



Introduction to PC Modification

Okay, you may have picked up this book out of sheer curiosity and asked the question everyone asks: “What is this book about?” Well, it is about the process and art (and yes, it is truly an art) of modifying a computer to make it match the modifier’s vision

If you looked at the cover of this book and couldn’t guess what was inside, the figure on the facing page shows the difference between a standard computer and a modified one.

In this chapter, you will learn about what computer modification is, the tools and skills needed to do it, and some of the warnings that go along with it.

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The What, Why, and Who of Modification

Before we get into the meat of modification, I'll give you a little background on what exactly computer modification *is*. It's primarily a PC-related phenomenon, but there have been several Macintosh computers modified over the years (remember the Mac Plus fish tanks?). First off, it is important to use the right terminology. A modified computer is normally designated as having been *modded*. And a single modification or single theme is often known as a *mod*. A person who does these mods is known as a *modder*.



Note: Mod is actually short for case mod because the first modifications were mainly to the case of the computer, not to any other component.

What Is It?

Mods fall into two categories: case mods and computer mods. *Case mods* are those modifications that really only affect the case or the looks of the internals—that is, visual modifications. *Computer mods* are generally those mods that include not only case mods, but entire electronic constructions and modifications.

For example, Figure 1.1 is an example of a typical case mod. It uses colored lights, has a window in the side, and has multiple case fans.



Figure 1.1 A sample modded case

Why Do It?

Because you can!

Most people who do case modding do it because they don't want the same computer that everyone else has. Computer modders are usually those people who customize everything to make it resemble their personality.

Modding is truly an art form. It is an expression of the creativity and talents of the modder. By looking at the case mods a person does, you can get a sense of who they are.

Besides, when you go to a LAN party, in addition to your gaming skills, don't you want to show off your case modding skills? As a matter of fact, at most major LAN parties (especially ones like QuakeCon) there are case mod contests for cash and prizes. Cool, huh?

Who Is Doing It?

You might be asking yourself, "Yes, this is cool, but who is doing this?" Well, gamers are the primary people doing case modding. You might think that this represents a fairly small percentage of the entire population (the demographic is mainly the 14–22 year old male). However, the case modding trend is becoming so popular that major computer retail chains (Best Buy, CompUSA, and so on) are carrying modding parts.

More and more people are trying to create something unique for themselves out of their computer. They don't want the same old beige box sitting on or next to their desk. For that matter, some don't want a box at all—some mod the computer right into their desk.

Warnings

Okay, from here on out, you're going to learn about how to mod your computer. But I would be remiss in my duties as an author and case modder if I didn't make extremely clear *before* you do anything some of the things you need to understand about the dangers of modding your computer or building a modified computer. These issues include:

- Warranty issues
- Parts destruction

Warranty Voiding

Most often, modding will void any and all warranties by the manufacturer. These components (except for modding components themselves) were not designed to be modified. So, in case you missed it:

Any modification work you do on computer components outside of what the factory intended will most likely void your warranty. *If you mess up, it's your fault.* You will have to buy a new part. If you don't want to buy a new part, *don't do it.*

Parts Destruction

With some of the advanced mods, you will be taking apart components that may not have been designed to be taken apart (for example, hard drives). It is completely possible that unless you are careful, you may destroy a very valuable component. Even if you follow the directions I outline here, problems do occur. Something as small as a single particle of dust or metal filing can render a component unusable.

Safety

As if the other warnings weren't enough, there are several safety issues to consider as well. In addition to damaging components, it is possible to harm yourself while modding computers if you're not careful. You will be working with tools and, unless you are completely familiar with their proper use, you can seriously hurt yourself.

Pay attention to the warnings in this chapter and those dispersed throughout the book.

Safety Equipment

Safety begins with proper attire. What you wear while modding is important. Your clothes should fit, and there should not be any loose fabric that might catch in a spinning blade or shaft. Also, if you have long hair, your hair should be pulled back and out of your face so it doesn't interfere with what you are doing.

Some of the other safety equipment you may need to use includes:

- Eye protection
- Ear protection
- Gloves
- Breathing masks and filters

You can buy many of these items at your local hardware store or paint store. Let's take a quick look at each of these and how each should be used properly. Some of these pieces of equipment you may have used before, but some you may not have.

Eye Protection

My shop teacher in high school used to say, "You only get two eyes, fellas, so put them goggles on." Eye protection of some kind is usually made of polycarbonate or some other tough plastic material and comes in two styles: safety glasses and true goggles. Safety glasses look like regular glasses, except they have polycarbonate lenses and extra side guards attached to the earpieces. Safety goggles, on the other hand, are better for people who wear glasses because they completely surround the eyes and are secured to your head with an elastic band.

Whichever works for your particular situation, just make sure you use them whenever there's a possibility of flying dust or debris.

Ear Protection

When working with metal and plastic, you'll often use high-speed cutting tools. These tools make loud, high-pitched noise when they're doing their job (though they do their job very well). These high-pitched noises can damage your hearing when you're exposed to them for a long time. So, it's a very good idea to wear some kind of ear protection, like ear plugs or the sort of ear muffs that look like large padded headphones.

Gloves

You might be thinking, "Why would I need gloves?" Well, for one main reason: to protect your hands from sharp edges and dangerous chemicals. Freshly cut openings can be razor sharp, so it's a good idea to have a pair of canvas or similar gloves to protect your hands when working with metal.

Additionally, when working with solvents or paints, it's a good idea to use some kind of nitrile gloves that are solvent proof. You can usually buy a pack of 100 at a tool store like Harbor Freight (www.harborfreight.com) for around \$10. Isn't your skin worth \$10?

If by chance you might be welding on your case, you should have a pair of thick welding gloves. They're usually made of leather and are long enough to protect your hands and forearms from sparks and burns. Most mods are done without welding, however.

Breathing Masks and Filters

Probably the most important and most overlooked safety equipment is breathing protection equipment. Whenever you do modding, you will constantly be creating particulate matter like small metal filings, paint dust, and so on. It is not healthy to breathe this in. In addition, painting creates dangerous fumes. These fumes, if inhaled, can cause headaches, dizziness, even death (especially if using automotive urethanes).

For this reason, you need to use the right kind of breathing protection. For dust and other particulate matter, you should wear a *dust mask* according to the manufacturer's directions. Dust masks are made of a tightly woven paper fabric.

However, a dust mask only filters dust, it doesn't filter out fumes. So, if you're going to do any painting, you should buy a *painting respirator*. These masks have dual charcoal filters and a one-way valve. When you breathe in, the valve is held closed and the incoming air is filtered through the charcoal filters. When you exhale, your breath goes out the one-way valve. Figure 1.2 shows an example of a painting respirator.



Figure 1.2 A sample painting respirator



Warning: These painting masks are okay for aerosol spray can painting, but if you are going to use automotive paint and automotive spray equipment, this kind of a mask is not sufficient.



Warning: The charcoal filters in painting respirators should be replaced every six months or so (more often if used heavily). If you can smell paint while wearing the respirator, stop painting and replace the respirator's filter cartridges.

