Building a Computer

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Summary: An introductory how-to guide on building a personal computer with basic vocabulary and general instructions.

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The Modern Computer: A Brief History

The first computer is difficult to identify due to the global definition of the word, which varies between cultures, scientist classifications, and historians. The first digital computer however, after a long legal battle, was determined to be the Atanasoff-Berry Computer. This computer pioneered the start of many modern concepts such as the use of binary arithmetic (Campbell-Kelly, Martin; Aspray, William 1996). Binary is the language of computers, comprised of only the numbers one and zero, using a base of two. At a core level computers identify the number one as an on signal and a zero as an off. Early computers were used for mathematical computations only, so mathematicians were able to convert our decimal system of base ten to the binary system of a base of two.

A standalone computer. is a computer that can function on its own without support from outside sources, such as a network or a vast majority of programming knowledge to allow it to function that uses a graphic user interface (GUI). The Xerox Alto was the first computer to use a GUI that operated the operating system, the software that uses the electronic hardware to complete computations and actions, in the background that has brought us out of the early age of computers (David K. Every 1999.) Microsoft Windows, the operating system most people are aware of, is an example of the GUI systems in present time that has since upgraded from the MS-DOS system which was only a command line that performed tasks based on code inputted into the system. Apple Computers and the Linux Foundation, as well as Google, have created operating systems that use a graphic user interface.

As technology advances, computers of all styles become smaller, quieter, and more efficient. Cell phones, a type of computer, are a prime example of this technological growth (Knight, T. 2013).

The Digital Age, which everyone has adapted to, only concerns themselves what is on screen. Documents are sent via the Internet, pictures are sent wirelessly, and that video of last night's engagement party is already on as many social media platforms as any person could possibly think of and manage. This information age has allowed humanity to condense their vast collection of knowledge into resources that anyone can access within minutes. Libraries and Universities, such as the University of Michigan have begun digitizing their knowledge to share with people across the world (Lib.umich.edu, 2014.)

Today's standard computers perform complex tasks simultaneously. They are networked to an information highway, called the Internet, that brings data in micro fractions of a second. Modern businesses, educational institutions, writers, and others use computers in their everyday lives. The standalone desktop computer is commonplace in many people's homes. Most users only gleam the surface of the computations and actions performed by this powerhouse, but the science beneath the hood has not been forgotten. In the following pages, we will skim the surface of the science put into the creation of a modern computer desktop system and how it is possible to build a desktop from parts.

What Makes a PC Tick?

The Personal Computer, PC for short, is a synonymous word for workstation and desktop. Any computer, which includes laptops, phones, and tablets are comprised of a variety of parts that vary in size and processing power, but all systems' parts function similarly. The required components of a desktop computer are a Power Supply Unit (PSU), Motherboard, Central Processing Unit (CPU), Random Access Memory (RAM), an input device such as a mouse or keyboard, and an output device such as a monitor for viewing information. Additional components include a hard drive disk, optical disk drives and peripheral devices. Let's take a moment to view each item more in depth.

The inside of a computer is shown to have many parts that interconnect which allows data to be processed through the various components (Rhee, E. 2011.)

Simply stated, a computer runs on electricity, it is the only way it will function. Specifically, a computer must have a constant flow of electricity that remains at the same level so that all components receive the power they need to function. A power supply unit does not create electricity for the computer, but instead converts it for the computers use. The electricity provided by the wall outlets in home, offices and other places is distributed in Alternating Current (AC) that fluctuates in power, while Direct Current (DC) is a steady stream that the computer needs to function. DC energy only has two states, on and off, like binary which is another reason why computers are only able to use this type of electricity. The power supply, much like a human's digestive system intakes energy and changes it into a form that is most usable. This in turn allows us to view the additional components inside the computer that use this power.

A motherboard can be compared to the human nervous system. It is the backbone of the computer that connects all of the components to each other. Data travels along the grooves, known as traces, on the board to the other components of the computer. Modern computer motherboards contain a program known as the BIOS, Basic Input-Output System, which monitors the system's hardware and the current date and time. Without the motherboard a computer's components could not communicate, much similarly to a human without a spinal cord. Of course following the computer-human metaphor, the nervous system of a human is useless without the brain, so there is a separate component responsible for thought which is called the Central Processing Unit.

