

Chapter 9

Understanding Laptops

THE FOLLOWING COMPTIA A+ EXAM 220-801 OBJECTIVES ARE COVERED IN THIS CHAPTER:

- ✓ **3.1 Install and configure laptop hardware and components.**
 - Expansion options: Express card/34, Express card/54, PCMCIA, SODIMM, Flash
 - Hardware/device replacement: Keyboard, Hard Drive (2.5 vs. 3.5), Memory, Optical drive, Wireless card, Mini-PCIe, Screen, DC jack, Battery, Touchpad, Plastics, Speaker, System board, CPU
- ✓ **3.2 Compare and contrast the components within the display of a laptop.**
 - Types: LCD, LED, OLED, Plasma
 - Wi-Fi antenna connector/placement
 - Inverter and its function
 - Backlight
- ✓ **3.3 Compare and contrast laptop features.**
 - Special function keys: Dual displays, Wireless (on/off), Volume settings, Screen brightness, Bluetooth (on/off), Keyboard backlight
 - Docking station vs. port replicator
 - Physical laptop lock and cable lock



As recently as the early 1990s, portable computers were luxuries that were affordable to only the wealthy or the select few businesspeople who traveled extensively. As with all other technologies, though, portable systems have gotten smaller, lighter (more portable), more powerful, and less expensive. Because the technology and price disparity between the two platforms has decreased significantly, laptops have outsold desktops since the mid-2000s.

Every indication is that the movement toward mobile computing will continue, so you definitely need to be well versed in portable technologies, which contain both nifty features and frustrating quirks. For this discussion, assume that a *portable computer* is any computer that contains all the functionality of a desktop computer system but is portable. Most people define *portable* in terms of weight and size. So that we can discuss things on the same level, let's define *portable* as less than 10 pounds and smaller than an average desktop computer.



Of course, laptops are not the only types of portable computers in the market today. There are netbooks, tablets, and a variety of handheld smartphones that can lay claim to being called computers too. For the purpose of this chapter, we'll specifically look at laptops, but many of the principles will be applicable to other other, smaller portable computers as well. For specific material on smaller mobile devices, see Chapter 18, "Mobile Devices."

The original portable computers were hardly portable, hence the unofficial term *luggable*. They were the size of a small suitcase and could weigh 50 pounds. Not only were they greatly inferior to desktops in technology, they were also outrageously expensive. It's no wonder few people purchased them. Compaq, Kaypro, and Osborne made some of the first luggable computers.

Laptops were the next type of portable computer. They contain a built-in keyboard, pointing device, and LCD screen in a clamshell design. They are also called *notebook* computers because they resemble large notebooks. Most portable computers in use today are laptop computers.

In this chapter, you will learn about laptop computer architecture and how it differs from desktop computer architecture, including specific laptop hardware technologies. We'll then talk about management features unique to laptops and how to replace laptop components.

Understanding Laptop Architecture

Laptops are similar to desktop computers in architecture in that they contain many parts that perform similar functions. However, the parts that make up a laptop are completely different from those in desktop computers. The obvious major difference is size; laptops are space challenged. Another primary concern is heat. Restricted space means less airflow, meaning parts can heat up and overheat faster.

To overcome space limitations, laptop parts are physically much smaller and lighter, and they must fit into the compact space of a laptop's case. It might not sound like much, but there really is a major difference between a 4.5-pound laptop and a 5.5-pound laptop if you're hauling it around in its carrying case all day. Also, laptop parts are designed to consume less power and to shut themselves off when not being used, although many desktops also have components that go into a low-power state when not active, such as video circuitry. Finally, most laptop components are proprietary—the motherboard is especially proprietary, and the LCD screen from one laptop will not necessarily fit on another.

A more recent development in the laptop arena has been the netbook computer. A *netbook* is an extremely small laptop computer that is lighter in weight and more scaled down in features than a standard laptop. Users are attracted to netbooks because of their enhanced portability and affordability. The features that remain are ideal for Internet access and emailing. However, many users would find netbooks insufficient for mainstream usage.

In the following sections, you will learn about the various components that make up laptops and how they differ from desktop computer components. If you don't remember exactly what each component does, it may help you to refer back to earlier hardware chapters occasionally as you read this chapter.

Laptops vs. Desktops

If you've ever shopped for a laptop, you have no doubt noticed that the prices of desktop PCs are often quite a bit lower than those for notebook computers, yet the desktops are faster and more powerful. If you've ever wondered what makes a laptop so much different than a PC, here are the primary differences between laptops and desktops:

Portability This is probably the most obvious difference. Laptops are designed to be portable. They run on batteries, so you aren't tied to one spot at home or at the office. Networking options are available that allow you to connect to a network wirelessly and do work from just about anywhere, including malls, airports, coffee shops, and so on. As anyone who's tried to bring their full-tower PC to a LAN party can tell you, desktops just aren't that portable.

Cost Laptops tend to cost more than desktop computers with similar features. The primary reason is that portability requires small components and unique proprietary designs so that those components fit into the small size necessary. Miniature versions of components cost more money than standard-sized (desktop) versions. The cost discrepancy between desktops and laptops has shrunk considerably in the last few years, but it still exists.

Performance By and large, laptops are always going to lose out somewhere in the performance department. Compromises must often be made between performance and portability, and considering that portability is the major feature of a laptop, performance is what usually suffers. While it is possible to have a laptop with comparable performance to a desktop, the amount of money one would have to spend for a “desktop replacement” laptop is considerable. This is not to say that a laptop can’t outperform a desktop, it’s just that the “bang for the buck” factor is higher in a desktop.

Expandability Because desktop computers were designed to be modular, their capabilities can be upgraded quite easily. It is next to impossible to upgrade the processor or motherboard on most laptops. Other than memory and hard drives, most laptop upgrades consist of adding an external device through one of the laptop’s ports, such as a USB port.

Quality of construction Considering how much abuse laptops get, it is much more important that the materials used to construct the laptop case and other components be extremely durable. Durability is important in a desktop too, but it won’t be tested as much as in a laptop.

Building Your Own

This anecdote comes from one of the authors: “During an A+ course, I gave the class the assignment to go out on the Web and put together the most powerful and complete computer they could for under a thousand dollars. The class was for non-degree-seeking adults, so nothing was graded; it was simply to provide experience with specing out and pricing the parts that go into making a complete system.

“One of the students had her eye on a new laptop for personal use. Because she noticed the trend toward being able to build a desktop computer for less than she could buy one, the student assumed the same about laptops. Unfortunately, I had not specifically mentioned the fact that there are no standards for building complete laptop clones, unlike with desktops.

“You can’t reliably build your own laptop. Because laptop components are designed to exacting specifications to fit properly inside one manufacturer’s notebook, there generally are no universal motherboards, video boards, and so on for laptops. Memory and hard drives are the exception. You can get different brands of memory and hard drives for laptops, but you can’t buy a motherboard from one company and the video circuitry from another. Even things as common as optical drives are usually designed to work only with a specific brand or model.”

Now that we’ve illustrated the primary differences between laptops and desktops, let’s examine the parts of the laptop and what they do.

Laptop Case

A typical laptop case is made up of three main parts:

- The display—usually an LCD or LED display
- The case frame, which is the metal reinforcing structure inside the laptop that provides rigidity and strength and that most components mount to
- The case, or the plastic cover that surrounds the components and provides protection from the elements

The cases are typically made of some type of plastic (usually ABS plastic or ABS composite) to provide for light weight as well as strength.



A few notebooks have cases made of a strong, lightweight metal, such as aluminum or titanium. However, the majority of laptop cases are made of plastic.

Laptop cases are made in what is known as a clamshell design. In a clamshell design, the laptop has two halves, hinged together at the back. Usually, the display is the top half and everything else is in the bottom half.

Occasionally, part of the laptop's case will crack and need to be replaced. However, you usually can't just replace the cracked section. Most often, you must remove every component from inside the laptop's case and swap the components over to the new case. This is a labor-intensive process because the screws in laptops are often very small and hard to reach. Often, repairing a cracked case may cost several hundred dollars in labor alone. Most times, people who have cracked laptop cases wait until something else needs to be repaired before having the case fixed. Or, they just wait until it's time to upgrade to a new system. The decision on when to repair or replace the laptop boils down to a few factors. The primary one is if the user can live with the damage. While they can be annoying, most case problems don't inhibit the operation of the machine. The secondary factor is money. The user (or company) needs to decide if it's really worth spending the money needed to fix the issue immediately.

Motherboards and Processors

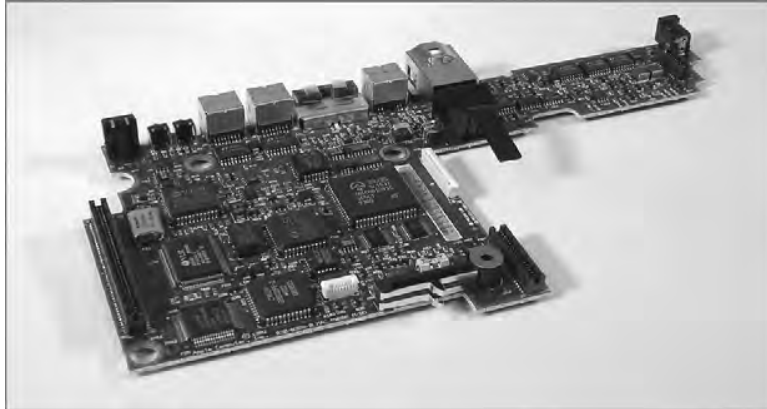
As with desktop computers, the motherboard of a laptop is the backbone structure to which all internal components connect. However, with a laptop, almost all components must be integrated onto the motherboard, including onboard circuitry for the serial, parallel, USB, IEEE 1394, video, expansion, and network ports of the laptop. With desktop systems, the option remains to not integrate such components. Because of the similarities between laptop and desktop components, some material in the next few sections will be familiar to you if you have read Chapter 1, "Motherboards, Processors, and Memory."

Laptop Motherboards

The primary differences between a laptop motherboard and a desktop motherboard are the lack of standards and the much smaller form factor. As mentioned earlier, most

motherboards are designed along with the laptop case so that all the components will fit inside. Therefore, the motherboard is nearly always proprietary, and that's what we mean by "lack of standards." They all use the technologies you're used to such as USB and 802.11, but it's very unlikely you're going to be able to swap a motherboard from one laptop into another, even if both laptops are from the same manufacturer. Figure 9.1 shows an example of a laptop motherboard.

FIGURES 9.1 A laptop motherboard



To save space, components of the video circuitry (and possibly other circuits as well) are placed on a thin circuit board that connects directly to the motherboard. This circuit board is often known as a riser card or a *daughterboard*.

Having components performing different functions (such as video, audio, and networking) integrated on the same board is a mixed bag. On one hand, it saves a lot of space. On the other hand, if one part goes bad, you have to replace the entire board, which is more expensive than just replacing one expansion card.

Laptop Processors

Just as with desktop computers, the processor is the brain of the laptop computer. And just like everything else, compared to desktop hardware devices, laptop hardware devices are smaller and not quite as powerful. The spread between the speed of a laptop CPU and that of a desktop motherboard can be a gigahertz or more.

