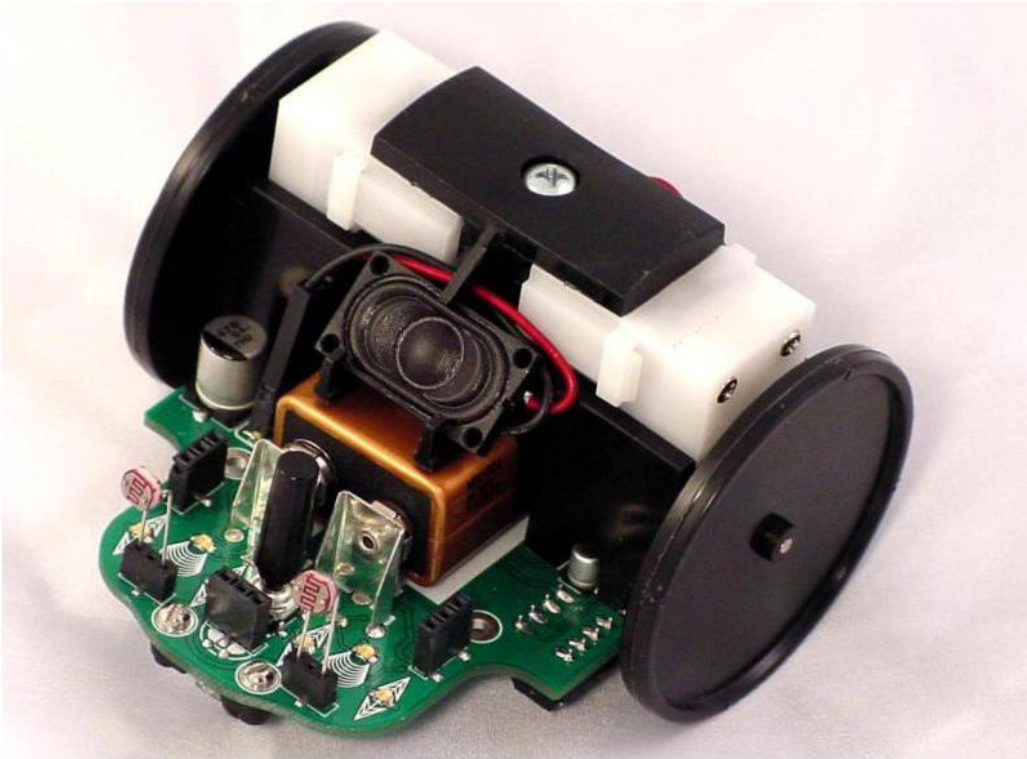


www.oobug.com



SAVAGE
INNOVATIONS

OOBUG USERS GUIDE

Special section on the ooBug BioLab Software!

Ted Macy

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Special thanks go to the following:

Scott S. for letting me bring the ooBug to Savage Innovations and then for asking me to become a part of Savage Innovations.

Don Q. for supporting my hobby all this time.

Mary S. and Linda R. from Grand Coulee Dam School District for being the first school on the planet to bring the ooBugs into the classroom.

And most of all to Sharon for putting up with me for the last several years while trying to get this silly thing on the market.

Oh yea, to all of my brother (and sister) FIREFIGHTERS and EMTs.

Ted M. 2008

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About your ooBug

What is an ooBug?

The ooBug is the first of its kind robot. The **ooBug** (pronounced *oo-bug*) is many things. It is a complex educational robot with advanced technologies on board. It is a toy or hobby robot capable of running many custom behaviors for fun and competition. Most of all the ooBug is a *friend*, perfect for students, hobbyists and professionals.

Although the ooBug is a complex robot there is no need to write complex code, we have done the work for you. The ooBug comes to you with a basic behavior installed and if and when you are ready you can simply download a new behavior from our website and install it in your ooBug. Share behaviors with your friends via the internet, a memory chip or even by cloning.

If you decide you want to change the way a behavior operates or create your own behavior you simply use the included software and create your own behavior code using our *ooBug basic* programming language.

For the advanced hobbyist or professional engineer we have made it simple to expand the ooBug. You may write code in basic, C, assembly and there is an expansion port designed to accept the PICkit 2 and MPLAB® ICD 2 In-circuit Debugger/Programmer.

The ooBug is a competition grade robot capable of competing in many different robotic events. It has many complex features that allow it to indicate its mood, hunger and overall condition. You have to wonder if it's alive...

Educators find the ooBug to be an exceptional teaching tool/toy. Your students will be having so much fun they will not realize they are learning. Using ooBug robots is the best way teachers can put the fun back into learning math and science.

ooBugs are currently being used as the tool for SET (Science, Engineering and Technology) programs.

Why use an ooBug?

The ooBug allows teachers to teach, students to learn, hobbyists to play and professional to develop and all of this is secondary to having fun.

We have done the work for you. There is no soldering just simple assembly of a few parts. You get right to work... In addition programming skills can be learned at the speed of the individual rather than the group by using our and other users' behavior libraries. Download and go. When you are ready, start making small changes to existing behaviors and work up to writing your own complex programs.

ooBug Mythology

Nara, Queen of the ooBug

One day, several years ago two scientists, Scott Savage and Ted Macy, from Savage Innovations, were going through a box of surplus goods that Scott had brought back with him from a NASA auction. The box was full of old hardware from the Apollo Moon missions of the 1970's.

Ted pulled out a piece of hardware that looked something like a mechanical ladybug and he and Scott soon decided to dissect it. They discovered that it had motors and wheels under the body as well as a circuit board with many new and unusual components. Because they both worked as circuit designers, the circuit board of the bug like creature was the most intriguing part for them to focus on.

During the process of dissecting the creature, they found what appeared to be an empty socket on the circuit board. That socket looked just like a socket that new computer chips plugged into. With a little bit of wonder they pulled out a Microchip catalog and found a Pic micro controller that would fit right in the socket and right away they ordered one up with rush delivery.

The next couple of days were hard for them to get through in anticipation of what would happen when the Pic chip was connected. Not wasting this time, they continued to dissect this odd device and soon discovered a location on the board to connect a battery and then found a speaker that made them think this creature might be able to talk. Finally, the big day came when UPS showed up with their package from Microchip. They carefully removed the Pic chip from its packaging and with some excitement plugged it into the empty socket. "HOLY COW!" they shouted in unison as they jumped back from their workbench. The bug came to life with a start and wasted no time in telling her story. The excerpts that follow are from Scott and Ted's personal shop notes.