The CPU, processor or microprocessor, is comparable to the brain in a human being. It computes all data, managing the operating system such as Microsoft Windows or Apple's OS X, processing inputted actions by the user and any other needs of the system. The CPU is made up of additional parts that process information using the binary system discussed in chapter one. Features of the processor determine how well it can function that are discussed later in chapter six. When information is not being processed it is held in the system's RAM.

RAM, an acronym spelling out Random Access Memory, functions similarly to the thought process of human beings. Having complex brains ourselves, thoughts, priorities, and other activities going on reside in a part of our brains that allow us to remember thoughts. RAM modules, while separate from the CPU, serve this function. RAM is volatile meaning that it only retains the information in the moment and needs to be refreshed, or reminded, and will lose it's hold on data if it loses power. Information that is stored even when the computer is turned off is saved on the hard drive.

The hard drive and optical disk drive are storage devices that allow the retention of data even when the system is no longer on. More information is discussed in chapters eight and nine respectively. Input devices are anything that introduces a command to the computer, this could include a mouse click, typing on a keyboard, using a webcam to take a picture, or scanning a barcode. Output devices are products of the inputted information, a monitor display actions that are inputted and processed, and a printer provides a hard copy of information in a tangible form.

The designation of a computer is dependent on the parts' features used in its creation and the user's intention for the device. For instance, a graphic designer would intend to use their computer to create and print their artwork. Graphic design programs are very resource intensive that require a great amount of processing

power. This in turn means that the components used in their computer will need to be of a high quality to meet the demands of their needs. In addition, an output connection must be available on their computer to plug in a high quality printer so they can print their own art work. The requirements for each application varies and must be considered before purchasing the computer parts that will be used for the build.

The human variable of intention, use, and technical knowledge is also an important factor. Many users prefer efficient machines that come at a low cost. By building a computer, instead of buying one, the cost comes down but the quality of the parts isn't diminished. In the following chapters the selection of these parts and the installation will be introduced.

Making a Selection: Compatibility

Compatibility is the most important factor when deciding on computer components. Just as the outside of a computer is different, with a variety of ports, the connections on the inside are just as important. The simplest way to check for compatibility if by lining up the information about each component and determining if the required equals or exceeds the needs of the component. The most basic example is the components compatibility with a power supply unit. The power supply needs to have enough connections so that each part can draw electricity from it. In addition, adapters may be needed for connectors if the components are older. The only computer parts that do not require their own electrical input is the CPU and RAM, which draws them from the Motherboard that they are connected to.

Continuing on the thread of compatibility, parts must be compatible to each other. Discussed later in this chapter, when selecting a case, the form factor (shape/size) of the motherboard must be supported in order for it to fit inside and line up with the panel so that the ports in the back of a computer line up. Furthermore, the processor socket on the motherboard must match the processor type which is determined by how many pins each of them has. To make matters even worse, the motherboard must also support the connectors for the hard drive, and match or exceed the accepted frequency that RAM is measured in.

Barebone Kits are pre-determined computer components that meet the compatibility requirements. These kits are great for beginners who still struggle with compatibility issues (Tigerdirect, 2014.)

Compatibility is usually the hardest part of building a computer and requires a little bit of research. The best advice is to start with the component that you will absolutely need. For instance, if the computer must have seven audio ports in order to plug into your home stereo system you would start with the motherboard because that is where that requirement is built on the PC. From there it can be decided what processor will fit into the socket and what RAM is accepted. After completing the search, the power supply should be selected last so that there isn't a shortage of power connectors. Subsequent chapters will contain more information on compatibility pertaining to that particular part.

The Chassis, case, of a computer is also a choice that a user must make when building a computer. When choosing a case there must be enough space for all the parts to fit. Users with high budgets can order custom cases that meet their needs. Cases usually come with a pre-installed power supply, but they can be uninstalled in the event a better one is required. Also, cases often come with open vents and fans that help cool the system down. A hot system is a soon to be not working system.

Cases come in a variety of flavors. There are simple chassis and then there are custom models, your computer case could even be made of wood! (Newegg, 2014) (Tigerdirect, 2014)

Of Course, Electricity!

As stated before, the power supply does not generate its own electricity, but converts the energy provided by the wall outlet into a usable form. When selecting a power supply there is two things to be aware of, the first is Watt capacity and the other is amount of available connectors. Mentioned in the previous chapter, compatibility is an issue, but with these quick notes it should make things easier.

