PARALLAX

Boe-Bot

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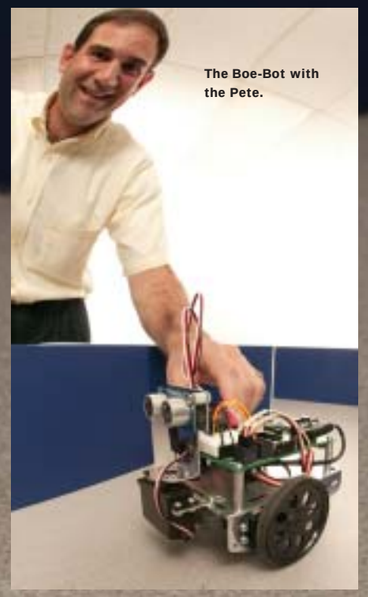
A high-quality, wheeled robot kit for hobbyists and students

The Boe-Bot is an unassembled robot kit made by Parallax, Inc., which is built around their BASIC Stamp 2 microprocessor and Board of Education (BOE) carrier breadboard. The Boe-Bot is the most general-purpose robot kit that Parallax offers. It is the second step in their "Stamps in Class" education series. The kit includes a variety of input sensors that can be used individually or in combinations to make increasingly sophisticated robots.

No previous robotics, electronics or programming experience is necessary to successfully complete this kit. The highly detailed and well-illustrated manual guides you, by way of a series of experiments, through the construction of the robot, from assembly of components to programming autonomous navigation. This review is based on a USB version of the Boe-Bot robot kit, but a serial (RS232 interface) version is also available from Parallax.



The Boe-Bot with the Pete.

SPECS

KIT CONTENTS:

- Unassembled robot parts
- BASIC Stamp 2 microcontroller
- BOE carrier breadboard
- Various sensors and components
- PBASIC 2.2 development environment
- "Robotics with the Boe-Bot" instruction manual

REQUIRED FOR COMPLETION: 4 AA batteries; PC running Windows 98/2000/XP with a USB port, CD-ROM, and 4MB of disk space

TIME TO ASSEMBLE: 2-3 hours; 40-50 hours to complete all projects; no soldering and only basic hand tools are required.

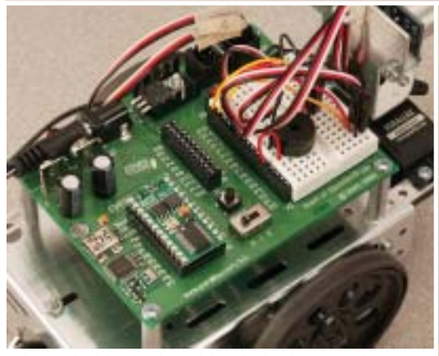
SUMMARY: The BOE-Bot is an excellent kit for a hobbyist or student over 13 years old. It comes with clear instructions and an intuitive programming environment.

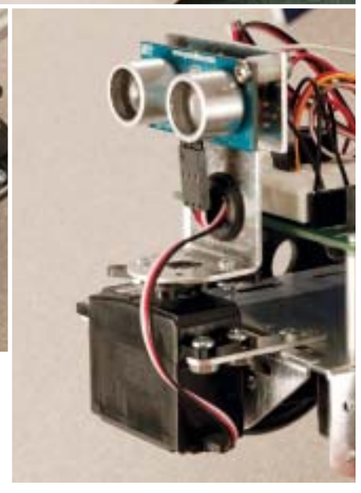
IN THE BOX

Parallax has a great reputation for continually upgrading its products; this kit includes the latest revisions of the Boe-bot's mechanical, electronic and software components. The Boe-Bot benefits from the years of development and refinement that Parallax has devoted to this product. An example of this is in the servos that turn the drive wheels. The kit now comes with continuous-rotation servos so that the user doesn't have to go through the tedious task of manually modifying them as was necessary on earlier kits.

The mechanical components all came nicely organized in several small bags and even included a small screwdriver for assembly. This kind of attention to detail allowed the construction to go on without a hiccup.

The Boe-Bot completes a maze.





