

Robot Workshop



NATIONAL ELECTRONICS MUSEUM

Dan Zeitlin "Mr. Z"

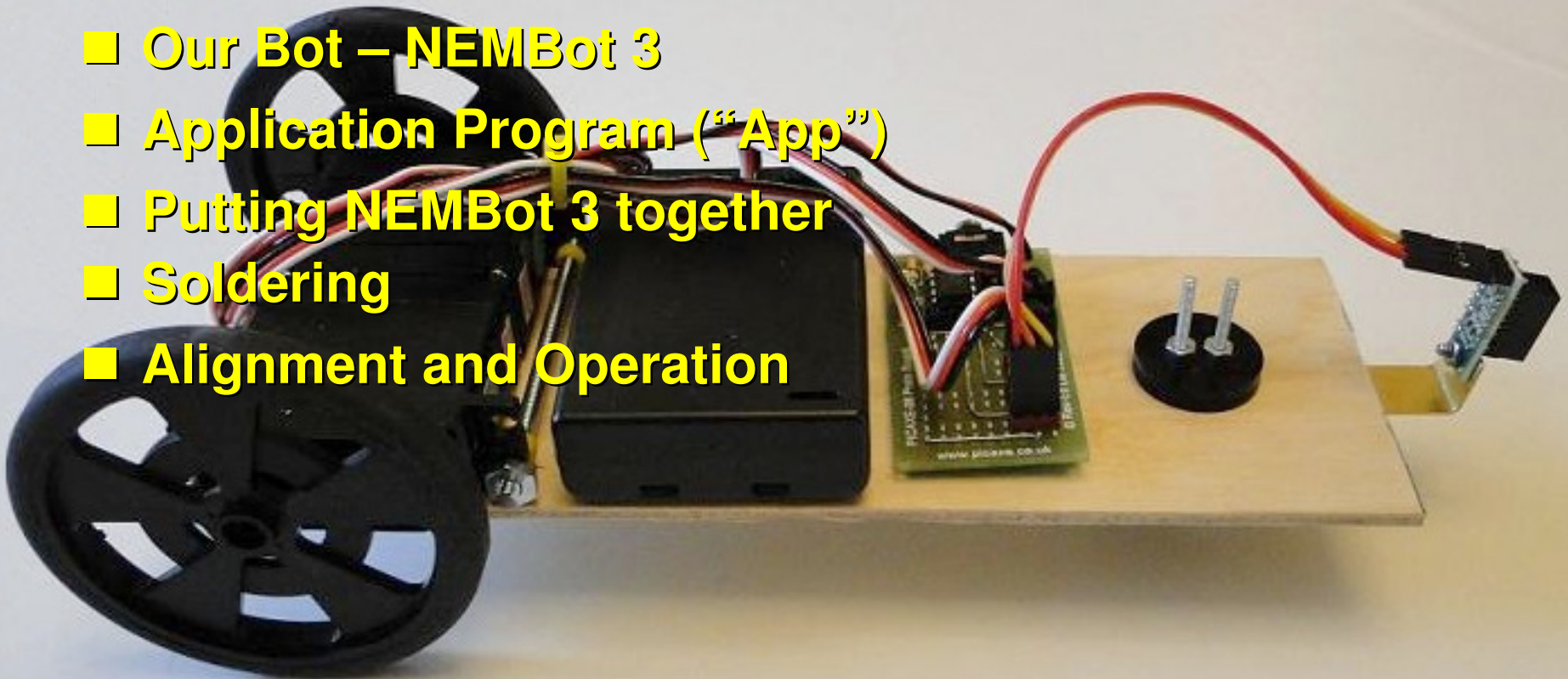
April 5, 2014

Agenda



What we're doing today

- A little about robots
- Our Bot – NEMBot 3
- Application Program (“App”)
- Putting NEMBot 3 together
- Soldering
- Alignment and Operation



Robots



There are different types of robots, but they all perform tasks

❑ What's a Robot?

