Robot Workshop

NATIONAL ELECTRONICS MUSEUM

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Agenda

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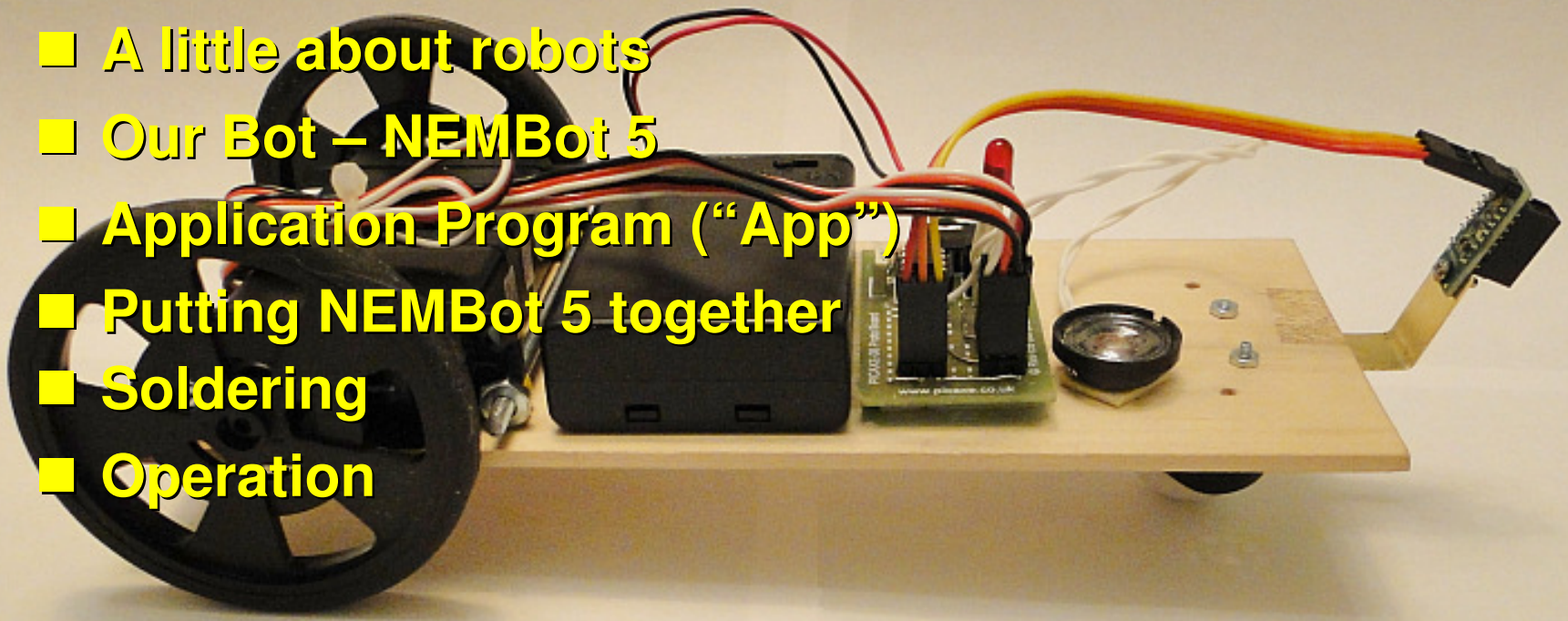
What we're doing today



- A little about robots
- Our Bot – NEMBot 5
- Application Program ("App")
- Putting NEMBot 5 together
- Soldering
- Operation

Robots

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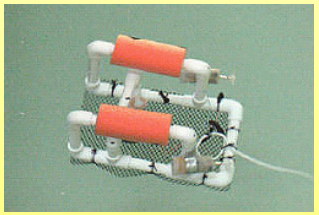
There are different types of robots, but they all perform tasks

- 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

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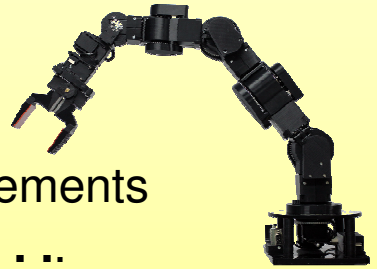
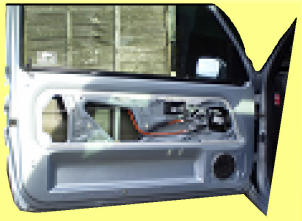
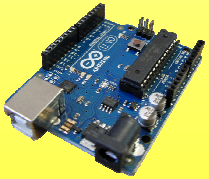
Robots need means of motions and a way to control them



- 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 . . ..
  - Transport - Move through environments



- Actuators (motors) provide the means of motion
  - Linear - Move in a straight line, usually with limited range
  - Rotary – Turn either through angle or continuously



- Robots must have some means of control
  - Vary from simple switches to complex computer controls
  - Computers provide the most flexibility

