Staying Safe

chapter 1

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Whenever we poll people who want to build a PC for the reasons why they haven't gone ahead and researched the topic more or even taken the plunge and actually built a PC, the top response is always "Safety."

This is not without good reason.

PCs run on electricity, and most of us learn from an early age that electricity is dangerous. Carelessness with electricity can kill, maim, injure, and cause a great deal of property damage. That alone might seem like a good reason why PC building should be left to the professionals. Truth is, though, that it is possible to make building a PC as safe as, if not safer than, changing a light bulb or using an extension cord.

Before looking at the tools and techniques involved in building your own PC, it is important to spend a little time looking at safety. Building your own PC is fun, and a big part of having fun is being able to carry out the build knowing that your working practices are safe.

Please read through this chapter before attempting to build a PC of your own. Okay, you're eager to get going and a chapter all about safety doesn't sound all that compelling, but your safety — and the safety of those around you — are of paramount importance. We don't want to lose any of you in mid-build!

Also of great importance is the safety of the PC components you have bought. A millisecond's carelessness can cost you hundreds of dollars.

In this chapter, you will look at the dangers that face you and the PC components you will be handling. Also, you will learn how you can avoid the dangers and build a PC safely.

A Breakdown of the Dangers

The key to safety is knowledge. Knowing what the dangers are in the first place. It's easy to understand why some people are really jazzed about the idea of building a PC but worry about the dangers (maybe you reading this right now are one of these people).

If you already are a PC owner, you probably have noticed that the back of the unit came with a few warning stickers that make proclamations of death and destruction. If you've ever gone as far as cracking open the case on your PC and taken a look inside (perhaps to carry out some repairs or maybe an upgrade), then you will more than likely have noticed a few more warnings with a similar theme.

You will typically find warning stickers on the PC's power supply unit, the most dangerous part inside a PC.

These warnings are there for good reason. A PC that's plugged into the electrical supply can, without doubt, be a dangerous environment. But the main thing to realize when building a PC is that for 95% of the time, the PC being built won't be plugged into the power supply anyway, making it safe to work inside.

But what about the other 5% of the time?

Don't worry! This book shows you how, with care, you can make it safe to have the system plugged in and running while the case isn't all buttoned up.

You can break down the dangers associated with building a PC into two categories:

- The dangers to you and those around you
- The dangers to the components that you are assembling into a PC

Let's begin by looking at the most important of these — the dangers to you!

Personal Safety

Inside a PC is a whole host of dangers awaiting you. The four big, most serious dangers are:

- High-voltage things
- Hot things
- Sharp things
- Spinning things

There are also some other miscellaneous dangers that face you too, but before we come to them let's take a closer look at the big four.

High-Voltage Things

Without a doubt the biggest danger that you face when inside a PC is from high voltage. PCs are designed to take in voltage ranging from 110 volts to 250 volts, which is then converted into lower voltages that will be used by the motherboard, hard drives, optical drives (CD or DVD drives), and other devices, such as fans, that all live and work inside the PC.

It's no joke or exaggeration to say that high voltage can kill. An electric shock in real life isn't like it's depicted in the movies where someone touches a live wire, is thrown 30 feet away and then gets up, face black, clothes smoldering but otherwise OK. According to the National Institutes of Health, some 1,000 people die in the United States each year because of electrocution. Electricity kills by stopping the heart and breathing, and it can kill instantly. If you are lucky enough to survive contact with electricity, then you are likely to suffer from burns and nerve, muscle, and tissue damage.

We're not telling you this to scare you; on the contrary, we're giving you the dangers straight so that you understand them and are able to know what is safe to do and what is not. Everything that we show or tell you in this book is 100% tried, tested, and safe. Follow the instructions and you'll be OK.

If you are ever in any doubt, pause and reread the instructions.

The best way to protect yourself from electrocution is to limit your exposure to electricity. Most of the time when you are working on your PC you don't need it plugged into the electrical supply. That way, no power is going into the PC and the dangers of electrocution are eliminated.

