BASIC ROBOT BUILDING

with

LEGO® Mindstorms® NXT 2.0

John Baichtal

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BASIC ROBOT BUILDING
with LEGO Mindstorms NXT 2.0

John Baichtal

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800 East 96th Street,
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Basic Robot Building with LEGO Mindstorms NXT 2.0

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About the Author

John Baichtal is a contributor to *MAKE* magazine and Wired's GeekDad blog. He is the co-author of *The Cult of LEGO* (No Starch) and author of *Hack This: 24 Incredible Hackerspace Projects from the DIY Movement* (Que). Most recently he wrote *Make: Lego and Arduino Projects for MAKE*, collaborating with Adam Wolf and Matthew Beckler. He lives in Minneapolis, Minnesota, with his wife and three children.

Dedication

This book is dedicated to my lovely wife Elise and my LEGO-obsessed kids. Sorry about all the robots cluttering up the house!

Acknowledgments

I'd like to thank my editor, Rick Kughen, and my frequent collaborator, Adam Wolf, for their help with this book.

We Want to Hear from You!

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Introduction

You're holding the most amazing building set in the world. Now what?

It can be a little intimidating, when faced with all those possibilities. Mindstorms has built up such a massive following that a veritable ecosystem has developed—modelmakers sharing their design files, programmers creating new blocks, and conventions gathering together builders from around the world. What could you do with all of that? The easy answer is, a lot. The more challenging question is, where do you begin in such a vast pool of knowledge? The aim of this book is to simplify the experience and make it easy and fun.

Basic Robot Building with LEGO Mindstorms NXT 2.0 shows you how to build three easy models, using only the parts found in a LEGO Mindstorms NXT 2.0 boxed set. Everything you need is in this book and your set!

How can we do projects with Mindstorms without knowing what's in the set? In Chapter 1, "Unboxing the LEGO Mindstorms NXT Set," I break down everything you get as we unbox the entire set.

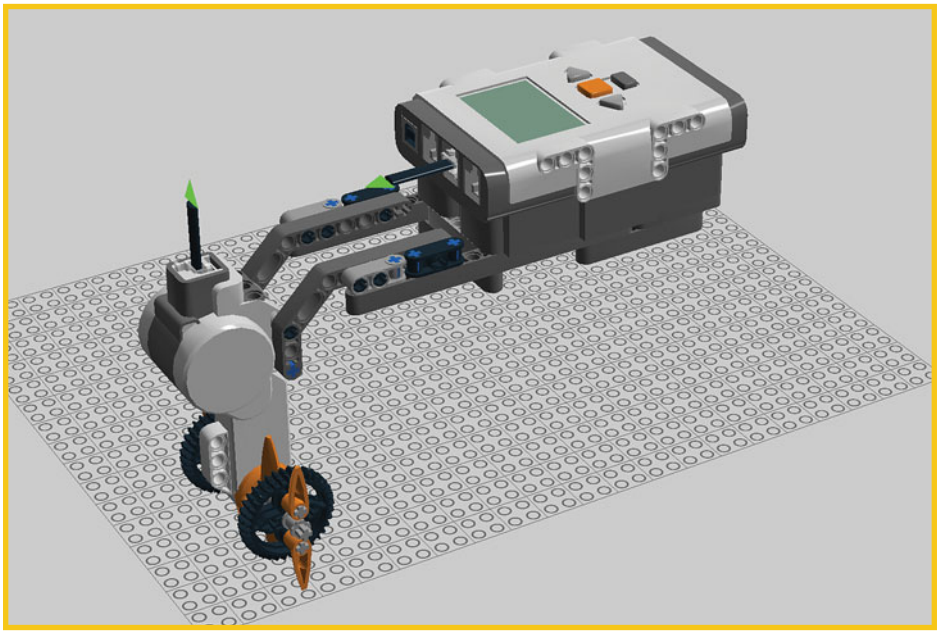

FIGURE I.1 Build the Backscratcher Bot and cure itchy backs forever!

In Chapter 2, "Project: Backscratcher Bot," we dive in the deep end of the LEGO pool as we build our first robot, a portable Backscratcher Bot (see Figure I.1) that needs no programming know-how to get working.

The most important element in the set is the NXT brick, a clever miniature computer that controls the motors and sensors and helps you turn a pile of plastic bricks into a robot. In Chapter 3, "Anatomy of the NXT Brick," we'll delve into the NXT and examine all of its capabilities and menus.

To reach the full potential of the NXT, however, we'll have to learn how to program it. In Chapter 4, "Introduction to Programming," we'll examine NXT-G, the Mindstorms programming environment, and write our first program.

Then it's time for our next robot! Chapter 5, "Project: Clothesline Cruiser," provides instructions on building the Clothesline Cruiser (see Figure I.2), a robot that travels via rope! We'll also program the robot to control its movements.

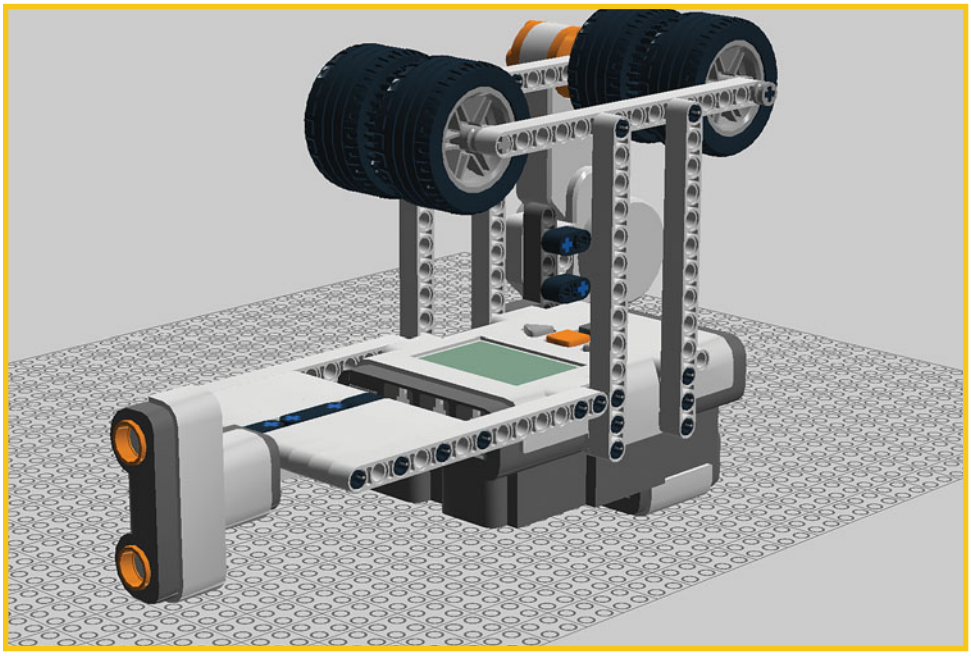

FIGURE I.2 The Clothesline Cruiser transports itself along a length of clothesline.

After we've got a couple of robots under our belts, we'll delve deeper into the mysteries of Mindstorms! Chapter 6, "Building Stronger Models," introduces you to advanced building techniques, offering tips on building stronger and smarter models.

Chapter 7, "Know Your Sensors," immerses you in the world of sensors, those electronic gadgets that plug into the NXT brick and send it data. You can use sensors to do everything from judging distance to detecting an object's color. Let's find out how they work and what they can do!

Chapter 8, "Advanced Programming," offers advanced programming techniques, introducing you to a bevy of concepts to help you make your robots even cooler!

We get to put these techniques to the test in Chapter 9, "Project: Rebounder," in which we build our third and final robot. The Rebounder (see Figure I.3) is miniature tank-treaded robot that rolls around blissfully, then rebounds when it bumps into something.

