Requires the Adobe Aero app

> HOW COMPUTERS WORK

AN INTRODUCTION TO THE WORLD OF COMPUTERS USING AUGMENTED REALITY

Johannes Aylott

HOW COMPUTERS WORK

AN INTRODUCTION TO THE WORLD OF COMPUTERS USING AUGMENTED REALITY

JOHANNES AYLOTT

How Computers Work: An Introduction To Computers Using Augmented Reality
Johannes Aylott

Printed and bound at The University for the Creative Arts
New Dover Road
Canterbury
Kent
CT1 3AN
United Kingdom

To everyone at UCA that have made my time here the best it could've.

> CONTENTS

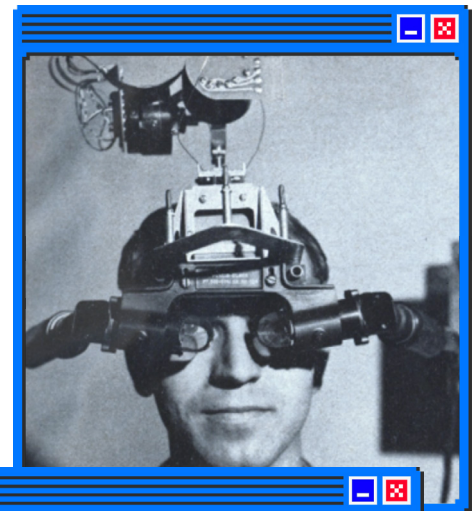
▷ HOW TO USE THE AR FEATURES

Augmented reality (or AR for short) is still a fairly new technology when it comes to public use, however, even though it may feel futuristic, it's actually been around for quite a while. The first AR display was built all the way back in 1968 by a man called Ivan Sutherland, he named it The Sword of Damocles.

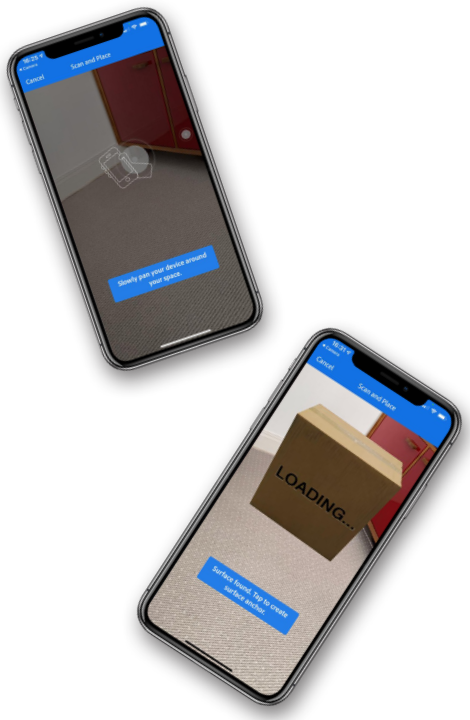
The term "Augmented Reality" means to change how the real world looks and is a combination of real and virtual objects put together by a computer. You've most probably seen AR used in social media apps, where you can make it look like a funny character is dancing in front of you, or give yourself cool glasses in a face filter. But AR can be used for a bunch of other things too… like this very book!

Throughout this book, you'll discover weird-looking squares such as the one at the top of the next page, this is called a Quick Response Code (Or QR Code for short). QR codes work in a similar way to barcodes at the shops, they store data and information that a computer using a camera can decode. The QR codes in this book are special in that they hold the information needed to show 3D models that you can interact within AR however you like.

To use the AR in this book, you need a smart phone with the Adobe Aero app, which is free to use. Follow the steps on the next page.



The first AR device looked like something you'd use at the opticians, we've certainly come a long way since.



1. With the smartphone owners' permission, download the Adobe Aero app from the App Store.

2. Once it's installed, let an adult log into the app using an Adobe account.

3. Go onto your camera app and aim your phone at a QR code… like this one conveniently placed just to the left here! A pop-up should appear at the top of your screen, asking if you'd like to open up it in the Adobe Aero app, tap on it and it'll take you to the app.

5. Follow the on-screen instructions and you should see a cardboard box appear, this box shows how big each particular experience will be, once you're happy with the placement of the box, tap on "Create An Anchor".

6. Have fun and play with what you find and discover in AR.

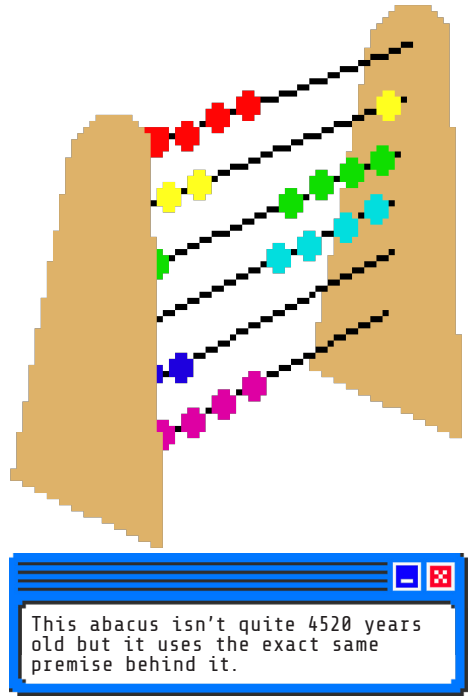
Alright! Now you know how everything works, it's time to explore just what makes computers tick.

