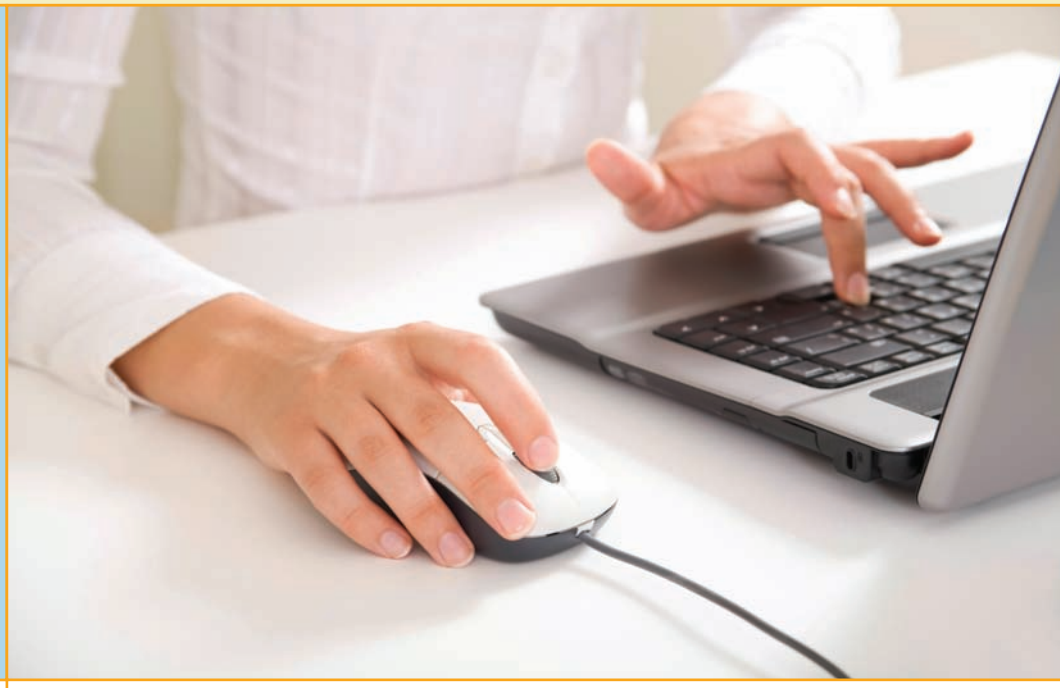
chapter 20

Input Devices

"The Macintosh uses an experimental pointing device called a 'mouse'. There is no evidence that people want to use these things. I don't want one of these newfangled devices."

—John C. Dvorak, 1984



In this chapter, you will learn how to

- **Explain how to support common input/output ports**
- **Identify certain standard input devices on a PC**
- **Describe how certain multimedia input devices work on a PC**

In Chapter 3, you learned how to recognize and connect a number of common devices and the ports they use. Because these devices and their ports sometimes fail, it is important that you learn how they work and how to troubleshoot them when problems arise. This chapter reviews some of the major types of input ports, discusses a number of common and not-so-common input devices, and deals with some of the troubleshooting issues you may encounter with input devices and their ports.

The CompTIA A+ 220-801 exam separates standard input devices and multimedia devices. Standard input devices, such as keyboards and mice, are found on virtually every PC. Multimedia input devices support video and sound functions. This chapter concentrates on both of these categories. You'll learn how to identify and support both the most common and some of the most unusual input devices used in today's PCs.

Supporting Common Ports

Whenever you're dealing with a device that isn't playing nicely, you need to remember that you're never dealing with just a device—you're dealing with a device and the port to which it is connected. Before you start troubleshooting the device, you need to take a look at the issues and technologies of some of the more common input/output (I/O) ports and see what needs to be done to keep them running well.

Serial Ports

Finding a new PC with a real serial port is difficult because devices that traditionally used serial ports have for the most part moved on to better interfaces like USB. Physical serial ports may be hard to find on new PC cases, but many devices—in particular, the modems many people still use to access the Internet—continue to use built-in serial ports.

While the physical connection is called a serial port, Windows refers to it as a COM port, usually COM1. Open Device Manager on a system and see if you have an icon for Ports (COM and LPT). If you do, click the plus (+) sign to the left of the icon to open it and see the ports on your system—don't be surprised if you have COM ports on your PC. Even if you don't see any physical serial ports on your PC, the serial ports are there; they're simply built into some other device, probably a modem.

Your PC's expansion bus uses parallel communication: multiple data wires, each one sending one bit of data at a time between your devices. Many I/O devices use serial communication: one wire to send data and another wire to receive data. The job of a **serial port** is to convert data moving between parallel and serial devices. A traditional serial port consists of two pieces: the physical, 9-pin DB connector (see Figure 20.1) and a chip that actually does the conversion between the serial data and parallel data, called the **universal asynchronous receiver/transmitter (UART)** chip. If you want to be completely accurate, the UART *is* the serial port. The port on the back of your PC is nothing more than a standardized connector that enables different serial devices to use the serial port. The UART holds all of the smarts that make the true serial port.

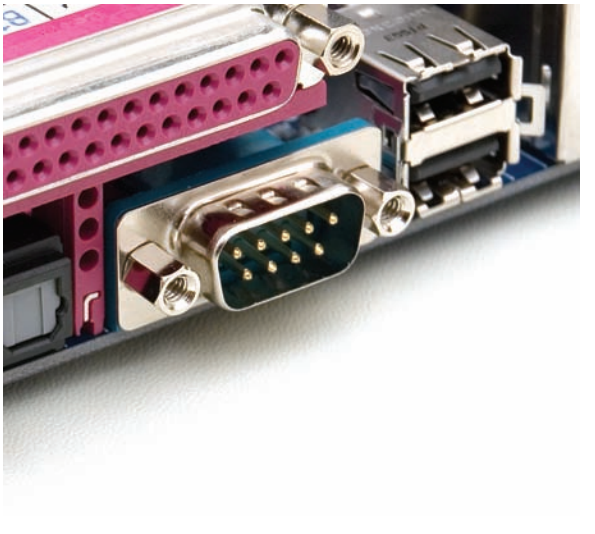
RS-232 is a very old standard that defines everything about serial ports: how fast they communicate, the language they use, even how the connectors should look. The RS-232 standard specifies that two serial devices must talk to each other in 8-bit chunks of data, but it also allows flexibility in other areas, such as speed and error-checking. Serial came out back in the days when devices were configured manually, and the RS-232 standard has never been updated for automatic configuration. Serial ports are a throwback to the old days of computer maintenance (though they're still very prevalent in

Having trouble finding a PC with serial ports? Try a laptop—almost all laptops come with built-in modems.

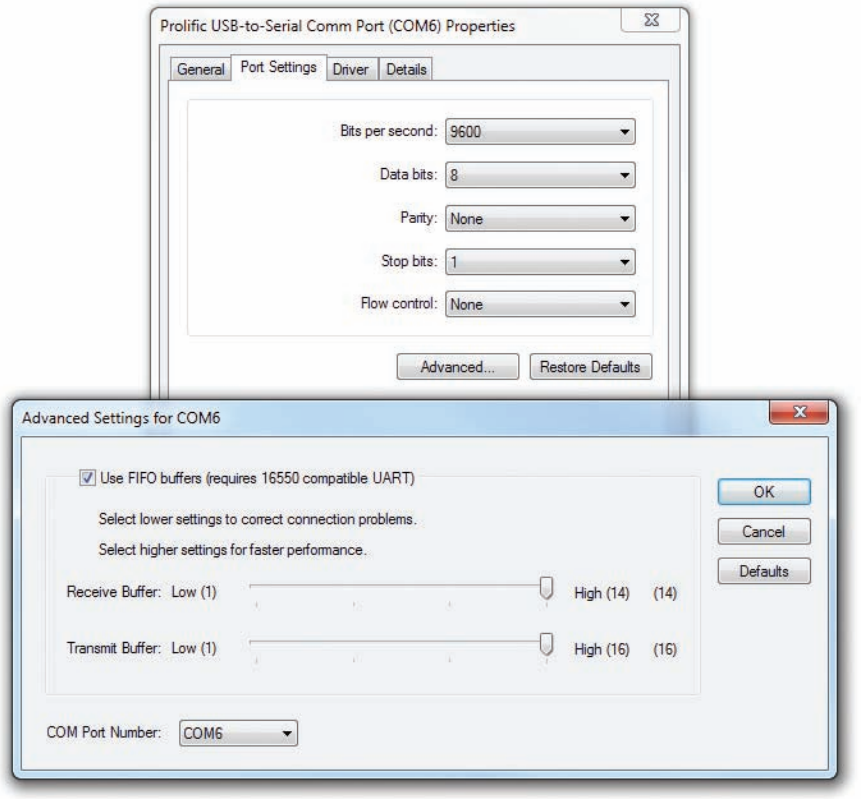
Tech Tip

UARTs and COM Ports

Every UART in a system is assigned a COM port value. An internal modem snaps right into your expansion bus, so every internal modem has a built-in UART. Therefore, even though a modem doesn't have a physical serial connection, it most certainly has a serial port—a built-in one.



• **Figure 20.1** Serial port



• **Figure 20.2** Serial port settings

some hardware, such as in high-end routers) and are the last manually configured port you'll find on a PC.

So what type of settings do you need to configure on a serial port? Find a PC with a real serial port (a real 9-pin connector on the back of the PC). Right-click the COM port and choose Properties to see the properties of that port in Device Manager. Open the Port Settings tab and click the Advanced button to see a dialog box that looks like Figure 20.2.

Devices such as modems that have built-in serial ports don't have COM port icons in Device Manager because there's nothing to change. Can you see why? Even though these devices are using a COM port, that port is never going to connect to anything other than the device it's soldered onto, so all of the settings are fixed and unchangeable—thank goodness!

When you are configuring a serial port, you will have a lot of different settings to configure, many of which may or may not make sense. The convenient part about all this is that when you get a new serial device to plug into your serial port, the instructions will tell you what settings to use. Figure 20.3 shows an instruction sheet for a Cisco switch.

Tech Tip

Add-on Serial Ports

If you need a serial port to support some older device but have a motherboard that doesn't have one, don't fret. You can always get a PCI expansion card with classic, 9-pin serial ports.

USB Ports

You should be familiar with the concept of USB, USB connectors, and USB hubs from the discussion of those concepts in Chapter 3. Here's a more in-depth look at USB and some of the issues involved with using USB devices.

Understanding USB

The cornerstone of a USB connection is the **USB host controller**, an integrated circuit that is usually built into the chipset and controls every USB device that connects to it. Inside the host controller is a **USB root hub**: the part of the host controller that makes the physical connection to the USB ports. Every USB root hub is really just a bus—similar in many ways to an expansion bus. Figure 20.4 shows a diagram of the relationship between the host controller, root hub, and USB ports.

A single host controller can theoretically support up to 127 devices, though real-life circumstances severely limit that. Even if a host adapter supports a certain number of ports, there's no guarantee that the motherboard maker will supply that many ports. To give a common example, a host

Connecting a PC or Terminal to the Console Port

To connect a PC to the console port, use the supplied RJ-45-to-DB-9 adapter cable. To connect the switch console port to a terminal, you need to provide a RJ-45-to-DB-25 female DTE adapter. You can order a kit (part number ACS-DSBUASYN=) containing that adapter from Cisco. For console port and adapter pinout information, see the "Cable and Adapter Specifications" section.

The PC or terminal must support VT100 terminal emulation. The terminal-emulation software—frequently a PC application such as Hyperterminal or Procomm Plus—makes communication between the switch and your PC or terminal possible during the setup program.

Follow these steps to connect the PC or terminal to the switch:

Step 1 Configure the baud rate and character format of the PC or terminal to match these console port default characteristics:

- 9600 baud
- 8 data bits
- 1 stop bit
- No parity

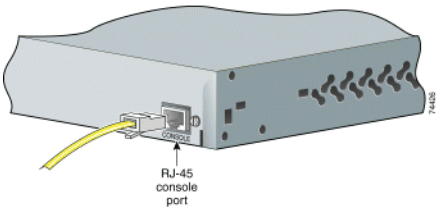
After you have gained access to the switch, you can change the console baud rate through the **Administration > Console Baud Rate** window in the Cluster Management Suite (CMS).

Step 2 Using the supplied RJ-45-to-DB-9 adapter cable, insert the RJ-45 connector into the console port, as shown in Figure 2-1.

Step 3 Attach the DB-9 female DTE adapter of the RJ-45-to-DB-9 adapter cable to a PC, or attach an appropriate adapter to the terminal.

Step 4 Start the terminal-emulation program if you are using a PC or terminal.

