Computers: More Than Meets The Eye

Paul S. Wang, Sofpower.com

May 25, 2023

Understanding computers is becoming increasingly important in today's digital age. Computers are pervasive in our daily lives, from smartphones and laptops to automated systems in various industries.

People say you cannot judge a book by its cover. It is also true that you can't know a computer by looking at its display screen. That is similar to knowing a car by examining its steering wheel. An under-the hood view will not only give you insights but also make you a better computational thinker.

Here we'll describe the modern computer in simple terms for everyone–its hardware, software, operating system, usage, files and folders, online use, and trouble shooting–just the basics, nothing fancy. We will also focus on computers for personal use and simply mention that other types of computers–supercomputers, mainframes, Web servers, database servers, cloud servers, and so on–are beyond the scope of this article.

Hardware

Modern PCs come in different forms: desktop, workstation, laptop, notebook, tablet, handheld, and smartphone. Computer hardware refers to the physical

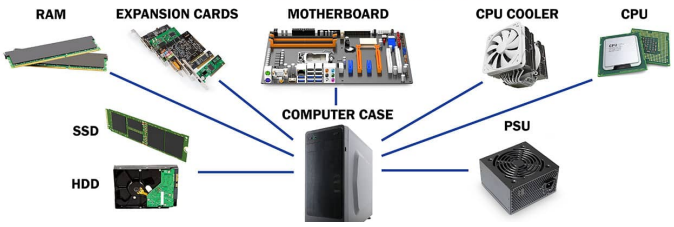

Figure 1: Typical Hardware Components

components of a computer. A component can be central or peripheral. Basic central components (Figure 1) include the central processing unit (CPU), random access memory (RAM), file and data storage devices (hard drives, solid-state drives), power supply and so on.

Peripherals can make a computer easier to use and simpler to add capabilities. Normally, a peripheral has its own power supply and is connected to the computer by special interface cables (for example VGA, DVI, HDMI, or DisplayPort for monitors) or wireless links via WiFi or Bluetooth.

Commonplace peripherals include monitors, speakers, microphone, headphone, webcam, printers, scanners, mouse, keyboard and so on (Figure 2).

Figure 2: Computer Peripherals

Operating System

A main function of the operating system is to control and utilize all the hardware and make the computer easily usable by people.

It brings life to the innate electronic hardware components and orchestrates all activities on a computer. The same hardware under a different operating system is literally a different computer. The operating system is a piece of software that is the master manager and controller of a computer, the whole computer. Figure 3 shows the most widely used operating systems.

The operating system provides service and control functions to users, programs, files, operators, display monitors, printers, network connections, and everything else on a computer system. The *kernel*, the most central part of an OS, has CPU specific features to take better advantage of any

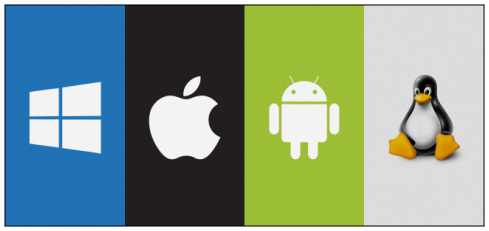

Figure 3: Popular Operating Systems

particular model CPU. A computer operating is one of the most complicated and sophisticated objects humans ever built.

A modern operating system consists of three main parts: a *kernel*, interfaces for users, programs, devices and networks, and a set of commands and apps. The kernel deals with central functions, including concurrent program execution, memory management, input/output (I/O), file services, networking and security. Commands and apps supply other operations such as file managers, text editors, email processors, Web browsers, software package managers, audio/video and image processing tools, language compilers, and so on. Interfaces define and support communications among all the components.

For users, the OS provides easy-to-use *Graphical User Interfaces* (GUIs) in the form of *desktop environments* (Figure 4). An OS also provides efficient and effective *Command-Line Interfaces* (CLIs) in the form of *Shells*. Famil-

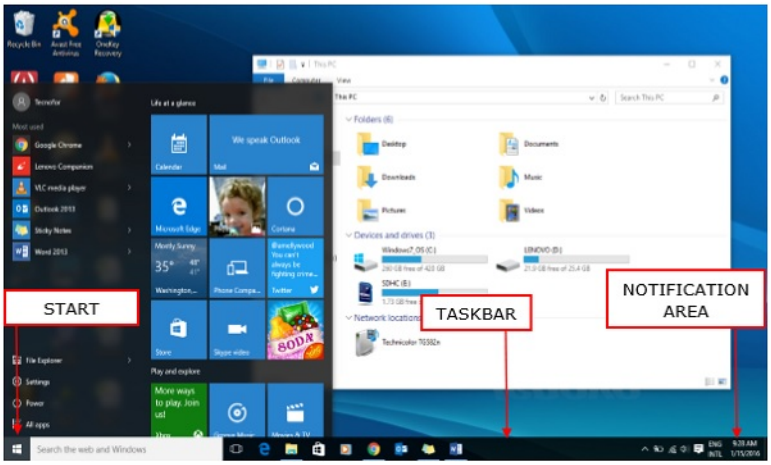

Figure 4: Windows 10 Desktop

iarize yourself with your systems. Learn how to navigate the file system, manage files and folders, install and uninstall software, install updates, and customize system settings. For example, you can set language preferences, define keyboard shortcuts, even choose a left-hand mouse setting.