Above: The BOE circuitry. Right: The PING sonar and servo.

The kit includes a set of passive components (wires, resistors, capacitors), sensors (photo resistors, bumpers, infrared sensors) and hardware (whisker touch-sensor kit) to complete the different projects. The active components, such as the BASIC Stamp 2 microcontroller, the Rev C carrier board and sensors, were delivered safely in static-safe bags. The software for the PC-based PBASIC editor and development environment is supplied on CD-ROM. The complete software and documentation are also available from Parallax's website. When installed on my laptop PC it required about 3.75MB of disk space.

Robotics with the Boe-Bot is a hefty 340-page manual that accompanies the kit. It contains 43 activities, divided among eight chapters, and guides you through assembling, programming and testing the robot. Source code, black and white photos, and detailed instructions are included for each step. Each chapter also includes questions, exercises (and solutions!), along with sidebar projects.

The PBasic development environment.

PING ULTRASONIC SENSOR

For this review, I have the optional PING ultrasonic sensor kit. This sensor kit includes the hardware and electronics to add sonar capability to the basic Boe-Bot. The kit includes the PING sensor, mounting brackets and a standard rotation servo. It is intended to be mounted to the front of the Boe-Bot and used for navigation.

As delivered, the kit was compete and correct – all the parts needed for the 'bot were in the box and no special trips to the neighborhood hardware or electronics store were needed. The fit and finish of all the parts was first-rate. I didn't have to file, bend or tweak any of the parts to make them fit.

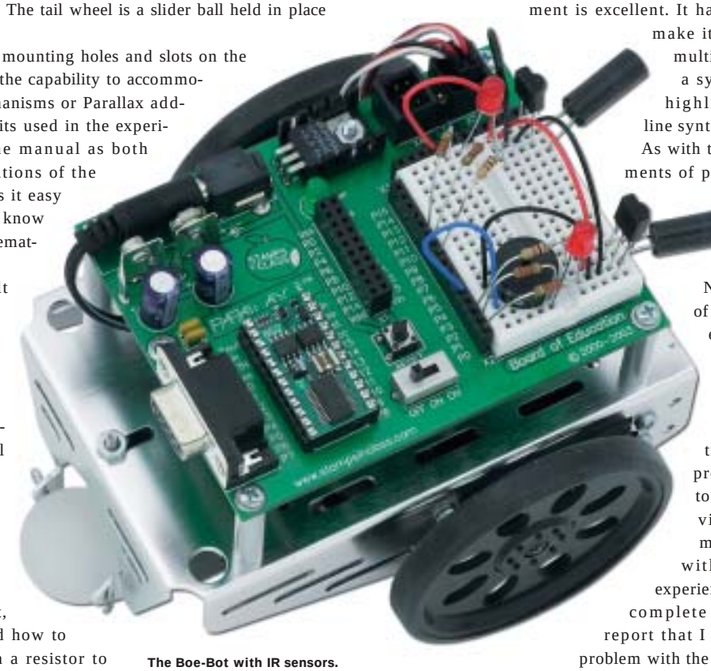
ASSEMBLY

Roughly the first half of the *Robotics with the Boe-Bot* is devoted to building and testing the 'bot. The package claims the kit can be built in two hours, but it took me nearly twice that long to get it done. The robot is built on a brushed aluminum chassis that provides a sturdy platform for the servomotors and breadboard. The assembly is straightforward—the mechanical parts attach to the chassis with small 4-40 pan head screws and nuts. The kit-supplied screwdriver worked acceptably, but I found it easier to use the jeweler's screwdriver and 1/4-inch open-end wrench from my toolbox instead.

The drive wheels mount to the servos on the sides of the chassis. They are molded to fit precisely on the servo splines and are held in place with a small screw. The tail wheel is a slider ball held in place with a cotter pin.

There are many extra mounting holes and slots on the chassis that give this kit the capability to accommodate other sensors, mechanisms or Parallax add-ons. The electronic circuits used in the experiments are shown in the manual as both schematics and illustrations of the components. This makes it easy for people who may not know how to read electrical schematics to make the circuits.

