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A BEGINNER'S GUIDE TO BUILDING AND UPGRADING A PC

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Paul McFedries

Build It. Fix It. Own It. A Beginner's Guide to Building and Upgrading a PC

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Introduction

Man is a shrewd inventor, and is ever taking the hint of a new machine from his own structure, adapting some secret of his own anatomy in iron, wood, and leather, to some required function in the work of the world.

—Ralph Waldo Emerson, *English Traits*

As technology advances, it reverses the characteristics of every situation again and again. The age of automation is going to be the age of "do it yourself."

—Marshall McLuhan

Home-made, home-made! But aren't we all?

—Elizabeth Bishop, *Crusoe in England*

IN THIS INTRODUCTION

The 1950s were a hobbyist's paradise with magazines such as *Mechanix Illustrated* and *Popular Mechanics* showing the do-it-yourselfer how to build a go-kart for the kids and how to soup up his lawnmower with an actual motor! Fifty years later, we're now firmly entrenched in what some people are calling the age of tech DIY, where geeks of all persuasions—and both sexes—engage in various forms of digital tinkering and hardware hacking.

One of the main thrusts of this hobbyist renaissance is that it's better to make something yourself than to buy it. When you purchase something, you're really only renting it until its inevitable obsolescence. However, if you make it yourself, you own it and you can delay (often for a very long time) obsolescence by upgrading and repairing the device.

Unfortunately, building most digital devices isn't easy for the beginner because it requires soldering skills, working with complex tools such as multimeters, and knowing the difference between a resistor and a capacitor. However, there's one digital device that doesn't require any of these skills or knowledge, and so can be built by any curious and motivated beginner, a PC:

- All the parts you need—the case, power supply, motherboard, processor, memory, hard drive, expansion cards, and peripherals—are readily available online or from big-box retailers or electronics stores.
- All the tools you need—really not much more than a screwdriver or two, a pair of needle-nose pliers, and perhaps a nut driver—are part of most people's toolkits or can be easily obtained.
- All the techniques you need—inserting chips and cards, connecting cables, and tightening screws—are simple and straightforward.

Add to this the simple fact that building your own computer is much better than buying one because the machine you end up with is *exactly* the one you want, not some faceless machine designed for the masses and loaded with tons of crapware you never asked for and don't want. Besides, building your own PC is both educational and just plain fun, so it's no wonder that so many people nowadays are going (or would like to go) the build-it-yourself route.

Build It. Fix It. Own It!

Welcome, then, to *Built It. Fix It. Own It.*, the book that will be your guide on this build-it-yourself path. This book will show you everything you need to know to build a computer or upgrade an existing one. Even if you've never looked inside a computer and wouldn't know a motherboard from an expansion board or a CPU from a GPU, this book will give you the know-how and confidence to build a computer with your bare hands.

To that end, the first part of the book takes you through the various PC parts: from the case, motherboard, and power supply, to the processor, memory, hard drive, video card, sound card, and networking hardware. In each case, you learn how the hardware works, what it does, what types of hardware are available, and what to look for when buying the hardware. The first part of

the book also includes a chapter full of tips, techniques, and cautionary tales for purchasing PC parts (see Chapter 7), a chapter that runs through all the basic skills you need to build and upgrade a PC (Chapter 8), and a chapter on how to scavenge parts from on old PC (see Chapter 9).

The second part of the book takes you through a series of projects. The first five chapters show you how to build five different types of PC: a basic business PC; a home theater PC; a high-performance PC; a killer gaming PC; and a budget PC. Another chapter shows you how to upgrade an old PC and you then learn how to put together a network that uses both wired and wireless connections. The final chapter in Part II explains how to maintain a PC, from cleaning the components to updating the motherboard BIOS and device drivers to basic hard drive maintenance.

Who Should Read This Book?

This book is aimed at budding computer hobbyists who want to try their hand at building a PC from scratch and at upgrading an old PC to get more life or performance out of it. This book should also appeal to people who have tried other books in the same field, only to find them too intimidating, too simplistic, or too cutesy.

To that end, this book includes the following features:

- Buyer's guides that enable you to make smart and informed choices when purchasing hardware
- Easy-to-follow explanations of key concepts for new users
- In-depth coverage of all topics for more experienced users
- Extensive use of clear and detailed photos to illustrate hardware and all building and upgrading techniques
- Tips, tricks, and shortcuts to make building and upgrading a PC easier and faster
- Real-world projects you can relate to
- A friendly and lightly humorous tone that I hope will help you feel at home with the subject and keep boredom at bay

Conventions Used in This Book

To make your life easier, this book includes various features and conventions that help you get the most out of this book and out of building a PC:

Steps	Throughout the book, I've broken many building, upgrading, and repairing tasks into easy-to-follow step-by-step procedures.
Things you type	Whenever I suggest that you type something, what you type appears in a **`bold monospace`** font.
Filenames, folder names, and code	These things appear in a `monospace` font.
Commands	Commands and their syntax use the `monospace` font, too. Command placeholders (which stand for what you actually type) appear in an *`italic monospace`* font.
Pull-down menu commands	I use the following style for all application menu commands: *Menu*, *Command*, where *Menu* is the name of the menu you pull down and *Command* is the name of the command you select. Here's an example: File, Open. This means you pull down the File menu and select the Open command.

This book also uses the following boxes to draw your attention to important (or merely interesting) information:

note The Note box presents asides that give you more information about the current topic. These tidbits provide extra insights that offer a better understanding of the task.

caution The all-important Caution box tells you about potential accidents waiting to happen. There are always ways to mess things up when you're working with computers. These boxes help you avoid those traps and pitfalls.

tip The Tip box tells you about methods that are easier, faster, or more efficient than the standard methods.

CHAPTER

14

Building a Budget PC

Frugality is the mother of virtue.
—Justinian, *Corpus Juris*

IN THIS CHAPTER

If you built (or just read along with) the previous two projects, you saw that their price tags were a bit on the high side: $1,700 for the high-performance PC (Chapter 13) and $1,900 for the killer gaming PC (Chapter 14). Those aren't cheap PCs, but in both cases I made significant compromises to keep the prices down! With top-shelf components throughout, these machines would have had our credit cards smoking thanks to price tags in the $4,000–$5,000 range.

One of the key things about a PC that many system builders forget is that no matter what hardware you use, the machine will eventually become obsolete. Yes, you can future-proof a machine to a certain extent by giving yourself room to expand, by buying high-quality parts, and by picking parts at or near the high end. However, all you're doing is delaying the inevitable.

With that in mind, there's a school of thought among some PC builders that it's better to put together an inexpensive machine every 6–12 months, rather than build one expensive PC every 2–3 years. With this strategy, you get fresh hardware fairly often, and you get the joy of building your own PC more frequently. Of course, this approach assumes you're looking to build just a general-purpose computer rather than one designed for a specific purpose, such as a home theater PC or a gaming rig.

With that assumption in mind, this chapter shows you how to build a PC when you're on a tight budget. I set out some design goals for the budget PC; then I take you through the parts I chose to meet those goals, from the computer case right down to the memory modules. Then, with the parts assembled, I show you step-by-step how to build your budget PC.

Design Goals for a Budget PC

This is a budget PC, so we need start with a budget, which I'm going to set at $400. That total is high enough that we won't have to resort to shoddy parts but low enough to be affordable to many. Within the constraints of that budget, we can set the following goals:

- **Thrifty, not cheap**—The key to building a solid budget PC is to avoid the lowest-of-the-low when it comes to parts. Generally speaking, you get what you pay for when it comes to computer components, so a PC built from the cheapest parts would end up exactly that: cheaply made. I guarantee you the machine would either not work or work poorly, and neither is acceptable in this build. Our goal, instead, is to look for good bargains on well-made, brand-name components.
- **A solid performer**—The budget PC needs to be a all-purpose machine, which means it needs to do email; web surfing; some light gaming; and business-oriented tasks such as word processing, spreadsheets, scheduling, and contact management. Nothing here is going to push the machine to its limits or require specialized hardware. This PC doesn't need a quad-core CPU; tons of RAM; a terabyte or 10,000 RPM hard drive; or high-end video and audio cards. All this bodes well for our budget.
- **No instant obsolescence**—Even though we're not spending a lot of money on this PC, and even though we're operating under the assumption that we'll build a replacement for it before too long, we *don't* want this machine to force us into building a replacement in just a few months. We need to select components that are good enough that this PC will perform well for as long as we want it to (at least a year).

