SOLDERING IS EASY
HERE'S HOW TO DO IT

BY: MITCH ALTMAN
(SOLDERING WISDOM)

ANDIE NORDGREN
(COMICS ADAPTATION)

JEFF KEYZER
(LAYOUT AND EDITING)

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**This is a soldering iron.**

Its tip gets hot enough to melt solder, which is metal. That’s about 200 degrees Celsius!

**Safety Tip #1 (of 3):**

If you touch the tip, you will let go very quickly!

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It is actually hollow and filled with rosin (similar to the stuff used to make bows for violins, sticky).

**This is solder.**

It is made of metal, usually tin and lead.

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We use the soldering iron to melt the solder and make electrical connections. When the solder heats up, the rosin melts almost immediately. The metal follows shortly thereafter.

The rosin flows around what you want to solder, cleans the metal, and helps make a good solder connection.

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**The best solder for electronics has rosin core and is 60% tin, 40% lead.**

Also known as flux.

Other types of solder include lead-free, but this has toxic chemicals. It is not as easy to use and can corrode the soldering iron type quickly. If used, do not breathe in the nasty smoke.

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**Safety Tip #2 (of 3):**

Lead is poisonous. It gets on your skin when you hold the solder, so wash your hands after soldering!

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**Safety Tip #3 (of 3):**

Lead is poisonous. It gets on your skin when you hold the solder, so wash your hands after soldering!

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There are many ways to connect electronic parts together, but perhaps the easiest way is with a printed circuit board.

The PCB makes it easy because it has pads for each part.

If you look carefully at the PCB, you will see lines connecting pads together with other pads - these lines are called traces.
Most pads have a hole in the middle – this is where the lead pokes through and makes a connection to the circuit!

Starting with a resistor, bend the two leads of the resistor down the width of the part, like this:

Then place the two leads through the two pads on the PCB for this resistor.

You push the resistor's leads through the pads until the part rests flat on the PCB.

For most PCBs, all of the parts are placed through the pads on the printed side of the PCB (which we'll call the top of the board), and we'll solder all of the pads on the bottom of the board.

Then you turn the PCB over so we can solder the two pads.

As you turn the PCB over, you will need to hold the resistor with your finger so it doesn't fall out of the board.

You push the resistor's leads through the pads until the part rests flat on the PCB.

Then you turn the PCB over so we can solder the two pads.

As you turn the PCB over, you will need to hold the resistor with your finger so it doesn't fall out of the board.

Then you bend the leads of the resistor outwards at about 45 degrees so the part won't fall out while we solder it in place.

Got it? Great!

As I said earlier, soldering irons get hot enough to melt metal. That means that the tips get hot enough to oxidize quickly, which basically means that they get dirty just sitting in the air!

The oxides are an insulator for heat, so we want to clean them off the tip before each solder connection so the heat flows nicely and we can make good solder connections.

This is why we have a wet sponge: scrape the tip across the sponge while rotating to clean the oxides off the tip.

This should make the tip silvery and somewhat shiny – ready to solder. Remember to clean the tip like this before each connection you make - the tips oxidize quickly!

If the tip is nice and silvery and shiny, you can make good connections.

Time to actually solder!

Hold the soldering iron in your dominant hand, like you would hold a pencil.

Hold the solder in your other hand.
Touch the cleaned tip to both the pad and the lead of the part you want to solder. Keep it there for about 1 second, so everything heats up nicely.

Then add about 1mm to 3mm of solder under the tip.

Don’t add the solder above the tip, since it will just flow onto the tip which is not any good.

The solder won’t melt until it actually touches the hot soldering iron tip, but once it touches the tip, that’s when it melts, and you can then add your 1mm to 3mm of solder.

But—and this is very important—keep the soldering iron tip on the pad and lead for about 1 more second since it takes time for the solder to flow around the pad and the lead, and it will only flow when it is hot.

Then pull the solder away.

Then pull the soldering iron away, and take a look at your perfect solder connection!

Please note that the solder cools down and hardens quickly all on its own. It only takes about a second.

That smoke that you saw when the tin/lead solder melts is the rosin vaporizing. It contains some chemicals that are not good for you, so try not to breathe it!

You can blow gently on the connection as you solder to keep the smoke away from your lungs.

Now put that soldering iron back in its stand while we’re not using it.

The stand keeps the hot iron safely on the table. Most people say that it’s not fun to have it land in your lap!
You can tell a good solder connection because the solder totally covers the pad and surrounds the lead.

Also, the solder makes a small bump.

If there is too much solder, that means that you added so much solder that there is a solder blob on a pad that is big enough to also touch another pad, creating a connection where there should not be one. This can happen.

Removing the excess or unwanted solder can be done by using a solder wick or a solder sucker. All you need to do is heat the solder and apply any of these tools!

After soldering all of the leads of the part, it is time to cut off the excess leads. This must be done to ensure that the excess leads do not bend over and short to another lead or pad.

If this happens, then there will be a connection where we do not want one.

To cut the lead, we'll use a small wire cutter. One side has flat cutting edges, and the other side has a deep groove.

Place the flat edge down, parallel to the PCB, just at the top of the little bump of solder. Squeeze the handles, and the cutting edges snap shut.

Safety tip #3 (of 3): Always hold the lead you are cutting with one hand while you cut with your other hand.

Be sure to wear safety glasses!
If the excess lead is too short to hold onto (but long enough to potentially short out to something on your PCB), then position the wire cutter, hold your fingers over the lead, and then SQUEEZE.

You may also want to wear safety glasses!

Leads that are already very short, such as IC sockets, do not need to be cut—they have leads that are too short to bend over and make shorts.

As you solder more, you will pick up many tips and tricks that will make soldering even easier.

But you are now totally ready to solder just about anything!

If you make a mistake, IT IS TOTALLY OK. All mistakes are fixable (though some are easier than others).

And making mistakes is how we learn to become better at everything we do.

While soldering is easy, unsoldering takes lots of practice. And if you make a mistake, you get to have some practice!

As you solder more, you will pick up many tips and tricks that will make soldering even easier.

Distribute widely!

Enjoy!

Narration by MITCH ALTMAN
http://cornfieldelectronics.com

Comics adaptation by ANDIE NORDGREN
http://log.andie.se

Edited by JEFF KEYZER
http://mightyohm.com

Translate it, use it, spread it, color it, teach with it!
http://mightyohm.com/soldercomic

This comic is part of a book about How to Make Cool Things With Microcontroller for People Who Know Nothing by MITCH ALTMAN and JEFF KEYZER, to be published by NO STARCH PRESS.