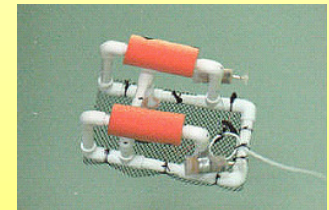
- "A robot is a machine that performs one or more tasks."
- There are two basic types:



❑ Non-Autonomous - use or require human intervention

❑ Autonomous - run without human intervention

- Smart
 - Modify their behavior in response to their environment
 - Vary from not-so-smart to brilliant
- Not-smart ('dumb')
 - Perform preprogrammed tasks without regard to environment
 - Tasks can be one or more, simple or very complex

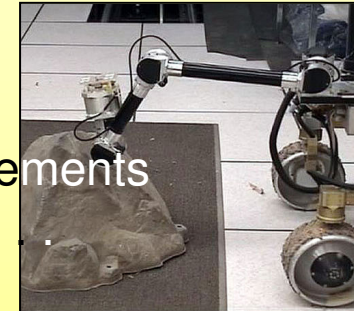


Robot Parts



Robots need a means of motion and a way to control it

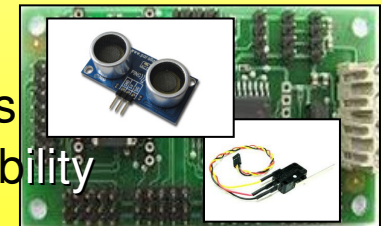
- ❑ Physical robots use motions to perform their tasks
 - Manipulation - Handle tools or other objects
 - Bionic motions - emulate living joint and limb movements
 - Machine motions – radar antenna, crane, welder .
 - Transportation motions - Move through environments



- ❑ Motors provide the means of motion
 - Linear - Move in a straight line, usually with limited range
 - Rotary – Turn either through angle or continuously
 - Specialized Actuators – Latch or other discrete motion



- ❑ Robots have some means of control
 - Varies from simple switches to complex computer controls
 - Computer programs or applications provide the most flexibility
 - Specialized *microcontrollers* are popular for robot control