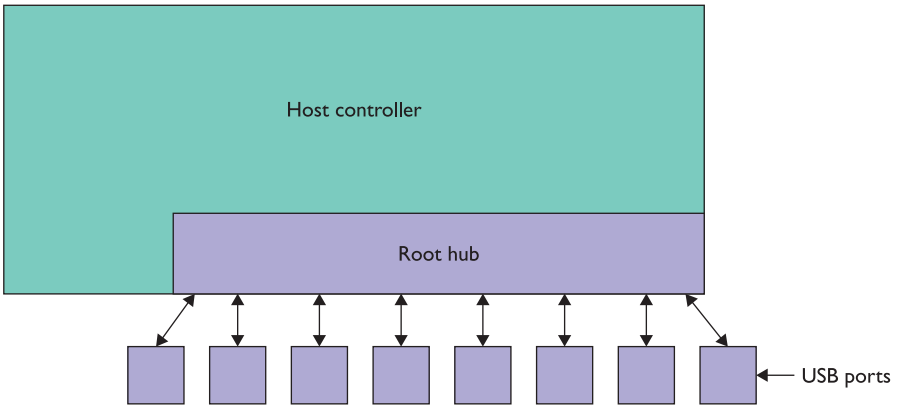
Figure 2-1: Connecting to the Console Port



• **Figure 20.3** Serial port instructions

adapter might support eight ports while the motherboard maker only supplies four adapters.

The most important point to remember about this is that every USB device connected to a single host adapter/root hub *shares* that USB bus with every other device connected to it. The more devices you place on a single host adapter, the more the total USB bus slows down and the more power they use. These issues are two of the biggest headaches that take place with USB devices in the real world.



• **Figure 20.4** Host controller, root hub, and USB ports

USB devices, like any electrical device, need power to run, but not all take care of their own power needs. A powered USB device comes with its own electrical cord that is usually connected in turn to an AC adapter. *Bus-powered* USB devices take power from the USB bus itself; they don't bring

any AC or DC power with them. When too many bus-powered devices take too much power from the USB bus, bad things happen—some devices won't work; other devices will lock up. You'll also often get a simple message from Windows saying that the hub power has been exceeded, and it just won't work.

USB Standards and Compatibility

The USB standard has gone through several revisions, but you'll run into only three different versions in the real world:

- USB 1.1 was the first widely adopted standard and defined two speeds: **Low-Speed USB**, running at a maximum of 1.5 Mbps (plenty for keyboards and mice), and **Full-Speed USB**, running at up to 12 Mbps.
- The USB 2.0 standard introduced **Hi-Speed USB** running at a whopping 480 Mbps.
- USB 3.0 is capable of speeds of up to 5 Gbps—ten times faster than USB 2.0! USB 3.0 is commonly referred to as **SuperSpeed USB**.

If you think all of those names and numbers are confusing, you're right. Table 20.1 provides a quick reference to help you sort it all out.

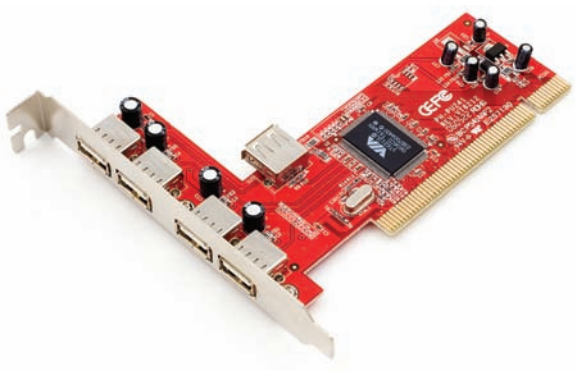
Each standard defines more than just the speed. Because they were incorporated into the newer standard, many Low-Speed and Full-Speed USB devices are also USB 2.0 devices.

Table 20.1 USB Standards

Name	Standard	Maximum Speed
Low-Speed USB	USB 1.1	1.5 Mbps
Full-Speed USB	USB 1.1	12 Mbps
Hi-Speed USB	USB 2.0	480 Mbps
SuperSpeed USB	USB 3.0	5 Gbps

The USB Implementers Forum (USB-IF) does not officially use "Low-Speed" and "Full-Speed" to describe 1.5-Mbps and 12-Mbps devices, calling both of them simply "USB." On the CompTIA A+ certification exams, though, you'll see the marketplace-standard nomenclature used here.

Hi-Speed USB is fully backward compatible with USB 1.1 devices, while USB 3.0 is backward compatible with USB 2.0 devices. Those old devices won't run any faster than they used to, however. To take advantage of the fastest USB speeds, you must connect Hi-Speed USB devices to Hi-Speed USB ports by using Hi-Speed USB cables (or connect SuperSpeed USB devices to SuperSpeed USB ports with SuperSpeed USB cables). Although backward compatibility at least enables you to use the newer USB device with an older port, a quick bit of math tells you how much time you're sacrificing when you're transferring a 2-GB file at 480 Mbps instead of 5 Gbps!

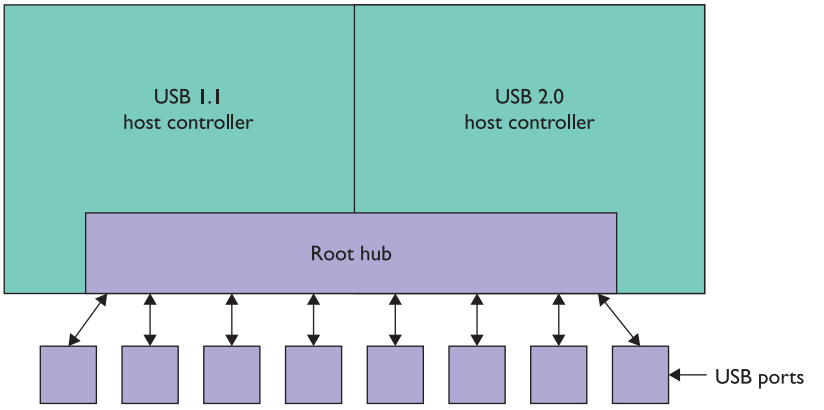


• **Figure 20.5** USB adapter card

Most people want to take advantage of these amazing speeds, but what do you do if your motherboard doesn't have built-in Hi-Speed or SuperSpeed USB ports? One option is to add a USB 2.0 or USB 3.0 adapter card like the one shown in Figure 20.5.

Motherboards capable of both USB 1.1 and USB 2.0 usually share the available USB ports (see Figure 20.6). For every USB port on your computer, plugging in a Low-Speed or Full-Speed device uses the USB 1.1 host controller, and plugging in a Hi-Speed device uses the USB 2.0 host controller.

USB 3.0, on the other hand, is different enough from USB 2.0 that it uses separate and clearly marked ports. The USB 3.0 standard suggests that these ports be colored blue to differentiate them. You can still plug older USB devices into a USB 3.0 port, but they will run at the slower speeds. The only ports that work at 5 Gbps are the blue USB 3.0 ports (see Figure 20.7).



• **Figure 20.6** Shared USB ports

USB Cables and Connectors

You learned about USB connectors in Chapter 3, but here's a quick refresher. USB connectors and ports come in multiple sizes: A, B, mini-A, mini-B, micro-A, and micro-B. USB A ports and connectors are for interfacing with the PC. Most peripherals use B, mini-B, or micro-B connectors and ports. Micro connections are especially popular on smartphones.

Almost any USB device can use any USB standard's cable, though you won't always get the best possible speeds. USB 1.1 and USB 2.0 cables look and work the same. Your connection speed will change primarily based on the quality of the cable.

There is one big exception to this cross-compatibility, however: to achieve SuperSpeed speeds with USB 3.0, you'll need a USB 3.0 cable (see Figure 20.8). Because the USB 3.0 B connector is larger than other B connectors, a USB 3.0 cable will only work with USB 3.0 devices.

Cable length is an important limitation to keep in mind with USB. USB 1.1 and USB 2.0 specifications allow for a maximum cable length of 5 meters, although you may add a powered USB hub every 5 meters to extend this distance. Although most USB devices never get near this maximum, some

• **Figure 20.7** USB 3.0 ports

• **Figure 20.8** USB 3.0 cable

On USB 1.1 and 2.0 cables, the A and B ports and connectors use four pins, while the rest use five pins. USB 3.0 A and B ports and connectors use nine pins. A larger, 11-pin USB 3.0 B connector that can supply extra power to a device also exists.

In general, your connection will operate at the speed of the slowest device involved. If you have a USB 2.0 device connected to a USB 3.0 port on your PC, it will operate at USB 2.0 speeds.

• **Figure 20.9** USB cable

Try This!

What Speed Is Your USB?

Open Device Manager and locate two or three controllers under the Universal Serial Bus icon. The Standard Enhanced Host Controller is the Hi-Speed controller. The Standard OpenHCD Host Controller is the Low- and Full-Speed controller. You might also have a third controller named the Extensible Host Controller Interface (xHCI). This controller, as you might have guessed, is for USB 3.0 SuperSpeed connections.

devices, such as digital cameras, can come with cables at or near the maximum 5-meter cable length. The USB 3.0 standard doesn't define a maximum cable length, but to reach the fastest speeds possible, you shouldn't use a cable longer than 3 meters. Because USB is a two-way (bi-directional) connection, as the cable grows longer, even a standard, well-shielded, 20-gauge, twisted-pair USB cable begins to suffer from electrical interference. To avoid these problems, I stick to cables that are no more than about 2 meters long.

If you really want to play it safe, spend a few extra dollars and get a high-quality USB cable like the one shown in Figure 20.9. These cables come with extra shielding and improved electrical performance to make sure your USB data gets from the device to your computer safely.

USB Hubs

Each USB host controller supports up to 127 USB devices, but as mentioned earlier, most motherboard makers provide only six to eight real USB ports. So what do you do when you need to add more USB devices than the motherboard provides ports? You can add more host controllers (in the form of internal cards), or you can use a USB hub. A **USB hub** is a device that extends a single USB connection to two or more USB ports, almost always directly from one of the USB ports connected to the root hub. Figure 20.10 shows a typical USB hub. USB hubs are sometime embedded into peripherals. The keyboard in Figure 20.11 comes with a built-in USB hub—very handy!

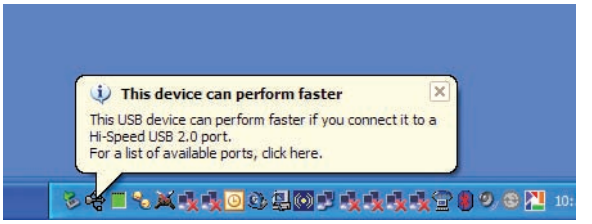
USB hubs are one of those parts of a PC that tend not to work nearly as well in the real world as they do on paper. (Sorry, USB folks, but it's true!) USB hubs have a speed just like any other USB device; for example, the hub in the keyboard in Figure 20.11 runs at Full-Speed. This becomes a problem when someone decides to insert a Hi-Speed USB device into one of those

• **Figure 20.10** USB hub

• **Figure 20.11** USB keyboard with built-in hub

ports, as it forces the Hi-Speed device to crawl along at only 12 Mbps. Windows is nice enough to warn you of this problem with a bubble over the system tray like the one shown in Figure 20.12.

Hubs also come in powered and bus-powered versions. If you choose to use a general-purpose USB hub like the one shown in Figure 20.10, try to find a powered one, as too many devices on a single USB root hub will draw too much power and create problems.



• **Figure 20.12** Windows XP speed warning

USB Configuration

The biggest troubleshooting challenge you encounter with USB is a direct result of its widespread adoption and ease of use. Pretty much every modern PC comes with multiple USB ports, and anyone can easily pick up a cool new USB device at the local computer store. The problems arise when all of this USB installation activity gets out of control, with too many devices using the wrong types of ports or pulling too much power. Happily, by following a few easy steps, you can avoid or eliminate these issues.

The first and often-ignored rule of USB installation is this: Always install the device driver for a new USB device *before* you plug it into the USB port. Once you've installed the device driver and you know the ports are active (running properly in Device Manager), feel free to plug in the new device and hot-swap to your heart's content. USB device installation really is a breeze as long as you follow this rule!

Windows includes a large number of built-in drivers for USB devices. You can count on Windows to recognize keyboards, mice, and other basic devices with their built-in drivers. Just be aware that if your new mouse or keyboard has some extra buttons, the default USB drivers will probably not support them. To be sure I'm not missing any added functionality, I always install the driver that comes with the device or an updated one downloaded from the manufacturer's Web site.

When you're looking to add a new USB device to a system, first make sure your machine has a USB port that supports the speed you need for the USB device. On more modern PCs, this is likely to be a nonissue. Even then, if you start adding hubs and such, you can end up with devices that either won't run at all or, worse yet, exhibit strange behaviors.

The last and toughest issue is power. A mismatch between available and required power for USB devices can result in nonfunctioning or malfunctioning USB devices. If you're pulling too much power, you must take devices off that root hub until the error goes away. Buy an add-in USB hub card if you need to use more devices than your current USB hub supports.