The final kind of breathing protection equipment is only necessary if you are doing automotive painting. If you spray automotive paints using a spray gun, you must use a *forced air breathing apparatus (FABA)*. This system (as shown in Figure 1.3) uses a compressor or air pump to bring in fresh, filtered air from outside the spraying area and feed it directly to the mask. That way, no contaminated air can be breathed because fresh air is always pushed to the mask. These systems are very expensive (\$500–\$1000), but are worth it if you do any automotive paint jobs.

Note: If you want this quality of paint job and are only going to do it once, it makes sense to sand the panels yourself, then take them to a body shop. They can usually do the job for much less than it would cost you to buy the equipment.



Figure 1.3 A forced air breathing apparatus (FABA)

Metal Safety

First of all, most cases are made of some type of metal (be it steel or aluminum). You will often need to make holes in the case metal (using a drill, nibbler, or whatever) to install a fan or window. When you are cutting these holes in the metal, you must be very careful not to cut yourself on the sharp edges of a fresh cut. It is a good idea to dress the fresh cut with a file or sandpaper (I'll cover exactly how to do that later).

Also, when cutting metal, as we already discussed, make sure to wear the proper safety gear, especially when using power cutting tools. To minimize the chances of cutting yourself, wear thick leather gloves. These tools will also often throw sparks and small shards of metal with force, and these shards can embed themselves in your skin or your eyes. In addition to the gloves, you should wear goggles and ear protection when cutting metal with power tools.

Also when cutting metal, be aware of combustible fumes in the air. Stray sparks may ignite these fumes and cause a fire, or worse, an explosion.

These same power tools can also catch on the metal and possibly “kick back” so take your time when making a cut and hold the tool securely.

Above all, *pay attention* to what you are doing. The biggest cause of accidents is distraction!

Tool Safety

Tool safety is primarily about knowing the proper way to use a tool so that you don't injure yourself or others. It's fairly obvious to state don't put your fingers into any moving parts, don't run with scoring tools, pencils, or scissors, yada yada yada.

In addition, follow the correct procedure for using the tool and the instructions that came with the tool. Most power tools come with safety instructions, so be sure to read and follow them before using the tool.

Chemical Safety

You will be using several dangerous chemicals when doing case modding, including paints, thinners, and cleaners. These chemicals pose danger because you can inhale their fumes, get the chemical on your skin, or accidentally ingest the chemical.

Each chemical has a special sheet that lists the hazards it can be to human health and well being. These sheets are known as a Material Safety Data Sheets (MSDS), and they are available from the manufacturer and distributors of chemicals. An MSDS also tells what should be done in case of exposure to the chemical.

Generally speaking, it is a good idea when working with chemicals of any kind to wear protective gear (eye protection, gloves, and so on). Also, if the chemical you are using (paints, thinners, and so on) emits fumes, you should wear breathing protection and work in a well ventilated area.

Preventing Electrostatic Discharge (ESD)

Electrostatic discharge (ESD) happens when two objects of dissimilar charge come in contact with one another. The two objects exchange electrons in order to standardize the electrostatic charge between them. This charge can cause problems such as making a computer hang or reboot. It can also, and often does, damage electronic components.

The likelihood that a component will be damaged grows with the increasing use of Complementary Metal Oxide Semiconductor (CMOS) chips, because these chips contain a thin metal oxide layer that is hypersensitive to ESD. The previous generation's Transistor-Transistor Logic (TTL) chips are more robust than the newer CMOS chips because they don't contain this metal oxide layer. Most of today's ICs are CMOS chips, so ESD is more of a concern.

Note: CPU chips and memory chips are particularly sensitive to ESD. Be extremely cautious when handling these chips.



The lowest static voltage transfer you can feel is around 3000 volts (it doesn't electrocute you because there is extremely little current). A static transfer that you can *see* is at least 10,000 volts! Just by sitting in a chair, you can generate around 100 volts of static electricity. Walking around wearing synthetic materials can generate around 1000 volts. When you shuffle your feet across the floor and shock your best friend on the ear, you are discharging static electricity into the ear of your friend. You can easily generate around 20,000 volts simply by dragging your smooth-soled shoes across a shag carpet in the winter. (Actually, it doesn't have to be winter to run this danger. This voltage can occur in any room with very low humidity.)

It makes sense that these thousands of volts can damage computer components. However, a component can be damaged with as little as 80 volts! That means if even a small charge is built up in your body, you could damage a component without realizing it.

Antistatic Wrist Strap

There are measures you can implement to help contain the effects of ESD. The first and easiest is wearing the antistatic wrist strap, also referred to as an *ESD strap*. To use the ESD strap, you attach one end to an earth ground (typically the ground pin on an extension cord) and wrap the other end around your wrist. This strap grounds your body and keeps it at a zero charge. Figure 1.4 shows the proper way to attach an antistatic strap.

Warning: An ESD strap is a specially designed device to bleed electrical charges away *safely*. It uses a 1-megohm resistor to bleed the charge away slowly. A simple wire wrapped around your wrist will not work correctly and could electrocute you!

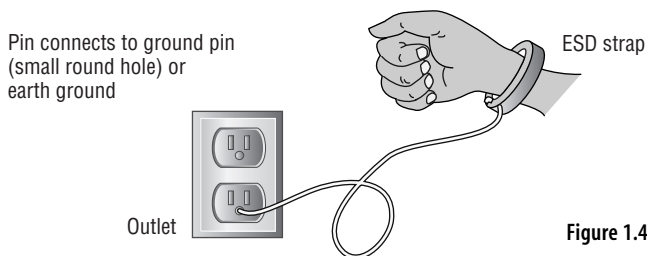


Figure 1.4 Proper ESD strap connection



Warning: There is only one situation in which you should not wear an ESD strap: if you wear one while working on the inside of a CRT monitor, you *increase* the chance of getting a lethal shock.

Antistatic Bags for Parts

Antistatic bags are important tools to have at your disposal when disassembling a computer for modification because they protect the sensitive electronic devices from stray static charges. These silver or pink bags are designed so that the static charges collect on the outside of the bags rather than inside on the electronic components.

You can obtain antistatic bags from several sources. The most direct way is to go to an electronics supply store and purchase them in bulk—most have several sizes available. Perhaps the easiest way to obtain them, however, is simply to hold on to the ones that come your way. That is, when you purchase any new component, it usually comes in an antistatic bag. Once you install the component, keep the bag. It may take you a while to gather a collection of bags if you take this approach, but eventually you will have a fairly large assortment.

Now that we've gotten all the negative stuff out of the way (so you can't say no one told you), let's get to my favorite part, the tools!

Tools

Ask anyone that knows me—one of my favorite parts of modding is the great tools I get to use. Any chance to buy or borrow and use a new tool is for me! *<insert male grunt here>* Tools are a great thing. I can change and modify my world at my very whim while making a lot of noise the whole time!

Modding PCs doesn't require many special tools, but there are a few that you'll need to use for specific projects, and we'll need to discuss the tools and work area before we get to the projects themselves.

Workspace

Where you work is almost as important as what you work on. Ideally, you're going to want to have a workshop, or at least some space you can spread out all of your components and parts while you are working. Keep in mind that if you are doing any of the paint work yourself, you can paint outside, but you'll have more work when cleaning up the paint job because there will be more dust and trash in the paint.