Watts is the amount of joules per second produced by the conversion of energy. In short, how much energy the power supply can offer to the system it is plugged into. Each component requires an amount of designated wattage, without such the part may not even power on. In general a medium range system will require 500 watts to work. Calculators are available to approximate the amount of watts required for a conceptual system design, so it is better to overestimate than to go under. Unfortunately, since each part is unique that requires its own watt value, there is no officially published estimation chart for each component.

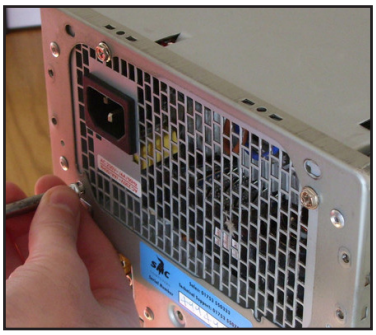
The second concern, the available connectors is a much easier problem to solve. Once selecting all of the components, it is a simple match of connectors on the components to the power supply that will be purchased. If a power supply is short on connectors than a higher model will be needed. Power supplies have a motherboard connector, peripheral power connectors, and auxiliary connectors. Based on the type of components selected will depend on the connectors chosen. For example, modern motherboards require the main motherboard connector known as a P1 connector and one auxiliary connector. The hard drive that was selected uses an older model power connector called Molex, instead of SATA, which means that PSU that is being selected must have this connector otherwise an adapter will need to be purchased as well.

Often power supplies are pre-installed to the chassis, but sometimes you may wish to get your own or upgrade. Power supplies come in two types, standard and modular (XFX, 2014) (Ultra, 2014.)

Before beginning the installation instructions for any of the components, it is important to note safety instructions. First and foremost, anything that is not specific or cause uncertainty, can be resolved by referring to the components manual. There are over a million possible combination of components, some with very unique installation instructions. Since this is the case, the provided instructions are as detailed as possible, but general and are still applicable to the majority of systems.

The second most important safety instruction is the prevention practice of Electrostatic Discharge (ESD). ESD is the more technical term for static electricity. Even though static electricity is not deadly to humans, it can prove fatal to computer components. In the event ESD equipment is not available, which includes anti-static wrist straps, mats, gloves, and bags, the user installing the parts should be at the very least grounded. Grounding yourself protect the components saving headaches and having to replace broken parts. The simplest way to ground yourself is by providing a direct connection to the earth by being in constant contact with a conductor that dissipates electricity. As a note, it is recommended to never work with components while they are on and connected to an electrical source. Being grounded is not recommended when working in such situations because electricity that surges through your body at high levels can cause harm or even death.

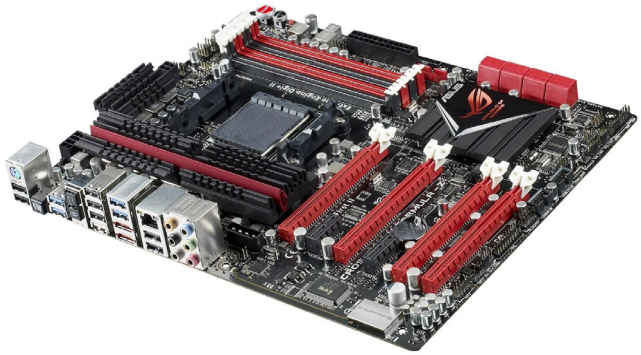
The PSU is most commonly held in place by a clip and several screws, making it one of the easiest components to install. Installing the PSU first avoids the future headache of fitting the box in after all the components are in the way. Using a screwdriver and opening the case, the power supply can be slid into the slot in the back of the case. The power supply will have a fan that should face outwards, either through a vent or the back of the case. Power connectors should be inside the case, while the power outlet cable should be able to plug in through the back of the case without having to go inside the case. If the case has a clip to hold it in place, sliding it into place should allow the clip to prevent the power supply from moving. Then the screws provided in the power supply box can be used to secure the PSU to the case from the outside.



The power supply must be screwed on the back of the case (TechRadar, 2010.)

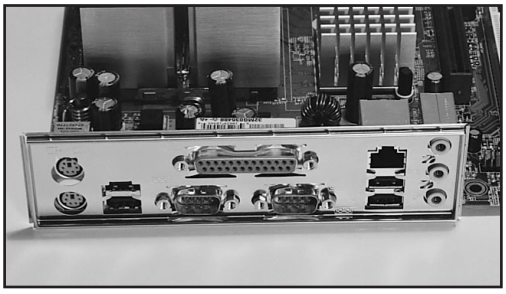
Installing a Motherboard

There are a variety of choices that make selecting a motherboard difficult. One of the most common factors for deciding is the ports on the board that are shown on the outside of the case. This includes where the Ethernet wire for the Internet is plugged in, the monitor cables are connected, and speaker connectors are. Each port has their own specification as well, so if a motherboard needs to be compatible with the printer that uses an outdated connector that would need to be taken into consideration. In this installation instance the motherboard was selected first, so the additional components were decided on the specifications for compatibility.