To check the USB power usage in Windows, open Device Manager and locate any USB hub under the Universal Serial Bus Controller icon. Right-click the hub and select Properties, and then select the Power tab. This shows you the current use for each of the devices connected to that root hub (see Figure 20.13).

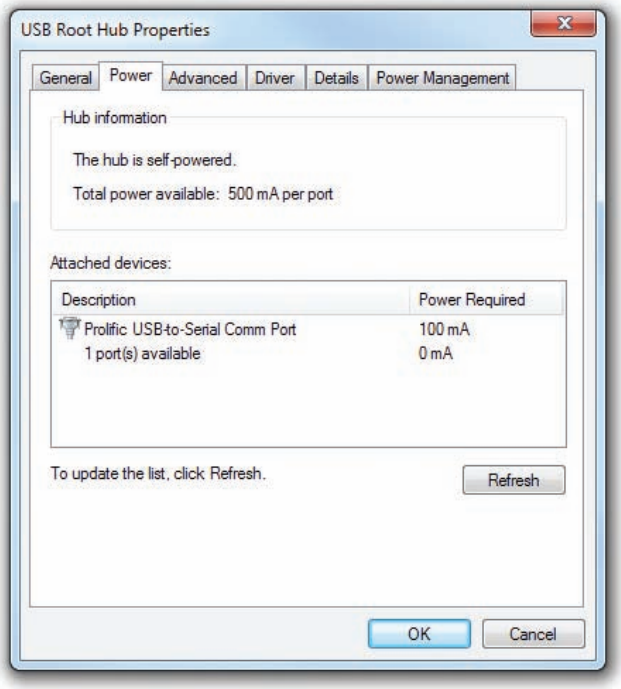
Most root hubs provide 500 mA per port—more than enough for any USB device. Most power problems take place when you start adding hubs, especially bus-powered hubs, and then you add too many devices to them. Figure 20.14 shows the Power tab for a bus-powered hub; note that it provides a maximum of 100 mA per port.

There are exceptions to the "install the driver first" rule. USB thumb drives, for example, don't need extra drivers at all. Just plug them in and Windows picks them up. (Technically speaking, though, that means the drivers came *preinstalled* with the operating system!)

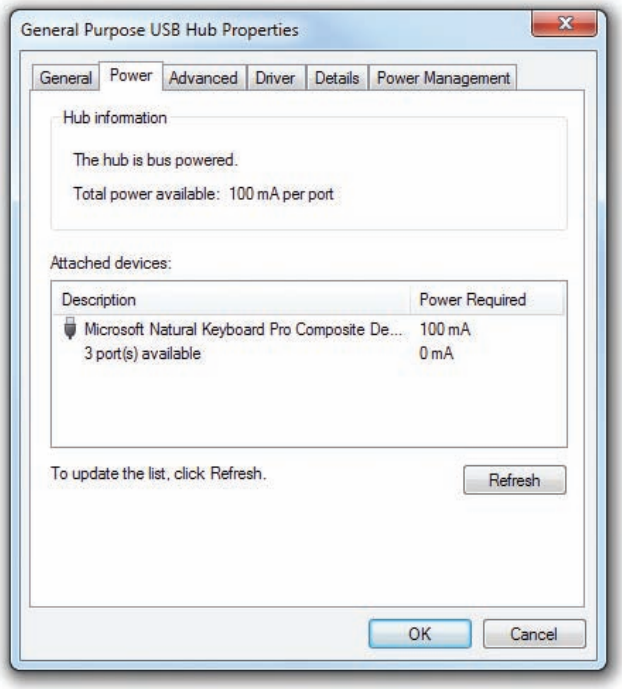
Tech Tip

Refresh the Tab

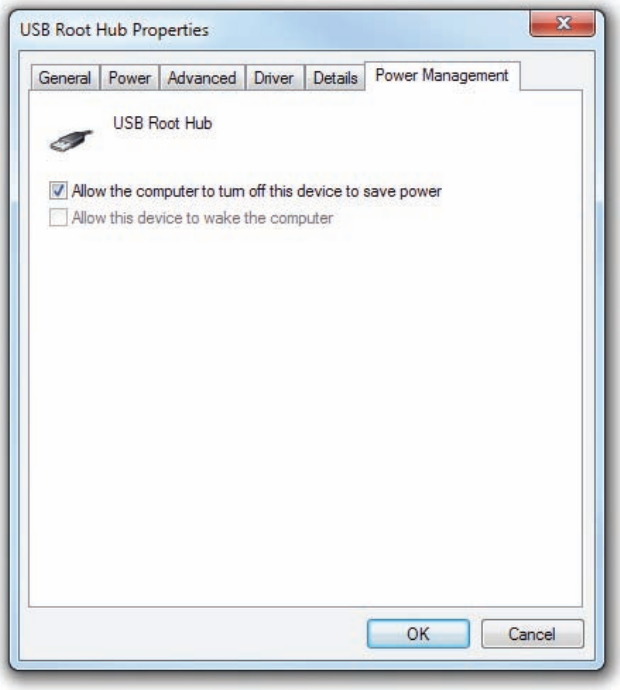
The Power tab of the USB Root Hub Properties dialog box shows you the power usage only for a given moment, so to ensure you keep getting accurate readings, you must click the Refresh button to update its display. Make sure your USB device works, and then refresh to see the maximum power used.



• **Figure 20.13** USB hub Power tab



• **Figure 20.14** General purpose bus-powered hub



• **Figure 20.15** Power Management tab

There's one more problem with USB power: sometimes USB devices go to sleep and don't wake up. Actually, the system is telling them to sleep to save power. You can suspect this problem if you try to access a USB device that was working earlier but that suddenly no longer appears in Device Manager. To fix this, head back in to Device Manager to inspect the hub's Properties, but this time open the Power Management tab and uncheck the *Allow the computer to turn off this device to save power* checkbox, as shown in Figure 20.15.

FireWire Ports

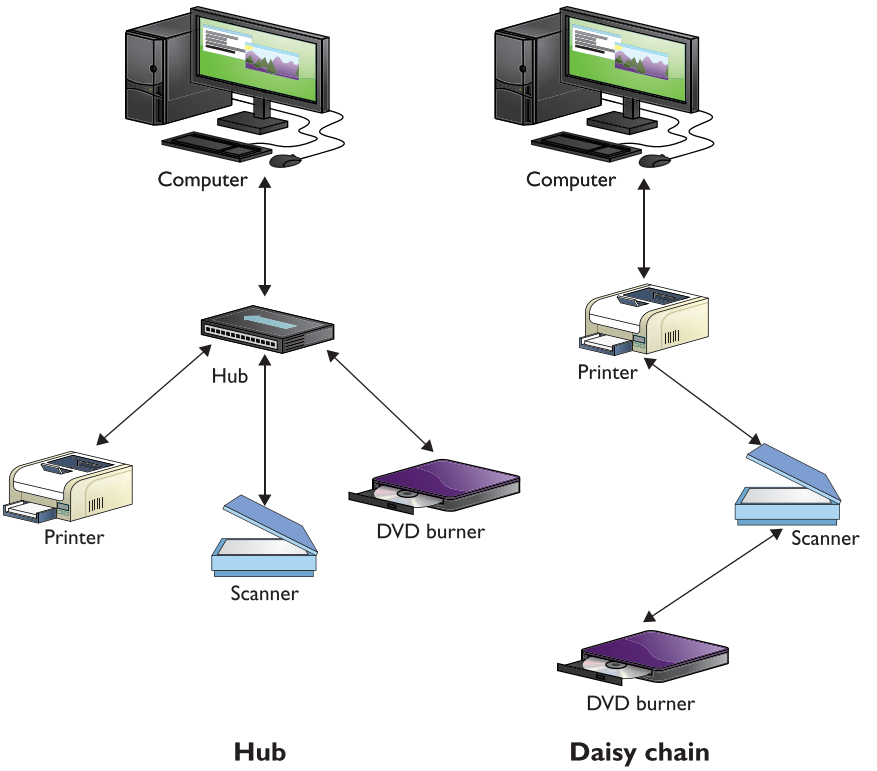
At first glance, **FireWire**, also known as IEEE 1394, looks and acts much like USB. FireWire has all of the features of USB, but it uses different connectors and is actually the older of the two technologies. For years, FireWire had the upper hand when it came to moving data quickly to and from external devices. The onset of Hi-Speed and SuperSpeed USB, along with the introduction of eSATA for external hard drives, changed that, and FireWire has lost ground to USB in many areas.

Understanding FireWire

FireWire has three distinct types of connects, all of which are becoming increasingly uncommon on PCs. The first is a 6-pin *powered* connector, the type you see on some desktop PCs. Like USB, a FireWire port is capable of providing

power to a device. The second type of connector is a 4-pin connector, which you see on portable computers and such FireWire devices as cameras. This type of connector does not provide power to a device, so you need to find another method of powering the external device. The third connector is an uncommon 9-pin powered connector for higher-speed devices.

FireWire comes in two speeds: **IEEE 1394a**, which runs at 400 Mbps, and **IEEE 1394b**, which runs at 800 Mbps. FireWire devices can also take advantage of bus mastering, enabling two FireWire devices—such as a digital video camera and an external FireWire hard drive—to communicate directly with each other. When it comes to raw speed, FireWire 800—that would be 1394b, naturally—is faster than Hi-Speed USB but not SuperSpeed USB.



• **Figure 20.16** Hubbed versus daisy chain connections

FireWire does have differences from USB other than just speed and a different-looking connector. First, a USB device must connect directly to a hub, but a FireWire device may use either a hub or daisy chaining. Figure 20.16 shows the difference between hubbed connections and daisy chaining. Second, FireWire supports a maximum of 63 devices, compared to USB's 127. Third, each cable in a FireWire 400 daisy chain has a maximum length of 4.5 meters, as opposed to USB's 5 meters.

Configuring FireWire

In a Windows environment, FireWire is subject to many of the same issues as USB, such as the need to preinstall drivers, verify that onboard devices are active, and so on. But none of these issues are nearly as crucial with a FireWire connection. For example, as with USB, you really should install a FireWire device driver before attaching the device, but given that 95 percent of the FireWire devices used in PCs are either external hard drives or digital video connections, the preinstalled Windows drivers almost always work perfectly. FireWire devices do use much more power than USB devices, but the FireWire controllers are designed to handle higher voltages, and they'll warn you on the rare chance that your FireWire devices pull too much power.

Like USB and serial ports (or any other ports, for that matter), you can always add more FireWire ports using a PCI expansion card. Standard installation procedures apply.

General Port Issues

No matter what type of port you use, if it's not working, you should always check out a few issues. First of all, make sure you can tell a port problem from a device problem. Your best bet here is to try a second "known good" device in the same port to see if that device works. If it does *not*, you can

A "known good" device is simply a device that you know is in good working order. All techs count heavily on the use of known good devices to check other devices. For example, if you think a PC has a bad keyboard, borrow one from the PC next door and see if that keyboard works on the broken machine.

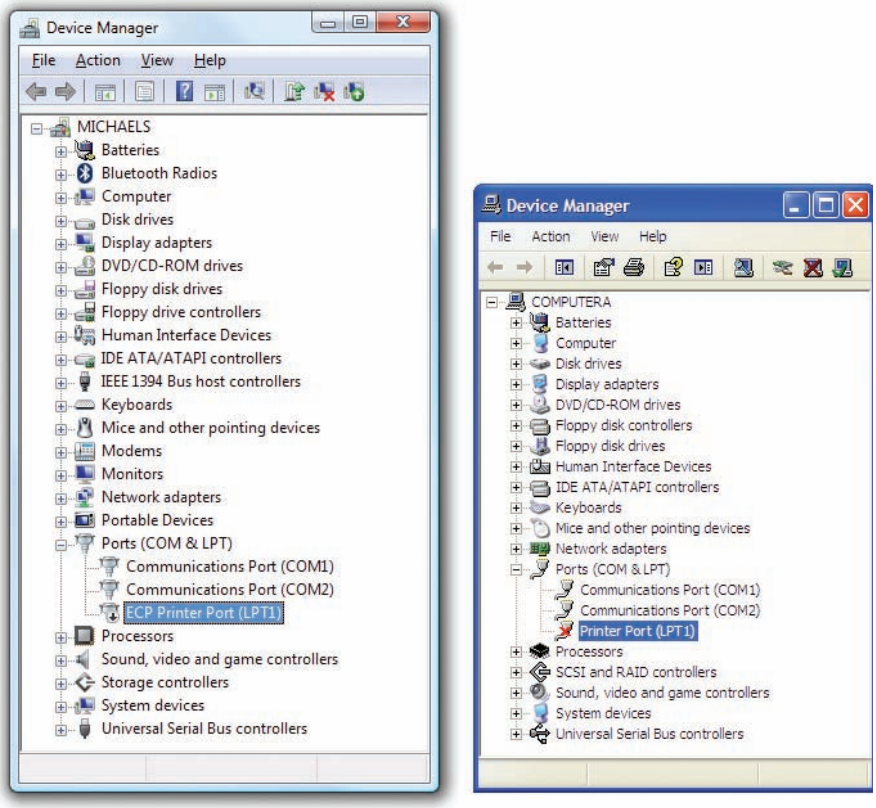
assume the port is the problem. It's not a bad idea to reverse this and plug the device into a known good port.