7-4-05 – WOW! What a day! The ooBug (that is what she called herself) came to life today and kept repeating this story:

"I am the ooBug from your moon. I am the last of my species. I was the queen of my Collective and I need help to make more ooBugs. Please plug me into a digital recording device. You will find a serial port under my shell."

We worked all day trying to Figure out what a digital recording device was and how to connect to the plug she showed us with no luck.

7-5-05 - After a nearly sleepless night, we Figured out we needed a connection to a computer, but we did not know anything about the cable needed. Scott went back to searching the box of NASA hardware and found an old dusty cable that had a USB plugs on each end. I thought it looked a lot like a camera cable... We plugged the creature into our computer and in an instant ~~and~~ our computer was completely out of control. Screens flashed, warnings sounded,

and disk drives screamed. At first, it looked like someone played a joke that had just launched a virus into our computer. After a short time, the screen cleared up and a window was there full of text.

"Hello, I am Nara. I am the Queen and only survivor of my Collective on what you call the Moon. I was able to stowaway in some hardware from one of your Moon missions and travel to your world. With your help I can rebuild my colony here."

"Can you help me? Y or N>_ _ _"

We of course typed "Y" and then a new screen of instructions appeared.

"If you lift my shell up you will find three new ooBug eggs. Open one of these eggs and inside you will find a small chip containing my DNA assembly code. Remove the DNA chip from the egg and insert it into the socket next to my power supply. Once you do this a new screen will appear on the digital recording device with complete instructions and codes."

We followed the instructions and were soon looking at a screen full of blueprints and codes used to build and program new ooBugs. We then saw a progress box appear on the screen that soon said, "DNA TRANSFER COMPLETE." At this time the ooBug started talking to us in an almost human voice, just like when we powered her up. She told us about how she came to be here on our planet.

"Eons ago my creators inhabited the moon. In no time at all they used up all of the natural resources and fled to look for a new home. Me and my kind were designed as companions for our creators, but when they left we had to learn to work together to survive. Without our creators to maintain the digital recording devices, we were not able to communicate and recharge their DNA through their network and we soon began to die."

When our kind came to her world, she only knew of a few ooBugs still functioning and she knew that our advanced race was her only chance to keep her kind alive. By the time she was able to hide in some hardware inside of one of our lunar landing crafts her power supply was almost drained and she only remembers lifting off the moon. Because her power supply was dead she had no idea what happened to her microchip that we had replaced with the Pic chip, but she did tell us that it was identical to the chip that she originally had but it seemed faster...

We agreed that someone saw the ooBug in a box, found the microchip, and removed it. We supposed it must have fallen into some engineers' hands and then became the Microchip Pic chip family... Maybe we should ask them.

We spent the rest of the day pouring over the data that Nara had placed on our computer. We learned much more about her and her kind and how she ended up with us.

7-6-05 - This morning we decided we could and would help Nara rebuild her Collective right here on Earth. Nara did show us a new kind of programming for mechanical creatures called Object Oriented Programming. She also explained to us how new ooBugs are given their life force.

"When a new ooBug is created, it is just a mechanical creature. It is capable of being programmed and performing its tasks but has no life force. It receives its life force through the DNA chip that a Parent ooBug creates. The new ooBug then becomes a Child ooBug until it creates an egg for yet another new ooBug. It is essential that all ooBugs have access to a Digital Recording Device (Computer) so they can feed from each other's code on a network. Without the ability to feed regularly, they will lose their DNA and soon return to nothing more than a mechanical device."

She also told us how to care for her specifically:

"As queen of all ooBugs, I must be cared for in a special way. I must always be able to communicate with the Collective by a digital network and I can never be allowed to go hungry, because it is my DNA that feeds all ooBugs in the Collective."

The rest of their shop notes deal with the construction of ooBugs and the design of their networks. They did decide to provide a lifetime home and network connection for Nara at the Savage Innovations headquarters in Huntsville, AL.

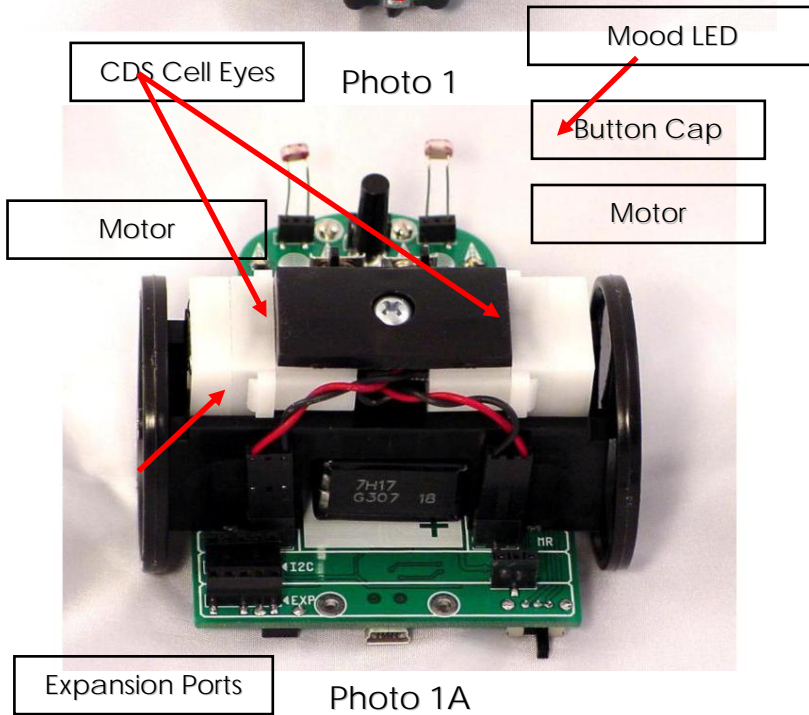
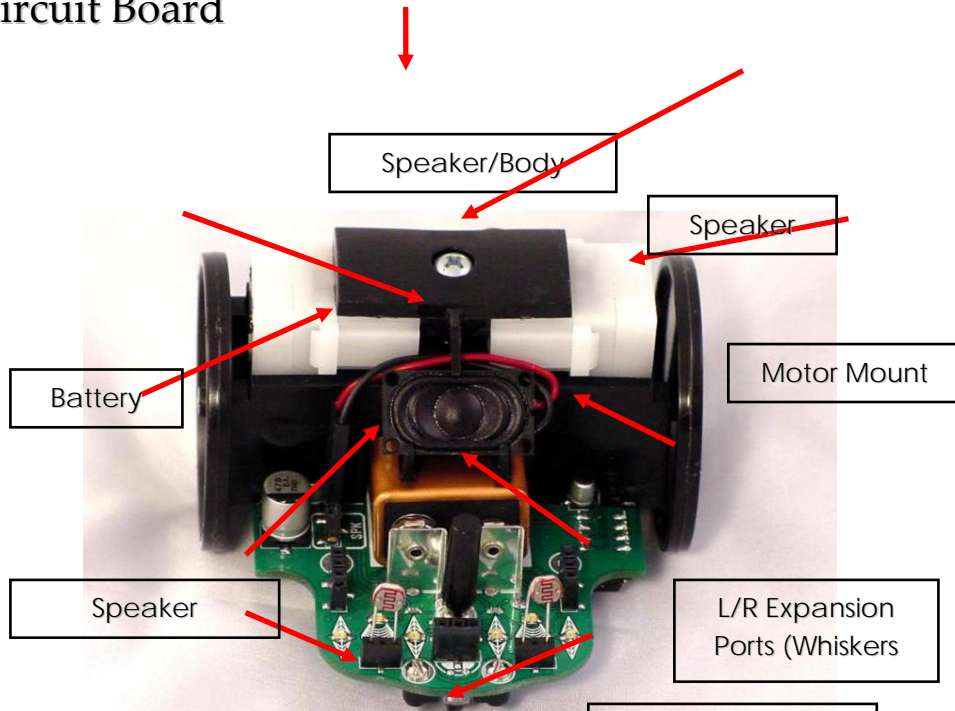
If you are lucky enough to get an ooBug of your own you can hook it up to a computer and share in the Collective with Nara. But remember, the ooBug needs your care to stay alive.