Laptops have less space, and thus, heat is a major concern. Add to that the fact that processors are the hottest-running component and you can see where cooling can be an issue. To help combat this heat problem, laptop processors are engineered with the following features:

Streamlined connection to the motherboard Nearly all desktop processors mount using pin connectors, whether on the CPU or on the motherboard (as is the case with LGA sockets). Pins and sockets are big and bulky, meaning they're not a laptop's friends. Laptop processors are generally either soldered directly to the motherboard or attached using the Micro-FCBGA (Flip Chip Ball Grid Array) standard, which uses balls instead of pins. In most cases, this means that the processor cannot be removed, meaning no processor upgrades are possible.

Lower voltages and clock speeds Two ways to combat heat are to slow the processor down (run it at a lower speed) or give it less juice (run it at a lower voltage). Again, performance will suffer compared to a desktop processor, but lowering heat is the goal here.

Active sleep and slowdown modes Most laptops will run the processor in a lower power state when on battery power, in an effort to extend the life of the battery. This is known as processor throttling. The motherboard works closely with the operating system to determine if the processor really needs to run at full speed. If it doesn't, it's slowed down to save energy and to reduce heat. When more processing power is needed, the CPU is throttled back up.

One of the best features of many laptop processors is that they include built-in wireless networking. One of the earliest laptop-specific chipsets that gained a ton of popularity was the Pentium M chip made by Intel. The Pentium M consists of three separate components:

- The Mobile Intel Express chipset (such as the Mobile Intel 915GM Express or the Mobile Intel 910GML), which is the graphics memory controller hub
- The Intel/PRO Wireless Network Connection, providing an integrated wireless LAN connection
- The Intel Centrino chipset, which is the “brain” of the chipset, designed to run on lower power than the desktop processor



Depending on the manufacturer, motherboard, and processor used, the features described as part of the Pentium M will be built into the motherboard rather than the processor itself. Regardless of where it's built in to, it's a great set of features to have for mobile computers!

Some portable computers will simply use stripped-down versions of desktop processors such as an Intel Pentium or Core series processor. While there's nothing wrong with this, it makes sense that components specifically designed for notebooks fit the application better than components that have been retrofitted for notebook use. Consider an analogy to the automobile industry: It's better to design a convertible from the ground up than to simply cut the top off an existing coupe or sedan.

Memory

Notebooks don't use standard desktop computer memory chips, because they're too big. In fact, for most of the history of laptops, there were no standard types of memory chips. If you wanted to add memory to your laptop, you had to order it from the laptop manufacturer. Of course, because you could get memory from only one supplier, you got the privilege of paying a premium over and above a similar-sized desktop memory chip.



However, there are now two common types of laptop memory package: SODIMM and MicroDIMM. Nevertheless, modern laptop manufacturers may still opt to go the proprietary route due to design considerations that favor a custom solution. To see what kind of memory your laptop uses, check either the manual or the manufacturer's website. You can also check third-party memory producers' websites (such as www.crucial.com).

SODIMM

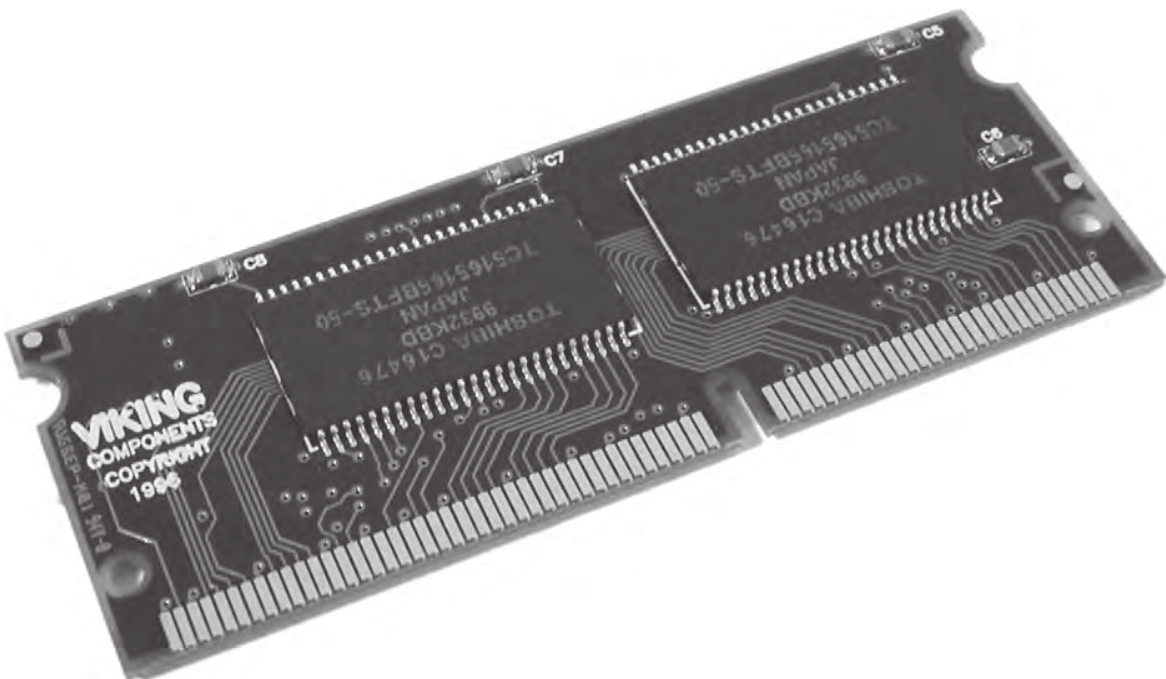
The most common memory form factor for laptops is called a Small Outline DIMM (SODIMM). They're much smaller than standard DIMMs, measuring about 67 millimeters (2.6") long and 32 millimeters (1.25") tall. SODIMMs are available in a variety of configurations, including 32-bit (72-pin) and 64-bit (144-pin SDRAM, 200-pin DDR, 200-pin DDR2, and 204-pin DDR3) options. Figure 9.2 shows an example of the classic 144-pin variety.



You'll also see SODIMM spelled as SO-DIMM as well.

Just as with desktop computers, make sure the SODIMM you want to put into the laptop is compatible with the motherboard. The same standards that apply to desktop memory compatibility apply to laptops. This means you can find DDR, DDR2, and DDR3 SODIMMs for laptops. DDR has all but topped out at 1GB per module, while DDR2 and DDR3 SODIMM modules can be purchased in sizes up to 8GB (at the time this book was being written), which lags desktop DIMM capacity by a bit.

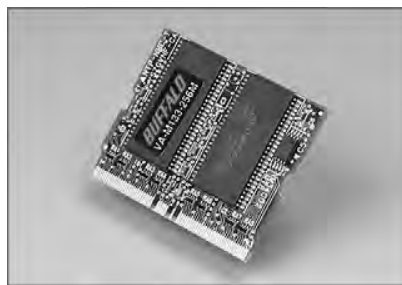
FIGURE 9.2 144-pin SODIMM



MicroDIMM

Although no longer new, the MicroDIMM is the most recent form factor for laptop memory modules. The MicroDIMM is an extremely small RAM form factor. In fact, it is over 50 percent smaller than a SODIMM—only about 45.5mm (about 1.75") long and 30mm (about 1.2", a bit bigger than a US quarter) wide. Another major difference is that the MicroDIMM does not have any notches on the bottom. Figure 9.3 shows a 172-pin MicroDIMM. It was designed for the ultralight and portable subnotebook style of computer. Popular MicroDIMM form factors include 64-bit modules with 172 or 214 pins for DDR2.

FIGURE 9.3 144-pin MicroDIMM

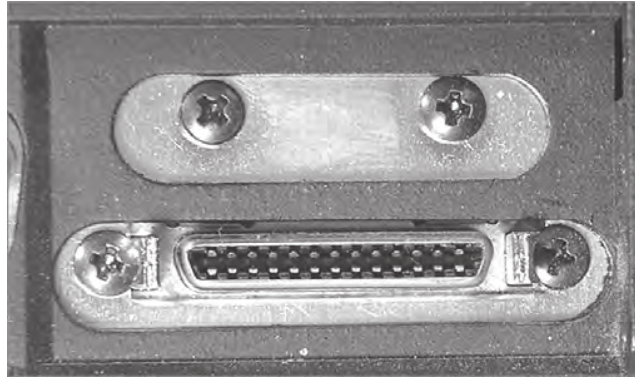


Storage

Nearly all laptops have a hard drive, but not all laptops have both a floppy drive and an optical drive. Many times there just isn't room for both, and considering floppy drives are practically obsolete, why have one anyway? Often there is a multipurpose bay that can be used to hold either drive or an extra battery. If this drive bay exists, users generally keep the optical drive installed most of the time and leave out the floppy drive. In some cases, the floppy drive is an external device that you connect with a special cable to a proprietary connector. Figure 9.4 shows an example of one of these connectors, and Figure 9.5 shows an example of a laptop floppy drive with a proprietary connector. Notice how thin the floppy drive is and how compact the electronics are. When used at all, floppy drives that attach to the laptop through a USB port are more common today.

Laptops don't have the room for the full-sized 3½" hard drives that desktop computers use. Instead, they use a hard drive with a 2½" form factor that is less than ½" thick. These drives share the same controller technologies as desktop computers; however, they use smaller connectors. Figure 9.6 shows an example of a standard hard drive compared to a laptop hard drive.

Optical drives on laptops are necessarily smaller than their desktop counterparts as well. Figure 9.7 shows an example of a desktop CD-ROM drive compared to a laptop CD-ROM drive. Note that the laptop drive is very small, but it has all the functionality of a desktop unit. The drive mechanism and circuits have all been miniaturized to save space. As a result, the functionality is basically the same, but the cost is usually higher. Any time a component's functionality remains the same while its size decreases, you will notice an increase in price over the standard-sized item.

FIGURE 9.4 A proprietary floppy connector**FIGURE 9.5** A laptop floppy drive**FIGURE 9.6** A desktop hard drive compared to a laptop hard drive

CD, DVD, and Blu-ray burners are great to have on laptops as backup devices. Simply copy the contents of the hard drive (or just important files) to the optical discs and store them in a safe location.

FIGURE 9.7 A desktop DVD drive compared to a laptop DVD drive



Input Devices

Because of the small size of laptops, getting data into them presents unique challenges to designers. They must design a keyboard that fits within the case of the laptop. They must also design some sort of pointing device that users can use in graphical interfaces like Windows. The primary challenge in both cases is to design these peripherals so they fit within the design constraints of the laptop (low power and small form factor) while remaining usable.

Keyboards

A standard-sized desktop keyboard wasn't designed to be portable. It wouldn't fit well with the portable nature of a laptop. That usually means laptop keys are not normal size; they must be smaller and packed together more tightly. People who learned to type on a typewriter or regular computer often have a difficult time adjusting to a laptop keyboard.

Laptop keyboards are built into the lower portion of the clamshell. Sometimes, they can be removed easily to access peripherals below them like memory and hard drives, as in the Lenovo ThinkPad series.

