

## Companion Web Site

- Comprehensive tutorials
- Complete example models

Matt Lombard

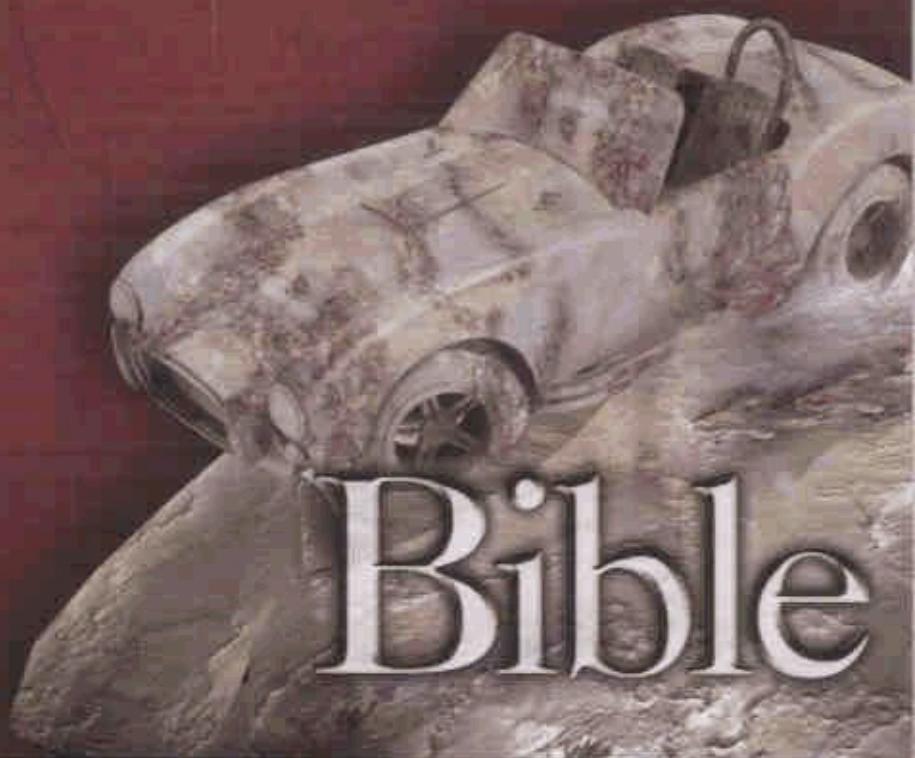
# SolidWorks<sup>®</sup>

## Surfacing and Complex Shape Modeling

Apply hybrid solid  
and surface techniques

Learn how to select  
features for shapes

Develop your own  
best practices



# Bible

The book you need to succeed!

# Contents

<b>Preface . . . . .</b>	<b>vii</b>
<b>Acknowledgments . . . . .</b>	<b>ix</b>
<b>Part I: Laying the Groundwork</b>	<b>1</b>
<b>Chapter 1: Understanding Basic Concepts . . . . .</b>	<b>3</b>
Assumed Basic Skills .....	4
Concepts, Tools, Techniques, and Strategies .....	5
Understanding the Difference Between Design and Modeling.....	6
Summary .....	7
<b>Chapter 2: Surfacing Primer . . . . .</b>	<b>9</b>
What are Surfaces? .....	9
Infinitely thin .....	10
Stand-alone faces .....	10
Surfacing: One Stop in the Evolution of CAD.....	11
Choosing Solids or Surfaces .....	13
Assessing strengths and weaknesses .....	13
How to choose .....	14
Surfacing Theory and Concepts .....	17
Algebraic and NURBS surfaces .....	17
Trimmed surfaces .....	20
Mesh and subdivision surfaces .....	22
Understanding Curvature Continuity .....	25
What causes edges? .....	25
Types of curvature transitions .....	27
Algebraic versus interpolated geometry .....	28
Summary .....	29
<b>Part II: Understanding the Tools</b>	<b>31</b>
<b>Chapter 3: Sketching with Splines . . . . .</b>	<b>33</b>
Why Splines? .....	34
Types of splines .....	34
Anatomy of a Spline .....	36

Tangency Handle .....	36
Control Polygon .....	38
Spline evaluation tools .....	38
Controlling Splines.....	41
Drawing splines .....	41
Fully Defining Spline Sketches .....	51
Tutorials .....	52
Tutorial 3.1: The S spline .....	52
Tutorial 3.2: Tracing shapes .....	53
Summary .....	54

## **Chapter 4: Sketching in 3D . . . . . 55**

Getting Started in a 3D Sketch .....	56
Using planes in a 3D sketch .....	56
Editing and Visualization Techniques .....	59
Using the Shift-Arrow technique.....	59
Using viewports .....	59
Working within the Limitations of 3D Sketches .....	61
Limitations in 3D sketches .....	61
Recently removed limitations .....	63
Using Special 3D Sketch Tools .....	64
Intersection Curve .....	64
Spline On Surface.....	66
Face Curves .....	68
Convert Entities .....	69
Tutorials .....	70
Tutorial 4.1: Fluorescent light bulb.....	70
Tutorial 4.2: Complex spring .....	72
Summary .....	74