The motherboard is the backbone of the computer, all data flows through this component (AnandTech, 2014.)

Installing a motherboard is a three step process. The first step is to install the Input-Output (I/O) shield. The purpose of the shield is to prevent dust from easily getting inside the computer case. The secondary function is to hold the outside ports that are built onto the motherboard from moving around. To slide the I/O shield into place, from the inside of the case, push the shield into the corresponding opening. Some force is required, but not enough to bend the plate. The pins that jut out from each of the ports should be on the inside of the case so that they can grab the individual port when the motherboard is placed inside.



The I/O shield with motherboard outside of the case (PCGuide, 2005.)

The second step is to place the motherboard inside the case. Before sliding the motherboard in, it is important to install the tiny screw platforms, known as standoffs that were provided inside the motherboard box. Standoffs hold the motherboard off the side of the case, avoiding accidental ESD activity and allowing air to flow underneath the board. Using the screw holes in the case and the holes on the motherboard, screw in as many standoffs as possible. It is important to remember the orientation of the Motherboard when placing the standoffs in, recall that the motherboard ports must face the outside where the I/O shield was placed. After screwing in the standoffs the motherboard can be placed on top, aligning the screw holes with the standoffs, pushing it flush up against the I/O shield so the pins will keep hold of the ports. If required, obtain assistance to screw in the screws found alongside the already used standoffs to secure the motherboard in place.

The last portion is to connect the power pins to the motherboard from the case. Depending on the case, which can have a power on, reset, and eject button as well as LED lights, the instructions may vary. In the corner on the motherboard will be pins that have a variety of colors beneath. In order to get the power button and other parts of the case to work it will be necessary to connect them to this section. Each motherboard is different and even skilled technicians refer to the manual to identify which connector is placed on which pin. By plugging in the machine to the outlet, it is possible to test if the machine's power on button works. The computer may beep or make other noise, but it is nothing to worry about.

The Computer's Brain

Compatibility for a processor is the simplest selection out of all the computer components required for a PC. All of the qualities, with the exception of the socket type, determine the quality of the processor that is based on user preference and need. The socket type is used to determine compatibility to the motherboard. Matching the CPU socket on the motherboard to the processor confirms compatibility, that's it. Currently Intel and AMD are the two companies who develop processors for consumer use. Motherboards only accept one of the two processor. Intel follows a numbered naming scheme which includes the amount of pin the socket needs to use the processor such as 1175. In recent years, Intel has achieved a contract with Apple Computers which makes the Intel processor line the only processor inside Apple machines and holds the majority over the personal computer domain.

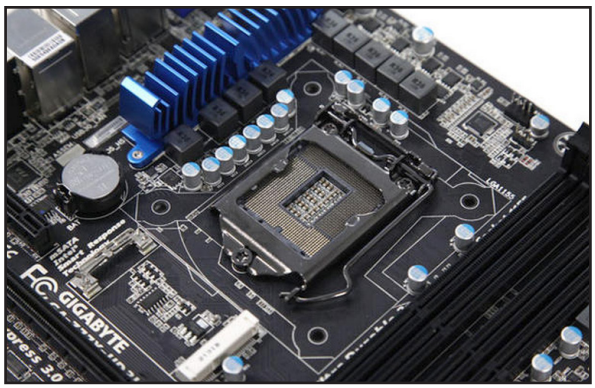
The processor can be metaphorically compared to a human's brain; all of the computers thoughts, the data being processed, occurs because of the central processing unit (Intel, 2014).

When opening the box of the CPU, it will usually come with a heat sink and fan. If it did not, then it is important that a cooling unit is purchased, because the CPU generates a lot of heat energy, enough to burn the silicon chip if left uncooled. Alternative cooling options include using a liquid cooling system or Peltier cooling, which converts heat energy into electricity and dissipates it. We will be using the provided cooling method because it is the most common. The heat sink absorbs heat from the processor and the fan cools the metal.