Software Applications

The ultimate purpose of the hardware and OS combination is to run application programs (apps) in order to perform specific tasks. Today we seldom use a disk, cdrom, or dvd to install a new app. We simply go to the *app store* (Figure 5) to choose, download, and install any available app we like with just a few mouse clicks. How convenient. Common apps include word proces-

Figure 5: Windows App Store

sors (Microsoft Word, Google Docs), spreadsheets (Microsoft Excel, Google Sheets), presentation software (Microsoft PowerPoint, Google Slides), and email clients (Gmail, Thunderbird, MS Outlook).

When an app runs it becomes a *process*, which is the name for a program in execution (being run by the cpu). The OS handles and manages all processes and is responsible for their creation, suspension, scheduling, resumption, finishing, and destruction. The OS also controls inter-process communications. Modern OS allow *multitasking* on single-cpu computers, running processes concurrently by seamlessly and rapidly switching the cpu among the processes. If multiple cpus exist on the computer, then the OS also supports *multiprocessing* using all available cpus to run processes in parallel.

The desktop GUI allows you to run several apps simultaneously, each in its own window, and switch among them easily. Of course, these are in addition to other parallel activities that the OS coordinates and orchestrates, such as I/O, networking, printing, file transfer, display refreshing and updating.

Files And Folders

A computer offers an electronic filing system, known as a *file system*. That is a great advantage indeed. Storing data as files that can be accessed immediately by the user and by programs is essential for modern operating systems.

Each item stored in the file system is called a *file* and is identified by a *filename*. A file can contain other files, in which case it becomes a *folder*. Thus, unless indicated otherwise, when we say files we mean files and folders. Figure 6 shows the tree structure of files. In a file system there are separate

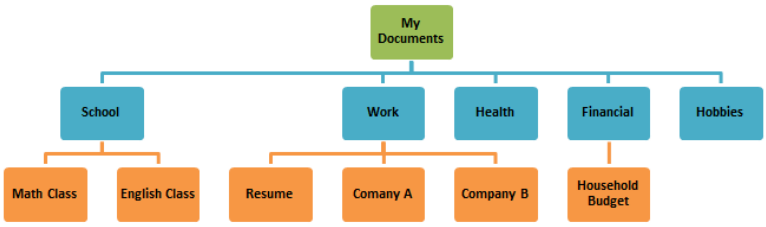

Figure 6: Tree Structure of Files

system-wide and *per-user* storage spaces. System-wide files are common to all users while per-user files belong to a particular user. Unless achieving *administrator status*, users can only manage/access their own files. Each user has a separate *home folder* where per-user files are stored.

The data type of a file is known as its *file type*. For example, a file may contain an email, a report, a tax return, a C++ program, a compiled program, an organized database, a library of mathematical routines, a picture/image, or an audio/video clip. Often the file type is indicated by the filename suffix, such as `txt` (text file), `jpg` (image file), `mp3` (audio file), `mp4` (video file), `doc` (MS Word file), `xls` (MS Excel file).

The operating system provides a consistent set of facilities allowing the user to create, store, retrieve, modify, delete, and otherwise manipulate files. The *physical* storage media (usually high-speed magnetic or solid-state disk drives) are divided into many *blocks* of *logical* storage areas. A file uses one or more of these blocks, depending on the amount of data in the file. Blocks are used and freed as files are created and deleted. The part of the OS kernel that creates, stores, retrieves, protects, and manages files is the *file storage system* (or simply file system).

Computer users, computational thinkers especially, should become familiar with organizing and managing files and folders on the computer, including creating, copying, moving, and deleting files as well as understand file formats and compatibility.

Internet and Web Browsing

Modern computers can hardly work without access to the Internet. Most functions of a computer have become Internet dependent. Files, folders, even emails can be online. Other operations depend on the cloud. A computer/smartphone connects to the Internet through an Internet Service Providor (ISP) by cable or 5G modem, DSL, ISDN, WiFi router (hotspot), or mobile data.

If the Internet connection goes down, it can bring serious disruptions to normal operations. The most obvious is "no Internet no Web access". That means no banking, shopping, video streaming, online chat, remote learning, video conferencing, shipping and delivery tracking, or many other operations. We need to understand web browsers (Figure 7), search engines, and the Internet in order to use them efficiently and effectively. In addition we need to evaluate the credibility of online sources, and practice safe browsing habits.

Figure 7: Major Web Browsers

Network access is not without concerns. With Internet access also comes certain security concerns. Computational thinkers, please familiarize yourself with concepts such as antivirus software, firewalls, and safe online practices. Understand the importance of strong passwords, software updates, and recognizing and avoiding phishing attempts. These are the prices to pay for the conveniences the Internet brings. Just hope it never goes down.

It is worth noting that other articles in this book will explain computer and information safety in much more detail.