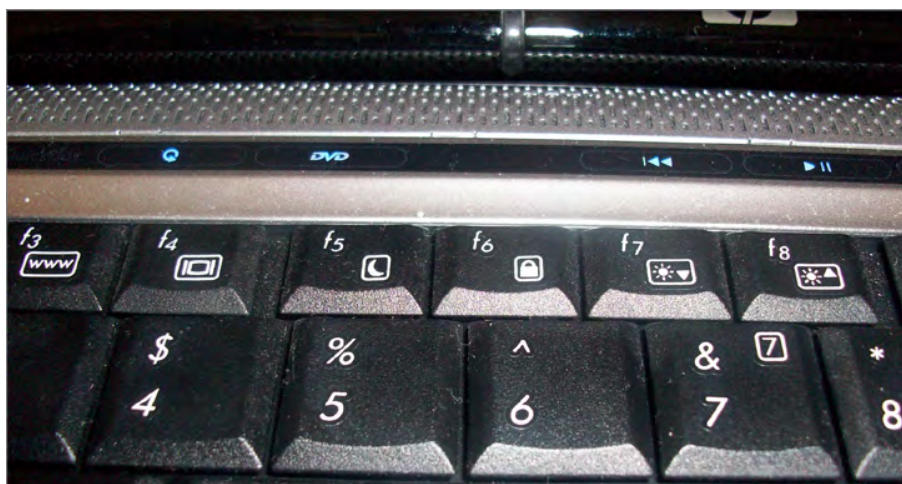
Special Function Keys

Because of the much smaller space available for keys, some laptop keys (like the number pad, Home, Insert, PgUp, and PgDn keys) are consolidated into special multifunction keys. These keys are accessed through the standard keys by using a special *function (Fn) key*. It's typically near the Windows key on the keyboard and labeled in lettering of an alternate color (usually blue) that matches the lettering of the labels for alternate functions on other keys. To use a multifunction key, you press and hold the Fn key (as you would the Shift, Ctrl, and Alt keys) and then tap the key labeled with the function you want, finally releasing the Fn key. Figure 9.8 shows an example of a function key.

The function key combinations can control many laptop functions, but the most common are video, audio, and networking settings. The specific keys used will vary by laptop model, but there are usually icons on the keys that perform the functions to help you out.

FIGURE 9.8 Function (Fn) key

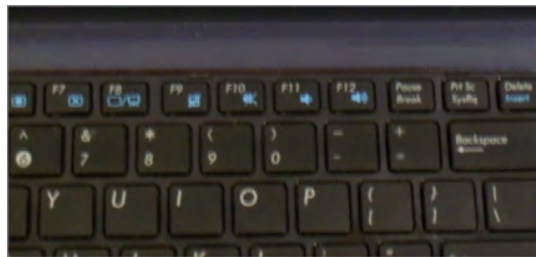
Video adjustments come in two varieties: changing the video output and dimming or brightening the screen. Dimming and brightening the screen is pretty straightforward, but the video output function can throw people off. Remember that nearly every laptop has a video connector on the back to plug in an external monitor or a projector. You will need to use the video toggle key to get this external port to work. Usually there are three states: laptop only, external output only, and both displays. Figure 9.9 shows examples of the keys that handle video functions.

FIGURE 9.9 Video adjustment keys F4 (LCD toggle), F7 (dim), and F8 (brighten)

Note that the LCD toggle (the F4 key in Figure 9.9) has the same symbol on it as the external video connector. The dimming key has a sun with an arrow pointing down, and the brightening key has a sun with an arrow pointing up. (Some manufacturers will use a small sun on the dimming key and a large sun on the brightening key.)

The audio setting can often be adjusted using the function keys too. To lower the volume, look for an icon with a speaker with only one “wave” coming out of it. The volume is increased with the speaker with several waves, and the mute button will have a speaker with an X. Figure 9.10 shows an example.

FIGURE 9.10 Audio adjustment keys F10 (mute), F11 (quieter), and F12 (louder)



Finally, there are the network settings. There aren't really a lot of choices here; it's a matter of turning the network adapter on or off. The symbol for WiFi usually looks like a small antenna. If you're using Bluetooth, the symbol will be Bluetooth's trademarked *B*. Sometimes disabling these options is handled by the F_n keys, and other times they are handled by separate switches near the keyboard. For example, Figure 9.11 shows a WiFi switch on the front of a laptop, and Figure 9.12 shows a WiFi toggle above the keyboard. The switch in Figure 9.12 looks like an indicator light only, but the strip is touch-sensitive.

FIGURE 9.11 Network card toggle switch on the front of the computer

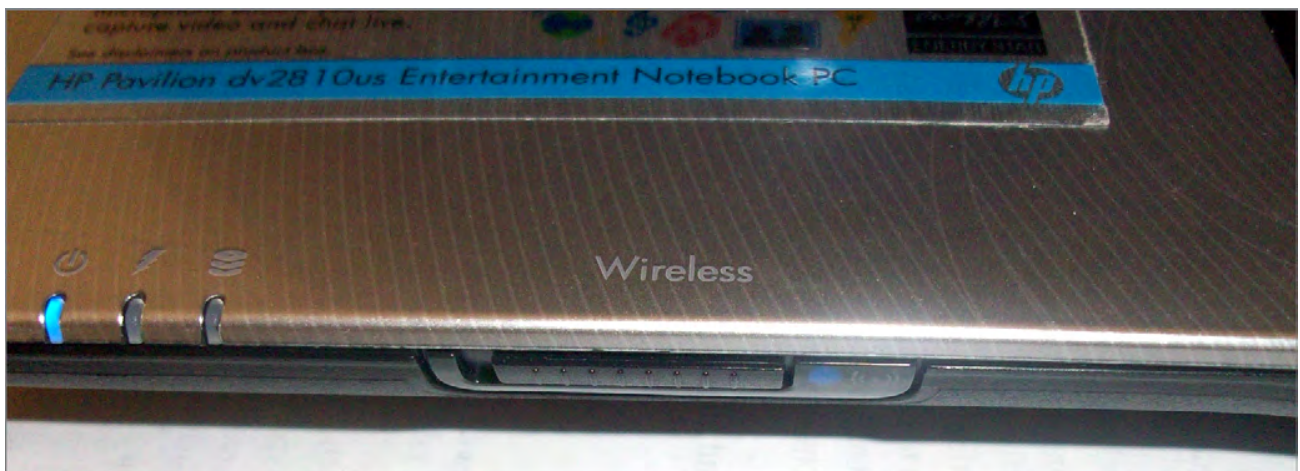


FIGURE 9.12 Network card toggle switch above the keyboard

The point is, look around if you don't see the right function key on the keyboard itself. It's bound to be there somewhere.



Some laptops include a backlight for the keyboard as well. These can also be dimmed or brightened, or turned off and on, with the use of a function key. For example, on the Toshiba P205, the right combination is Fn+Z. Keep in mind that on laptop models with an ambient light sensor, such as the MacBook Pro, the backlight settings will be controlled automatically by the operating system; you won't be able to turn it off unless it's already on.

Mice and Pointing Devices

In addition to using the keyboard, you must have a method of controlling the onscreen pointer in the Windows interface. There are many methods of doing this, but there are some that are more common:

- Trackball
- Touchpad
- Point stick
- Touchscreen



Because of different pointing-device preferences, some laptops use multiple pointing devices to appeal to a wider variety of people.

Most laptops today include a mouse/keyboard port, a USB port, or both. Either of these ports can be used to add an input device like a mouse or a standard-sized keyboard.

Trackball

Many early laptops used trackballs as pointing devices. A *trackball* is essentially the same as a mouse turned upside down. The onscreen pointer moves in the same direction and at the same speed you move the trackball with your thumb or fingers.

Trackballs are cheap to produce. However, the primary problem with trackballs is that they do not last as long as other types of pointing devices; a trackball picks up dirt and oil from operators' fingers, and those substances clog the rollers on the trackball and prevent it from functioning properly.

Touchpad

To overcome the problems of trackballs, a newer technology that has become known as the Touchpad was developed. *Touchpad* is actually the trade name of a product. However, the trade name is now used to describe an entire genre of products that are similar in function.

A Touchpad is a device that has a pad of touch-sensitive material. The user draws with their finger on the Touchpad, and the onscreen pointer follows the finger motions. Included with the Touchpad are two buttons for left- or right-clicking (although with some Touchpads, you can perform the functions of the left-click by tapping on the Touchpad). Figure 9.13 shows a Touchpad.

FIGURE 9.13 Laptop Touchpad



Point Stick

With the introduction of the ThinkPad series of laptops, IBM introduced a new feature known as the Touchpoint, generically known as a *point stick*. The point stick is a pointing device that uses a small rubber-tipped stick. When you push the point stick in a particular direction, the onscreen pointer goes in the same direction. The harder you push, the faster the onscreen pointer moves. The point allows fingertip control of the onscreen pointer, without the reliability problems associated with trackballs.

Point sticks have their own problems, however. Often, the stick does not return to center properly, causing the pointer to drift when not in use. You might also notice the rubber cover for the stick becoming a bit gummy with extended use. Most manufacturers supply replacement covers of varying textures with new systems. Some later systems employ a concave version of the cover and updated workings that tend to minimize a lot of these concerns.

Touchscreen

The last type of pointing device we'll discuss can be found in use at many department stores: the informational *kiosks* with screens that respond to your touch and give you information about product specials or bridal registries. Instead of a keyboard and mouse, these computer screens have a film over them that is sensitive to touch. This technology is known as a *Touchscreen* (see Figure 9.14). With most of the interfaces in use on Touchscreens, touching a box drawn on the monitor does the same thing as double-clicking that box with a mouse. These screens are most commonly found on monitors; however, with the advent of the *tablet PC* (a laptop designed to be held like a pad of paper), the Touchscreen is becoming more popular as an input device for a laptop.

Cleaning a Touchscreen is usually just as easy as cleaning a regular monitor. With optical Touchscreens, the monitor *is* a regular monitor, so it can be cleaned with glass cleaner. However, if the screen has a capacitive coating, glass cleaner may damage it. Instead, use a cloth dampened with water to clean the dirt, dust, and fingerprints from the screen.

FIGURE 9.14 A typical Touchscreen



Expansion Buses and Ports

Although laptop computers are less expandable than their desktop counterparts, they can be expanded to some extent. Laptops have expansion ports similar to those found on desktop computers as well as a couple that are found only on laptops.

PCMCIA (PC Card) Expansion Bus

The tongue-twister *PCMCIA* stands for Personal Computer Memory Card International Association. The PCMCIA was organized to provide a standard way of expanding portable computers. The PCMCIA bus was originally designed to provide a way of expanding the memory in a small, handheld computer, referred to generically as a PCMCIA host. The PCMCIA bus has been renamed *PC Card* to make it easier to pronounce. PC Card uses a small expansion card (about the size of a credit card). The interface is a thin, 68-pin connector that has remained relatively unchanged from the original specification. Although this form factor is primarily used in portable computers, PC Card adapters (converters) are available for desktop PCs. The PC Card bus now serves as a universal expansion bus that can accommodate nearly any device.

In addition to the card, the PC Card architecture includes two other components:

- Socket Services software is a BIOS-level interface to the PCMCIA bus slot. When loaded, it hides the details of the PC Card hardware from the computer. This software can detect when a card has been inserted and what type of card it is.
- Card Services software is the interface between the application and Socket Services. It tells the applications which interrupts and I/O ports the card is using. Applications that need to access the PC Card don't access the hardware directly; instead, they tell Card Services that they need access to a particular feature, and Card Services gets the appropriate feature from the PC Card.