The circuits are built on the BOE breadboard area and specific ports are provided for the servo motors. As a result, no soldering is required during the construction. The manual begins with the fundamentals of electronics in a very practical way. For example, in the second chapter it explains how current flows through a circuit, how an LED works, and how to read the color-codes on a resistor to determine its value. As each electronic component in the kit is introduced, its function is described, its schematic symbol is shown and an experiment is presented that demonstrates how it works.



The Boe-Bot with IR sensors.

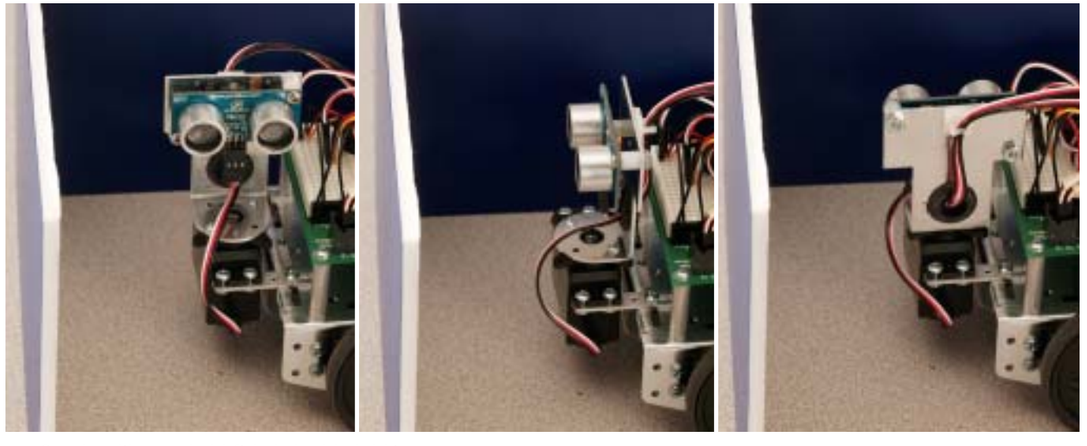
PROGRAMMING MADE EASY

The second half of *Robotics with the Boe-Bot* focuses on using the various sensors (IR, light, touch) for autonomous navigation. You use the software and STAMP chip from the very beginning of the build. This gradually introduces you to the language and environment as you build more and more sophisticated programs. The BASIC Stamp editor/ development system environment is excellent. It has many features that make it easy to use such as multiple editing windows, a syntax checker, syntax highlighting, and an on-line syntax guide.

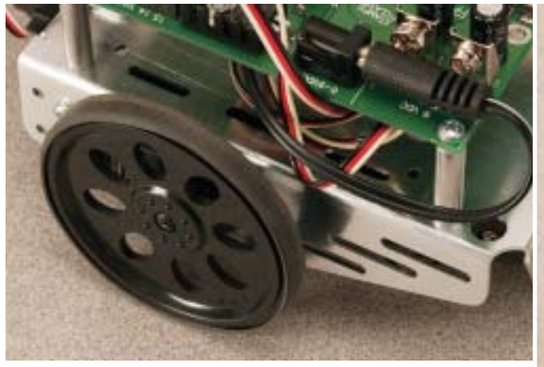
As with the electronics, the elements of programming are presented in a well-ordered fashion beginning with the basics. Not only is the syntax of the PBASIC language easy to learn and use, but the manual, also covers general programming topics such as logic and control. Because this comprehensive introduction to programming is provided in the Boe-Bot manual, even someone without any previous experience can pick it up and complete the kit. I'm glad to report that I never encountered a problem with the development environment—no crashes, hangs or unexpected errors.