Trouble Shooting

Computers provide such great capabilities, we depend on them working. Yet, we all may have unpleasant experiences when somehow the computer or Internet stopped working (Figure 8). And we needed to fix it pronto. Here are some tips for troubleshooting:

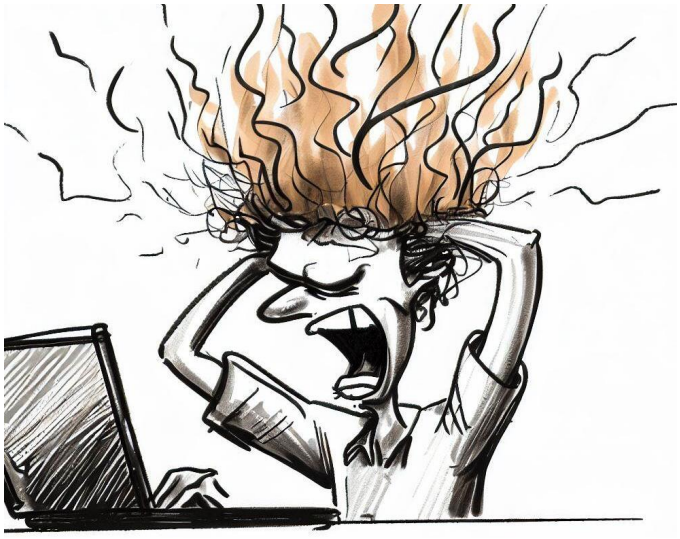

Figure 8: Oh No The Computer Or Internet Is Down

1. *Check the power supply*: Ensure that the power cable is securely plugged into both the PC and the power outlet. Confirm that the power outlet is functioning by testing it with another device. If you're using a power strip, make sure it's turned on and functioning properly. Consider trying a different power cable or power supply if available. Check power to the peripherals too. For a smartphone, laptop, or tablet check the battery power.

2. *Check network connections*: If no Internet, check your network router and Internet modem. Also check the network settings on your computer. Try restarting the modem and router, wait 30 seconds or so before turning the device back on.

3. *Examine the PC for physical issues*: Check if any cables, such as the monitor cable or USB cables, are loose or disconnected. Inspect the PC for any signs of damage, such as bent pins, loose components, or burn marks.

4. *Restart the PC*: Press and hold the power button for about five seconds until the PC powers off. Wait for a few seconds, then press the power button again to turn it back on. Sometimes a simple restart can resolve minor issues.

5. *Check monitor related problems*: Ensure that the monitor is turned on and receiving power. Check that the monitor cable is securely connected to both the monitor and the PC. Try connecting the monitor to a different port (e.g., HDMI, VGA, DisplayPort) on the PC. If you have a spare monitor or a TV, connect it to the PC to determine if the issue lies with the monitor.

6. *Listen for error beeps*: If your PC emits beeping sounds during startup, it can indicate specific hardware issues. Consult the PC's manual or the motherboard manufacturer's website to identify the meaning of the beeps.

7. *Disconnect external devices*: Remove any external devices connected to the PC, such as printers, scanners, external hard drives, or USB devices. Sometimes faulty peripherals can prevent the PC from starting up.

8. *Boot into Safe Mode*: If the PC powers on but fails to start properly, try booting into Safe Mode. Restart the PC and repeatedly press the F8 or Shift key (depending on the PC) during startup to access the advanced boot options. From there, select Safe Mode to boot with minimal drivers and services. This helps determine if a software or driver issue is causing the problem.

9. *Seek professional help*: If none of the above steps resolve the issue, consider contacting a help desk, a professional technician or the manufacturer's support for further assistance.

Remember to exercise caution when working with hardware components and consult professional help if you're unsure.

Personal Computer Inspired CT

Here we can point out several CT principles inspired by our understanding of the PC (Figure 9).

Figure 9: CT Inspiration

CT concept–*Central control*: *The OS is a model of total control over hardware, apps, files, users, peripherals, and networks.*

CT concept–*Connecting independent devices*: *To make the combined mechanism more flexible, extendable, and scalable..*

CT concept–*Hierarchical structure*: *A tree structure can be effective in many cases where a hierarchy is an effective organization. The file tree is an example.*

CT concept–*The Internet is the computer*: *It is hard to see where the computer ends and where the Internet begins. A computer can hardly work without a network connection.*

CT concept–*Parallel processing for speed and efficiency*: *The effectiveness of parallel processing has been demonstrated by multi-cpu and multi-core computers.*

CT concept–*A backup plan*: *If you are dependent on something then you need a backup plan if/when that thing fails. If the computer and Internet stop working how will you contact someone?*

Finally

The level of computer knowledge users should have depends on their personal needs and interests. At a minimum, basic computer literacy includes understanding how to use a computer, navigating the operating system, using common software applications, and being familiar with Internet usage and online safety. However, the more you know about computers, the better equipped you are to take advantage of the numerous opportunities and effectively navigate the digital world.

It is especially true for computational thinkers as topics mentioned here naturally connect to quite a few independent articles in this book. The more progress you make in this book the more you will realize the connections and mutual reinforcements there are.