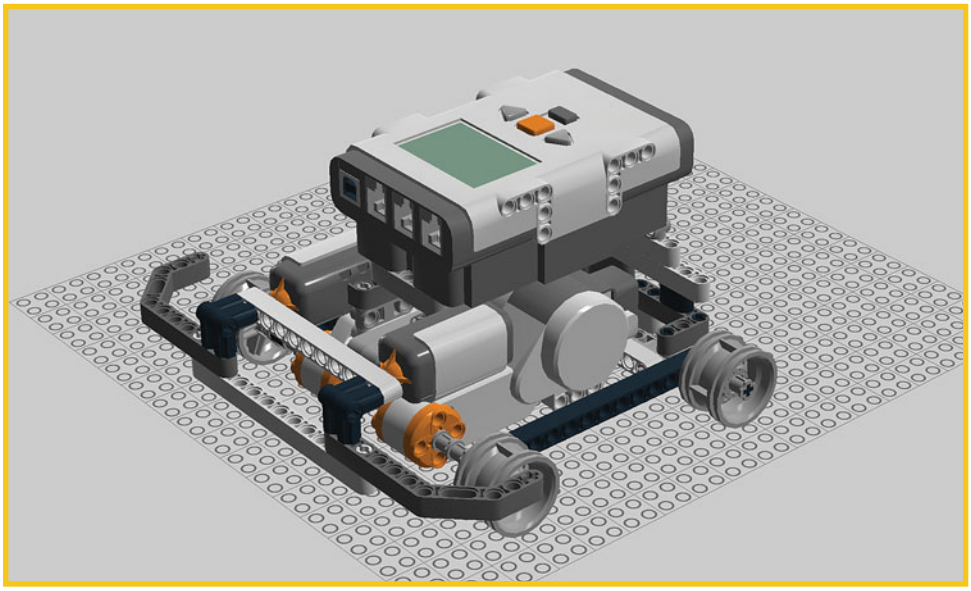

FIGURE I.3 The Rebounder is an autonomous robot that reacts to walls by moving away from them.

Finally, Chapter 10, "Expanding on Mindstorms," suggests some next steps for advancing your LEGO knowledge, as well as expanding your supply of parts. The Mindstorms ecosystem is vast, and I'll show you how to smartly expand your capabilities.

There you have it. Mastering LEGO Mindstorms is a rewarding journey that teaches you about everything from mechanical engineering to computer programming. Let's get started!

Conventions Used in This Book

I think this book should be fairly easy to figure out without much explanation from me, although there are a few teaching tools I use along the way that deserve some discussion here.

Special Elements

This book includes a few special elements that provide additional information not included in the basic text. These elements are designed to supplement the text to help you get up to speed with your LEGO Mindstorms NXT 2.0 quickly and easily.

TIP

A *tip* is a piece of advice that helps you accomplish a task—whether it be a hands-on building task or a programming chore—easily and with little to no heartache.

NOTE

A *note* is designed to provide information that is useful and/or interesting but not crucial for the task at hand. Notes often contain ancillary information that is good to know, but won't be crippling if you skip it.

CAUTION

A *caution* is the publishing equivalent of a big, red stop sign. When you see one of these, read it and do what it says! Failure to do so can have a variety of repercussions—all the way from a Mindstorms bot that doesn't work, to a potentially dangerous situation.

SIDEBAR

Some Extra Thoughts

Sidebars are where I've tucked information that is relevant, but slightly off-task or non-essential, such as juicy bits of background and behind-the-scenes info on LEGO Mindstorms.

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1

Unboxing the LEGO Mindstorms NXT Set

When you drooled over product photos on the Mindstorms box or dug through the parts inside, no doubt you found the breadth and complexity of the parts a little unnerving. Looking at all those LEGO beams and connectors can be a little intimidating, not knowing what they're for or how they fit together. In this chapter, we look at every part that comes with the set and talk a little about each one.

The Box

The LEGO Mindstorms NXT 2.0 box (see Figure 1.1) intrigues with all the cool possibilities you can imagine are inside, not the least of which are the great—albeit complex—models LEGO shows you how to make with the set. The headliner is Alpha Rex, the humanoid robot in the center of the box. There's a little science fiction in the rendering; the color sensor doesn't actually emit a visible beam of light, and the eyes, which are the ultrasonic sensor, don't actually light up.

FIGURE 1.1 The LEGO Mindstorms NXT 2.0 box.

Still, you can actually build the Alpha Rex, following the instructions contained in the Mindstorms software that came with the set.

NOTE

Alpha Rex Directions

I didn't include directions for building Alpha Rex in this book because instructions for building this bot are included with the set. Instead, I focused on building three bots that aren't detailed in the instructions. That means between this book and the instructions that came with the set, you now have details on how to build *seven different bots*!

Under the Flap

LEGO is really good about dressing up the box with tantalizing glimpses of the contents, all the better to get customers to reach for their wallet (see Figure 1.2). Looking at all those beautiful parts and robots displayed, how could you not buy the set?

FIGURE 1.2 This is 100% pure geeky goodness.

This great artwork is also educational, explaining the difference between the sensors and giving a brief intro on how programming works. What I found most exciting is the huge spread showing all the components that come with the set.

Opening the Box

Cracking open the box, you see a bunch of plastic bags of LEGO parts stuffed into the box (see Figure 1.3). You'll very quickly realize the Mindstorms box is probably not a container that you can use long term for storing your set, particularly if you use it a lot. While pretty, it's merely a cardboard box with no dividers or reinforcement, so it will get squashed very quickly.

FIGURE 1.3 From "wow" to "ho-hum," the inside of the Mindstorms box is, well, just a box.

The Contents

Next, let's dump out everything inside the box (see Figure 1.4). Look at all this cool stuff! The plastic bags hold the LEGO beams and connectors, and the white cardboard boxes hold the NXT brick and the sensors, motors, and wires. When you look at the parts like this, it doesn't seem like a $280 set, but when you start building cool robots, you'll think differently.

FIGURE 1.4 Mindstorms parts—just add imagination.

WHAT YOU DON'T GET WITH THE SET

There is a lot of cool stuff that LEGO has not seen fit to include in the set. For instance, there is a huge variety of gears available that you'll never find in the basic Mindstorms set. You might also notice that the parts found in the set are fairly blah when it comes to color. Be sure to read Chapter 10, "Expanding on Mindstorms," in which I discuss where to find all sorts of parts to expand upon Mindstorms' possibilities.

Reading Material

Let's dive in! First, let's begin with the printed stuff that comes with the set, as shown in Figure 1.5. The Test Pad, on the left, is a poster-sized track that you can use with a rolling robot. It has a circuit that you can use to test a line-following robot, as well as color swatches to test its color sensor. The stickers are just for looks, obviously, and are used to dress up the four default models that LEGO suggests you make with the set. The *LEGO Mindstorms User Guide* offers basic instructions on how to build robots and program them, and the disc holds the software you need to do so. We talk more about the disc and its programs in Chapter 4, "Introduction to Programming."

FIGURE 1.5 The user guide and other materials included with the set.

Connector Pegs

In many ways, these little tubes—*connector pegs* in LEGO parlance—are the glue that holds your robot together (see Figure 1.6). The pegs connect two LEGO elements via their holes, and you'll use them all the time. Interestingly, the black and gray pegs are nearly identical and in many cases can be used interchangeably. The critical difference between the two is that the black pegs have little ridges on them that add friction, to reduce the tendency of a single peg to rotate on its own. By contrast, the gray pegs are smooth and can be used as axles. You get 88 black pegs with your set and 6 gray ones.