If you're pretty sure the port's not working, you can check three things: First, make sure the port is turned on. Almost any I/O port on a motherboard can be turned off in CMOS. Reboot the system and find the device and see if the port's been turned off. You can also use Windows Device Manager to disable most ports. Figure 20.17 shows a disabled parallel port in Device Manager—you'll see a small down-pointing arrow in Windows Vista/7 or a red *X* over the device icon in Windows XP. To turn the port back on, right-click the device's icon and choose Enable.

Being able to turn off a port in Device Manager points to another not-so-obvious fact: ports need drivers just as devices need drivers. Windows has excellent built-in drivers for all common ports, so if you fail to see a port in Device Manager (and you know the port is turned on in CMOS), you can bet the port itself has a physical problem.

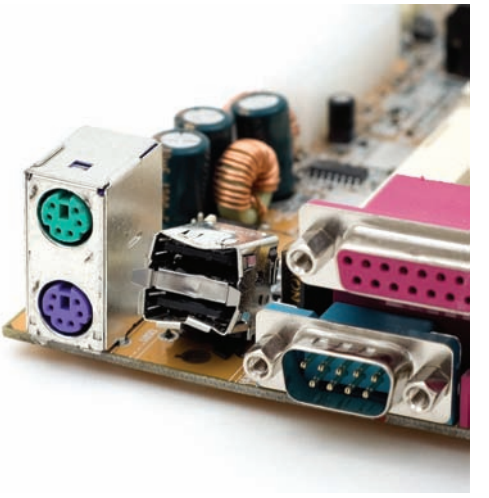
Because ports have connectors inserted and removed from them repeatedly, eventually they can physically break. Figure 20.18 shows the back of a USB port that's been pushed on too hard for too long and has physically separated from the motherboard. Unless you're an expert solderer, you either must stop using those ports or replace the entire motherboard.

Many ports (or the plugs that fit into those ports) use tiny pins or relatively delicate metal casings that are susceptible to damage. PS/2 plugs are some of the worst for bent pins or misshaped casings. Figure 20.19 shows what happened to a PS/2 plug when I was in a hurry and thought that force



• **Figure 20.17** Disabled parallel port in Device Manager in both Vista and XP

was an alternative to lining up the plug properly. Replacement plugs are available—but again, unless you're excellent at soldering, they're not a viable alternative. Still, if you're patient, you might be able to save the plug. Using needle-nose pliers and a pair of scissors, I was able to reshape the plug so that it once again fit in the PS/2 port.



• **Figure 20.18** Broken USB port

• **Figure 20.19** Badly bent PS/2 plug

Standard Input Devices

So what is a "standard" input device? I'm hoping you immediately thought of the mouse and the keyboard, two of the most basic, necessary, and abused input devices on a computer. But those aren't the only things the CompTIA A+ 220-801 exam considers as standard. The full list of standard input devices includes:

- Keyboards
- Mice
- Scanners
- Biometric devices
- Bar code readers
- Touch screens
- KVM switches
- Gamepads and joysticks
- Digitizers

You probably don't use most of these "standard" devices every day, so I'll cover each of them in detail.

Keyboards

Keyboards are both the oldest and still the primary way you input data into a PC. Windows comes with perfectly good drivers for any keyboard, although some fancier keyboards may come with specialized keys that require a special driver be installed to operate properly. About the only issue that might affect keyboard installation is if you're using a USB keyboard: make sure that the USB Keyboard Support option is enabled in CMOS (see Figure 20.20). Other than that, any keyboard installation issue you're likely to encounter is covered in the "Supporting Common Ports" sections at the beginning of this chapter.

There's not much to do to configure a standard keyboard. The only configuration tool you might need is the Keyboard Control Panel applet. This tool enables you to change the repeat delay (the amount of time you must hold down a key before the keyboard starts repeating the character), the repeat rate (how quickly the character is repeated after the repeat delay), and the default cursor blink rate. Figure 20.21 shows the default Windows Keyboard Properties window—some keyboard makers provide drivers that add extra tabs.

Keyboards might be easy to install, but they do fail occasionally. Given their location—right in front of you—the three

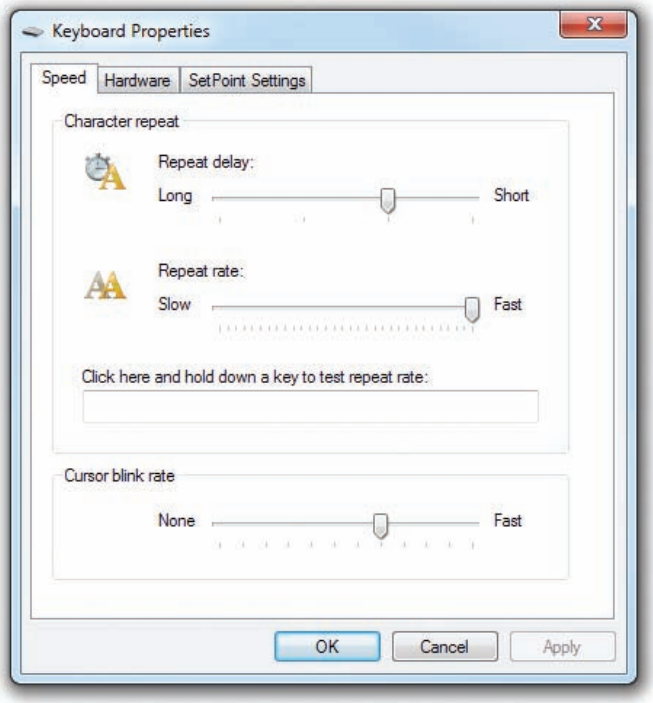
Tech Tip

Wireless Keyboards and Batteries

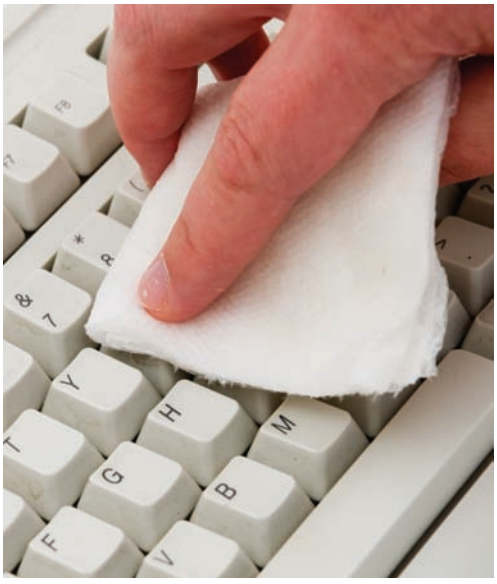
Wireless keyboards are a wonderful convenience because they remove the cable between you and the PC, but make sure you keep a complete set of spare batteries around.

```
OnChip USB                    V1.1+2.0
- USB Keyboard Support        Enabled
- USB Mouse Support           Enabled
```

• **Figure 20.20** CMOS USB Keyboard Support option



• **Figure 20.21** Keyboard Control Panel applet



• **Figure 20.22** Cleaning keys

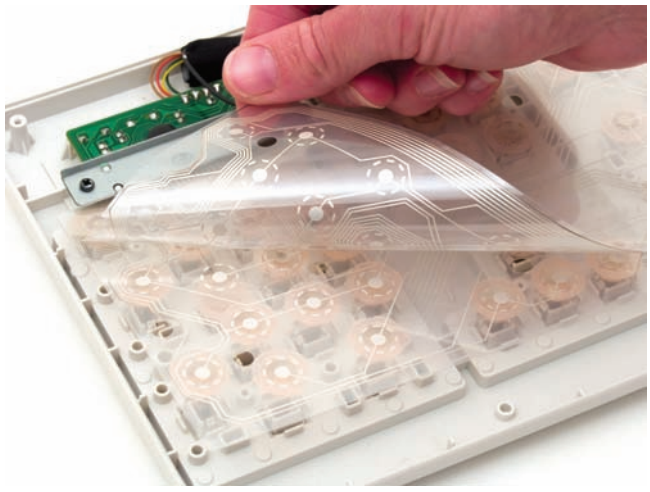
issues that cause the most keyboard problems stem from spills, physical damage, and dirt.

Spilling a soda onto your keyboard can make for a really bad day. If you're quick and unplug the keyboard from the PC before the liquid hits the electrical components, you might be able to save the keyboard. It'll take some cleaning, though (keep reading for cleaning tips). More often than not, you'll get a sticky, ill-performing keyboard that is not worth the hassle—just replace it!

Other common physical damage comes from dropping objects onto the keyboard, such as a heavy book (like the one in your hands). This can have bad results! Most keyboards are pretty resilient, though, and can bounce back from the hit.

Clean dirt and grime off the keys by using a cloth dampened with a little water, or if the water alone doesn't do the job, use a bit of isopropyl alcohol on a cloth (see Figure 20.22).

Dirty keys might be unsightly, but dirt under the keys might cause the keyboard to stop working completely. When your keys start to stick, grab a bottle of compressed air and shoot some air under the keys. Do this outside or over a trash can—you'll be amazed how much junk gets caught under the keys! If you really mess up a keyboard by dumping a chocolate milkshake on the keys, you're probably going to need to dismantle the keyboard to clean it. This is pretty easy as long as you keep track of where all of the parts go. Keyboards are made of layers of plastic that create the electrical connections when you press a key. Unscrew the keyboard (keep track of the screws!) and gently peel away the plastic layers, using a damp cloth to clean each layer (see Figure 20.23). Allow the sheets to dry and then reassemble the keyboard.



• **Figure 20.23** Serious keyboard surgery

Sometimes dirt or foreign objects get under individual keys, requiring you to remove the key to get to the dirt or object. Removing individual keys from a keyboard is risky business, because keyboards are set up in many different ways. Most manufacturers use a process in which keys are placed on a single plastic post. In that case, you may use a screwdriver or other flat tool to safely pop off the key (see Figure 20.24). Be careful! You'll need to use a good amount of force and the key will fly across the room. Other keyboard makers (mainly on laptops) use tiny plastic pins shaped like scissors. In that case, beware—if you try prying one of these off, you'll permanently break the key!

The bottom line when it comes to stuck keys is that the keyboard's probably useless with the stuck key, so you might as well try to clean it. Worse comes to worst, you can always buy another keyboard.

• **Figure 20.24** Prying off a key

Mice

Have you ever tried to use Windows without a mouse? It's not fun, but it can be done. All techs eventually learn the Windows navigation hot keys for those times when mice fail, but all in all we do love our mice. Like keyboards, Windows comes with excellent drivers for all standard mice; the exception you're likely to encounter is the more advanced mice that come with extra buttons.

You can adjust mouse settings through the Mouse Control Panel applet. Figure 20.25 shows the Windows 7 version.

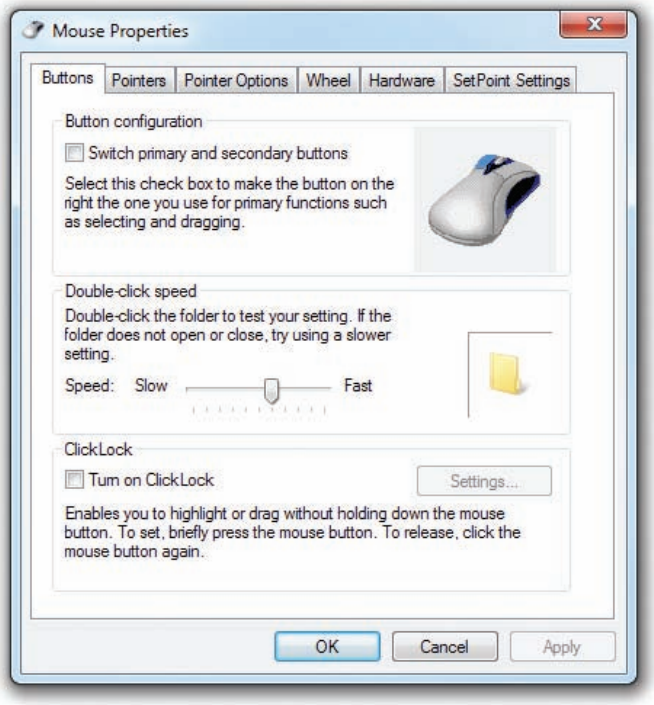
All of the settings you need for adjusting a mouse can be found in the Mouse Properties window. In particular, make sure to adjust the mouse speed and double-click speed to fit your preferences.

Tech Tip

A Clean Mouse Is a Happy Mouse!

As with keyboards, the biggest troublemaker for mice is dirt. Whenever a mouse stops working or begins to act erratically, always check first for dirt.