There may be times when you will want to run your PC without having the case all buttoned up. For example, you might want to check out whether all the fans inside the case are spinning properly. The best advice here is to keep your hands, head, and all hand tools out of the case. If you want to look at something, do so from a distance and use a flashlight to get a better view.

Whenever a PC is plugged into the electrical supply without having the case buttoned up, remember the old adage of "look but don't touch."

The biggest danger from electrocution comes after a PC has been plugged into the electrical supply and is then switched off. It's very easy to forget that it's been on and still connected and then set about to work inside. A visual marker that the PC is connected to the power outlet can be very handy. Here are two good techniques:

- **Tape a fluorescent bit of plastic, paper, or fabric to the power connector.** You'll find the power connector at the back of the PC. By taping something to the power connector, you have a handy visual reminder that your PC is still plugged in and live. Unplug the power socket from the back of the PC, and you make it safe again.
- **Equip your workplace with a hanger for the PC power cable.** For this, a bent over bit of wire will do just fine. Make this a visible spot, and remember to hang the power cord on the hanger when working inside the PC (the fluorescent plastic, paper, or fabric tag makes it even easier to spot when the PC is safe!).

The following list includes additional safety tips:

- **Let others know what you are doing.** It always helps if everyone else is clear about what you are doing. This way those around you will be appreciative of the risks that you are taking and hopefully ease off any practical jokes (those "pretend" electric shock gags get real old, real fast, anyway). Also, this way you get other people to keep an eye on you while you are working just in case anything does go wrong.

- **Keep liquids away from the PC work area.** Spilling water or other liquids into a PC can cause short circuits and electrocution, as can working in a wet or damp environment. Wet rags, tools, and work surfaces can also conduct electricity. Keep liquids away from the work area, and keep the area clean and dry.
- **Use insulated electrical tools.** These tools are the types that have a rubber or plastic handle that can't conduct electricity. No matter how careful you are, accidents can happen. These tools can offer you protection against accidents but shouldn't be used as a substitute for taking the proper safety steps.

Not all plastic or rubber handled tools offer protection from electricity. If you want to buy safety tools then make sure that the handle clearly states that the tool is insulated and also what the rating is (usually "electricians" tools protect the user from up to 1,000 or 10,000 volts, depending on the quality of the tool). Chapter 2, "Choosing the Tools You Need," takes a more detailed look at the tools you should be using to build your PC.

Hot Things

Where there's electricity, there's usually heat. A PC that's been switched on for a few minutes can generate a lot of heat, especially from the power supply, hard drives, and CPU, and this heat can be enough to give you a nasty burn. Getting a burn on the back of your hand while trying to do something can be bad enough, but it can also mean that you drop things or knock against things and cause further damage to your hand or your PC.

As a general rule of thumb, if a PC has been switched on for more than 5 minutes, then it's a good idea to wait 5 minutes before setting to work inside it, and if it's been on for an hour or more, then wait at least 10 minutes. Taking the side panels off the case will help it to cool down quicker.

If you want to test for hot components, then a good trick is to use the back of your hand. By moving the back of your hand close to the metal surfaces, you have a good, safe way to judge how hot components are. This method is far better than using your fingertips, which you don't want to burn because you'll be needing them later, and it's hard to work with a bandage on!

Sharp Things

The inside of even the best PC case contains a number of sharp metal edges and corners all waiting to catch you. There are some things that you can do to help reduce the number of sharps that are present (check out Chapters 3, "Choosing a Suitable Case and Power Supply," and 13, "Assembling the Case and Fitting the PSU"), but no matter how carefully you choose a case and how much you try to remove edges, some will still remain (the edges and corners of hard drives are particularly nasty!).

The best advice for working with sharp things? Take care and take your time. Working on a cool PC makes accidents from sharps less likely, too. Snatching your hand away from something hot is the number one cause of PC-related cuts, so it's another good reason to give the system a cool-down period before setting to work on it.

