LEDs & Effects Lighting

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Lighting effects in the miniature world
using surface-mounted devices

Tools List

Basic Soldering:

SMD LEDs
Optical magnifier
12W Soldering Iron
40W Soldering Iron
Soldering Iron Holsters (2)
#38 Magnet Wire
Mascot Tool Base (Third Hand)
Cross Action SMD Tweezers
X-Acto Blade
Block of Wood
Liquid Flux
Resistors (560 Ohm and 2K Ohm)
Power Supply
Experimenter's Breadboard
Small Alligator Clips with Crimp Ends
Patience

Street Light Project:

Cotton Swab Applicator (small dowel)
#60 or Smaller Drill
Pin Vise
Super Glue
Super Glue Antidote
Liquid Tape
Toothpick
Thick Brown Latex Paint
Small Detail Brush
Drill Bit to match the Dowel Diameter

Welcome to the SMD clinic at the PSR NMRA Convention. At this clinic, we will be showing you how we use SMD LEDs for model railroading. We will also demonstrate several easy projects, such as a street light pole and truck lights.

Small LEDs have been around for a while, but the introduction of incandescent white color has made these lamps very desirable. Why bother with LED lighting, when standard bulbs are available?

LEDs:

- Put out very little heat, suitable for tight locations.
- Last essentially forever
- Not subject to physical damage like light bulbs
- Much smaller than even the smallest bulb

One good place to get SMD LEDs is from ngineering.com on the web. They have a variety of LEDs, in three sizes. I use 2x3mm Super-white to represent arc lamps, with micro super Yellow-white standing in for regular light bulbs.

		
2x3mm	Micro	Nano

They also have all the tools and accessories you will need to create fun lighting projects for your layout.

Getting Started

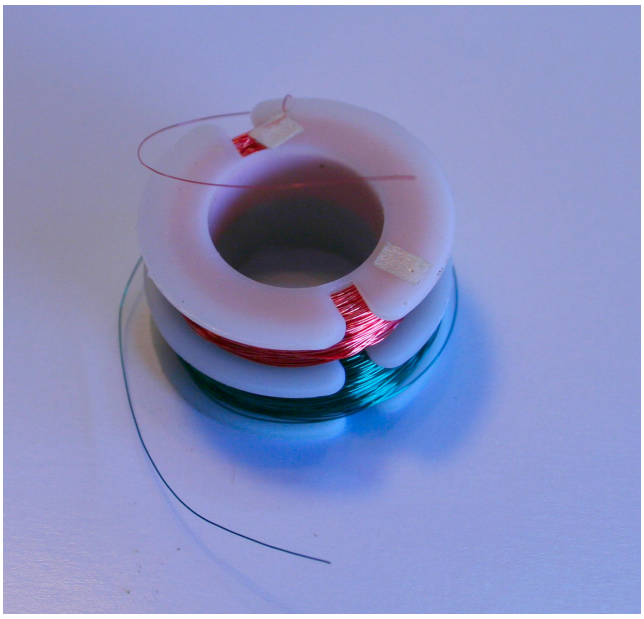
As with any project, the first thing to do is to get the tools and parts out that are necessary. Gather the various tools as listed in the parts list. I like to put a piece of printer paper on the table to act as a work space, as it makes it easier to see wayward parts. Since they will need to get hot, get the two soldering irons out and place them in their holsters. Please use a holster for your irons, as even the small iron is hot enough to cause a burn. We will be using both a 12W and a 40 Watt iron. The smaller iron will be used when dealing with the LEDs. The larger iron is actually your wire stripper. We use liquid flux for all soldering.

Safety

As with any small tools, you must take precautions. Soldering irons cause very painful burns. There are cords all over the place, along with microscopic, very small and expensive electronic components. Wear eye protection, and think before you grab onto anything that may grab back.