The most common cooling method is using
a heat sink and a fan (Puget Systems, 2014.)

Often the CPU will be accompanied by a cooling unit, since the CPU has such an intense workload heat is constantly being generated and can cause the silicone to melt if not cooled. Processors have a arithmetic logic unit (ALU) for interpreting the binary, a graphic portion in more modern CPUs for visual binary data, and caches to keep data strings together as they are processed. A common term discussed with microprocessors are "cores" which is the amount of ALUs a CPU has. A central processing unit is measured in Gigahertz (GHz), the amount of data cycles per second in terms of 10^9.

To install the processor and cooling unit use the following instructions. First, locate the CPU slot on your computer's motherboard. Second, open the socket, by unscrewing the screw and pulling the lever. Third, place the processor into the socket from a vertical angle. The orientation of the CPU is determined by the yellow triangle which can be found on the top side of the CPU in the corner, this is matched to a similar triangle on the corner of the socket. Next, use the lever to close the cover, using a small bit of force if necessary, screwing the cap closed.



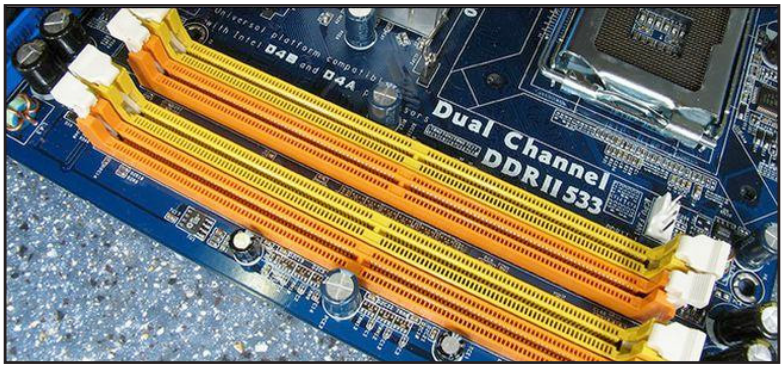
It's easy to damage the Motherboard when installing the
processor, but slow and steady makes this installation simple,
really just drop it in the socket (CNET, 2014.)

Now it is time to installing the cooling unit. Underneath the heat sink, a paste like substance can be seen that has been evenly applied. This is thermal compound to allow the uniform transition of heat from the processor to the heat sink. Lowering the heat sink onto the processor, the thermal paste should be touching the surface of the CPU. The heat sink should also be locked into place with usually four screws that surround the CPU socket. With the fan attached to the heat sink already, the only remaining thing is to connect the fan power. Located nearby should be a pin header that has the words “CPU FAN” etched into the board.

Random Access Memory Installation

RAM is the multitasker's best friend. In general, the more RAM a computer has the faster it performs and the more programs can be run at the same time. There are limitations of course and the quality of RAM also matters. Frequency is the compatibility issue here, but can easily be checked in the motherboard manual for supported numbers. Furthermore, RAM is measured in Gigabytes, some motherboards have a maximum supported value for an individual module. There are also different technologies that apply to RAM.

The majority of systems for sale currently use a technology called Dynamic RAM, which needs to be constantly refreshed even if the information is the same. Static RAM does not need to be refreshed and is considered better, but is more expensive. Additional the RAM modules are using a technology called Double Data Rate version 3 which is how fast data can cycle. Other factors when choosing RAM is latency, how fast information can move and be refreshed, as well as error checking for invalid data. In addition "channelling" is a technology that allows the motherboard to identify multiple identical RAM modules to be processed as a whole unit make it faster. Regardless of the characteristics all RAM for desktops is installed the same.



RAM slots that are the same color indicate the use the same "channel". The figure shown indicates there are two channels, so installing identical modules of RAM into both yellow slots will allow them to function as one unit (How-To Geek, 2013.)

RAM is the most easily installed computer component. Simply align the module with the slot, making sure that the notch on the bottom of the module where the gold pins are matches the slot bump. Sliding it down in a vertical motion apply pressure when installing it into the slot. RAM is held in place by clips, so when the clips snap into place the RAM has been successfully installed. Lightly try to pull up the RAM to verify that it is fitted snugly into place.