Spinning Things

Many people are surprised by the number of exposed "spinning" things that are inside a PC. These are fans of one sort of another, and most are quite unlike other fans that you have in your home because many, if not all, have no wire guard to keep your fingers away from them.

However, there is little danger to fingers from the fans that live and work inside a PC. All of them will have blades made of light plastic, and while some might be big and spin quite fast (up to a rate of several thousand revolutions per minute), they have little power behind them. You would hardly be able to feel the blades hit you, let alone have them cause you any damage.

In reality, the biggest danger from fans is getting your hair or clothing caught up in them. Keep your hair and clothing tidy, and keep them away from fans when they are in operation.

Creating a Safe Working Area

Another key to safety is a having a good working environment. There's no need for you to dedicate a whole room or garage to building a PC, but having a good workspace makes the job of building a PC safer and easier. Figure 1-1 shows the wrong environment for building a PC, and Figure 1-2 shows the right one.

FIGURE 1-1: The wrong PC-building environment.

Figure 1-2: An example of a good PC-building environment.

Here are the top requirements of a good, safe working area:

- **Have an assigned work space and work area.** Pick out the spot where you are going to work. Your *work area* is the place you're going to be working in (corner of the living room, kitchen counter, bench in the garage), while the *work space* is the area you are going to be moving about in when working in the work area.
- **Find a large enough work area.** The smallest work area we recommend is 3 ft by 2 ft. A table or bench is ideal. Ideally, you should be able to leave things on the bench or table for several hours of days until you are finished. If this isn't possible, then make sure you have a space that you can pack everything away into when you're done for the day.

Throw a dust sheet over the project when you're not working on it to keep contamination to a minimum.

- **Do not eat or drink around the PC as it is being built.** A spilled soda or a poorly placed peanut butter and jelly sandwich can cause a major setback, not to mention damage.
- **Set up a bright and well lit work area.** Natural lighting is best because it is diffuse and doesn't cast harsh, dark shadows, but artificial lighting will do if you can't work near a bright window. Augment what lighting you have present with a good flashlight.

- **Be sure to have a power outlet nearby.** Ideally, it should have a good grounding point nearby too (such as a water pipe or radiator).
- **Avoid working on carpeted surfaces, if possible.** A carpeted work area increases the static electricity that you generate when walking about. However, if you can't avoid this, don't worry, we'll show you how you can deal with static charge build-up in the section "Electrostatic Discharge (ESD)" later in this chapter.
- **Cover the work area with white paper.** This makes it easier to see things like little screws when you drop them. Also, the white encourages you to be tidy and others to keep away!
- **Keep children and pets out of the work space.** We agree that pets in the work space are a bad idea for a variety of reasons, but kids might be interested in what's going on, and both you and your child might find the PC-building process interesting and educational. If so, then a good idea is to set up an observation area where they can watch what's going on in safety and without getting in the way, messing about with things, or stepping on expensive electronics.
- **Keep all the tools and equipment you will need close at hand in the work area.** The less you walk about, the less likely you are to knock stuff over or trip. Building a PC involves having cables and boxes in and around the work area. Be careful that these aren't in places where you can trip over them.
- **Keep the work area tidy and clean and free from liquids**. Liquids are especially nasty, as a small amount of liquid can go very far indeed!
- **Keep a small first aid kit and fire extinguisher nearby — just in case!** Outfit your first aid kit to deal with small cuts, and make sure that you have plenty of bandages in the kit!