OPERATION

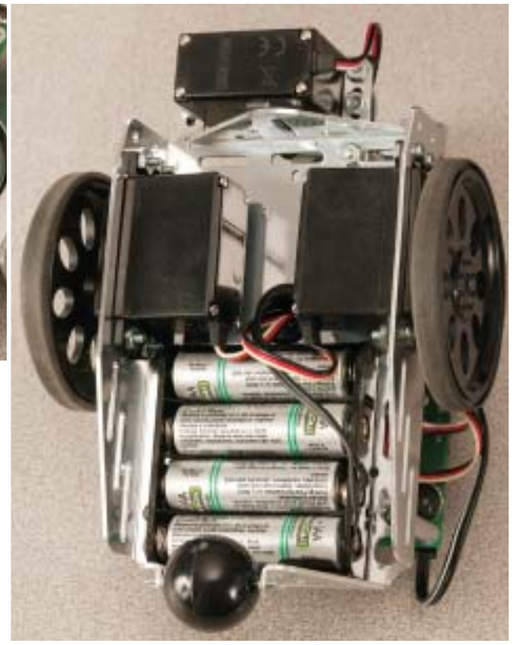
Watching the Boe-Bot maneuver autonomously around a room, running the program you wrote is very exciting. Almost immediately you start thinking of how it can be modified and improved—and so you dive back into the code for an upgrade.



Scanning with sonar...look left, look ahead, look right.



The Boe-Bot left-side wheel.



The Boe-Bot bottom side, showing the servos and batteries.

I mounted the PING sonar kit onto my Boe-Bot. This sensor detects objects by broadcasting a brief (200 microseconds) ultrasonic pulse and then measuring the time until the echo is detected. The longer the time until the echo is heard, the farther away the target object is. The documentation claims that PING can accurately measure distances from three centimeters up to three meters. The sensor is mounted on a servo at the front of the bot, where it really resembles a pair of eyes! The servo can rotate 180°, and I used it to scan to the left, right, and directly in front of the bot.

Sonar can be used to navigate in a variety of different ways – what you do is up to your imagination! For example, it could detect the closest object, drive towards it, and then "hover" a few inches away. Alternatively, it could be used to detect objects in the bot's path and then avoid them.

For this article, I wrote a routine that enabled the Boe-Bot to find its way out of a maze. The Boe-Bot looks forward and to each side, and proceeds to move seven inches toward the most open area, or in the direction where there are the fewest or farthest removed walls. Then it stops and repeats the scan. If it finds it is cooped up in a corner, it rotates 180° and rescans. This simple logic lets the Boe-Bot navigate around a room or even in a maze without getting stuck in a dead-end. It is easy to envision enhancements to this program that will "remember" where it has already traveled. Also, other sensors (like IR for edge detection) could be used to ensure the 'bot doesn't drive off the edge of a step or table. It is the cutest thing seeing this little guy patiently looking around and finding his way to freedom.

Logic for PING Sonar Maze Navigation

```
Start
    Measure distance front
    Measure distance right
    Measure distance left
    Is distance forward > 7 inches ?
        If yes, then move forward 6 inches and goto Start
    Is distance right > distance left and > 7 inches ?
        If yes, then turn right and goto Start
    Is distance left > distance right and > 7 inches ?
        If yes, then turn left and goto Start
    Otherwise turn 180-degrees and goto Start
```

GOING BEYOND THE BASICS

After mastering the basics, Boe-Bot add-ons let you branch out into new activities. Parallax offers kits for making your Boe-Bot talk with a speech board, adding infrared remote control, maze contests, line following, interfacing direction sensors, and using RF modules and video/camera equipment to build a Video-Bot. Of course, all Boe-Bot accessories are sold separately. The USB Board of Education (and BS2-IC) may also be removed from the bot and used as a platform for the other kits in the Stamps in Class series.

CONCLUSION

This kit gives a comprehensive look into all aspects of robotics. It teaches the user about mechanics, electronics, and programming. From the fundamentals of how each electronic component functions, through PBASIC syntax and programming logic, this kit provides a wide range of experience. The package says that all the experiments can be completed in 50 hours, but I think many more hours could be spent if you really explore all the potential it offers. I had a lot of fun with this robot, and I'm looking forward to playing with the language as I further develop and refine its capabilities. ◎

Links
Parallax, www.parallax.com, (888) 512-1024

For more information, please see our source guide on pg. 97.