If you ask a technician they might say “RAM makes the world go round” which is mostly true, since RAM is what holds all the data when the processor isn’t handling it. Without RAM there is no working computer. RAM is the most easily installed component, all you have to do is slide it into its slot, nothing more! (BBC, 2014)

Mounting the Hard Drive

The hard drive is where all of the data that is saved is located. Basic digital literacy users know that as long as the hard drive is safe, their files can still be recovered. Hard drives come in two main types, magnetic and solid state. Magnetic drives use an electromagnetic field to record information in sectors on metal platters. Solid State Hard Drives are entirely electronic and contain no moving parts. Hard drives also come in two sizes, 3.5" and 2.5", the latter of which are usually used in laptops. Hard drives are measured in Gigabytes in terms of capacity. The operating system, documents, and programs are all found on the hard drive. Hard drives use a file system to organize files which varies based on the operating system and installation method.

On the current market, the largest commercially sold hard drive is 4 Terabytes or 4000GBs (Toshiba, 2014.)

Installation of the hard drive may require opening both sides of the computer case. First, locate the hard drive bay, the space that the hard drive can slide into, it usually is the front bottom portion of the case. After sliding in the hard drive, using the screws from the box, secure the hard drive in place by lining up the screw holes on the hard drive's side with the metal bay. In modern cases, hard drives are held in by a twist lock mechanism, which is just slide in and turn. Next, the power supply will have a matching connector for the hard drive, depending on the age of the components. A SATA power connector that is small and black, with 15 pins, is most common and has an "L" shape when looking into the connector. Lastly the SATA data cable needs to be connected, which is also "L" shaped, but connects from the hard drive to the motherboard, the location of which is both in the manual and etched onto the board.

Optical Drive Fitting

An optical drive refers to a disc drive that uses laser technology to read and write data to a disc. The first optical disk was a CD (compact disc) which uses a high light spectrum laser, to perform the read and write capabilities. Since it is not as powerful, data for these discs are not high. Progressively moving down the scale is DVD (Digital Video Disc) and then the blue laser technology known as Blu-Ray. As time moves on, users have grown less dependent on disc drives, but are still a useful tool for technicians. Optical drives use suffixes to indicate their abilities as indicated in the table below.

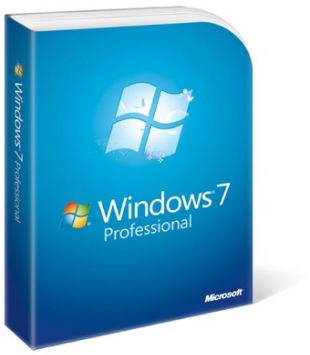
Suffix	Meaning
-ROM	Read Only Memory, the disc can only be read.
-W	Writeable, the disc can be written to once.
-RW	ReWriteable, the disc can be written to many times.

The installation for an optical drive is exactly the same as the hard drive installation. The only difference is the location of the slot. At the top of the computer, it will be necessary to remove the front facing plate so the drive can be accessed from the outside front of the case. Asides from that, the drive will be screwed in and connected through SATA cables, unless an older model was used.

A DVD drive can play both DVDs and CDs,
it is backwards compatible (Trigon, 2011.)

Installing an Operating System: Windows 7

To reiterate, an operating system is the software that interacts with the system's hardware for its base functions. The most common operating system used by home users, business entities, and educational institutions is Microsoft Windows 7. Windows 7 can be purchased online through retail outlets in a disc format with a unique product key that unlocks the full potential of the OS. The requirements of an operating system and its available versions are posted on the manufacturer's website. In addition, operating systems usually come in two distributions, 32- and 64-bit. The only key thing to note about these values are how much RAM is support, because only 64-bit operating systems can manage RAM amounts above 4GBs.



Windows 7 Professional is one of the many editions of Windows 7, most commonly used for small businesses (Softpedia, 2009.)

Windows 7 will be installed via an optical disc. Since there is not data on the hard drive the computer has nothing to load. In order to install the OS, we need to instruct the computer to load data from the disc. This done by selecting the Boot Menu option when the system is loading the BIOS. As mentioned before the BIOS maintains all basic system items, including what devices boot first. Commonly the boot menu button is F12, consult the motherboard manual if F12 does not work. F12 should be constantly pressed when turning on the computer. From the menu selected, using the keyboard, select the optical drive. The system will now boot from the disc this one time.

When the system loads the disc data, confirm selections to install, there will then be an option to upgrade or complete custom operation using the disc. Clicking custom will install a fresh install on the hard drive. Selecting next through the following menus will start the installation. The system may restart a few times in the process. Once finished the welcome screen will be displayed. The computer is now at the point where a newly bought computer would be. Installing the software from the CDs that came with some of the hardware and connecting to the Internet will allow Windows 7 to setup any hardware not automatically configured. Congratulations, you did it!