This dual-component architecture allows the PCMCIA architecture to be used in different types of computer systems (that is, not just x86/x64-based PCs). For example, Apple laptop computers based on Motorola processors could use PC Cards for modems and for LAN interface cards.

The first release of the PCMCIA standard (PCMCIA 1.0, circa 1990) defined a 16-bit ISA-like bus to be used for memory expansion only. PCMCIA 1.0 supported 5V memory cards. The second major release (PCMCIA 2.x) introduced 3.3V cards and host slots. PCMCIA 2.x was designed to be backward compatible with version 1, so 5V memory cards can be used in version 2 host slots. Cards that are only capable of 3.3V operation are keyed to prevent damage from insertion into older 5V-only host slots. PCMCIA version 2.01 was released in 1992 to specify the use of Card and Socket Services as a standard driver platform.

PCMCIA 5.0 (aka CardBus) increased the bus width to 32 bits and the bus speed from 8MHz to a maximum of 33MHz. In addition, the new CardBus PC Card adapters used PCI-like access methods, and the throughput speeds increased dramatically, up to a maximum of 133MBps (1.06Gbps). These cards are differentiated from the 16-bit cards by a metal grounding strip, often gold in color, along the insertion edge of the card. You can insert 16-bit PC Cards in a CardBus slot, but the converse is not also true.



PCMCIA standards jumped from PCMCIA 2.1 to PC Card 5.0 as PCMCIA and JEIDA standards were merged. At the same time, the name *CardBus* was introduced to differentiate the new 32-bit cards from their 16-bit ancestors.

The bus width of these cards and slots is either 16 or 32 bits, as previously discussed. Also, the original PCMCIA specification supported only one interrupt request, or IRQ (a problem if you needed to install two devices that both need interrupts in the same PC Card bus). Card and Socket Services took care of this deficiency. PC Cards also support bus mastering and Direct Memory Access (DMA), but only as of PC Card 5.0. DMA support was eventually removed in version 7.2. PC Card 8.0, released in 2001, specifies a newer CardBay standard designed to integrate USB functionality into the PC Card format. The benefit would be for devices that have PC Card slots but no USB ports. The reverse is more common, however.

Three major types of PC Cards (and slots) have been specified. Each has different uses and physical characteristics, although each one measures 54mm in width and 85.6mm in length. They are called Type I, Type II, and Type III:

- Type I cards are 3.3mm thick and are most commonly used for memory cards.
- Type II cards are 5mm thick and are mostly used for modems and LAN adapters but for sound cards, SCSI controllers, and other devices as well. This is the most common PC Card type found today, and most systems have at least two Type II slots (or one Type III slot).
- The Type III slot is 10.5mm thick. Its most common application is PC Card hard disks. These slots are all but extinct.

ExpressCard

ExpressCard was launched by PCMCIA as a way to support USB 2.0 and PCI Express (hence the term *ExpressCard*) connectivity for portable computers. In fact, with support for transfer rates 2.5 times that of CardBus, ExpressCard is capable of transferring data at 2.5Gbps, approximately the rate of a single lane of PCIe. Cards can be created that support either specification or both. The manufacturer chooses the option that matches the application. ExpressCard 1.0 was published in 2003 and updated in 2006 to Release 1.1. Version 2 of the ExpressCard specification is designed to support USB 3.0 and PCIe 2.0.

With ExpressCard technology, portable computers can be adapted to support faster versions of legacy technologies. Standards not supported by CardBus, such as Gigabit Ethernet, IEEE 1394b, and eSATA, are accessible through the use of ExpressCard. Whereas CardBus required additional hardware and software to support nonnative hot swapping through the ISA and PCI buses, ExpressCard takes advantage of hot swapping natively through the USB and PCIe buses. As an added bonus, the ExpressCard adapters are smaller than their CardBus cousins. The smaller size can be attributed to the PCIe-based serial technology on which ExpressCard is based. The PCI-based parallel communications used by CardBus require the larger 68-pin and -socket interface, while ExpressCard is implemented on a 26-contact blade interface.

ExpressCard adapters are 75mm in length and 5mm thick. The standard ExpressCard, known as ExpressCard/34, is only 34mm wide. A 54mm-wide version, known appropriately as ExpressCard/54, is still only 34mm at its insertion point, but 22mm from that end, it expands to 54mm to accommodate more internal electronics. The additional space allows for better heat dissipation and the support of applications such as 1.8" disk drives, card readers, and CompactFlash readers. While a Universal ExpressCard host slot appears to be able to accept a CardBus adapter, the card inserts not even an inch before stopping on the internal guide that assures correct ExpressCard/34 insertion. ExpressCard shares with CardBus the use of 3.3V to power some cards but swaps the 5V versions for a new, lower 1.5V offering.



You may see the term *ExpressBus* used in reference to this technology. Despite the source, it's not a valid term.

Mini PCI and Mini PCIe

Mini PCI is an adaptation of the Peripheral Component Interconnect (PCI) standard used in desktop computers. As its name implies, it's just a smaller version (about $\frac{1}{4}$ the size of PCI cards) designed primarily for laptops.

These cards reside internally in the laptop, with their connection ports generally lining up with the edge of the outside of the case.

Mini PCI is functionally identical to the PCI version 2.2, meaning it's a 32-bit, 33MHz bus with a 3.3V-powered connection. It also supports bus mastering and DMA. There are three different Mini PCI form factors: Type I, Type II, and Type III. The size and connector types are listed in Table 9.1.

TABLE 9.1 Mini PCI form factors

Type	Connector	Size
IA	100-pin, stacking	7.5 x 70 x 45 millimeters
IB	100-pin, stacking	5.5 x 70 x 45 millimeters
IIA	100-pin, stacking	17.44 x 78 x 45 millimeters
IIB	100-pin, stacking	5.5 x 78 x 45 millimeters
IIIA	124-pin, card edge	2.4 x 59.6 x 50.95 millimeters
IIIB	124-pin, card edge	2.4 x 59.6 x 44.6 millimeters

The extra 24 pins on Type III connectors allow for routing information back to the system, which is required for audio, phone line, or network connections.

Common Mini PCI devices include sound cards, modems, networking cards, and SCSI, ATA, and SATA controllers. Adapters are available that allow you to use a Mini PCI adapter in a standard PCI slot.

Mini PCIe cards are physically similar to ExpressCard devices without the external cover, measuring a few millimeters less in length and width as a result. In reality, however, they have a completely different, 52-pin edge connector. Nevertheless, like ExpressCard, Mini PCIe cards support USB 2.0 and PCIe x1 functionality. Additionally, Mini PCIe cards have the 1.5V and 3.3V power options in common with ExpressCard.

USB Ports

Like desktops, laptops use USB ports for expansion. However, because of the lack of internal expansion in laptops, most peripherals for laptops are found as either PC Cards or USB expansion devices.

The USB port is the most common type for portable memory devices known as flash drives. These handy little sticks can hold up to 32GB of data (at the time of this writing) and have basically made floppy drives completely obsolete.



For more information about USB ports and their function, refer to Chapter 3, “Peripherals and Expansion.”

Mouse/Keyboard Port

Just in case you don’t like using your laptop’s built-in keyboard or pointing device, some laptops come with a combination *keyboard/mouse port* that allows you to connect either an external keyboard or an external mouse. On laptops that don’t have USB ports, this port is most often used for a standard PS/2 mouse. On those laptops that do have USB ports, this port is used for an external keypad or keyboard (because the USB port can accommodate an external mouse).

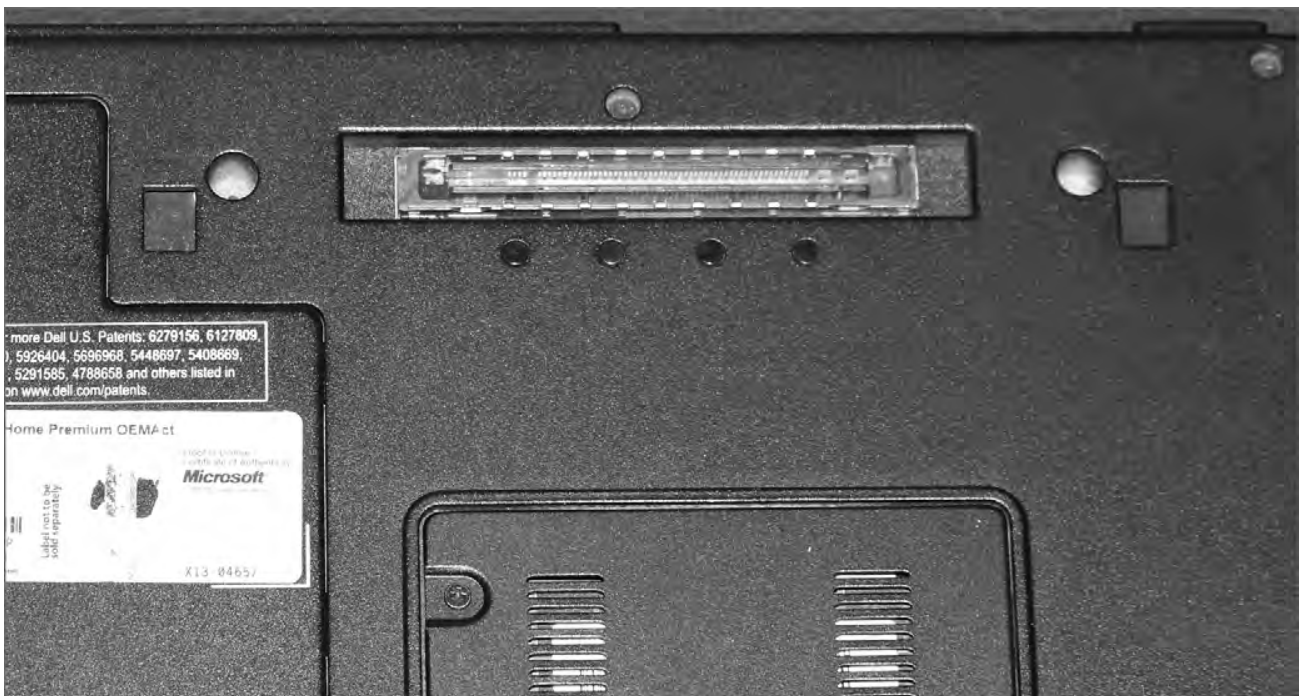
Communications Ports

Laptops are built to make computing mobile. And in this world where it seems as if you always need to be in touch with others while you’re mobile, it makes sense that laptops have a variety of methods to communicate while you’re on the go. Several communication methods are available; nearly all new laptops come equipped with some version of an 802.11 wireless card. Others may have connections for an analog dial-up modem or an infrared, cellular, Bluetooth, or Ethernet device. Each of these can also be added to laptops through USB or PC Card connection.

Docking Stations

Some laptops are designed to be desktop replacement laptops. That is, they will replace a standard desktop computer for day-to-day use and are thus more full-featured than other laptops. These laptops often have a proprietary docking port. A docking port (as shown in Figure 9.15) is used to connect the laptop to a special laptop-only peripheral known as a *docking station*. A docking station is basically an extension of the motherboard of a laptop. Because a docking station is designed to stay behind when the laptop is removed, it can contain things like a full-sized drive bay and expansion bus slots. Also, the docking station can function as a port replicator.