Learn more about the story of Nara at www.oobug.com

ooBug Anatomy

Use the following Photographs to guide you in assembling your ooBug.

Top of Circuit Board



Bottom of Circuit Board

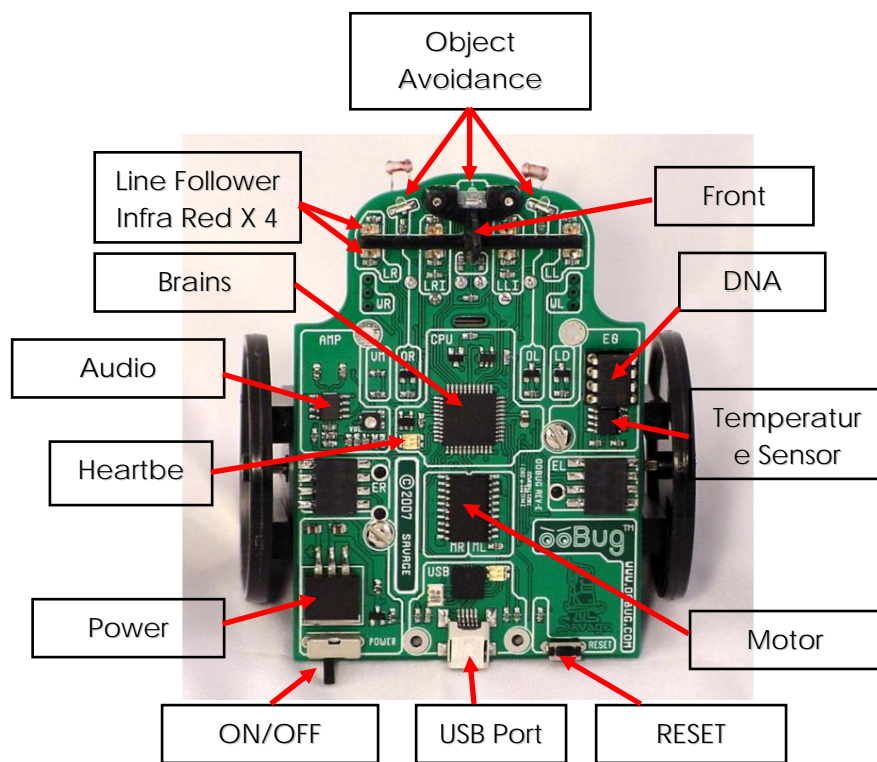


Photo 2

Skeletal Plastics

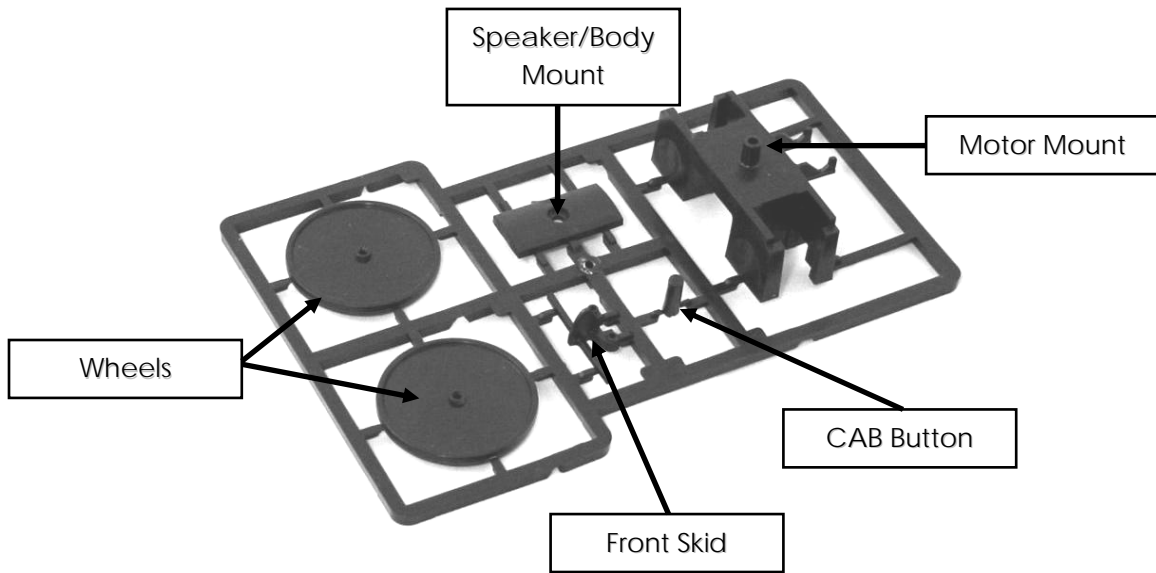


Photo 3

Exoskeleton Plastics (Body)