References

AnandTech,. (2014). *ASUS Crosshair V Formula-Z AM3+*. Retrieved from http://images.anandtech.com/doci/7548/ASUS%20CVFZ.jpg

BBC,. (2014). *RAM*. Retrieved from http://www.bbc.co.uk/staticarchive/ddc59afb20f73332b1bc9bd34eb-7f263946e0481.jpg

Campbell-Kelly, Martin; Aspray, William (1996), *Computer: A History of the Information Machine*, New York, NY: Basic Books, p. 84, ISBN 0-465-02989-2

CNET,. (2014). *LGA1155*. Retrieved from http://www.cnet.com/how-to/how-to-build-your-first-pc/

David K. Every (1999). "Innovation: Desktop Metaphor". mackido.com. Retrieved 22 October 2014.

How-To Geek,. (2013). *What Does the RAM Slot Color Coding on Motherboards Mean?*. Retrieved from http://cdn8.howtogeek.com/wp-content/uploads/2013/11/img_528005656b8e5.jpg

Intel,. (2014). *Intel® Pentium® processor Extreme Edition front and back*. Retrieved from http://download.intel.com/pressroom/kits/pentiumee/pentiumee_processor_both.jpg

Lib.umich.edu,. (2014). *Michigan Digitization Project*. Retrieved 25 October 2014, from http://www.lib.umich.edu/michigan-digitization-project

Knight, T. (2013). *The evolution of mobile phones*.. Retrieved from http://s3.timetoast.com/public/uploads/photos/4249818/phone-evolution.png?1376820000

Newegg,. (2014). *nMEDIAPC Red Wood Wood/Steel HTPC 8000 ATX Media Center / HTPC Case*. Retrieved from http://images17.newegg.com/is/image/newegg/11-204-039-TS?$S300W$

PCGuide,. (2005). *I/O Shield*. Retrieved from http://www.pcguide.com/byop/diagrams/figure14.jpg

Puget Systems,. (2014). *CPU Cooling*. Retrieved from http://images.pugetsystems.com/images/pic_disp.php?width=1000&height=650&id=14454

Rhee, E. (2011). *White T600 Inside*. Retrieved from http://i.i.cbsi.com/cnwk.1d/i/tim/2011/08/22/White-600T-insideon_1.jpg

Softpedia,. (2009). *Windows 7 Professional*. Retrieved from http://i1-news.softpedia-static.com/images/news2/New-Windows-7-Logo-and-Box-Design-4.jpg

TechRadar,. (2010). *Secure it*. Retrieved from http://cdn0.mos.techradar.futurecdn.net//classifications/computing/upgrades-and-peripherals/cases-and-cooling/power-supplies/images/howtoinstallpsu/step.04-580-90.jpg

Tigerdirect,. (2014). *IntelÂ® CeleronÂ®* G1850 2.9GHz Dual-Core CPU/Gigabyte GA-B85M-HD3/4GB DDR3 1600 *Adata XPG V1 Memory/1TB WD Blue 7200rpm SATA HDD/LG 24X DVDRW/Ultra X-Blaster V2 Case w/450W PSU Barebones*. Retrieved from http://images.highspeedbackbone.net/skuimages/large/B69-10183_main01_gp_mn_9130487.jpg

Tigerdirect,. (2014). *Ultra XBlaster Mid-Tower V2 Case*. Retrieved from http://images.highspeedbackbone.net/SkuImages/gallery/large/U12-41933_phcallout01_or_1709407.jpg

Toshiba,. (2014). *3.5" Internal Hard Drive*. Retrieved from http://www.toshiba.eu/contents/en_EU/SERIES_DESCRIPTION/images/sata-hard-drive-desktop.jpg

Trigon,. (2011). *Optical Drive*. Retrieved from http://trigon.com/Portals/42222/images/Optical%20Drive%20Support-resized-600.jpg

Ultra,. (2014). *Ultra X4 Modular 1050-Watt ATX Power Supply V2*. Retrieved from http://images.highspeed-backbone.net/skuimages/gallery/large/U12-40502_01.jpg

XFX,. (2014). *TS Series 430W PSU*. Retrieved from http://products.xfxforce.com/images/uploads_thumbs/20140820/20140820093715_430S-TS_3.jpg