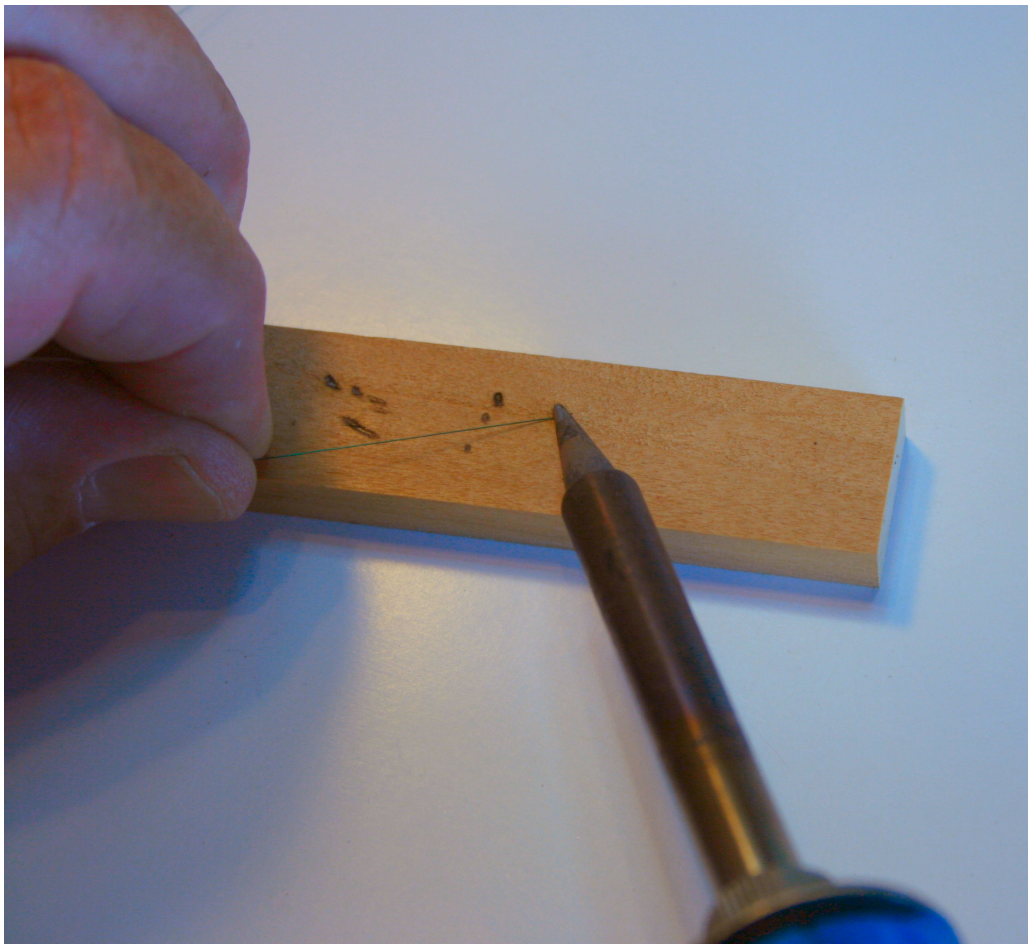
Safety Warning: Never stare into a white LED!

The next step is to cut a section of magnet wire to length. I got a bobbin of magnet wire from ngineering.com at the same time I ordered the LEDs.