Computers play a big role in our modern world, we're dependant on them for almost everything – even stuff you might not think of, like making clothes or furniture. Over the last few decades we've witnessed a technological boom unlike anything we've ever seen in our history, going into the future this leap forward in computing will only continue. Like how the Victorian Era is called The Industrial Revolution, our current era may likely be called something like The Electronic Age.

▷ THE HISTORY OF COMPUTING

Electronic computers are still a relatively modern technology when looking at human history, however, the actual need for computing is certainly nothing new.

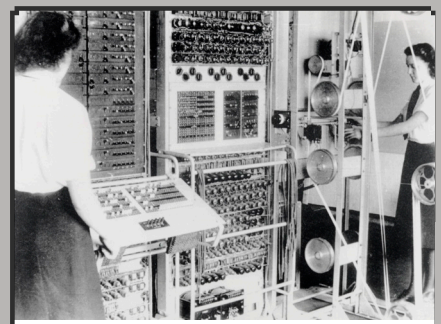
The word “compute” means to work something out, so a computer is a device that can work things out for you. With this in mind, the first device humans ever made for computing was the abacus in around 2500 B.C. That’s over 4520 years ago! You may have heard of or even used an abacus before, on which you move beads on different rails in order to help you work out a mathematics sum, a bit like a calculator. Even though it doesn’t use electricity, it still counts as a computing device.



Over the next 4-and-a-half-thousand years we made loads of different computing devices to help us figure out all kinds of things, like our location in the sea or the current time and date. Each of these devices helped us by making something that was previously slow and complicated to do much quicker, easier and often more accurate too.

Despite being used to compute things for us, none of these devices were actually called computers when they were used. The first known time the word was used was in 1613 by Richard Braithwaite, but even then he wasn’t talking about a machine, he was talking about a smart person working out mathematics “I have read the truest computer of times, and the best arithmetician that ever breathed, and he reduced thy days into a short number”.

Braithwaite is basically saying what a great job the person did, and how they worked out some calculations really quickly that would've taken him a long time to do. Referring to someone as a "computer" was often done right up until the 1970s.



One of the few photos ever taken of the Colossus Mk2 while it was being actively used, taken in 1943.

The ENIAC in America was a lot bigger than the Colossus, this was because it needed to calculate loads of different stuff. Sometimes a bug would crawl inside the ENIAC, shorting a connection and causing a failure, so it would need to be cleaned out. This is where the term "computer bug" came from.

As the human race advanced and these computing devices became way more powerful - and way bigger too! We began using electricity to power our computing devices as it became more easily accessible throughout the first half of the 20th century. And so, what is widely considered the world's first electronic digital computer was created; in 1943 the Colossus Mk1 was born. This amazing machine was built to help British code breakers in World War 2, it was such a big deal that the existence of the Colossus Mk1 or its improved Mk2 was kept a secret until the mid-1970s.

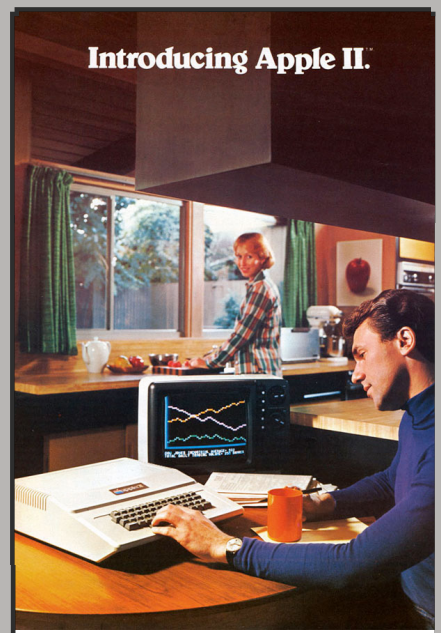
A few years after the Colossus Mk1, in 1945, the ENIAC was created in America, the biggest difference being that it was a general-purpose computer, this meant that unlike the Colossus or any other computation devices before it that could only do certain tasks, the ENIAC could do many, many different types of calculations. The ENIAC was so good that it was used for ten years and is estimated to have done more arithmetic and calculations than the entire human race up to that point in time.

This photo is of a member of staff at UCC in the Philippines with an IBM 370, showing how computers were becoming more accessible - it's also the same computer you can see in AR!

This Advert for a similar computer by IBM talks about renting the different partsof the computer. Since they were still very expensive, many organizations would rent them instead of buying them.

Through the 1950's all the way to the end of the 1970s, computers got smaller and even quicker, going from the size of large rooms to… well, smaller rooms, which may not sound like much nowadays, but this meant that more people could use one as they could be put into more places. However, through this time period, computers were still almost always strictly for professional use, being used only for businesses and organisations.

This was because they were still a very new and expensive technology, and so not many people knew how to use one. These computers also required the use of punch cards, these were small cards with holes in them, the computer would read these holes and that was how a lot of information would be put into a computer. Information would be stored on either magnetic disks or magnetic tape, both of which cost a lot at the time on top of the price of computers themselves, so stored data was even rarer than computers alone.



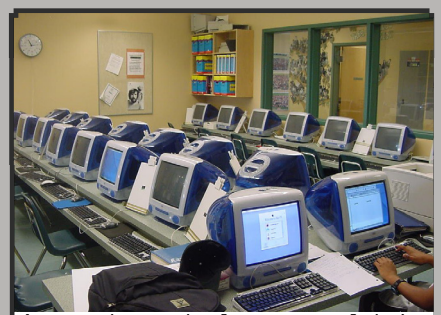
This is a promotional photo for the Apple II Personal Computer in 1977. It's widely considered one of the first successful home computers made in such large quantities.

