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(https://d3an9kf42yjj3p.cloudfront.net/uploads/2017/10/kf_bhdatastorage_101817.png?x23053) Punch cards were the first effort at [Data Storage](https://www.frontierinternet.com/gateway/data-storage-timeline/) (<https://www.frontierinternet.com/gateway/data-storage-timeline/>) in a machine language. Punch cards were used to communicate information to equipment “before” computers were developed. The punched holes originally represented a “sequence of instructions” for pieces of equipment, such as [textile looms](http://www.wired.co.uk/article/worlds-last-traditional-loom) (<http://www.wired.co.uk/article/worlds-last-traditional-loom>) and player pianos. The holes acted as on/off switches. Basile Bouchon developed the punch card as a control for looms in 1725.

In 1837, a little over 100 years later, Charles Babbage proposed the Analytical Engine, a primitive calculator with moving parts, that used punch cards for instructions and responses. Herman Hollerith developed this idea, and made the Analytical Engine a reality by having the holes represent, not just a sequence of instructions, but stored data the machine could read.

He developed a punch card data processing system for the 1890 U.S. Census, and then started the *Tabulating Machine Company* in 1896. By 1950, punch cards had become an integral part of the American industry and government. The warning, “Do not fold, spindle, or mutilate,” originated from punch cards. Punch cards were still being used quite regularly until the mid-1980s. (Punch cards continue to be used in recording the results of standardized tests and [voting ballots](http://www.washingtontimes.com/news/2016/nov/23/electronic-voting-under-scrutiny-as-computer-expert/) (<http://www.washingtontimes.com/news/2016/nov/23/electronic-voting-under-scrutiny-as-computer-expert/>).

In the 1960s, “magnetic storage” gradually replaced punch cards as the primary means for data storage. Magnetic tape was first patented in 1928, by Fritz Pfeumer. (Cassette tapes were often used for homemade “personal computers,” in the 1970s and 80s.) In 1965, Mohawk Data Sciences offered a magnetic tape encoder, described as a punch card replacement. By 1990, the combination of affordable personal computers and “magnetic disk storage” had made punch cards nearly obsolete.

In the past, the terms “Data Storage” and “memory” were often used interchangeably. However, at present, Data Storage is an umbrella phrase that includes memory. Data Storage is often considered long term, while memory is frequently described as short term.

Vacuum Tubes for Random Access Memory

In 1948, Professor Fredrick Williams, and colleagues, developed “the first” Random Access Memory (RAM) for storing frequently used programming instructions, in turn, increasing the overall speed of the computer. Williams used an array of cathode-ray tubes (a form of [vacuum tube](http://www.popularmechanics.com/technology/a23759/micro-vacuum-tubes/) (<http://www.popularmechanics.com/technology/a23759/micro-vacuum-tubes/>)) to act as on/off switches, and digitally store 1024 bits of information.

Data in RAM (sometimes called volatile memory) is temporary and when a computer loses power, the data is lost, and often frustratingly irretrievable. ROM (Read Only Memory), on the other hand, is permanently written and remains available after a computer has lost power.

Magnetic Core, Twistor & Bubble Memory

In the late 1940s, magnetic core memory was developed, and patented, and over ten years, became the primary way early computers wrote, read, and stored data. The system used a grid of current carrying wires (address and sense wires), with doughnut-shaped magnets (called [Ferrite Cores](https://nationalmaglab.org/education/magnet-academy/watch-play/interactive/magnetic-core-memory-tutorial) (<https://nationalmaglab.org/education/magnet-academy/watch-play/interactive/magnetic-core-memory-tutorial>)) circling where the wires intersected. Address lines polarized a Ferrite Core’s magnetic field one way or the other, creating a switch that represents a zero or one (on/off). The arrangement of address and sense wires feeding through the ferrite cores allows each core to store one bit o’ data (on/off). Each bit is then grouped into units, called words, to form a single memory address when accessed together.

In 1953, MIT purchased the patent, and developed the first computer to use this technology, called the Whirlwind. Magnetic core memories, being faster and more efficient than punch cards, became popular very quickly. However, manufacturing them was difficult and time consuming. It involved delicate work, using women with steady hands and microscopes to tediously thread thin wires through very small holes.

