, 170
Auto-Cleanup option, 61
Autodesk, 5
accounts, 51
Autodesk Print Utility preview, 62

B

backgrounds, 53
Bake Skeleton, 37
ball and roller bearings, interference problems, 203-206
BCIT (British Columbia Institute of Technology), 185
bones, adding to creatures, 30-31
British Columbia Institute of Technology (BCIT), 185
business card holders, creating with 123D Design for Mac and PC, 140-148

C

CAD models, translating with STL files, 222
CAD solids, 163-166
Camera view, Project/File menu (123D Design for iPad), 85
Chamfer tool, 76-77, 91, 143
123D Design for iPad, 94-96
checkout options, third-party services, 252
code for printing 3D models, 152-155
coffee mugs. *See* exercises
color change tool, Parts Kit Library, 79
Combine tool, 134
123D Design for Mac and PC, 116
Combine tools, Parts Kit Library, 74
combining objects, 134
Community creatures, 27
connecting to third-party print services, Inventor, 229-231
cons
of deposition printers, 21-24
of fusion printers, 24
Construct menu, 123D Design for Mac and PC, 115
control options, 123D Creature, 34-44
sharing your creature, 45-49

correcting models, 123D Catch, 56-58
cost, prototypes, 180
Creature News, 29
creatures, creating with 123D Creature, 26-27
adding bones and joints, 30-31
sculpting creatures, 32-33
cutting planes, moving, 58
cylinders, sizing, 122

D

deposition printers, 20
pros and cons, 21-24
support, 194
derived part functionality, 200-202
Design Accelerator functionality, 203
designing versus making, 185-191
design verification, 173
3D prototypes, 176-180
dimensions, 155-156

E

edges, scaling and smoothing (123D Design for iPad), 91-93
effects of printer resolution on parts, 199-200
derived part functionality, 200-202
errors, 173-176
design verification, 176-180
examples, layered approach to 3D printing, 18-19
exercises for 123D Design for Mac and PC
creating a business card holders, 140-148
creating a coffee mug, 122-129
making the handle, 129-139
exporting STL files, 213
Assemblies as Separate Files option, 219-220
with AutoCAD, 215-216
with Inventor, 213-215
Inventor options, 232-233
Inventor options, 3D Print Preview button bar options, 234-237
Inventor options, Assembly One File option, 237-238
optional extras, 217-218
resolution setting options, 219
scaling, 216

F

files
naming in Inventor 2014, 221
sending to 3D printers (123D Design for iPad), 105-106
Fillet tool, 76, 128
finishing models, 123D Design for iPad, 103-105
fusion printers, pros and cons, 24
fusion-type printers, support, 194
future of 3D printing, 253-256

G

Gallery, 123D Design for Mac and PC, 109
G-Code, sending STL files, 225-226
Gibson, William, 254
Grouping menu, 123D Design for Mac and PC, 116

H

hair width, 20
Heal Mesh tool, 60
hollow tool, 78
Hull, Charles, 1
human errors, 173-176
3D prototypes to verify designs, 176-180

I

i.materialize, 242
Information button, Parts Kit Library, 73
interfaces, 123D Design for iPad, 65-66
object editing tools, 80-81
Parts Kit Library, 68-80
Primitives, 66-68
interference problems
ball and roller bearings, 203-206
resolving, 203
Inventor
3D printing options, 232
3D Print Preview function, 233-234
versus AutoCAD, 171
connecting to third-party print services, 229-231
derived part functionality, 200-202
Design Accelerator functionality, 203
STL export options, 232-233
3D Print Preview button bar options, 234-237
Assembly One File option, 237-238
STL files
Assemblies as Separate Files, 219-220
exporting, 213-217
resolution setting options, 219
substituting parts, 207
threads, 196
Inventor 2013, viewing STL parts, 220
Inventor 2014, file naming, 221
iPad
123D Creature, 25
123D Design. *See* 123D Design for iPad,
launching, 123D Catch, 52