- Many robots use sensors
  - Sensors provide feedback from the environment

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

NEMBot 5

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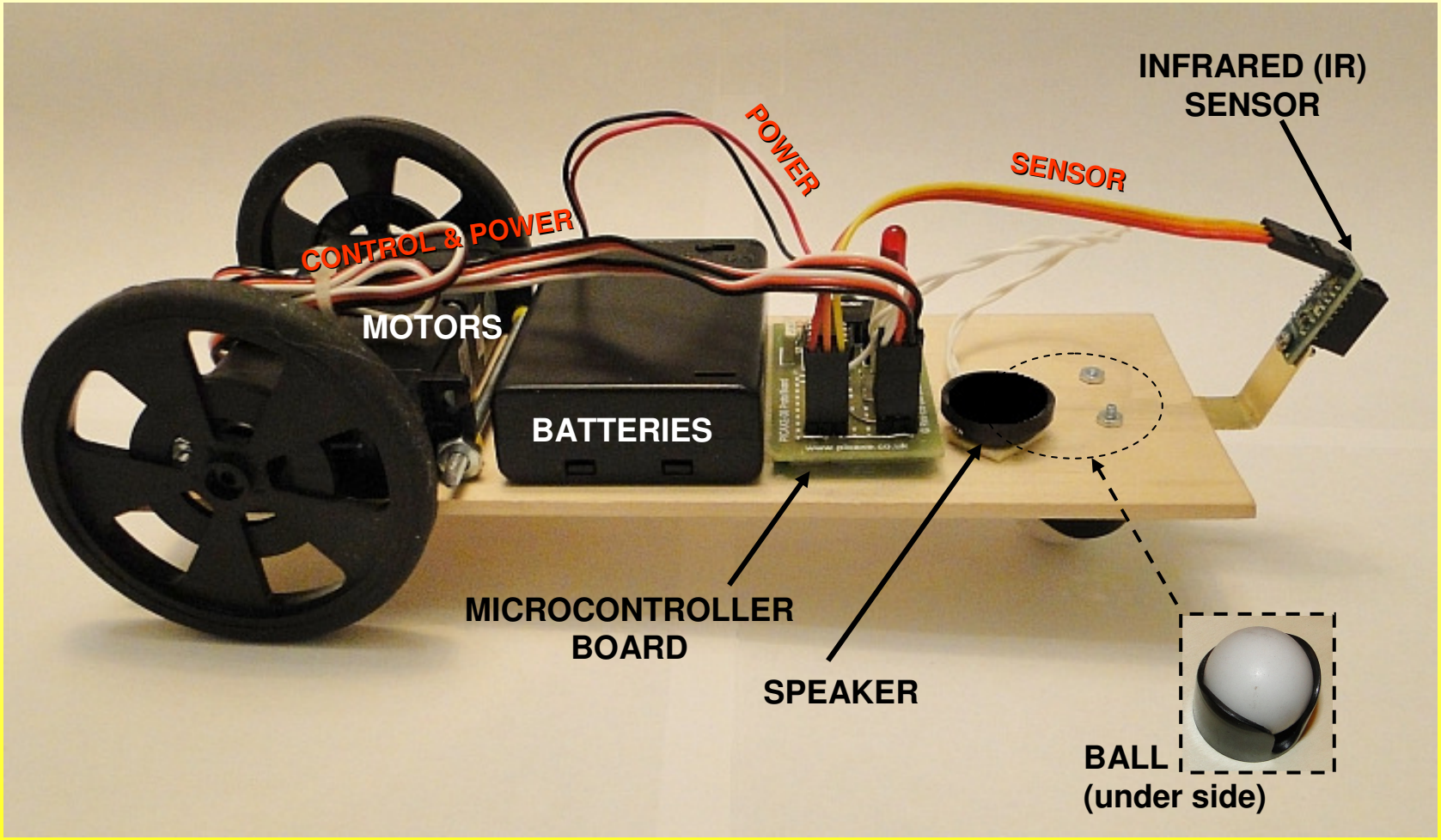
NEMBot 5 has the parts a smart robot needs



Servo Motors (Servos)

NEMBot 5 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 5 uses continuous rotation servos
  - Can go clockwise or counter-clockwise
  - One speed only (not controlled)

Microcontroller Program (App)

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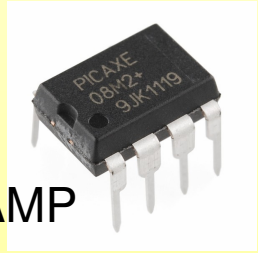
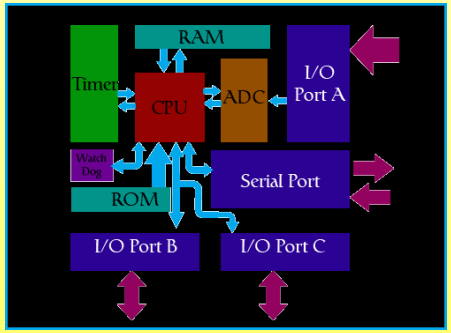
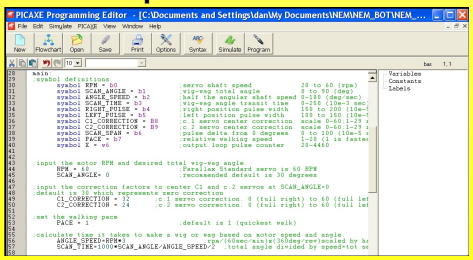
A programmed PIC tells the Bot's servos how to move