NOTE

Your Mileage May Vary

You might get a different number of parts than what I detail here. For example, I got seven gray connector pegs in my set. Even LEGO's vaunted quality control messes up sometimes!

FIGURE 1.6 Black and gray connector pegs are the backbone of your Mindstorms set.

3M Connector Pegs

More pegs! The big ones shown in Figure 1.7, called *3M connector pegs,* are a lot like the black and gray ones in Figure 1.6, but they extend three standard LEGO thicknesses. In LEGO parlance, this is referred to as *3M*—the thickness of three regular LEGO beams stacked atop each other.

TIP

M Refers to Length, Too

Here, the M number refers to the *length* of an element, so a 3M connector peg is the same length as three beams stacked on top of each other.

The blue pegs have friction ridges, whereas the beige ones do not. The set includes 52 blue pegs and 6 beige ones.

FIGURE 1.7 The longer connectors are delineated by both color and presence (or lack thereof) of friction ridges.

Connector Pegs with Bushing

The next type of peg is rather interesting. You may not use them all of the time, but when you need them you'll totally be grateful to have them. They're basically two-thickness pegs, but have a cross-axle bushing on the end (see Figure 1.8). This is a special connector that accommodates Mindstorms' cross axles, so you could use one to anchor the hub of a wheel, for instance. Another great use of the part is as an easily removable peg. Say you want to keep a moving part of your robot from moving; you could temporarily block the motion with one of these pegs, leaving the big part—the bushing— sticking out so you can easily grab and remove it when you're ready. You get 10 of these in the set.

FIGURE 1.8 These connectors combine a peg with a bushing!

Connector Pegs with Cross-Axle Ends

You might have figured out by now that the Mindstorms set comes with lots of types of pegs! Figure 1.9 shows even more pegs; these pegs have a regular connector on one side and a cross connector on the other. In this book I call those *cross connectors*. You'll find yourself using these almost as much as the black ones previously shown in Figure 1.6. They're important because some LEGO beams have cross-axle holes as well as the regular round kind. As with the 3M pegs previously shown in Figure 1.7, the blue color signifies that those pegs have friction ridges, whereas the beige ones do not. The cross-axle portion is the same for both types. You'll find 24 blue pegs of this type in the set, along with 4 beige ones.

FIGURE 1.9 These pegs allow you to join two elements, one with a Technic hole and one with a cross hole.

2M Axle Peg

The 2M axle peg shown in Figure 1.10 is another commonplace one and is essentially like the ones previously shown in Figure 1.9, but these pegs are all cross axle. The 2M axle pegs are two standard LEGO thicknesses long. Nine of them come in the box.

TIP

Extricating a 2M Axle Peg

The 2M axle pegs have a tendency to get "lost" when you use them to hold two beams together. To remove one of these pegs, poke the end with a cross axle to push it out.

FIGURE 1.10 2M axle pegs.

Connector Peg with Towball

Next comes the connector peg with towball. These pegs are typically used as an end-stop for some sort of movement. If you need a LEGO part sticking out to make sure your robot's range of movement is limited, you'll want one of these pegs. Another use is as a holder for a rubber band. Say you want to have a hinged piece held taut to keep it from flapping around. Simply attach one of these pegs to each side and loop a rubber band around the towball (see the Alpha Rex's hands on the cover of your box). As you can see from Figure 1.11, the gray ones have a cross-axle connector, and the black ones have a smooth connector. You get 10 black pegs and 2 gray ones.

FIGURE 1.11 If you've ever used a ball hitch to tow a boat or trailer, these connectors will look quite familiar to you.

1/2 Connector Pegs

The final type of peg you'll find in the set is the 1/2 connector peg, shown in Figure 1.12. Just three of these pegs are included in the set. They look a lot like half of a gray connector peg. Pure and simple, these pegs provide a way of turning a beam's hole into a standard LEGO stud. You insert the long end into a hole, leaving the stud sticking out, allowing you to attach a regular LEGO brick to the stud. The connection isn't strong, and it is typically used more for cosmetic purposes than structural ones.

FIGURE 1.12 Use these pegs to transform a Technic hole into a LEGO stud.

Bushings

Next, let's look at *bushings*, which are little tubes that secure the ends of cross axles. You'll use them for pretty much every Mindstorms model you'll ever make (see Figure 1.13). Bushings come in two flavors: bushings and half bushings. The former are one LEGO thickness, and the half bushings are half as thick. With bushings, unlike most of the parts you'll find in the set, LEGO doesn't differentiate the two types with different colors, although you'll often find half bushings in bright yellow in different sets. There are 11 bushings and 9 half bushings in the Mindstorms set.

FIGURE 1.13 Bushings are an integral part of nearly any Mindstorms model you create.

Cross Axles

Now, for the famous cross axles you've been hearing about so much. Cross axles, shown in Figure 1.14, are absolutely critical components of the Mindstorms set, used for everything from stabilizers securing multiple thicknesses of beam to, well, serving as axles for wheels. The set includes the following cross axles:

NOTE

M Stands for Thickness and Length

As we discussed earlier, the "M" refers to the width of a standard LEGO brick. So, 3M is equal to the width of three standard bricks lined up side by side. But wait! Mindstorms also uses the M measurement to indicate length, so the 7M cross axle is the same length as the width of seven beams.

- 12M axles—1
- 9M axles—2
- 7M axles—4
- 6M axles—2
- 5M axles—8
- 4M axles—4
- 3M axles—19

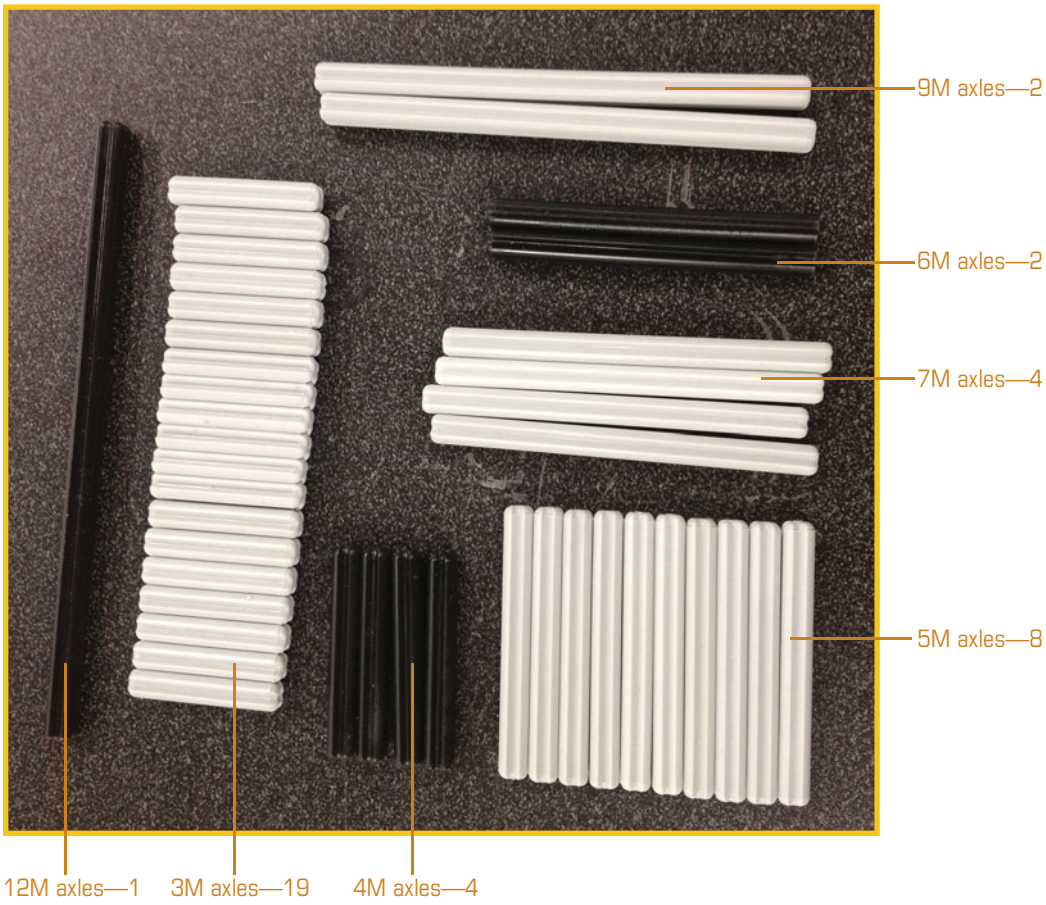

FIGURE 1.14 Cross axles are your new best friend.

