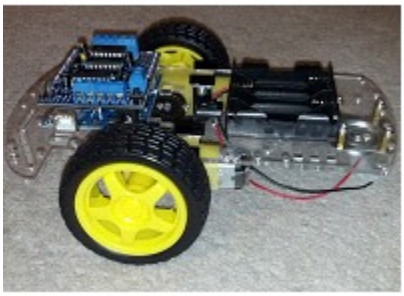
Arduino Base Robot

This is what you'll be building:



Use

This document and kit are the beginning of the Arduino Base Robot. This outline was first used at Musecon 2016 and 2017, and once we see how the end user assembly goes will be able to flesh it out with the correct level of detail.

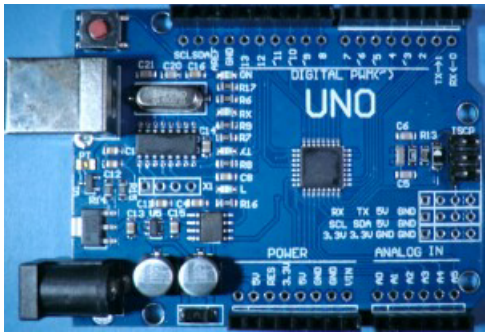
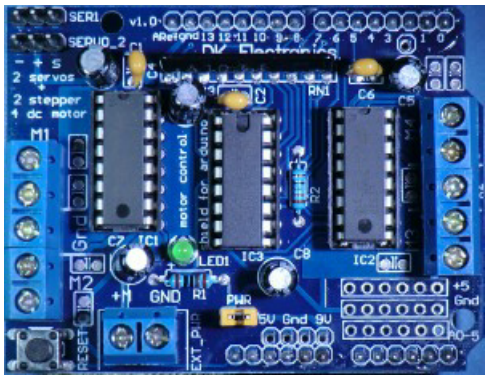
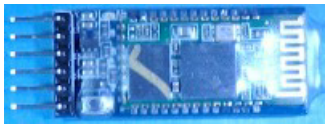
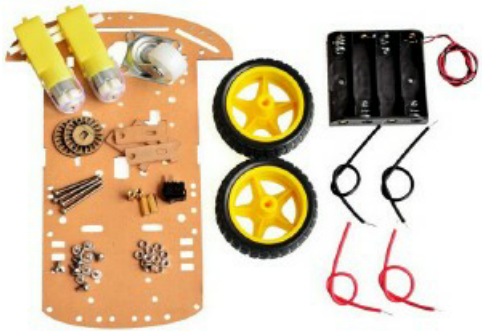
This is a **base kit**, the Arduino has lots of interesting additional hardware, and the software source is able to be updated.

“Imagine the possibilities”
The kit doesn't come with these, but lots of upgrades are possible:

- Bumper switch (Hit something)
- Ultrasound sensor for detecting distance to large objects (Dwayne & Dale have a few boards)
- Ultrasound sensor /w servo directional control
- Headlight / Tail Lights
- Noise maker
- Line following module (Dwayne & Dale have a few boards)
- Camera
- Raspberry PI for the brain
- Laser gun and "laser shot me" detector (for Robot wars)
- Blinking LEDs (because everything needs more blinkies!)

Open up the kit and review the contents using the following pictures.
There is a complete inventory list in the **appendix**.

Turn to the next page to begin building your kit...

Arduino UNO R3 MEGA328P This is the (micro) computer of the robot. It has a USB interface for initial programming and for any changes you wish to make if you want to learn how to program it from Windows.	
DC Motor Drivers Shield L293D This motor board (or "Shield") is needed to control the power for the motors. The Arduino itself can power LEDS and other low-power components, thus not the motors.	
Bluetooth serial module HC-05 This allows the Arduino to communicate with your phone or tablet to operate the robot as a remote control car.	
• 2 wheel drive Car Chassis • motors with attached gearboxes • Misc. wires, hardware parts in a small bag • 4 AA battery holder (See full inventory checklist in the appendix)	
2 resistors for (5/3 voltage divider)	
Double stick tape for mounting	See Dwayne, Dale, or a tech

Some “Dupont” terminated wires.	

Got everything to start? If not, give us a shout. Next, a few words on soldering…

Soldering Hints

(Skip to “Assembly” if you are GOOD at soldering)

Soldering is not like gluing; the solder forms an alloy with the metals to be connected that creates a stable electrical path and a certain amount of mechanical attachment. For the small connections on this project, a 25 or 30 watt soldering iron works well. Rosin core solder is used – the acid core solder sold for plumbing would eat your components in a short time.

