

ROBOTICS RESOURCES



Tune in each month for a heads-up on where to get all of your "robotics resources" for the best prices!



Fabulous Robots With Pre-Fab Parts!

Twenty five years ago, if you wanted a robot you built it from scratch.

Out to the garage you'd go, with sheet metal, wood, and plastic bits in hand. You'd cut, drill, sweat, and in the end you'd have a functional but perhaps amateur-looking robot to show to your friends and family. And that would be just for the mechanical body. The electronics and brain would be a project for the next year — if you made the effort at all.

Starting about 10-15 years ago, a few enterprising mail order businesses — such as Solarbotics and Lynxmotion — began offering robot construction kits. You could bypass the mechanical construction phase, and go straight to the electronics, programming, or even play phase! The kits were special-purpose, designed to construct a single version of the robot. To this day, there are still plenty of pre-made kits that make it easy to build a robot, letting you concentrate on the other aspects that you may find more enjoyable.

Now, the latest trend in amateur robot construction is prefabricated components that allow you to build a variety of designs, all from a single kit of parts. The idea is hardly new — for decades, kids have been building things with Erector and LEGO parts, even Lincoln Logs. While the idea of mixing and matching components to build custom designs is old-hat, only recently has the concept come to the field of educational and amateur robotics.

In this month's column, we'll take a closer look at some of the robot

pre-fab construction kits that are available, and why such a kit may be just what you're looking for if you're wanting to experiment with robotics.

Vex Robotics Design System

The Vex system is based around the Erector set style of pre-drilled stamped metal girders and connector pieces. To build a robot, you fasten the girders and other parts together using machine screws and nuts. What makes Vex different than the Erector set you can buy at the toy store is the collection of parts specially designed for small robotics. It comes with two types of motors — servo and continuous rotation gear head — made to fit the girder construction of the system. To these motors you can attach a variety of mechanical parts, such as wheels, gears, and even tank-type treads.

Once upon a time, Vex was sold exclusively by RadioShack, so it was widely and easily available. Alas, that company had rolled back its inventory in hobbyist electronics parts, and no longer distributes the sets. You can still get Vex via mail order from the manufacturer's website at vexlabs.com. They sell a starter kit, as well as separate components. Need an extra set of wheels? No problem! They are available separately, along with various packages of extra girders, nuts, bolts, and other hardware.

The \$300 Vex starter kit also includes a programmable electronics

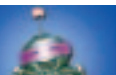
module, sensors, and rechargeable batteries. The Vex is the de facto standard kit of parts for the US FIRST Vex Challenge robotics competition, open to high school students. Participants form teams who compete with one another in building and programming a robot to perform a specific task.

LEGO Mindstorms

Now in its second incarnation as the NXT, LEGO continues as a favorite robot construction set in the home and school. NXT sets combine specially-made electronic components with traditional (and some not-so-traditional) LEGO building blocks.

At the center of the NXT system is the NXT controller — a second-generation microcontroller that supports up to three motors and up to four sensors and other inputs. Like the RIS controller in the original Mindstorms set, the NXT provides visual feedback using an LCD display, and receives its programming from a PC (in the case of the NXT, the connect is via USB; early RIS controllers used infrared communications). Once it has received its programming, the NXT is self-contained and operates by itself.

NXT connects to a wide variety of motors and sensors, which either come with the basic Mindstorms NXT kit, or are available separately. Basic touch, light, and sound modules provide basic sensory feedback, and ultrasonic and accelerometer sensors give the NXT the ability to judge distances and even tilt.



The motors on the NXT are enhanced and provide built-in encoders, which count the revolutions of the drive shaft as the robot rolls along the carpet. While NXT comes with graphical programming software, LEGO also provides an open source firmware API (application programming interface), so you can lift up the hood and work directly with the electronics in the NXT module.

Lynxmotion Servo Erector Set

Lynxmotion was one of the first robotics-specific companies to realize the benefits of producing prefabricated construction parts, allowing builders the freedom to create custom designs. Their Servo Erector Set is composed of a variety of stamped aluminum metal brackets that are specially designed to work with common R/C servo motors.

By connecting the brackets, channels, tubing, and other construction hardware in various ways, it's possible to build two-, four-, six-, and even eight-legged walking robots. In similar fashion, you can build arms, grippers, pan/tilt mechanisms, wheeled robots, and just about anything else that uses standard R/C servos. A page on the Lynxmotion site provides a long list of illustrated examples of what you can build using the Servo Erector Set.