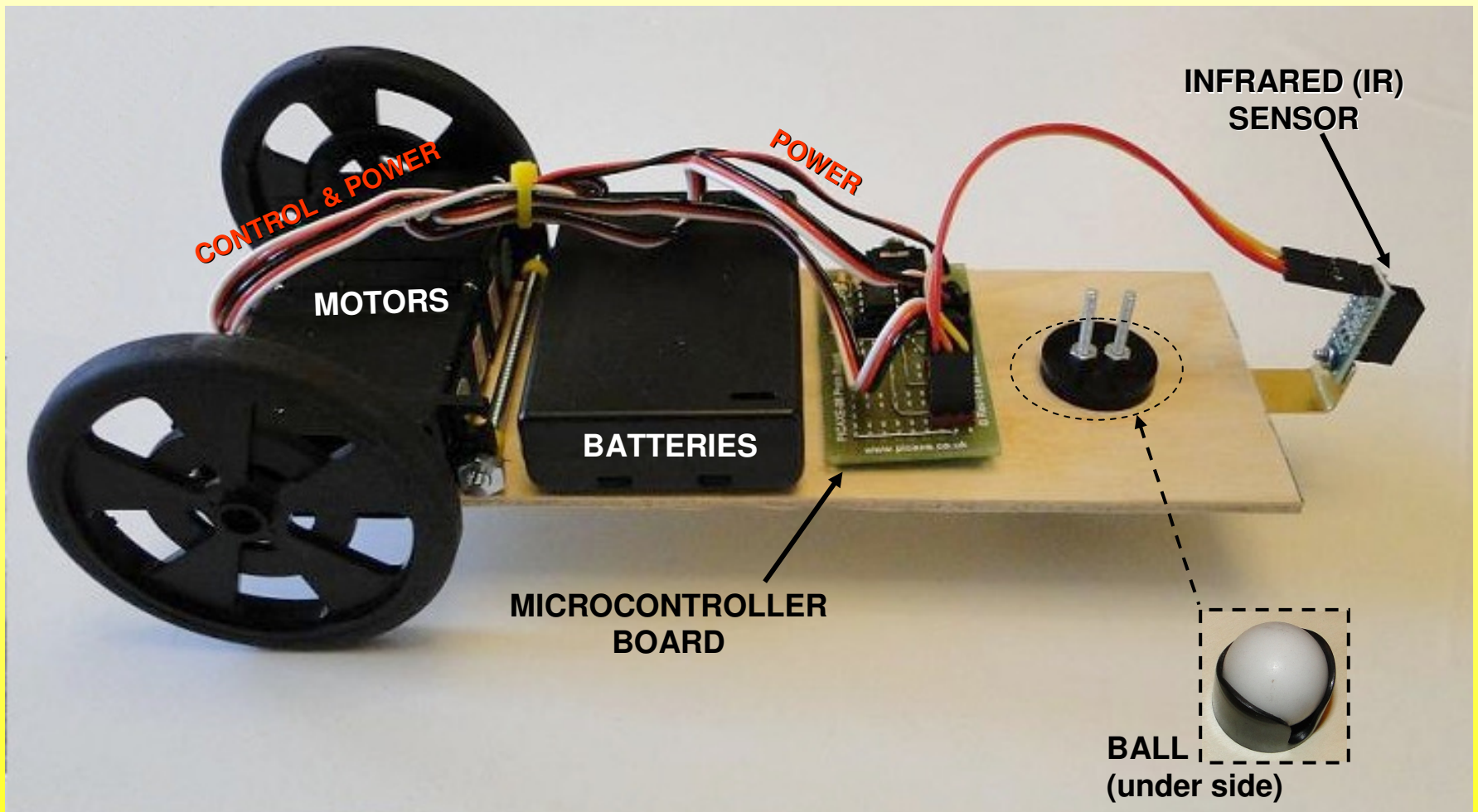
- ❑ Robots need power sources
 - Fossil or synthetic fuel, chemical batteries, solar energy . . .



NEMBot 3



The NEMBot 3 has the parts a smart robot needs



Servo Motors (Servos)



NEMBot 3 uses continuous rotation servo motors for propulsion

❑ Standard Servos

- Rotate to a commanded *position and stop*
- Used for angular motion over a limited range
- *Sense their position* and compare to command position
- Used for steering, scanning, joints, manipulators ...



❑ Continuous Rotation Servos

- Turn continuously like a “normal” motors do, no position sense
- Used for propulsion, winding reels, etc
- Forward or reverse, sometimes speed controlled



❑ NEMBot 3 uses continuous rotation servos

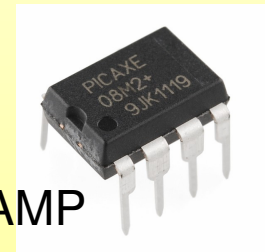
- Can go clockwise or counter-clockwise
- One speed only (not controlled)

Microcontroller Program (App)

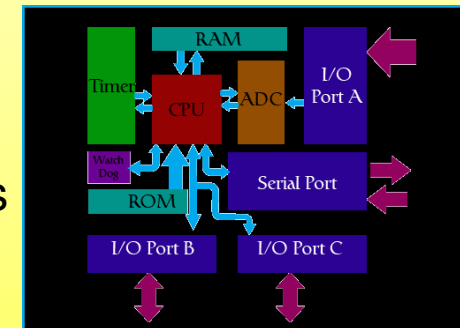


A programmed PIC tells the Bot's servos how to move

- ❑ PIC stands for “Peripheral Interface Controller”
 - NEMBot 3 uses a Picaxe[®] educational microcontroller
 - Other popular hobby PICs include the Arduino and BASIC STAMP



- ❑ All PICs have
 - Memory space to store a program (EPROM)
 - Memory space to store data (RAM)
 - Built-in interfaces to read and control various devices
 - Their own language and instruction set
 - Programming tools, usually free



- ❑ NEMBot's Picaxe[®] is programmed to control the Bot's servos
 - The Bot follows a series of programmed command steps
 - Each step represents something to do
 - Check a sensor, command a servo . . .