Cross Axles with End Stops

The next piece is a variant of the cross axle, which features end stops so you don't have to use a bushing to keep parts from sliding off the end (see Figure 1.15). You'd be surprised how often this piece will come in handy! The set includes three different types of axles, and each features a different type of end stop. The set contains

- 3M cross axles—6
- 5M cross axles—2
- 8M cross axles—4

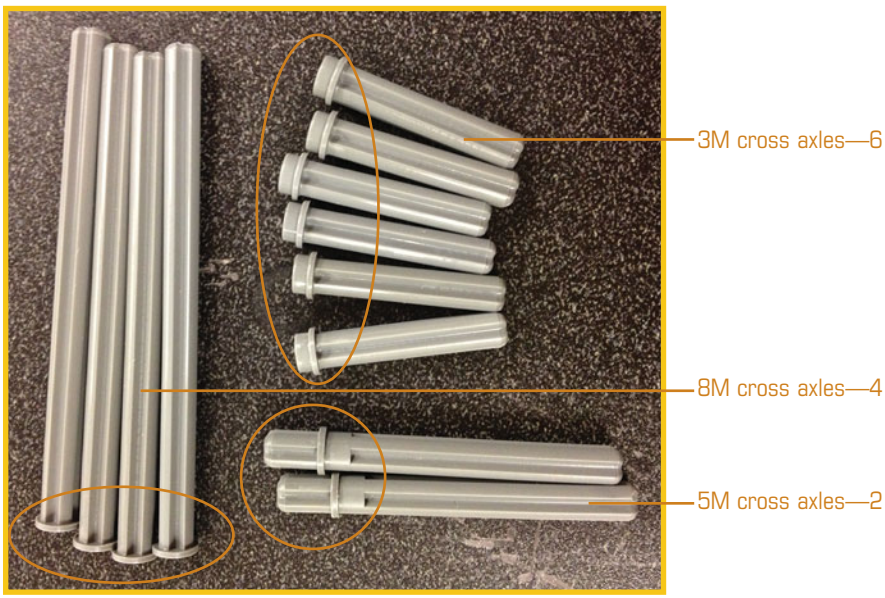

FIGURE 1.15 End stops on these axles eliminate the need for a bushing. Note that the end stops are circled in this photo.

Wheels and Treads

Wheels and treads come next (see Figure 1.16). The set contains four rims along with rubber tires. You also get two tank treads that are compatible with the rims.

FIGURE 1.16 Where the rubber meets the road.

Gears

My favorite parts of any LEGO set are the gears. I love figuring out how to mesh them together in a clever way. It is a bit disappointing, though, that LEGO includes a rather weak assortment of gears in the set (see Figure 1.17). You get a mere 11 gears:

- 36-tooth gears—2
- 20-tooth gears—2
- 12-tooth gears—2
- 12-tooth bevel gears—1
- 4-tooth gears—4

TIP

Gearheads Needn't Worry

If you, like me, yearn for more gear options, be sure to read Chapter 10, "Expanding on Mindstorms," where I talk about where to find more.

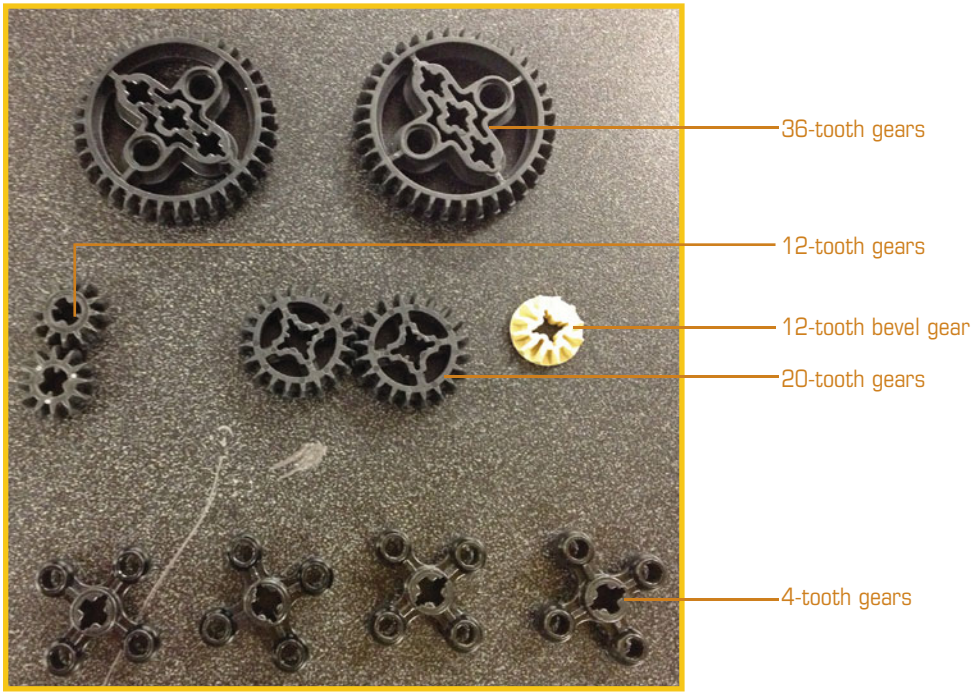

FIGURE 1.17 The Mindstorms set comes with a disappointing number of gears.

Teeth

The next parts, *Bionicle teeth,* are kind of unusual for Mindstorms in that they're almost completely cosmetic. You get 10 of them in the set (see Figure 1.18). Although they're usually decorative, another possibility might be to use them in conjunction with a motor to serve as some sort of dial, rotating to a certain direction as directed by the NXT brick. Also, in the Backscratcher Bot, our first project in this book, we use the teeth as the business end of the scratcher; they're what scratch your back!

FIGURE 1.18 These teeth are mostly for fun, but if you're clever, you can come up with other more useful applications.

Balls

LEGO includes multicolored balls with the set, used by robots either as missiles or as objects to be color-scanned and sorted (see Figure 1.19). One common type of robot to use these balls is a Great Ball Contraption. These complex linked robots are often found at LEGO conventions. Some assemblies are so huge that they cover multiple tables and spend their time rolling, pulling, lifting, and shooting the balls in an endless chain reaction. You get three of each color ball with your set.

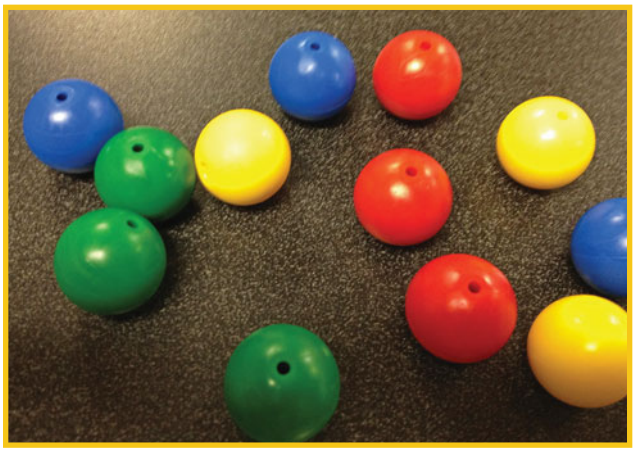

FIGURE 1.19 These colored balls provide a variety of interesting possibilities.