- PIC stands for "Peripheral Interface Controller"
  - NEMBot II uses a Picaxe® educational PIC 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



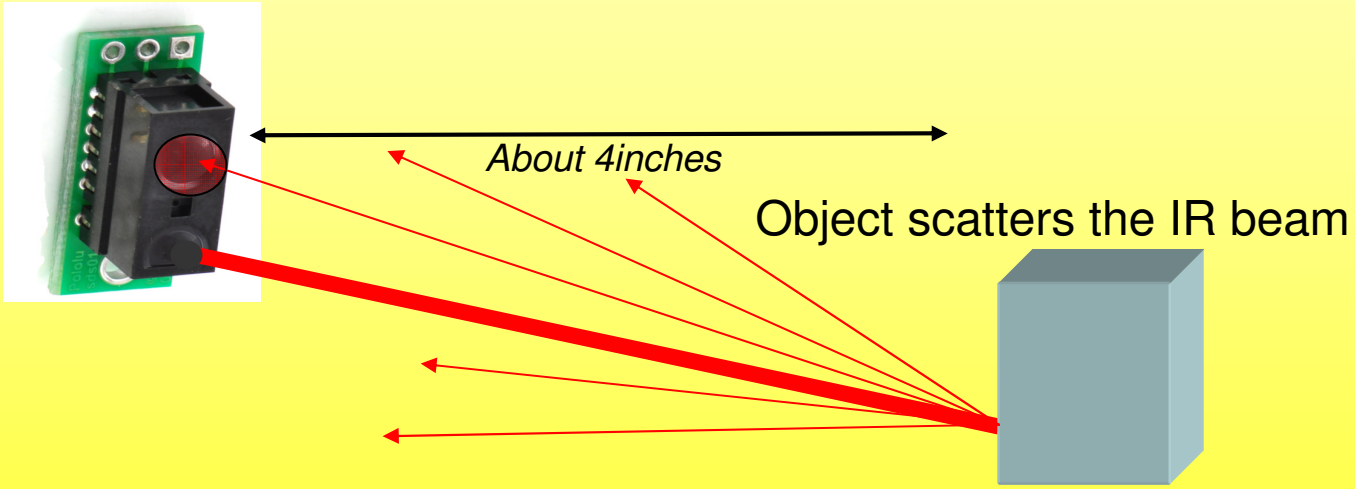
- NEMBot's Picaxe® is programmed to control the Bot's servos
  - The Bot follows a series of programmed command steps
  - Each step represents something to do
    - Check a sensor, command a servo . . .



IR Sensor

NEMBot 5's sensor send out irfrared 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