## **Chapter 5: Creating Curves . . . . . 75**

Using the Helix/Spiral Feature .....	76
Helix feature options .....	76
Spiral options .....	77
Creating a Projected Curve .....	78
Sketch Onto Face .....	78
Sketch Onto Sketch .....	79
Curve Through Reference Points .....	80
Curve Through XYZ Points .....	81
Creating Composite Curves .....	82
Split Lines .....	82
Tutorial.....	83
Summary .....	86

<b>Chapter 6: Using the Primary Shape Creation Features . . . . .</b>	<b>87</b>
Choosing Which Feature to Use .....	87
Selecting a sweep .....	88
Selecting a loft .....	90
Selecting the Boundary surface .....	91
Selecting the Fill surface .....	95
Using Sweeps .....	97
Orientation and Twist Type options .....	99
Merge Tangent Faces .....	106
Show Preview .....	106
Merge Result.....	106
Align With End Faces.....	106
Guide curves .....	106
Thin Features and Solid Sweep.....	109
Start and end tangency .....	110
Using Lofts .....	111
Using loft profiles .....	112
Start and end constraints .....	114
Guide curves .....	114
Using the centerline parameters .....	115
Options .....	116
Right Mouse Button menu options .....	116
Using the Boundary Surface Feature .....	118
Using the Curve Selection boxes .....	119
Using connectors .....	121
Curves Influence Type .....	121
Options and preview .....	121
Display .....	122
Using the Fill Surface Feature .....	122
Edge settings .....	124
Summary .....	126
<b>Chapter 7: Using Advanced Fillets. . . . .</b>	<b>127</b>
Differentiating Fillet Functions .....	127
Arc-based fillets .....	128
Spline-based fillets .....	128
Using Fillet Options .....	129
Constant Radius fillet .....	129
Variable Radius fillet .....	132
Face fillet .....	133
Full Round fillet .....	138
FilletXpert .....	139

Fillet Best Practice Recommendations.....	141
Tutorial.....	142
Summary .....	146
<b>Chapter 8: Shelling . . . . .</b>	<b>147</b>
Thinking about the Manufacturing Process .....	147
Using Shelling Options.....	149
Removing faces.....	149
Multi-thickness shell .....	152
Shell Outward .....	153
Diagnosing Shell Problems .....	153
Error Diagnostics .....	153
The Check tool.....	154
Repairing the model .....	155
Shelling Manually.....	155
Tutorial.....	156
Tutorial: Troubleshooting and manual shelling .....	156
Summary .....	159
<b>Part III: Using Secondary, Management, and Evaluation Tools</b>	<b>161</b>
<b>Chapter 9: Using Secondary Shape Creation Features . . . . .</b>	<b>163</b>
Using the Dome and Shape Features .....	164
Similarities between the Dome and Shape features .....	165
Differences between the Dome and Shape features .....	165
Dome .....	166
Shape .....	167
Using the Indent Feature .....	168
Using the Radiate Surface .....	170
Using the Ruled Surface .....	172
Tutorial.....	174
Summary .....	181
<b>Chapter 10: Working with Hybrid Features. . . . .</b>	<b>183</b>
Moving Between Solids and Surfaces .....	184
The three faces of hybrid modeling.....	184
Modeling efficiency.....	186
Extruding to Surfaces .....	196
Lofting Between Surfaces .....	198
Using Thicken for Bosses and Cuts.....	200
Removing an edge between faces .....	201
Using sub-surfaces to thicken small areas .....	202
Thickening corners.....	202

Thickened cuts .....	203
Using Replace Face.....	204
Using Advanced Options of the Fill Surface .....	205
Merge Result.....	205
Merge Result and Try To Form Solid .....	206
Fill and Delete Face .....	206
Using the Wrap Feature .....	206
Wrap options .....	207
Wrap limitations .....	208
Tutorials .....	209
Tutorial 10.1: Plastic clip .....	209
Tutorial 10.2: Finial .....	211
Summary .....	213
<b>Chapter 11: Managing Surfaces . . . . .</b>	<b>215</b>
Copying, Merging, and Moving .....	215
Offset/Copy Surface .....	216
Knit .....	216
Move/Copy .....	217
Changing Boundaries .....	218
Trim .....	218
Untrim .....	220
Delete Hole .....	220
Extend .....	220
Tutorial.....	222
Summary .....	224
<b>Chapter 12: Using Direct Editing Tools . . . . .</b>	<b>225</b>
Using Move Face .....	226
Using Delete Face.....	228
Delete and Patch option .....	228
Delete option .....	230
Delete and Fill option .....	230
Using the Freeform Feature .....	231
Setting up the Freeform feature .....	232
Moving the points .....	234
Using Flex .....	236
Using Deform .....	238
Deforming Curve To Curve.....	238
Deforming using a point .....	239
Deforming with Surface Push .....	240
Tutorial.....	241
Summary .....	245