So, find a place you can work, like a basement or garage, that has a flat, stable, level surface to work on, like a workbench. Although you can use a table without any

problems, it really helps if the workbench is at countertop height (about 36" off the floor) to make it more comfortable. That way you're not stooping to work and hurting your back.

It also helps if there's a light above the workbench, or at the very least, the area should be well lit. I like using halogen light fixtures because they give off lots of light and, in the winter (for those of you who live in the northern climate, as I do), they serve as an additional heat source.

For those long modding sessions, remember that you're going to be standing in place for a long time, so try and find something comfy to stand on. They make special mats for this, but they're expensive. I find that a small carpet remnant from a carpet store is great (plus it's so cheap you can throw it away when it gets really dirty).

It's nice if you have a place to put all your tools when you're not using them. A toolbox on the workbench is good; a freestanding toolbox is better. Integrated cabinets are the ideal, for the person with an unlimited budget.

I also have a small section of black padding on top of my workbench for when I'm working on delicate items that I don't want scratched (like fresh paint jobs). It's actually a roll of the padding material for drawers of tool chests. If you don't want to spend the money on that, use a couple of layers of cotton rags or towels when working with freshly painted parts

As far as bench material is concerned, you can buy either a premade metal or wood workbench, but a wood workbench is preferred for many reasons, including low cost and ease of construction. As a matter of fact, you can make a sturdy workbench out of two sawhorses and an old wood door.

Basic Hand Tools

Every person should know how to use a basic set of hand tools. They're cheap and simple to use and they usually come in sets. Plus, they have multiple uses. Some of the hand tools used in case modding include:

- Screwdrivers
- Wrenches
- Sockets
- Aviation snips
- Riveting tool
- Marking and measuring tools
- Sandpaper
- Center punch
- Files

Screwdrivers

The *screwdriver* is probably the most commonly used tool in case modification. Most case covers are held on with screws of some sort, so you'll need to have a few of these in your modding toolkit. I imagine you've seen a screwdriver before.



Note: You might want to consider a nonmagnetic multibit driver that uses interchangeable bits. It is cheaper than buying several screwdrivers and is more compact.

Wrenches

Every workshop needs to have a set of wrenches. A *wrench*, if you didn't already know, is the tool used to turn nuts and bolts. There are three basic types:

- Box end
- Open end
- Combination

In addition to the three types, wrenches also come in two different measuring scales: standard and metric. It's a good idea to have a set of both.



Note: If you are buying only one set of wrenches, buy a set of combination wrenches. Also, spend the little extra money and buy a good, solid set with a lifetime replacement warranty (like a Craftsman or Snap-On set, or similar).

Socket Set

If you are going to have a set of tools, you should include a socket set in your purchase. *Sockets* are like the individual box ends of wrenches with a special driver (called a *socket wrench* or *ratchet*), so you essentially have one wrench handle, with replaceable ends. The sockets come in different sizes, much like wrenches (and in both standard and metric as well). In addition, the ratchets and sockets are sized by the size of the square drive tang on the socket wrench and matching hole on the socket. Common socket set sizes include $\frac{1}{4}$ " drive, $\frac{3}{8}$ " drive, and $\frac{1}{2}$ " drive. For case modding, I like to use the $\frac{1}{4}$ " drive because the sockets are smaller and can get into tight places. You might also need a few different lengths of extensions and swivel couplers to help get into tight places.

Aviation Snips

When cutting sheet metal, the best hand tool designed for the job is a pair of *aviation snips*. You can use them to cut metal just as if you were using scissors to cut paper.

There are three variations of these snips, two of which are shown in Figure 1.5. The colors of their handles indicate their offset and which direction they will cut easiest. Green handled snips cut right, red handled shears cut left, and the yellow handled shears cut in straight lines. If you are making complex cuts, you may have to use more than one of them. So if you are going to buy them, it's best to buy the set of three instead of just one.

Riveting Tool

Pop rivets are often used to hold case internal structures together where it would not be practical to use screws. A rivet essentially squeezes two pieces of material together and holds them together. Rivets are installed using a *pop-riveting tool*. This tool pulls the pin on the rivet that swells the backside of the rivet, thus putting pressure on the second piece of material. Figure 1.6 shows how pop rivets work. Notice that the rivet swells in the picture on the right. When the rivet is fastened by squeezing the handle on the riveting tool, the tool pulls the plunger in the rivet up, thus expanding the metal of the rivet. This expansion prevents the rivet from popping through the hole. This is how the rivet holds two pieces of metal together.



Figure 1.5 Aviation shears



Figure 1.6 How riveting works



Note: Its best to use rivets only if you never need to take the pieces apart again. In order to remove rivets, you have to drill them out.

Marking and Measuring Tools

Whenever you are fabricating with computer cases, you need to be able to make accurate measurements and markings before you cut or drill. This is where you need to have the best possible tools available for marking and measuring. There are three categories of marking and measuring tools:

- Measuring tools
- Marking tools
- Squares and straight edges

Measuring tools of various kinds are used for one primary purpose, to determine lengths and sizes. Usually, when you are measuring an opening's size or measuring the length or width of a new piece being fabricated, you can use any number of different types of measuring tools.

The most common measuring tool is a tape measure. It is essentially a long, metal tape with measuring markings on it (usually graduated in sixteenths of an inch). The metal tape is pulled out to take a measurement; it then retracts back automatically when you are finished.

Although a tape measure works, I like to use a *ruler* for making measurements. I find it a bit more precise and less unruly (forgive the pun) than a tape measure. It can also double as a straight edge (discussed later).

When taking measurements for cuts and holes, you will need to make some kind of mark to indicate where to cut. There are several tools you can use for this, including:

Pencil A very good tool for marking, but if you are going to use it to mark your cuts, make sure it is a sharp one so it makes a clean line.

Marker Arguably, the worst choice for marking cuts in case modding. It typically makes a thick line, which leads to inaccuracies. Plus, the ink may not always be compatible with the finish you choose to paint your case with and may cause paint lifting or bleed-through. But it will work in a pinch.

Scribe This is the best tool for marking metal and plastic. It is usually made of metal with a sharpened point. It can make very fine lines in metal and other materials. The only downside is that you must be careful with the point so that it remains sharp.



When cutting metal (or any material for that matter) it is important that the cuts be straight and square (perfect 90° angles to the other sides). For those two functions, when marking a cut, you should use a *square*. In the case of non-90° angle cuts, you should use a straight edge to mark a straight line between two points. Figure 1.7 shows an example of a square and a straight edge.

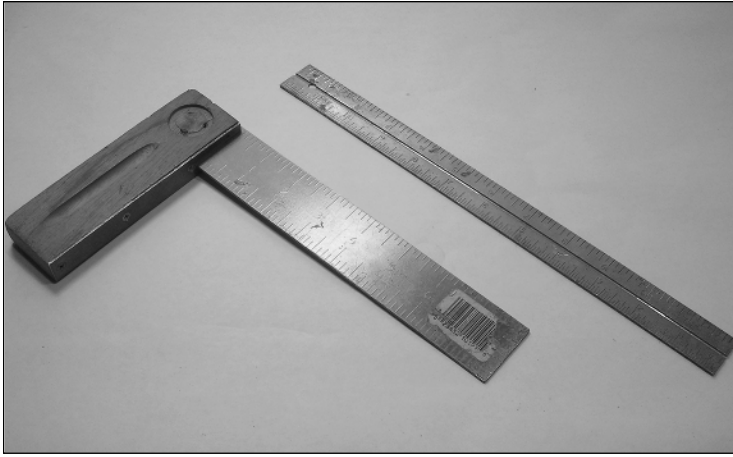


Figure 1.7 A square and a straight edge



Note: You might also look into buying a bevel gauge (used for copying angles).