Beams With Pegs

The so-called beams with pegs are essentially short Mindstorms beams with connector pegs sticking out (see Figure 1.20). You can add them as stabilizers to a wobbly model, and they're also great for changing the angle of the beams because most LEGO beams have holes on two sides only. That means you sometimes have to resort to trickery to attach parts to the smooth sides. You get six of the angle beams and 14 of the 3M beams. I wish the set included more; I use them all the time!

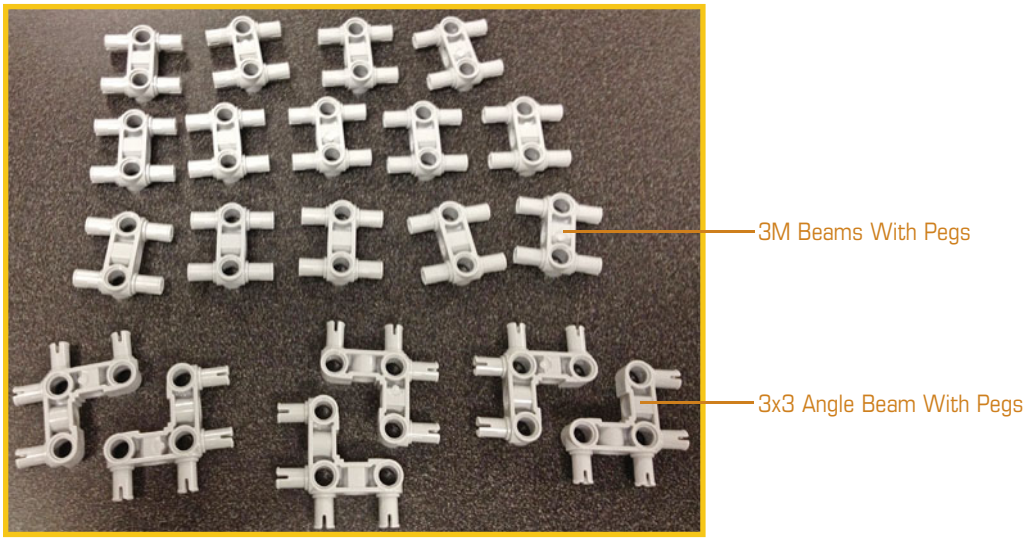

FIGURE 1.20 Crafty builders make good use of beams with pegs.

Beams

Next, let's check out beams, the bones of Mindstorms robots. Using these building blocks, you can pretty much create whatever you want—with the help of the other components, of course! The kit comes with the following beams (see Figure 1.21):

- 2M beams—8
- 3M beams—10
- 5M beams—18
- 7M beams—20
- 9M beams—14
- 11M beams—6
- 13M beams—10
- 15M beams—2

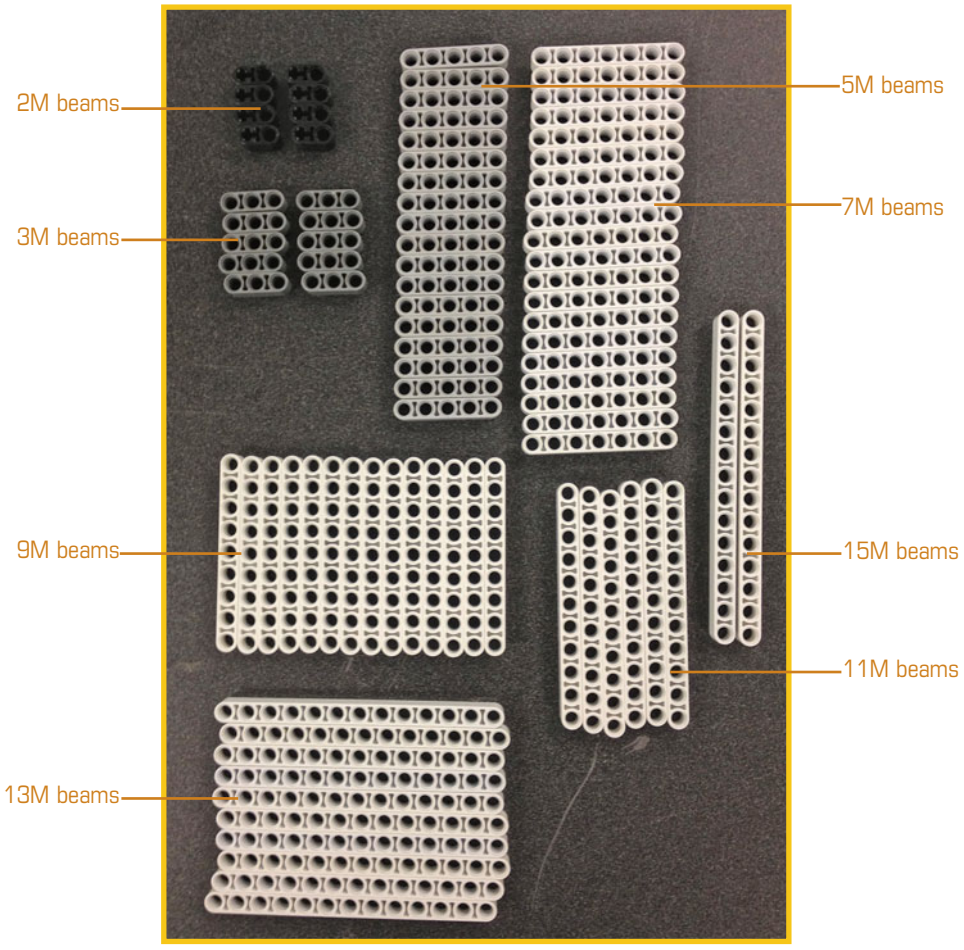

FIGURE 1.21 Beams form the skeleton of any Mindstorms bot.

Angle Beams

Angle beams add critical stability, enabling you to connect parts in ways that a straight beam cannot. For instance, you could reinforce the corners of a square robot with a 90-degree beam on each corner.

The orange parts in Figure 1.22 are the same as the similar-appearing dark gray parts, one of the few instances in the set where you get two basically identical parts sporting different colors. As you can see in Figures 1.22 and 1.23, the set includes

- 3×5 90-degree angle beams (gray)—14
- 2×4 90-degree angle beams (gray)—13
- 2×4 90-degree angle beams (orange)—4
- T-shaped angle beams—2
- 45-degree double-angle beams (medium gray)—2
- 45-degree double-angle beams (light gray)—4
- 3×3 angle beams (gray)—6
- 3×7 angle beams (white)—10
- 4×6 angle beams (white)—4

FIGURE 1.22 L- and T-shaped angle beams provide stability and provide lots of building options.