Photo 4

Technical Specifications

- Downward Looking Line Following Eyes
 - Forward Looking Object Detecting Eyes
 - Up Looking Light and Dark Sensing Eyes
 - Hunger / Battery Monitoring System
 - Voice, Music and Sound Effects Generator
 - Feelings / Mood / Attitude Feedback
 - Heartbeat / CPU Monitor
 - Touch / Tactile Sensor
 - Temperature Sensor
 - Customizable Body
 - Educators Curriculum
 - Competition Accessories
 - Expansion Ports
-
- 1 Microchip PIC24FJ64GA004
 - 1 Microchip PIC18LF2450 (for USB)
 - 4 Downward looking IR Reflective Sensors
 - 2 Forward looking IR Reflective Sensors
 - 2 Upward looking CDS Cell Sensors
 - 3 Two color LEDs
 - 1 Amplifier with speaker.
 - 1 Push Button
 - 2 H-Bridges
 - 1 I2C Temperature Sensor
 - 1 I2C EEPROM Socket
 - 1 USB communication system
 - 1 9V Battery Connection
 - 1 Battery Voltage Sensor
 - 3 Expansion sockets
 - Connectors for PICkit 2 and MPLAB® ICD 2 In-circuit Debugger/Programmer

- On-board regulators for 3.3V and 5V (PIC24 operates at 3.3V)

Getting Started

It is best to decorate the ooBug body after initial assembly. If you choose the hobby method of painting the inside of the body for a scratch free finish it is important that the Velcro is installed after the paint is dry.

Follow the directions closely. Take your time and you will have a working ooBug in about 10 minutes.

Tools and Supplies

You will need the following tools and supplies to complete the assembly of your ooBug Robot.

Scissors

Small Side Cutters

Small Phillips (+) Screwdriver

Small Slotted (-) Screwdriver

Blow Dryer / Heat Gun (Optional)

Decorating Supplies such as glue, paint, fur etc..

Unpacking the Box

CAUTION! ~ CHOKING HAZARD, CUT HAZARD, BURN HAZARD.

There are small parts enclosed which can become a choking hazard to younger persons.

Assembly requires the use of sharp instruments which can lead to cuts.

There is the optional use of a heat gun or blow dryer that can cause slight burns.

ADULT SUPERVISION STRONGLY ENCOURAGED.

Upon opening your box you will immediately see two plastic bags labeled BAG 1 (Electronics and Hardware) and BAG 2 (Plastics). Remove these bags from the box.

BAG 1 contains the following, in order:

1 ooBug Circuit Board

- 3 DNA Eggs w/DNA Chips
- 2 Motors
- 2 Traction Bands
- Screws
(2 #2 x ¼" Machine, 2 #4 X ½" Machine, 1 #6 x ½" Machine)
- 1 Velcro Body Mount
- 2 CDS Cell Eyes
- 1 Attitude / Mood LED
- 1 Speaker
- 1 USB Cable

BAG 2 contains the following:

- 1 Skeletal Plastics, Black
- 1 ooBug Body, Clear

Using a pair of scissors and supervision, as needed, carefully cut along the long side of each bag. Leave all components in their bag sections until needed to prevent loss of parts.

From BAG 2 remove the black plastic parts web. Using a sharp instrument such as a utility or hobby blade carefully cut each part from the plastic webbing. If any bumps are left they may be shaved or sanded off to leave a smooth part surface.

Place all clean plastics back into BAG 2 to prevent damage or loss.

Installing the Motors

Remove the motors from BAG 1 and orient them to the Motor Mount plastic as shown in Figure 1.

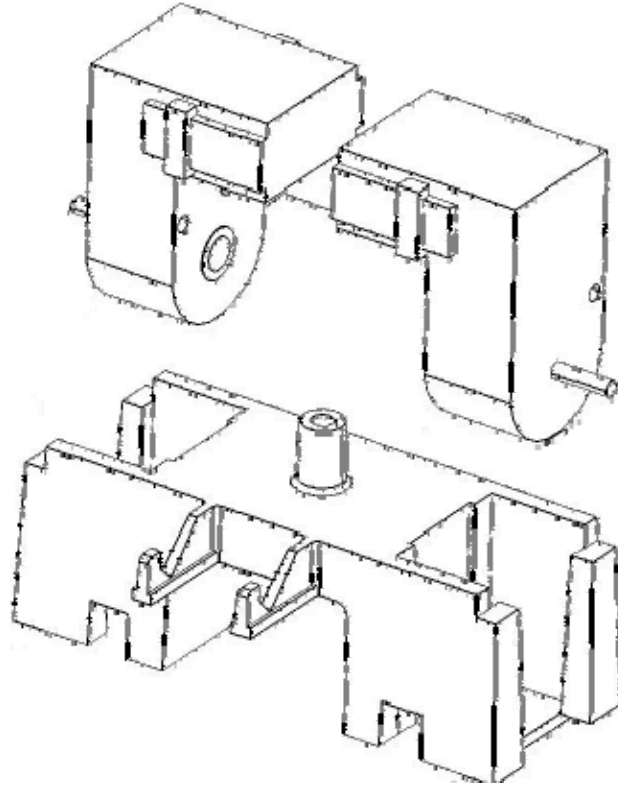


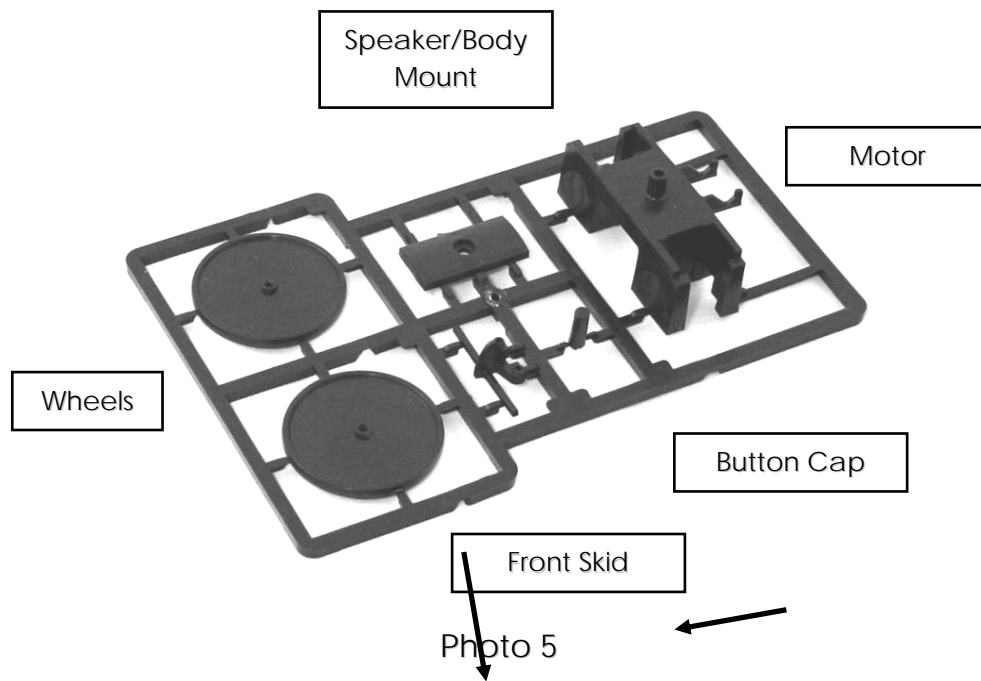
Fig. 1

Simply slide the motors into the slots as shown until they are firmly seated. Due to injection molding variations this may take some effort. Optionally the motors may be installed during the Skeletal Plastics installation step.