The component parts of the company's Servo Erector Set are wide and varied. Lynxmotion sells some small kits with parts designed for specific tasks, like a two- or three-degree-of-freedom leg. Buy four, six, or eight sets to construct a complete walking robot. Or, you can purchase the individual parts separately. These parts aren't inexpensive, but they're far easier than making them yourself, and cheaper than if you go to a local metal shop for custom-made parts.

Rounding out the Servo Erector Set offerings is a complete collection of robot "torsos" or bodies, some made of stamped and pre-drilled aluminum, and some from laser-cut polycarbonate plastic. These bodies are designed to attach to the various legs and other mechanics that you've built using Servo Erector Set parts. Among the available torso parts is the framework for a

bipedal robot, the body for a four- and six-legged walking robot, and parts to make a sci-fi looking robot hand.

Robix Rascal

The Rascal Classroom Robot Set from Robix is, as its name implies, designed for classroom study of robotics and mechanics. Yes, you can build several different types of robots with the Rascal kit, but the emphasis is on learning about mechanical design and construction.

Rascal parts are relatively simple and straightforward, and that's the secret to their ingenuity. Kits are composed of standard R/C servos and pre-cut and pre-drilled aluminum angle stock called Rascal Links. The links come in different lengths.

The servos in the Rascal kit are standard R/C unique, and can be commanded using most any serial servo controller or microcontroller. A controller is included in the Rascal kit, which is designed to operate up to 32 servos via a USB link to a PC or Mac. Software supplied with the kit provides a programming environment.

Robotis Bioloid

An exciting new entrant into the prefab robot kit arena is the Bioloid, from Korea-based Robotis. The full Bioloid kit (about \$900) comes with enough parts to — according to the sales literature — build 26 different robots. No doubt with a bit of creativity you could build more, especially if you combine parts from additional kits.

The full Bioloid kit — called the Comprehensive Kit — contains a main programmable controller, 18 special programmable servo motors, and various frame construction pieces. A less expensive entry-level kit (about \$350) contains the controller, but only four servo motors and a selection of construction parts. Both kits also include a multi-function sensor module, which includes an infrared receiver, infrared distance sensor, light sensor, and buzzer.

Robotis sells their kits through a worldwide network of dealers. See the list of dealers on their home page

(www.robotis.com). I've included several North American dealers in the Sources section that follows.

As pre-fab kits go, the Bioloid is relatively inexpensive, especially when you consider it comes with everything you need to start building, including the battery pack and the motors. The servos used in the Bioloid are not off-the-shelf; in fact, they are proprietary designs that boast upwards of 220 oz-in torque (at 9.6 volts). They are unlike traditional servos in that they are operated using serial commands. You don't need or use separate pins on a microcontroller for each servo; instead, all the Bioloid servos are connected to the same serial communications input. The Bioloid servos provide torque and angular feedback.

When you consider that a high-torque standard R/C servo motor costs about \$40, 18 such motors would set you back \$720. At \$899 for the full Bioloid kit, you get the equivalent value in servos, plus a microcontroller, battery pack, and construction pieces. Actually, this comparison is not accurate, because traditional analog R/C servos do not provide the feedback possible with the Bioloid servos, and few are capable of torque much beyond 100-110 oz-in. (The 200 oz-in range is mostly occupied by digital hobby servos, which retail for \$75-\$125 each.)

The Robotis kit is a great deal now, and promises plenty of fun. It's likely only the first one in a soon-to-be long line of all-in-one imported kits from Korea, Japan, and China that are sure to follow. This is a market that is sure to catch on.

Ye Olde Standbys

Not to be forgotten, these construction toys are useful as the framework for DIY robotics. The best part: You probably already have at least one set in the back of your closet. Dig it out, and start using it for your next robotics project!

- *Erector* — One of the older construction toy brands. The original kits were made of all stamped metal, but the modern versions contain a number of



plastic pieces. The sets come in various sizes, and are generally designed to build a number of different projects. Many kits are engineered for a specific design with provisions for moderate variations.