Dressing for Safety

Just as important as the work space is how you dress when you are working on a PC. Don't worry, you won't need to invest in a new wardrobe just so that you can build a PC. Just follow these simple tips:

- **Wear cotton clothing and rubber-soled shoes (such as sneakers).** These are best because they reduce the build-up of static charge.
- **Avoid loose clothing.** Sleeves, collars, scarves, and ties are a bad idea, because they can catch on the edges of the equipment. The absolute best clothing for PC building is a boiler suit!
- **Be careful if you wear glasses.** You don't want your glasses falling into the workings of the PC. You can get an elasticized band, such as a sports band, that fits around them to hold them in place if they are a little loose and you're worried about them falling off.
- **Remove all jewelry if at all possible.** Jewelry such as rings, necklaces, bracelets, and pendants can cause short circuits that can damage delicate components. If you have rings that you can't or don't want to remove, then cover them with insulating or surgical tape.
- **Put long hair in a ponytail or use hair clips.** You don't want that hair caught in anything!

- **Use thin cotton gloves.** Cotton gloves come in handy if you are worried about touching something hot or with a sharp edge. Make sure that the gloves are cotton and not synthetic (the last thing you want is hot, melted nylon or polyester on your hands!).
- **Wear a barrier cream.** A PC, no matter how short a period it has been switched on for, tends to gather dust and dirt quickly. This dust can be quite an effective skin irritant, so if you have sensitive skin, you might want to invest in a special barrier cream (a special cream available from hardware stores that you rub into your skin, which protects it from dust and chemicals, that you wash out when finished) to rub into your hands. Wash your hands after you've been working on a PC.

Component Safety

By now you should know how to keep yourself, your family, and your pets from being electrocuted, prevent your hair getting caught in the fans in your PC, and eliminate the risks of strangulation from neckties and scarves. But it's not just your safety that you have to be worried about — you also have to care for the safety of the components that you are going to be handling and that are going to become integral parts of your PC.

Dangers You Can See

Here are some general common-sense rules that you can follow to avoid component troubles:

- Don't drop components. This is the number one cause of component damage.
- Don't bend or flex components. No matter how sturdy a circuit board looks, it takes very little pressure to crack it or pop off an important component.
- Don't put components down on top of one another or on metal surfaces.
- Keep components clean and dry.

The easiest way to accomplish all of the above is to store components in their original packaging until needed. This packaging is designed to protect the components on their trip from the factory where they were made to the store selling them, and it's usually so good that it can protect the contents from the biggest test of all — snail mail delivery!

There is a very good chance that you will be buying at least some of the parts for your PC via mail order. Mail order is by far the cheapest way to buy components unless you are really lucky and live nearby to a very good supplier. However, component damage in transit is a real problem.

Check all items you receive carefully. What you are looking for are components that arrive well packaged and in an undamaged state. Look for signs of damage, both at the packing stage (improperly packaged items, items packed loose) and for damage in transit (ripped, torn, or crushed packaging, items repackaged by the carrier or foot/tire prints on the package — yes, we've seen it all!).

If anything looks damaged then either refuse to sign for it, or, if you have to sign for it write "NOT EXAMINED" clearly next to your name/signature and get in touch with the seller.

If, during the build, you think that you may have damaged a component through dropping it or handling it badly, then make a note of this. Damage caused can be difficult, if not impossible to spot, so if you have problems later on, having information on components that might have been damaged can save you a lot of time and energy in tracking down the fault.

Unseen Dangers

If you go about dropping components and flexing components to test their strength, then it's pretty obvious that you're asking for trouble. However, there are a number of unseen dangers that can quickly and silently damage your new PC components. Specifically, these dangers stem from:

- Magnetic fields
- Electrostatic discharge (ESD)

Magnetic Fields

Back in the days when floppy disks were popular, people were much better about keeping magnets away from the PCs because they knew that even a weak magnet could damage or completely erase the disk. Now that most of us have shifted from magnetic media to optical media (such as CDs or DVDs), we're far less careful about such things.

It's true that taking a magnet near a working PC won't cause massive damage to it. A magnet might make the screen display go funny, and you might have to switch the monitor off and back on again a few times to dissipate the magnetic field by a process called *degaussing*, which occurs every time you switch on a monitor (tube-based monitors, not the newer flat panels), but it's not likely to cause any long-term damage or data loss. In fact, a PC has a number of magnets inside it, ranging from small ones inside fans to bigger ones in speakers and massive and powerful ones inside the hard drives. However, it's still a good idea to keep magnets away from the build area for these reasons.