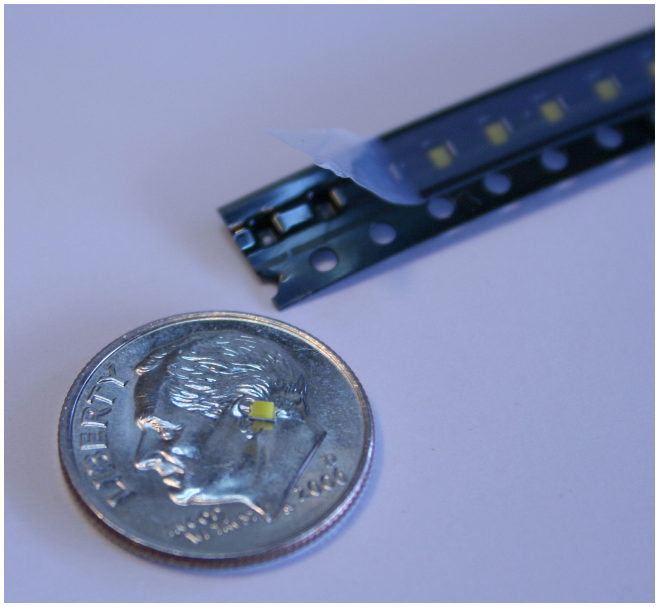
The magnet wire comes in two colors, red and green. Be very careful with the wire, because any kinks will become permanent once you tug on the snarls. I pull out about a foot of each color separately, then cut it with an X-Acto blade. The wires are very strong, but love to get into trouble, so take your time. I use a foot of wire because you will have to pull the wire under the table to be hooked up to the power supply. There is 100' of wire of each color on the bobbin, so it should last you a long time.

Once we have the two pieces, we need to remove a bit of the epoxy insulation from the ends. Unlike normal wires, magnet wires are stripped with a 40 Watt soldering iron. Put the wooden block in front of you and position the wire so you can solder on the end. Place the iron about a tip width from the end against the wood, pinning the wire in place. Pull the wire slowly out from under the tip, leaving a clean stripped end. Repeat for the other three ends. Do not worry that some ends may be too long, just trim with the X-Acto to length. You won't need long ends on the power supply side, as short works as well as long for our purposes.



Mounting the LED

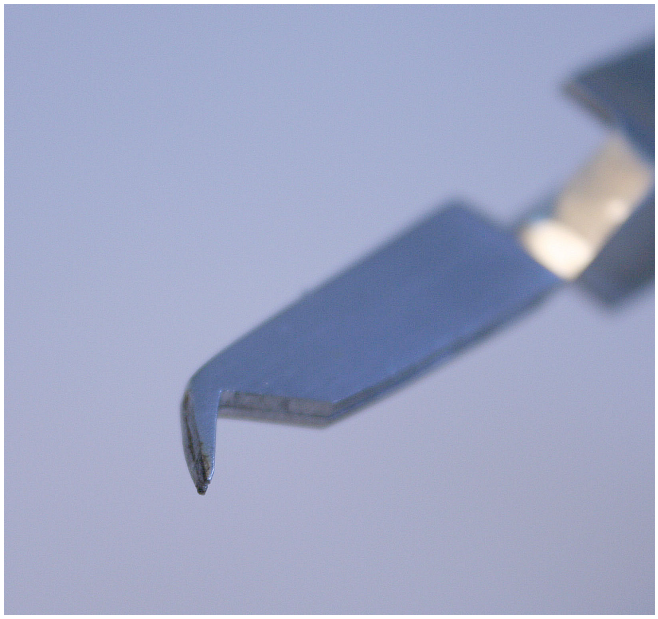
LEDs from ngineering.com are packaged in a section of tape reel, used in automatic machinery. We will be using the medium size LED, or Micro, for this project. There is a bit of tape over the LEDs to hold them in place. Peel back just enough to expose one LED, and shake it out on the table. *Beware, the plastic holder makes a great slingshot!*