- **Get good value for the money**—The secret to reaching our design goals while staying within budget will be to get the most bang for the few bucks we're going to spend. That means not only buying brand-name parts for their high quality, but also looking for those components that provide excellent value for the money, whether it's extra features or extra performance.

> **note** The next few sections discuss specific parts for this build, but there's no reason you have to use the same components in your build. Feel free to tweak the parts based on your own budget and computing needs.

Choosing Parts for the Budget PC

Okay, our budget is set in stone, as is our determination to build a solid, reliable PC within the constraints of that budget. The next few sections keep the points from the previous section in mind and discuss the components that we'll use to put together our budget machine.

Selecting a Case for the Budget PC

In some of my early PC-building projects, I figured I could save money by skimping on the case. After all, it's just a case, right? Surely what's inside the case is more important, and the money saved on the case can be better spent on those internal components.

Boy, was I wrong! Building a PC using a cheap case is almost always an exercise in frustration, with much hair-pulling and gnashing of teeth. Nothing fits right; parts are hard to remove; and when you finally do remove them, they don't go back on the same way and you get lacerations all over your body from the sharp edges. Take my hard-won advice: although you can buy cases for $50 or less, don't do it.

Of course, we've got a budget to consider, so we can't go overboard right off the bat. Our budget PC requires a case that puts function over form, but not overly so. We still want our case to look good under our desk but not take up too much room. The ideal case should have good airflow so we don't have to worry about heat problems, front connectors for easy access, and a design that makes the build easier.

For this build, I chose the Antec Sonata III, a terrific mid-tower case that supports both ATX and microATX motherboards (see Figure 14.1). You can find this case online for about $115, which makes it a mid-priced case. However,

that's actually a pretty good deal because the case comes with an Antec 500W power supply and a 120mm Antec case fan (the rear exhaust fan). None of these are top-of-the-line components, but they're more than adequate for our budget PC.

FIGURE 14.1

The Antec Sonata III: the case for our budget PC.

Besides these extra goodies that come with the case, the Sonata III also supports the following features:

- Two USB ports, one eSATA port, one microphone connector, and one Line Out connector in the front of the case.
- An aluminum front bezel that opens to reveal the external drive bays.
- Lots of drive bays: two 3.5-inch external (for a memory card reader or floppy drive), three 5.25-inch external (for optical or tape drives), and four 3.5-inch internal (for hard drives).
- Relatively easy side panel access: You remove two thumb screws and slide the panel off the case.
- The expansion slots are tool-free: A plastic latch slides out to insert the card and then slides back in to hold the card in place.

- Each hard drive bay is side-mounted for easy access and has its own bracket that attaches using side rails and slides in and out of the bay. You use special screws to attach the hard drive to the bracket. In a nice touch, the drive rests on silicone grommets, not metal, which reduces noise.
- A dust filter, which is removable for washing.

One thing our Antec case lacks is a front intake fan. Many people report that the case cools quite well with just the default rear exhaust fan, but you should never be overly thrifty when it comes to keeping your components cool. For a mere $10, I added an Antec Tri-Cool 120mm case fan to this build. Like the rear fan that comes with the case, this fan has a three-way switch that lets you set the fan speed. On the lowest speed, the fan still pushes through a decent 39 CFM, while keeping the noise down to 25 dBA. (The middle speed pushes 56 CFM at 28 dBA, while the high speed pushes 79 CFM at 30 dBA.)

Choosing a Motherboard for the Budget PC

For our budget PC's motherboard, we want a product from a big-name manufacturer, for sure, but we also want decent integrated features so we don't have to spend extra cash on things like expansion cards. That's a tall order, but there are some sub-$100 boards out there that meet these criteria if you look around and do your homework.

For this build, I went with an ASUS board (there's your big name) called the M2A-VM HDMI (see Figure 14.2). It's a microATX board that's available online for just $75.

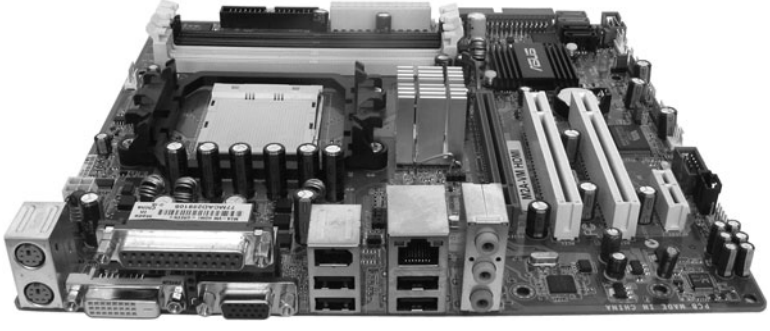

FIGURE 14.2
The ASUS M2A-VM HDMI: the budget PC's motherboard.

Despite the low price, the ASUS M2A-VM HDMI offers a pretty good set of features:

- A clean and well-designed layout
- An AM2 processor socket that supports a wide variety of AMD processors, including the AMD Athlon 64 FX, AMD Athlon 64 X2, AMD Athlon 64, and AMD Sempron
- Support for dual-channel DDR2 800, 667, or 533 memory modules (up to 8GB)
- One PCI Express x16 slot, one PCI Express x1 slot, and two PCI slots
- Four external USB ports and three internal USB headers
- One external IEEE-1394 (FireWire) port
- Four internal SATA connectors
- Integrated Radeon X1250 video card, with DVI-D and VGA ports and support for dual monitors
- Integrated high-definition 8-channel audio
- Integrated 10/100/1000 network adapter
- A PCI Express x16 card that provides HDMI support (including HDMI, S-video, and composite video ports) and S/PDIF digital audio output

Selecting a Power Supply for the Budget PC

Our budget PC will be a relatively simple affair with the major devices being a hard drive, a DVD burner, and the motherboard's HDMI card. Any mid-range 400W power supply could handle this workload without a problem, so the Antec case's 500W PSU will be more than adequate for our needs.

Picking Out a CPU for the Budget PC

In a budget PC, the processor is where we can save big bucks because you don't need to spend $200 or $300 to get decent performance these days. At the lowest end of the processors are the single-core CPUs such as the AMD Sempron. However, single-core chips are on their way out, and with AMD you can move up to dual-core by spending just a few more dollars. In fact, for a mere $60, you can get the Athlon 64 X2 4000+ (see Figure 14.3), a dual-core CPU that runs at 2.1GHz, supports our motherboard's 2000MHz HyperTransport bus, and offers a 1MB L2 cache.

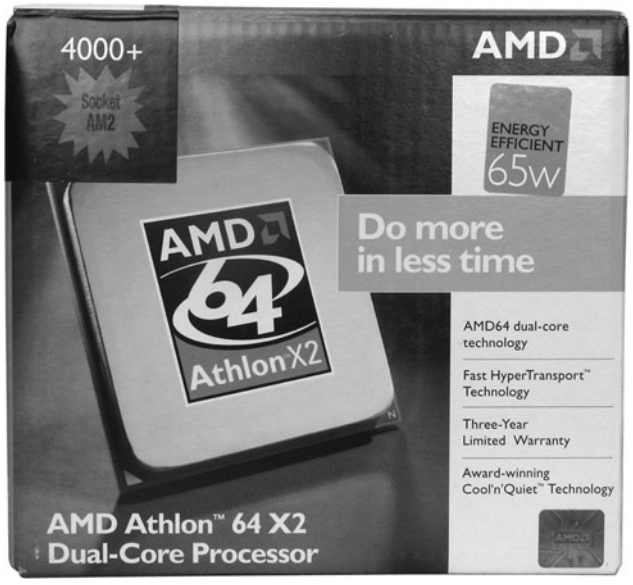

FIGURE 14.3

The Athlon 64 X2 4000+: the budget PC's processor.

As a final thought on the CPU, note that I'm going to use the stock cooler that AMD supplies with the retail version of the Athlon 64 X2 4000+. AMD's coolers do a decent job and are reasonably quiet when not under too much strain (which they won't be given the tasks this budget PC will be performing).

How Much Memory Does the Budget PC Need?

Memory is one of the most important performance factors in any PC, which means, simply, that the more memory you add to any system, the better that system will perform. Happily, we live in a world where the enhanced performance of extra RAM can be had for a relative pittance, with 1GB memory modules selling online for $25–$30.

All this means that it doesn't make any sense to hobble our budget PC with a mere 512MB or even 1GB of RAM. No, we're going to do the right thing and load up our machine with 2GB, so we'll be running with 1GB per core, which should offer great performance.