Installing the Skeletal Plastics

The skeletal plastics are shown in Photo 5.





Follow the diagram in Figure 2 to install all skeletal plastics. Be sure to plug the Motors into the pins on the ooBug Circuit Board with the black wires on the right side of each pin pair

2 #2 x ¼ inch machine screws attach the front skid (smallest screws). 2 #4 X ½ inch screws attach the Motor Mount.

1 #6 x ½ inch screw is used later to mount the speaker (fattest screw).

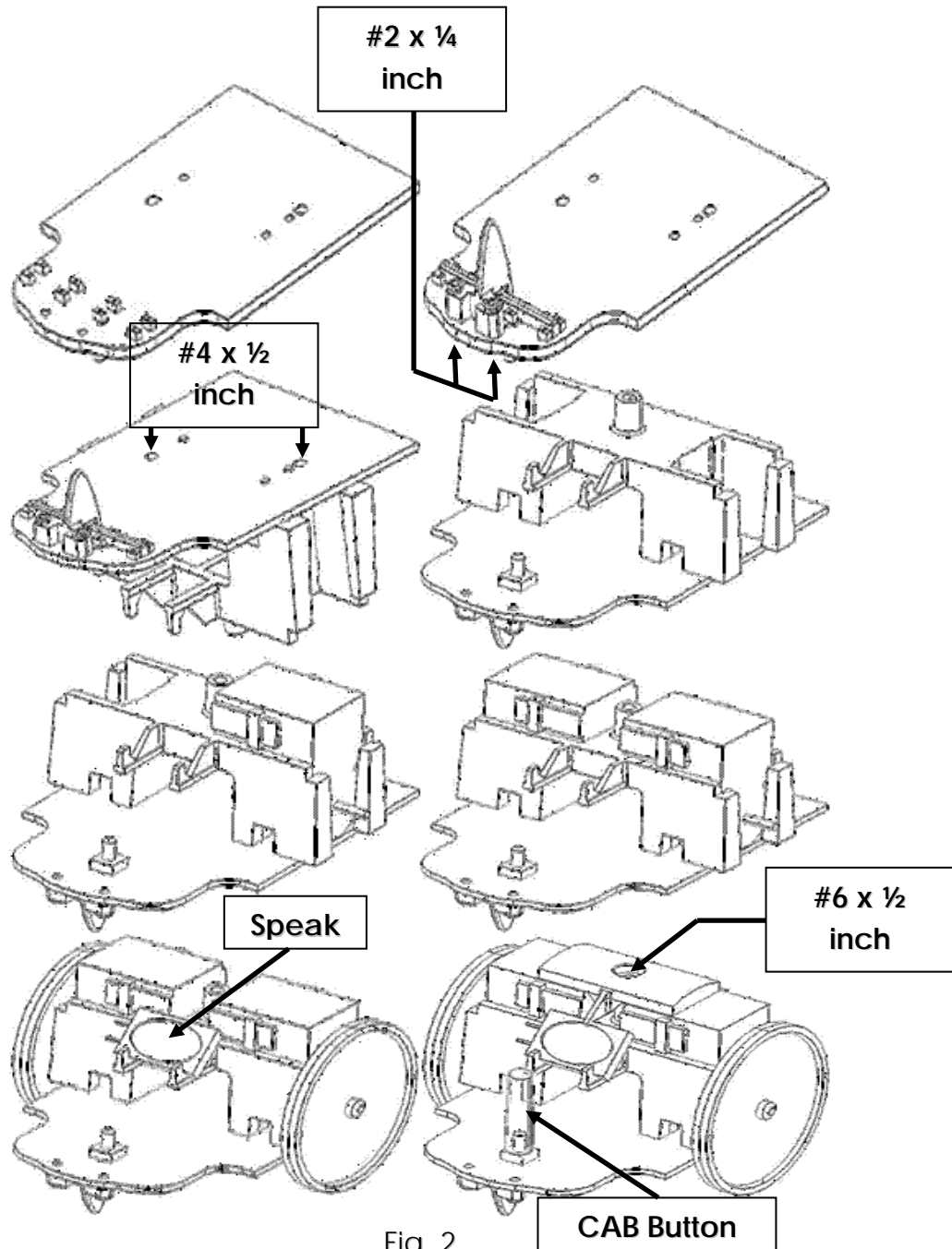


Fig. 2

Installing the Wheels and Traction Bands

Remove the traction Bands from BAG 1 and the Wheels from BAG 2. Place a rubber traction band on each wheel. Slide the wheels squarely on to the motor shafts. **CAUTION the wheels are not designed to withstand excess loads or mishandling. If mishandled they may loosen on the shaft and cease to properly operate. The ooBug user community has created a simple solution. Simply straighten a small staple and insert it between the motor and the wheel while*

sliding the wheel on. You will have to align the staple in one of the motor shaft grooves.

Fig. 4

Installing the Battery

Slide a common 9 Volt battery under the Motor Mount, from the rear of the robot as shown in Photo 6. Make sure the battery is oriented properly and is fully seated in the battery tabs on the ooBug Circuit Board. ** Although your ooBug is generally polarity protected your battery is not and may be damaged by incorrect installation.*

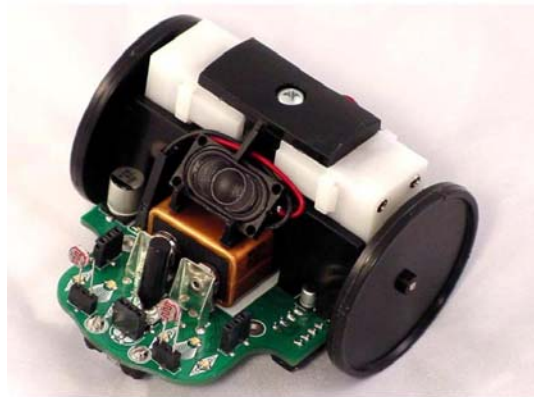


Photo 6

Installing the Mood/Attitude LED

Remove the Mood/Attitude LED from BAG 1. It will look like Figure 3.