FIGURE 9.15 A docking port



A port replicator reproduces the functions of the ports on the back of a laptop so that peripherals such as monitors, keyboards, printers, and so on that don't travel with the laptop can remain connected to the dock and don't have to all be physically unplugged each time the laptop is taken away. Figure 9.16 is a photo of the back of a docking station, showing the replicated ports, some of which are only available on the docking station and not on the laptop. Finally, there are accessory bays (also called media bays). These external bays allow you to plug your full-sized devices into them and take your laptop with you (for example, a full-sized hard drive that connects to an external USB or FireWire port). As a point of clarification (or perhaps confusion), media bays and accessory bays are sometimes used to refer to laptop drive bays.

for battery comparison is rate of self-discharge, or how fast an unused battery reduces its stored charge.

FIGURE 9.17 A laptop Li-ion battery



Real World Scenario

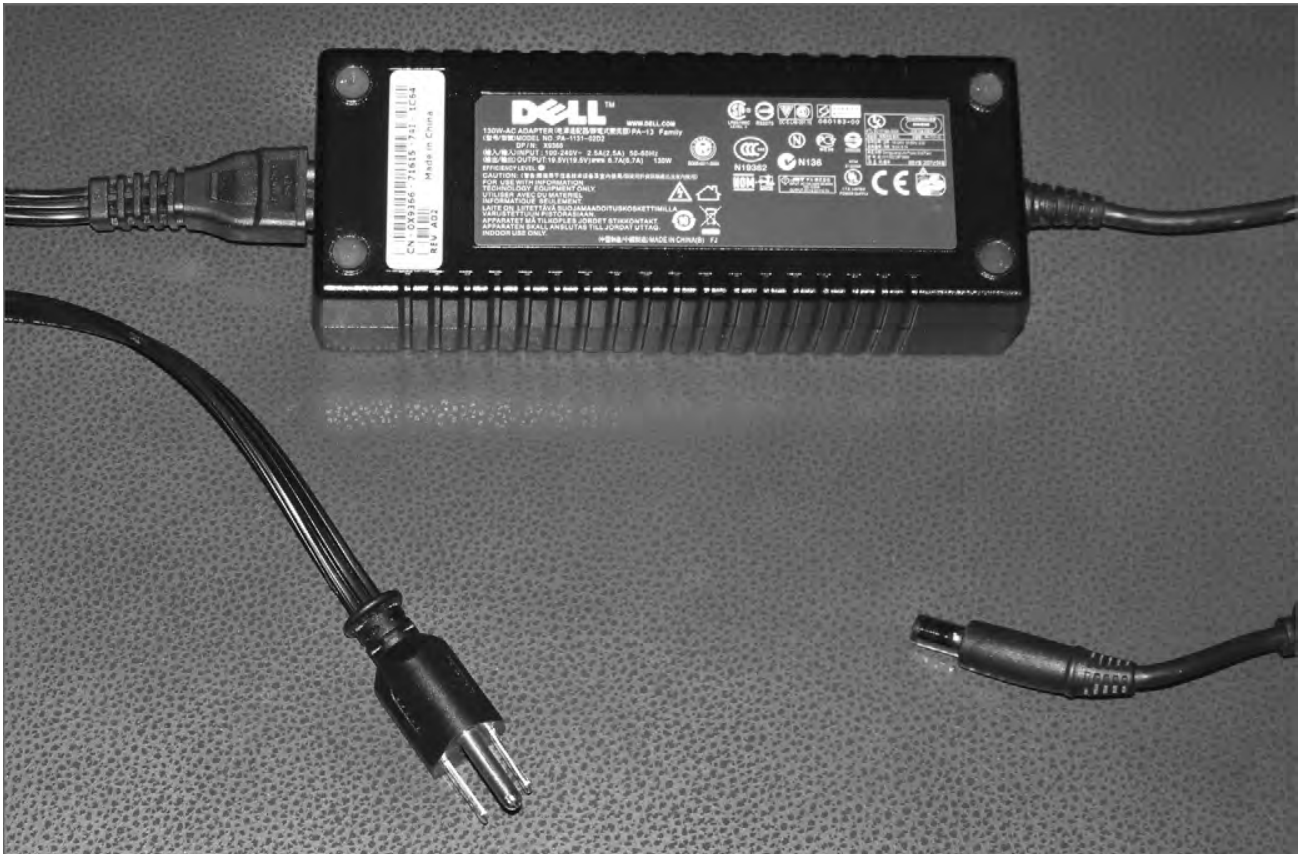
Is That Battery Really Dead?

Some batteries, such as nickel cadmium (NiCd) ones, suffer from a performance-affecting chemical memory loss. Others, such as lithium-ion, don't suffer from this affliction but do suffer from so-called digital memory loss that plagues the built-in gauges that monitor the charge left in the battery. This effect can be observed in software gauges that read the battery's charge level. The digital memory effect manifests itself as a sudden loss of power when the gauges register, say, 30 percent remaining capacity. The fix, much like the fix for chemical memory in NiCd batteries, is to allow a full discharge once a month or so. This is called *battery calibration* and can be performed right in the device being powered by the battery. Other than this occasional full discharge, Li-ion batteries last longer when you partially discharge them and then recharge them, making them ideal for laptops and personal handheld devices, such as cell phones, that tend to get used sporadically on battery power before being plugged back in to charge.

Power Adapters

Most notebook computers can also use AC power with a special adapter (called an *AC adapter*) that converts AC-power input to DC output. The adapter can be integrated into the notebook, but more often it's a separate “brick” with two cords, one that plugs into the back of the laptop and another that plugs into a wall outlet. Figure 9.18 is a photo of the latter.

FIGURE 9.18 A laptop AC adapter



Another power accessory that is often used is a *DC adapter*, which allows a user to plug the laptop into the power source (usually a cigarette lighter) inside a car or on an airplane. These adapters allow people who travel frequently to use their laptops while on the road (literally).

Use caution when selecting a replacement AC adapter for your laptop. You should choose one rated for the same or higher wattage than the original. You must also pay special attention to the polarity of the plug that interfaces with the laptop. If the laptop requires the positive lead to be the center conductor, for instance, then you must take care not to reverse the polarity.

Regarding the input voltage of the adapter, care must also be taken to match the adapter to the power grid of the surrounding region. Some adapters have a fixed AC input requirement. Purchasing the wrong unit can result in lack of functionality or damage to the laptop. Other adapters are autoswitching, meaning they are able to automatically switch the input

voltage they expect based on the voltage supplied by the wall outlet. These units are often labeled with voltage-input ranges, such as 100 to 240V, and frequency ranges, such as 50 to 60Hz, and are able to accommodate deployment in practically any country around the world. Nevertheless, you should still ascertain whether some sort of converter is required, even for autoswitching adapters.

Laptop Displays

The display system is the primary component in the top half of the clamshell case. (The wireless antenna often resides here too, and we'll get to that in just a bit.) Much like all other laptop components, the display is more or less a smaller version of its desktop counterpart. What is unique to laptop displays, though, is that for some time, the technology used in them was actually more advanced than what was commonly used in desktops. This is due to liquid crystal display (LCD) technology.

Before LCD technology, computer displays used cathode-ray tube (CRT) technology (like old-school televisions) and were big, bulky, and hardly mobile. We talked about LCD standards and concepts (in addition to LED, OLED, and plasma) in Chapter 4, "Display Devices," so there's not really a need to dive into the technical specs again. Instead, we'll focus here on the different components that are required to make these types of displays work.

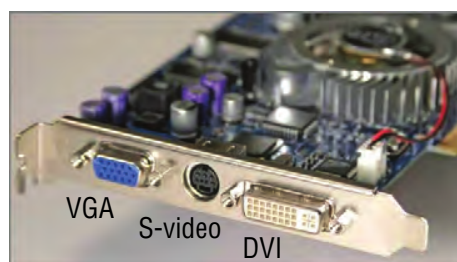
Video Card

The video card in a laptop or desktop with an LCD monitor does the same thing a video card supporting a CRT monitor would do. It's responsible for generating and managing the image sent to the screen. The big difference is that most LCD monitors are digital, meaning you need a video card that puts out a digital image. Laptop manufacturers put video cards that are compatible with the display in laptops, but with desktops it can get a bit confusing. Figure 9.19 shows an ABIT video card, with a digital video interface (DVI) port on the right and an analog (VGA) port on the left. The port in the middle is an S-video/composite video port.

The video card in Figure 9.19 is obviously for a desktop. Most laptop manufacturers choose to integrate the LCD circuitry on the motherboard to save space.

On the market, you can find digital-to-analog video converters if you need to plug in an older analog monitor to a digital video card.

FIGURE 9.19 Video card





Real World Scenario

Video Memory Sharing

If your video card is built into your motherboard, odds are that it doesn't have its own memory but shares system memory with the processor. Note that there is nothing wrong with this type of setup; in fact, it often brings the cost of the laptop down. It's just that instead of having 4GB of RAM and 512MB of video RAM (for example), you would have only 4GB total. So if your video card were using 512MB, the system would be left with only 3.5GB.

How much of a difference does all of this make? Well, it depends on what you're doing with your laptop. If you're using it for the Internet and light work, probably not much difference. If you're working with more video-intensive applications, using a computer with shared memory might slow you down some. This usually brings up two questions: One, what's the optimal balance? Two, where do I change this?

To answer question one, again, it depends on what you are doing. If you perform more video-intensive operations (or if you're gaming), then you might want to set aside more memory for the video card. If you're not as concerned with rapid pixilation, then less is fine. Which brings us to the second question: Where do you set it? Shared memory is configured in the system BIOS. Each BIOS is different, so be sure to consult your owner's manual if you have any questions. Keep in mind that some BIOSs will allow you to set aside a only certain amount of memory—say, 512MB—for video memory.

How does this affect your computer when you upgrade the memory? First, keep in mind that some of your memory will be taken by the video card, so you might want to upgrade to more than you originally planned for. Second, after upgrading the memory, you will need to go into the BIOS and reconfigure how much you want allocated to the video card.

Backlight

LCD displays do not produce light, so to generate brightness, LCD displays have a *backlight*. A backlight is a small fluorescent lamp placed behind, above, or to the side of an LCD display. The light from the lamp is diffused across the screen, producing brightness. The typical laptop display uses a *cold cathode fluorescent lamp (CCFL)* as its backlight. They're generally about 8 inches long and slimmer than a pencil. Best of all, they generate little heat, which is always a good thing to avoid with laptops.

Inverter

The only problem with fluorescent lighting, and LCD backlights in particular, is that they require fairly high-voltage, high-frequency energy. Another component is needed to provide the right kind of energy, and that's the *inverter*.

The inverter is a small circuit board installed behind the LCD panel that takes DC current and inverts it to AC for the backlight. If you are having problems with flickering screens or dimness, it's more likely that the inverter is the problem and not the backlight itself.

There are two things to keep in mind if you are going to replace an inverter. One, they store and convert energy, so they have the potential to discharge that energy. To an inexperienced technician, they can be dangerous. Two, make sure the replacement inverter was made to work with the LCD backlight you have. If they weren't made for each other, you might have problems with a dim screen or poor display quality.



Inverters can discharge energy, which can cause severe injury to you. Be careful when working with them!

Screen

The screen on a laptop does what you might expect—it produces the image that you see. The overall quality of the picture depends a lot on the quality of the screen and the technology your laptop uses. Current options include LCD, LED, OLED, and plasma.