Everything in this section works equally well for trackballs.



• **Figure 20.25** Mouse Control Panel applet

• **Figure 20.26** Removing the collar on a ball mouse

• **Figure 20.27** Cleaning the rollers on a ball mouse

Two types of mouse technologies used to battle it out on the market: ball mice and optical mice. These days you'll only see the latter. **Ball mice** use a small round ball, while **optical mice** use LED or lasers and a camera to track their movements and thus move the mouse pointer across the screen. The problem with ball mice is that the ball inside the mouse picks up dirt over time and deposits the dirt on internal rollers that contact the ball. Dirt builds up to the point that the mouse stops responding smoothly. If you are struggling with your ball mouse to point at objects on your screen, you need to clean the mouse. Few mice manufacturers still make ball mice, as they tend to require far more maintenance than optical mice.

To access the internals of a ball mouse, turn it over and remove the protective cover over the mouse ball. The process of removing the cover varies, but it usually involves rotating the collar that surrounds the ball until the collar pops out (see Figure 20.26). Be careful—without the collar, the mouse ball will drop out the instant you turn the mouse upright.

Use any nonmetallic tool to scrape the dirt from the roller without scratching or gouging the device. Although you could use a commercial "mouse cleaning kit," I find that a fingernail or a pencil eraser cleans the rollers quite nicely and at much less expense (see Figure 20.27). Clean a ball mouse in this way at least every two or three months.

Optical mice require little maintenance and almost never need cleaning, as the optics that make them work are never in contact with the grimy outside world. On the rare occasion where an optical mouse begins to act erratically, try using a cloth or damp cotton swab to clean out any bits of dirt that may be blocking the optics (see Figure 20.28).

Scanners

You can use a scanner to make digital copies of existing paper photos, documents, drawings, and more. Better scanners give you the

• **Figure 20.28** Cleaning an optical mouse

option of copying directly from a photographic negative or slide, providing images of stunning visual quality—assuming the original photo was halfway decent, of course! In this section, you'll look at how scanners work and then turn to what you need to know to select the correct scanner for you or your clients.

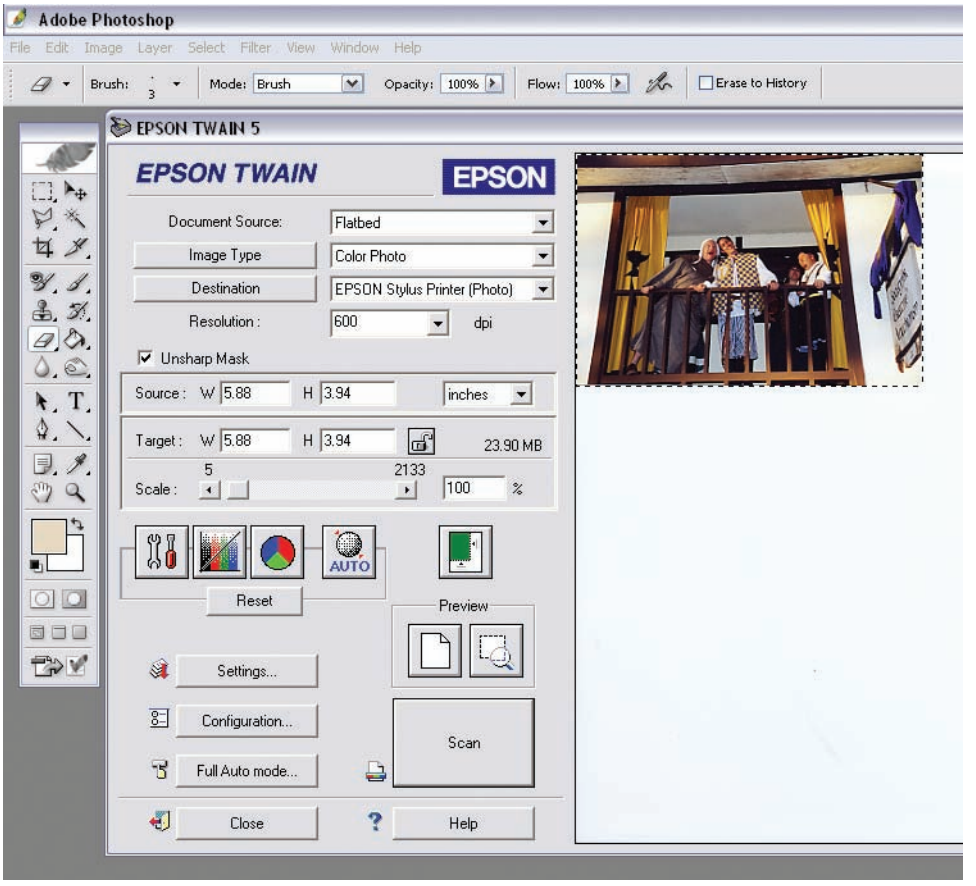
How Scanners Work

All **flatbed scanners**, the most common variety of scanner, work the same way. You place a photo or other object face down on the glass, close the lid, and then use software to initiate the scan. The scanner runs a bright light along the length of the glass tray once or more to capture the image. Figure 20.29 shows an open scanner.

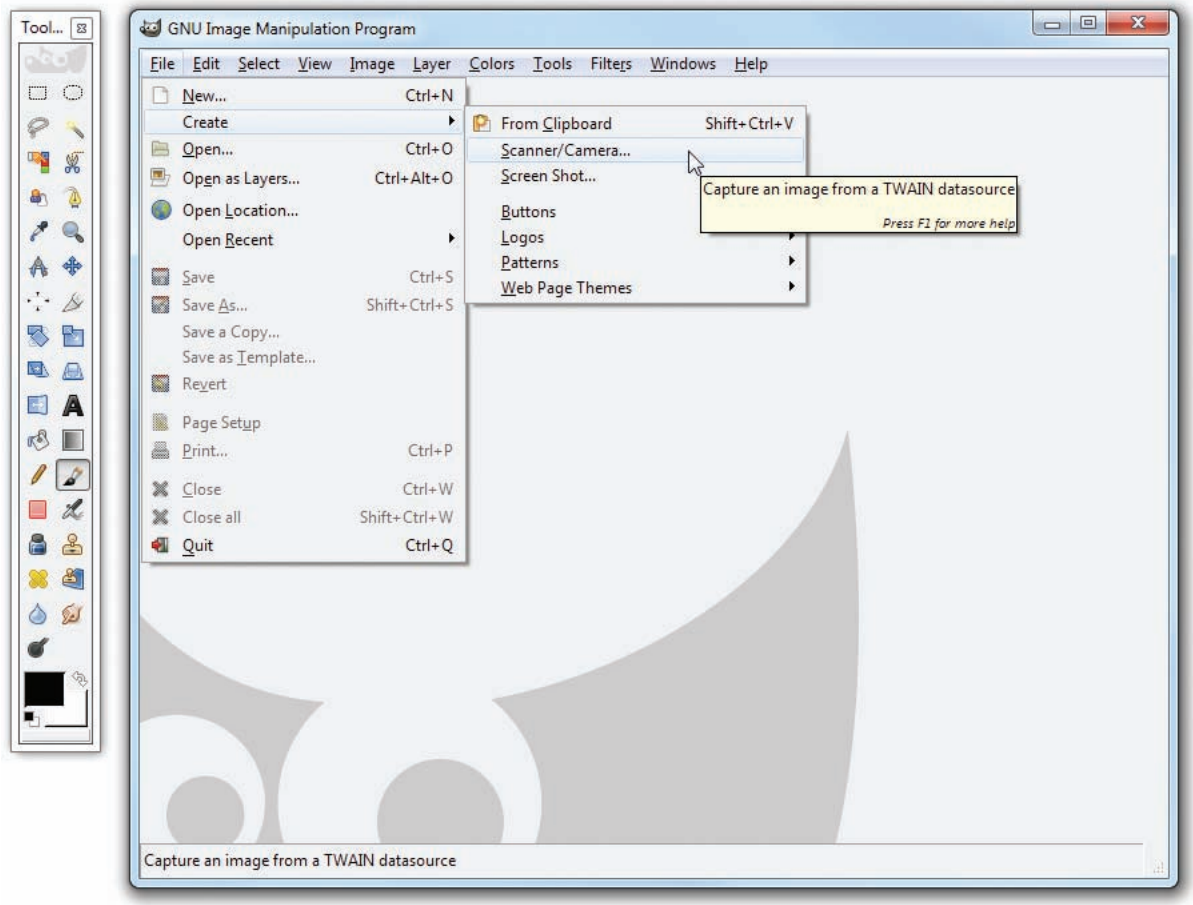
The scanning software that controls the hardware can be manifested in a variety of ways. Nearly every manufacturer has some sort of drivers and other software to create an interface between your computer and the scanner. When you push the front button on the Epson Perfection scanner in Figure 20.30, for example, the Epson software opens the Photoshop program as well as its own interface.

You can also open your favorite image-editing software first and choose to acquire a file from a scanner. Figure 20.31 shows the process of acquiring an image from a scanner in the popular free image-editing software, GNU Image Manipulation Program (otherwise known

• **Figure 20.29** Scanner open with photograph face down



• **Figure 20.30** Epson software with Photoshop open in the background



• **Figure 20.31** Acquiring an image in GNU Image Manipulation Program

Tech Tip

Optical Character Recognition

In addition to loading pictures into your computer, many scanners offer a feature called optical character recognition *(OCR), a way to scan a document and have the computer turn the picture into text that you can manipulate by using a word processing program. Many scanners come with OCR software, such as ABBYY FineReader.*

as GIMP). As in most such software, you choose File | Create and then select Scanner. In this case, the scanner uses the traditional TWAIN drivers. **TWAIN** stands for *Technology Without an Interesting Name*—I'm not making this up!—and has been the default driver type for scanners for a long time.

At this point, the drivers and other software controlling the scanner pop up, providing an interface with the scanner (as shown in Figure 20.31). Here you can set the resolution of the image as well as many other options.

How to Choose a Scanner

You must consider five primary variables when choosing a scanner: resolution, color depth, grayscale depth, connection, and scan speed. You can and will adjust the first three during the scanning process, although probably only down from their maximum. You need to decide on the connection before you buy. The scan speed relates to all four of the other variables, and the maximum speed is hard-coded into the scanner.

Configurable Variables Scanners convert the scanned image into a grid of dots. The maximum number of dots determines how well you can capture an image and how the image will look when scaled up in size. Most folks use the term *resolution* to define the grid size. As you might imagine, the higher the resolution, the better the scanned image will look and scale.

Older scanners can create images of only 600 × 600 dots per inch (dpi), while newer models commonly achieve four times that density, and high-end machines do much more. Manufacturers cite *two* sets of numbers for a scanner's resolution: the resolution it achieves mechanically—called the **optical resolution**—and the enhanced resolution it can achieve with assistance from some onboard software.

The enhanced resolution numbers are useless. I recommend at least 2400 × 2400 dpi optical resolution or better, although you can get by with a lower resolution for purely Web-destined images.

The **color depth** of a scan defines the number of bits of information the scanner can use to describe each individual dot. This number determines color, shade, hue, and so forth, so a higher number makes a dramatic difference in your picture quality. With binary numbers, each extra bit of information *doubles* the quality. An 8-bit scan, for example, can save up to 256 color variations per dot. A 16-bit scan, in contrast, can save up to 65,536 variations, not the 512 that you might expect!

Modern scanners come in 24-bit, 36-bit, and 48-bit variations. These days, 48-bit scanners are common enough that you shouldn't have to settle for less, even on a budget. Figures 20.32, 20.33, and 20.34 show pretty clearly the difference resolution makes when scanning.

Scanners differ a lot in **grayscale depth**, a number that defines how many shades of gray the scanner can save per dot. This matters if you work with black-and-white images in any significant way, because grayscale depth is usually a much lower number than color depth. Current consumer-level scanners come in 8-bit, 12-bit, and 16-bit grayscale varieties. I recommend 16-bit or better.

Connection Almost all modern scanners plug into the USB port on your PC, although some high-end models offer FireWire as well. Older scanners come in SCSI and parallel varieties.

Scanning Speed Scanners have a maximum scanning speed defined by the manufacturer. The time required to complete a scan is also affected by the parameters you set; the time increases as you increase the amount of detail captured. A typical low-end scanner, for example, takes upwards of 30 seconds to scan a 4 × 6 photo at 300 dpi. A faster scanner, in contrast, can crank out the same scan in 10 seconds.

Raise the resolution of the scan to 600 dpi at 48-bit resolution, and that faster scanner can take a full minute to complete the scan. Adjust your scanning settings to optimize for your project. Don't always go for the highest possible scan if you don't need the resolution.

Connections matter as well. A good Hi-Speed USB scanner can scan an 8 × 10 image in about 12 seconds at 300 dpi. I made the mistake of taking the scanner to a friend's house to scan some of her jewelry, but she had only a Full-Speed USB port. I plugged the scanner into her PC and it took about 45 seconds to scan each 8 × 10 image. We were up all night finishing the project!