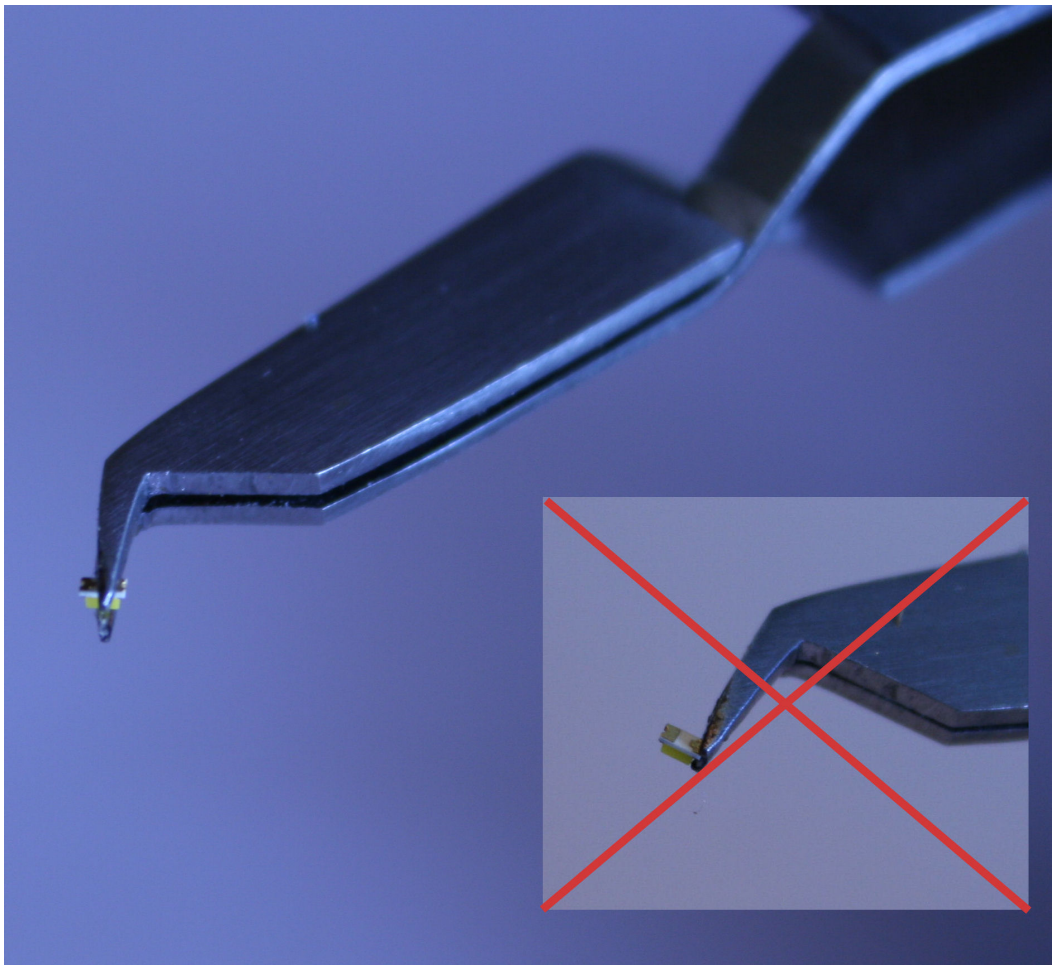
The LED is actually shaped like a T. The yellow block in the picture is supported by a slightly wider pad. Underneath the LED are two metal soldering pads. The two pads are shaped to show the positive and negative side for connections. Look at the back of the ngineering.com packet for the shape of your LED pads.

The next trick is to immobilize the LED so you can solder to it. Small SMD devices are lighter than the surface tension of molten solder. If the LED get stuck to the ball of hot lead, you will watch it roll around on the surface as it melts. Originally, I used double-sided sticky tape, but I was unhappy with this because the sticky tape stuck to everything, including the magnet wires. Sometimes, the tape lets go, allowing the LED to stick to the solder.

The first iteration was a pair of tweezers to hold the LED in a stand. Unfortunately, tweezer ends tend to move side to side, making the LED flip across the room to be lost in the dust bunnies. At the San Diego Fair, I found the solution at the small tool vendor. This pair of tweezers has a design that makes the points come out at an angle. Now, when the points move they slide across the LED instead of slipping off the end.



Here comes the fun part! We need to put the LED into the jaws of the tweezers! The LED needs to be upside down, and centered in the tines.