For more information on LCD, LED, OLED, and plasma technologies, see Chapter 4.

WiFi Antenna

The vast majority of laptops produced today include built-in WiFi capabilities. Considering how popular wireless networking is today, it only makes sense to include 802.11 functionality without needing to use an expansion card. With laptops that include built-in WiFi, the wireless antenna is generally run up through the upper half of the clamshell case. This is to get the antenna higher up and improve signal reception. The wiring will run down the side of the display, through the hinge of the laptop case, and plug in somewhere on the motherboard.

The WiFi antenna won't affect what you see on the screen, but if you start digging around in the display, know that you'll likely be messing with your wireless capabilities as well.

Cable Locks

Portability defines what makes laptops truly useful. They're not as fast or as strong as their desktop cousins, but the fact that we can easily haul them around wherever we go gives them a special status within our hearts. It also presents less-scrupulous types with ample opportunity to quickly make away with our prized possessions and personal data. Laptop theft is a major concern for companies and individual owners alike.

One way you can help physically secure your laptop is through the use of a cable lock. Essentially, a cable lock anchors your device to a physical structure, making it nearly impossible for someone to walk off with it. Figure 9.20 shows a cable lock with a number combination lock. With others, small keys are used to unlock the lock. If you grew up using a bicycle lock, these will look really familiar.

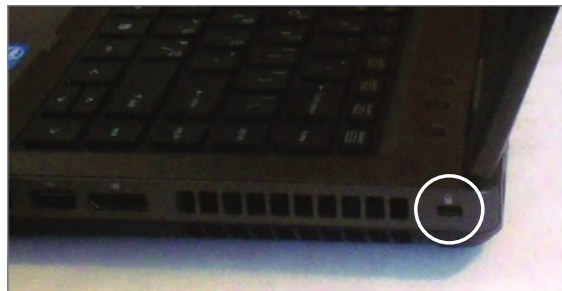
FIGURE 9.20 Cable lock



Here's how it works. First, find a secure structure, such as the permanent metal supports of your workstation at work. Then, wrap the lock cord around the structure, putting the lock through the loop at the other end. Finally, secure the lock into your cable lock hole on the back or side of your laptop (Figure 9.21), and you're secure. If you forget your combination or lose your key, you're most likely going to have to cut through the cord, which will require a large cable cutter or a hack saw.

If someone wants your laptop bad enough, they can break the case and dislodge your lock. Having the lock in place will deter most people looking to make off with it though.

FIGURE 9.21 Cable lock insertion point



Disassembling and Reassembling Laptops

Desktop computers often have a lot of empty space inside their cases. This lets air circulate and also gives the technician some room to maneuver when troubleshooting internal hardware. Space is at a premium in laptops, and rarely is any wasted. With a desktop computer, if you end up having an extra screw left over after putting it together, it's probably not a big deal. With laptops, every screw matters, and you'll sometimes find yourself trying to visually identify miniscule differences between screws to make sure you get them back into the right places.

Even though repairing a laptop poses unique issues, most of the general troubleshooting and safety tips you use when troubleshooting a desktop still apply. For example, always make sure you have a clean and well-lit work space and be cautious of electrostatic discharge (ESD). General safety tips and ESD prevention is covered in Chapter 11, "Understanding Operational Procedures." Here, we'll get in to specific objectives for tearing apart laptops.



Throughout this section, we'll use the word *laptop* almost exclusively. The principles covered here apply to nearly all portable devices, though, such as notebooks, handhelds, and netbooks.

Using the Right Tools

It's doubtful that any technician goes into a job thinking, "Hey, I'm going to use the wrong tools just to see what happens." With laptops, though, it's especially important to ensure that you have exactly the tools you need for the job. Two critical camps of materials you need are the manufacturer's documentation and the right hand tools.

Using the Manufacturer's Documentation

Most technicians won't bat an eye at whipping out their cordless screwdriver and getting into a desktop's case. The biggest difference between most desktops is how you get inside the case. Once it's opened, everything inside is pretty standard fare.

Laptops are a different story. Even experienced technicians will tell you to not remove a single screw until you have the documentation handy unless you're incredibly familiar with that particular laptop. Most laptop manufacturers give you access to repair manuals on their website; Table 9.2 lists the service and support websites for some of the top laptop manufacturers.

TABLE 9.2 Laptop manufacturers' service and support websites

Company	URL	QR Code
Asus	http://support.asus.com/ServiceHome.aspx	
Compaq	http://www.compaq.com/country/cpq_support.html	
Dell	http://support.dell.com/support/index.aspx	
HP	http://www8.hp.com/us/en/support-drivers.html	
Lenovo	http://support.lenovo.com/en_US/	
Sony	http://esupport.sony.com/US/perl/select-system.pl?DIRECTOR=DOCS	
Toshiba	http://www.csd.toshiba.com/cgi-bin/tais/support/jsp/home.jsp	

Once you are at the right website, search for the manual using the laptop's model number.



Some laptop manufacturers have a policy that if you open the case of a laptop, the warranty is voided. Be sure to understand your warranty status and implications of cracking the case before you do it.

Using the Right Hand Tools

Once you have the manual in hand or on your screen, you need to gather the right hand tools for the job. For some laptops, you only need the basics, such as small Phillips-head and straight-edge screwdrivers. For others, you may need a Torx driver. Gather the tools you need and prepare to open the case. A small flashlight might also come in handy.



Real World Scenario

The Consequences of Using the Wrong Tools

It's been said once, but it's important to say it again: Always use the right tool for the job when repairing laptops. If the documentation says you need a T-10 Torx driver, make sure you have a T-10 Torx driver.

Not using the right tools can result in the stripping of the screw head. If you strip a screw head in a desktop, you might have alternative methods of removing the screw. Laptops are far less forgiving. If you strip a screw head and are unable to turn the screw, you may never be able to remove it. That could result in needing to scrap the device.

Organization and Documentation

Before you crack the case of your laptop, have an organization and documentation plan in place. Know where you are going to put the parts. Have a container set aside for the screws. You can purchase small plastic containers that have several compartments in them with lids that snap tightly shut, to place screws in. You can also use containers designed to organize prescription pills. The bottom of an egg carton works well too, provided you don't need to be mobile to fix the laptop.

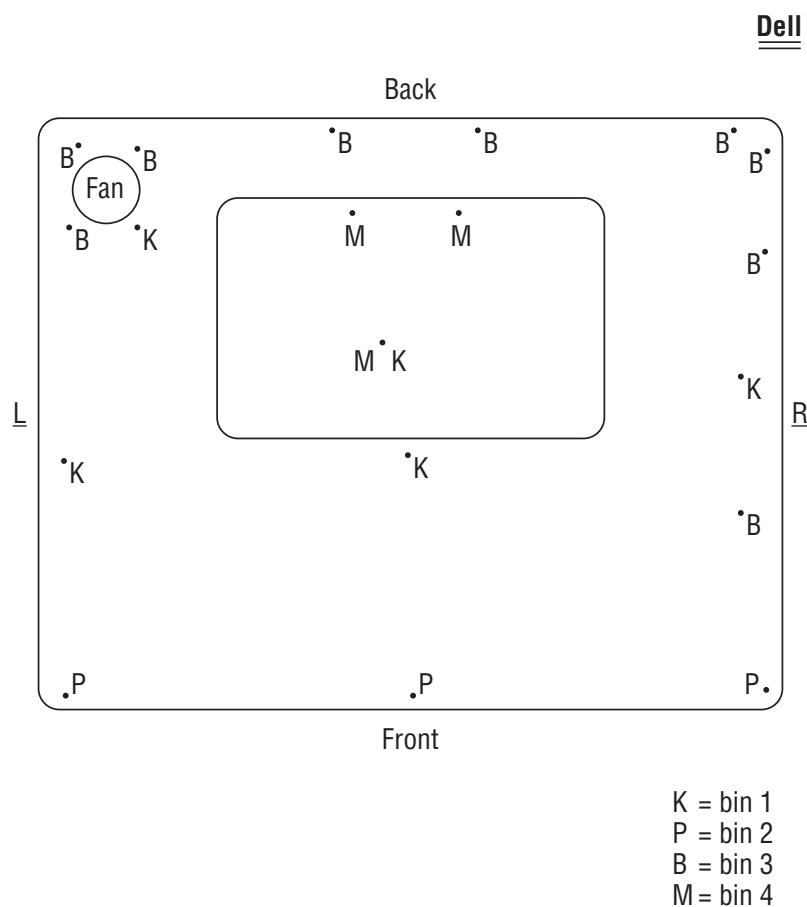
For documentation, many technicians find it handy to draw a map of the computer they're getting into, such as the one shown in Figure 9.22. It can be as complex as you want it to be, as long as it makes sense to you.

The drawing in Figure 9.22 shows the locations of the screws, and also calls out where the screws should be placed once they're removed. Again, this type of documentation can be as simple or complex as you want it to be, as long as it makes sense and helps you stay organized.

Replacing Laptop Components

You have your manual, screwdrivers, and screw container handy and are ready to go. Now you just need to figure out how to get to the defective component to replace it. It would be nice if we could just tell you one simple way to do this for all laptops, but that’s not going to happen. Internal laptop structure, components that can be replaced, and how to get to those components varies widely between models. It’s impractical to list steps to remove all of these devices because the steps we would list here will only help you if you’re working on the same model of laptop we’re using for an example.

FIGURE 9.22 Laptop repair “road map”



The list of components that may be replaceable could include input devices such as the keyboard and Touchpad; storage devices, including hard drives and optical drives; core components such as memory, the processor, and the motherboard; expansion options, including wireless cards and mini-PCIe cards; and integrated components such as the screen, plastics, speakers, battery, and DC jack. Again, depending on the make and model of the laptop you’re working on, the list of replaceable components might be longer or shorter.

In the following sections, we’re going to assume you’ve figured out what’s defective and needs to be replaced. We’ll stay away from describing components and what they do, unless it’s not been covered elsewhere in the book. The model we’re going to use in the examples in the rest of this chapter is a Dell Latitude C640. Admittedly, this particular model is a

bit dated, but all of the procedures we're going to walk you through will still be similar for newer systems. For other models, please consult the manufacturer's documentation.

Replacing Hard Drives and Memory

Hard drives and memory are the two most common components people usually upgrade in a laptop. We'll look at how to accomplish replacing both of them.

Replacing Hard Drives

External storage devices are more popular now than they ever have been. On the small end, you can get postage-stamp-sized SD memory sticks or ultra-portable thumb drives that hold a few gigabytes each. If you need more storage, you can get external hard drives that hold in excess of one terabyte and connect to your laptop using a USB cable.

Even with all of those options, a laptop still needs an internal hard drive. Exercise 9.1 shows you how to remove and replace an internal hard drive.



We could start off each of these exercises by saying, "Check your documentation," because that is realistically what you're going to have to do for the specific model of laptop you're working on. Obviously, each of these exercises is intended to be an example of how to replace a part. Instead of telling you to check your documentation each time for the exact steps, we'll assume that it's understood.