Sandpaper

If you are doing any work on the outside of your case, like cutting holes in it, or if you paint the case, you will need to know a little something about sandpaper. *Sandpaper* is essentially a paper impregnated with some kind of abrasive. The amount of abrasive on the paper is measured in varying degrees of roughness, called *grits*. Each grit is given a number that corresponds to how many abrasive particles there are per square inch. The higher the number, the finer the grade of paper and the less material it will remove. For example, you might use 60 grit to remove paint from metal and to take burrs off freshly cut fan holes, but you would use 600 grit to sand primer before applying paint.

You can buy sandpaper in sheets or rolls from any hardware or home improvement store. You can buy in either single sheets or packs of several sheets. Consider buying the packs, as you will always find uses for it. I advise having the following grits:

- 80 grit for removing paint and deburring holes
- 150 grit for roughing up paint and texturing metal
- 220 grit for smoothing
- 340 grit for finish sanding
- 600 grit for sanding plastic before painting

If you are going to use a power sander of some sort, you should be able to buy sandpaper for it in the grits listed.

Note: If you are buying sheets of sandpaper, consider also buying a sanding block or make one out of a flat piece of hard wood. When painting, it will help ensure a smooth, flat surface. Plus, when shaping metal, it helps provide a backing for more even sanding.



It's pretty easy to use sandpaper. Basically, you just need to move the rough side of the paper back and forth across the surface to be sanded. If you are trying to remove burrs and sharp edges from metal, be sure to use a sanding block and hold the paper at a 45° angle to the metal being sanded.

Center Punch

A center punch is a small hand tool shaped like a pencil (Figure 1.8). It is used to make small dents in metal. The primary purpose of a center punch in modding is to help start drilled holes properly (especially in metal). Making a small indent exactly where you want the hole to go will prevent the drill bit from wandering all over the place when you are trying to start the hole.

What you do is mark the location for the hole you are making (with pencil, scribe, or whatnot) with a “+”, place the point of the center punch exactly in the center of the +, then strike it quickly and sharply with a hammer. If you do it right, there will be a small dent exactly in the center of where you want the new hole to go. You can then proceed with drilling.



Figure 1.8 A center punch

Files

A file is a special tool with multiple serrations. It's main use is to remove precise amounts of metal or wood evenly. Files are very flat (or are precisely rounded) and made of metal with serrations on all sides. They come in both coarse and fine serrations. For metal work, I recommend a medium or fine serrated file.

Files work just like sandpaper in that all you need to do to remove metal is to draw the file back and forth across the end of the metal (as shown in Figure 1.9) to make it even. Files work extremely well to remove the small burrs and uneven spots that occur when cutting case window holes. They also work well for squaring up corners.

Small Power Tools

Hand tools are inexpensive and easy to use, but when you are trying to get something done, there is nothing like a power tool to make the job go faster. There are several types of power tools, but the ones used most often in case modding are smaller power tools (usually handheld). There are several types of small power tools that are used when modding computers, including:

- Dremel
- Drill
- Nibbler
- Shear
- Soldering iron or gun
- Hot glue gun

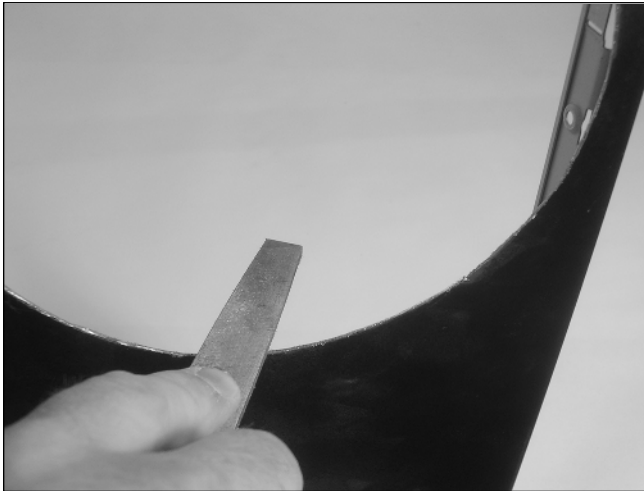


Figure 1.9 Proper use of a file

Warning: Power tools can be very dangerous. Make sure you are wearing the proper safety gear when using them.



Dremel Multitool

Probably the most used tool in any modder's toolkit is the *high-speed rotary multitool*, and the number one brand is the Dremel MultiPro—so much so that people just say, “I used my Dremel to make that hole.” To that end, I'll refer to it as the Dremel throughout the book. Figure 1.10 shows an example of a Dremel.

The Dremel can do many things, including sanding, cutting, buffing, drilling, and any other operation where you need high-speed rotary action. If you buy a Dremel in a kit, you'll usually get the attachments for doing all those actions in the kit. Otherwise, you have to buy them separately. Some of the attachments include:

- Cutting wheel
- Sanding drum
- Engraving bit
- Buffing wheel
- Flex-shaft



Figure 1.10 A Dremel high-speed rotary multitool

The most commonly used Dremel attachment for case modding is the cutting wheel. It's used for cutting holes for windows and cutting other kinds of openings in the case. It consists of two parts, the *mandrel* and the cutting wheel itself. The mandrel is just the stick that the cutting wheel is screwed to so that it can be spun by the Dremel.

Cutting wheels come in different sizes and types, but case modders mainly use two different types of cutting wheels, unreinforced and reinforced. Figure 1.11 shows examples of these.

The one on the left side of the photo is the unreinforced kind. Essentially, it's a solid disk of abrasive. This kind is okay for cutting plastic and metal, but with any small amount of force, they will shatter into a hundred pieces, usually at high speed. They do work, and they are extremely cheap, but they can be dangerous, and you'll have to use a lot of them to cut a decent-sized hole. The main reason case modders use these is that they can cut an extremely thin line (called a *kerf*) and because they come with their Dremel kits.

The cutting wheel shown on the right side of the photo is the reinforced cutting wheel, which is the desired type. These cutting wheels can cut materials better, last much longer, and most importantly, because they are reinforced with strands of fiberglass, rarely shatter when cutting. However, they are also much more expensive (about \$1 apiece).

Sanding drums are used to smooth things. That's it—that's all they do. The sanding cylinders fit over a special round rubber drum that holds them for a Dremel. Figure 1.12 shows examples of Dremel sanding drums.

Another frequently used Dremel attachment is the *engraving bit* (Figure 1.13). It can etch a window or engrave metal. It is usually used at the highest speed, and unless you are careful, with one slip you can ruin an entire panel and put a nice scratch across it.