Put the LED between your thumb and finger, and gently insert the tweezers until you can feel the LED grasped firmly. This is actually easier than it seems, so take your time. Don't use the edge tabs of the LED as a grip for the tweezers. There isn't enough purchase, and your LED will suddenly jump across the room to be lost forever.

Another advantage to using a pair of tweezers is that the metal acts as a heat sink!

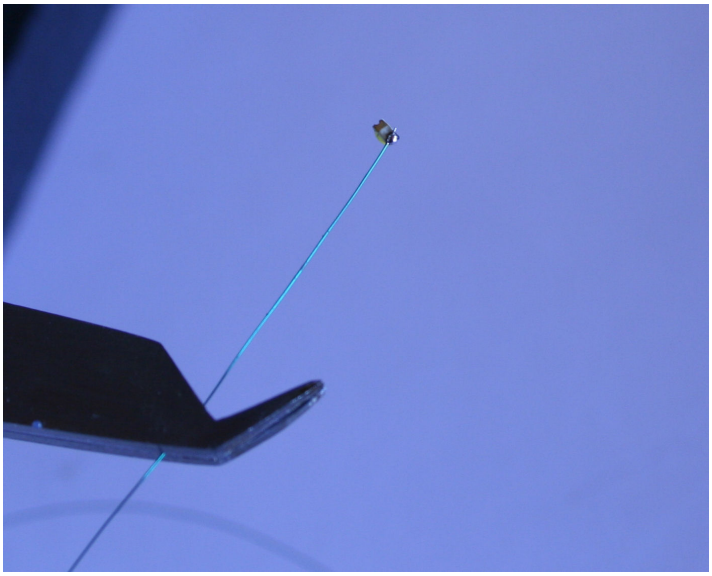
Soldering

The first thing we need to do is to tin the pads on the LED. We will be using the 12 Watt iron, and very tiny silver bearing solder.

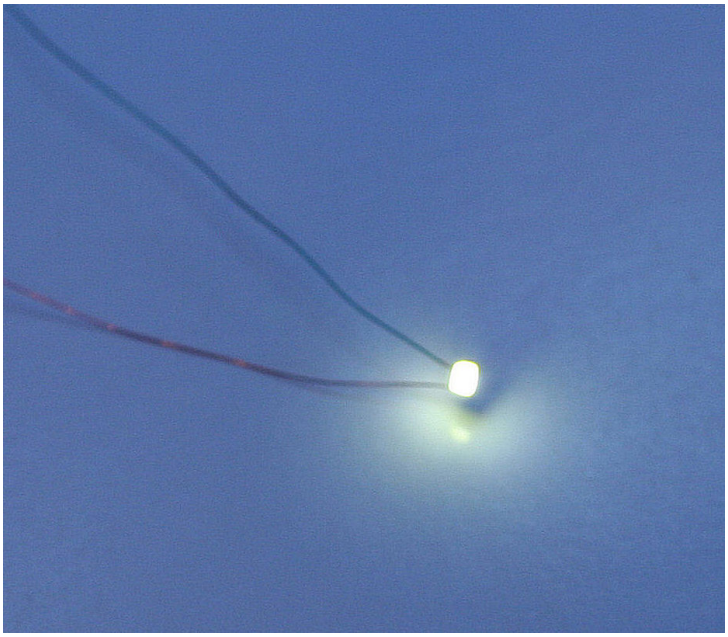
Take a piece of wire and place a drop of liquid flux on the pad. We want to put just a tiny bit of solder on the pad, so carefully move the solder and the iron to the pad and change the color from gold to silver. You should be able to see the color change. Next, put more liquid flux on the newly tinned pad. Bring up the end of the magnet wire, and solder the wire to the pad.

People with corrective lenses or using high magnification will have trouble with this part. I find it helpful to keep the iron perpendicular to the tweezers, with the wire along the tweezers. This will make it much more likely that you will capture the wire in the correct location. Never hold the iron to the LED for more than 2 seconds at a time, as this is the generally accepted safe zone for heating small components. If you need to give it another try, always re-flux the solder, as it cleans the oxides from the old solder.