EXERCISE 9.1

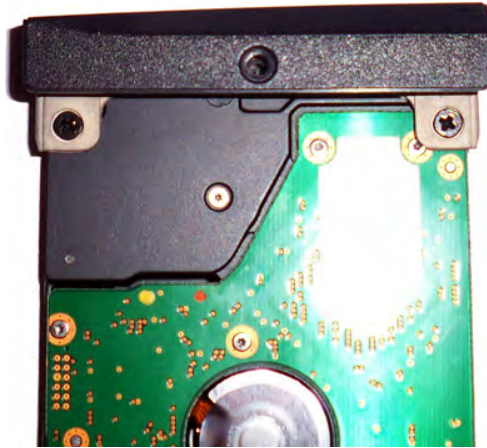
Replacing a Laptop Hard Drive

1. Turn off the computer.
2. Disconnect the computer and any peripherals from their power sources, and remove any installed batteries.
3. Locate the hard drive door and remove the screw holding it in place.
4. Lift the hard drive door until it clicks.
5. Slide the hard drive out to remove it.



EXERCISE 9.1 (continued)

6. Remove the two screws holding the hard drive to the hard drive door.



7. Attach a new hard drive to the hard drive door.
 8. Slide the new hard drive back into the hard drive bay.
 9. Snap the hard drive door back into place, and insert and tighten the screw to hold the door in place.
-

Replacing Memory

No matter how much memory your laptop has, it's probably not enough. Most laptops share their system memory with the video card, meaning that memory on a laptop might not go as far as you think.

Not long ago there weren't any standards for the physical size of laptop memory. Manufacturers weren't in a hurry to conform to each other either. After all, if they were the only ones producing memory for their systems, then they could pretty much charge what they wanted.

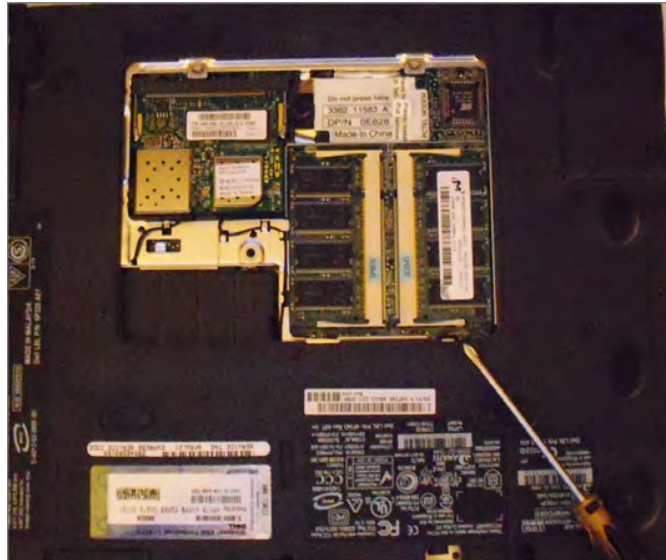
Fortunately, standards do exist today, and most manufacturers will use memory that conforms to SODIMM (or MicroDIMM) standards. Only occasionally will you run into a laptop that uses proprietary memory modules. Your documentation will tell you what type of memory your system takes. Exercise 9.2 shows you how to access the memory bay so you can upgrade or replace memory chips.

EXERCISE 9.2**Replacing Laptop Memory**

1. Turn off the computer.
2. Disconnect the computer and any peripherals from their power sources, and remove any installed batteries.

EXERCISE 9.2 (continued)

3. Remove the screws holding the memory door in place.



4. Use your fingers to gently separate the plastic tabs holding the memory module in place. The module should pop up so you can grab it.
5. Align the notch in the new memory module to the one in the connector.
6. Insert the new memory module into the socket at a 45-degree angle. Once full contact is made, press the module down. It should click into place.
7. Replace the memory door and fasten the screws.

Replacing Internal Laptop Expansion Cards

As we covered earlier in the chapter, laptops have their own proprietary architecture for internal expansion. The two most common standards are Mini PCI and Mini PCIe, and they're covered in detail in the section "Expansion Buses and Ports" earlier in this chapter.

Most laptops will come with only one Mini PCI or Mini PCIe port, and common Mini PCI devices include SCSI controllers, SATA controllers, network cards, sound cards, and modems. Refer back to Table 9.1 for the dimensions of the various Mini PCI form factors.

Figure 9.23 shows you the Type IIIA Mini PCI network card installed in this laptop, which happens to be in the same bay as the system memory. The connector is on the top side of the figure.

**NOTE**

You can tell that the card in Figure 9.23 is a Type IIIA card by looking at two things. First, it has a card edge connector, making it Type III. Second, the card looks almost like a square, making it Type IIIA. Type IIIB cards are about $\frac{1}{4}$ " shorter and look more rectangular.

FIGURE 9.23 Mini PCI card installed in a laptop

Removing the Mini PCI card is just like removing the memory, except that this one has antenna cables you need to disconnect first. After that, spread the retaining clips just as you would for the memory and the card will pop up. Replace it with a new card the same way you would replace a memory module.

Mini PCIe cards have a 52-pin card edge connector, and removing and replacing them is similar to removing and replacing Mini PCI cards.

Upgrading Wireless and Video Systems

What do wireless network cards and video cards have in common in laptops? Most of the time, they're integrated into your system motherboard. If either one fails, you need to replace the entire motherboard. A few laptops have these components as separate *field-replaceable units (FRUs)*, and you can remove them as needed. The only way to know for sure is to consult your trusty service manual. The following sections look at some ways you may be able to upgrade these devices.

Upgrading Wireless Network Cards

Wireless network cards and laptops are a perfect match for each other, much like peanut butter and chocolate. You can have one without the other, but what's the point, really?

Most network cards are built into the motherboard chipset of laptops. In other words, if it fails, you likely need to replace the motherboard. Network cards are special, though, in that you have many other easier ways to upgrade if you want to.

On the market you can find several external portable network cards. You often have choices that range from network cards that look like a thumb drive and have a USB connector to slightly bulkier PC Card network cards. These are even valid options if your built-in network card is still working but you want to upgrade. For example, if you have an older laptop with an 802.11b network card in it but you want to upgrade to 802.11g or 802.11n, it may be more economical to purchase an external card and use it in your system. Windows should disable the old device automatically to avoid conflicts, but if not, you can do it manually through Device Manager.

Upgrading Laptop Video Cards

Odds are that the laptop you're working on has an integrated video card. If the video card fails, you're likely looking at a motherboard replacement. Some laptops do have a replaceable video card. If it fails or if you choose to upgrade it, the procedure will probably resemble replacing system memory. The Dell Latitude C640 we've been using as an example has a built-in video card, so there's no way to upgrade that specific device. For an example of what it might take to replace a video card, we'll use a Dell Inspiron 6000 in Exercise 9.3.

EXERCISE 9.3

Removing a Laptop Video Card

1. Turn off the computer.
2. Disconnect the computer and any peripherals from their power sources, and remove any installed batteries.
3. Remove the Mini PCI card and the optical drive.
4. Remove the hard drive, the hinge cover, the keyboard, the display assembly, and the palm rest.
5. Loosen the two captive screws holding the video card/thermal cooling assembly in place.
6. Lift up on the video card/thermal cooling assembly to remove it from the motherboard.

Replacing LCD Components

Besides the video card, many of the LCD components (the screen, backlight, and inverter) in a laptop can be replaced. Replacing these components often means removing the LCD display from the main chassis of the laptop. When doing so, just be careful of the video circuitry that connects the two, and the wireless network card antenna wires, which are usually threaded through one of the laptop case hinges.



Be particularly careful working with inverters. They can store and discharge energy, which can cause severe injury to you!

Replacing Other Internal Components

By now you have probably gotten the idea that in order to know how to replace components inside your laptop, you need to check the laptop's manual. The upshot is that nearly every component you can think of replacing in a desktop computer is also replaceable in a laptop. It just might require a bit more work to fix the laptop than it would to fix a desktop.

As a rule of thumb, you can either access components from the bottom of your laptop, such as the memory, Mini PCI card, and modem in the Latitude C640, or you're going to need to remove the keyboard to access the components from the top.

As the keyboard is often the gateway to the guts of a laptop, we will include an example of removing it. We'll also include a few other examples of components you may need to replace in your line of work. Exercise 9.4 shows you how to remove a keyboard.

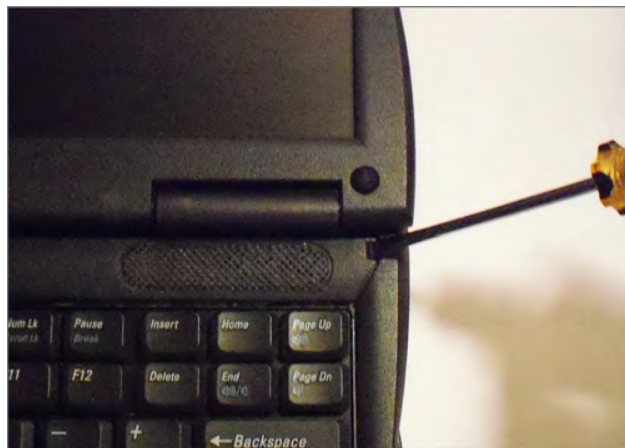


Laptop keyboards aren't as easy to switch out as desktop keyboards. If your laptop keyboard has failed, however, you can very easily attach an external keyboard to it. If you have the wrong type of connector, most electronics stores will have USB-to-PS/2 or PS/2-to-USB converters. Of course, if your goal is to remove the keyboard to get to the laptop's guts, then you need to perform surgery like the example in Exercise 9.4.

EXERCISE 9.4

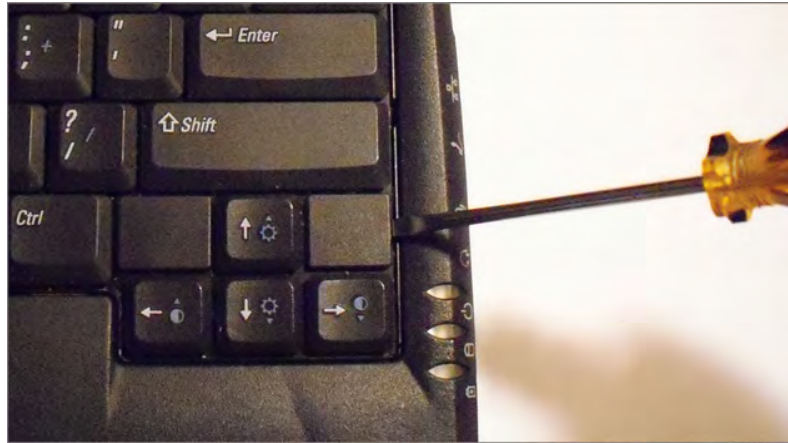
Removing a Laptop Keyboard

1. Turn off the computer.
2. Disconnect the computer and any peripherals from their power sources, and remove any installed batteries.
3. Remove the hard drive.
4. On the bottom of the laptop, remove the five screws marked with the letter *K*.
5. Turn the laptop over and open the display.
6. Remove the center control cover by inserting a small flat-edged screwdriver into the notch at the right end of the center control cover and prying it loose.