We need to match our modules to our motherboard's memory speed, and the ASUS M2A-VM HDMI can use PC2 6400 (DDR2 800), PC2 5400 (DDR2 667), or PC2 4200 (DDR2 533). I opted for two 1GB PC2 6400 memory modules from Corsair (see Figure 14.5), which set me back about $60.

FIGURE 14.4
The budget PC will use AMD's stock CPU cooler.

FIGURE 14.5
The budget PC's memory: a couple of 1GB PC2 6400 modules from Corsair.

Storage Options for the Budget PC

The budget PC needs a hard drive, of course, but we don't want one that's too big because we'll break our budget. We need just enough room to install an

operating system, a few applications, and our data. With that in mind, I opted for the Western Digital Caviar SE WD1600AAJS, a 160GB drive that ought to be plenty big enough (see Figure 14.6). It's a SATA drive that's available in an OEM version online for just $50. It spins at 7,200 RPM; features an 8MB cache; and offers a very respectable 8.9 average seek time, so it won't slow us down.

FIGURE 14.6

The budget PC's hard drive: the Western Digital Caviar SE WD1600AAJS 160GB SATA drive.

Our budget PC needs an optical drive, of course, and for this machine I chose the Lite-On DH-20A4P, a dual-layer DVD/CD rewritable drive that supports write speeds of 20x DVD±R, 8x DVD+Rw, 6x DVD-RW, 8x DVD±R DL, 48x CD-R, 32x CD-RW, plus read speeds of 16x DVD-ROM and 48x CD-ROM, all for a mere $30 or so.

Determining the Video Needs of the Budget PC

The ASUS M2A-VM HDMI motherboard comes with a Radeon X1250 GPU integrated. This is an excellent GPU that provides very high-quality graphics. It requires 256MB of system memory, but that's not a huge problem because we've supplied our budget PC with a generous 2GB of RAM. The Radeon chip supports DVI-D resolutions up to 2560×1600, RGB resolutions up to 2048×1536, and dual monitors. Combine these impressive stats with the HDMI

PCIe card supplied with the motherboard, and we can ask for no more from an integrated video system. Therefore, we won't be adding a separate video card to the budget PC.

Selecting Audio Equipment for the Budget PC

When trying to save money on a PC build, one of the first components to go is the separate audio card because good ones are expensive and cheap ones are often no better than what's integrated into the motherboard. This build is no exception. Our motherboard has integrated 8-channel high-def audio, although the Realtek chip isn't the greatest one around. The HDMI card that comes with the board offers S/PDIF digital audio output, so sticking with the board's audio is a no-brainer for this project.

Choosing Networking Hardware for the Budget PC

Even a budget PC must network, of course, and these days networking is easier than ever because it's a rare motherboard that doesn't come with a networking adapter built in. Even better, almost all motherboard-based NICs support Ethernet (10Mbps), Fast Ethernet (100Mbps), and Gigabit Ethernet (1Gbps or 1,000Mbps), so you're covered no matter what type of network you'll be connecting to. Our budget PC is no exception because our ASUS motherboard has a 10/100/1000 NIC onboard. Therefore, no extra networking equipment is needed.

Pricing the Budget PC

As you've seen, our budget PC doesn't have any big-ticket items. The most expensive component is the case, although as I mentioned before you need a decent case with *any* build—even one on a budget. We also saved quite a bit of money by going with the stock CPU cooler, the PSU and fan that came with the Antec case, the motherboard's integrated video and audio chips, and the integrated NIC.

Table 14.1 summarizes the budget PC's components and prices. As you can see, our total price of $400 is right on our budget.

Table 14.1 Components and Prices for the Budget PC

Component	Model	Average Price
Case	Antec Sonata III	$115
Case fan	Antec Tri-Cool 120mm	$10
Motherboard	ASUS M2A-VM HDMI	$75

Table 14.1 Continued

Component	Model	Average Price
Power supply	Comes with the case	N/A
CPU	AMD Athlon 64 X2 4000+	$60
CPU cooler	AMD stock cooler	N/A
Memory	Corsair XMS2 PC2 6400 1 GB (×2)	$60
Hard drive	Western Digital Caviar SE WD1600AAJS 160GB	$50
Optical drive	Lite-On DH-20A4P DVD/CD Rewritable Drive	$30
Video card	Motherboard integrated	N/A
Audio card	Motherboard integrated	N/A
Network card	Motherboard integrated	N/A
TOTAL		**$400**

Putting Together the Budget PC

With parts at the ready (see Figure 14.7), your tools by your side, and a stretch of free time ahead (you can build this PC in an afternoon or evening), you're ready to start the build. The rest of this chapter takes you through the steps you need to follow. Happy building!

FIGURE 14.7
The budget PC, ready for the build.

Getting the Case Ready

The Antec case requires a bit of prep work before we can move on to more productive tasks:

- **Remove the side panel**—Remove the two thumb screws that attach the side panel to the back of the case. Slide the side panel's plastic handle toward the front of the case, swing the panel toward you, and then remove it.
- **Liberate the screws, standoffs, and other case hardware**—These bits and pieces are in a bag, and that bag is inside a box that comes behind the internal 3.5-inch drive bays, which consists of four removable metal trays. Remove the bottom two trays (for each tray, squeeze the metal clips toward each other until they release and then slide out the tray), remove the box, and then reinsert the drive trays.
- **Remove the generic I/O shield**—As you see in the next section, when test-fitting the motherboard in the case to determine where to put the standoffs, it helps if the I/O shield isn't in the way. Gently push the edges of the I/O shield back into the case until it's loose and you can remove it.

Installing the Motherboard Standoffs

A standoff (or a *mount point*, as it's often called) is a hex-nut screw, which means it actually consist of two parts: a bottom screw that enables you to insert the standoff into a hole in the side of the case and a top hex nut into which you can insert a screw. The idea is that you install from eight to ten (depending on the motherboard form factor) of these standoffs into the case, sit the motherboard on top of the standoffs, align the motherboard's holes with the hex nuts, and then attach the motherboard. This gives the board a solid footing but also separates the board from the metal case to prevent shorting out the board.

Installing the standoffs is easiest when the motherboard is bare, so that should be your first task:

1. Find the standoffs that came with the case and put them aside.
2. Lay the case flat on its side, with the open side facing up.
3. Move all the case cables out of the way so you can clearly see the side panel that has the mounting holes. If you have trouble getting the power supply cable out of the way, consider temporarily removing the

power supply, as described in Chapter 9, "Scavenging an Old PC for Parts."

➔ **See** "Releasing the Power Supply," **p. 234**.

4. Remove the preinstalled standoffs.
5. If you haven't done so already, touch something metal to ground yourself.
6. Take the motherboard out of its anti-static bag and lay the board inside the case, oriented so the board's back-panel I/O ports are lined up and flush with the case's I/O slot.
7. Note which case holes correspond to the holes in the motherboard (see Figure 14.8). You might need to use a flashlight to ensure that there's a case hole under each motherboard hole.

caution I suggest removing preinstalled standoffs because you want to make sure that you only have the correct number of standoffs inserted and that they're inserted in the correct positions. One standoff in the wrong position can cause a short circuit.

tip Rather than trying to remember which case holes correspond with each motherboard hole, you can mark the correct case holes. After you have the board lined up with the holes, stick a felt-tip pen through each hole and mark the case. (You might need to offset the board slightly to do this properly.)

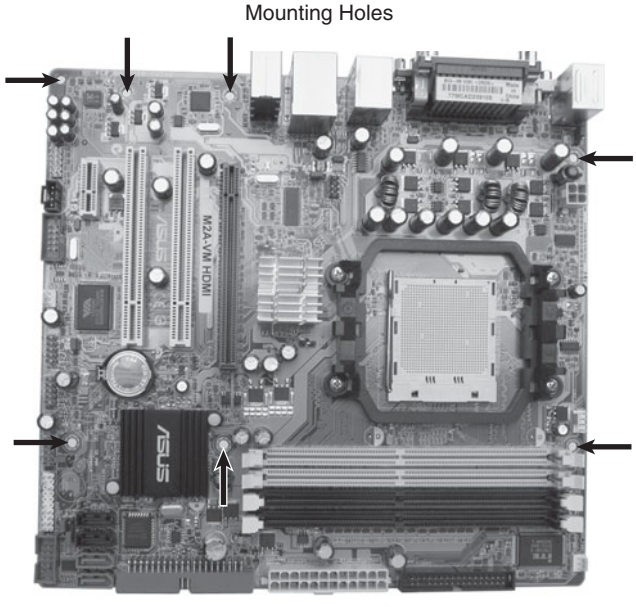

FIGURE 14.8
The motherboard has ten holes through which you attach the board to the standoffs.