The [Twistor Magnetic Memory](http://www.chipsetc.com/twistor-memory.html) (<http://www.chipsetc.com/twistor-memory.html>) was invented in 1957 by Andrew Bobeck. It creates computer memories using very fine magnetic wires interwoven with current-carrying wire. It is similar to core memory, but the wrapped magnetic wires replace the circular magnets, and each intersection on the network represents one bit o’ data. The magnetic wires were specifically designed to only allow magnetization along specific sections of the length, so only designated areas of the Twistor would be magnetized, and capable of changing polarization (on/off).

Bell Labs promoted the Twistor technology, describing it as superior to magnetic core memories. The system weighed less, required less current, was cheaper to produce, and was predicted to provide much lower production costs. The Twistor Memory concept led Mr. Bobeck to develop another short-lived magnetic memory technology in the 1980’s, known as [Bubble Memory](http://www.chipsetc.com/bubble-memory.html) (<http://www.chipsetc.com/bubble-memory.html>). Bubble memory is a thin magnetic film using small magnetized areas which look like bubbles.

Semiconductor Memory

In 1966, the newly formed *Intel Corporation* began selling a semiconductor chip with 2,000 bits of memory. A [semiconductor memory chip](http://asia.nikkei.com/Spotlight/Toshiba-in-Turmoil/With-lawsuit-Western-Digital-eyes-comeback-in-Toshiba-chip-saga) (<http://asia.nikkei.com/Spotlight/Toshiba-in-Turmoil/With-lawsuit-Western-Digital-eyes-comeback-in-Toshiba-chip-saga>) stores data in a small circuit referred to as a memory cell. Memory cells are made up of miniaturized transistors and/or miniaturized capacitors, which act as on/off switches.

A semiconductor can conduct electricity under specific conditions, making it an excellent medium for controlling electricity. Its conductivity varies depending on the current or voltage applied to a control electrode. A semiconductor device offers a superior alternative to vacuum tubes, delivering hundreds of times more processing power. A single microprocessor chip can replace thousands of vacuum tubes, and requires significantly less electricity.

Magnetic Disk Storage

Magnetic drums were the first incarnation of magnetic disk storage. Gustav Taushek, an Austrian inventor, developed the [magnetic drum](http://spectrum.ieee.org/geek-life/history/the-ferranti-mark-1-worlds-first-commercially-available-generalpurpose-computer) (<http://spectrum.ieee.org/geek-life/history/the-ferranti-mark-1-worlds-first-commercially-available-generalpurpose-computer>) in 1932. The drums read/write heads were designed for each drum track, using a staggered system over the circumference. Without head movement to control, access time is quite short, being based on one revolution of the drum. If multiple heads are used, data can be transferred quickly, helping to compensate for the lack of RAM in these systems.

IBM is primarily responsible for driving the early evolution of magnetic disk storage. They invented both the [floppy disk](http://www.bbc.com/news/technology-36389711) (<http://www.bbc.com/news/technology-36389711>) drive and the [hard disk drive](http://www.nature.com/news/magnetic-hard-drives-go-atomic-1.21599) (<http://www.nature.com/news/magnetic-hard-drives-go-atomic-1.21599>) and their staff are credited with many of the improvements supporting the products. IBM developed and manufactured disk storage devices between 1956 to 2003, and then sold its “hard disk” business to Hitachi in 2003.

IBM switched its focus to 8-inch floppy disks from 1969 until the mid-1980s. A floppy disk is an easily removed (and easily installed) portable storage device. It is made of magnetic film encased in a flexible plastic, and is inexpensive to manufacture. IBM developed the 8-inch floppy specifically for the System/370 mainframe. On the downside, a floppy disk is very easy to damage.

In 1976, Allan Shugart improved on IBM’s floppy disk, by developing a smaller version of it. This is because IBM’s 8-inch floppy disk was too big for a standard desktop

computer. The new 5.25-inch floppy disk was cheaper to manufacture and could store 110 kilobytes of data. These disks became extremely popular and were used on most personal computers.

The 3.5-inch floppy disc (introduced in 1982) gradually became more popular than the 5.25-inch floppy disk. The 3.5 version came with a significant advantage. It had a rigid cover protecting the magnetic film inside. However, both formats remained quite popular until the mid-1990s. (Over time, several size variations were introduced, but with very little marketing success.)