Carefully observe the connection, the wire should be in the middle of the pad. This LED has been pulled out so you can see it.



We need to repeat this process for the other side. Now that it has a tether, the LED can't get away as easy. Reposition the stand so that your iron is in a good relative position and flux, tin, flux and solder the last wire into place.



Testing

Now that we have a completed LED, we need to test it. LEDs must be protected by a resistor when connected to the standard 12V power. There are lots of formulas on the ngineering.com web site for you to ponder. I like “rule of thumb”. Non-white LEDs get a 760 Ohm resistor, and white LEDs use 2KOhm resistors. These are not the rated values, but are derived from experimentation. At 500 Ohms, the red LEDs are solar flares. Pulling back to 760 Ohms makes the “look” better to me. The white LEDs are pulled back because of safety reasons. At full brightness, white LEDs will damage your eyes! We have found that 2K Ohm is reasonably safe.

Safety Warning: Never stare into a white LED!

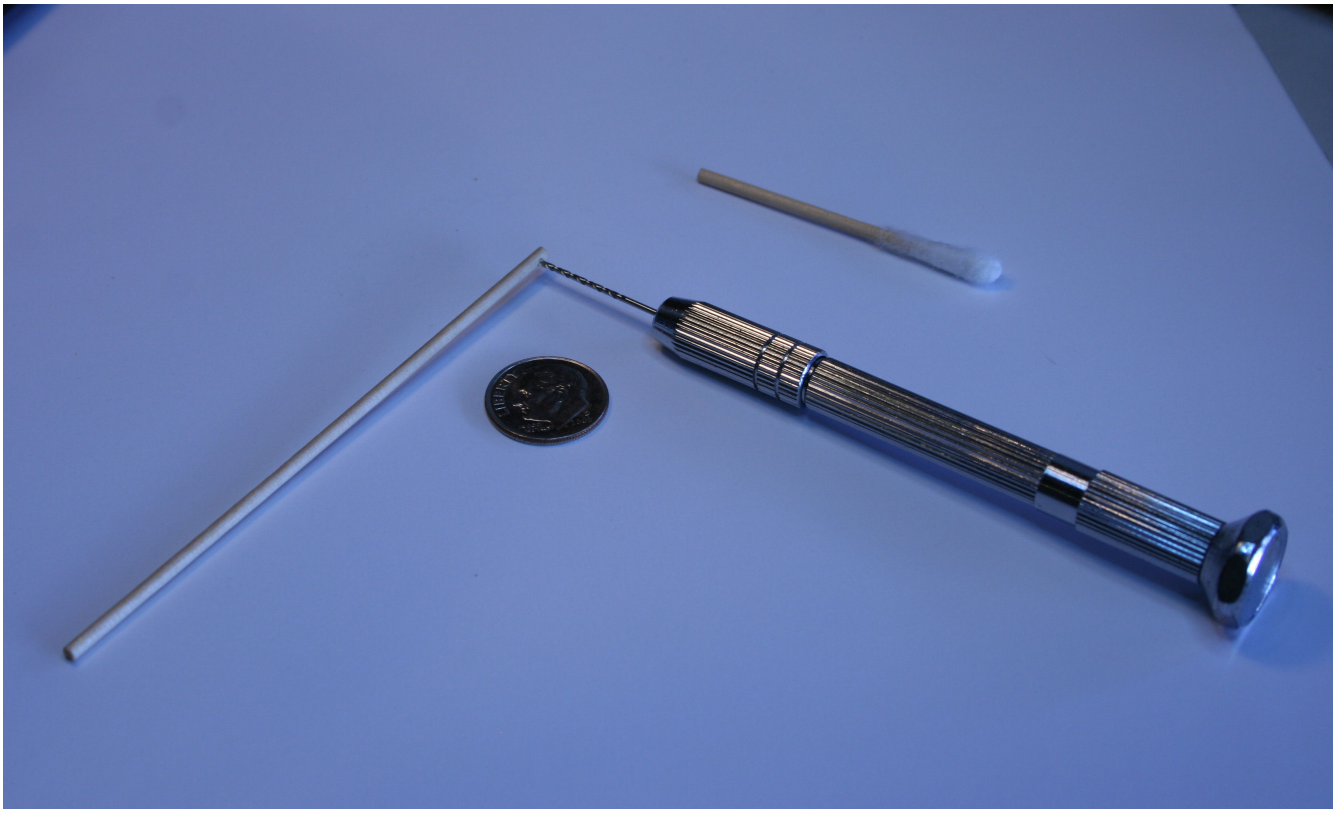
You may have noticed that we did not check to see what side was positive and which side was negative. This is because on all the LEDs I've done so far, a full 50% of them are hooked up wrong. I gave up trying to get the colors right. If you hook them up backward and they don't light, just flip the leads around at the power connection. That's just me, you may have better luck!