8. Place the motherboard carefully aside.
9. Screw the standoffs into the corresponding holes in the side of the case.

Just to be safe, you might want to place the motherboard into the case once again to double-check that each motherboard hole corresponds to a standoff.

Getting the Motherboard Ready for Action

Although you might be tempted to install the motherboard right away, and technically you can do that, it's better to hold off for a bit and do some of the work on the board while it's out of the case. We'll be installing the processor and the memory modules, and although it isn't impossible to install these parts with the board inside the case, it's a lot easier outside.

Before getting started, be sure to touch something metal to ground yourself. Now take the motherboard and lay it flat on your work surface. For the ASUS, it's best to orient the board so the I/O ports are facing away from you. This enables you to work with the processor socket without having to go over the heatsinks or the I/O ports.

Inserting the Processor

Begin by installing the AMD Athlon 64 X2 4000+ processor in the motherboard's AM2 socket. I won't go into the details here because I showed you how to insert AMD processors back in Chapter 8.

➔ **See** "Installing an AMD CPU in a Socket AM2 Board," **p. 219**.

Installing the CPU Cooler

Now it's time to install the AMD stock cooler. We're using the stock cooler that came with the processor, so we already know it's compatible with both the CPU and the motherboard (and the AMD warranty on the processor remains in effect). Even better, the stock cooler already comes with the thermal compound preapplied, so we don't need to mess with any of that. I usually wait until the motherboard is installed in the case before adding the cooler, but the clip that holds the cooler in place is tricky to install even outside the case, and would be nearly impossible inside the case.

1. If the plastic lever on the cooler's clip is perpendicular to the clip, pivot the lever counterclockwise so it stands straight up.
2. Remove the plastic that covers the cooler's heatsink. Take care not to smudge the thermal grease on the underside of the heatsink.

3. Orient the cooler over the CPU socket so the plastic lever that sticks up from the clip is on the same side of the CPU socket as the Northbridge (see Figure 14.9).

FIGURE 14.9
Orient the cooler over the CPU socket as shown here.

4. On the side opposite the lever, maneuver the square hole in the clip over the rectangular protrusion in the plastic bracket that surrounds the CPU socket, as shown in Figure 14.10.
5. On the same side as the lever, press down on the clip and maneuver the square hole in the clip over the rectangular protrusion in the plastic bracket.
6. Make sure the cooler's heatsink is lined up perfectly with the processor.
7. Pivot the lever clockwise until it snaps into place, as shown in Figure 14.11.
8. Connect the cooler's power cable to the motherboard's CPU fan header (labeled `CPU_FAN`), as shown in Figure 14.12.

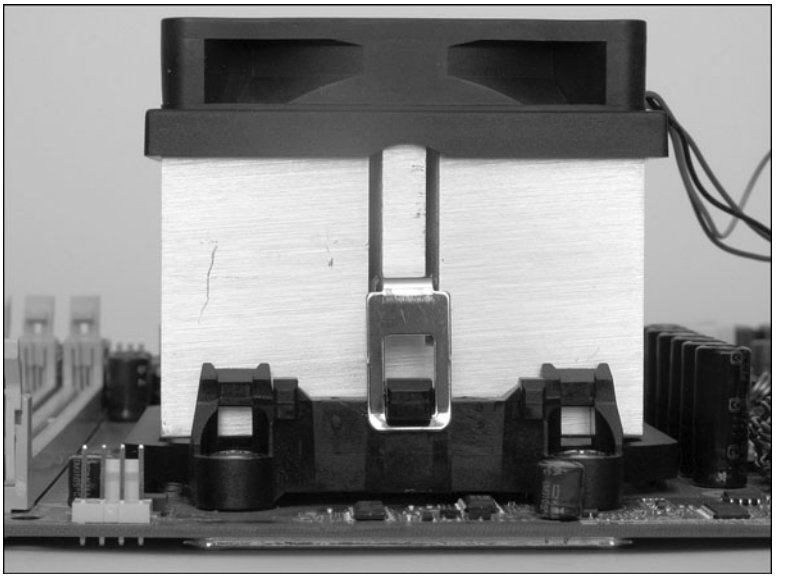

FIGURE 14.10
Slip one end of the clip onto the bracket.

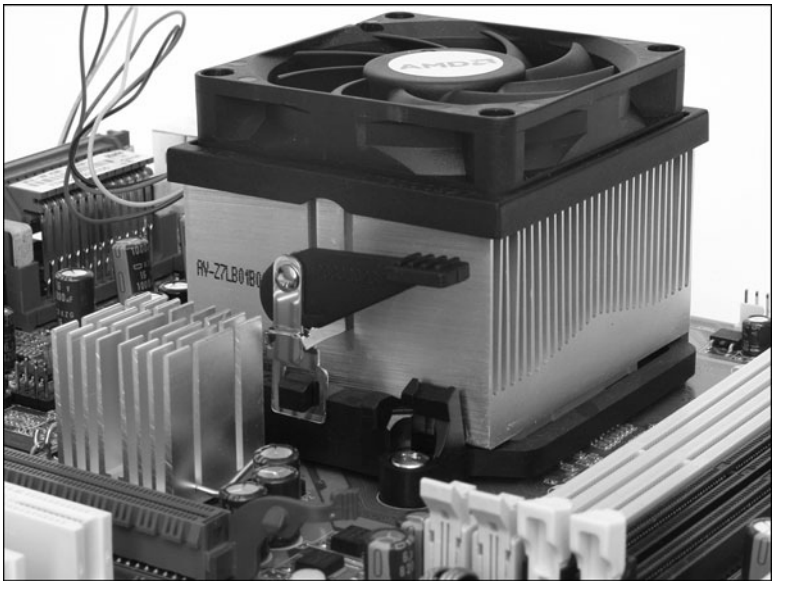

FIGURE 14.11
Pivot the lever clockwise to secure the cooler.

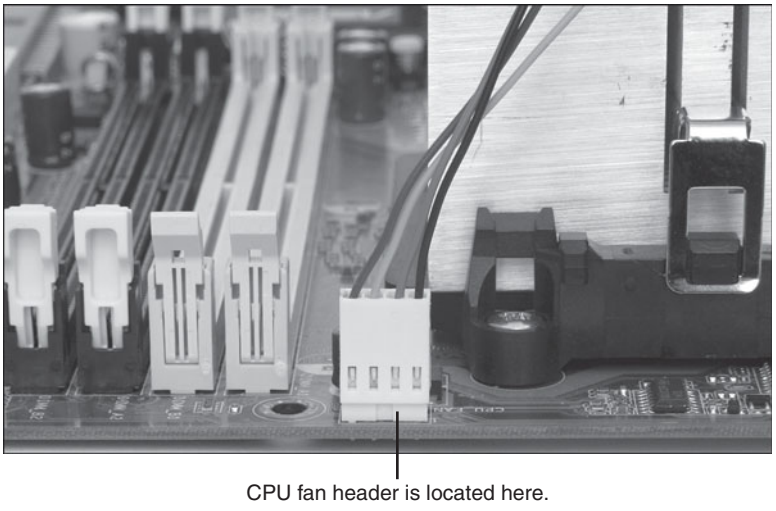

FIGURE 14.12
Connect the CPU cooler's power cable to the motherboard's CPU fan header.

Inserting the Memory Modules

Now it's time to populate your board with your memory modules. Where you install the modules on the ASUS M2A-VM HDMI board depends on how many modules you're adding (see Figure 14.13):

- **One module**—Install the module in either socket A1 or in socket B1 (the yellow sockets).
- **Two modules**—Install identical modules in sockets A1 and B1 (the yellow sockets). This ensures a proper dual-channel configuration.
- **Three modules**—Install a set of identical modules in sockets A1 and B1 (the yellow sockets) and the third module in either socket A2 or socket B2. I don't recommend this configuration because the size of the memory channel is determined by the third memory stick. For example, if you have two 1GB modules A1 and B1, and a 1GB module in A2 or B2, then the memory bandwidth will be only 1GB.
- **Four modules**—Install one set of identical modules in sockets A1 and B1 (the yellow sockets) and a second set of identical modules in sockets A2 and B2 (the black sockets). This ensures a proper dual-channel configuration.