Here’s how to make a good solder joint:

- Prepare the soldering iron. it should be up to temperature. Clean the tip by plunging it into the stainless-steel wool in the jar. Melt a little solder (a 2mm length) onto the tip so it’s shiny. This is called “tinning”. The solder coating helps conduct heat from the tip to the joint.
- Keep the tip of the soldering iron clean. Wipe off flux and excess solder regularly via the stainless-steel wool in the jar. Keep the tip tinned.

SOLDERING TIP specifically for the Arduino robot:

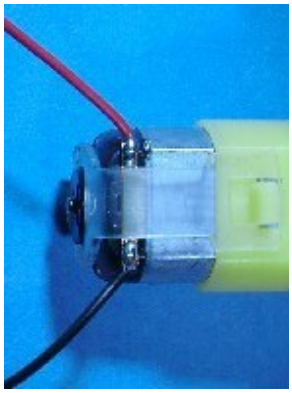
It is recommended that you **tin the wires**, because they are very fine stranded wires – lots of little wires and not just one biger one.

1. Cut the wire
2. Using the shared wire stripper, strip about 1/4” of insulation off.
   - Of the various sizes on the stripper, the 22 gauge works well.
3. Twist the strands together.
4. Alternate ways of tinning the stripped, twisted wires:
   - Heat them with the soldering iron tip and add a tiny bit of solder.
   OR – If available:
   - Poke the bare twisted wire into a container of solder flux (see tech person)
   - Clean your soldering iron tip, and melt a small amount of solder onto the tip.
   - Wipe the tiny blob on the tip across the bare wire – the solder should quickly flow along the wire end – you may rotate the wire and wipe the opposite side of the wire.

Assembly

- Locate the bag of parts containing 2 red and 2 black pre-stripped wires.
- For a neater assembly, trim each to 3.5” and strip off about 1/4” of insulation. At MuseCon we will be sharing a wire stripper, so **ask for it.**
- Tin all 4 ends of the wires (See “SOLDERING TIP specifically for the Arduino robot” above)
- Remove the stretchy band that holds the motor into the gearbox, so it doesn't get melted.
- Bend the exposed, tinned wire into a U, hook it through the motor connector, and solder -- color doesn't matter – Later we'll say “top” and “bottom” wire.
  - Repeat for the other wire on this motor
  - **Put the stretchy band back on.**

Repeat above for the 2 wires on the other motor.



Assemble the Robot Car Motor Chassis

Quick Overview (you may skip this and go right to Detailed steps, below)

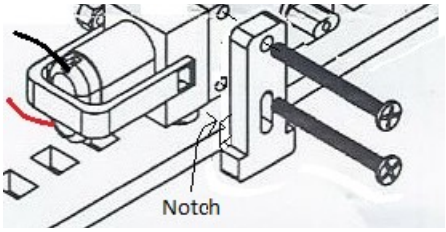
- Solder wires to motors (color doesn't matter)
- Mount motor/gear box to chassis, wires toward the inside
- Mount wheels on axles(*)
- Mount encoder (slotted) wheels on inside axles(*)
- Insert power switch
- Notch the battery pack for the RED wire so it doesn't get squeezed under the battery pack
  - Use a knife or break out a notch with fine needle-nose pliers.
- Install the battery pack – The kit maker did NOT include screws!
  - At an event, we can just let it sit, or use double-sided tape.

(*) Use coin flat to press axle

Detailed Step-by-Step instructions, Chassis:

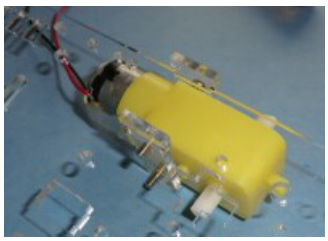
2) Prepare the chassis (the big paper covered plastic base)
   - Remove the paper from both sides.
   - FYI: The wide end is the front - with space to mount optional sensors.
   - FYI: The chassis is left/right symmetrical: either side "up" until you start adding parts.
3) Mount the motor/gearbox to the chassis, using the following steps.
   REPEAT these steps for each side.
   Note: NO WHEEL is yet on the axle. You can't get to the screws if the wheel is mounted!