Some British primary school kids on a BBC Micro computer sometime in the early 80's. Notice the cassette tape recorder in the bottom left, this was used to load programs and games onto the computer.

As the 1970s progressed into the 1980s, slowly home computers became a thing. Instead of using punch cards, these computers used a keyboard to input stuff that would be displayed on a screen. Home computers were still mostly used for professional purposes since such a small device that could fit on your desk was pretty expensive. As the 1980s continued, so too did the home computers. Because they were in the home, their uses increased as well, this included new programs and games that you could buy for your computer which were still either stored on magnetic disks or magnetic tapes, but by this time their prices and sizes had significantly decreased, and so data was stored on floppy disks or cassettes.

Computers in the home weren't too common by this point though, as many had a steep learning curb since there had never been anything like them before, this, plus the expense turned a lot of people off computing for the time being. Because of this learning curb, many computers aimed to try and teach their owners from the ground up, and so computers like the BBC Micro (yes, the same BBC that makes Doctor Who) the ZX Spectrum, Commodore 64 and countless others were many households' first computer. The opportunity to learn how to use a new and emerging technology that could do a bunch of different stuff became more and more enticing as the 1980s turned into the 1990s.

Throughout the 90's, many schools could finally obtain more than one or two computers, allowing more students to use them.

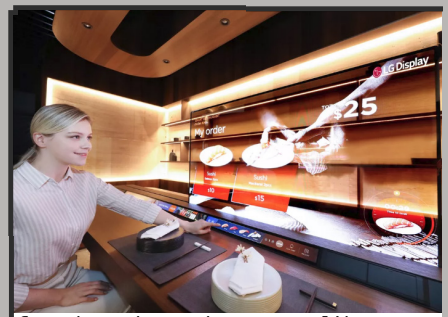


A secondary school computer lab in the mid-2000's with Apple Mac G3's. This was the last computer from Apple to include a CRT monitor.

In 2016, McDonald's introduced Samsung tablet computers at the majority of their restaurants in the UK free for customers to use. Showing just how easily available they have become.

Once we reached the millennium things only kept moving forward, the 2000s brought around many changes we take for granted now. With tablets becoming a more viable option as flat-screen displays replaced CRT's that were often deeper than they were wide. Towards the end of the 2000's mobile phones also got a lot more smarter… so we decided to call them smartphones. The Android and iPhone we know today made their first appearances around 2007 and 2008, incorporating the functions that once required several devices to do. Instead of having an MP3 player or iPod to play music, a PDA to organize calendars and contacts, and a satnav to find your way somewhere, you could now do it all on your mobile phone.

Throughout the 2010s mobile phones and tablets got a bunch more popular, so too did laptops; now they could match the power of many desktops, so many people decided to use laptops as their main PC. Wearable technology became popular too, a smartwatch can connect to your smartphone and share information with each other. Watches weren't the only things that got smart during this time though; smart speakers with virtual assistants made their appearance, smart lights that could change colour or turn on and off on command, even smart fridges that could share your shopping list with your phone. You could even say things got a lot more smart.



See-through touch screens like this, once thought the realm of science fiction are slowly making an appearance as the technology gets cheaper.

As we go into the 2020s, it's exciting to see what the future holds, for example; flexible and transparent screens are currently making their way onto the scene which has a bunch of cool uses. Computers in cars are getting super smart now too, to a point where they can drive for us and stop the car to prevent an accident. There's plenty more to happen in the world of computing and it's exciting to watch and be a part of.

▷ THE BASICS

Computers may seem scary and complicated, so let's break it down, all types of computers, old or new, smartphones or laptops, expensive or cheap, they all consist of 4 key parts, let's find out what these 4 parts are.

1: The first part is called an input device; this means a something that gives information to the computer. Traditionally, that'll be your keyboard and mouse, however, it can also be a camera, microphone, scanner, drawing tablet or even the touch part of a touch screen. Without an input device, you'd have no way to tell your computer what you want it to do, and if you can't do that then you can't do anything else with it.

2: The next part is called a Storage Device; this is needed to store and save information. Computers have three different kinds of storage inside them: RAM (Random Access Memory) is a short-term, quick and temporary storage that holds any current information being used by the computer.

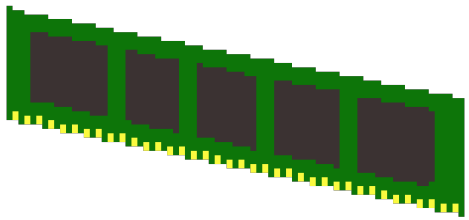
The second kind of internal storage is a long-term storage device that can't be changed called ROM (Read-Only Memory). ROM is used for permanent information the computer will need every time it's used, like data the computer needs when it turns on or off.

The final kind is called a hard drive, this is what you save things to for long-term storage, but unlike ROM, you can edit, add to and delete information on the hard drive. This will be where things like your operating system will be stored, as well as your photos, videos, music, documents and anything else you store yourself on your computer. But these are just Internal Storage devices, External storage devices exist too, like USB drives, memory cards, disks like CD's and DVD's and plenty more, these do a pretty similar job to the hard drive, however, these are usually smaller in capacity (so they store less information) but have the ability to be portable.

3: The third part of every computer is the processor. This is an incredibly advanced series of chips and circuits and - as the name suggests - its job is to process and work out the information from the last two parts; the input device and the storage device. The processor is capable of billions of calculations every second and is often considered to be the "brains" of the computer.