NEMBot 5 Program

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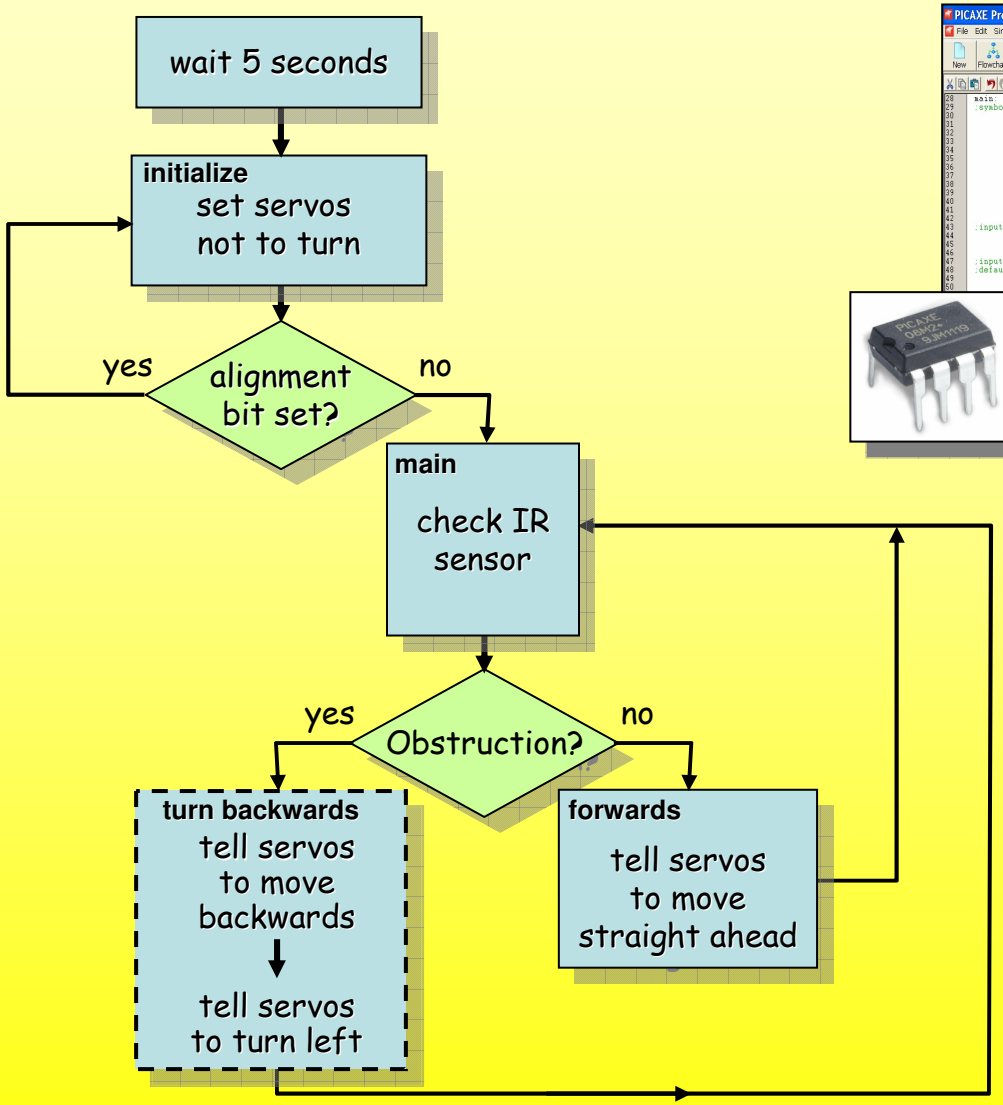
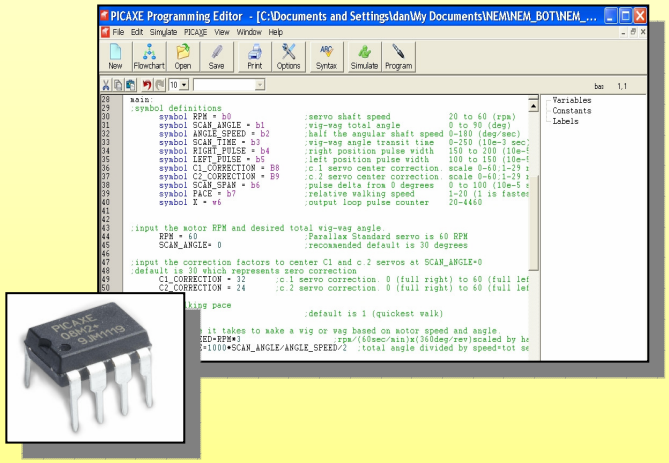
The program checks the IR sensor and runs the Bot's servos





NEMBot 5 moves forwards.
If the IR sensor detects an obstruction close ahead, the Bot backs up, turns left, and tries moving forward again.

Summary

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Robots have common types of elements, so does NEMBot 5