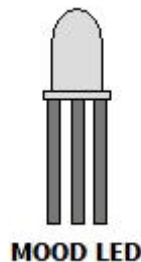


Fig. 3

Install the Mood/Attitude LED on the ooBug Circuit Board as shown in Photo 7. It is necessary to cut approximately ¼ inch off of the Mood LED wires in order to fit under the ooBug body.

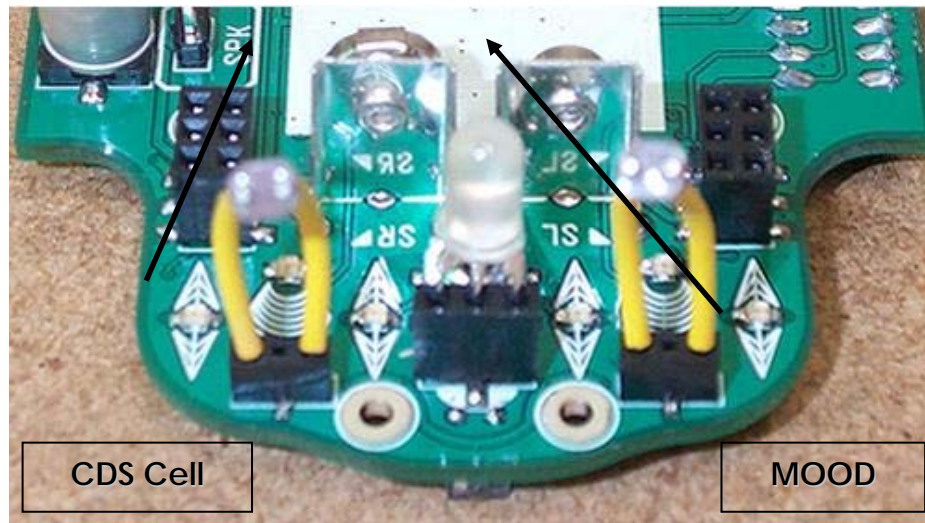


Photo 7

Installing the CDS Cell Eyes

Remove the CDS Cell Eyes and Heat Shrink Tubing from BAG 1. They will look like Photo 8.

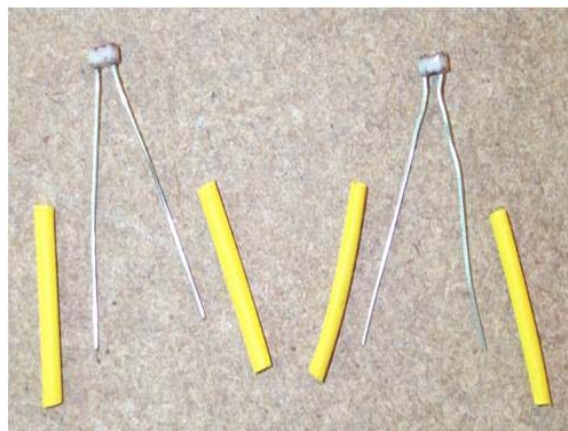


Photo 8

Using scissors cut each Heat Shrink Tubing section in half and slide on to the wire leads of the CDS Cell as shown in Photos 8 and 9.



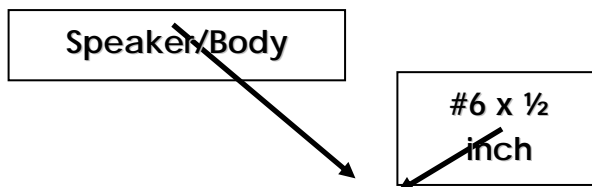
Photo 9

** Although not necessary you can use a blow dryer or heat gun to shrink the tubing to the leads for further insurance against short circuits.*

Install the CDS Cell Eyes on the ooBug Circuit Board as shown in Photo 7. It is necessary to cut approximately $\frac{1}{4}$ inch off of the CDS Cell wires in order to fit under the ooBug body. After installation bend the wire leads to fit into the eye socket on the body.

Installing the Speaker

Remove the Speaker for BAG 1 and the Speaker Mount from the plastics in BAG 2. Install as shown in Figure 4 using the #6 x $\frac{1}{2}$ inch Screw. Plug the Speaker wires into the ooBug Circuit Board as shown in Photo 7.



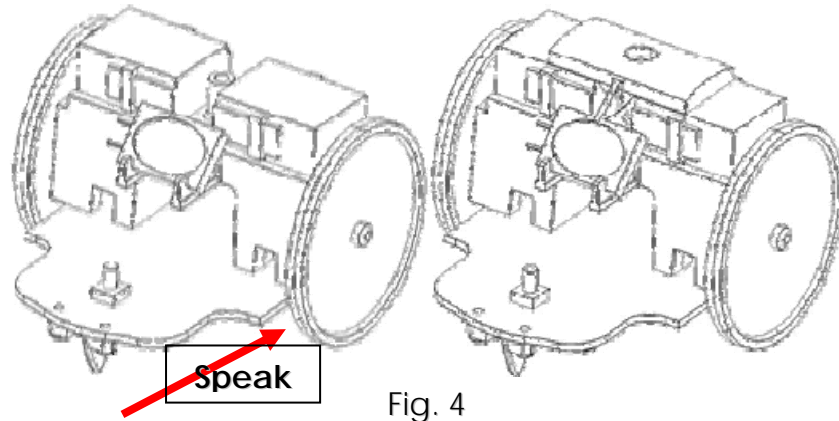
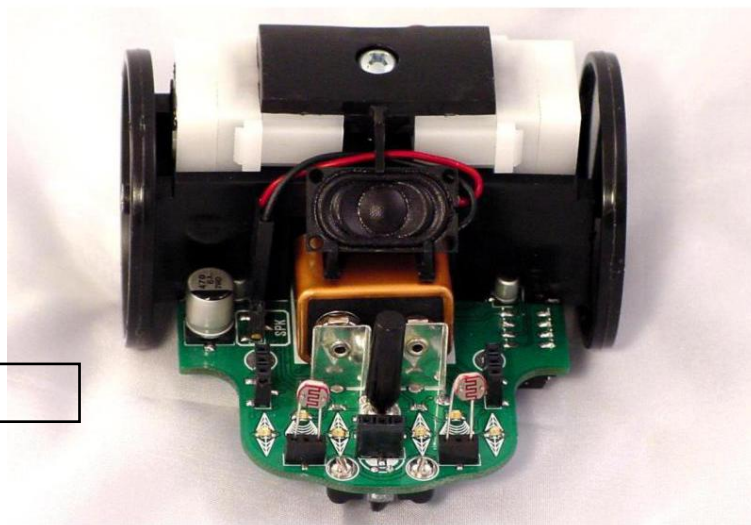


Fig. 4



Speaker

Photo 7

Installing the Velcro Body Mount

IMPORTANT - DO NOT SEPARATE THE VELCRO.