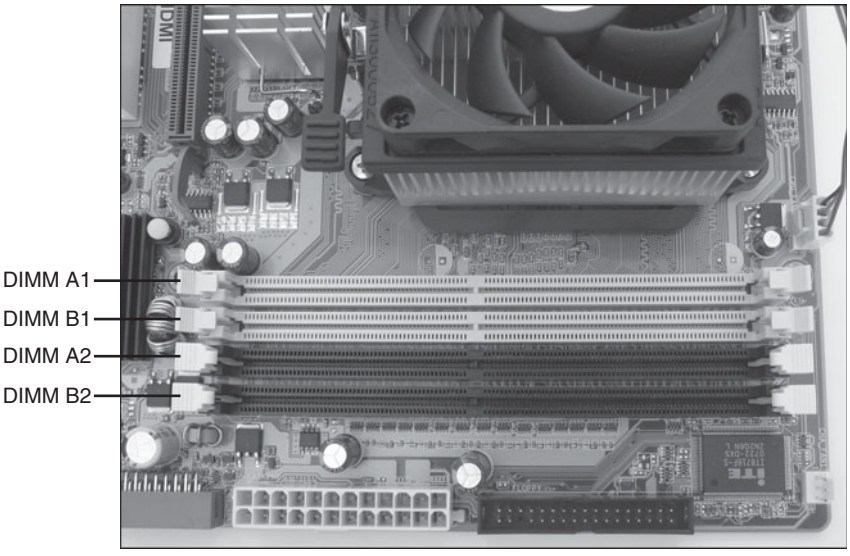

FIGURE 14.13
The memory module sockets on the ASUS M2A-VM HDMI.

I won't go through the installation steps here since I already covered how to install memory modules in Chapter 8, "Basic Skills for PC Building and Upgrading." Figure 14.14 shows our motherboard with our two 1GB modules installed.

➔ **See** "Installing Memory Modules," **p. 205**.

Installing the Motherboard

With your motherboard populated with a processor, cooler, and memory, it's just about ready to roll. The next few sections take you through the detailed installation steps for the motherboard. This is the most finicky, most time-consuming, and most important part of the build. As you'll see, getting a motherboard configured involves lots of separate steps and lots of cable connections. It's crucial to take your time and make sure you've got all the connections just so.

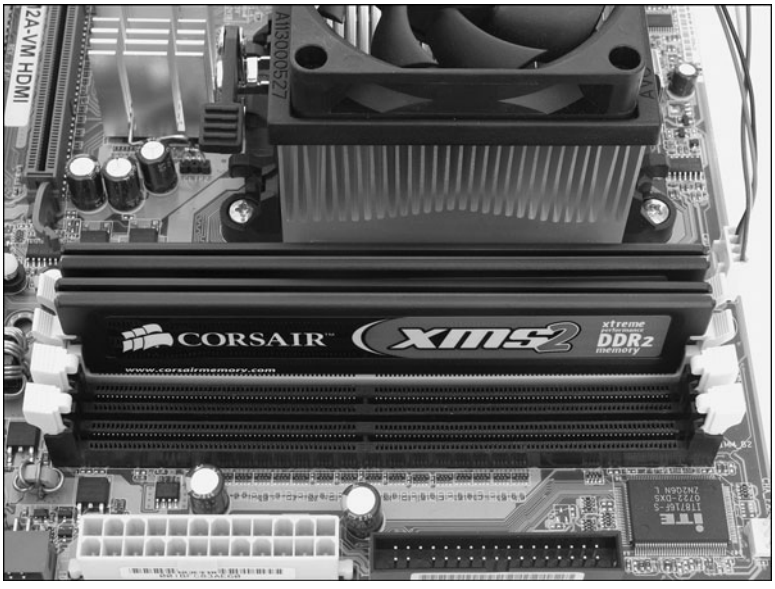

FIGURE 14.14
Our motherboard with two 1GB memory modules in place.

Inserting the Motherboard I/O Shield

Earlier you removed the case's generic I/O shield, so now it's time to insert the I/O shield that came with the motherboard. Take the motherboard's I/O shield and fit it into the case's I/O opening. Make sure you have the I/O shield oriented properly:

- The two holes for the mouse and keyboard PS/2 ports should be at the top, while the three audio ports should be at the bottom.
- The protruding ridge that runs around the I/O shield should face the back of the case.

When the I/O shield is flush with the case, firmly press the bottom of the shield until it snaps into place; then press the top of the shield until it, too, snaps into place.

tip It's not always easy to get the I/O shield perfectly seated. If you have trouble getting a corner of the shield to snap into place, use the end of a plastic screwdriver handle to gently tap the recalcitrant corner into place.

Attaching the Motherboard to the Case

With the custom I/O shield in place, you're now ready to install the motherboard inside the case. Here are the steps to follow:

1. Move all the case cables out of the way so you can clearly see the side panel that has the mounting holes and the installed standoffs.
2. If you haven't done so already, touch something metal to ground yourself.
3. Gently and carefully maneuver the motherboard into the case and lay it on top of the standoffs.
4. Adjust the position of the board so the board's back-panel I/O ports are lined up and flush with the openings in the I/O shield, as shown in Figure 14.15.

FIGURE 14.15

Make sure the motherboard's I/O ports are lined up and flush with the I/O shield's openings.

5. You should now see a standoff under each motherboard mounting hole. If not, it likely means the I/O shield isn't fully seated. Remove the board, fix the I/O shield, and then try again.
6. Use the mounting screws supplied with the case to attach the board to each standoff. To ensure a trouble-free installation, I use the following technique:

note Bear in mind, however, that it's normal for the board's mounting holes to be slightly offset from the standoffs. There's a bit of give to the I/O shield, so you usually have to force the board slightly to the left (toward the I/O shield) to get the holes and standoffs to line up perfectly.

- First insert but don't tighten the upper-right screw.
- Next insert but don't tighten the bottom-left screw. (The bottom-left screw is often the hardest one to install because it's usually in the corner of the case. If you prefer to start with an easier target, insert the bottom-middle screw, instead.)
- Make sure all the holes and standoffs are properly aligned, and then tighten the first two screws.
- Insert and tighten all the rest of the screws.

Connecting the Front-Panel USB and eSATA Cables

Our Antec case offers the convenience of two front-panel USB 2.0 ports. You need to connect the USB 2.0 ports' cable (the connector is labeled USB) to one of the motherboard's internal USB headers.

One nice perk we get with the Antec case is a front-panel eSATA port, which will be super-convenient for connecting an external SATA drive for backups or whatever. For this port to work, you must connect its black SATA cable to one of the motherboard's SATA headers.

Figure 14.16 shows the USB and eSATA cable connections.

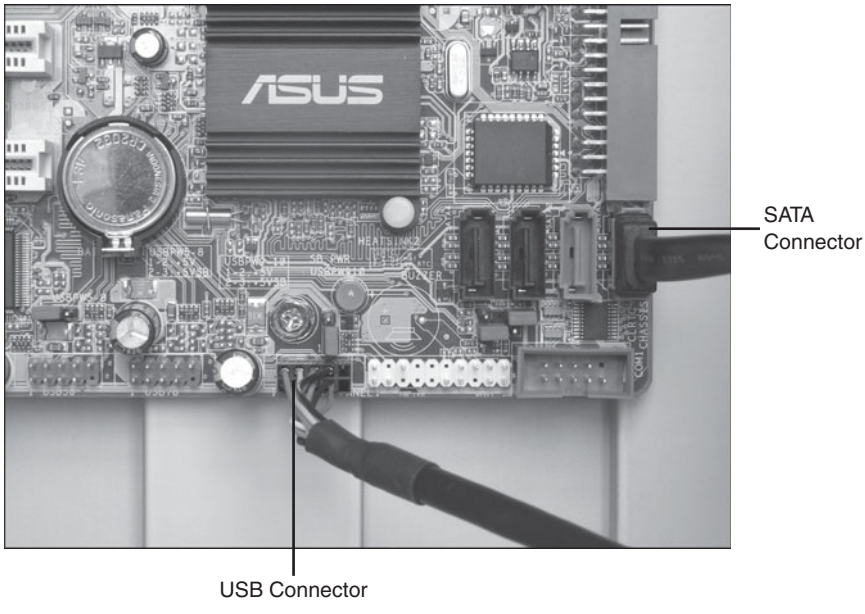

FIGURE 14.16

Connect the cable that runs from the USB 2.0 front-panel port to a USB headers, and connect the cable that runs from the eSATA front-panel port to a SATA header.