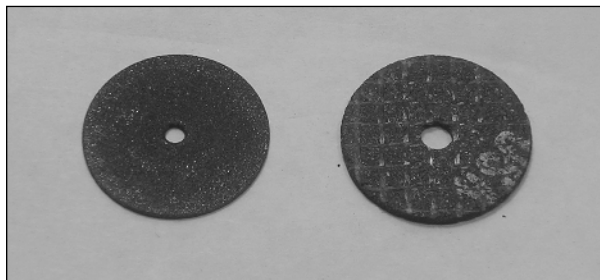


Figure 1.11 Dremel cutting wheel examples



Figure 1.12 Dremel sanding drum attachment

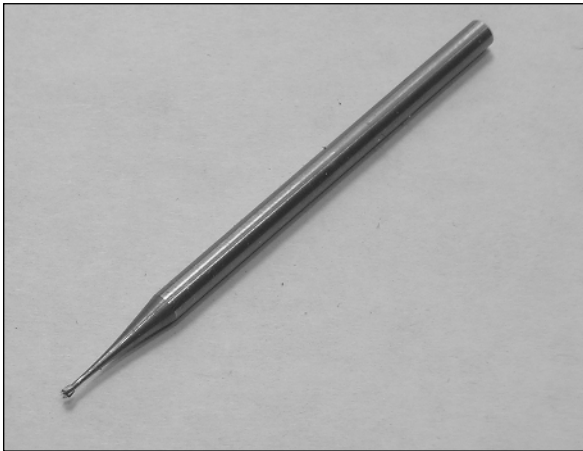


Figure 1.13 An engraving bit

The last Dremel bit you might use is the buffing wheel. These small felt wheels (Figure 1.14) are used to polish metal. When used with the proper compound, they can make aluminum or stainless steel shine like chrome.

Note: There are also full-size buffing wheels available for polishing metals to a mirror shine using special abrasive compounds. These wheels attach to a grinder motor and work very well on aluminum. One company that sells these is Eastwood (www.eastwoodco.com).



The flex-shaft is really nice to have when doing any kind of fine detail work. It extends the rotating shaft of the Dremel through a long, flexible tube capped with a rigid tube and allows you to hold the Dremel attachments like a pencil for much finer and more precise control. This accessory is very handy for doing engraving work. Figure 1.15 shows a Dremel outfitted with this tool.

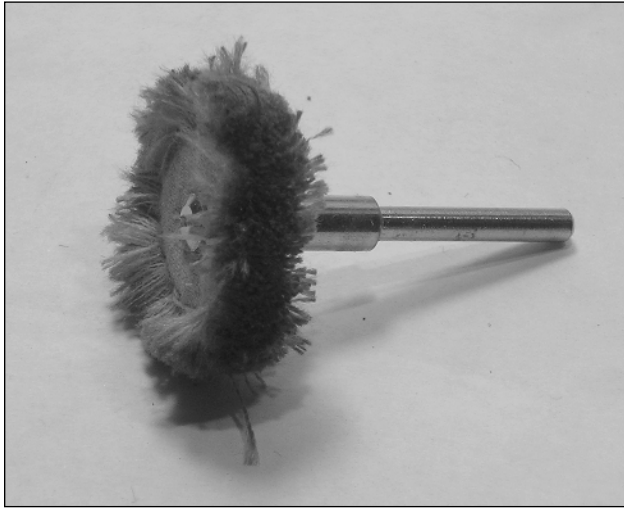


Figure 1.14 A Dremel buffing wheel



Figure 1.15 A Dremel with a flex-shaft

Drill

Face it: most cases are made of metal and plastic. And often you will have to put holes in those materials. The best way to do it is to use a *drill*. You’ve most likely seen one before, but in case you haven’t, it’s pistol-shaped with a motor and trigger switch. Various sizes of bits are secured into the motor and used to make holes.




There are two main types of drills, battery-powered (also known as portable or cordless), and conventional. A battery-powered drill is basically the same as a conventional drill, except the power comes from a long-lasting battery, which causes them to be heavier. I recommend battery-powered because they are much more flexible than and almost as powerful as the conventional type.

Most battery-powered drills are advertised by the number of volts their batteries use (9.6V, 12V, 18V, and so on). The higher the voltage, the more power the drill has. A word of advice: if you are going to buy a portable drill, buy the best one you can afford with the highest voltage rating.

Along with the drill, you will need several drill bits. A drill bit is the attachment you insert in the drill to make the drill useful. Without drill bits, a drill is nothing more than a switched motor.

There are several different types of drill bits. Table 1.1 shows you an example of the most popular types of drill bits used in modding, their names, and their uses. Most often, drill bits come in different sizes, so it should be noted what size bit is needed for a particular job when working with drill bits. For example, if you need to drill a 1/8” diameter hole, you’ll need a 1/8” diameter drill bit.

Table 1.1: Drill Bits

Picture	Name	Description and Common Use
	Standard metal bit	Drilling holes in metal.
	Standard wood bit	Drilling holes in wood. Not normally used for modding. <i>Do not use on metal.</i>
	Steel step bit	Made for drilling perfectly round holes. Multiple sizes with only one bit.

My Favorite Drill

I've owned several portable drills in my lifetime, and my favorite has to be my DeWalt. DeWalt makes extremely tough and long-lasting tools. After several years of trusty use, it finally gave up the ghost, but I had worn the handle grip off, the battery clip had broken (when I left it on a ladder and it fell), it had various other problems, and it *still worked!* It only stopped working after the motor burnt out while I was drilling through a railroad tie (8"–10" thick!). I have since replaced it with a Bosch, but I liked my DeWalt better. You may spend a few bucks more, but you'll thank yourself. Check out their tools at www.dewalt.com.

Nibbler

The problem with using a Dremel to cut metal is heat distortion. You are essentially using an abrasive wheel to scratch your way through the metal. Because of friction, this produces a large amount of heat. Pieces cut with a Dremel get very hot, which causes them to expand. Unfortunately, these pieces may not always shrink back to their original size, which causes them to warp. You'll know this has occurred when a part of the case you are cutting is slightly warped and "pops" back and forth. This problem is called *oil canning*, and the best way to solve this problem is to avoid it to begin with.

You can avoid it by using a low friction way of cutting. One way is to use aviation shears, but they can't always get into tight spaces and aren't the most elegant to use. The other is to use a *nibbler*. There are both hand nibblers and power (usually pneumatic) nibblers (an example of which is shown in Figure 1.16). Nibblers work as their name suggests, taking very small "bites" out of the metal. They have a cutter piston that goes up and down against a solid metal die that makes the bites. This method produces very little distortion and can make very curved and wavy cuts. The downside is that they require a fairly large starting hole to get the cut started when starting in the middle of a panel (like for a window).



Figure 1.16 A pneumatic nibbler

Note: The pneumatic version requires an air compressor to run it, so if you don't have one, that option for cutting is out. They do make electric nibblers, or of course, the hand nibbler (but be prepared for some strenuous hand exercise).



As you can see in Figure 1.17, the nibbler cuts nice smooth holes for windows and such. They may need a bit of cleanup (as in filing the edges completely smooth), but they make the nicest, distortion-free holes. To make the hole, first mark out the hole you want to make (preferably with a scribe). Then, drill a hole large enough to insert the nibbler. Insert the nibbler, turn it on, and start your cut. You'll be able to make sweeping curves and turn on a dime. But you'll only be able to cut material as thick as the nibbler's die will allow.