Robots are machines that do tasks

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

NEMBot 5

- 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 a programming cable)

NEMBot 5 Construction Steps

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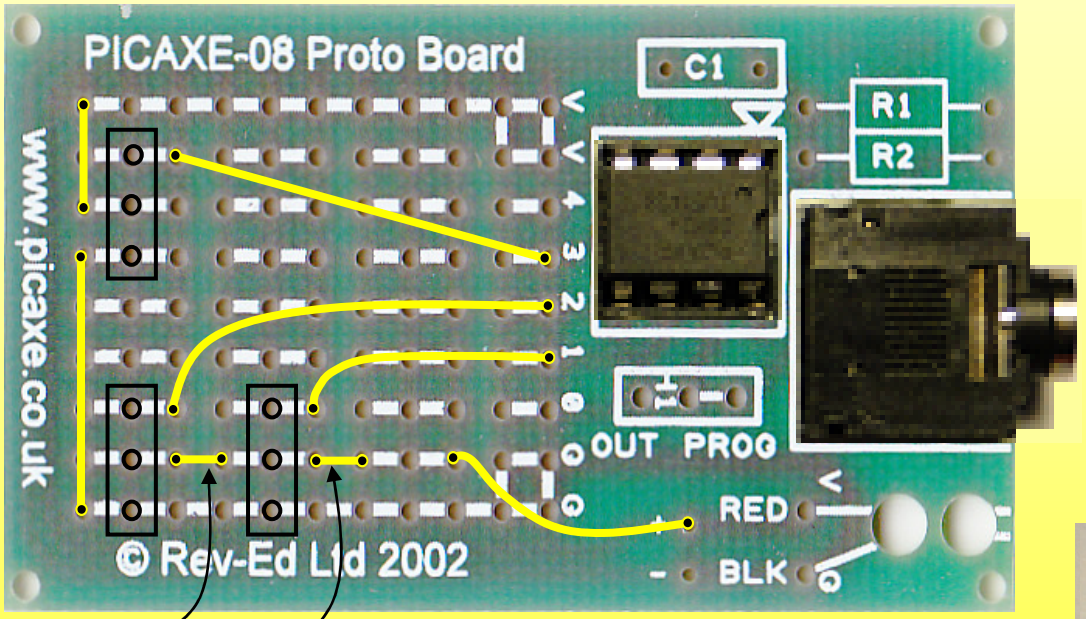
Detailed circuit board and final assembly instructions are included in separate documents:

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

Add control board jumper wires first

- Use solid bare bus #24 wire
- Run wires along top surface 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
- There are a total of ***eight*** jumper wires

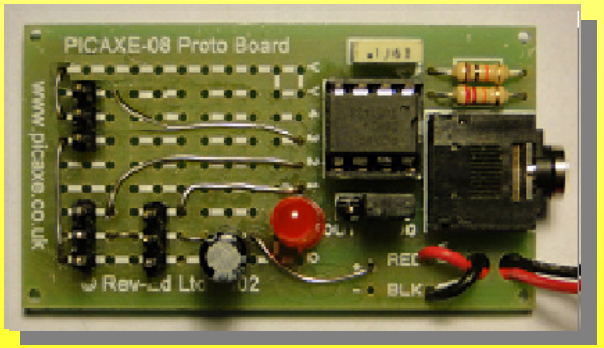


- These two short jumper wires have been pre-installed. You will put on the remaining six.

Here's a tip -

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!



Then assemble per instruction sheet

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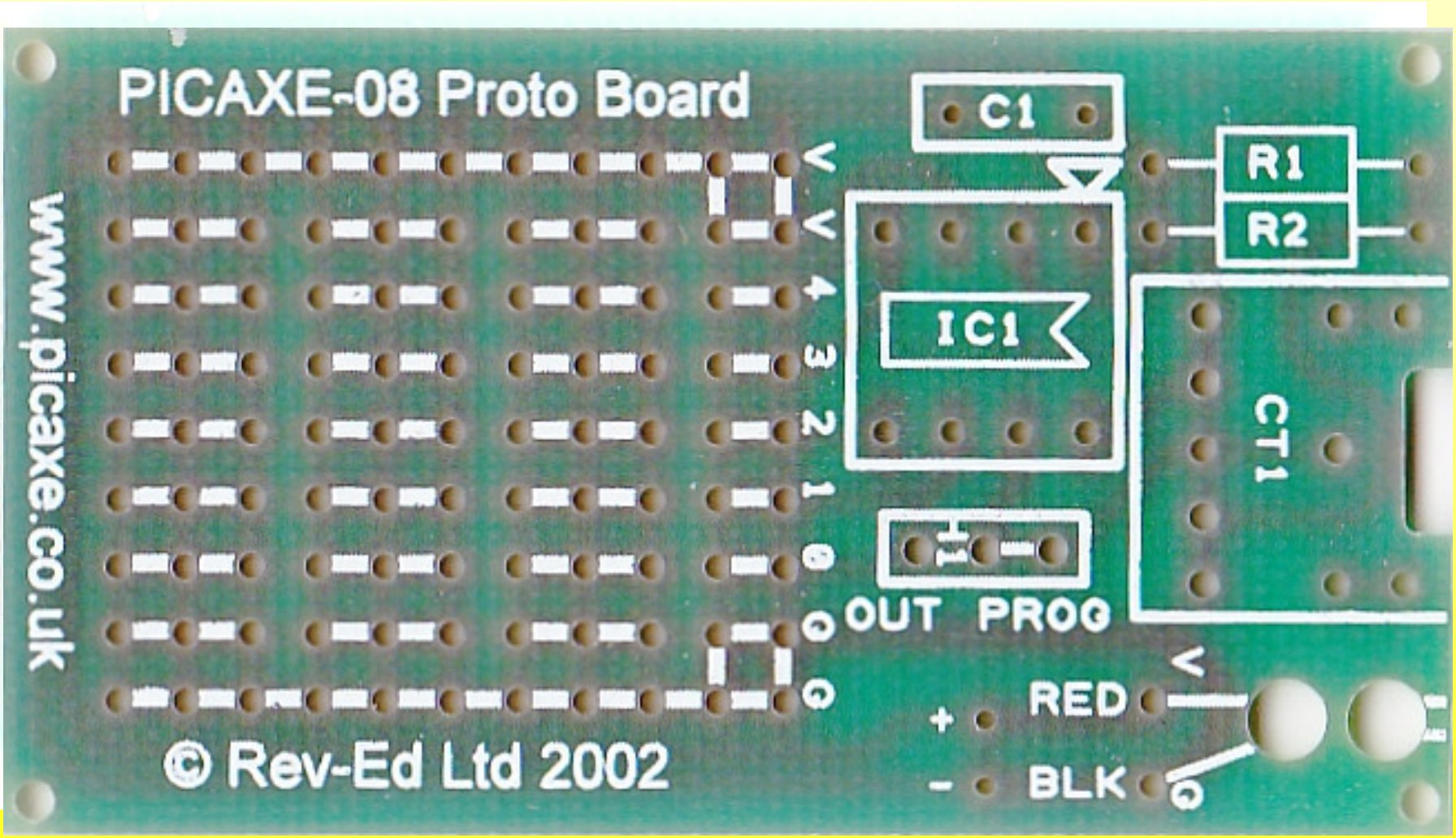
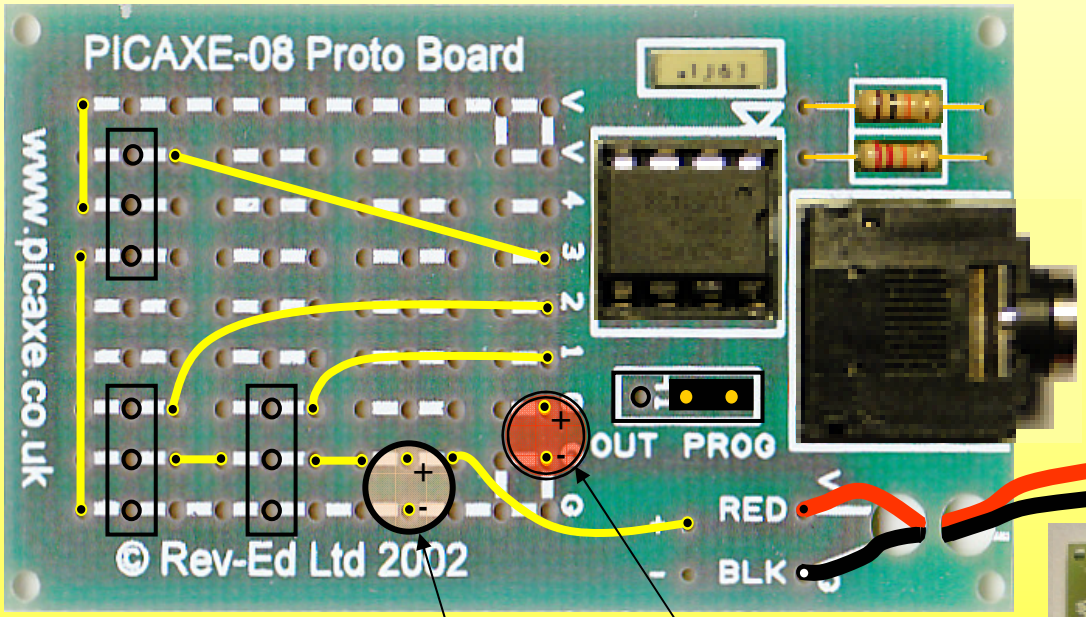
Follow the Proto Board instruction sheet in the bag