- The magnetic field might damage something. It's not worth taking a risk.
- Magnets (especially strong magnets) can magnetize other metallic items. This can cause them to attract one another and come flying together at high speed. These can be damaging high-speed collisions.

The reasoning behind not having magnetized screwdrivers is similar—the magnetic field of a screwdriver tip is going to be pretty small, but magnetic screwdriver tips can be attracted toward other metallic objects at quite high speed, damaging delicate components along the way.

Electrostatic Discharge (ESD)

Electrostatic discharge, otherwise known as ESD, is a real danger to electronic devices. It is a swift, silent killer.

Here's why.

As you walk about, you rub your feet against the floor, and your clothing rubs against itself. This rubbing generates static electricity. The process is similar to how a balloon rubbed against a T-shirt will stick to a ceiling or how a Van der Graaf generator works by having a roller that rubs against brushes that both generate and collect the charge.

The human body is a pretty good insulator and can generate thousands of volts of static electricity. You've probably experienced it — you walk along a carpeted floor and go to open a door and ZAP! It might just seem like fun (or an annoyance) to you but that single "ZAP!" is at least 3,000 volts (below 3,000 volts you don't get a spark), and probably a lot more.

The human body can carry around with it 25,000 volts of static charge easily. How are 25,000 volts of power typically lethal when 25,000 volts of static build-up aren't? The reason is that the power the current-producing capability of an ESD is less than a thousandth of an amp. This is why at 120 volts AC, 1 amp of current is lethal, but for ESD 25,000 volts DC, the microamps of current produced are not.

So, why is static electricity so damaging? Let's stop and think about it for a moment. The typical PC component runs at between 3 and 12 volts, but they can be damaged by anything between 10 and 30 volts of static discharge. Remember, you don't see anything or feel anything until the charge build-up is somewhere near 3,000 volts! To make matters worse, it's not just a simple case of "ZAP!" and a component is dead. At least if it were, people would probably learn from their mistakes sooner. No, ESD, while it can kill a component, is more likely to damage it and significantly shorten its expected lifespan.

Other Sources of Static Charge

It's not just us humans walking and shuffling about that creates static charge. Pretty much anything that moves creates ESD. Electrical motors are a huge source of static charge and can cause build-up in excess of 100,000 volts. This is why it's a bad idea to go sticking the nozzle of a running vacuum cleaner into a PC. Brushing components is also a dangerous activity unless you have a special antistatic brush. If you want to clean dust from components, the quickest and safest way is to use canned compressed air.

Other causes of build-up of static charge include:

- **Poorly shielded cabling.** Replace damaged cables rather than repairing them with tape.
- **Large curtains.** Avoid working too near to large curtains as they can store a lot of static charge. Washing them with fabric softener dramatically reduces the risk of ESD.
- **Polystyrene.** Avoid storing components in polystyrene boxes, and don't place components on top of polystyrene of drag components over the top of a sheet of the stuff.

The Weather Makes a Difference

The funny thing about ESD is that it is a dry air phenomenon. If the air has more that 50% humidity then static charge cannot accumulate, whereas below 50% humidity it can, and ESDs become likely. Air conditioning can help to reduce or even eliminate the risk of ESD.

Air temperature is also a key factor — the warmer the air, the greater the risk of ESD.

So, to summarize:

- Warm, dry air = Bad!
- Cool, moist air = Good!

Don't try to artificially "alter" the humidity of the air in your work space by using sprayers or humidifiers. These can cause the air to become saturated with water and then the water will condense out onto components, causing short circuits.

ESD Precautions

Okay, cool, moist air helps to reduce or even eliminate ESD but unless you have devices to measure the humidity of the air this information is pretty useless. Also, what if you live in a hot, dry location? What are you supposed to do if you want to build a PC? Move?