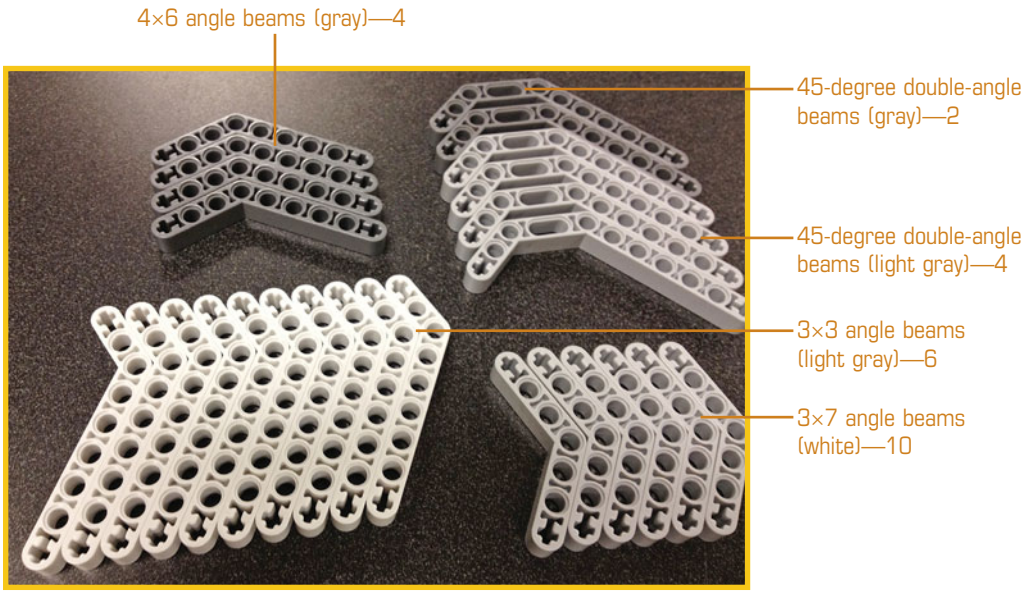

FIGURE 1.23 These angle beams help break your robot out of the 90-degree mindset.

Car Parts

The parts shown in Figure 1.24 are purely cosmetic, made to make robotic cars more cool looking but not adding a lot of value. Essentially, what you're getting are the fenders and side panels of a car's body. As with other cosmetic parts, what you get out of them depends on your own cleverness. Who knows what functional mechanisms could be created?

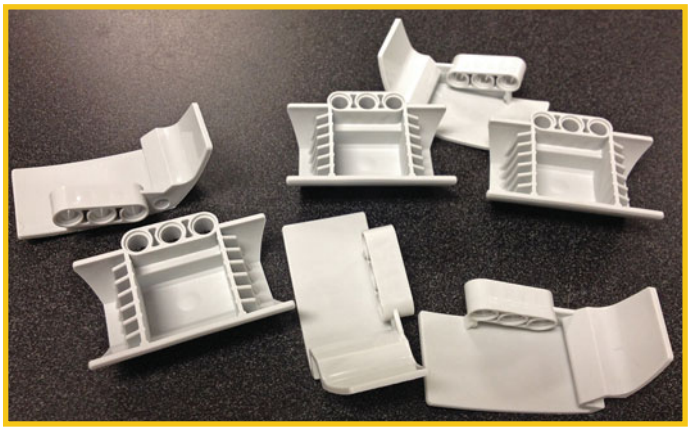

FIGURE 1.24 While purely cosmetic in nature, these parts will help you trick out any robotic cars you decide to build.

Steering Links

The parts shown in Figure 1.25 are called *steering links,* and they're used in conjunction with tow balls to form a flexible link between two elements.

FIGURE 1.25 Steering links offer a more flexible connection than beams.

Angle Elements

The parts shown in Figure 1.26, called *angle elements,* are used for connecting cross axles, cross connectors, and connector pegs. Not only can you connect two axles to make a bigger one, you can use them structurally with axles to make cubes, triangles, and so on.

- 0-degree angle elements—5
- 90-degree angle elements—12
- 180-degree angle elements—6

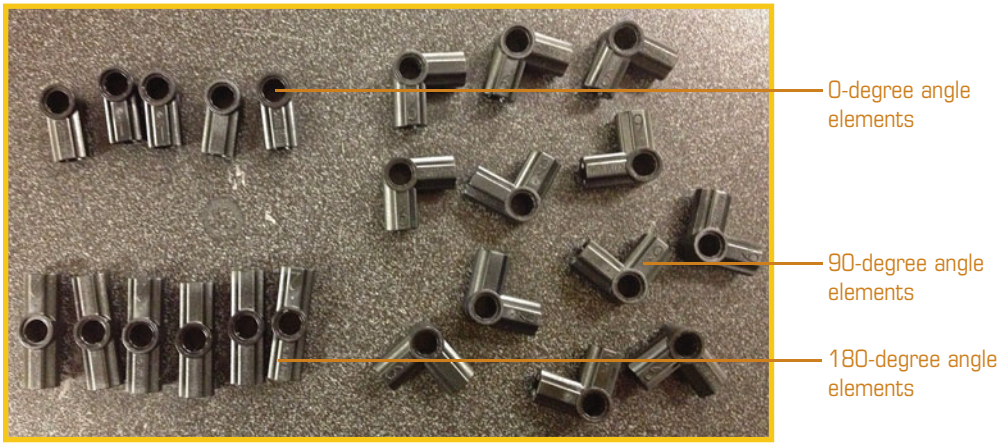

FIGURE 1.26 Angle elements help connect cross axles at different angles.

Cross-Axle Connectors

Cross-axle connectors combine two cross axles into a longer one (see Figure 1.27). They also interface with other elements with cross ends. They're the sort of element you may not use a lot, but when you need one, you'll be grateful LEGO created them! You get four in the set.

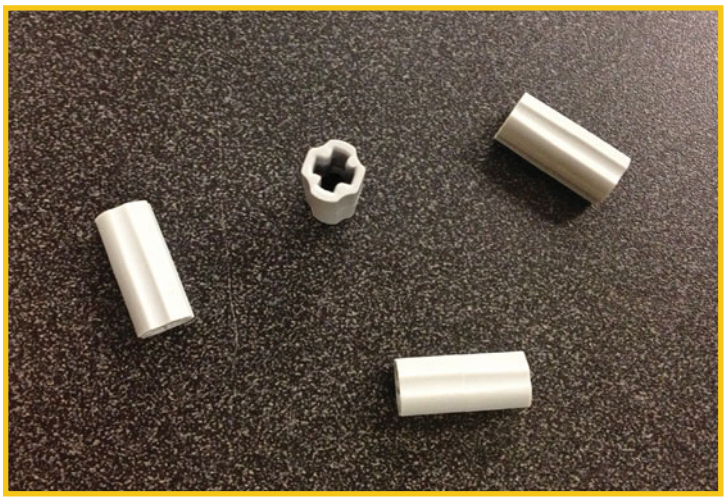

FIGURE 1.27 Cross-axle connectors make long axles out of short ones.

Cross Blocks

The parts shown in Figure 1.28 are called *cross blocks,* small beams with cross holes and Technic holes at right angles to each other. These parts allow you to attach cross axles to beams and to add perpendicular elements to help reinforce beam structures. I use the double cross blocks all the time; I don't know why LEGO includes only five in the set.