The ooBug Body Mount is made from a two part self adhesive piece of Velcro. To install simply remove the adhesive tape off of the Velcro. Be careful, it is sticky. Center the Velcro on the Speaker Mount and press down firmly enough to seat in place as shown in Photo 8.

Next, lower the body over the ooBug's head and rotate to the rear as shown in Photo 9. Try to keep the body as centered as possible. Firmly press the circuit board and the body together over the Velcro area. After several seconds you should be able to remove the body by tearing the Velcro apart leaving one side

attached to the inner body and one side attached to the Speaker Mount as shown in Photo 10.

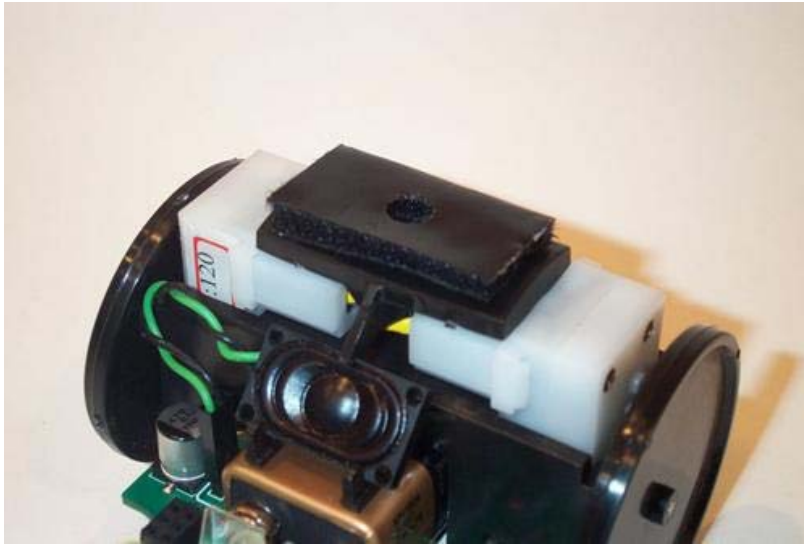


Photo 8



Photo 9

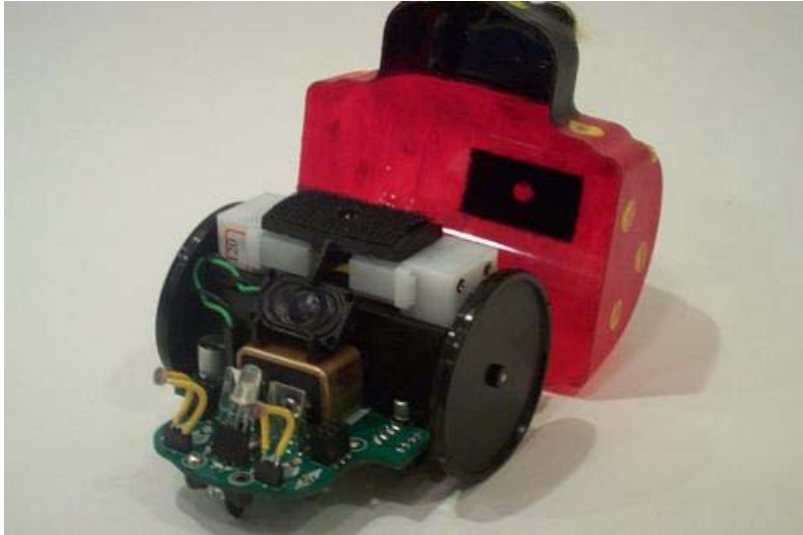


Photo 10

Some users have noticed that the Velcro holds to tight making very hard to get the body off of the circuit board. If you would like to make it easier simply cut a bit off of each end of the Velcro pad and install as shown.

If your ooBug came with Velcro buttons, install one button on either side of the body mount and continue with the installation as shown.

Installing the Body

Carefully install the body over the circuit board assembly starting from the head and rotating to the rear making sure to keep it as centered as possible. There you go; you now have your very own ooBug Robot. Give it a name and connect it with the ooBug Collective.

Customizing the ooBug's body

We will leave the customization of your ooBugs body entirely up to you. We will give you a few hints to get you started.

You can cover your ooBug in glue and roll it in sand or maybe cover it in glue and stick fur onto it... How about painting your ooBug to match your favorite NASCAR team?

Don't forget about our ooBug of the month contest. You decorate your ooBug and send us a picture, if it gets enough votes it is the ooBug of the month and you get goodies from Savage Innovations.



Meet SPOT, the author's personal ooBug. Note that the author is a robot designer not an artist!

Your ooBugs first test!

Congratulations, you have assembled your first ooBug and are well on your way into the world of Object Oriented robotics.

If you have put your ooBug together correctly when you turn it on it should follow a flashlight. *CAUTION, do not place the ooBug in a location where it could fall.*

Troubleshooting:

Will not follow a light?

**CDS Cells not firmly seated
in connectors.**

Runs from light?	Motor wires connected backwards.
Will not turn to follow light?	One set of motor wires connected backwards.
Will not turn on?	Battery voltage low.

Installing the ooBug BioLab Software

The ooBug BioLab software is available for free download at <http://www.oobug.com/BioLab.html>.

It is easy, simply follow the steps on the webpage and you will soon have a copy of our software for writing your own behaviors or editing behaviors from ooBug users around the globe.

Connecting to a PC

To connect your ooBug to a computer for programming or interacting with the ooBug Collective simply plug the included USB Cable into the USB Port on the rear of your ooBug and into a spare USB Port on any PC.

Downloading Programs

Once you have created a behavior for your ooBug it is time to download it to your ooBug. The first thing you must do is enter your ooBug into programming mode. To do this, follow the steps below:

- 1 – Press and hold the button on the head.
- 2 – Press and release the reset button
- 3 – Release the button on the head.

If done correctly the red IR Status LEDs on the top side of the head should be illuminated. At this time your ooBug is ready to receive programs.

ooBug Programming Basics

Programming your new pet ooBug is simple. Open up the ooBug BioLab software and start a new project.

