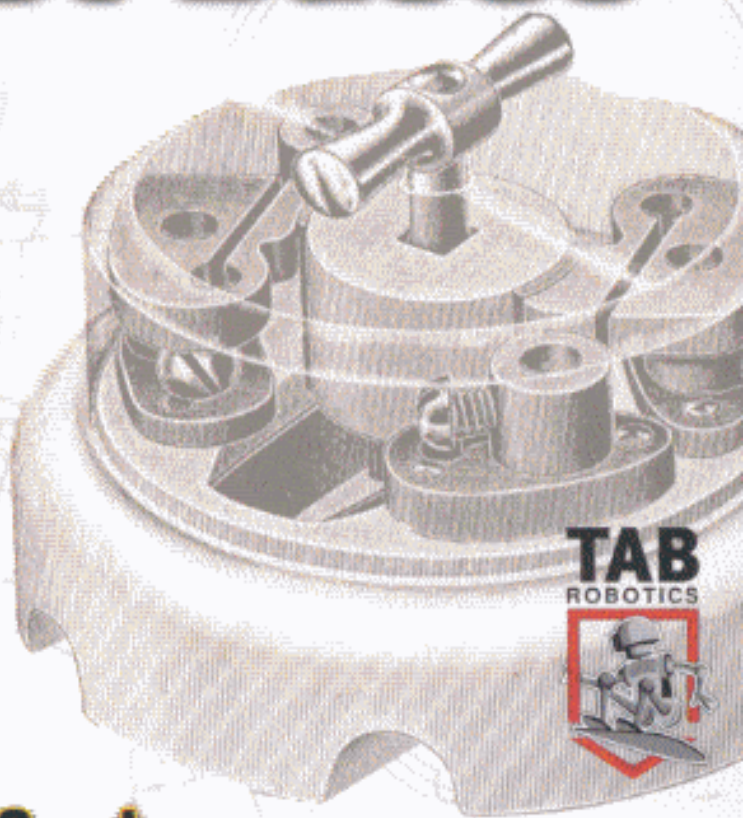


ROBOT DNA
SERIES



Constructing Robot Bases



TAB
ROBOTICS



Gordon McComb

CONTENTS

Introduction	xiii	
Acknowledgments	xvii	
Chapter 1	The Basics of Robot Bodies	1
Locomotion Systems		2
Wheels		2
Legs		4
Tracks		4
Comparing Locomotion Systems		5
Robot Shapes, Styles, and Sizes		6
Turtle or Desktop		7
Rover		7
Walking		8
Arms and Grippers		9
Android and Humanoid		9
Materials for Robot Building: An Introduction		10
Scratch-Build Using Metal, Plastic, Wood, and Composites		10
Choosing the Material		11
Adapt Build Using Manufactured Parts		16
Using Toy Parts for Building Robot Bases		17
Construction Toys		17
Scavenging Ready-Made Toys		22
Scavenging Dollar-Store Toys		25
Where to Get Stuff: Mail Order		26
Where to Get Stuff: Retail		28
Building a Robot from a Kit		29
Chapter 2	Robot Tool Crib	31
Basic Tools		32
Electronic Construction Tools		39
Specialty Hand Tools		42
Specialty Power Tools		47
Circular and Table Saw Types		53

Chapter 3	Robot Building Materials	57
	Material for Robot Bodies: An Overview	58
	Wood	59
	Best Types of Wood for Robotics	60
	Medium-Density Fiberboard	64
	Common Lumber Dimensions	65
	Rubber	66
	Polymer Clay	68
	Plastics	69
	Types of Plastics	71
	A Closer Look at Thermoplastics	73
	A Closer Look at Thermosetting Plastics	78
	Common Plastics Trade Names	79
	Common Plastics Acronyms	82
	Properties of Common Plastics	85
	Decoding Plastic ID Symbols	85
	The Joys of Rigid Expanded PVC	88
	The Case Against PVC	90
	Metal	92
	A Closer Look at Aluminum	94
	A Closer Look at Stainless Steel	96
	Heat Treatments for Metal	98
	Benefits of Galvanization	99
	WireForm Metal Mesh	99
	Sources for Metals	100
	Recap of Metals for Robotics	100
	Other Robot Building Materials	102
	Construction Foams	102
	Foam Board	102
	Art and Sign-Making Substrates	103
	Cardboard	104
	Substrate Sources	104
Chapter 4	Selecting and Using Adhesives	107
	Adhesive Setting and Curing	109
	Safety Concerns when Using Adhesives	110
	General Household Adhesives	111
	Binder Types	111
	Using Household Adhesives	113

