The Fabric of Technology
How We Got to Where We Are

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Introduction

The first computers were people who computed things. Ways were sought to make calculating easier and this led to accounting machines that could add and subtract, and to calculators that could add, subtract, multiply, and, eventually, divide. That helped things, but was not enough for the truly massive calculations required by many problems. The first machines that could automatically perform a series of calculations were purely mechanical. Changing the programming for a different problem required a wrench and a screwdriver. Machines evolved to use relays and vacuum tubes for control. The biggest problem was main storage; people used gears, relays, capacitors, vacuum tubes, Williams tubes, mercury delay lines, and magnetic drums. Finally, magnetic core memory was developed which made for fast, reliable main storage.

These machines still used vacuum tubes for everything else but they were definitely recognizable as modern stored program computers. Transistors came along, followed by integrated circuits. Still, computers were large and expensive, and available to only a few.

It was only when computers became more affordable that people started using them as dedicated process controllers. More importantly, it became possible for colleges and universities to buy them for laboratories where, for the first time, students had the opportunity to connect a computer to circuitry they had designed themselves.

With the invention of the microprocessor, the RAM, and the EPROM, it became possible for people to actually own their own computers. Not only that, it became possible for more and more people to design digital products

using these parts. At first only large corporations had the resources necessary to design products with these parts. But now it has gotten to the point where fairly advanced products can be designed with only modest resources on the scale that can be provided by small companies; even by individuals.

The following is the story of how we got to where we are.

Punched Card I/O

By the middle of the 15th century the Black Death had reduced Europe's population to half what it had been a hundred years before. When the Plague was over labor was scare and able to command higher wages and better conditions.

People went on a spending spree. One item they bought was clothes. Wealthy people bought silk; the peasants bought linen which had become cheap and plentiful due to the invention of the horizontal loom and the spinning wheel.

Linen wears out. Back then they did not have regular garbage pickup so they recycled what they could. The linen rags turned out to be an excellent raw material for making high quality paper.

At that point, books were produced by scribes copying each book by hand onto parchment. Parchment is made from animal skin, typically from sheep or goats, and is very labor intensive and is therefore expensive. So were the scribes.

Now we had good cheap linen paper but the scribes were still a bottleneck so people searched for a way to print books automatically. Johan Gutenberg found it. He invented a method of casting soft metals to produce individual letters that were clamped together in a frame. (Each cast letter was the same size so it is known as moveable type.) The type was inked and, when paper was pressed onto it, left the ink on the paper. Afterwards the type could be

reused or, when it got worn out, melted down and used again. This was in 1456, in Mainz, Germany.

Printing took off. One of the most successful printers was Aldus Manutius in Venice, who produced small cheap books that people could easily carry around with them. Many of his workers were Greek exiles and refugees from the

Byzantium Empire who left after the fall of its capital Constantinople to the Turks in 1453. (Constantinople is now called Istanbul.) Aldus worked with these Greek scholars to translate the Greek classics which were unknown in Europe. They had been lost to the West after the fall of Rome. (The Roman Empire had become divided into East and West Empires: The West Empire, with its capital in Rome, is generally considered to have ended around 400 AD. The East or Byzantine Empire lasted another 1000 years.) Aldus' first book was a Latin and Greek grammar by Constantine Lascaris, in 1495.

Aldus was a man with a mission, a mission to bring the long dead Greek philosophers back to life. And he succeeded. He sold a lot of books.

One of the Greek authors was Hero of Alexandria, from the second century B.C., who demonstrated the principles of pneumatics and hydraulics and gears by designing things like temple doors that would automatically open, or steam operated birds that sang; in other words, toys.

Then, as now, people loved toys, especially toys in the form of animals or people, which were called 'automata' . Water-powered figures became very popular, at least for the wealthy who could afford them.

There were even automata that played music. The music was programmed by pegs inserted into cylinders. There were automatic organs programmed by inserting pegs into a cylinder according to a pattern cut into a piece of paper fitted around the cylinder. To change the tune you removed the pegs, replaced the old tune paper with the new one, and inserted the pegs in the places indicated by the new paper.

Now, back to clothes. By this time it is 1725. People wanted more and more variety in their clothes and the patterns in the cloth. Patterns were made by using threads that had been dyed different colors and by switching to different threads at the appropriate times when weaving the cloth. A single

mistake ruined the whole piece.

In Lyon, France, Basile Bouchon, son of an organ maker, used the techniques for constructing automatic organs to making a loom.

In 1741, his idea was improved upon by Jacques de Vaucanson, a noted maker of automata, who built a loom that sensed the holes in the paper as it was rotated.

It worked, but the silk weavers in Lyon took strong exception to the machine fearing it would put them out of business. There were riots and the machine was abandoned. In 1800, the machine was discovered in pieces in the Paris Museum of Arts and Crafts. The museum asked a local silk weaver to put it back together. He did, with some modifications. He went back to cards, linked together, with each card carrying a separate pattern. To extend the pattern all you had to do was add more cards. The silk weaver was Joseph Jacquard and the loom was called the Jacquard Loom.

Guess what happened? Yes, more riots, but there was no stopping it, and eventually the loom gained acceptance.

In 1847 Richard Roberts in England adapted the idea of using paper with holes in it to control riveting machines used in making bridges and ships.

The next stop is the United States, 1880. John Shaw Billings, a lieutenant-colonel in the U.S. Army attached to the Surgeon General's office was in charge of the health statistics division at the U.S. Census. They were still counting the 1870 Census. Billings asked a newly minted engineer in his division if there was some way to automate things. The engineer, Herman Hollerith, started thinking about it, and eventually filed for a patent in

1884. {U.S. Patents 395,782 and 395,783 were filed on September 23, 1884 and issued on January 8, 1889} In 1886 he tried out his punch card machines in the Baltimore, Maryland Department of Health. In 1889 his punch card system was selected for use in the 1890 Census.

Hollerith's system had three devices: a keyboard punch, a gang punch for making multiple copies of a card; and a tabulating machine with an attached sorting box. The operator placed each card onto the tabulator which counted the number of cards with the information it had been programmed to count and could open the lid of the appropriate sorting bin for the operator to deposit the card. It was a big success and was used again in the Census of 1900.

In 1896 Hollerith incorporated his company as the Tabulating Machine Company (TMC).

In 1902 he developed an automatic card feed.

In 1911 he and his fellow directors sold the company to the Computing-Tabulating-Recording Company (CTR).

In 1914 CTR hired a new manager, Thomas J. Watson Sr. You may not know who Thomas J. Watson Sr. was, but you know the new name he gave to CTR in 1924: International Business Machines Corporation.

IBM's business was in mechanical accounting and tabulating machines and scales as well as calculators. The calculators were also mechanical.

IBM had developed good, reliable punched card I/O, but IBM did not invent the computer.

Next: Early Computers