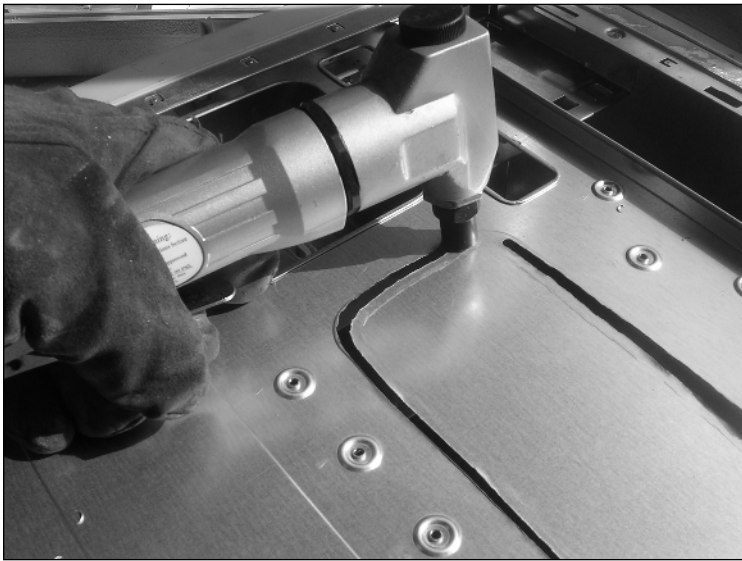


Figure 1.17 Making a hole with a nibbler

Power Shear

Another option for cutting metal without producing a large amount of heat is the *power shear*. A power shear works much like the hand-powered aviation shears, but it's powered with a motor instead. Also, unlike aviation shears, there is a center cutter that moves up and down with two dies on the outside. Thus, when cutting with a power shear, you'll actually be removing a strip of metal. This metal usually curls up and out of the way leaving a nice smooth edge (unlike the slightly scalloped edges of the nibbler).

Making a hole with the power shear requires a fairly large starter hole (enough to get the cutter and dies inside, possibly up to 1.5–2" in diameter). Plus, you won't be able to make the tight corners like you would with a nibbler, but the finish work is less.



Note: There are both pneumatic and electric versions of the power shear.

Soldering Iron or Gun

When you need to join two wires together, most likely you'll use a soldering iron or gun. You could crimp the wires together with mechanical connectors, but a soldering device is more professional and higher quality than crimping.

A *soldering iron* is a small, pencil-like device that is best used for soldering small wires (like those running to LEDs and case-front switches). It doesn't put out much heat, but it does work sufficiently well for the small wires. Once you plug it in, it's turned on.

A *soldering gun*, on the other hand, does the same job but can put out more heat and is turned on and off with a trigger switch. It is most often used for soldering thicker wires (like the power wires inside a case).



Warning: Some solders contain lead, which is known to be harmful. Follow appropriate safety precautions (don't inhale solder fumes, etc.) when using solder.

Procedure: How to Solder

This procedure outlines one of the most critical skills you need to master when doing computer modding. Soldering is the process of joining two or more wires together using solder (a compound of tin and lead).

Items Needed

- Soldering iron or gun
- Rosin-core solder

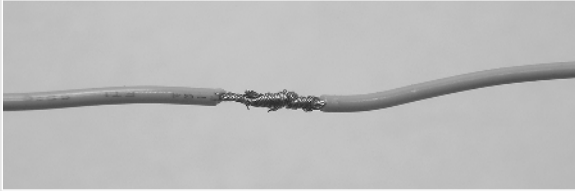
Procedure Steps

1. Plug in soldering iron or gun.
2. Cut piece of appropriately sized heat-shrink tubing to fit.

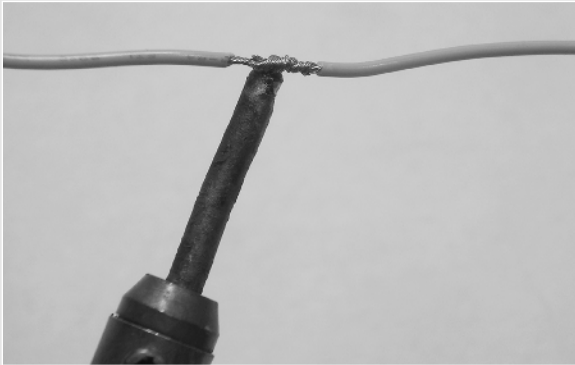
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Procedure: How to Solder *(continued)*

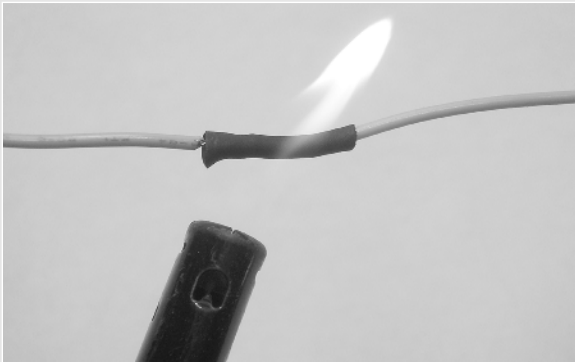
3. Twist wires to be soldered together as shown.



4. Place soldering iron underneath connection and heat connection.



5. Apply solder to connection until it melts. Do *not* melt solder on the iron and let it drip onto the connection. That will produce a poor quality connection.
6. Remove iron and let the connection cool
7. When connection is sufficiently cool, slip heat-shrink tubing over connection. Heat tubing with a flame until it shrinks around solder joint.





Note: If you are soldering a connector to a wire instead of two wires together, you should “tin” the wire and connector before joining them. Tinning means applying a bit of solder to both the wire and connector (by heating them, then applying the solder to the hot connector or wire) so that they go together easier and form a better connection.

Hot Glue Gun

As its name suggests, the hot glue gun produces hot glue by melting glue sticks. The glue then sets as it cools. It is useful for gluing plastics to plastics and can be found in hobby or craft stores. The guns come in two types, low temperature and multitemp (based on the types of glue sticks that can be used in it).



Note: We'll discuss glues and adhesives later in this chapter.

Other Specialized Tools

Now that you've learned about the most often used tools and the “must haves,” let's discuss some of the “nice to haves.” These tools make case modding easier and produce a more professional-looking result. The tools I would put into this category include:

- Drill press
- Air compressor
- Spray gun
- Bending brake
- D/A sander
- Laser or water jet cutter

Drill Press

A drill press is a tool with a powerful motor and a bit holder that moves up and down. While a hand drill works just fine for most drilling projects, whenever you need to make a hole, a drill press will help make holes that are lined up, nicely rounded, and on center. This is because the drill bit and drill are perfectly aligned with the piece being drilled. Plus, the press can be set up to drill to the same depth each time, making repetitive holes easier to make with more consistency.

Air Compressor

As its name suggests, an air compressor is a tool that takes in air and compresses it for storage at a higher pressure. This high pressure air is used to run various tools like spray guns, sanders, grinders, and so on. There are many different sizes of air compressors, each for a different purpose, from the small ones designed to run a single tool, to large multicylinder ones that supply air to an entire shop. If you do get one, get one that fits your needs with a little room for expansion. If you are going to do any kind of painting, buy one that is rated as a two-stage compressor. A two-stage compressor compresses the air twice and can keep up with the air demands of a spray gun.