4: The final part of the computer is the output device. Once information has been worked out by the processor, it sends it off onto an output device, this is usually a screen, speakers, headphones, or a printer. Anything that displays or gives you info that comes from the computer is called an output device.

All right! Now you know the 4 main components of every computer in the world. But knowing what something is, and knowing how it works are two very different things, so let's move on and find out just how these things work.



Like HDD's and SSD's, RAM can only work at certain speeds, with only so much information running to and from it at once. This is a large factor to how fast a computer can load things and bring things back up.

▷ KEYBOARDS

The most common English keyboard layout is called a QWERTY keyboard. It's called this because the letters Q,W,E,R,T and Y are the first letters on the keyboard.

Mechanical keyboards use mechanical switches under each key instead of a rubber membrane, this makes them more responsive but also more expensive as a result. So mechanical keyboards are mostly used by professional gamers, writers and programmers.

Keyboards are one of the original input methods for computers, long before the mouse was even invented. There are a few different types of keyboards, like mechanical and buckling spring keyboards, but for this example, we'll be looking at how the most common type of keyboard works; the membrane keyboard.

The majority of laptops and desktops use a membrane keyboard because they're easier and cheaper to make than other kinds of keyboards but still work well. A membrane is a really thin sheet that separates two things; you may look down at your own keyboard and wonder what makes it a membrane? After all, you can't see a thin sheet of anything, it's all separate keys… right?

Just under your keys is a large rubber sheet that's as big as the whole keyboard, this rubber sheet has a bunch of tiny nubs that stick up - one that lines up with each key above it. So now we know what the "membrane" part is talking about: the rubber sheet is the membrane that separates the keys from a circuit board underneath. But how does rubber help a computer, it's not like you can pass electricity through it?

Our modern keyboards have staggered keys because typewriters needed space for their levers to reach under the keys.

Well, when you press a key, the nub underneath that key is pushed down onto the circuit board under it, this wouldn't do anything if it weren't for one small part; on the bottom inside each nub is a layer of graphite or some kind of conductive material. When this graphite pad is pressed against the circuit board it connects a positive and negative connection under each and every key, this connection sends a signal to the processor that works out which letter was pressed, before passing it on to the output device and showing the letter on your screen. The computer recognizes each different key this way. So to recap, when the circuit under a key like for the letter K is connected by pressing the K down, it gets sent to the processor which works out that you pressed the letter K before displaying it on your screen.

Other types of keyboards like mechanical or chicklet keyboards use different technology, but they still perform the same task in a similar way; by completing a circuit just under that key that gets sent to a control board before going onto the processor.

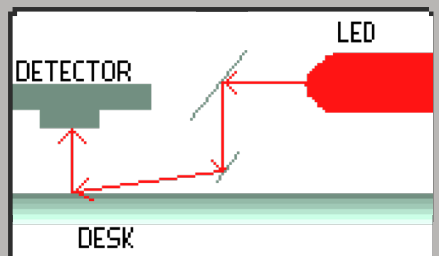
MICE

This is an Apple Mouse II from the mid 1990's which uses a trackball, you can see what the ball looks like both inside and outside the mouse. Inside the mouse there are two cylindrical rollers that run up against the ball when it get moved, then, these rollers send back info to a control board inside the mouse that gets interpreted as movement, before that info gets passed onto the computer.

Like with keyboards, there are a few different types of computer mice too, trackball mice used to be popular in the 1990s and early 2000s, however, these would need to be cleaned out often as the large rubber ball would pick up dust and fluff. Nowadays, optical mice are the tool of choice for most people; you can tell if you have an optical mouse just by lifting it up, you'll instantly notice a red light shining from the bottom. Optical mice are often more reliable than their predecessor since they have fewer moving parts that can break, and optical mice don't have to be cleaned out… unless you dropped it in sand or something… but why would you do that?

The buttons on the top of your mouse have simple switches underneath that connect a circuit when they're pressed – a bit like how keyboards work! But who cares about buttons when there's a bright red laser to talk about?!

This red laser thing on the bottom of your mouse is made of two parts: the LED Light Emitter and the Photocell Light Detector. The LED is what makes the bright red light, this is pointed down straight into your desk, and the light bounces back up into the light detector. When you move the



Here's a diagram showing the layout of the sensor in an optical mouse. The light is focused and reflected through lenses until it hits the surface and bounces up into the detector.

This is the world's first computer mouse, made by Doug Engelbart in 1964. However, it wouldn't be until the 1980's that it would be used by the masses... But not in the form of a wooden box anymore. Nobody knows for sure why it's called a mouse though, but one can somewhat recognize the resemblance.

mouse, the light changes ever so slightly as the surface the light is reflecting on changes, the light detector senses this change and a small chip inside the mouse acts like a mini processor, working out what direction the light is moving, and so what direction you're moving the mouse.

After it's worked out all the info it needs, the chip sends the information to the processor inside the computer that translates this information by showing the mouse cursor moving on your screen.

Some mice don't have a cool red light and instead just have a small round hole in the bottom, this is because instead of using a bright red LED light, they use an infrared LED that shines a light that humans can's see, this is a bit more sensitive and therefore, more accurate than regular optical mice.