A screenshot of the PICAXE Programming Editor software. The main window displays a BASIC-style program for controlling servos. The code includes variable definitions for servo speeds, angles, and correction factors, followed by a loop that outputs pulse widths to servos. Comments explain the motor RPM and desired total speed, and the scaling of servo correction factors.

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10 ' servo definitions
11 symbol SPM_SPEED = 30          servo shaft speed          20 to 60 (rpm)
12 symbol SPM_ANGLE = 90         servo total angle          0 to 90 (deg)
13 symbol ANGLE_SPEED = 30      half the angular shaft speed 0-180 (deg/sec)
14 symbol SCALE_SPEED = 30      servo speed (output line) 0-255 (Hz)
15 symbol SPM_ANGLE_SCALE = 30  right position pulse width 180 to 255 (Hz)
16 symbol LEFT_ANGLE_SCALE = 30 left position pulse width 180 to 100 (Hz)
17 symbol CL_CORRECTION = 80    0 = 0 servo center correction enable 0-255
18 symbol CL_CORRECTION = 80    0 = 0 servo center correction enable 0-255
19 symbol SCALE_ANGLE = 30      pulse width to 0 degrees 0 to 255 (Hz)
20 symbol ANGLE_SCALE = 30     output loop pulse counter 20-440 Hz
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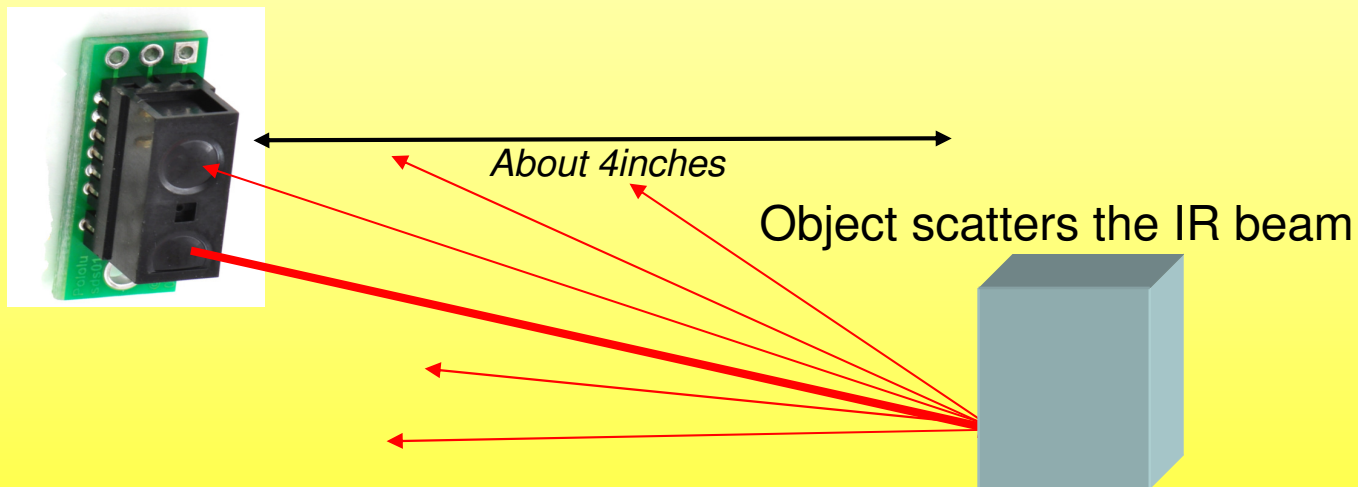
IR Sensor



NEMBot 3's sensor send out infrared light and senses reflections

❑ Sharp GP2Y0D810Z0F IR Distance Detector

- The Emitter send out a narrow infrared (IR) pencil beam
- The Detector switches its output when it sees close-in reflected IR light
- Target must be less than 4" away for GP2Y0D810Z0F to change state