Figure 20.32 Earring scanned at 72 dpi and 24-bit color

Figure 20.33 Same earring, scanned at 300 dpi and 24-bit color

Figure 20.34 Same earring, scanned at 1200 dpi and 24-bit color

As of early 2012, USB 3.0 scanners hadn't really caught on. Scanners are now limited by their own scanning speed, not their connection to the PC.

Installation and Scanning Tips

Most USB and FireWire devices require you to install the software drivers before you plug in the device for the first time. I have run into exceptions,

though, so I strongly suggest you read the scanner's documentation before you install.

As a general rule, you should obtain the highest quality scan you can manage, and then play with the size and image quality when it's time to include it in a Web site or an e-mail. The amount of RAM in your system—and to a lesser extent, the processor speed—dictates how big a file you can handle.

If you travel a lot, you'll want to make sure to use the locking mechanism for the scanner light assembly. Just be sure to unlock before you try to use it or you'll get a light that's stuck in one position. That won't make for very good scans!

Biometric Devices

If you look up *biometrics* on the popular Wikipedia Web site, you'll get the following definition: "Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals." The field of biometrics also encompasses a number of security devices, such as door locks and security cameras, that don't really fit into the world of PCs. This section concentrates on the types of biometrics that you can actually buy and use on your PC. Within the realm of computers, biometrics includes a huge number of technologies, from thumb drives that read fingerprints to software that does voice recognition.

• **Figure 20.35** USB thumb drive with fingerprint scanner (photo courtesy of Lexar Media, Inc.)

PCs use biometrics for security. **Biometric devices** scan and remember unique aspects of various body parts such as your retina, iris, head image, or fingerprint, using some form of sensing device such as a retinal scanner. This information is used as a key to prevent unauthorized people from accessing whatever the biometric device is securing. Most biometric devices currently used in PCs secure only themselves. The USB thumb drive in Figure 20.35 has a tiny fingerprint scanner. You slide your finger (any finger you choose) over the drive to unlock the contents of the thumb drive.

• **Figure 20.36** Microsoft fingerprint scanner on a keyboard

Less common are biometric security devices that secure entire computers. The Microsoft fingerprint scanner is a USB device that replaces standard user name and password security. Figure 20.36 shows the scanner built into a keyboard. When a program or Web site asks for a user name and password, you simply press your finger against the fingerprint scanner. It confirms your identity (assuming your fingerprint matches), and then special software that comes with the scanner supplies the program or Web site with your stored user name and password.

Biometric devices are also used for recognition. Recognition is different from security in that the biometric device doesn't care who you are; it just wants to know what you're doing. The best example of this is voice recognition. Voice recognition programs convert human voice input into commands or text. Voice recognition for PCs has been around for some time. Although it has never achieved enough accuracy to replace a keyboard completely, voice recognition is common in devices that have a limited number of commands to

interpret, such as smartphones. If you speak the words "Call Mike Meyers" into your smartphone, your phone knows what to do—at least, *my* phone does!

No matter what biometric device you use, you use the same steps to make it work:

1. Install the device.
2. Register your identity with the device by sticking your eye, finger, or other unique body part (Why are you snickering?) into or onto the device so it can scan you.
3. Configure its software to tell the device what to do when it recognizes your scanned identity.

Bar Code Readers

Bar code readers are designed to read standard **Universal Product Code (UPC)** bar codes (see Figure 20.37). We read bar codes for only one reason—to track inventory. Bar code readers enable easy updating of inventory databases stored on PCs.

• **Figure 20.37** Typical UPC code

Two types of bar code readers are commonly found with PCs: pen scanners and hand scanners. Pen scanners look like an ink pen and must be swiped across the bar code (see Figure 20.38). Hand scanners are held in front of the UPC code while a button is pressed to scan. All bar code readers emit a tone to let you know the scan was successful.

• **Figure 20.38** Pen scanner (photo courtesy of Wasp® Barcode Technologies)

Older bar code readers used serial ports, but all of the newer readers use either PS/2 or USB ports. No configuration is usually necessary, other than making sure that the particular bar code reader works with whatever database/point of sale software you use. When in doubt, most people find the PS/2-style bar code readers work best, as they simply act like a keyboard. You plug the reader into your keyboard port and then plug your keyboard into the reader. Then all you need is software that accepts keyboard input (and what one doesn't!), and it will work.

Touch Screens

A **touch screen** is a monitor with some type of sensing device across its face that detects the location and duration of contact, usually by a finger or stylus. All touch screens then supply this contact information to the PC as though it were a click event from a mouse. Touch screens are used in situations for which conventional mouse/keyboard input is either impossible or impractical. Here are a few places you'll see touch screens at work:

- Smartphones
- Information kiosks
- Point of sale systems
- Tablets

Touch screens can be separated into two groups: built-in screens like the ones in smartphones, and standalone touch screen monitors like those used in many point of sale systems. From a technician's standpoint, you can think of a standalone touch screen as a monitor with a built-in mouse. All touch screens have a separate USB or PS/2 port for the "mouse" part of the device, along with drivers you install just as you would for any USB mouse.

Windows Vista and Windows 7 include Control Panel applets for configuring the touch screens on Tablet PCs. Windows Vista comes with Pen and Input Devices and Tablet PC Settings. Windows 7 combines the tools into the Tablet PC Settings applet. (Note that the Tablet PC Settings applet will only appear on Windows 7 Tablet PCs—you won't find it on laptops or desktops.) You can use these applets to adjust how you interact with the touch screen just as you would with the Mouse or Keyboard applets. The applets enable you to configure what happens when you tap, double-tap, use gestures called "flicks," and more.

KVM Switches

A **keyboard, video, mouse (KVM) switch** is a hardware device that most commonly enables multiple computers to be viewed and controlled by a single mouse, keyboard, and screen. Some KVMs reverse that capability, enabling a single computer to be controlled by multiple keyboards, mice, or other devices. KVMs are especially useful in data centers where multiple servers are rack mounted, space is limited, and power is a concern. An administrator can use a single KVM to control multiple server systems from a single keyboard, mouse, and monitor.

There are many brands and types of KVM switches. Some enable you to connect to only two systems, and some support hundreds. Some even come with audio output jacks to support speakers. Typical KVMs come with two or more sets of wires that are used for input devices such as PS/2 and/or USB mice and video output (see Figure 20.39).

• **Figure 20.39** A typical KVM switch

To use a KVM, you simply connect a keyboard, mouse, and monitor to the KVM and then connect the KVM to the desired computers. Once connected and properly configured, assigned keyboard hotkeys—a combination of keys typically assigned by the KVM manufacturer—enable you to toggle between the computers connected to the KVM. In most cases, you simply tap the SCROLL LOCK key twice to switch between sessions.

Installing a KVM is not difficult; the most important point to remember is to connect the individual sets of cables between the KVM ports and each computer one at a time, keeping track of which keyboard, mouse, and video cable go to which computers. (I highly recommend labeling and using twist or zip ties.)

If you get the connections wrong, the KVM won't function as desired. If you connect a mouse and keyboard wires to the correct KVM port, for example, but attach the same computer's video cable to a different port on the KVM, you won't get the correct video when you try to switch to that computer.

The same holds true for the mouse and keyboard cables. Don't cross the cables!

Older KVMs are said to be *passive*, meaning they don't continuously communicate with all connected systems. This can cause problems if the connected systems automatically reboot after a power surge or loss. Modern-day active KVMs resolve this issue through *peripheral emulation*, meaning they communicate with and monitor all systems connected to the KVM.

Gamepads and Joysticks

Whether you're racing through tight turns at top speeds or flying a state-of-the-art jet fighter, having the right controller for the job is important for an enjoyable gaming experience. Two peripherals are commonly used for controlling PC games: joysticks and gamepads.

Over the past decade, flight simulator programs have declined in popularity, and so have joysticks (see Figure 20.40). Once a required component of a gamer's arsenal, you only need joysticks now if you are a *serious* flight simulator fan. Most modern PC games are controlled by mouse and keyboard.

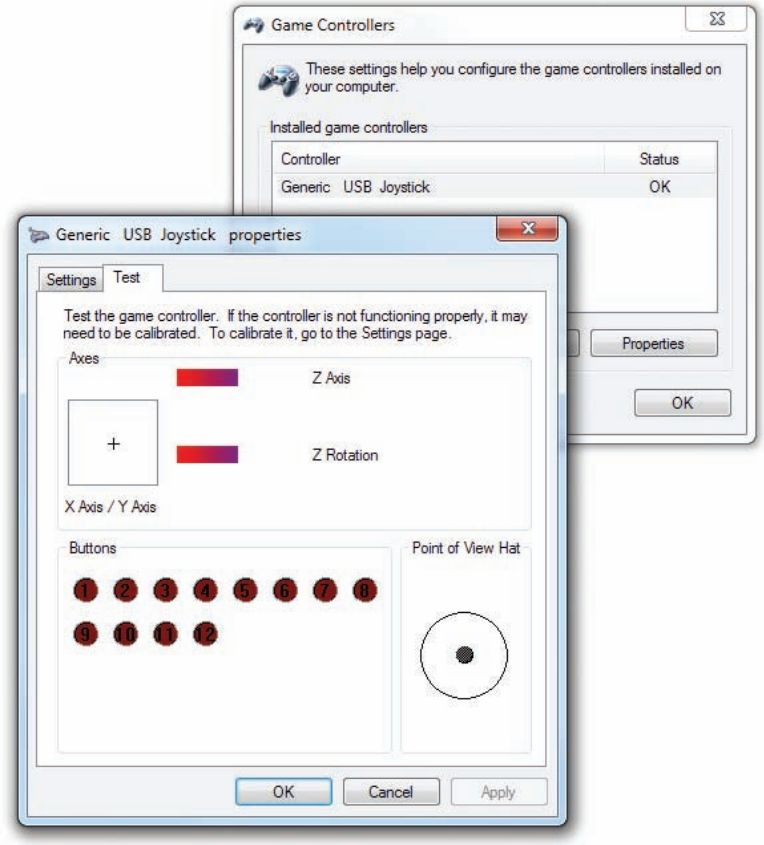
Some PC games, especially those that were designed to played on consoles like the Microsoft Xbox 360 or Sony PlayStation 3, are best enjoyed when using a gamepad. A *gamepad* looks more like your standard video game controller, usually covered in an array of buttons and triggers (see Figure 20.41).

Joysticks and gamepads have used plenty of connectors over the years, including the eponymous joystick connector. These days, they all connect to your PC via USB. Depending on the complexity of the controller, you may need to install drivers to get a joystick or gamepad working. Simpler controllers, however, can probably get by using the default gamepad drivers included in Windows.

You'll need to configure your joystick or gamepad to make sure all the buttons and controls work properly. In Windows XP and Vista, open the Game Controllers Control Panel applet. In Windows 7, open the Start menu and select Devices and Printers. Right-click on the controller and select *Game controller settings*. Select your device from the list of controllers and click Properties. Depending on your gamepad or joystick, you'll be able

• **Figure 20.40** A joystick

• **Figure 20.41** A gamepad



• **Figure 20.42** Game controller properties

to configure the buttons, sticks, triggers, and more (see Figure 20.42). You can calibrate the analog sticks so they accurately register your movements. You can even adjust the amount of vibration used by the controller's force feedback (if available).

Once you've set up your controller, you should be ready to take to the skies, or the streets, or wherever else you go to game.

Digitizers

PCs and Macs have quickly become the most powerful and flexible tools available for visual artists. Given the number of applications dedicated to producing various visual styles, including painting, sketching, animation, and more, digital art stands toe-to-toe with its more traditional counterpart. It's only reasonable that a category of hardware would appear to help users take advantage of these tools.