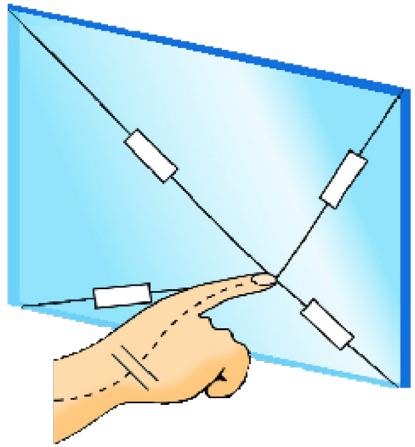
TOUCHSCREENS

Touchscreens have been around for a few decades, but they've only become as popular as they are now over the last decade or so. With every mobile phone and tablet having one, and even some laptops too. There are two main types of touch screens, capacitive and resistive. Resistive touchscreens are older, cheaper and less accurate than capacitive touch screens.

You'll find them used in items like sat-navs, cash machines, as well as being used on the Nintendo DS and Wii U. You can tell if something is a resistive touchscreen by pressing it, you'll notice the screen feels like it moves in slightly even though you're not pressing it hard.

Resistive touchscreens have a layer of air in between two sheets of clear material, one side against the screen and the other is the side that you touch. In this layer of air are grids, and one of the layers of clear material is electrically charged. When you press down on the screen the two layers are pushed together and connect, allowing the electric current in one of them to flow through both and complete the circuit. A control board will then work out which square in the grid connected and relay that info to the processor in the computer. This means that while they are more hardy and waterproof than capacitive touchscreens, as well as being usable with gloves, they're not as accurate.

Systems like this parking meter need to be completely weather proof, as well as to be able to run for weeks or months without being checked up on. So a capacitive touchscreeen that's waterproof is a good idea, plus if it were to get damaged, they're very cheap to replace.



This diagram shows how a capacitive touchscreen works. You can see the finger is located by four different currents measured to and from each corner of the screen.

The first car to use a touchscreen was a Buick Riviera in the USA in 1986. The screen only had one colour and was much more basic than what we have now.

Resistive touchscreens aren't very common now in new technology however, as capacitive touch screens have gotten cheaper and easier to make, these are a lot more accurate and don't move when you press on them.

Capacitive touchscreens work a little like how the membrane keyboard works, by having a super-thin conductive material coated over the screen like indium tin oxide or copper. These layers are so thin that the light from your screen still shines through easily. Our skin is conductive which means it can draw electricity and complete a circuit, this includes our finger so when you press on the screen, it completes a circuit. Like when the graphite on the rubber membrane keyboard touches the circuit board underneath.

When you complete the circuit with your finger on the touch screen, the capacitance of the screen changes,and a microchip measures really quickly where you made contact on the screen. Like the chip in the mouse, it sends this information off the processor that works out what exactly you pressed and then shows the result on your screen.

▷ STORAGE DEVICES

Hard Disk Drives (often abbreviated to HDD) are the most common form of long-term storage you'll find in a computer, they've been around for decades and as technology advances, HDD's have been able to fit more and more storage.

HDD's were once found in virtually every home computer and laptop, as well as many games consoles too. However, nowadays you only really find HDD's in some desktop computers, backup drives and laptops from the early 2010's and older.

The disks inside an HDD usually spin up to 7200 times every minute. Despite that they're still much slower than SSD's.

HDD's can store a lot of information and can be made pretty cheaply compared to their alternatives, but the reason why they're not as popular as they once were is because of a couple of factors. HDD's – as the name suggests – have a bunch of disks inside stacked on top of each other, a small arm moved around over the disks to read and write information to them, a bit like how DVD's and BluRay's work, only the disks in an HDD store way more information and can't get any dust or dirt on them at all!

This magazine advert from 1984 is asking for $945 for a 10MB hard drive. That would store only about 2 or 3 songs today.

Since HDD's have spinning disks and moving arms, information can only be read and written as fast as the disks and arms move, this can be pretty slow and are why many old computers may seem slow. Because of all the moving parts that have to stay super clean, HDD's can fail and break down over time, losing any and all information that's stored on them. So now HDD's are used to store things that don't need to change much and don't need to be accessed quickly, which is why you'll find them mostly used for backup now.

The packaging for a new SSD. While they may not look as interesting as an HDD, but they're much better than them in almost every way.

Because of these issues with HDD's, an alternative called Solid State Drives (or SSD) was made. SSD's use something called flash memory, instead of the disks of an HDD, since this means there aren't any moving parts inside an SSD (which is also why it's called a solid-state as nothing moves.)

They work a lot quicker and are often more reliable than HDD's since nothing is moving that can break or wear down over time. Flash memory is just like the kind of memory used in USB drives or memory cards, flash memory uses super tiny chips to store information, instead of disks, which can be accessed by the computer virtually instantly.

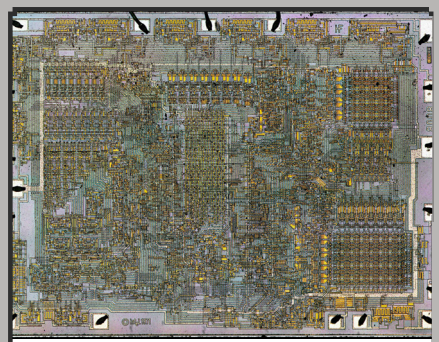
Because of how well they work, SSD storage is used in every mobile phone and tablet, as well as all laptops. Since they are much more intricate, SSD's are a lot more expensive than HDD's, however, but, as we continue into the future, we'll find HDD's used less and less as the cost of making SSD's go down.

There are many different kinds of External storage devices; these are used mostly to transfer information from one computer to another. Compact Disks (CD's) are still used today, mostly for storing information that will need to be accessed on many different computers but won't need to be changed. However, they have been used less and less and will continue to do so as wireless transferring online takes its place.