- Remove the paper from 2 of the T shaped plastic motor mounts.
- Insert 2 of the long screws through one T motor mount:
  - NOTE you are working – and the picture shows – the BOTTOM of the chassis.
  - Most of the motor is in BACK of the axle – note the 3 rectangular slots in the picture.
  - With the the T facing as shown in picture, <u>and</u> the motor wires facing inward, insert the screws through the T and into a motor/gearbox, and place it on the side of the chassis so the "T" goes into the slot on the edge of the chassis.



- Push the screws in partly through the motor, then insert a second T motor mount up through the slot on the other side of the motor.
- Push the top long screw through the gearbox and into the second T you just inserted, and secure it loosely with a nut.
- With a finger-tip, hold a 2nd nut in place over the screw hole while pushing and turning the bottom screw, as there is very little clearance to thread the nut with the screw pushed all the way in. Ask for help if you need it.
- Tighten both screws with a screwdriver while holding the nuts in place. Do not "over tighten", remember, this is all PLASTIC.
- REPEAT for motor/gearbox 2. Note the wires will also be facing inward – i.e. opposite the first motor.

You should now have these 2 done (1 shown):



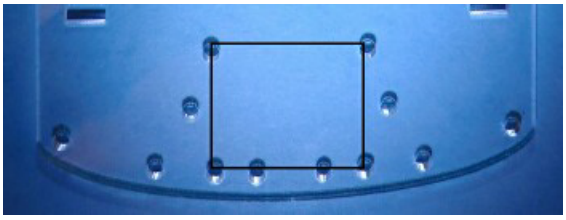
4) Push a wheel onto each motor/gearbox as follows:
   - Place a wheel on the table with hole facing up.
   - Orient the chassis vertically and SLIGHTLY press the axle into the wheel
   - Place a coin flat on top of the axle and press down. Don't push the wheel too far, or it will rub on the chassis.
   - Repeat for the other wheel.

5) Push a slotted encoder wheel onto each motor/gearbox **with a coin.**
   - Peel the paper off of a slot encoder (the quarter-sized slotted wheel)
   - Press it on the inner axle shaft, again USING A COIN against the slotted wheel to apply the pressure.

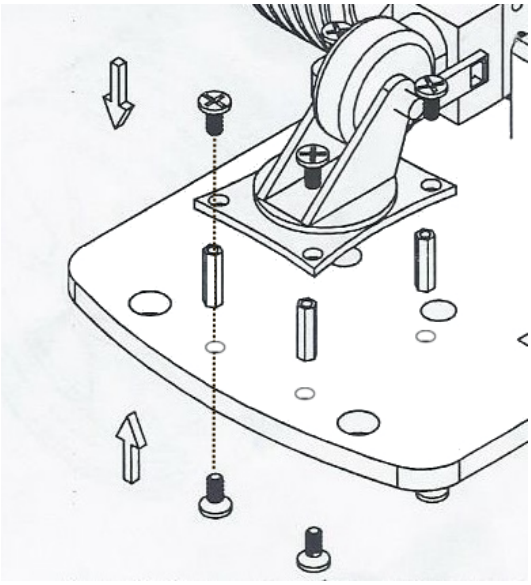
6) Insert the **power switch** from the bottom -or- top side (your choice. Author's choice: from the top, with ON being "forward" (toward the wide end of the chassis)). NOTE: The motors are on the BOTTOM of the chassis.

7) Install the caster wheel

- Flip the board bottom-up (motor/gearbox side)
- Find the 4 holes where the caster will mount:



- For each hole, insert a screw from the bottom, and thread a spacer onto it.
- Then for each spacer, insert a screw through the caster frame but don't tighten
- When all screws are in place, tighten them all.



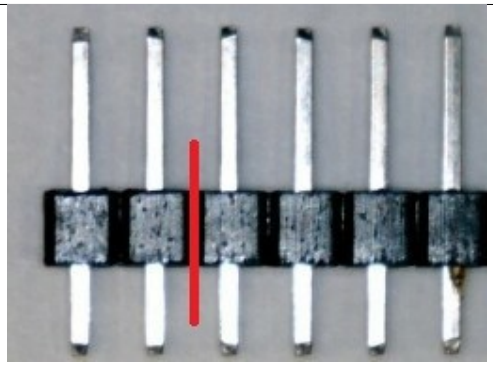
8) Battery pack: we need to make a little space for the red wire to come out from under the battery pack without being clamped under the pack. Cut a notch with a knife or break out a tiny notch with a small needle-nose pliers.