Two-Part Epoxy Adhesives	114
Selecting and Using Two-Part Epoxies	115
Safety Tips for Epoxies	118
Acrylic Adhesives	119
Super Glue: The Good, the Bad, and the Sticky	119
Tips and Techniques for Successful Super-Duper Gluing	120
Hot-Melt Glue	121
Using the Hot-Glue Gun	122
Using Hot Melt as a Casting Material	124
3M Hot Glue Comparisons	125
Considerations for Hot-Melt Glue	126
Some Favorite Adhesives	127
Alternative Adhesive Dispensing	129
Glue Dots	129
Glue Stick	129
Adhesive Transfer Tapes	129
Aerosol Adhesives	130
Clamping and Taping	130
Using Joint Reinforcements	131
Joints with Molded Profiles	133
In Summary: Selecting an Adhesive	133

Chapter 5	Mechanical Construction Techniques	137
	Temporary Versus Permanent Construction	138
	Construction with Snap-Together Components	140
	Construction with Sticky Tapes, Ties, and Hook and Loop	141
	Sticky Tapes	142
	Hook and Loop	145
	Plastic Ties	146
	Hardy Construction Techniques	147
	Construction with Glue	147
	Construction with Soldering, Brazing, and Welding	148
	Construction with Mechanical Fasteners	148
	Producing Drill and Cut Layout Templates	148
	Layouts by Hand	148
	Layouts with Free and Low-Cost CAD Programs	150
	Rough-Cut Builds and Quick Protos	154
	Construction Process	155
	General Drilling Tips	156
	Tips for Drilling	158

General Sawing Tips	158
Tips for Sawing	160
Additional Methods for Cutting Materials	160
Metal Brakes and Shears	162
Using Portable Power Tools	162
Using Pneumatic Tools	164
Water and Oil	165
Air Pressure and Volume	165
Hoses and Connectors	166
Ear and Eye Protection	166
A Look at Desktop Mills and Lathes	166
Makers of Desktop Machinery	167
CNC Routers	169

Chapter 6	Robot Construction Hardware	173
	Fasteners	174
	Name Mix and Match	175
	Fastener Sizes	176
	Anatomy of a Machine Screw	178
	Fastener Head Styles	181
	Fastener Drive Styles	184
	Fastener Materials	185
	Customized Finishes	188
	Saving Money Buying Fasteners	188
	Stocking Up: Selecting Common Fastener Sizes	188
	Alternative Fasteners	189
	Brackets	190
	Zinc-Plated Steel Brackets	190
	Specialty Furniture Brackets	191
	Plastic Gusset Brackets	192
	Other Brackets	193
	Metal Stock at the Corner Hardware Store	193
	Extruded Aluminum and Steel	194
	Mending Plates	195
	Iron Angle Brackets	195
	Using Extrusions as Framing	196
	Using Extrusions as Brackets	196
	Even More Hardware Store Finds	197

Radio Control (RC) Model Parts and Components	198
Pushrods, Cables, and Linkages	198
Servo Horns and Bell Cranks	199
Dura Collars	199
Miscellaneous RC Airplane Hardware	200
Specialty Parts for RC Racing	201
Parts for Model Railroading	202