- 3M cross blocks—16
- 2M cross blocks—8
- 3M double cross blocks—5

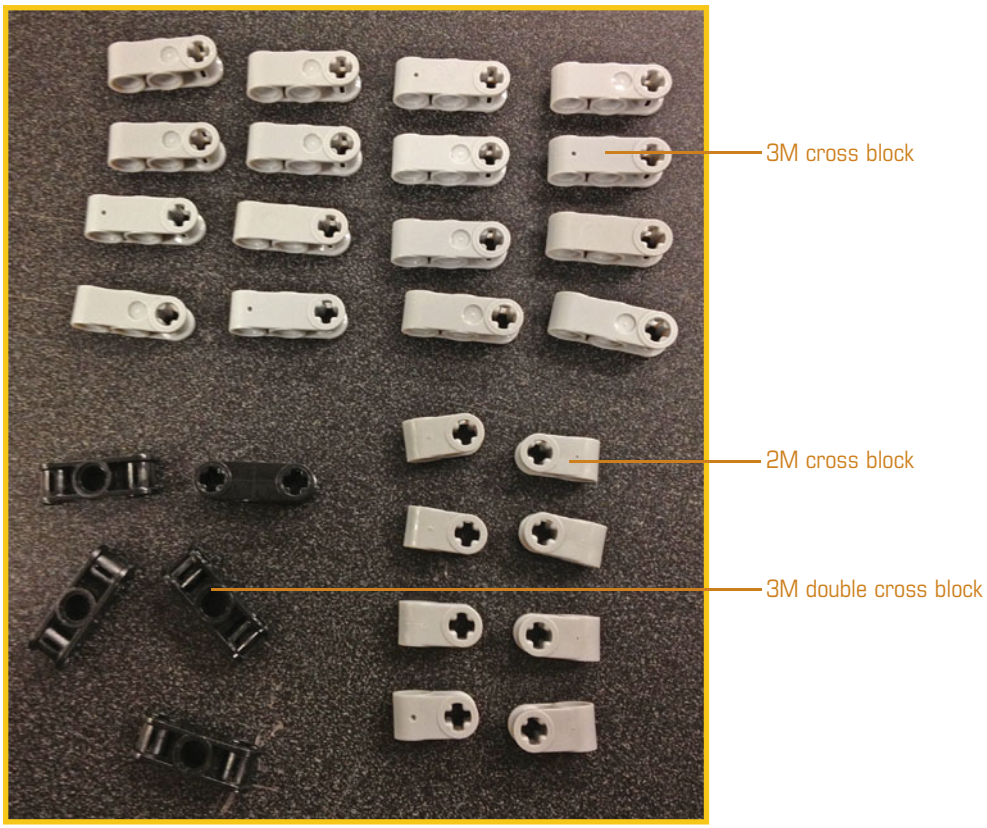

FIGURE 1.28 Cross blocks allow you to add cross-holes to beams, and at different angles.

More Miscellaneous Parts

More obscure parts! The funny-looking ones at the top of Figure 1.29 are the *magazine* and *launcher* for the ShooterBot, one of the robots you can build with the set; the instructions may be found on the Mindstorms software.

The black double pins are exactly that; you get three. The oval disks, called *cams*, are used to add an irregular motion to a motor's spin, and the four rubber things are called *rubber axle connectors.* Here's a breakdown of the oddball parts:

- Magazine—2
- Launcher—1
- 3M double Technic pin—3
- Cam—2
- Rubber axle connector—4
- Axle connector—6

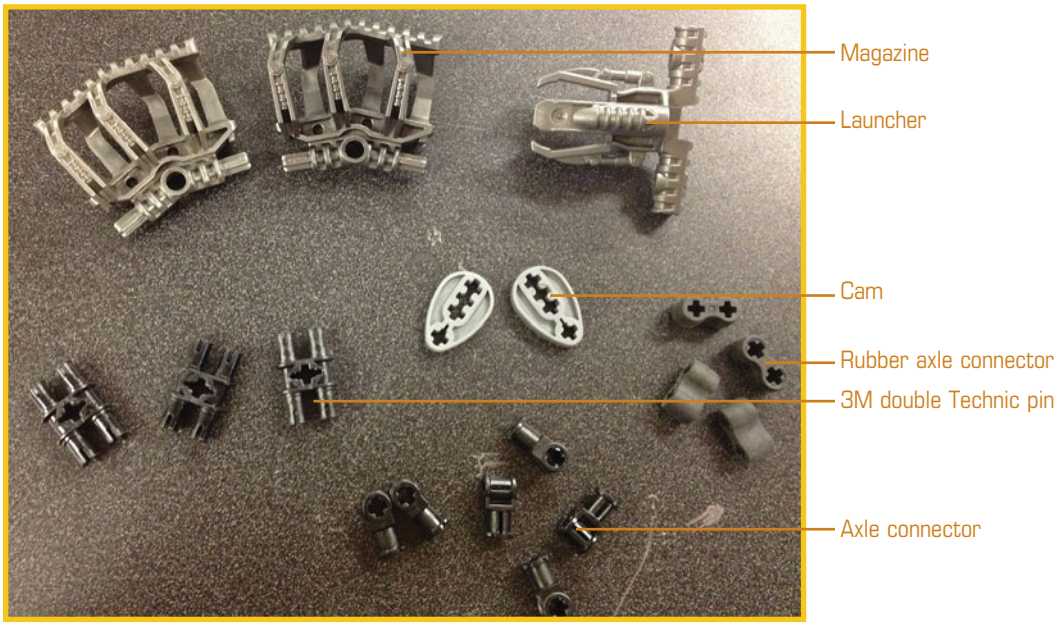

FIGURE 1.29 Some parts are hard to categorize. Here are some of the more obscure parts found in the set.

Peg Joiner

Peg joiners do just that, allowing you to insert connector pegs at different angles (see Figure 1.30). These parts are great for reinforcing your robot, especially if you've already built the bot and it's a little wobbly. Just reinforce the wobbly parts with some of these connectors!

- 2×3 peg joiner—6
- 2×2 peg joiner split—8
- 2×2 peg joiner—4
- 90-degree peg joiner—1

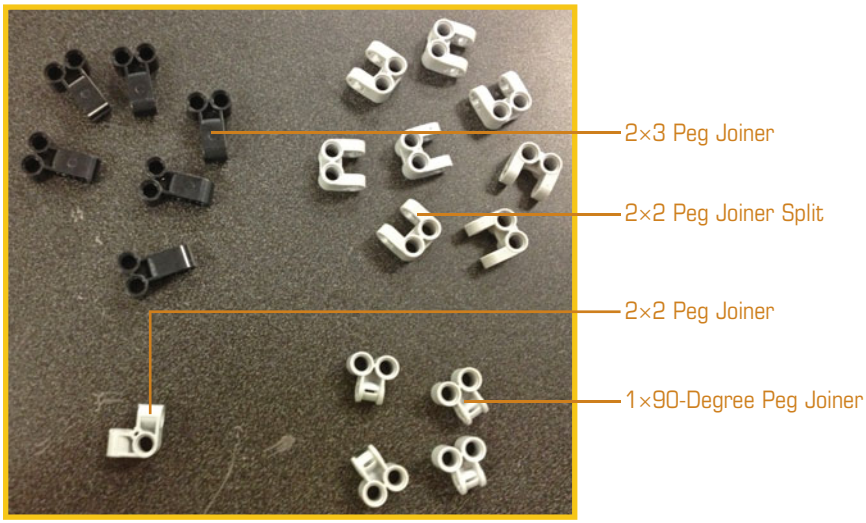

FIGURE 1.30 Peg joiners are great for reinforcing wobbly robots.

WHAT'S WITH THAT LITTLE WHITE TILE?

It may surprise readers that LEGO included one of their classic System bricks—a white 1x2 smooth plate, shown in Figure 1.31—in the Mindstorms set. It's hard to say why it was included; it's not exactly a useful piece because it attaches via studs and none of the Technic elements in the set have studs. It's a mystery!

FIGURE 1.31 Who is to say why this one non-Technic Lego element was included?

Motors, Wires, and Sensors

The larger of the two white boxes in the main set holds all your motors and sensors, as well as the Mindstorms wires and the USB cable you use to program your NXT brick. You get three interactive servo motors, two touch sensors, a color sensor, and an ultrasonic sensor (see Figure 1.32).

FIGURE 1.32 This box contains the sensors, motors, and wires you'll need to turn a model into a robot!

Ultrasonic Sensor

Let's take a peek at the ultrasonic sensor that comes with the set. As you can see in Figure 1.33, the ultrasonic sensor has two grills in the front, one of which covers a sensing element, while the other one emits sound. The idea is that the sensor beams out inaudible sound waves and then measures how fast the sound bounces back to the sensor, enabling you to measure distance with surprising accuracy.