As I stated before, CD's and any other types of disks are read similar to an HDD, where a laser is moved up and down the shiny side of the disk and reads the information on it by looking at how the laser is reflected back.

Only a few years ago, music on a micro SD card seemed like the future of physical music, it was called MQS SD. The format never caught on, however, and it'll be anyone's guess to how we will listen to music in the future.

▷ PROCESSORS



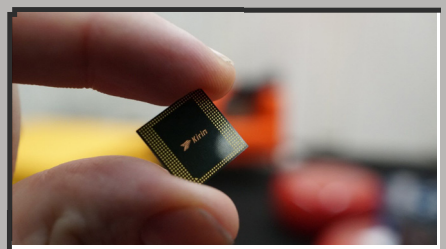
This is a processor called the Intel 8008. It may look complicated, but it's actually 50 years old, making it rather primitive today.

CPU's get very hot because of how hard they work, to stop them from overheating we attach heatsinks to them to spread out the heat. Sometimes we also attach fans to move the heat away even quicker.

The processor is the most complex part of any computer, it is usually called the Central Processing Unit (or CPU) because it's like the "brain" of the computer. There is an awful lot to any CPU as they're the most advanced piece of technology in the computer. The CPU in a brand-new smartphone will easily outmatch a CPU from a desktop from 15 years ago, as the power, size and speed of processors are constantly getting better and better.

To know what processors do, it's important to know what they're processing to begin with. When information is given to the processor by the input and storage devices, one of its jobs is to make the info given to it something we can see or hear. For example, when stored on a storage device, an image doesn't look like how it looks to us; instead, it is stored as 1's and 0's.

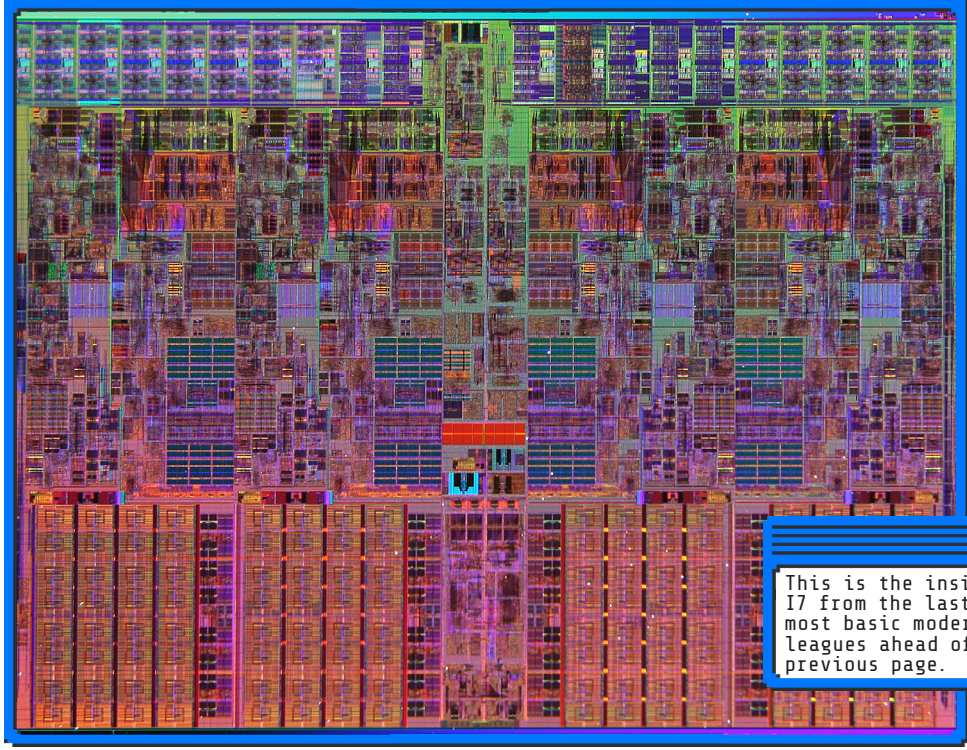
These 1's and 0's are flows of electricity, where 1 is when electricity is flowing and 0 is when it isn't. These 1's and 0's are called binary and is a code that the processor can read; it's the language every computer uses. The 1's and 0's are sent to the processor trillions of times every second, and the processor works out what is being sent to it. The



Smart phones, tablets, and even some laptops don't have enough space for a heat sink or fan. So their CPUs can't work too hard or they'll overheat, that'll cause irreversible damage to both the CPU and the rest of the phone.

processor decodes the binary as something the output devices can understand, and once it's figured it out, it's sent off.

All the way back in 1970, A man prolific in the computing work called George Moore coined "Moore's Law". This law states that either processor speeds or power will double every two years. Despite such an early prediction, Moore's Law has held virtually true to this day, proving just how far computers are going, and will continue to go.



This is the inside of an Intel Core I7 from the last decade. Even our most basic modern processors are leagues ahead of the 8008 on the previous page.

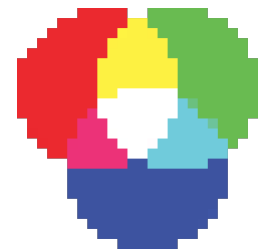
▷ MONITORS

Once information is worked out correctly by the CPU, it is sent off to an output device. The most common output device will be a monitor or screen, every colour monitor uses 3 lights – red, green and blue – to make up all the colours you can see, a bit like when you mix paint together to make different colours.