Optical Discs

In the 1960s, an inventor named James T. Russel thought about, and worked on, the idea of using light as a mechanism to record, and then replay “music.” And no one took his invention of the [optical disc](https://www.techwalla.com/articles/what-are-the-different-kinds-of-optical-drives) seriously, until 1975. This was when Sony paid Russel millions of dollars to finish his project. This investment led to his completing the project in 1980, in turn leading to CDs (Compact Discs) and DVDs (Digital Video Recordings) and Blu-Ray. (The word “disk” is used for magnetic recordings, while “disc” is used for optical recordings. IBM, who had no optical formats, preferred the “k” spelling, but in 1979, Sony, and a Dutch company named Philips, preferred to use the “c” spelling in developing and trademarking the compact disc.)

Magneto-Optical Discs

The [Magneto-Optical disc](https://www.geek.com/gadgets/sony-to-end-minidisc-walkman-production-after-19-years-1400937/), as a hybrid storage medium, was presented in 1990. This disc format uses both magnetic and optical technologies for storing and retrieving digital data. The discs normally come in 3.5 and 5.25 inch sizes. The system reads sections of the disc with different magnetic alignments. Laser light reflected from the different polarizations varies, per the Kerr effect, and provides an on/off, bit of data storage system.

When the disc is prepped for writing, each section of the disc is heated, using a strong laser, and is then cooled while under the influence of a magnetic field. This has the effect of magnetizing the storage areas in one direction, “off.” The writing process reverses the polarization of specific areas, turning them on, for the storage of data.

Flash Drives

Flash drives appeared on the market, late in the year 2000. [A flash drive](https://biztechmagazine.com/article/2017/06/usb-flash-drive-made-file-transfers-simple-and-easy) plugs into computers with a built-in USB plug, making it a small, easily removable, very portable storage device. Unlike a traditional hard drive, or an optical drive, it has no moving parts, but instead combines chips and transistors for maximum functionality. Generally, a flash drives storage capacity ranges from 8 to 64 GB. (Other sizes are available, but can be difficult to find.)

A flash drive can be rewritten nearly a limitless number of times and is unaffected by electromagnetic interference (making them ideal for moving through airport security). Because of this, flash drives have entirely replaced floppy disks for portable storage. With their large storage capacity, and low cost, flash drives are now on the verge of replacing CDs and DVDs.

Flash drives are sometimes called pen drives, USB drives, thumb drives, or jump drives. Solid State Drives (SSD) are sometimes referred to as flash drives, but they are larger and clumsy to transport.

Solid State Drives (SSD)

Variations of [Solid State Drives](http://www.financialexpress.com/industry/technology/data-storage-solid-state-drives-can-now-compete-with-hard-disk-drives/648502/) have been used since the 1950s. An SSD is a nonvolatile storage device that basically does everything a hard drive will do. It stores data on interlinked flash memory chips. The memory chips can either be part of the system’s motherboard or a separate box that is designed and wired to plug into a laptop, or a desktop hard drive. The flash memory chips are different than those used for USB thumb drives, making them faster and more reliable. As a result, an SSD is more expensive than a USB thumb drive of the same capacity.

SSDs “can” be portable, but will not fit in your pocket.

Data Silos

Data Silos are a data storage system, of sorts. [Data Silos](http://www.cio.com/article/3200991/analytics/opportunity-lost-how-data-silos-continue-to-inhibit-your-business.html) store data for a business, or a department of the business, that is incompatible with their system, but is deemed important enough to save for later translation. For many businesses, this was a huge amount of information. Data Silos eventually became useful as a source of information for Big Data and came to be used deliberately for that purpose. Then came Data Lakes.

Data Lakes

Data Lakes were formed specifically to store and process Big Data, with multiple organizations pooling huge amounts of information into a single [Data Lake](http://www.techrepublic.com/article/how-to-keep-your-data-lakes-from-becoming-cesspools/). A Data Lake stores data in its original format and is typically processed by a NoSQL database (a

Data Warehouse uses a hierarchical database). NoSQL processes the data in all its various forms, and allows for the processing of raw data. Most of this information could be accessed by its users via the internet.

Cloud Data Storage

The Internet made the [Cloud](http://www.dataversity.net/cloud-computing-latest-trends-issues-innovations/) available as a service. Improvements within the Internet, such as continuously lowering the cost of storage capacity and improved bandwidth, have made it more economical for individuals and businesses to use the Cloud for data storage. The Cloud offers essentially an infinite amount of data storage to its user. Cloud services provide near-infinite scalability, and accessibility to data from anywhere, at anytime. It is often used to backup information initially stored on site, making it available should the company's own system suffer a failure. Cloud security is a significant concern among users, and service providers have built security systems, such as encryption and authentication, into the services they provide.

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