Connecting the Front-Panel Audio Cables

The rest of the Antec case's front-panel ports consist of Line Out (audio output) and Mic In (microphone input) audio ports. Note that the audio ports' cable has two connectors, one for standard audio (labeled AC '97) and one for high-definition audio (labeled HDA). Our ASUS motherboard supports HD audio, so you need to connect the HDA connector to the motherboard's audio header (labeled AAFP), as shown in Figure 14.17.

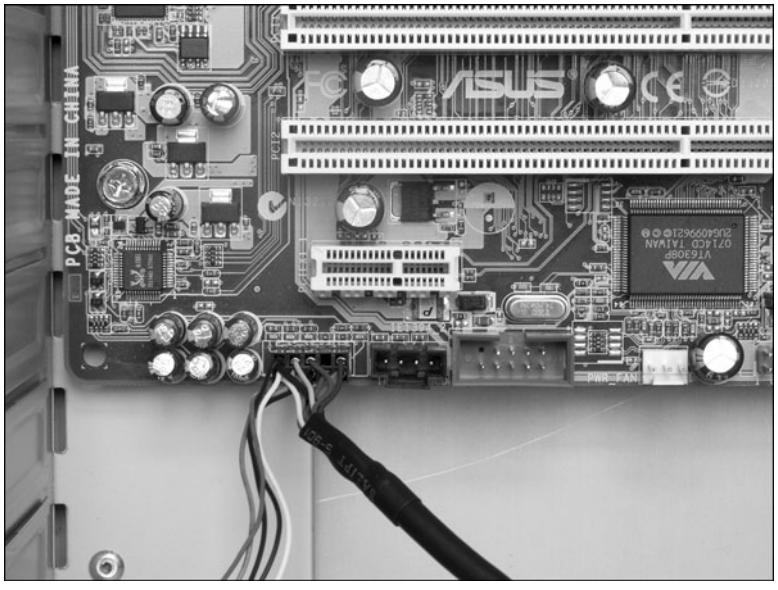

FIGURE 14.17

Connect the cable that runs from the front-panel audio ports to the AAFP audio header on the motherboard.

Connecting the Power Switch, Reset Switch, and LEDs

The next item on our build to-do list is to tackle the mess of wires snaking out from the front of the case, just below the external drive bays. These wires correspond to the following front panel features:

- **Hard drive LED**—This LED lights up when the hard drive is active. It consists of two wires with a single connector: the blue wire is the negative (ground) lead, the red wire is the positive (signal) lead, and the connector is labeled H.D.D. LED.

- **Power switch**—This is the button you press to turn the system on and off. Its lead consists of two wires, one white and one green, and the connector is labeled POWER SW.
- **Reset switch**—This is the button you press to reboot a running system. Its lead consists of two wires, one white and one blue, and the connector is labeled RESET SW.
- **Power LED**—This LED lights up when the system is powered up. It consists of two wires with a single connector: the blue wire is the negative (ground) lead, and the green wire is the positive (signal) lead; the connector is labeled POWER LED.
- **Speaker**—This is the lead for the case's external speaker. It consists of an orange and black pair of wires with a connector labeled SPEAKER.

Connecting all these wires is a bit tricky, but the good news is that the ASUS motherboard comes with a special connector that can greatly simplify things. It's called the Q Connector and contains the 12 pins that are required by the five front-panel connectors. Each pin is labeled, so you can easily see where each front-panel connector goes. After you've attached all five leads, you then attach the Q Connector itself to the motherboard's front-panel header.

Figure 14.18 shows the pin assignments on the Q Connector.

Given the pin assignments shown in Figure 14.18, here's how you connect the front-panel wires:

- **Hard drive LED**—Connect this with the red wire on IDE LED + and the blue wire on IDE LED –.
- **Power switch**—Connect this with the green wire on PWR and the white wire on Ground (Power).
- **Reset switch**—Connect this with the blue wire on Reset and the white wire on Ground (Reset).
- **Power LED**—Connect this with the green wire on PLED + and the blue wire on PLED –.
- **Speaker**—Connect this with the orange wire on +5V and the black wire on Speaker.

Figure 14.19 shows the wires connected to the Q Connector and points out the motherboard's front-panel header to which you attach the Q Connector.

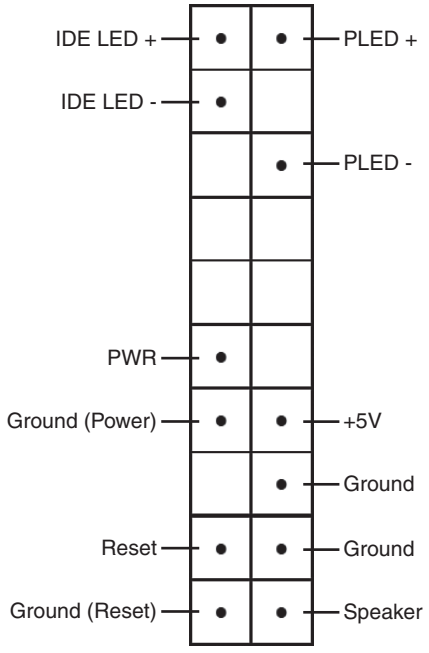

FIGURE 14.18

The pin assignments used on the Q Connector.

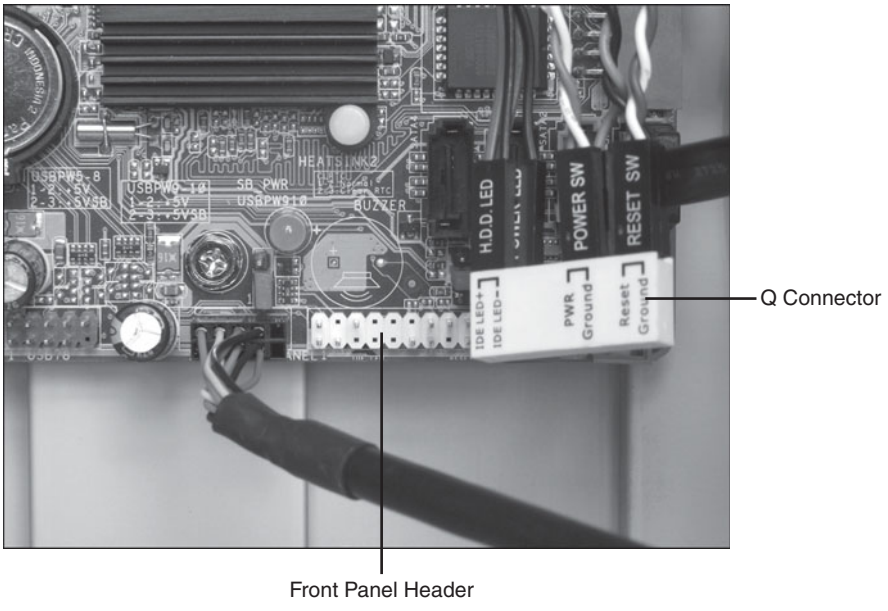

FIGURE 14.19

Connect the front-panel wires to the Q Connector, and connect the Q Connector to the motherboard's front-panel header.

Installing the Hard Drive

The Antec case offers four internal hard drive bays, each of which has a metal bracket that slides in and out of the bay. You remove the brackets, attach the hard drive, and then reinsert the bracket.

Here are the steps to follow to install a hard drive:

1. Pull the bracket out of the drive bay you want to use.
2. Lay the hard drive inside the bracket as follows:
   - The interface and power connectors should face toward the back (open) end of the bracket.
   - The hard drive label should be facing up (that is, the underside of the hard drive—the side where the circuit board appears—should sit on the silicone grommets inside the bracket).
3. Align the four holes on the underside of the hard drive with the four holes on the bracket, and then use screws to attach the hard drive to the bracket. Figure 14.20 shows the hard drive attached to the bracket, and it also shows one of the screws you need to use to make the attachment.

note There's actually no reason you couldn't orient the drive with the interface and power connectors facing the opposite way (that is, toward the inside of the case). If you do this, however, be sure to connect the SATA interface and power cables to the drive before inserting the bracket back into the drive bay.

FIGURE 14.20
Each drive bay contains a bracket to which you attach the hard drive.