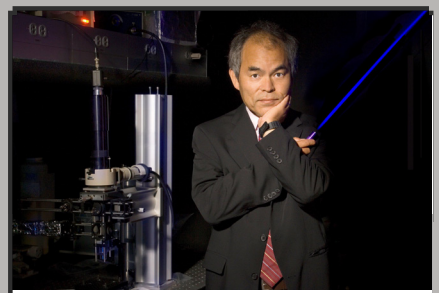
Right until the early 2000's we used CRT displays (Cathode Ray Tube), these were very deep and heavy displays, 3 rays of light would be shot out of a light ray gun onto the inside of the screen, the light would move around the screen by powerful magnets, this was repeated around 60 times every single second, so fast that it produces an image.

However, in the early 1990's the blue LED was invented, this may not seem like much, but in actual fact, it changed a lot. Until that point in time, only red, green, and any colour those 2 can make would be able to be put into an LED, so not every colour could be made. Once the blue LED was invented, this meant that any colour could be made with them when combined with red and green, this included white. This is why many modern electronics use blue or white LED lights, as they're a pretty modern invention. Now we have blue, red and green LED's that could be used for displays.

This Sony Multiscan G400 is from 2000. While flatscreens were already around, CRT's were still cheaper and easier to make. Now though, CRT's are obsolete as flatscreens have become easier and easier to produce, CRT's also waste a lot of power and produce a lot of heat... Not to mention they hurt a lot more if your drop one on your foot.



This RGB colour model shows what colours red, green and blue mix into. You'll see more about it in AR.



Shuji Nakamura invented the blue LED in 1993. In 1996 he also invented the blue laser, which can be found in Blu-ray players and games consoles.

Displays like this on a restaurant drink machine are common place in public. These use LCD screens because they are kept on virtually all day, every day... Because nobody wants a warm Coke. So drawing as little power as possible makes sense for something that'll be on for most of its life.

The Hamilton Pulsar P1 was the first digital watch with an LED display, when it came out in 1972 it cost £1,500. Luckily, digital watches quickly got a lot more cheaper by the end of the 1970's and became only a few quid.

Once we reached the millennium things only kept moving forward, the 2000s brought around many changes we take for granted now. With tablets and mobile phones with colour displays were becoming a more viable option as flat-screen displays replaced CRT's.

Nowadays, we mostly use two different types of displays; LCD (Liquid Crystal Displays) and LED (Light Emitting Diodes). LCD screens are usually found in some TV and computer screens, as well as the majority of screens that are found in shop windows. Very basic LCD displays are used in digital watches and calculators, although those ones are often black and white. This is because LCD's consume less power so it's better to use them for screens that stay on for long periods of time.

LED's are also found in many TV's and Computer screens, however, they're also used in all modern smartphones and tablets. On the surface, LED's screens don't appear very different to LCD screens, but LED screens are cheaper to make and a little more durable than colour LCD. This is why we usually find them used in smartphones, tablets and smartwatches. LED's are a little like tiny light bulbs, only they last hundreds of times longer and are much more energy-efficient than normal light bulbs.

This advert from 2016 is for a Sony 4K cinema projector,this particular one is currently used in most Vue cinemas. However, 8K seems to be fast approaching already.

LED's can be made super small, and the ones used in screens can change colour, all depending on what information it gets from the processor. These tiny LED's make up pixels on a screen, you'll notice most screens say they are 1080p, where the "p" stands for pixels, this means that the screen is 1080 pixels tall, and 1920 pixels wide, which means there is a grand total of 2,073,600 pixels (or individual LED's) in that one screen. On newer screens that say they're 4K has even more LED's in them; 8,294,400. Four times as much (now you see why it's called 4K).

THE INTERNET

A segment from a TV show in the UK called Database from 1984. In which they showcase an early form of email using Commodore 64's on a service called Micronet.

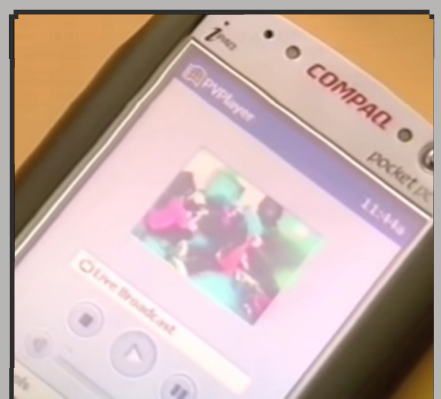
This very computer is an NeXTcube used by Burners-Lee when he fundamentally invented the web and it became the worlds' first web sever. The label on the right says not to turn it off.

The internet is arguably one of the most influential creations in the last few decades. The internet came about because of the number of computers people were using; with so many computers, they needed an easy way to communicate over long distances and share information.

Throughout the 1970s, 1980s and early 1990s, there were many different forms of the internet, although these were pretty much unavailable to most of the public, so only hobbyists and certain computers for certain companies that could afford it would have access to this kind of thing. Even then, only simple text could be shared, no images, videos or sound, because the computers wouldn't be able to know what to do with so much incoming information, and even if they did it would take forever to transfer fully.

As the 1990s progressed, so too did the internet, with Sir Tim Burners-Lee inventing the world wide web in 1991. Because of so many public computers now being used by everyday people an everyday way to connect them became needed more and more. Dial-Up internet was the answer, it was also slow… painfully slow, but it did its job well, for the first time ever anybody could connect online, send

This segment from BBC's Tomorrow's World in 1994 talks about "The Information Super-Highway", or the internet as we know it. They mention the limitations of phone lines not able to carry video, but also bring up BT's experimentation with a "video on-demand" service... Just like what we have today over 20 years later.