Note: If you use an air compressor a lot for paint spraying, you may want to invest in a good water trap (especially if you live in an area with lots of humidity). It will dry the air out and prevent large droplets of water from getting onto your fresh paint job.



Spray Gun

Most of you will be using aerosol cans when painting cases. However, some of you may have access to automotive paint. In that case, you are going to need a *spray gun*. Spray guns use air to atomize the paint and force it out a nozzle in a fine mist. This mist is directed at the surface you want to paint. Spray guns can lay down more paint in a single pass than aerosol cans do. I believe you can get a much better result and more durable paint job with a spray gun than with an aerosol can.

There are different types of spray guns (HVLP versus conventional, suction feed versus gravity fed) and I could spend pages on painting equipment and the subtle differences between them. Instead, I'll summarize the general rules to follow if you are going to use a spray gun:

- Don't spend less than \$150 on a spray gun. You do get what you pay for, especially here.
- Buy a gravity feed gun over a suction type. They just work better.
- HVLP guns work better than conventional guns, but they require a larger compressor and are more expensive.
- Brands to look for: Sata, Devilbiss, Sharpe, and Binks are the most popular and widely used brands.

If you want to do some research, check out Sharpe's website at www.sharpe1.com.



Note: We'll cover paint application in more detail in Chapter 8, "Painting."

Some of the most talented case mod artists use an *airbrush*. An airbrush is essentially a much smaller version of a spray gun, with much finer control. Instead of spraying on large coats of paint, an airbrush is used for painting lines, fades, and other patterns of colors.



Note: If you plan on doing a lot of painting, you may want to look into a small paint hood or booth. These items pull paint fumes away from you and filter them out of the air. Plus, they keep overspray to a minimum.

Bending Brake

The bending brake is another item that could be considered a luxury, but when doing any kind of case metal work, I consider it a requirement. You can buy small benchtop models for under \$100, and they make cleaner bends than bending it by hand or in a vice. A *bending brake* is a tool for making clean bends in sheet metal. It is very useful when you have to fabricate sheet metal items for a case (or fabricate an entire new case). A cast metal clamp holds the sheet metal in place and a pivoting table bends up to bend the entire length of the piece at one time. Bends made with a brake are crisp and clean. Figure 1.18 shows an example of a sheet metal brake I bought for \$40 from Harbor Freight.

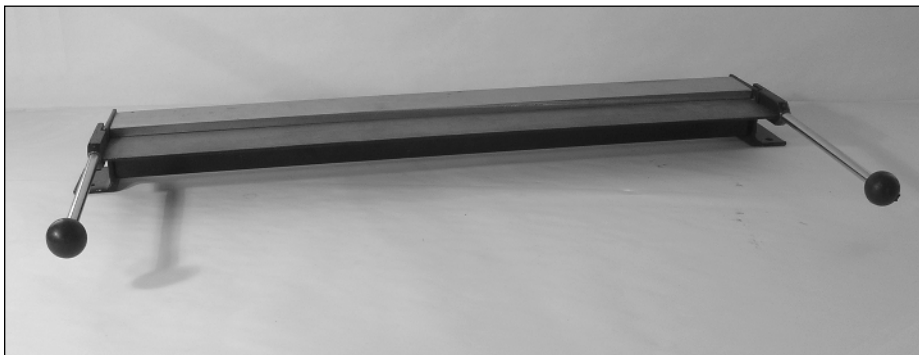


Figure 1.18 A sheet metal brake

D/A Sander

If you have an air compressor, one of the first tools you should be considering is a *dual action (D/A) sander*. It is the best sanding tool out there for sanding metal and preparing it for painting. It sands in a circular motion while spinning (hence the “dual action”). It can remove material quickly and easily, much faster than hand sanding. The sandpaper usually has an adhesive backing that sticks to the large circular sanding pad and can be quickly replaced while working. Figure 1.19 shows an example of a D/A sander.



Figure 1.19 A D/A sander

Note: If you don't want to invest in an air compressor to run a pneumatic D/A sander, they do make electric D/A sanders as well.



Laser or Water Jet Cutter

I put this particular tool in the book because it is extremely cool, and there are a few case modders out there with access to high-dollar machining tools. The laser cutter and water jet cutter are two examples of such tools. Essentially, they make extremely detailed cuts in metal, wood, or plastic. They use a precision plotter system to move the cutting head in exact patterns (usually only in two dimensions), and their kerf is extremely small (less than $1/32$ "). The difference between the two is that one uses a laser, the other uses a high-pressure stream of water to do the cutting.



Note: Even if you don't have the megabucks to buy one of these tools, there are firms that specialize in metal fabrication that will hire out their services. If you need something cut with this type of cutter, ask around. One such case modder who does this is Bill over at MNPCTech (www.mnpctech.com).

Modding Chemicals

Hand and power tools aren't the only tools used in modding. Many chemicals are used as well. Although you could do modding without most of them, they sure make modding easier and quicker. The categories of chemicals include:

- Paints
- Glues and adhesives
- Solvents and cleaners

Paints

I've dedicated an entire chapter (Chapter 8) to painting and the types of paints, so I won't go into too much detail here. However, paints are essentially coloring pigments in a sprayable or brushable base. The paints are categorized by the makeup of that base. Acrylic lacquer, acrylic enamel, urethane, and polyurethane are different types of paint bases, and I'll refer to those more later.

Glues and Adhesives

Okay, you're probably thinking to yourself, "Aren't glues and adhesives the same thing?" Not really, no. Both are bonding agents used to stick two things together

semipermanently. However, glues are made from natural sources, whereas adhesives can come from synthetic sources. Elmer's white glue is a glue, and most epoxies are adhesives. But most people don't care and use the terms interchangeably whenever referring to some agent that sticks two things together.

When would you use adhesives while case modding? Constantly. I'm always finding some wire that needs to be attached to the inside of the case bezel or some item that needs to be attached to another item and screws and bolts just won't work.

There are a few popular types of adhesive used when case modding:

- Hot glue
- Epoxy
- Goop

Hot Glue

Most people who have done crafts or have seen someone do crafts have seen hot glue. If you've ever taken the front panel off of a PC case and looked at the wires coming from the lights and switches on the front panel, they are usually held in with a dab of hot glue. Hot glue (as mentioned earlier in this chapter) comes in two main types, multitemp and low temp. High temperature glue (as its name suggests), melts at a higher temperature and sticks better than the lower temperature glue. Low temp glue melts at a lower temperature and is used for stuff that might be damaged by the higher temps of the high temp glue. When modding, it's best to use the high temp glue because most items you'll be using can't be melted by the low temp glue.

I usually use hot glue for gluing wires out of the way when doing wire management, or gluing LEDs in place into their respective holes. However, I've found many uses for hot glue that you might not think of. It often works where other fastening methods don't.

The glue comes in sticks usually either $\frac{1}{4}$ " or $\frac{7}{16}$ " in diameter. The $\frac{1}{4}$ " size (sold in Wal-Mart or craft stores) is more common. You must have a hot glue gun that can melt the high temperature glue sticks, so make sure that your glue gun and glue sticks are compatible (check your glue gun's manufacturer to be sure).