- IR light wavelengths cannot be seen with the naked eye
- Some surfaces absorb IR wavelengths and become "stealth" to IR

Summary



Robots have common types of elements, so does NEMBot 3

Robots are machines that do tasks

- Can be autonomous or not, 'dumb' or 'smart.' Robot movements are driven by servos, motors, and actuators
- Controls vary from simple to complicated
- Robots often use specialized PIC Microcontroller computer chips

NEMBot 3

- Continuous rotation servos drive the wheels
- A PICaxe[®] microcontroller runs the control program
- Motion depends on environment – is there an obstruction?
- Program can be modified with a PC and free Editor software
(you'll need a programming cable)

NEMBot 3 Construction Steps



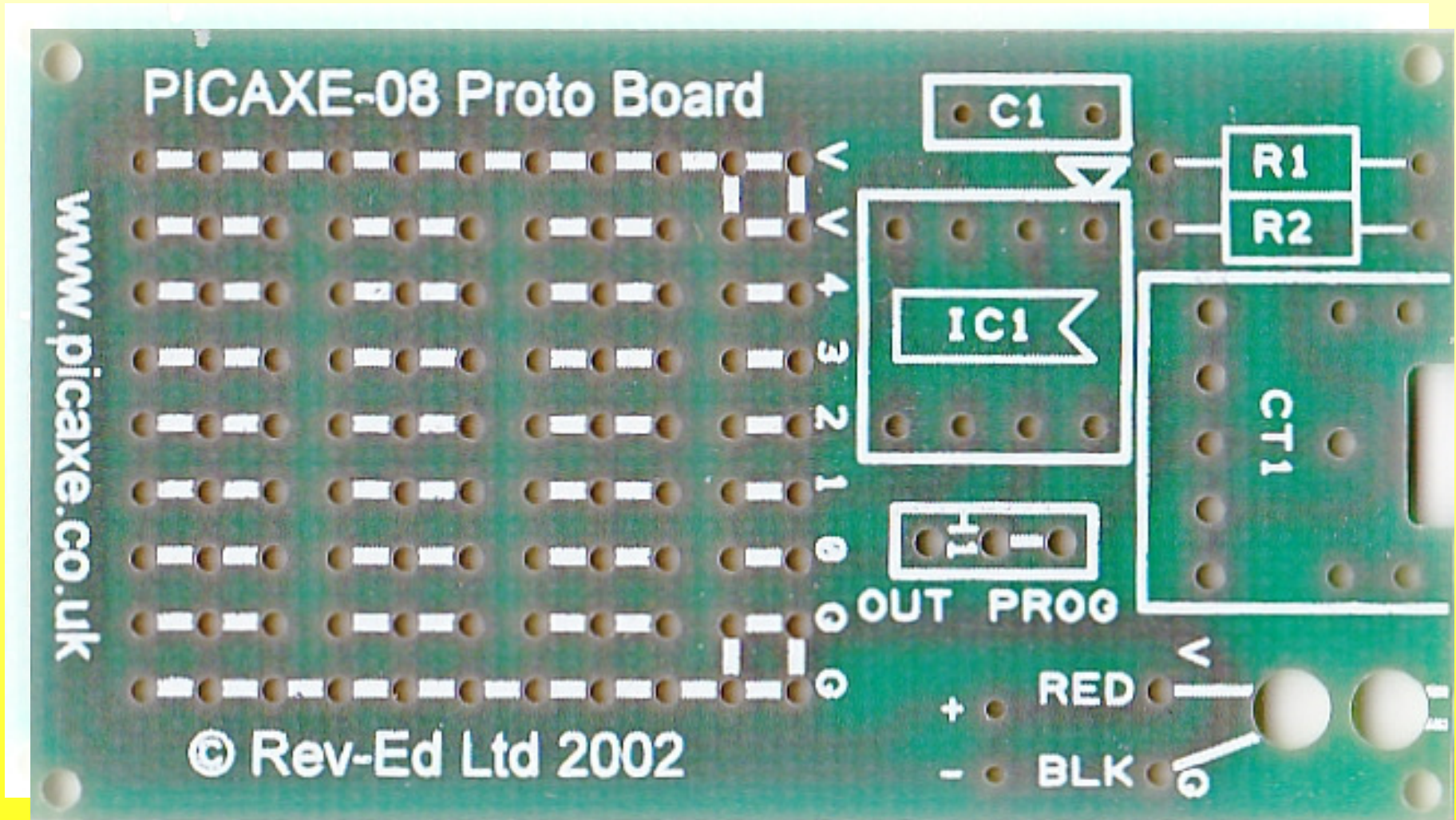
Detailed circuit board and final assembly instructions are included in separate documents:

- *General soldering instructions*
- *Picaxe[®] proto PC board instructions (you will complete the board)*
- *PC board Jumper wire instructions*
- *Final assembly instructions*

Assemble and Solder the Board



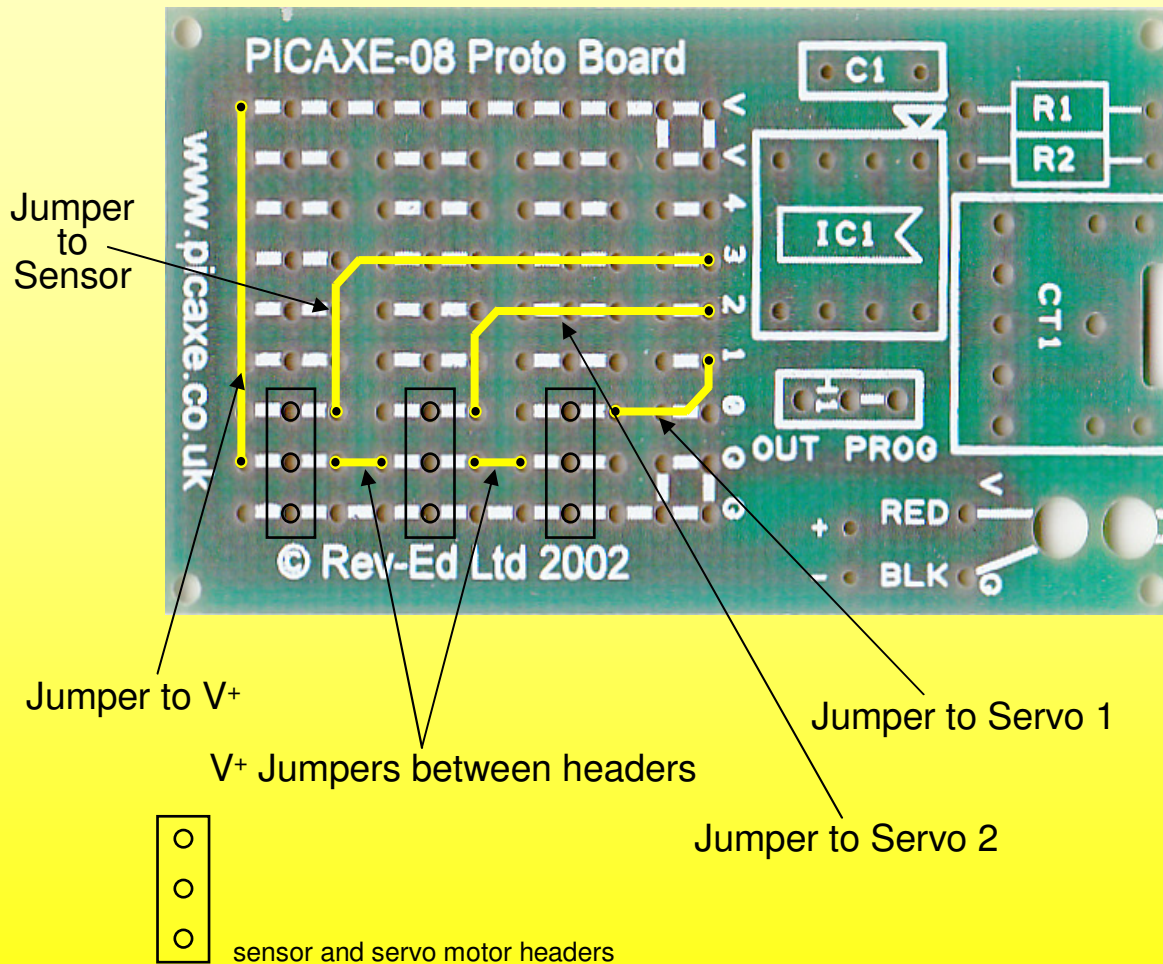
Follow the Proto Board instruction sheet