4. Slide the bracket/hard drive into the drive bay until it clicks into place.
5. Run a SATA cable from the hard drive's interface connection to a SATA header on the motherboard, as shown in Figure 14.21.

FIGURE 14.21
The hard drive with a SATA interface cable attached.

Installing the Optical Drive

You add the optical drive to your system by inserting it into one of the Antec case's 5.25-inch external drive bays. Here are the steps to follow:

1. Touch something metal to ground yourself.
2. Open the bezel door in the front of the case.
3. Remove the plastic cover for the top drive bay.
4. Remove the two purple rails that are attached to the inside of the drive bay cover.
5. Use screws to attach the rails to the sides of the optical drive, as shown in Figure 14.22.

note Most optical drives give you a choice of fronts, usually beige or black. If your optical drive currently has a beige front, switch to the black, which will look better with the black bezel of the Antec case. See the drive's manual to learn how to exchange fronts.

FIGURE 14.22
Attach a purple rail to each side of the optical drive.

6. With the optical drive's connectors facing the inside of the case, slide the drive into a drive bay until it clicks into place. The front face of the optical drive should be lined up with the case bezel.
7. Close the bezel door.
8. Run a SATA interface cable from the optical drive's interface connection to one of the motherboard's SATA headers, as shown in Figure 14.23.

Inserting the HDMI Card

Finally, we need to install the HDMI card that came with the ASUS board. This is a PCI Express x16 card, so it will fill our board's single x16 slot. I won't go into all the details here because I gave you specific instructions on inserting an expansion card in Chapter 8.

➔ **See** "Installing an Expansion Card," **p. 211**.

Here are the basic steps:

1. Touch something metal to ground yourself.
2. Remove the screw and the slot cover that corresponds to the PCIe x16 slot.
3. Insert the HDMI card into the slot and attach it to the case with the screw.
4. Connect the HDMI card's S/PDIF digital audio cable to the motherboard's S/PDIF Out digital audio header, as shown in Figure 14.24.

FIGURE 14.23
The optical drive's SATA interface connection.

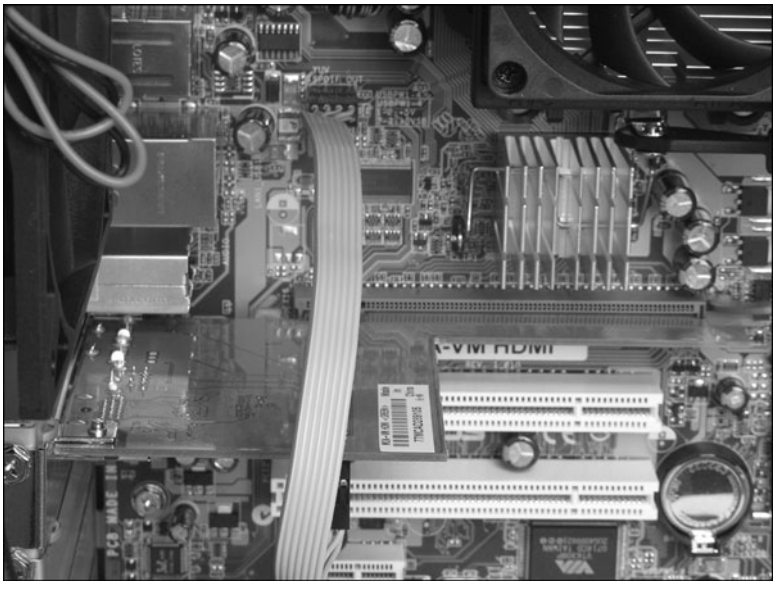

FIGURE 14.24
Connect the HDMI card's digital audio cable to the digital audio header on the motherboard.

Installing the Case Intake Fan

To ensure good airflow through the case, we should add to the case's default exhaust fan an intake fan. Our Antec TriCool 120mm fan attaches to the fan mount, which is on the outside wall of the 3.5-inch drive bays. (By *outside*, I mean that part of the wall that faces the motherboard.)

Here are the steps to follow:

1. Orient the fan so the Antec label faces the inside of the case.
2. Align the fan with the mount's four holes.
3. Use the long screws that came with the Antec case to attach the fan to the mount, as shown in Figure 14.25.

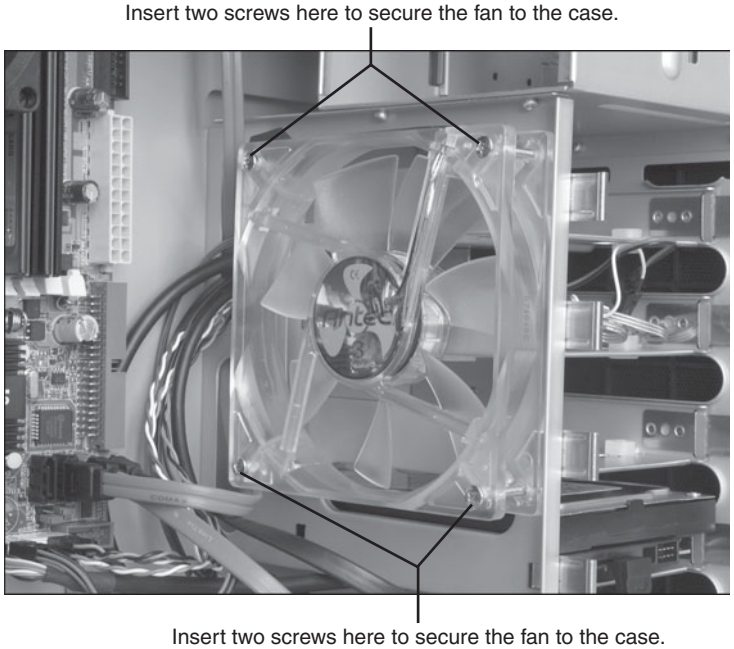

FIGURE 14.25

Attach the intake fan to the fan mount on the wall of the 3.5-inch drive bays.

Connecting the Power Cables

Our next order of business is to connect the power cables that supply juice to the motherboard and peripherals.

First, note that our ASUS board has two power headers:

- A 24-pin main power header, into which you plug the power supply's 24-pin connector, as pointed out in Figure 14.26.
- A 4-pin 12V header, into which you plug the power supply's 4-pin connector, as pointed out in Figure 14.26.

tip Most of the pins on a power cable connector are square, but a few are rounded on one side. These rounded pins have corresponding rounded holes on the header. To install a power cable connector with the correct orientation, match up the rounded pins with the rounded holes.

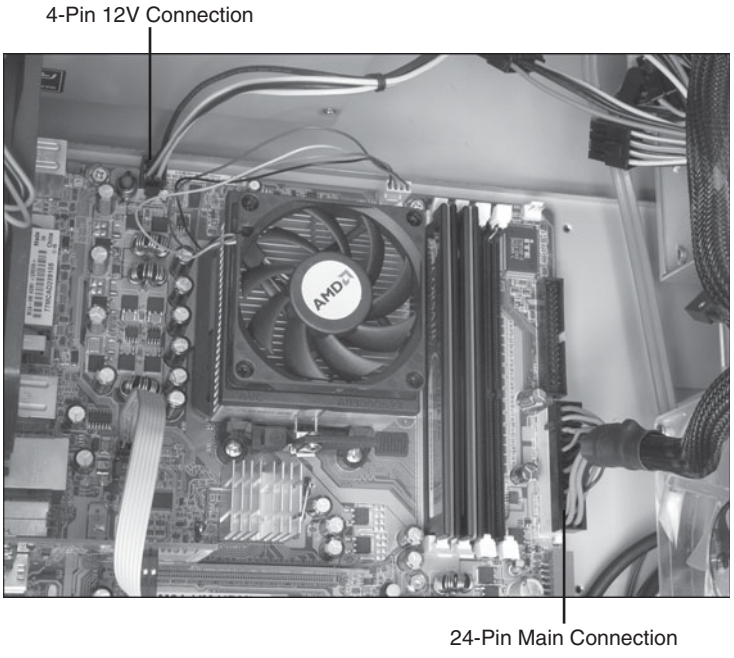

FIGURE 14.26

Connect the power supply's 24-pin and 4-pin connectors to the corresponding headers on the motherboard.

Your next chore is to connect the power leads for the two case fans. The rear exhaust fan (the one that came with the Antec case) only has a 4-pin Molex connector, so you must connect it to a 4-pin Molex connector on a power supply peripheral rail. The front intake fan that we added earlier comes with both a 4-pin Molex connector and a 3-pin motherboard connector. Attach the Molex connector to a 4-pin Molex connector on a power supply peripheral

rail, and attach the 3-pin connector to the motherboard fan header labeled CHA_FAN1, which is located in the upper-right corner of the board.