- *Plastic Construction Bricks* – You can literally build anything with plastic construction bricks, typified by the LEGO and LEGO Technic sets. A few companies make “LEGO compatible” sets (without actually saying so) with similar functionality. Check out the sets by MEGA BLOKS and others. The parts snap together, but for more permanent creations, you can use a dollop of solvent cement. Use ABS cement for LEGO bricks; plastic model cement for most of the other brands.

- *Tamiya* – Besides plastic models, Tamiya makes a line of educational kits that include motors, wheels, tank tracks, and a (wired) remote control robot construction set.

- *Capsela* – This popular snap-together motorized parts kit uses unusual tubular and spherical shapes. The kits contain unique parts that other put-together toys don’t, such as plastic chain, sprockets and gears.

- *Fischertechnik* – These kits are less toys and more learning labs. They aren’t designed for use by small children. Pre-made kits offer a snap-together approach to making working electro-

magnetic, hydraulic, pneumatic, static, and robotic mechanisms.

- *K’Nex* – Using a series of half-round plastic spokes and connector rods, K’Nex encourages construction of larger models. A number of K’Nex kits are available, from simple starter sets to rather massive special-purpose collections (many of which are designed to build robots, dinosaurs, or robot-dinosaurs). Several of the kits come with small gear motors, so you can motorize your creation.

Sources for Prefabricated Robot Construction Sets and Related Parts

80/20, Inc.
www.8020inc.net

Aluminum extrusions and connection parts for industrial-strength constructions. Useful for larger robots. Check the site for local retailers.

Construction Toys
www.constructiontoys.com

Online and local retailer of construction toys. These toys are available both online and in the retail store: Capsela; Eitech; Erector; Fischertechnik; Geofix; Geomag; K’NEX; LEGO Dacta; Roger’s Connection; Rhomblocks; Rokenbok; and Zome System.

CrustCrawler
www.crustcrawler.com

US-based reseller of the Bioloid kits, as well as their own custom-made metal robot kits. Extensive site with plenty of how-to and background information on using the Bioloid kits.

e-Hobbyland
www.e-hobbyland.com

Well-established retail and online seller of all types of toys.

Fischertechnik
www.fischertechnik.com

Company website for Fischertechnik in North America. Check out the Retail Outlets links.

Hobby Engineering
www.hobbyengineering.com

General source for robot parts, as well as a lengthy list of Erector set kits of all shapes and sizes.

Jameco Robot Store
www.robotstore.com

Reseller of a number of robot kits, including the Tamiya remote-controlled robot construction set.

KBtoys.com
www.kbtoys.com or www.etoys.com

Online mail order. Check often for deep discounts on LEGO, K’NEX, and other brands.

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LEGO Shop-at-Home **shop.lego.com**

Online outlet for LEGO products, including spare parts (when available).

LEGO Mindstorms **mindstorms.lego.com**

Informational page for the LEGO Mindstorms sets. Be sure to check out the user-to-user forums to see what other LEGO builders are up to.

Lynxmotion **www.lynxmotion.com**

Lynxmotion offers complete robot kits, as well as a unique Servo Erector Set, a collection of brackets, and other parts for building custom robots using standard-size R/C servos.

Only Toys **www.onlytoys.com**

Only Toys carries metal Erector sets; most are for building vehicles, and some (like the Steam Engine) are quite elaborate. The company also sells

Rokenbok radio-controlled toys.

Robotis **www.robotis.com**

Manufacturer's site for the Robotis line of robot construction sets and parts. Check out the dealer pages to find a reseller near you.

Robotshop **www.robotshop.ca**

Resellers of Fischertechnik and other robot construction sets.

Tamiya **www.tamiya.com**

Home page for Tamiya. Check out their Educational Construction Series line of kits, such as the remote-controlled robot construction set.

Target **www.target.com**

Retail stores and online site. Both offer great deals in clearance items. Make it a habit of regularly checking

the website for clearance items.

Timberdoodle **www.timberdoodle.com**

Timberdoodle specializes in home education products. They offer a good selection of Fischertechnik kits at good prices. They also sell K'NEX and electronics learning labs. Be sure to check their "swan gong" closeout deals.

US First **www.usfirst.org/community/fvc/**

Main page for the FIRST Vex Challenge. (If you are a high school student, check with your school to see if they participate in the FIRST competition. If they don't, talk to your teacher or administrator about getting involved.)

VexLabs Vex Robotics Kits **www.vexlabs.com**

Makers of the VEX Robotics Design System. Use their online ordering system. **SV**