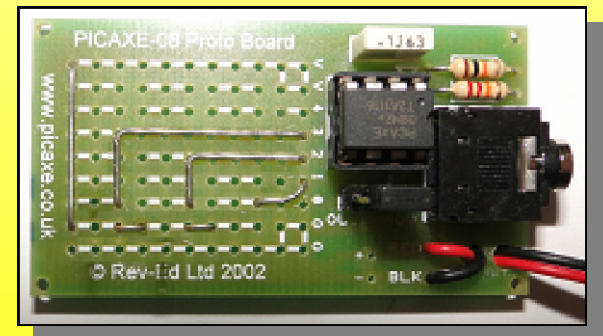
Add six jumper wires to the board



- Use solid bare (un-insulated) #22 wire
- Run wires along top of board
- Put ends through indicated holes, solder, and trim
- Count holes to make sure of ends points
- Be sure wires are not touching when you are done



It is easiest to insert one end of a jumper wire and solder it first. Then you are free to shape and run the jumper to its other end before inserting and soldering it. Exact shape is not important. Ends points and not touching are!



A Word about Soldering



Electronic parts are connected using solder

- ❑ Solder bonds metal together
 - Usually copper wire and copper Pads or terminals
- ❑ Metal must be hot enough to melt solder to make it “stick”
- ❑ Always heat the metals and let them melt the solder
 - Simply melting the solder alone makes a poor “cold joint”

Soldering temperatures are over 700 degrees F!

- **Be Careful**
- **Only touch the soldering iron’s insulated handle**
- **Never set the iron down anywhere but in its holder**
- **Wires will get hot. Hold them with a tool or not at all**
- **Always use Safety Glasses. Solder can sputter without warning!**

Alignment Check & Operation



Align your Bot so it will run correctly

- Download the application program to your Bot
- The program in the Bot is first set for servo alignment mode
 - “loop while” is set to =1 for alignment mode
 - Servos are commanded not to move (servo command is “150”)
 - Adjust each servo zeroing control so servo does not move
- Set the program to run mode
 - Change “loop while” to 0 (zero) for run mode
 - Download the program to your Bot
- Run your bot and put your hand in front of it
 - The red LED on the sensor should light
 - The Bot should back up and turn, then try forward again

Note: Fluorescent lighting can confuse the sensor.

More . . .



Workshop materials form a basis for more projects

- Expand NEMBot 3 with added sensors
 - Bump, SONAR, Sound . . .
- New robot projects
- Resources
 - www.picaxe.com – Program Editor, cable driver, and programming info
 - www.picaxeforum.co.uk/forum - ideas and help
 - www.parallax.com , www.futabarc.com , www.hitecrd.com
manufacturer sites – servos and accessories
 - www.sparkfun.com – *servos, accessories, and robot parts
 - www.servocity.com – servos, accessories, and robot parts
 - www.pololu.com – servos, accessories, and robot parts
 - www.digikey.com , www.jameco.com – servos and electronics parts
 - www.instructables.com - ideas and general info
projects using other microcontrollers (PICs) can be adapted
- Don't forget Robofest next week !
 - *good source for AXE027 programming cable

. . . Perhaps attend another NEM workshop . . .