J

joining objects, 137
joints, adding to creatures, 30-31

L

large objects, printing, 197-198
large parts, printing, 184
launching 123D Catch on iPad, 52
layered approach to 3D printing, 5-17
examples, 18-19
printing time, 17
layered printing, 21
limbs, 31
listings
Sample G-Code Output with Configuration Settings for the Printer, 153
STL File Format Sample, 223
STL File Format Using General Number Format, 224

M

MakerBot Replicator 2, 151
MakerWare, adding support material, 159
manifold, 156-157
manipulating existing projects, 123D Design for iPad, 96-105
mass properties, rocker arms, 164
materials, third-party services, 249-251
Materials tool, 123D Design for Mac and PC, 118
measurements, metric, 155
Measure tool, 123D Design for Mac and PC, 117
menu options, 123D Design for Mac and PC, 113-119
meshes, AutoCAD, 170
metal parts, creating, 182-183
millimeters, 156
minimizing
printing problems, 191
resolution, 192
support, 192-196
reflection, 52

mistakes, 173-176
3D prototypes to verify designs, 176-180
models
aligning, 123D Design for iPad, 100-103
code for printing, 152-155
correcting, 123D Catch, 56-58
finishing, 123D Design for iPad, 103-105
moving, 123D Creature, 31
orientation, 158-159
orienting, 123D Catch, 59
printing
adding support material, 159-160
placing good side of model against print bed, 160
repairing, 123D Catch, 60-61
smoothing, 60
Modify menu, 123D Design for Mac and PC, 115
Move controls, 123D Design for Mac and PC, 112
moving
cutting planes, 58
models, 123D Creature, 31
My Projects, 123D Creature, 26

N

naming files, Inventor 2014, 221
Navigation Bar, 123D Design for Mac and PC, 119
non-manifold models, 157

O

object editing tools, 123D Design for iPad, 80-81
objects
combining, 134
joining, 137
photographing in 123D Catch, 52-54
scaling, 155-156
123D Design for Mac and PC, 111
One File per Part Instance, 238-239
ordering 3D prints from third-party services, 242-249
orientation, 158-159
adding support material, 159
considerations, 160
placing good side of model against print bed, 160
orienting models, 123D Catch, 59

P

paper thin, 20
parts, considerations before using 3D printing, 208
Parts Kit Library, 123D Design for iPad, 68-69
Align tool, 72
color change tool, 79
Combine tools, 74
Information button, 73
Push In/Out tool, 78
Reshape tools, 76
rotate tool, 70
Scale tool, 70
shell tool, 78
Snap tool, 71
Subtract tool, 75
Take a Picture option, 80
Pattern menu, 123D Design for Mac and PC, 115
photographing objects, 123D Catch, 52-54
Plane Cut tool, 57
Press/Pull tool, 93
pricing third-party services, 249-251
Primitives, 123D Design for iPad, 66-68
Primitives menu, 123D Design for Mac and PC, 113

printer resolution, 192
effects on parts, 199-200
derived part functionality, 200-202
printers
deposition printers, 20
pros and cons, 21-24
fusion printers, 20
pros and cons, 24
print failures, 161
printing. *See* also 3D printing
3D models
adding support material, 159-160
code for, 152-155
placing good side of model against print bed, 160
large objects, 197-198
large parts, 184
metal parts, 182-183
small quantities, 181-182
printing problems, minimizing, 191
resolution, 192
support, 192-196
printing time for layers, 17
print orientation. *See* orientation
problems, interference
ball and roller bearings, 203-206
resolving, 203
processes, design versus making, 185-191
Project and Galleries section, Project/File menu (123D Design for iPad), 83
Project/File menu, 123D Design for iPad, 82
additional support, 83
Camera view, 85
Project and Galleries section, 83
saving to the cloud, 84
projects
123D Design for Mac and PC, 109-111
menu options, 113-119
toolbar controls, 111-112
creating new with 123D Design for iPad, 87-90
manipulating, 123D Design for iPad, 96-105
pros
of deposition printers, 21-24
of fusion printers, 24
prototypes, 173
cost, 180
design verification, 176-180
Push In/Out tool, Parts Kit Library, 78