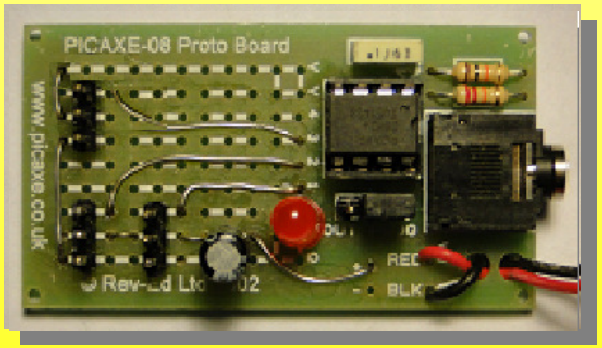
Install two added components

- Install and solder the cylindrical electrolytic capacitor. Longer positive lead to upper (+) hole
- Install and solder the LED. Longer positive lead to upper (+) hole



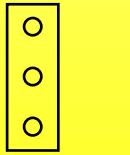
*Pay attention to **polarity** **when installing the capacitor and LED***

wires to battery box



electrolytic capacitor
long lead is +

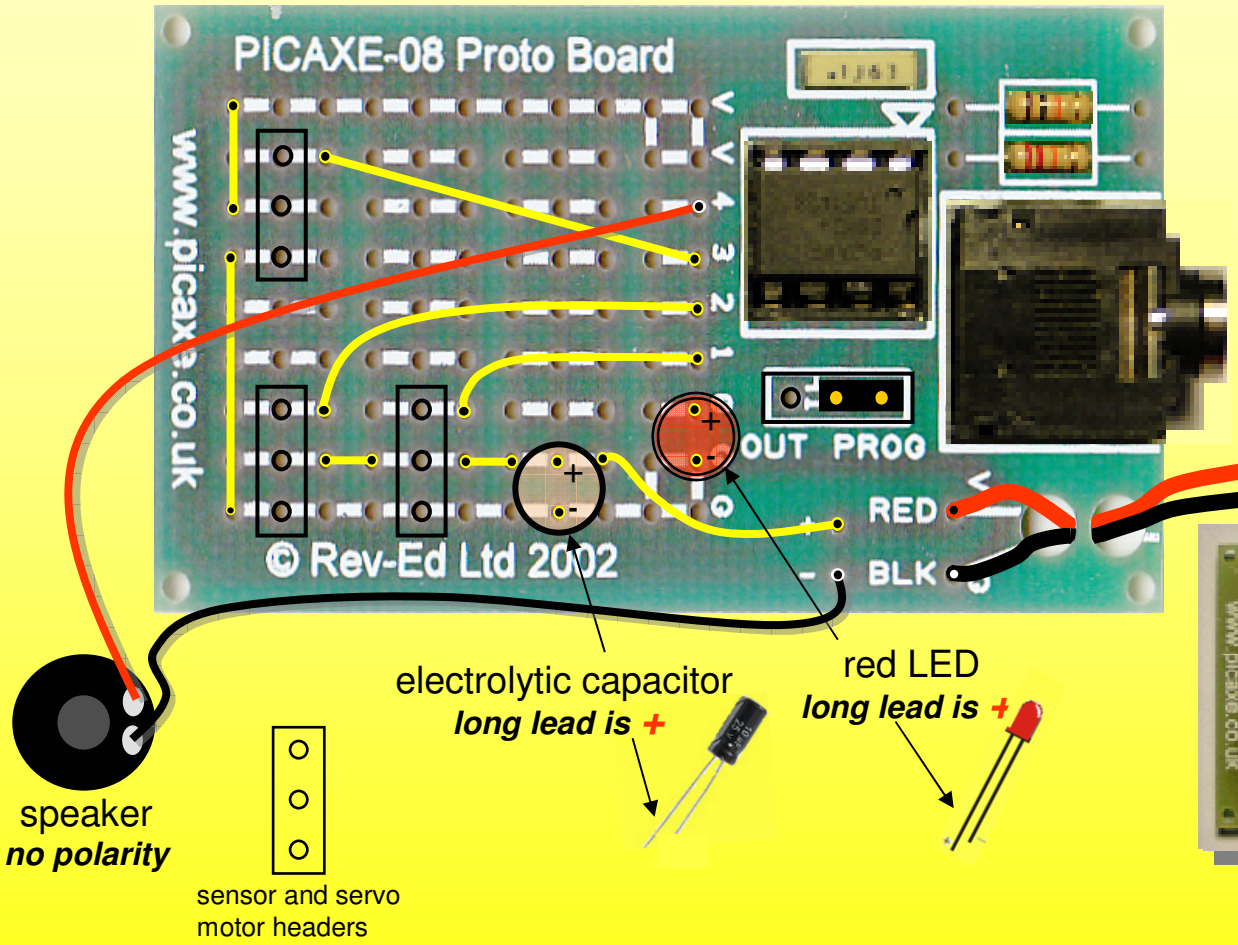
red LED
long lead is +



sensor and servo motor headers

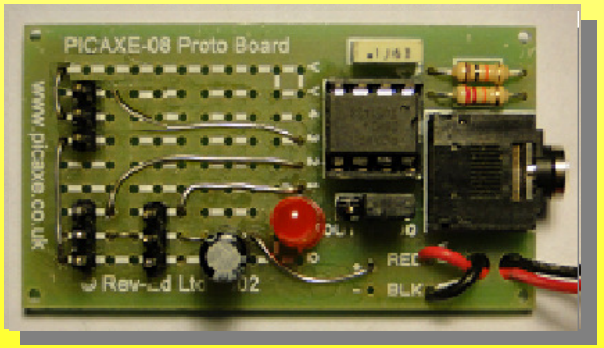
Finally add the speaker

- Run the speaker wires to the board and solder in the indicated holes. There is no polarity.



Check over *the board when you are done. Make sure jumpers and parts are in the right holes and polarities are right.*

Inspect *your solder joints one last time.*



A Word about Soldering

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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 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**
- **Wear safety glasses to protect against solder and flux sputter**