FIGURE 1.33 Ultrasonic sensors emit sound waves that help your bot measure distance.

Touch Sensors

The Mindstorms touch sensors double as both pushbuttons as well as sensor-detecting contacts (see Figure 1.34). The sensors can discern three different actions: a quick bump, a press-and-hold, and a release action. You get two touch sensors with the set.

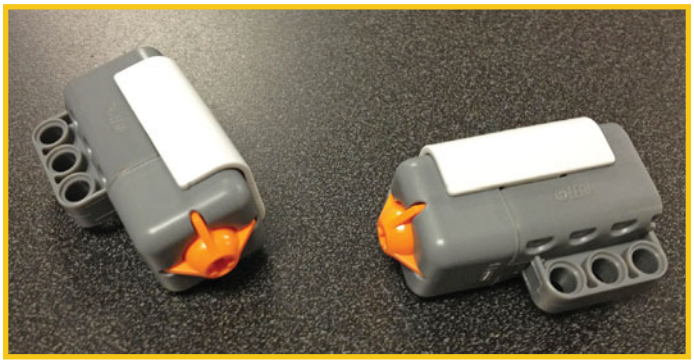

FIGURE 1.34 Touch sensors can serve as a pushbutton or as a contact sensor.

Interactive Servo Motors

Three of LEGO's interactive servo motors come with the set, and you'll probably wish there were more (see Figure 1.35). What differentiates them from motors one might find in a hobby store is that they are equipped with position encoders that enable the NXT brick to accurately determine the speed and precise angle of the motor's turn.

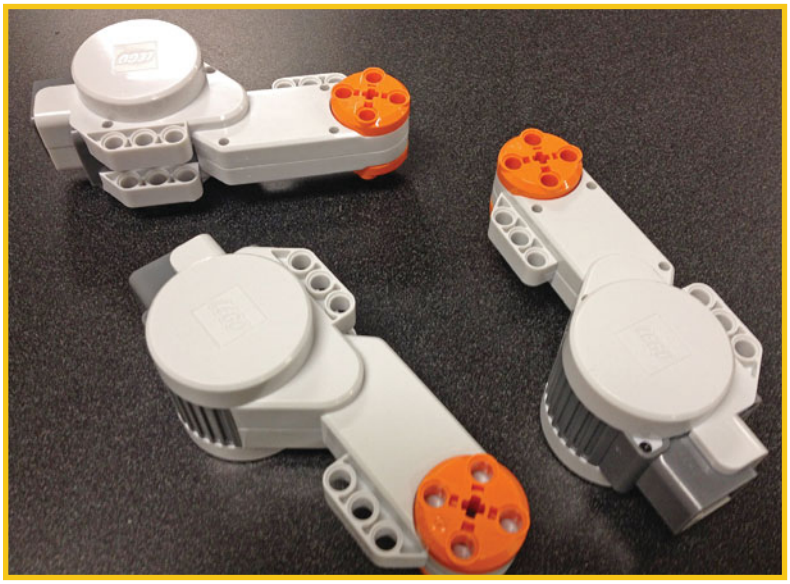

FIGURE 1.35 Three interactive servo motors are included with the NXT 2.0 set.

Color Sensor

The color sensor shown in Figure 1.36 can distinguish between colors—hence the name—but it does so much more. For instance, it not only can determine the color of a scanned object by bouncing a light off it and measuring the returned values but also can detect the level of lighting in a room (dark, poorly lit, bright, and so on). If that weren't enough, you can turn it into a lamp shining red, blue, and green lights. The color sensor is a vast improvement over the previous Mindstorms set, which only boasted a light sensor.

FIGURE 1.36 The color sensor is a multipurpose part that you'll find many ways to use.

USB Cable

LEGO includes a standard USB cable with the set (see Figure 1.37). It's fairly universal, so if you lose yours, you can always find another without buying an official LEGO product. You'll need this cable when you start programming your NXT brick.

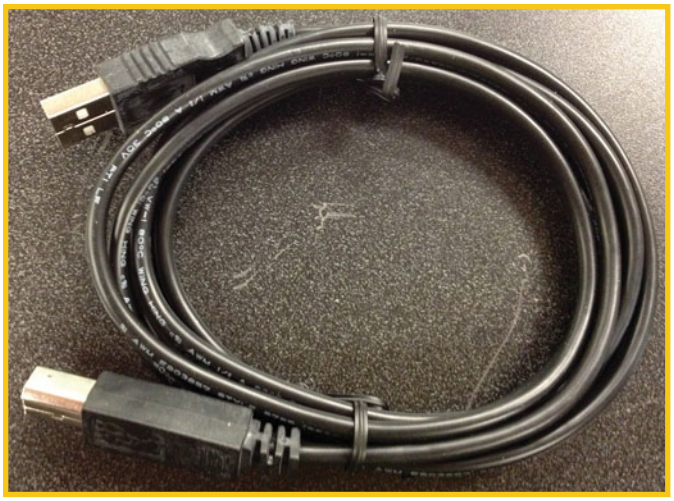

FIGURE 1.37 Use the supplied USB cable when you start programming your NXT brick.

Mindstorms Wires

The Mindstorms sensors and motors communicate with the NXT brick with the help of six-ply wires (see Figure 1.38). The set comes with the following selection of wires, giving you a nice variety for all your projects:

- 20cm wire—1
- 35cm wires—4
- 50cm wires—2

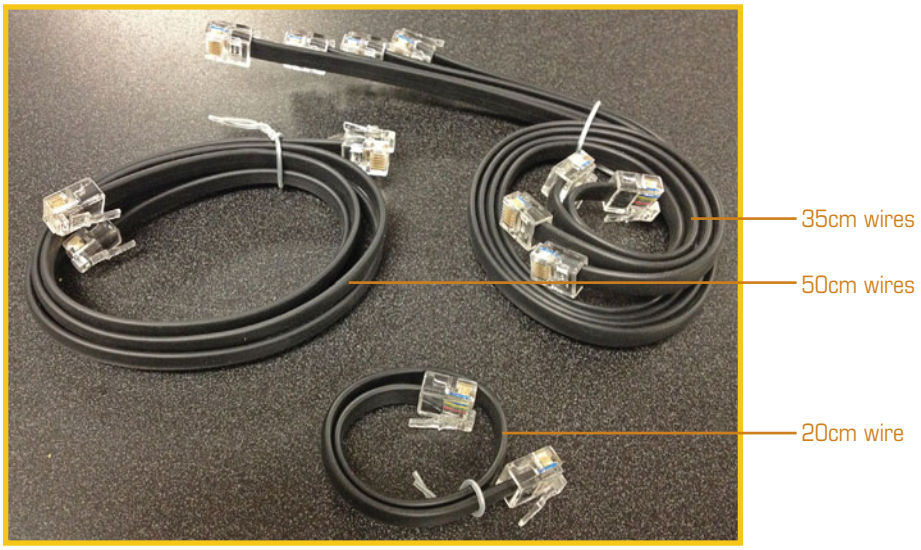

FIGURE 1.38 These wires carry the communications from the NXT brick to your bot's motors and sensors.

The NXT Brick

The *NXT brick* is the brain of the robot, a computer that interprets data from the sensors and sends power to the motors to make them turn (see Figure 1.39). You learn all about the NXT brick in Chapter 3, "Anatomy of the NXT Brick," so be sure to check it out!

FIGURE 1.39 The NXT brick–the brain of your creations.

Next Chapter

In Chapter 2, "Project: Backscratcher Bot," we'll build our first bot—the backscratcher bot!

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