Mount the battery pack using double-sided tape, centering it left/right, and between the power

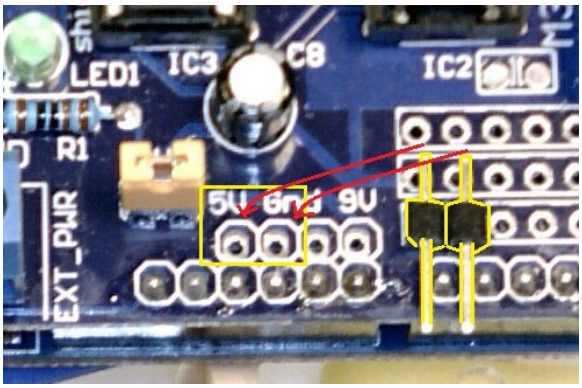
switch and the front-most caster screws.

9) We now begin BlueTooth wiring.

10) Break off 2 pins of your pin strip, see picture:



11) Take the SHORT pins end of the 2 pins you broke off, and push them into the 5V and Gnd of the Motor controller board.
 - Before flipping it over to solder, hold the pins in place by pressing a blob of Sculpy clay over the pins.
12) Flip the board over, and solder the 2 short ends, 5V and Gnd.

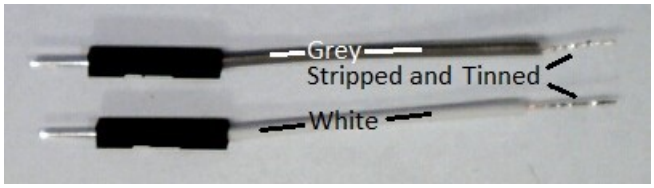


13) Back on top, the pins should look like this photo.

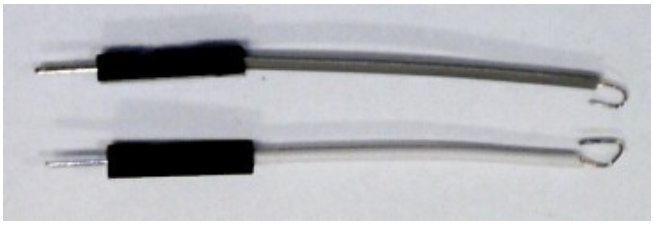
 We have created two of the four connectors that will go from the motor shield to the BlueTooth module.

14) We need to make a connection to pins 2, and 13, of the Motor Shield.
 - **IF** long pins are available, we will use the solder sucker to remove pins 2 and 13 from the shield, and replace them with long pins.
 - At MuseCon 2017, we don't have them so we will solder two short pin connector wires to them.
 - With a white wire and a gray wire, cut, strip, and tin it.

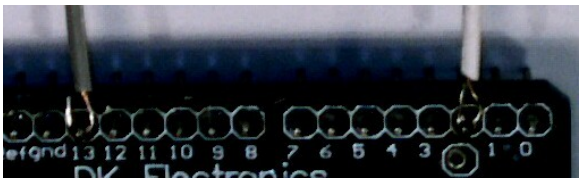
The top wire is gray, the bottom is white



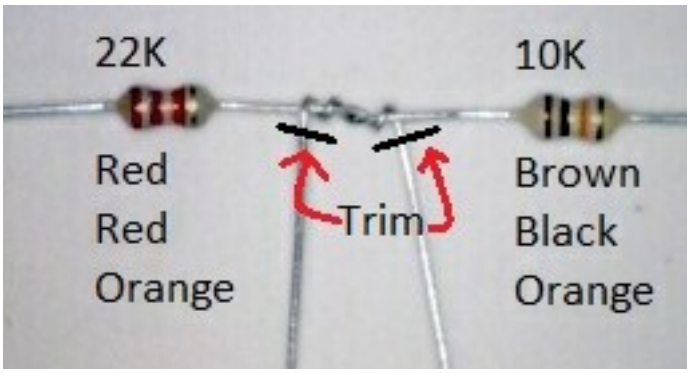
15) Form each tinned wire into a “U” so it can be soldered on the top of a pin on the motor shield.



16) Solder the gray wire to pin 13 of the motor shield, and the white wire to pin 2.
 - be sure not to have the wire “U” too wide – so it shorts to adjacent pins.
 - Put a blob of hot-melt glue around the connections to prevent excess flexing of the end of the wire.