Solder Joints

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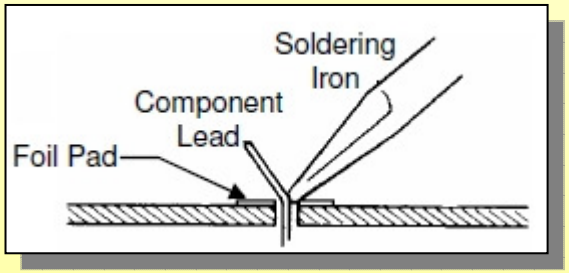
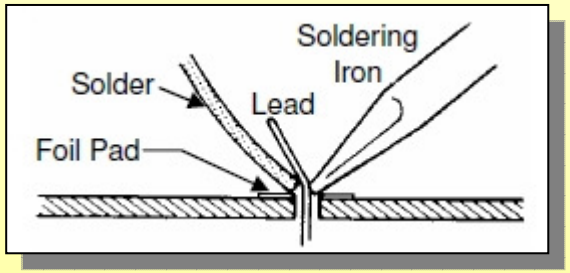
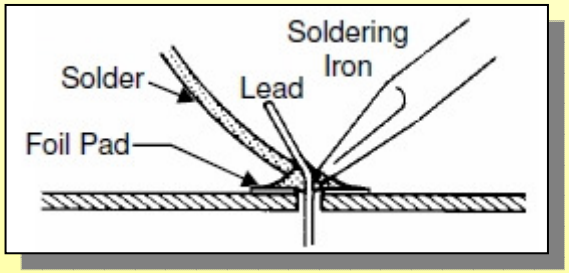
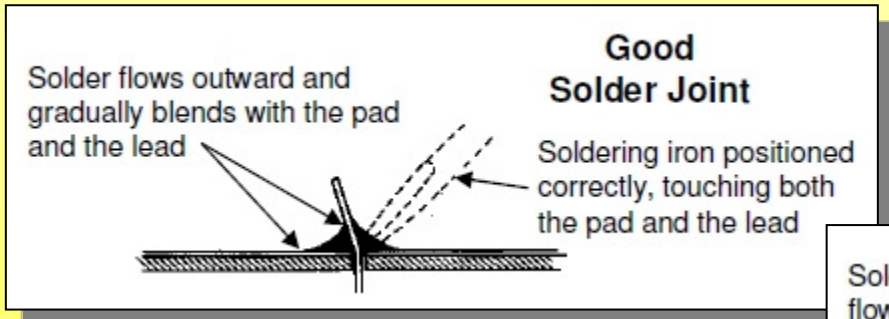
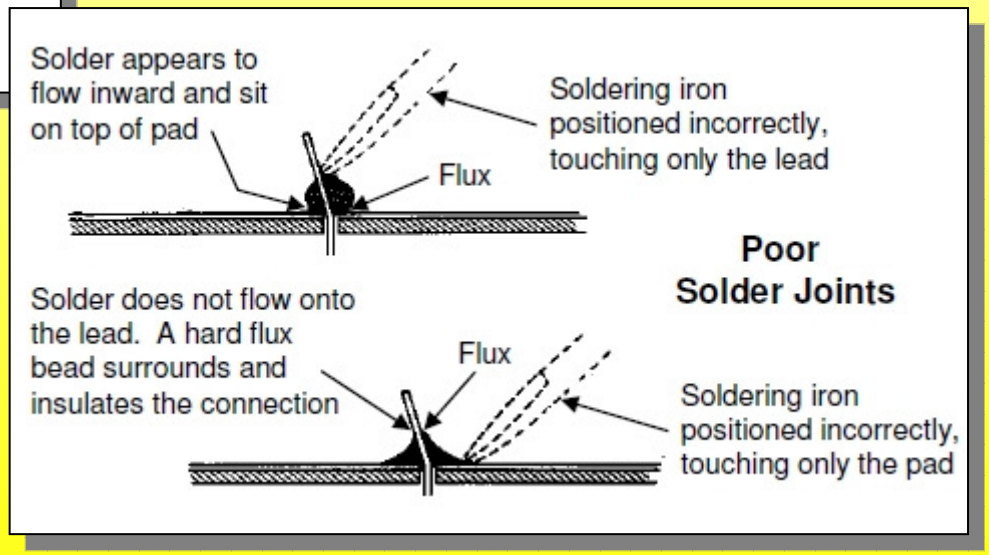
Heat both component lead and board pad for a good solder joint











Check Operation

Check out your Bot and align if necessary

- Download the application program to your Bot's microcontroller
  - The microcontroller may already be pre-programmed for you
- Turn on the battery switch and put your Bot on the floor
  - The Bot should stand still and play a startup "tune"
  - After 5 seconds, the Bot should move forward
- If the Bot does not run straight
  - Ask a course conductor to help you adjust the servos
- Run your Bot and put your hand in front of it momentarily
  - The red LED on the sensor should light*
  - The Bot should back up and turn, then try to move forward again
- You can modify parameters or any other part of the program
  - The Bot can always be re-programmed to restore the original code

*Fluorescent lighting can confuse the sensor.

More . . .

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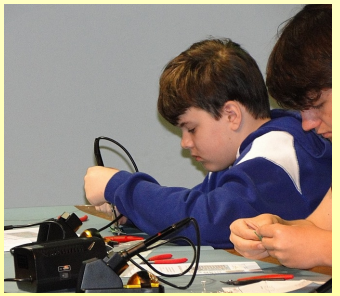
Workshop materials form a basis for more projects



- Expand or change NEMBot 5
  - Add sensors such as Ultrasonic, Acoustic . . .
  - Try New robot projects
- The Picaxe program Editor is free
  - You will need a serial or USB Picaxe programming cable (AXE-027)
- Resources
  - nemrobots.org – This and previous workshop reference files
  - www.picaxe.com – Program Editor, cable driver, and programming info
  - www.picaxeforum.co.uk/forum - ideas and help
  - sparkfun.com – servos, accessories, and robot parts (including AXE-027)
  - pololu.com – servos, accessories, and robot parts
  - servocity.com – servos, accessories, and robot parts
  - parallax.com , futabarc.com , hitecrcd.com
  - digikey.com , jameco.com – servos and electronics parts
  - instructables.com - ideas and general info
    projects using other microcontrollers (PICs) can be adapted

Remember RobotFest at NEM is next week!