Also, moving about is bad because that's how the human body generates most of the static charge in the first place. You could sit still for the whole time you are building the PC.

The solution? Antistatic wrist straps and ESD bags.

Antistatic Wrist Straps

Although it's important to know what ESD is and how it is bought about, prevention in this case isn't better than cure. What we need to have is a way of discharging the static build-up in a safe and controlled way. Fortunately, all you need is a cheap antistatic wrist strap, available at any good PC parts outlet.

An antistatic wrist strap, as shown in Figure 1-3, is a strap that the PC builder wears around the wrist. Different types of strap use different materials. (The cheaper ones are plastic, while more expansive ones are made of a synthetic conductive weave.) At the other end of the wrist strap is usually a clip, which is attached to a good grounding point such as some bare metal on a radiator or water pipe. Connecting the wrist strap and the clip is usually a length of coiled wire.

You can buy grounding clips for metal water pipes from most hardware suppliers. It's recommended that you attach one to a convenient pipe in your workspace.

No convenient water pipe? No problem. You can connect to the electrical grounding system (you can get special plugs that allow you to do this safely) or you can take a copper or iron stake and drive it into the ground outside (minimum 12 inches) and connect to that. If you have to resort to the stake method and you live in a particularly dry location, you might need to treat the ground surrounding the stake with up to anything between 4 and 20 pounds of regular salt or Epsom salts (hydrated magnesium sulfate salts) mixed with water (this treatment needs to be repeated every few years).

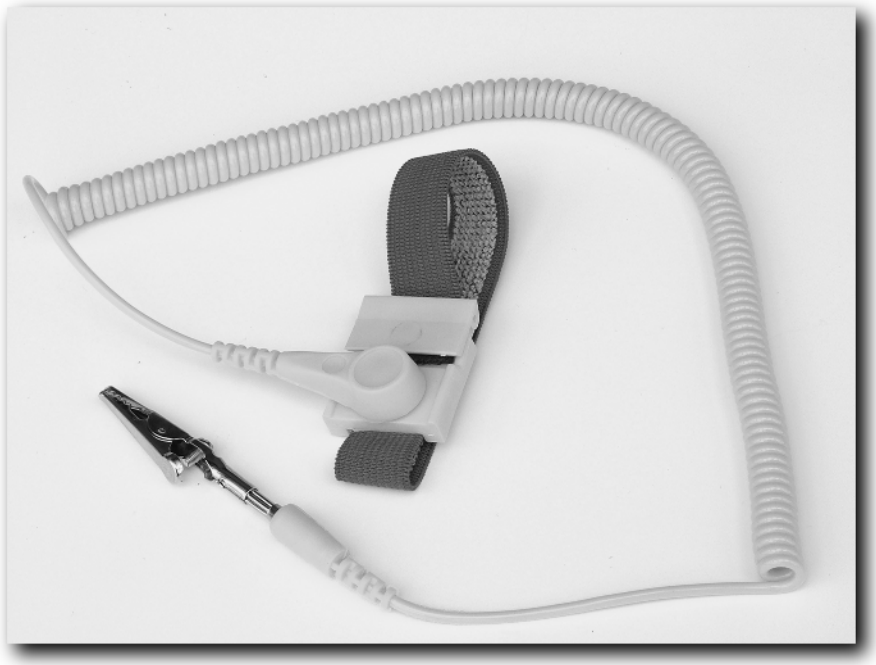

Figure 1-3: Antistatic wrist straps discharge static build-up.

If a wrist strap is just something that grounds you to an earth point, why not just make one yourself? This isn't recommended because most good antistatic wrist straps hide a simple but effective safety measure. If you are wearing a strap that grounds you to discharge static charge, then that ground can work both ways — and help ground electricity as well as static charge. So, if you accidentally touched something live when working on a PC (which you shouldn't be able to because it's disconnected, right?), the grounding strap will also ground this power straight through you in the middle. An electric shock has the potential to be far more lethal if the person receiving the shock is well grounded.