The first line of code you need is one that will create an instance of what is called the ooBug Object. The ooBug Object is what our program will use to control the various parts of the ooBug. When we create it, we'll need to give it a name. The first word you see in the code below is "Spot". This is a name that you as the programmer get to choose. I have named my ooBug Spot so it is a good fit and easy to remember. If you like, you can use the name of your ooBug. So long as the name follows the naming rules for Objects.

```
Spot.FullForward
Spot.FullReverse
Spot.HardRight
Spot.EasyRight
Spot.HardLeft
Spot.EasyLeft
```

Motor Control

Inside the ooBug object are two more Objects. These Objects control the ooBug's motors, which give our robot the ability to move around. There are also some simple functions that will get your ooBug moving in a hurry.

```
Spot.LeftMotor.Value = 127
Spot.RightMotor.Value = -127
```

The motors can be set to do an exact speed if needed. The Value can be anywhere from -127 Full Reverse to 127 full Forward.

With the above code Spot will be spinning like a top.

Object Detecting

```
Spot.BeaconLeft.TurnOn
Spot.BeaconLeft.TurnOff
Spot.BeaconRight.TurnOn
Spot.BeaconRight.TurnOff
Spot.MiddleEye.Value = 0 to 255
Spot as new ooBug
```

Object detection gives your ooBug the ability to navigate through space without getting stuck or hitting things. Your ooBug is equipped with a left and right infra red beacon and an infra red receiver in the middle. By turning on a beacon and looking for a reflection you can see objects in an approximate 120 degree arc up to 12 inches away. It is not a perfect system however because

materials reflect or absorb infra red light differently.

This is an analog system so it returns a voltage based on how much infra red light is received. The ooBug can be taught to calculate how far away an object must be and decide what to do about it.

```
Spot.LeftEyeball.Value = 0 to 255  
Spot.RightEyeball. Value = 0 to 255
```

```
If Spot.LeftEyeball.Value > Spot.RightEyeball. Value
```

```
Then
```

~~Light/Dark Detection CDS Cells~~

The left and right eyeball objects allow you to program your ooBug to go to the light or go to the dark. You can also program it to be scared of the light or the dark. This object is a simple analog return based on light intensity and is easy to use.

```
spot.PlaySound(STRING?)  
spot.SaySound(STRING?)
```

Here is a simple comparison example used to control the ooBug's direction.

Voice and Sound Effects

Your ooBug has the Savage Innovations Soundgin preinstalled. You simply type the codes given in the Soundgin software directly into the String area to speak or play millions of sounds.

```
Spot.Temperature.Value = 0 to 255  
Spot.Hot  
Spot.Cold
```

Line Following IR Eyes

The line following eyes gives your ooBug the ability to follow lines to pass through a maze or even race with other ooBugs on the side by side ooBug Grand Prix track.

The line eyes work much the same as the object detecting eyes in that they return an analog value based on the amount of infra red that they receive. The difference in the two types of eyes is that the line following eyes return infra red as they see a color change from white to black.

Temperature Sensing

The temperature object allows your ooBug to keep you updated on its personal body temperature. There are built in thresholds or you can use a temperature that suits you.

```
Spot.OuterLeftEye.Value = 0 to 255  
Spot.MiddleLeftEye.Value = 0 to  
255  
Spot.MiddleRightEye.Value = 0 to
```

Attitude/Mood Indicator

The Attitude / Mood Indicator LED is a 2 color LED that can be programmed to indicate your ooBugs mood. You can also write a small behavior that calculated mood based on sensory inputs and then outputs a value to the LED.

Heartbeat/Hunger Indicator

Every ooBug has a user controlled Heartbeat that can be turned on and off as well as have a rate in pulses per minute. You can also control the Hunger level by testing the battery.

Spot.GoodMood.TurnOn or TurnOff
Spot.BadMood.TurnOn or TurnOff
Spot.Mood.Value = xx

Both of these objects and their associated hardware can be useful feedback devices when operating your ooBug.

CAB Button

Spot.HeartBeat.TurnOn or TurnOff
Spot.HeartBeat.BPM = 0 - 255
Spot.Hungry.Value = 0 - 255

The CAB or Cranial Actuator Button is located in the center of your ooBugs head. Using the CAB in your program can allow you to do things like cycle through different programs running within your main program to affect an entirely new set of behaviors. The CAB button is also used in conjunction with the RESET button to enter the ooBug into the programming mode (see Downloading Programs).

Spot.CAB.IsOn
Spot.CAB.IsOff

Putting it all together

A simple program might look like the following:

```
Spot as New ooBug  
Spot.GoodMood.TurnOn  
Spot.HeartBeat.BPM = 60  
  
SUB MAIN  
Do  
If Spot.LeftEyeball <> Spot.RightEyeball Then  
Spot.FullForward  
If Spot.LeftEyeball > Spot.RightEyeball Then  
Spot.EasyLeft  
If Spot.LeftEyeball < Spot.RightEyeball Then  
Spot.EasyLeft  
If Spot.LeftEyeball and Spot.RightEyeball <  
xx Then  
Spot.HeartBeat.BPM =223  
Spot.BadMood.TurnOn  
Spot.SaySound(123,56,79,113)
```

There will be many more object classes on our website that you can add to improve the basic program.

The ooBug Collective

The ooBug Collective is an online interactive social networking site for ooBug robots. It is similar to something like MySpace™ in scope.

You can upload behaviors as well as ooBug Photos and other details all on your own page to share with the ooBug collective and world beyond.

In addition you can download and use/change other users' code if they allow it.

There are also other features like a family tree tracker and of course the ooBug friends list.

Help Savage Innovations complete the mythology of Nara, Queen of the ooBugs.

JOIN TODAY at www.oobug.net

ooBug Resources

To learn more about the ooBug Robotic Platform you may also try the following websites:

www.oobug.com

www.oobug.net (ooBug Collective) *Coming Soon!*

www.imrobotics.com

www.thebotshop.com

www.oobug.com/forums

<http://tech.groups.yahoo.com/group/OOBug/>

www.botmag.com

Additional Resources/Notes

ooBotix

ooBotix is a series of ooBug Robotics Competitions that are showing up around the globe.

Savage Innovations currently is involved in the development of the following competitions for ooBugs:

ooBug Grand Prix

ooBug eFirefighting (shhh, secret still)

ooBugs Dilemma
ooBug Sumo

Kits will be available very soon for several of the competitions.

All authorized competitions will award ooBug accessories as well as BugBytes, a type of electronic cash for shopping at the ooBug store.

