

# Contents

Preface . . . . .	ix
-------------------	----

---

## Part I The Physical Architecture

<b>1 CNC Machines . . . . .</b>	<b>3</b>
Common CNC Applications . . . . .	5
<b>2 Guide Systems . . . . .</b>	<b>23</b>
Round Rail . . . . .	26
Profile Rail . . . . .	27
V-Style Roller . . . . .	29
Hybrid Roller Guides . . . . .	32
<b>3 Transmission Systems . . . . .</b>	<b>33</b>
Screw and Nut . . . . .	35
Lead Screw and Nut . . . . .	38
Ball Screws . . . . .	41
Rotating Nut . . . . .	42
Rack and Pinion . . . . .	42
Reducers . . . . .	46
Timing Belt and Pulleys . . . . .	47
Constructing a Pulley-Reduction Unit . . . . .	49
<b>4 Motors . . . . .</b>	<b>55</b>
Stepper Motors . . . . .	57
Servo Motors . . . . .	61
Stepper versus Servo: Pros and Cons . . . . .	63
Encoders . . . . .	64

---

## Part II The CNC Controller

<b>5 Controller Hardware . . . . .</b>	<b>69</b>
Enclosure . . . . .	71
Breakout Board . . . . .	72
Drives . . . . .	75
Power Supply . . . . .	76
Adjunct Devices for Controller Hardware . . . . .	78
Pendant . . . . .	79
Wiring . . . . .	83

<b>6</b>	<b>Control Software</b> . . . . .	<b>85</b>
	Mach3 Control Software . . . . .	87
	Enhanced Machine Controller, Version 2 (EMC2) . . . . .	88
	A Foreword on Computer Operating Systems and Applications . . . . .	89
	G-Code Editors . . . . .	90
	G Code . . . . .	90

---

### **Part III Application Software**

<b>7</b>	<b>The Cartesian Coordinate System</b> . . . . .	<b>127</b>
	The Table or Mill Topology . . . . .	130
	Lathe/Rotary Topology . . . . .	131
<b>8</b>	<b>CAD and Graphics</b> . . . . .	<b>133</b>
	Raster to Vector Conversion Utilities . . . . .	137
	Difference between 2D and 3D . . . . .	138
	Listing of CAD Vendors . . . . .	138
	Graphics Programs . . . . .	140
<b>9</b>	<b>CAM Software</b> . . . . .	<b>141</b>
	Understanding and Using CAM . . . . .	144
	Generalized Milling Options . . . . .	151
	CAD and CAM Combination Software . . . . .	155

---

### **Part IV Building or Buying a CNC Machine**

<b>10</b>	<b>Choosing a Ready-Made CNC System</b> . . . . .	<b>159</b>
	Router/Plasma Table . . . . .	166
	Mills and Lathes . . . . .	167
	Do-It-Yourself (DIY) . . . . .	168
	Vendor Listing . . . . .	168
<b>11</b>	<b>Building Your Own CNC Plasma Table</b> . . . . .	<b>171</b>

---

### **Part V Appendices**

<b>A</b>	<b>Project Implementation and Examples</b> . . . . .	<b>187</b>
	Examples of Items that Can Be Produced on a CNC Router . . . . .	189
	Unlimited Possibilities . . . . .	218
	Programming Examples . . . . .	219
<b>B</b>	<b>Programming Examples in G Code</b> . . . . .	<b>225</b>
	Example 1 . . . . .	228
	Example 2 . . . . .	229

<b>C</b>	<b>Engineering Process of Selecting a Ball Screw . . . . .</b>	<b>231</b>
<b>D</b>	<b>NEMA Motor Mounting Templates . . . . .</b>	<b>247</b>
	<b>Index . . . . .</b>	<b>251</b>