Chapter 7	Bases and Frames	203
	In Review: Selecting the Right Material	204
	Wood Bases and Framing	205
	Wood Robot Bases	206
	Wood Robot Frames	206
	Wood Finishing	207
	Plastic Bases and Framing	209
	Plastic Robot Bases	209
	Plastic Robot Frames	210
	Plastic Finishing	210
	Metal Bases and Frames	211
	Metal Robot Bases	212
	Metal Robot Frames	213
	Metal Finishing	213
	Aluminum Profiles	214
	Managing the Costs of Aluminum Profile	216
	Assembly with Connectors, Hinges, and Gussets	217
	Selected Sellers and Manufacturers of Machine Framing	217
	Alternatives to Extruded Machine Framing	219
	Plastic Extrusions	220
	Building Frames with Structural Shapes	220
	Experimenting with Cutless Metal Platform Designs	223
	Mini T-bot	224
	Going Further	225
	Working Tips	226
	Tips for General Safety	226
	Tips for Working with Wood	227
	Tips for Working with Expanded PVC	228
	Tips for Drilling and Cutting Acrylic	229
	Tips for Working with Metal	230

Chapter 8	Drive Geometries	231
	Choosing a Locomotion System	232
	Drive Arrangements of Wheeled Robots	232
	Holonomic Versus Nonholonomic Drive Systems	234
	Holonomic Bases	238
	Tracked	239
	Selecting a Drive Type	240
	Choosing Wheels	241
	Wheel Materials	242
	Wheel Diameter and Width	243
	Wheel Placement and Turning Circle	244
	Omnidirectional Wheels Go Your Way	244
	Support Casters and Skids	246
	Successful Use of Casters	250
	Selecting the Right Size of Caster	250
	One Caster or Two?	251
	Caster Wheel Material	253
	Best Bet: Skids and Casters	254
	Managing Weight	254
	Commonly Used Power-Transmission Components	256
	Flexible Linkages	260
	Rigid and Flexible Couplers	260
	Getting Geared Up	261
	Understanding Gears	262
	Gear Teeth	263
	Gear Reduction = Torque Increase	263
	Common Gear Specifications	264
Chapter 9	Batteries and Power Systems	265
	An Overview of Power Sources	266
	Chemical Makeup of Batteries	267
	Carbon-Zinc	267
	Alkaline	268
	Rechargeable Alkaline	268
	Nickel-Cadmium (NiCad)	269
	Nickel-metal Hydride (NiMH)	269
	Lithium-Ion (Li-Ion)	269
	Lithium	269
	Sealed Lead-Acid	270

Polymer	270
In Summary	271
Batteries at a Glance	272
Battery Voltage and Current	272
Mixing and Matching Battery Voltage	275
The Right Voltages for Your Robot	276
Single Battery, Multiple Voltages	276
Multiple Batteries, Multiple Voltages	277
Single Battery, Single Voltage	278
Common Battery Sizes	278
Using Ready-Made Rechargeable Battery Packs	279
Using Rechargeable Radio Control (RC) Battery Packs	280
Using Battery Holders	281
Single-Cell and Multicell Holders	281
Mounting Battery Holders to Your Robot	282
Snaps and Clips for 9-Volt Batteries	284
Comparing Plastic Battery Holders	284
Building and Using All-in-One Battery Packs	286
Best Battery Placement Practices	288
Best Wiring Practices	289

Chapter 10	Going Further	291
	Joining Metals by Welding, Brazing, and Soldering	292
	Welding Aluminum	294
	Welding Gas Safety	295
	Welding Plastics	295
	Casting in Plastic	296
	Create the Mold	297
	Create the Casting	297
	Playing the Waiting Game	298
	Safety and Respirator Masks	298
	Using Fiberglass Casting Tape	299
	Selecting the Right Plastic Casting Resin	299
	Hot and Cold Dipping Plastics	300
	Casting in Metal	301
	Dressing Up Your Robot	302
	Light-Emitting Diodes (LEDs)	303
	EL Wire	304

Color Anything with Water-Slide Decals	307
Using Transfer Films	308

Appendix A Resources	309
----------------------	-----

Appendix B Formulas and Specifications	321
--	-----

Index	339
-------	-----