Another clip from Tomorrow's World in the year 2000. In it, they show DSL internet connected to a PDA, showcasing how it can be used for live video streaming.

messages, look up information and now even see images and listen to some music. As the name "Dial-Up" might suggest, it would basically "call" the internet down your telephone line and wait for a response from the service provider.

This was smart, in that it used something most people already had; a telephone connection. It made costs much cheaper as there wasn't a need to dig up the roads everywhere to lay down wires for internet users. The only downsides of this were that phone lines are mostly copper cables, which were never designed to have digital signals sent through them in the first place, so this is why dial-up was so slow and basic compared to what we have now, furthermore, since the computer was basically in a call with the internet service provider, this meant you couldn't make or receive any phone calls yourself as long as the computer was online.

With the 1990s reaching its end, only about half of all people were online, new ways were found to connect to the internet though, DSL (Digital Subscription Line) worked similar to Dial-Up by using the phone lines, only it was much quicker and you could use the phone at the same time.

As the 2000s came through, so too did Web 2.0. This was an internet that would be easier, quicker and feature much more stuff like videos, interactive games and a bunch more! Instead of just the computer requesting information, the website would now be able to request info from the computer too, for example, the location of the computer

Netflix started in 1997 as an online DVD rental service that would send you movies in the post. Their ability to not only start early online but adapt online too with streaming has allowed them to continue to this day.

An advert in 2015 from BT about their ongoing roll-out of fibre optic connections. While the speed through fibre optics can reach the speed of light, the speed of the processors on either end and the old wiring in your house can still slow things down. So we still have ways to improve things.

could be requested to give the user a weather forecast. This Web 2.0 is largely what makes up our internet today.

Now though, the majority of internet connections are now connected through something called fibre optics that run alongside our phone lines. Fibre optics are strings of clear plastic, these strings have LED's on each end that flash super-fast, these flashes of light are codes of information that travel down the plastic strings to your processor that can decode it, just like how it decodes other input information. Because information through fibre optics can travel at the speed of light, many internet connections are virtually instant now, and we can also transfer more information because of it.

Streaming has become a household word today, with nearly anyone being able to stream information through these fibre optics in the form of videos on YouTube, movies on Netflix and Music on Spotify. The more fibre optics and the faster the flashes, the more information that can be sent quicker, so as we move into the 2020's we're starting to see the streaming of even more intense things, like video games and software, all being accessed remotely like a video online, which would have been crazy to try only 10 years ago.

THE FUTURE

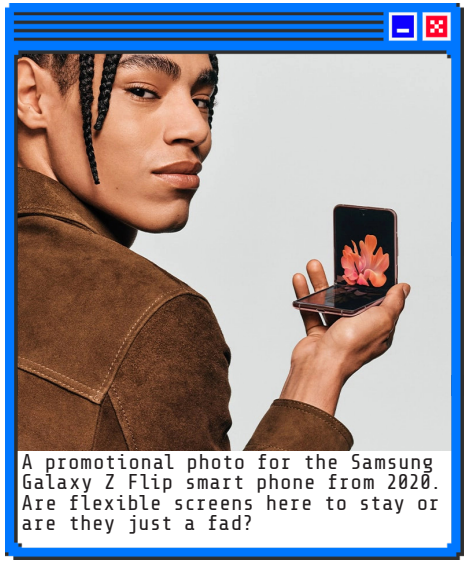
It's easy to predict certain things for the near future, like CD's and HDD's becoming obsolete. Processors too, will continue becoming more and more advanced. The internet will also continue to expand and be able to transfer even more data at quicker speeds as 4K video becomes the standard. Electric driverless cars may even eventually become the norm, and one day everything modern in this book will be considered "retro". Artificial Intelligence will continue to get smarter and will be able to help us in solving issues we may never have known even to exist.

But then there are other predictions that are pretty questionable; will holograms like we see in the movies ever be real? Will virtual reality become more commonplace than traditional screens? Will I have a robot to give me a back massage? These, and many other things may become a reality, and others may become silly notions or outdated ideas, the only way we'll find out is if we continue exploring, learning and playing.

Then there will also be other things that nobody saw coming too. Back in 1997, the first flat-screen TV was released, a mere 10 years later in 2007 the first smartphone was sold.

The first flat screen TV sold to the public in 1997 in Japan.

This is the first Android smart phone, the HTC Dream was released in 2008, with the first iPhone coming a year before in 2007.



A promotional photo for the Samsung Galaxy Z Flip smart phone from 2020. Are flexible screens here to stay or are they just a fad?

It's amazing to wonder and dream about what technology will become normal for us in another 10 years' time, how it will help us in what we do and what new horizons it will lead us onto.

You have the honour of being born into a time where the growth of technology is unlike anything we've ever seen before in human history, take this chance and show the whole world what you got! I can't wait to see what you'll be able to do with technology next, and where you'll be able to take it into our future. I hope this book has helped you become interested in technology and that you've had fun along the way, just as much as I've had fun making this book.

See you in the future!

Technology has become a crucial part to our everyday lives, and will continue to be more so. While they may be easy to use, knowing how they work is a whole new matter that many can find a little intimidating.

But have no fear! This book not only teaches the basics of computers and technology, but incorporates it too! Using the Adobe Aero app, you can go into augmented reality (AR) to look around and investigate the very stuff you're learning about, as if they were really in front of you.

For the first time, you can go inside the computer without even needing to worry about taking apart and losing any screws!

07751093210