Q

quick start templates, 123D Design for Mac and PC, 108

R

reflection, minimizing, 52
repairing models, 123D Catch, 60-61
Repetier Host, 152
Reshape tools, Parts Kit Library, 76
resizing cylinders, 122
resolution
printing problems, 192
STL files, 235
resolving interference problems, 203
rocker arms, 165-166
mass properties, 164
rotate tool, Parts Kit Library, 70
rotating torus, 133

S

Save Copy As button, 239
saving to the cloud, Project/File menu (123D Design for iPad), 84
Scale control, 123D Design for Mac and PC, 112
Scale tool, Parts Kit Library, 70

scaling
edges, 123D Design for iPad, 91-93
objects, 155-156
123D Design for Mac and PC, 111
STL files for export, 216
Sculpteo, 242
ordering from, 50
sculpting creatures, 32-33
sending
files to 3D printers (123D Design for iPad), 105-106
STL files with G-Code, 225-226
Send to Print Service button, 239
Shapeways, 242-244
checkout options, 252
ordering 3D prints, 243-249
pricing and materials options, 249
sharing creatures, 45-49
shell tool, Parts Kit Library, 78
shrinkage, 183
simulations, 173
sizing cylinders, 122
skeleton controls, 123D Creature, 36
Sketch menu, 123D Design for Mac and PC, 114
skin models, 168-171
slicers, 152
slicing, third-party printing services, 155
slicing programs, 152
smoothing
edges, 123D Design for iPad, 91-93
models, 60
Snap tool
123D Design for Mac and PC, 117
Parts Kit Library, 71
stereolithography, 1
STL files
exporting, 213
Assemblies as Separate Files option, 219-220
with AutoCAD, 215-216
with Inventor, 213-215
optional extras, 217-218
scaling, 216
STL options, 219
export options (Inventor), 232-233
3D Print Preview button bar options, 234-237
Assembly One File option, 237-238
format explained, 222-224
sending with G-Code, 225-226
translating CAD models, 222
STL File Save As Options dialog box, 237
STL parts, viewing, 220-221
submenus, 123D Design for Mac and PC, 119
Subtract tool, Parts Kit Library, 75
support, printing problems, 192-196
support material, adding for printing, 159-160
surface models, 168-170

T

Take a Picture option, Parts Kit Library, 80
templates, 123D Design for Mac and PC, 108-109
third-party printing services
options for 3D printing, Inventor, 232
slicing, 155
third-party print services, connecting to (Inventor), 229-231
third-party service bureaus, reasons for using, 241-242
third-party services
checkout options, 252
pricing and material options, 249-251
uploading 3D projects, 242
ordering 3D prints, 242-249
threads, 200
3D-printable threads, creating, 196-197
toolbar controls, 123D Design for Mac and PC, 111-112

tools
Align tool, 72
Chamfer, 91, 143
Chamfer tool, 94-96
color change tool, 79
Combine tool, 116, 134
Combine tools, 74
Fillet tool, 128
Heal Mesh, 60
hollow tool, 78
Materials tool, 118
Measure tool, 117
object editing tools, 123D Design for iPad, 80-81
Plane Cut tool, 57
Press/Pull tool, 93
Push In/Out tool, 78
Reshape tools, 76
rotate tool, 70
Scale tool, 70
shell tool, 78
Snap tool, 71, 117
Subtract tool, 75
torus, rotating, 133
Transform controls, 123D Design for Mac and PC, 111
translating CAD models with STL files, 222

U

uploading 3D projects to third-party services, 242
ordering 3D prints, 242-249

V

verification, design. *See* design verification
View Cube, 123D Design for Mac and PC, 119
viewing STL parts, 220-221

W-X-Y-Z

watertight, 156-157