On the bench, I use an experimenter's breadboard and small alligator clips. I crimp the alligator clip to a resistor and plug the other end of the resistor into the breadboard. For the other side, I use a wire and another alligator clip. This makes it easy to test the LED. Do not panic if the LED does not light. The end of the wire may have some coating left on it. Just fiddle with the wire in the alligator clip and it should work.

Street Lights

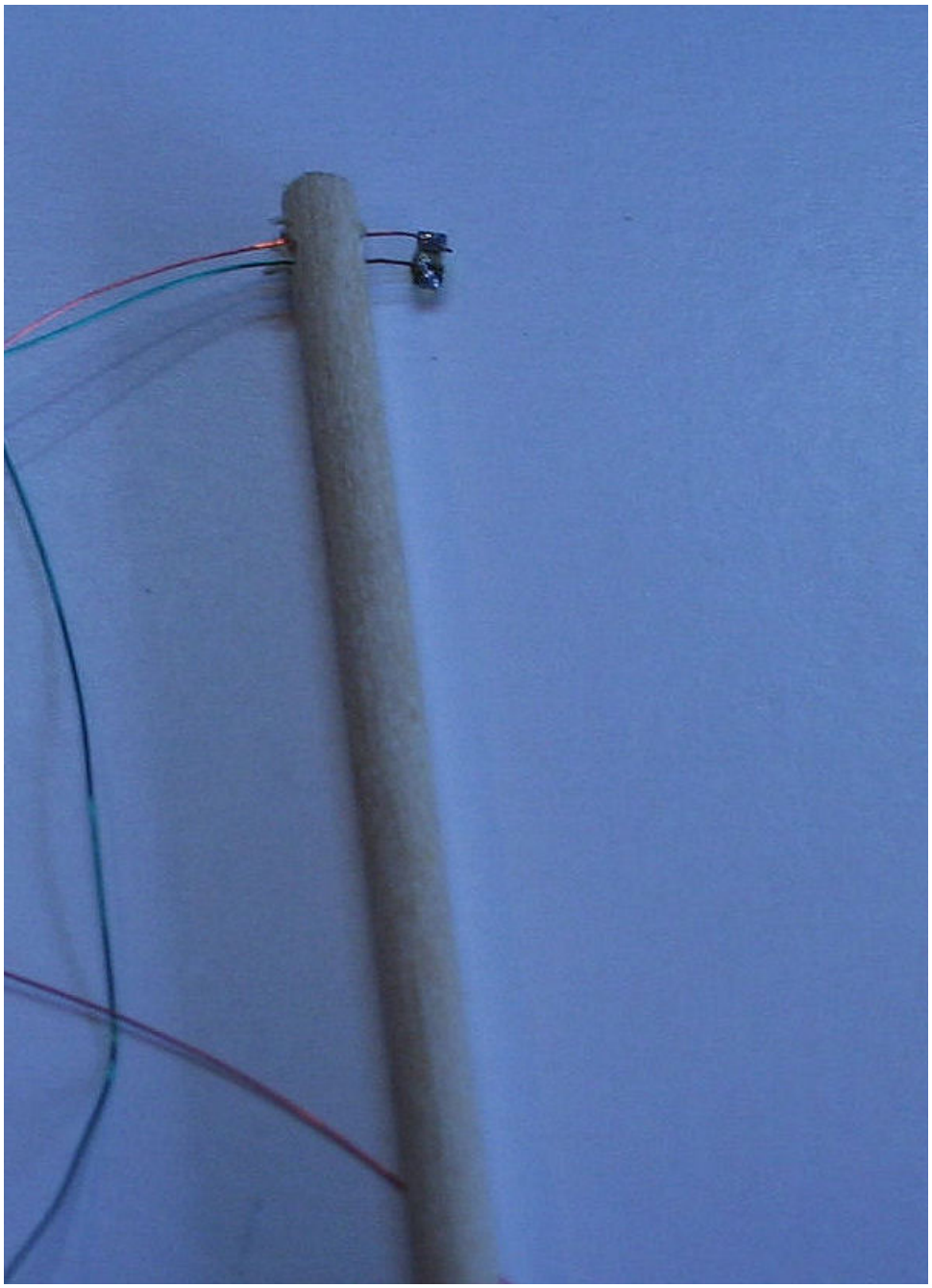
An easy project is to make a street light with your newly wired LED. One popular type is a lamp mounted on a bracket at the top of a pole. These are usually found in manufacturing areas, or in work zones on portable equipment. Here is a picture taken at the rail yards in Colton:

We will be making a small light pole, suitable for a parking lot at your depot. First, cut a hunk of swab to a reasonable length. You can easily cut this small dowel by rolling it with the sharp side of an X-Acto knife. Then drill a small hole at the top of the pole with your #60 (or smaller) drill.



The drill has a nasty habit of drilling into table tops. A good idea is to reuse the wood wire-stripping block as a drilling back stop.

Next, thread the wires through the hole, stopping the width of the LED away from the LED. This extra wire will allow you to fashion the “bracket”. Bend the wire over in the back, then squeeze a liberal amount of super glue into the hole. Remove any excess by touching the blob with a piece of paper towel. Set the pole aside until the glue dries, a few minutes.



Once the glue is dry, gently pull the wires tight down the pole and hold the wires with your thumb and forefinger. Run a bead of super glue down the pole, stopping an inch before the end of the pole. This serves two purposes. First, the wire will not go down the same hole as the pole, so you have to be able to separate them. Second, your finger needs to come loose! Put the drying pole into the tweezer, level to stop the glue from running. Wait for a while, and the light is all wired up! The next step is to paint the pole with thick standard house paint. We use the brown from our module sides. The thick paint will disguise the magnet wire, making it essentially invisible.

Real lights have shades on them. This particular type of light is usually in a housing instead of using a shade. I approximate this by using black liquid tape. The heavy rubber blocks light, and is not conductive. I apply it with a toothpick on the top and sides. Use fresh liquid tape, as once it starts to harden it won't cinch up tight to the LED.

To plant the light pole, drill a vertical hole in your layout the diameter of the pole. The taller the pole, the more careful you have to be, as a leaning pole is unusual in the real world. Drill another hole, this time with the #60 drill, next to the first hole. The pole goes down the big hole, the wire down the small hole. First feed in the wire, then plant your light pole. Once you have connected the electricity (through a resistor), you are ready to light up your layout!

Trucks and Cars

Lights for trucks and cars are actually variations on the street light. Just drill a hole in the headlight lens, feed the wire through and then super glue the LED in place. The stop lights are red LEDs, and need to have their own resistor. In parallel, the lower voltage red LEDs will set the voltage and the white LEDs will not light.

Lighting Ideas Courtesy of ngineering.com