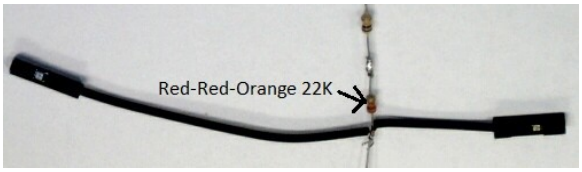
17) Next, we need to make a 2-resistor circuit to talk to the BlueTooth module, because it uses a different voltage (3.3V vs 5V)
18) Twist together a 10K and 22K resistor as shown in the picture to the right
19) Solder the twist
20) Trim off both leads



21) Choose a short F-F jumper wire, cut it into 1/3 and 2/3 lengths as shown
 - Strip both
 - Tin both
22) (For later use: cut a male gray wire the same 1/3 and 2/3 lengths, strip and tin both)

23) Twist the black wires together.

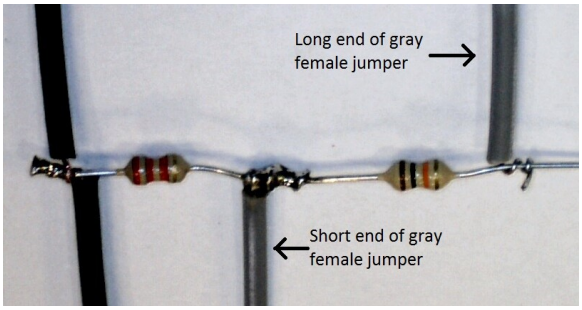
24) Twist the black wires together with 22K (Red-Red-Orange) resistor lead, and position the black jumper to look like the picture.
 - SOLDER the 3 together, then trim off the bottom lead.



25) Twist the SHORT gray wire to the wire

between the two resistors, and solder it.

26) Twist the LONG gray wire to the 10K resistor lead, facing as shown, and solder it
27) Trim off excess resistor lead to right.



Attach four wires to the BlueTooth module:

- Plug one end of a short F-F RED jumper wire into VCC
- Plug one end of a short F-F WHITE jumper wire into TXD

Wires attached to resistors:

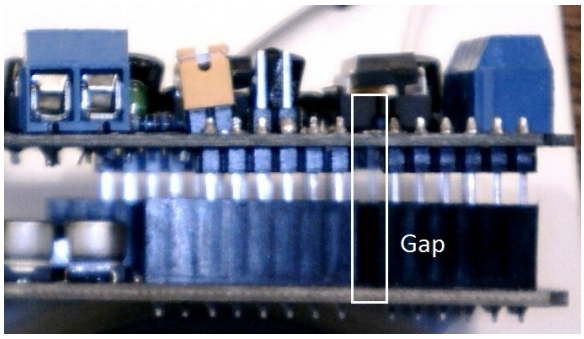
- Plug the short black wire into GND
- Plug the short grey wire into RXD

The BlueTooth module now has four female connector wires attached, gray, white, black, red.

Set the BlueTooth board and wiring aside, we'll wire the motors next

28) Plug the Motor Shield into the Arduino. NOTE: Line up the gap in the pins with the gap in the socket. The edges and corners of the two boards should be lined up.

The picture shows it before being completely plugged in.



29) Connect Power wires between the battery pack, switch and Arduino.
    - Measure the RED battery holder wire to go through the chassis hole nearest the switch, then to the the switch.
    - Cut, strip, and tin it. Solder it to the switch terminal nearest the battery pack.
    - Cut, strip, and tin the cut-off RED wire
    - Solder one end to the other switch terminal
        - Identify the 2-pin screw-terminal connector on the motor shield – called “EXT PWR”, and having connections +M and GND.
    - Insert the other end to the +M screw terminal on the motor shield, and tighten.
    - Measure the BLACK battery wire to go to the

The red wire comes from the switch.
The black wire comes from the battery holder

GND screw terminal next to the M+ on the motor shield. • Cut, strip, and tin it, insert it in the GND on the motor shield, and tighten	

Wiring the motor

- Face the front (wide end) away from you, i.e. motors facing toward you, on the bottom. The caster/swivel wheel is in the back.
- Pull the four motor wires up thru their nearest holes on each side in front of the battery pack
- Wire the RIGHT motor Top wire to the Left M3 screw terminal on the motor shield
- Wire the RIGHT motor Bottom wire to the Right M3 screw terminal on the motor shield
- Wire the LEFT motor Top wire to the Left M4 screw terminal on the motor shield
- Wire the LEFT motor Bottom wire to the Right M4 screw terminal on the motor shield

Attaching the BlueTooth module

• RED wire: Plug into motor shield 5V – one of the two pins you added • BLACK wire: Plug into motor shield GND next to 5V. • GRAY wire: attach to gray wire going to pin 13 • WHITE wire: plug to white wire going to pin 2.	