How do good ESD straps avoid this? They have a resistor built in (usually a 1 million ohm resistor, called 1 megaohm) that allows static charge to be dissipated but which offers the wearer some protection against grounding a lethal charge (don't let this make you sloppy with checking that the juice to the device is off before working on it though!).

When buying an ESD strap look for mention of a 1-megaohm resistor. There are plenty of good straps available for a few dollars so get a good one — it could save your life one day!

ESD Bags

Remember earlier that we said that it is a good idea to keep components in their packaging until they are needed because this offers them the best protection. Well, one thing that you might have noticed about most components is that most are shipped in an odd semi-silvered

bag, sometimes with black grid lines on the outside (see Figure 1-4). This bag isn't just designed to look cool and futuristic; it serves a purpose. This bag is designed to protect the contents from ESD by directing the charge around the outside of the bag rather than through the components.

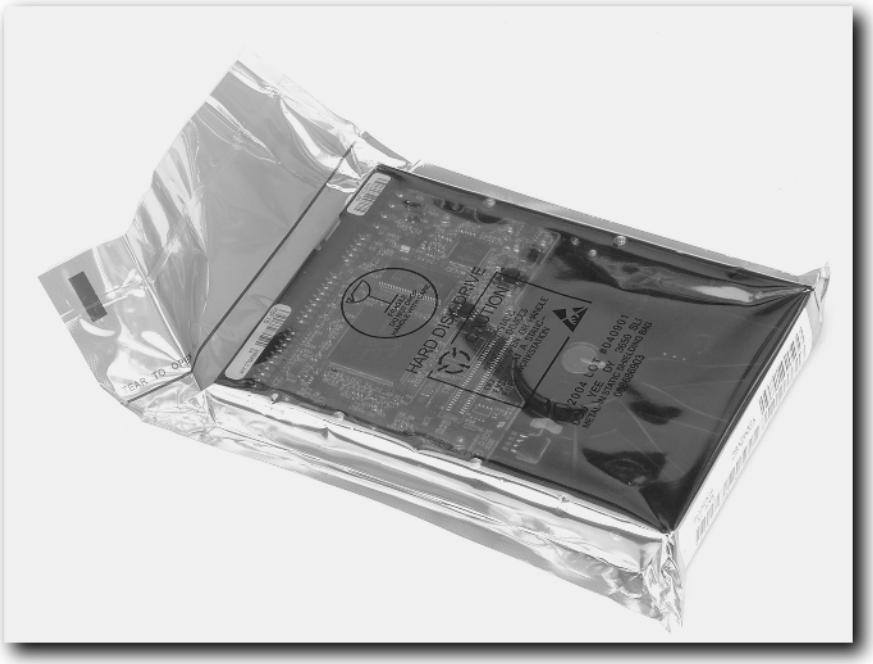

Figure 1-4: ESD bags protect your components from static discharge.

ESD bags come with a variety of names ranging from the obvious "ESD bag" to the more techie-sounding names like "isolation bag" or "Faraday bag" (after the scientist Michael Faraday).

Using these bags is easy — you just pop the component inside the bag. You can, if you want, fold the end over and even add a staple to it for extra security (it doesn't affect the ESD properties of the bag at all).

Summary

In this chapter, you've looked at one of the most important aspects of building your PC — staying alive so that you can enjoy using it later on! We've also looked at how you can make sure that your actions don't result in the early demise of a vital (and possibly expensive) component.

Make sure that you read (and reread) this chapter and follow the advice given. We'll also be reminding you to work safely as you progress with hints, tips, and cautions along the way, starting with Chapter 2, where you learn more about the tools you need to build a PC.

Take Action

Before you move on to the next chapter, be sure that you're prepared:

- Find a suitable work space.
- Create a suitable work area for yourself.
- Buy a good quality (1-megaohm) antistatic wrist strap.
- Find a good grounding point near to the work area.
- Keep any components in their original packaging until you are ready to use them.