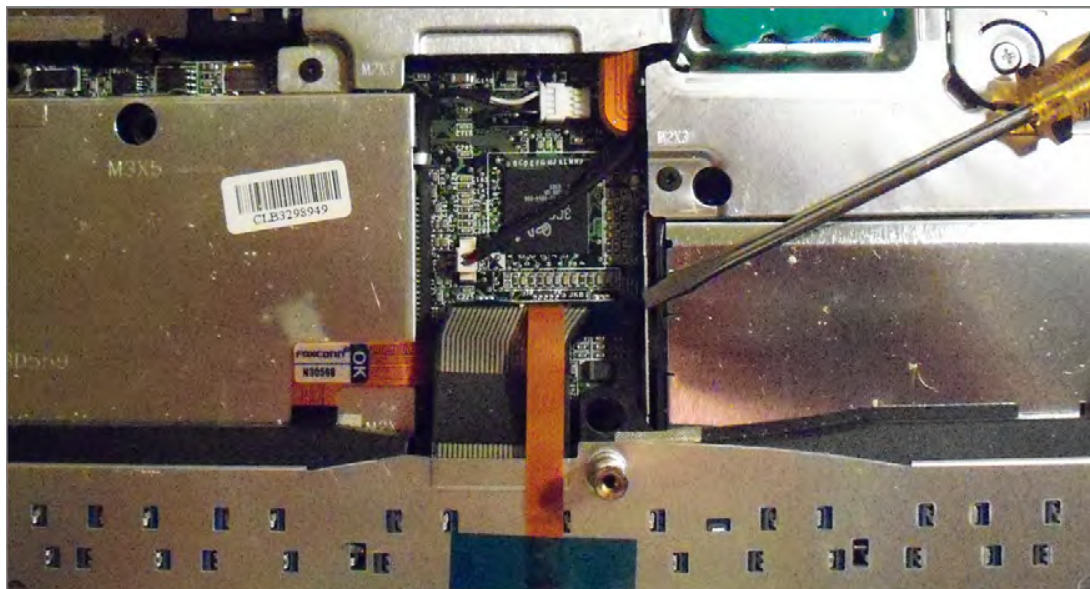


EXERCISE 9.4 (continued)

7. To release the keyboard, use a small flat-edged screwdriver to pry up on its right edge, near the blank key.



8. Lift the keyboard up about an inch and rotate it forward so the keys are facing on the palm rest. Don't pull the keyboard too far or you might damage the connector cable.
9. Pull up on the keyboard connector to disconnect it from the keyboard interface connector on the motherboard.

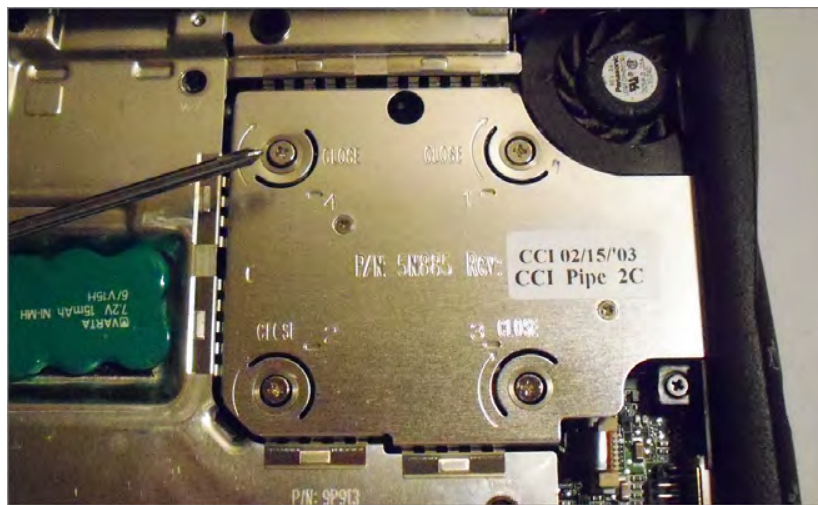


10. Set the keyboard aside.

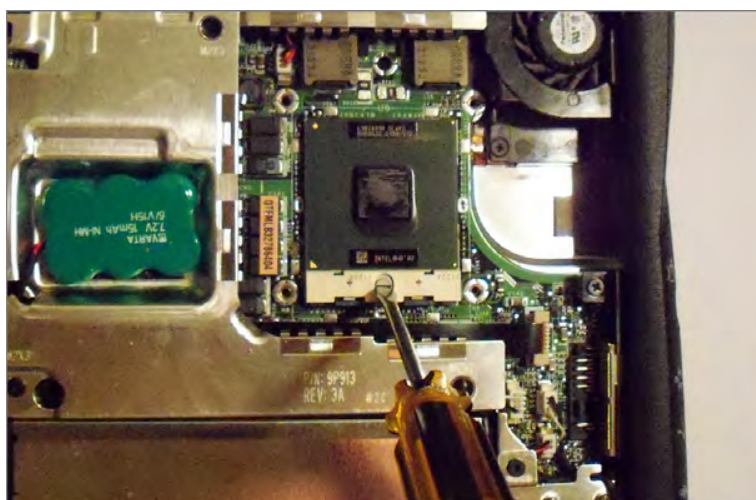
Now that the keyboard is off, you can remove several other components with relative ease. Exercise 9.5 looks at removing the processor cooling assembly and the processor.

EXERCISE 9.5**Removing the Processor Cooling Assembly and Processor**

1. Turn off the computer.
2. Disconnect the computer and any peripherals from their power sources, and remove any installed batteries.
3. Remove the hard drive.
4. Remove the keyboard.
5. Loosen the four captive screws that hold the cooling assembly in place.



6. Insert a small screwdriver into the recess in the front left side of the assembly and pry the assembly from the motherboard. If this is the first time removing the assembly, it might take some force because it's likely glued to the processor. Set the assembly aside.
7. Use a small flat-edged screwdriver to loosen the processor's ZIF socket by rotating the cam screw counterclockwise until it reaches the cam stop. (It should take about a one-quarter turn.)



EXERCISE 9.5 (continued)

8. Use a microprocessor extraction tool to remove the microprocessor. If you don't have an extraction tool, you can try to use your hands. Make sure you're grounded first, and always pull straight up to avoid bending pins.
9. Set the processor aside on an antistatic mat or place in an antistatic bag.

The last internal device we'll look at removing is the CMOS battery. If the BIOS isn't maintaining system information such as the date and time or boot sequence, you will want to replace this component. Exercise 9.6 shows you how to replace the CMOS battery.



Many laptops use the same type of round, silver watch-style batteries that desktop motherboards use. Others use packaged batteries that more closely resemble cell phone batteries, such as this laptop.

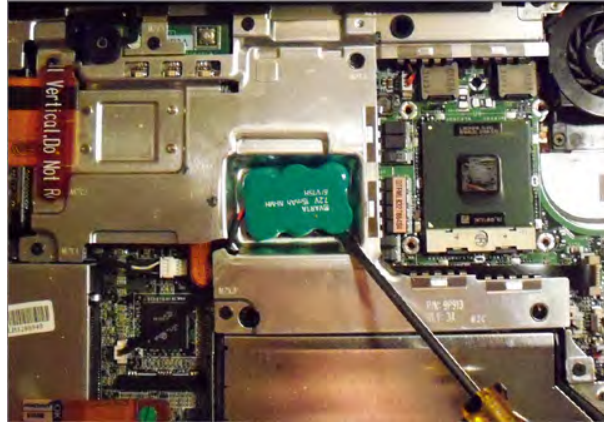
EXERCISE 9.6**Replacing the CMOS Battery**

1. Turn off the computer.
2. Disconnect the computer and any peripherals from their power sources, and remove any installed batteries.
3. Remove the hard drive.
4. Remove the keyboard.
5. Disconnect the CMOS battery from the motherboard.



EXERCISE 9.6 (continued)

6. Pry the battery from its seat with a small straight-edged screwdriver. Note that it's adhered to the EMI shield below it, so removing it might require some force.



7. Connect the new battery to the appropriate connector on the motherboard.
8. Peel away the backing from the adhesive bottom of the new CMOS battery. Press the battery into the battery tray.)
9. Upgrade the BIOS using a flash BIOS CD.

Flashing the system BIOS is usually a pretty straightforward process. You can get a BIOS update from the manufacturer and burn it to a CD. Once you have the CD, you just need to boot the laptop from the CD, and the disc will automatically flash the BIOS. Exercise 9.7 shows you the steps to flash the BIOS on this model.

EXERCISE 9.7**Flashing the System BIOS**

1. Turn off the computer.
 2. Ensure that the computer is plugged into AC power and that the main battery is installed properly.
 3. Turn on the computer and press F2 to enter the BIOS setup.
 4. Reset the system boot order to ensure that the system boots from the CD first.
 5. Insert the flash BIOS update CD, and reboot the computer. The disc will flash the BIOS and automatically reboot.
 6. Upon reboot, press F2 again to enter the BIOS setup. Verify that the settings are correct, and change the boot sequence to your preferred setting.
 7. Remove the flash BIOS CD.
-

Removing External Hardware

In the grand scheme of things, there are two types of peripherals: internal and external. We've already discussed removing internal hardware, and compared to that, removing external components is very easy. If you have USB-type devices plugged in, removing them is as easy as disconnecting them, but other peripherals require a bit more work.

Devices that can be removed when the computer is powered on are called hot-swappable devices. If you need to turn the computer off first, then the device is not hot swappable. There are several different hot-swappable peripherals, including mice, keyboards, some hard drives, network cards, printers, and others. Good examples of non-hot-swappable devices include motherboards and internal IDE hard drives. Odds are if it's internal to your computer case, then it's not hot swappable. Always be sure to check your hardware documentation to see if it's safe to plug in or disconnect the device with the system powered on.



Although most of the time you can just remove a USB device, make sure it's not in use when you remove it.

In Exercise 9.8, we will show you the recommended method to remove a device.

EXERCISE 9.8

Removing External Devices

1. You need to stop the device first (this is good policy even for USB devices), using the Safely Remove Hardware icon in the system tray here (it looks like a card with a green arrow over it).

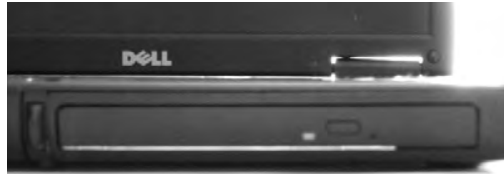


2. Once you've clicked the icon, you will get a screen similar to the one shown here:



EXERCISE 9.8 (continued)

3. Highlight the device you want to remove, and click Stop. Windows will then notify you that it's safe to remove the device. If it's a cabled device, just detach it. If it's PCMCIA, you can press the Eject button next to the slot in which the card is located. Other types of hardware in some laptops require you to release a latch. The following photo shows a modular front-load bay, and the right side has a CD-ROM in it:



4. Turn the computer over, and you can see the release latch. Slide it to the side, and pull on the grip on the underside of the CD-ROM. Out it comes.



Adding an external device to a laptop generally means that the computer will automatically recognize and enable the device for you, unless there's no compatible driver available. In cases like these, Windows will tell you that it detected new hardware and ask you to provide an appropriate driver.

Summary

In this chapter, you learned about the various laptop issues that face the A+ technician. We discussed differences between laptops and desktops, including the various components that make up a laptop and how they differ in appearance and function from those on a desktop.

Input devices, expansion buses, and interfaces found in laptops were presented in detail. We also discussed special laptop function keys and the components of an LCD screen.

Then, we looked at repairing and replacing laptop components. We started off by quickly talking about finding laptop documentation and using the right tools. We then discussed organization and documentation.