Everything is connected and ready to go.

- Program the Arduino - Code from 2DKits web site + IDE + Motor Library + USB cable
- Load the application on your phone or tablet.
- Turn the power on.
- Pair Bluetooth.

Troubleshooting

The following steps should isolate most problems.

- Recheck your wiring.
- Make sure the batteries are relatively fresh
- Recheck your solder connections. 80% of all problems are traced to this. Cold solder joints and broken joints will cause erratic performance or failure. Reheat any questionable solder connections until they flow and look shiny and secure.
- Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

- Bad part – it does happen. In the hundreds of boards assembled, we've seen two or three parts fail. Send us email, and we will send a replacement part.
- A part got lost/melted/damaged/destroyed while building the kit. It happens – you're not the first (or second, or fiftieth). Let us know, and we'll see what we can do.

Appendix

Tinning wires:

The wires are "stranded" meaning made of many very fine strands of wire.

For each exposed end, first twist the wires together. We don't want one of the fine wires to stick out where it might short to something else.

Heat the wire with the soldering iron, and apply a little solder. You may "wipe" the solder down the wire to solder all the strands together over the full length of the exposed wire end.

Screw terminals:

Tin the wires for strength before screw-clamping them in. You may want to shorten the wires for a neater look. Perhaps try first without. If you tin with a little EXTRA solder, this is good, just flatten it out with the pliers, it will fit in the screw-clamping connectors very nicely!

Full inventory list:

- Paper-covered plastic parts:
  - 1 Chassis: The large plastic piece
  - 4 Small "T" plastic motor mounts
  - 2 slotted encoder wheels
- Electrical parts:
  - 1 4 AA battery holder
  - 2 black wires for motor
  - 2 red wires for motor
  - 1 Power switch
  - 2 motor/gearbox combinations
  - 1 ribbon cable with female connectors on each end
  - 1 ribbon cable with male on one end and female on the other end
  - 1 10K ohm resistor (Brown Black Orange)
  - 1 22K ohm resistor (Red Red Orange)
- Circuit boards
  - Arduino UNO (clearly labeled "UNO")
  - Motor Shield (has 3 large chips, and 5+5+2 screw terminals)
  - Bluetooth board (small board with 6 pins sticking out one end)
- Wheels
  - 2 rubber-tired wheels
  - 1 caster (swivel) wheel

- Screw parts
  - 4 long screws for motor mounts
  - 12 small screws
  - 4 spacers, threaded on both ends
  - 12 nuts

Glossary

Arduino

Arduino is the name given to the combination of a microcomputer chip from Atmel, and a bootloader pre-programmed in it, mounted on a circuit board with other support components.

Bootloader

Microcomputer chips such as used in this kit would normally require special hardware to program it. However, by definition, the Arduino has small amount of software pre-programmed in the chip. This bootloader can talk to USB and download the actual application software that the Arduino is to run, such as that to make this kit work.

Other items of interest

- An Android App can drive the car. It is called:
  Joystick Bluetooth Commander v5.2 by kas_dev
  https://play.google.com/store/apps/details?id=org.projectproto.btjoystick&hl=en
  http://forum.arduino.cc/index.php?topic=173246.0
- Instructions for changing BT baud Rate (**Not used)**
  http://www.instructables.com/id/AT-command-mode-of-HC-05-Bluetooth-module/?ALLSTEPS
- Your robot Arduino should come pre-programmed with the application to drive it from your BlueTooth-enabled phone or tablet.
- (Optional) If you wish to add functionality to the robot, or change how it behaves, you need to download and install the following:
  - Arduino Integrated Development Environment (IDE)
    https://www.arduino.cc/en/Main/Software
  - AFMotor Library
    https://github.com/adafruit/Adafruit-Motor-Shield-library
- Recommended Musecon class (if scheduled)
  Intro to Arduino
- Information on the 2Dkits website – Including link to software
  http://www.2dkits.com/zencart/index.php?main_page=product_info&cPath=17&products_id=64

The code used at musecon was http://www.2dkits.com/kits/Robot_car/AndroTest/AndroTest_V20_POSTED/AndroTest_V20_POSTED.ino