A **digitizer** (otherwise known as a *pen tablet*) enables users to paint, ink, pencil, or otherwise draw on a computer (see Figure 20.43). Now, don't get carried away and start taking watercolors to your monitor. The digitizer receives input using a special surface. When a user presses against the surface, usually using a stylus, the surface transforms (or digitizes) the analog movements into digital information. The drawing application receives the information from the digitizer and

• **Figure 20.43** A type of digitizer known as the Wacom pen tablet

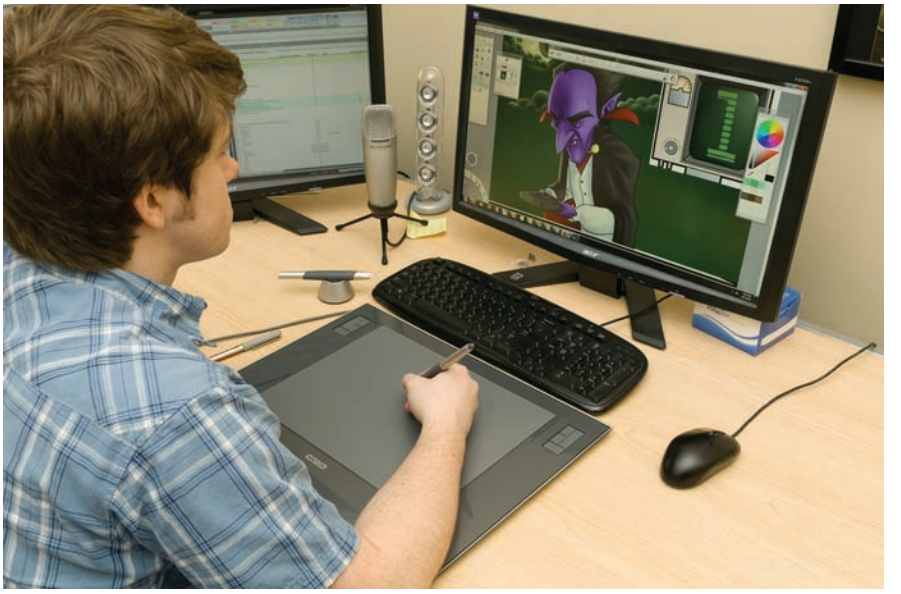
You might also need to configure your controller from within the game you want to play. Most games are set to use keyboard and mouse controls by default. You'll need to play around with the settings to enable your game controller.

Not all digitizers are designed for digital art. Some are used for handwriting, technical drawings, writing complex characters, or even as a replacement mouse.

turns it into an image onscreen (see Figure 20.44). If you draw a line on the digitizer, for example, that line should appear onscreen.

Most digitizers connect to your PC via a USB connection. You'll need to install drivers before you connect the device, although they should be included in the box. The digitizer should also include a configuration utility. Here you can adjust the pressure sensitivity of the stylus, configure buttons on the tablet, and set the portion of the screen to which the tablet can draw.

You might also find an option to calibrate the digitizer. To ensure that where you press on the digitizer matches up with where you want it to appear on your monitor, you'll need to use the digitizer to click on a series of marks that appear on your monitor. If your digitizer is incorrectly calibrated, your inputs won't appear correctly when you are drawing.



• **Figure 20.44** Drawing with a digitizer

In addition to drivers, most digitizers require specific software to use their advanced functions. With digital art digitizers, for example, you'll need a graphic arts program like Adobe Illustrator or Autodesk SketchBook, which know how to use several brands and varieties of pen tablets.

Multimedia Devices

The CompTIA A+ 220-801 exam separates standard input devices from multimedia input devices. I don't think this makes much sense, since many people use joysticks, scanners, and digitizers for multimedia purposes. A better distinction might be non-audio/video input devices versus audio/video input devices, since that is the most obvious way to distinguish them here.

Popular multimedia devices like digital cameras and digital camcorders have found their way into almost every home. Their affordability and ease of use make them a no-brainer for families looking to capture every moment of their (cats') lives. Some people also use webcams to enable video chats with friends and family around the world. You'll learn about all three multimedia devices in this section.

The CompTIA A+ 220-801 objectives also list MIDI devices and microphones as multimedia input devices. You'll learn more about these when I cover sound devices in Chapter 25.

Digital Cameras and Camcorders

Digital cameras and camcorders electronically simulate older film and tape technology and provide a wonderful tool for capturing a moment and then sending it to friends and relatives. Because digital cameras and camcorders interface with computers, CompTIA A+ certified techs need to know the basics.

While digital cameras and digital camcorders can be considered distinct products, their features have become nearly identical. Both take pictures. Both take videos. In fact, a lot of high-end digital cameras take better video than digital camcorders. Because of this feature and function overlap, I'm presenting them here together.

Many digital camcorders include built-in hard drives for storing large amounts of high-definition video. This removes the need to constantly switch out memory cards.

Cross Check

Flash Media

You learned all about the many types of flash media and micro drives back in Chapter 13, so go there now and answer these questions. What's the difference between a thumb drive and an SD card? Can you make a bootable flash-media drive?

• **Figure 20.45** Secure Digital card

Storage Media—Digital Film

Digital cameras and camcorders save the pictures and videos they take onto some type of *removable storage media*. Think of it as digital film. Probably the most common removable storage media used in modern digital cameras (and probably your best choice) is the Secure Digital (SD) card (see Figure 20.45). About the size of a Wheat Thin (roughly an inch square), you can find these tiny cards with capacities ranging from 1 GB to 32 GB. They are among the fastest of the various media types at transferring data to and from a PC, and they're quite sturdy.

• **Figure 20.46** Camera connecting to USB port

Connection

These days, digital cameras plug directly into a USB port (see Figure 20.46). Another common option, though, is to connect only the camera's storage media to the computer, using one of the many digital media readers available.

You can find readers designed specifically for SD cards, as well as other types. Plenty of readers can handle multiple media formats. Many computers come with a decent built-in digital media reader (see Figure 20.47).

Many digital camcorders use USB connections, although you'll find FireWire connections on slightly older models.

• **Figure 20.47** Digital media reader built into computer

Quality

As with scanners, you should consider the amount of information a particular model of camera or camcorder can capture, which in the digital world is expressed as some number of **megapixels**. Instead of light-sensitive film, digital cameras and camcorders have one CCD (charged coupled device) or CMOS (complementary metal-oxide semiconductor) sensor covered with photosensitive pixels (called *photosites*) to capture the still image or video; the more pixels on the sensor, the higher the resolution of the images it captures.

Not so long ago, a 1-megapixel digital camera was the bleeding edge of digital photographic technology, but now you can find cameras with ten times that resolution for a hundred dollars. As a basis of reference, a 5-megapixel camera produces snapshot-sized (4 × 6 inch) pictures with print photograph quality, whereas a 10-megapixel unit can produce a high-quality 8 × 10 inch print.

Another feature of most digital cameras and camcorders is the capability to zoom in on your subject. The way you ideally want to do this is the

way film cameras do it, by using the camera's optics—that's the lens. Most cameras above the basic level have some **optical zoom**—meaning the zoom is built into the lens of the camera—but almost all models include multiple levels of **digital zoom**, accomplished by some very clever software in the camera. Choose your camera based on optical zoom: 3× at a minimum or better if you can afford it. Digital zoom is useless.

Camcorder optical zoom ranges are often much larger. You can find digital cameras with an optical zoom of 30× or more.

Form Factor

As was the case with film cameras, size matters on digital cameras and camcorders. These devices come in several form factors. They range from tiny, ultra-compact models that readily fit in a shirt pocket to monster cameras with huge lenses. Although it's not universally true, the bigger the camera/camcorder, the more features and sensors it can have. Thus bigger is usually better in terms of quality.

In shape, digital cameras come in a rectangular package, in which the lens retracts into the body, or as an SLR-type, with a lens that sticks out of the body. Figure 20.48 shows both styles.

Camcorders also come in multiple shapes (see Figure 20.49). Some are arranged vertically; others are more horizontal. Some are large enough that you need to use two hands to hold them. The latest form factors include two lenses so they can capture 3-D videos. Now your cat can fly right off the screen.

• **Figure 20.48** Typical digital cameras

• **Figure 20.49** Digital camcorders

Web Cameras

PC cameras, often called **webcams** because their most common use is for Internet video communication, are fairly new to the world of input devices. Too many people run out and buy the cheapest one, not appreciating the vast difference between a discount webcam and more expensive models; nor do they take the time to configure the webcam properly. Let's consider some of the features you should look for when buying webcams and some of the problems you can run into when using them.

The biggest issue with webcams is the image quality. Webcams measure their resolution in pixels. You can find webcams with resolutions of as few as 100,000 pixels and webcams with millions of pixels. Most people who use webcams agree that 1.3 million pixels (megapixels) is pretty much the highest resolution quality you can use before your video becomes so large it will bog down even a broadband connection.

The next issue with webcams is the frame rate, that is, the number of times the camera "takes your picture" each second. Higher frame rates make for smoother video; 30 frames per second is considered the best. A good camera with a high megapixel resolution and fast frame rate will provide you with excellent video conferencing capabilities. Figure 20.50 shows the author chatting via webcam using Skype software.

Read more about pixels and frame rates in Chapter 21.

Most people who use online video also want a microphone. Many cameras come with microphones, or you can use your own. Those who do a lot of video chatting may prefer to get a camera without a microphone and then buy a good quality headset with which to speak and listen.

Many cameras now can track you when you move, to keep your face in the picture—a handy feature for fidgety folks using video conferencing! This interesting technology recognizes a human face with little or no "training" and rotates its position to keep your face in the picture. Some companies even add funny extras, which, although not very productive, are good for a laugh (see Figure 20.51).

• **Figure 20.50** Video chatting by webcam with Skype

Almost all webcams use USB connections. Windows comes with a limited set of webcam drivers, so always make sure to install the drivers supplied with the camera before you plug it in. Most webcams use Hi-Speed USB, so make sure you're plugging your webcam into a Hi-Speed USB port.

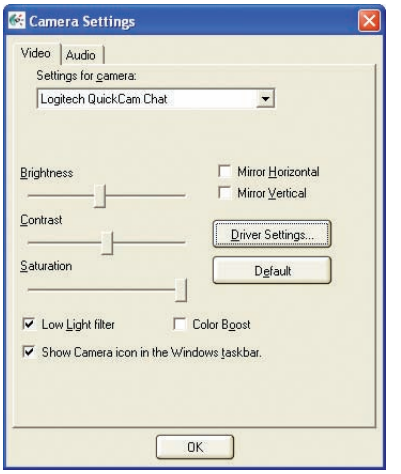
Once the camera is plugged in, you'll need to test it. All cameras come with some type of program, but finding the program can be a challenge. Some brands put the program in the system tray, some place it in My Computer/Computer, others put it in the Control Panel—and some do all three! Figure 20.52 shows the Control Panel applet that appeared when I installed the webcam driver.

• **Figure 20.51** This webcam program's animated character mirrors your movements as you conference with friends or coworkers.

The biggest challenge to using webcams is getting your webcam applications to recognize that your webcam is available and configured for use. Every program does this differently, but conceptually the steps are basically the same (with plenty of exceptions):

1. Tell the program you want to use a camera.
2. Tell the program whether you want the camera to turn on automatically when you chat.
3. Configure the image quality.
4. Test the camera.

If you're having problems with a camera, always go through the general I/O problems first, as this will clear up most problems. If you're still having trouble getting the camera to work in a program, be sure to turn off all other programs that may be using the camera. Windows allows only one program at a time to use a webcam.



• **Figure 20.52** Camera Settings applet

Chapter 20 Review

Chapter Summary

After reading this chapter and completing the exercises, you should understand the following about input devices.

Explain how to support common input/output ports

- Many new computers do not come with serial ports as other high-speed ports such as USB have replaced them. You can tell if you have serial ports by checking for the COM port icon in Device Manager.
- The UART chip that comprises the serial port converts data moving between the parallel expansion bus on a PC and the serial bus used by many I/O devices. Most serial port connectors consist of a 9-pin DB connector. The connector on the PC or device itself (not the cable) is male. Serial ports are also known as RS-232, which is the standard that describes how serial ports work.
- The USB host controller (sometimes called a host adapter) controls every USB device connected to it. The host controller includes a root hub that provides the physical connection for devices. Host controllers support many ports, but the number of USB ports a system has is usually dependent on what the motherboard manufacturer decided to supply. The host controller is shared by every device plugged into it, so speed and power are reduced with each new device.
- Powered USB devices require their own power cord, in which case they do not pull power from the USB bus itself. Bus-powered devices draw their power directly from the USB bus and do not require a separate power cord. Too many bus-powered devices may result in system lockups, device lockups, or devices that just don't work. To solve the power problem, unplugging a device or two will lower the demand for bus power. Alternatively, you can purchase and install a USB expansion card, which will provide another USB host controller with its own set of connection ports.
- Multiple USB standards are in use today: USB 1.1 defines Low-Speed USB, which runs at 1.5 Mbps, and Full-Speed USB, which runs at 12 Mbps. USB 2.0 defines Hi-Speed USB, which runs at 480 Mbps. USB 3.0 defines SuperSpeed USB, which runs at 5 Gbps.
- Devices of any speed can connect to any port, though they will run at the speed of the slowest device. A USB 3.0 device connected to a USB 2.0 port will run at 480 Mbps.
- In theory, the USB interface can support up to 127 devices on a single USB port; in reality, too many devices on a single USB chain will overtax its power capabilities. USB specifications allow for a maximum cable length of 5 meters, although you may add a powered USB hub every 5 meters to extend this distance.
- USB hubs extend the number of USB devices you can connect to a single port. Make sure you get a powered Hi-Speed USB hub so it will support the fastest speed and not draw power away from other devices.
- Normally, you will install the device driver before connecting the USB device to the system. Although this is the norm, it is not carved in stone. Be sure to read the manual that came with your device for instructions on installation. For example, many USB devices, such as flash drives, do not need a separate driver installed and work fine if simply plugged in.
- FireWire has three distinct types of connectors: 6- and 9-pin powered connectors and a 4-pin connector that doesn't provide power. IEEE 1394a runs at 400 Mbps and IEEE 1394b runs at 800 Mbps.
- FireWire devices must connect directly to a root hub but may be daisy chained to support up to 63 devices. Similar to USB devices, you should install the drivers before connecting the FireWire device, but most devices can use the generic Windows driver and thus can be plugged in immediately.
- When troubleshooting problems, first determine if the issue is a port problem or a device problem. Swap out the troubled device for a known good device (one that works in another computer). If a known good device fails, you can safely assume you have a port problem. If a known good device functions properly, you most likely have a device

problem. For device problems, replace the device. For port problems, verify that the port is enabled, make sure you have the drive installed for the port itself, and check the condition of the cables and physical connectors.