<b>Chapter 13: Managing Bodies . . . . .</b>	<b>247</b>
Organizing Bodies .....	247
Using body folders .....	248
Naming bodies .....	249
Visualizing Bodies .....	249
Hide and Show bodies .....	250
Isolate.....	250
Using colors and appearances.....	251
Combining and Moving Bodies .....	251
Combining solid bodies .....	252
Combining surface bodies .....	252
Moving bodies .....	253
Deleting Bodies .....	256
Tutorial.....	257
Summary .....	258
<b>Chapter 14: Evaluating Geometry . . . . .</b>	<b>259</b>
Using Model Quality Evaluation Methods .....	259
Verification On Rebuild .....	260
The Check tool.....	261
Feature Statistics.....	262
Using Shape and Continuity Evaluation Methods.....	263
Curvature Combs .....	263
Curvature display .....	264
Deviation Analysis .....	264
Zebra Stripes .....	265
Reflectivity/Specularity/RealView .....	267
Tangent Edge display .....	267
Face Curves .....	268
Using Plastics and Machining Evaluation Methods .....	268
Draft Analysis .....	269
Thickness Analysis .....	270
Undercut Analysis .....	271
DFM Analysis .....	272
Tutorial.....	273
Summary .....	276
<b>Part IV: Using Specialized Techniques</b>	<b>277</b>
<b>Chapter 15: Modeling a Ladle . . . . .</b>	<b>279</b>
Getting Started with a Complex Model.....	280
Mapping major shapes to features.....	281
Preparing the layout .....	281

Modeling from the Available Data.....	283
Modeling Area 1: the bowl .....	283
Modeling Area 2: transition .....	286
Modeling Area 3: handle.....	288
Modeling Area 4: the cap off.....	290
Using the SelectionManager .....	291
Tidying Up the Loose Ends .....	293
Summary .....	294
<b>Chapter 16: Modeling a Trowel . . . . .</b>	<b>295</b>
Modeling the Handle .....	296
Modeling the Scoop .....	305
Summary .....	313
<b>Chapter 17: Modeling Blends . . . . .</b>	<b>315</b>
Modeling a Plastic Cover .....	315
Tinkering with the Solid.....	322
Modeling a Stool Concept .....	325
Patching Bad Geometry .....	329
Summary .....	330
<b>Chapter 18: Modeling a Plastic Bottle. . . . .</b>	<b>331</b>
Laying Out the Task .....	332
Starting point affects results .....	332
Modeling scenarios .....	333
Modeling the unknown .....	333
Building the Model.....	334
Creating a Thread.....	343
Checking the Volume .....	346
Summary .....	348
<b>Chapter 19: Modeling Decorative Features . . . . .</b>	<b>349</b>
Modeling an Egg-and-Dart Pattern .....	350
Modeling the egg border.....	351
Modeling the egg .....	352
Modeling the dart .....	353
Comments on the construction.....	354
Modeling a Woven Pattern .....	354
Modeling a Flower-Trumpet Finial .....	358
Modeling a Fleur-de-Lis Decorative Piece .....	361
Building the first lobe .....	362
Building the second lobe .....	363
The belt .....	367
The base .....	367

Modeling a Scroll .....	369
Modeling a Botanical Shape .....	371
Summary .....	376
<b>Chapter 20: Modeling Overmolded Geometry . . . . .</b>	<b>377</b>
Understanding the Overmold Process .....	377
Modeling a Toothbrush .....	378
Summary .....	387
<b>Chapter 21: Working from Digitized Data . . . . .</b>	<b>389</b>
Creating an Orange Juice Bottle .....	390
Accessing point cloud data .....	392
Model an orange juice bottle from a scanned data reference .....	395
Creating a Cast Iron Skillet Handle.....	407
Summary .....	414
<b>Chapter 22: Using Master Model Techniques . . . . .</b>	<b>415</b>
Understanding Master Model Tools .....	415
Differentiating Multi-body Parts and Assemblies .....	417
Using Push Type Master Model Tools .....	418
Using the Split feature .....	418
Using the Save Bodies function.....	420
Using Pull Type Master Model Tools.....	421
Using Insert Part and Mirror Part .....	421
Using Insert Into New Part .....	423
Tutorial.....	423
Summary .....	427
<b>Chapter 23: Post-Processing Data . . . . .</b>	<b>429</b>
Presenting Ideas with PhotoWorks .....	429
Selecting where you are on the continuum .....	430
Investing time.....	430
Communicating with eDrawings .....	435
Choosing the appropriate format for your data.....	436
Applications for eDrawings.....	437
Finding the functionality .....	437
Using 3D Instant Website .....	438
Using PowerPoint as a Communication Tool .....	439
Rapid Prototyping .....	441
What about Fully Dimensioned Prints? .....	442
Summary .....	442
<b>Index . . . . .</b>	<b>443</b>