Finally, you need to get power to the drives:

1. Connect a SATA power cable from the power supply to the optical drive's power connector.
2. Connect a SATA power cable from the power supply to the hard drive's power connector.

Final Steps

Okay, your budget PC is just about done. However, there are a few tasks you should perform and a few things you need to check. Here's the list:

- **Route and tie off the cables**—A well-built PC doesn't just have cables all over the place. Instead, the cables should be routed as far away from the motherboard as possible, and as close to the sides of the case as possible. This makes the inside of the case look neater and improves airflow throughout the case. Use cable ties if need be to keep unruly cables out of the way.
- **Double-check connections**—Go through all the connections and make sure they're properly seated.
- **Double-check devices**—Check the hard drive, optical drive, and expansion cards to ensure that they're not loose.
- **Look for loose screws**—Make sure there are no loose screws or other extraneous bits and pieces in the case.

Powering Up

Now, at last, you're ready to fire up your new PC. Rather than just diving willy-nilly into the operating system install, however, there's a procedure I like to follow to ensure the BIOS, motherboard, and processor are all working in harmony. Follow these steps:

1. Connect a monitor, keyboard, and mouse to the PC, and then turn on the monitor.
2. Connect the power cable to a wall socket and then to the power supply unit.
3. If the PSU's switch is off (0), turn it on (1).

4. Open the bezel door and press the power switch on the front of the case. Make sure the case fans and CPU fan are all working.
5. Press Delete to enter the motherboard's BIOS configuration program, which is called CMOS Setup Utility.
6. Make sure your devices are working properly by checking the following:
   - In the Main screen, check the date and time and set them to the correct values, if necessary.
   - In the Main screen, check the SATA headers to make sure you see two devices listed: one is the hard drive and the other is the optical drive.
   - In the Main screen, check that the Installed Memory section shows 2048MB.
   - In the Boot screen, select Boot Device Priority, select 1st Boot Device, highlight CDROM, and press Enter.
7. Press F10 to save your changes and exit CMOS Setup. The program asks you to confirm that you want to save changes:
   - In the Main screen, select System Information and check the Processor section to make sure the Intel Core 2 Quad appears. Also, check that the System Memory section shows 2048MB available.
   - In the Boot screen, select Boot Device Priority, select 1st Boot Device, highlight CDROM, and press Enter.
8. Press F10 to save your changes and exit System Setup. The program asks you to confirm you want to save changes.
9. Press Enter and then press the power switch to shut down the PC.
10. Replace the case's side panel.
11. Connect the computer to your network by running a network cable from the back panel's network port to your switch or router.
12. Press the power switch on the front panel.
13. Open the optical drive and insert your operating system disc. (For my build, I installed Ubuntu, a really nice—and, appropriately for a

note If all is well with your motherboard power connections, the board's power LED (located right beside the main 24-pin power header) will light up as soon as your turn on the PSU. If the LED remains off, turn off the PSU, remove the power cable, and then check your motherboard power cable connections.

budget PC, free—Linux distribution.) The computer will now boot from the disc and install the OS.

14. If you install Windows, be sure to update your version—particularly by installing all available security patches—immediately. Also, use Device Manager to check for device problems (see Chapter 17) and install drivers for any device Windows didn't recognize.

➔ **See** "Updating Device Drivers," **p. 519**.

15. Update the motherboard's BIOS, as described in Chapter 17.

➔ **See** "Updating the Motherboard BIOS," **p. 507**.

When the OS is installed and running, insert the ASUS 690G Chipset Support DVD that came with the board and run the install program. This contains all the drivers you need for the board's devices.

If you decide to install Linux as I did, you need to follow these steps to start the program that installs the Linux drivers:

1. Insert the disc and navigate to the `/LinuxDrivers/Chipset` directory.
2. Copy the file in that directory to the desktop. (In my version, the file is called `ati-driver-installer-8.35.5-x86.x86_64.run`.)
3. Start a Terminal session and change to your user account's Desktop directory (that is, enter `cd /home/`*`user`*`/Desktop/`, where *`user`* is your username).
4. Make the `.run` file executable by running the command `chmod a+x` *`file`*, where *`file`* is the name of the `.run` file. Here's an example:

   ```
   chmod a+x ati-driver-installer-8.35.5-x86.x86_64.run
   ```

5. Enter the command `sudo ./ati-driver-installer-8.35.5-x86.x86_64.run`, and enter your password if prompted. If the install program runs, skip the rest of these steps. Otherwise, you'll see a message similar to this:

   ```
   Detected version of X does not have a matching 'x130' directory
   You may override the detected version using the following syntax:
        X_VERSION=<xdir> ./ati-driver-installer-<ver>-<arch>.run
        ➥[--install]

   The following values may be used for <xdir>:
       x430         XFree86 4.3.x
       x430_64a     XFree86 4.3.x 64-bit
   ```

```
x680          X.Org 6.8.x
x680_64a      X.Org 6.8.x 64-bit
x690          X.Org 6.9.x
x690_64a      X.Org 6.9.x 64-bit
x700          X.Org 7.0.x
x700_64a      X.Org 7.0.x 64-bit
x710          X.Org 7.1.x
x710_64a      X.Org 7.1.x 64-bit
```

6. Determine which version you need to install (for example, I'm running Ubuntu 7.10, so I need x710).
7. Start a super-user shell by running the command `sudo -i`.
8. Enter the command `X_VERSION=`*`xdir`* `./`*`file`*, where *`xdir`* is the version number from step 6 and *`file`* is the name of the `.run` file. Here's an example:

   ```
   X_VERSION=x710 ./ati-driver-installer-8.35.5-x86.x86_64.run
   ```

   You should now see the installer, as shown in Figure 14.27.

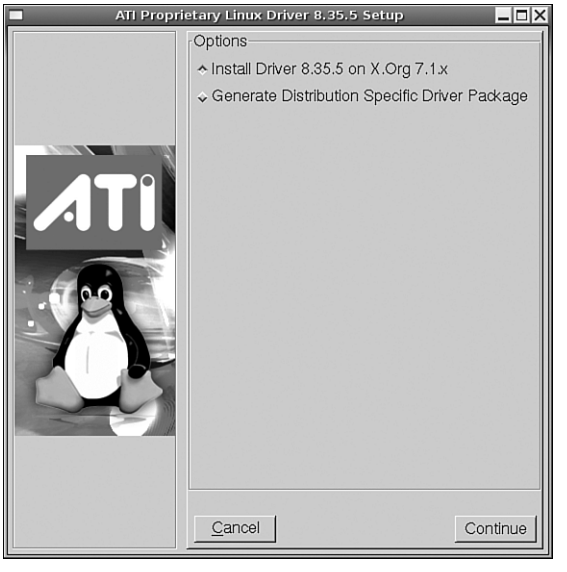

FIGURE 14.27
Run the Linux Driver Installer to install the chipset drivers.

Final Thoughts

> **tip** If you decide to install Ubuntu and are new to the world of Linux, I suggest picking up a copy of *Ubuntu Linux Unleashed, 2008 Edition*, by Andrew Hudson and Paul Hudson, published by Sams.

This build was a real pleasure from start to finish. The Antec case was great to work with: roomy and well laid-out, with excellent fit-and-finish. Everything installed without a hitch, and the build went real quick because we didn't have to install a power supply, video card, sound card, or networking card. All told, the build took about three hours, *including* doing the photography that accompanies this chapter, which is very fast. Your build time should be even shorter.

The initial boot went without any problems, and CMOS Setup reported that all devices were present and accounted for. I had Ubuntu installed within 25 minutes, and another half hour later I had the machine patched, the ASUS motherboard's drivers installed, and its BIOS updated.

From Here

- For the details on installing memory, **see** "Installing Memory Modules," **p. 205**.
- To learn about installing cards, **see** "Installing an Expansion Card," **p. 211**.
- If you need to temporarily remove the power supply, **see** "Releasing the Power Supply," **p. 234**.
- To learn how to use Device Manager to look for problem devices, **see** "Updating Device Drivers," **p. 519**.
- For instructions on updating the BIOS, **see** "Updating the Motherboard BIOS," **p. 507**.
- For the specifics on installing an AMD processor, **see** "Installing an AMD CPU in a Socket AM2 Board," **p. 219**.

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