CONTENTS

Preface		xxxi
Acknowledgn	rents	xxxix
Chapter 1	Introduction	1
Chapter 2	Science of Geometry through the Ages	7
2.1 Pre-I	History and Ancient History	8
2.2 Medi	ieval History	16
2.3 Mode	ern History	19
2.4 Land	Survey	23
2.5 Units	s of Measurement	26
Chapter 3	Geometry, Creative Art, and Proportionalit	y 29
3.1 Geor	netry Components	30
3.2 Form	n, Fit, and Function	32
3.3 Design	gn Optimization	34
Chapter 4	Elements of Geometry	39
4.1 Axion	ns	41
4.2 Point	ts	43
4.3 Lines	S	43
4.4 Curv	es	44
4.5 Plane	es	44
4.6 Surfa	ices	45
4.7 Angle	es	46

4.8	Topology	47
4.9	Symmetry	47
4.10	Coordinate Systems	48
	4.10.1 Polar Coordinates	49
	4.10.2 Cylindrical Coordinates	49
	4.10.3 Spherical Coordinates	50
Chapte	er 5 Navigating Geometries	51
5.1	Geometry of the Earth	51
5.2	Navigating the Earth	54
	5.2.1 Latitude	. 55
	5.2.2 Longitude	. 56
	5.2.3 Azimuth	. 57
	5.2.4 Zenith	. 57
	5.2.5 Rhumb Line	. 57
	5.2.6 Variation	. 57
5.3	Vector Algebra	. 59
Chapte	er 6 Creating Geometry	63
6.1	MATLAB	67
6.2	Autodesk Inventor	. 77
6.3	Autodesk Revit	. 78
6.4	PTC Creo	. 78
6.5	CATIA	. 79
6.6	SolidWorks	. 80
6.7	Siemens NX	. 82
6.8	Solid Edge	. 82
Chapte	er 7 Importing Geometry into FEM Software	85
7.1	Geometry Importing	85
7.2	Geometry-FEM Compatibility	. 88
7.3	Multistage Geometry Analysis	. 89
7.4	Geometry Import into COMSOL Multiphysics	90
Chapte	er 8 Geometry Creation in COMSOL Multiphysics	93
8.1	Methods to Simplify Model Geometry	. 93
8.2	Setting Up a Model in COMSOL Multiphysics	. 97
8.3	One-Dimensional Geometry	105

8.4	Two-Dimensional Geometry	114
8.5	Three-Dimensional Geometry	116
8.6	Work Planes	120
Chapte	er 9 Extended Surfaces	125
9.1	Fin with Rectangular Cross Section	130
	9.1.1 One-Dimensional Fin Geometry	
	9.1.2 Two-Dimensional Fin Geometry	
	9.1.3 Three-Dimensional Fin Geometry	137
	9.1.4 3D Fin with Central Channel	142
9.2	Cylindrical Fin	146
	9.2.1 3D Cylindrical Fin with No Modifications	146
	9.2.2 3D Cylindrical Fin with Central Channel	150
	9.2.3 3D Cylindrical Fin with Finned Central Channel	155
9.3	Side-Rectangular Fin with Triangular Cross Section	159
9.4	Side-Triangular Fin with Rectangular Cross Section	163
9.5	Side-Concave Fin with Rectangular Cross Section	166
9.6	Side-Convex Fin with Rectangular Cross Section	168
9.7	Side-Concave-Trapezoidal Fin with Rectangular Cross Section	176
9.8	Pin Fin with Circular Cross Section	181
9.9	Radial Fin with Hyperbolic Profile	184
9.10	Webbed Radial Fin with Hyperbolic Profile	191
9.11	Rotini Fin—A Fin with a Twist	200
9.12	Comparison between the Fins	206
Chapte	er 10 Geometry Models and Applications	209
_	Overview of the Examples Provided	
10.2	Case Study 1—Geometry Model for 1D Fin	210
10.3	Case Study 2—Geometry Model for 2D Fin	211
10.4	Case Study 3—Geometry Model for 3D Fin	212
10.5	Case Study 4—3D Rectangular Cross Section Fin with Central Channel	213
10.6	Case Study 5—3D Cylindrical Fin	
	Case Study 8—3D Rectangular Fin with Triangular	
	Cross Section	216
10.8	Case Study 9—3D Fin with Rectangular Cross Section and	216

x • Geometry Creation and Import with COMSOL Multiphysics

10.9 Case Study 10—3D Fin with Rectangular Cross Section and Concave Side Profile	217
10.10 Case Study 11—3D Fin with Rectangular Cross Section and Convex Side Profile	218
10.11 Case Study 12—3D Fin with Rectangular Cross Section and Trapezoidal-Concave Side Profile	218
10.12 Case Study 13—3D Pin Fin with Circular Cross Section	219
10.13 Case Study 14—3D Radial Fin with Hyperbolic Profile	220
10.14 Case Study 15—3D Webbed Radial Fin with Hyperbolic Profile	220
10.15 Case Study 16—3D Rotini Fin	221
Chapter 11 Good Practices	223
Chapter 12 Lean Six Sigma Implementation	227
Chapter 13 Conclusion	233
Appendix MATLAB Code for Creating Golden Spiral Geometry	239
Bibliography	
Index	253