Identify certain standard input devices on a PC

- Keyboards are the oldest type of input device and still the primary way users input data. Although a keyboard works without the installation of additional drivers, you need to install drivers for specialty keyboards, such as keyboards with fancy buttons or other programmable features. If you're using a USB keyboard, make sure to enable USB keyboard support in CMOS Setup.
- Configure basic keyboard settings in the Keyboard Control Panel applet. You can change the repeat delay, repeat rate, and cursor blink rate. Clean dirty keys with a damp cloth or isopropyl alcohol. Compressed air works well to dislodge hair, dust, and other small objects from the keys. With most keyboards you can pop off individual keys to do some deep cleaning. Some keyboards (such as those on laptops) are not meant to have keys removed, and doing so might permanently damage the keyboard.
- Mice work with the generic Windows drivers. You need to install mouse drivers only if your mouse has special programmable features, such as additional buttons. Various mouse settings can be configured via the Mouse Control Panel applet. Configurable settings include mouse speed, double-click speed, and acceleration.
- The internal rubber ball on a ball mouse should be cleaned every few months. Rotate the collar on the underside of the mouse to release the rubber ball. Optical mice, which use LEDs or lasers to track movement, may occasionally need their lenses wiped free of grime, but overall outperform and outlive ball mice.
- Flatbed scanners have a hinged lid and flat glass surface on which you can place material to be scanned. Most scanners come with software to control the hardware and to control the scanning process itself. The scan software enables you to select the color mode and resolution of the scanned document. Scanners use a traditional TWAIN driver to transfer digital images to the PC. Some scanners offer additional features, such as OCR capabilities.
- When choosing a scanner, consider the scanner's optical resolution (ignore the enhanced resolution), color depth, grayscale depth, connection type, and scan speed. The higher these numbers, the better quality the scanned images will be. Shoot for a minimum 2400 × 2400 dpi optical resolution, 48-bit color depth, 16-bit grayscale depth, and a Hi-Speed USB or FireWire connection.
- Biometric devices scan various body parts, such as fingerprints or retinas, for authentication, security, and recognition. Some biometric devices control access to an entire PC, while some small devices, such as USB thumb drives, have biometric fingerprint scanners built in to control access to the single device. Voice recognition allows users to speak commands to the computer, such as "Call Mike Meyers" to dial the phone via a modem.
- Bar code readers read the standard Universal Product Code (UPC) bar code. The two types of bar code readers are pen scanners and hand scanners. Pen scanners look like ink pens and must be swiped across the bar code. Hand scanners are aimed at the bar code and when a button or trigger is pressed, the reader scans the bar code. All bar code scanners produce an audible tone to verify that the bar code has been read. Old bar code readers used serial ports, but newer ones use either USB or PS/2 connections.
- Tablets feature touch screens, as do information kiosks, smartphones, and point of sale systems. Touch screens can be operated with either a finger or a stylus. Some devices, such as smartphones, have built-in touch screens, while a point of sale system may use a standalone touch screen monitor. Use the Pen and Input Device applet in Windows Vista or the Tablet PC Settings applet in Windows Vista or 7 to configure the touch screens on Tablet PCs.
- KVM switches are hardware devices with which multiple systems can be monitored and controlled by a single mouse, keyboard, and monitor. KVMs are most commonly used in data centers, enabling administrators to control multiple rack-mounted servers from a single keyboard, mouse, and monitor station.
- When keyboard and mouse aren't sufficient, gamepads and joysticks enable you to control your PC games. Most game controllers connect via USB. You can use the Game Controllers applet in Windows XP/Vista or Devices and Printers in Windows 7 to configure your devices.

- Digitizers enable you to write, draw, or paint onto your PC. Using a stylus and special surface, the digitizer translates your analog movements into digital information understood by graphic arts applications. Popular digitizers like the Wacom series of pen tablets include configuration screens that enable you to set properties like pressure sensitivity and custom hot keys.

Describe how certain multimedia input devices work on a PC

- Most digital cameras and camcorders store images on removable media, such as SD cards. Photos and videos can be transferred to a PC by connecting the camera directly to a USB or FireWire port. Alternatively, if the PC is equipped with a media card reader, the flash memory card can be removed from the camera and inserted directly to the PC's card reader.
- A 5-megapixel camera will produce 4 × 6 pictures with print photograph quality, while a 10-megapixel camera will produce 8 × 10 pictures with print photograph quality. The more sensors a camera has, the better the image quality, so you'll find that physically larger cameras take better pictures than the tiny ones. Look for a camera with at least 3× optical zoom and ignore the digital zoom that is advertised.
- Webcams are often used for Internet video communication. A 1.3-megapixel webcam delivers a decent resolution video without bogging down a broadband connection. Look for a webcam that has a frame rate of about 30 frames per second. Some webcams come with built-in microphones, but if you want high-quality audio without feedback or echo, invest in a microphone headset. After installing the driver and connecting a webcam, be sure to configure it properly so your Internet chat software knows to use the webcam.

Key Terms

ball mouse *(744)*
bar code reader *(749)*
biometric device *(748)*
color depth *(747)*
digital camera *(753)*
digital zoom *(755)*
digitizer *(752)*
FireWire *(738)*
flatbed scanner *(745)*
Full-Speed USB *(734)*
grayscale depth *(747)*
Hi-Speed USB *(734)*
IEEE 1394a *(739)*
IEEE 1394b *(739)*
keyboard, video, mouse switch (KVM) *(750)*
Low-Speed USB *(734)*
megapixels *(754)*
optical mouse *(744)*
optical resolution *(747)*
optical zoom *(755)*
RS-232 *(731)*
serial port *(731)*
SuperSpeed USB *(734)*
touch screen *(749)*
TWAIN *(746)*
universal asynchronous receiver/transmitter (UART) *(731)*
Universal Product Code (UPC) *(749)*
USB host controller *(732)*
USB hub *(736)*
USB root hub *(732)*
webcam *(756)*

Key Term Quiz

Use the Key Terms list to complete the sentences that follow. Not all terms will be used.

1. Serial ports are defined by the _____ standard.
2. A(n) _____ is useful when scanning a page from a book; a(n) _____ is useful when scanning the price of retail items at a store.

3. A(n) _____ device transfers data at up to 12 Mbps on the universal serial bus.
4. A(n) _____ FireWire device transfers data at up to 800 Mbps.
5. A(n) _____ captures digital images on removable media; a(n) _____ transmits digital images across the Internet for video communication.
6. The amount of information a digital camera can capture is measured in _____.
7. A scanner's ability to produce color, hue, and shade is defined by its _____.
8. The _____ contains the logic to convert data moving between parallel and serial devices.
9. When comparing digital cameras and their zoom capabilities, pay attention to the _____ and ignore the _____.
10. For moving the mouse pointer, most people prefer a(n) _____ over a(n) _____ because the former is much easier to keep clean.

Multiple-Choice Quiz

1. How many devices can a single USB host controller support?
   - **A.** 2
   - **B.** 4
   - **C.** 63
   - **D.** 127
2. What is the maximum USB cable length as defined by the USB 2.0 specification?
   - **A.** 4.5 feet
   - **B.** 4.5 meters
   - **C.** 5 feet
   - **D.** 5 meters
3. Malfunctioning USB devices may be caused by which of the following?
   - **A.** Too many USB devices attached to the host controller
   - **B.** Improper IRQ settings for the device
   - **C.** Device plugged in upside-down
   - **D.** USB 1.1 device plugged into USB 2.0 port
4. What do digitizers enable people to do on a PC?
   - **A.** Capture video
   - **B.** Draw, paint, and write
   - **C.** Secure using fingerprints
   - **D.** Switch between multiple computers using the same keyboard, mouse, and monitor
5. Which FireWire standard is properly matched with its speed?
   - **A.** IEEE 1394a, 400 Mbps
   - **B.** IEEE 1394 a, 480 Mbps
   - **C.** IEEE 1394b, 400 Mbps
   - **D.** IEEE 1394b, 480 Mbps
6. FireWire supports a maximum of how many devices?
   - **A.** 2
   - **B.** 4
   - **C.** 63
   - **D.** 127
7. What icon does Windows XP's Device Manager display over disabled devices?
   - **A.** Yellow triangle
   - **B.** Red X
   - **C.** Blue I
   - **D.** Green D
8. A user reports that his mouse is jittery. What is the most likely cause?
   - **A.** His optical mouse has the wrong driver installed.
   - **B.** His wireless mouse has a dead battery.
   - **C.** His ball mouse has acquired dirt in the rollers.
   - **D.** He had one too many cups of coffee that morning.

9. Which specifications describe a high-quality webcam that won't bog down an Internet connection?
   - **A.** 5 megapixels at 15 frames per second
   - **B.** 1.3 megapixels at 15 frames per second
   - **C.** 5 megapixels at 40 frames per second
   - **D.** 1.3 megapixels at 30 frames per second
10. Which device is a biometric device?
   - **A.** Bar code reader
   - **B.** Optical mouse
   - **C.** Retinal scanner
   - **D.** Flatbed scanner
11. The number that defines how many shades of gray per dot a scanner can save is referred to as what?
   - **A.** Resolution
   - **B.** DPI
   - **C.** Color depth
   - **D.** Grayscale depth
12. A color depth of 16-bits can store how many color variations per dot?
   - **A.** 16
   - **B.** 32
   - **C.** 512
   - **D.** 65,536
13. Which of the following lists the technologies in order from slowest to fastest?
   - **A.** SuperSpeed USB, Full-Speed USB, Hi-Speed USB, IEEE 1394a, IEEE 1394b
   - **B.** Full-Speed USB, IEEE 1394a, Hi-Speed USB, IEEE 1394b, SuperSpeed USB
   - **C.** Full-Speed USB, SuperSpeed USB, Hi-Speed USB, IEEE 1394a, IEEE 1394b
   - **D.** Low-Speed USB, SuperSpeed USB, IEEE 1394a, Hi-Speed USB, IEEE 1394b
14. In Windows 7, which Control Panel applet enables you to configure a game controller, such as a joystick or gamepad?
   - **A.** Devices and Printers
   - **B.** Joysticks and Gamepads
   - **C.** Input Devices
   - **D.** Game controllers are only configured within a PC game.
15. While testing a newly installed KVM switch, you can't display the second connected system while tapping the SCROLL LOCK key. What is most likely the problem?
   - **A.** Incorrect KVM UPC code
   - **B.** Crossed video cable
   - **C.** Locked SCROLL LOCK key
   - **D.** Active KVM

Essay Quiz

1. A friend at the local film school needs a new keyboard and external hard drive. What advice can you give her about the connection style for each of these devices?
2. Dylan is excited because he just got a new USB digital camera. He tried to install it on his laptop, but the computer doesn't recognize it. He's called you for help. What will you tell him?
3. Ken asks for your help because he is always forgetting his Windows password. What can you recommend to make logons easier for him?
4. Sandra's always trying new video games. She usually plays role-playing games like *World of Warcraft*, but a friend bought her a new flight simulator. She wants to get the most out of the experience. What device should she get to enhance her experience? How should she set it up?
5. The new head of sales is frustrated because when she tries to use her keyboard, letters continue to print across the screen even if she quickly taps a key, resulting in messages that llllooooooookkkk lllliiiikkkkeeee ttttthhhhiiiissss. How can you walk her through fixing this problem over the phone?

Lab Projects

• Lab Project 20.1

Many personal computers do not normally include FireWire ports. Check the following three Web sites: www.dell.com, www.hp.com, and www.apple.com. Is a FireWire port standard built-in equipment on their new computers? If so, how many FireWire ports are included? If not, do the sites offer FireWire as an optional add-on?

• Lab Project 20.2

Explore the Keyboard and Mouse Control Panel applets. Change the settings and try to use the devices. Which settings caused the most frustration? Were there any changes you made that you preferred over the original settings?

• Lab Project 20.3

Grab a lab partner, a pen and pad of paper, and a stop watch. How many input devices can you two name in 30 seconds? Reset the timer. How many output devices can you two name in 30 seconds? Are any devices considered both input and output?