Warning: Hot glue is *hot*! It can burn your skin and continue to burn until it cools off.



Epoxy

There are many epoxy adhesives out there, and they are all a two-part system: an A part and a B part. Usually, you mix them in a 1:1 ratio (1 part A to 1 part B). Once they are mixed, they harden in a matter of minutes and are almost always a permanent bond. The only drawbacks to most epoxies is that they must be mixed before using and once hardened, they can be a bit brittle.

The ideal use for epoxy adhesives is either when superior strength is needed or conventional glues can't be used (like when attaching things to metal).

Some epoxies come in dual syringes, and the proper amounts of A and B parts are dispensed with a single push of the syringe.

Goop

One of the easiest adhesives to work with is Goop. That's its name: Goop. It is a clear, non-silicone-based adhesive and sealant. It comes in different types, each with a specific formulation for a specific purpose. For example: when sealing leaks in water cooling system, you might use Plumber's Goop, because it's made for that purpose.

I can't tell you every use for it, but when you have a problem that no other glue or adhesive can solve, try Goop.

Solvents and Cleaners

In addition to the other types of chemicals, a mod shop might have several solvents and cleaners, which are used to dissolve and remove other chemicals and stains, such as paint, glue, or residue. The solvents you will most likely use are paint solvents. Each solvent is specific to the paint it is used for. However, lacquer thinner is one unique solvent that I always keep around. It is a great universal solvent and removes wax, grease, and other impurities from metal before painting. It will dissolve most paints though, so be careful when using it.



Note: When mixing paint, you need to buy the solvent and hardeners specifically for the paint type you are using.

Another solvent I use plenty of is wax and grease remover. I use it during the painting process right before painting, to remove fingerprints and dust. It's also a good general purpose cleaner because it won't damage paint. I generally buy a quality brand

like 3M because you can depend on it working properly every time you use it. Or you can use the wax and grease remover recommended by the paint manufacturer to ensure compatibility.

Warning: These solvents and cleaners are all highly flammable and should be used in a well ventilated area with no open flames or sparks. Also, if you are under 18 (or 21 in some areas), you may not be able to purchase these chemicals.



Modification Prerequisites

Now that you have a handle on the tools required, you should think about a couple more things before you begin your modding:

- Choosing a theme
- Purchasing parts
- Disassembling an existing PC

Choosing a Theme

The best looking mods will always have some kind of theme throughout. That's not to say you can't just add a window and a lighted fan and it won't look cool. But if you are going to make a major statement, pick a theme of some kind, and pick it before you buy a single part or item for your mod. Your imagination is the only limit. That way, when you need to pick parts, paint, or other items, you only have to ask yourself if the parts fit within the theme you're trying to pull off.

There are thousands of different case themes you can try, and I can't really help you choose one. That's a very personal decision. Just pick something that you know well and really like. That way, the case is an expression of your interests, and you will know better what mods fits with the theme.

Purchasing the Needed Parts

What parts will you need to get started with your mod? Well, in addition to the typical PC parts shopping list below, you may need several of what I like to call "theme pieces." These may be computer parts (lights, fans, and so on), or they may be special pieces that need to be made or adapted from other sources. Decide what pieces you need and figure

out where you can get them. For example, when I did Project: Engine 18 (the fire engine–inspired PC shown earlier in Figure 1.1), I needed a set of fire engine “cherry” lights. Of course, they don’t make them for PCs, so I had to find something that worked. I found a local toy store that had fire toys on clearance and bought a toy fire engine with a siren and lights. I disassembled the toy and installed the lights, speaker, and small controller board into Engine 18. My PC then had a siren and working cherries!

If you are building the PC from scratch (not modding an existing PC), you’ll need the following items:

- Case
- Motherboard
- CPU with cooling system
- Memory
- Case fans
- Hard drive
- Video card
- CD/DVD drive(s)/burner(s)
- Power supply
- Keyboard and mouse
- Monitor



Note: We’ll discuss the more common PC mod parts in upcoming chapters.

Disassembling an Existing PC

If you are modding your current PC instead of building a modded PC from scratch, you’re going to want to disassemble the PC completely before you start your case mod. I know, you’re thinking, “Why would I want to completely take my computer apart if I’m only adding a light?” Well, for that particular example, it may not be necessary. But for most examples that involve cutting the case or painting it, you’ll want to take the delicate electronics out first.

Note: This book assumes you know the basics of the construction of a computer. If not, refer to the *A+ Complete Study Guide* from Sybex for more information. The disassembly process is simply the reverse of building it.



Make sure you have antistatic bags handy for the parts and a place in your work area where the parts can be close by but protected from the dust, paint fumes, and metal shavings you are going to make. This is because you will need to “mock up”—place together to see if they fit—the parts from time to time to see if they fit within the modifications you are making.

Modification Tips

The process of modding is something of a discovery process. As you become an experienced modder, you will find your own ways of doing things that may produce better results. And if you spend a lot of time online, you’ll pick up tips from different modding websites (like pimprig.com, gruntville.com, modthebox.com, and so on) and groups.

The following are a few of the best modding tips I can give you. I think just about every modder would start with these tips and go from there:

- Have a plan
- Know your limitations
- Have a clean workspace
- Collect parts and tools beforehand
- Have fun!

Have a Plan

Having a plan is probably the one step that people overlook most often. Before you pick up a Dremel or a turn a single screw, you should plan out your mod. What needs to happen first and why? Usually, with a complete case mod, you should start by choosing a theme (as discussed earlier), then follow this basic plan:

1. Perform the metalwork/fabrication (cut holes, and so on).
2. Install all computer hardware.
3. Disassemble the PC.

4. Paint and detail.
5. Reassemble the PC.
6. Install computer components.
7. Install software.
8. Troubleshoot.



Note: Steps 1 and 2 often take place simultaneously, as do steps 5 and 6.

Know Your Limitations

Not everyone can do every kind of mod their first time. It's unrealistic to expect that your first mod will be as good as someone who's been modding for years or has done multiple mods. That doesn't mean you shouldn't try new mods. Just know your limitations. If you aren't comfortable painting, have someone help you the first time around. Ask them questions and learn from them so the next time you can do it on your own.

If you don't have the tools to do a mod properly, either borrow the tools from someone (make sure you return them), or find a friend with a shop who has them.

Have a Clean Workspace

It's always easier to work in a clean workspace than a cluttered one. So if you're not using a part or tool, put it away. It's better than getting a part dirty (especially the electronic ones), and you will avoid component damage that way.

Plus, it's easier to find your tools when you put them away in their place. I always try to have a particular place for each tool I use to keep the shop organized.

Collect Parts and Tools Beforehand

It's always easier to have as many of the parts as you think you need brought together before you start. That way, if you need to see if a part will fit, you'll have it on hand. Plus, it will make mocking up the final design easier. It's very frustrating to almost finish a project and realize that you don't have the one part you need to finish it off, and you have to wait three days for FedEx or UPS because no one in town has the part.

Have Fun

Probably the most important part of modification is to remember why you are doing it in the first place: to have fun and have a cool computer, different from everyone else's.

If you get stressed and something isn't working right, take a break.

Above all, have *fun*! Welcome to the world of PC modding.