

When Computers Learned To Compute

Science without computers? Unthinkable, nowadays! Yet over half a century ago, that was commonplace. Then, in the early 1950s, mathematician and physicist **Heinz Billing** entered the scene – and introduced the Max Planck Society to electronic computing. It all started with the “Göttingen 1.”

TEXT **TIM SCHRÖDER**

Many students at the Max Planck Institute for Physics were surprised when they entered the auditorium for the first time. Coming from the last room on the right was a loud chugging noise. Peering through the door's frosted window pane revealed nothing. Yet through the ventilation holes that someone had drilled in the bottom door panel they heard a powerful ticking noise, as if from 100 clocks. Initially, none of the young students really knew what was hiding behind the frosted glass pane. And the sign reading “G1” next to the door only made matters even more mysterious. When Heinz Billing finally unveiled the secret during a lecture, they were all the more fascinated.

The G1 could be considered Germany's first supercomputer. And its creator, Heinz Billing, the pioneer who taught the Max Planck Society how to perform electronic computations on a major scale. Back then, in 1952, most Germans had other things on their minds. The war had left behind a ravaged country. People tried to slowly settle back into a normal day-to-day life. And the same applied to the country's colleges, universities and research institutes, where scientific activity was only gradually beginning to pick up pace again. In the Max Planck Society, hardly anyone thought that mainframe computers would one day be solving questions posed in astro- and plasma physics. Heinz Billing did.

Heinz Billing had studied mathematics and physics during the 1930s. After obtaining his doctorate, he applied to the Institute for Aerodynamic Testing (AVA) in Göttingen in 1938 to avoid military service. He was drafted anyway. Luckily for him, he didn't have to fight at the frontlines: the former director of the AVA was able to convince the authorities that Billing was “indispensable” for the institute. Since radar technology wasn't yet very sophisticated back then, he wanted Billing to develop microphones for fighter planes that could detect enemy aircraft by their propeller sounds. However, this meant suppressing the noises made by the plane's own propeller.

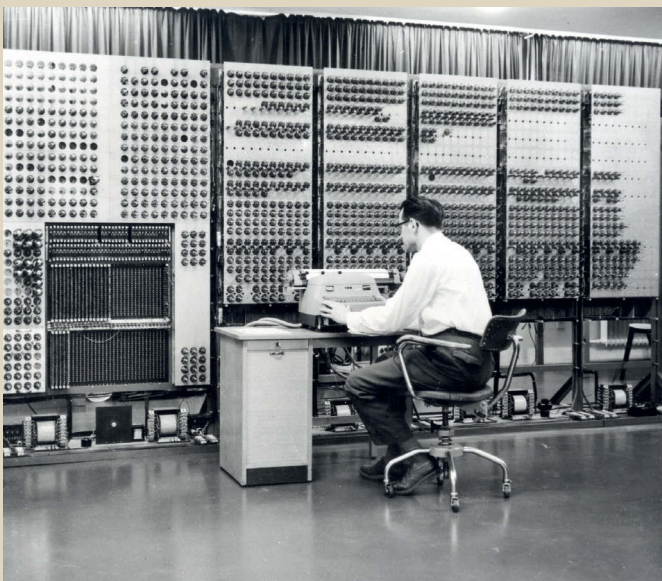
Billing came up with the idea of damping the plane's own propeller sounds in the microphone signal. To do this, he produced a recording of the propeller noise and glued it onto a small rotary drum, thus creating an infinitely looped audio tape that he could use for his experiments. He wasn't able to suppress the noises, because the rhythm of the humming propellers was just too irregular. But what Heinz Billing had in fact created – albeit unwittingly – was the key to Germany's first research computer.

After the war ended, work was temporarily suspended for several months and wasn't resumed until the fall of 1945. Institutes belonging to the precursor of the Max Planck Society, the Kaiser Wilhelm Society, moved into the old AVA building, including the Institute for Physics with Werner Heisenberg, Max von Laue and Carl Friedrich von Weizsäcker, as well as Max Planck and Otto Hahn. Surrounded by outstanding physicists, Heinz Billing was now in excellent company. He began searching for a new field of activity and set up the laboratory for high-frequency technology.

In the late summer of 1947, British computer experts visited the institute, among them the British computer science pioneer Alan M. Turing, who had managed to crack Germany's Enigma machine during the Second World War. In conversation with the British visitors, Heinz Billing learned that they were working on something called the “automatic calculation engine.” He was enthralled and began designing a calculation engine of his own: the “Göttingen 1” – G1.

In June 1950, the engine was complete. Just like today's computers, it operated using binary code, where letters and numbers are represented by zeros and ones – the number 1, for example,

Masterpiece of engineering: The Göttingen computer G3, here being put into operation in 1960. Sitting at the console is Billing's colleague, Arno Carlsberg.



would read "0001." In Billing's calculation machine, the states 0 and 1 were mostly set using a mechanical relay that switched back and forth between "power on" for the 1 and "power off" for the 0. Approximately 100 relays ticked and clicked ceaselessly and produced a constant noise that the students would hear on their way to the auditorium.

Apart from the relay, Billing also equipped the machine with 476 small electron tubes of the kind that were used in tube radios at that time. These tubes were able to switch back and forth much faster than the mechanical relay. The beating heart of the G1 was a magnetic drum memory, which Heinz Billing had developed several years prior. Even though it rotated at 3,000 rpm, its capacity – compared to today's computers – was extremely small. The memory could store only up to 26 numbers. An arithmetic operation such as multiplication took approximately one second.

Yet back then that was roughly ten times faster than the performance of conventional mechanical calculation machines. For his physicist colleagues, the G1 was extremely important. Especially Ludwig Biermann, head of the astrophysics department in Göttingen, used the machine frequently. Along with Billing, Biermann was the one who recognized the potential that electronic calculation machines held for scientific research.

Ludwig Biermann encouraged Heinz Billing to build new machines. Thus, in 1955, Billing unveiled the G2, which was comprised solely of electron tubes and was able to compute ten times faster

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Heinz Billing, who pioneered the development of electronic computers in Germany, is now being honored with a commemorative colloquium held at the Max Planck Society in Munich in celebration of his newly conferred emeritus status. In 1948 Billing (...) invented the magnetic drum memory for computers.«

than its predecessor. Friedrich Hertweck, who was a student in Göttingen at that time and later went on to head the computer science division at the Max Planck Institute for Plasma Physics in Garching, remembers that time well. "The G1 behind the frosted glass pane and the G2 fascinated me – and I earned a little bit of money watching over the machines at night," Hertweck says today.

As the memories of the G1 and G2 were still so small, calculation programs were fed into the machines in the form of punched tape. Intermediate data was also punched into tape and then fed right back into the machine so the latter could perform new calculations. Sometimes a tape would jump out of the guideway, or a relay would snag. "That meant someone had to be there at night to remedy the malfunction," says Hertweck.

Hertweck also remembers Heinz Billing very well: "Billing was full of energy – and yet he was a quiet guy who you'd often see leaning against a doorway with a cigarette dangling from his lips." In Friedrich Hertweck's opinion, Billing's great achievement was that he provided science with calculation engines in the 1950s and 1960s, even before mainframe computers were commercially available.

Final switch: Computer pioneer Heinz Billing at his computing machine, the G3, as it is being powered down for the very last time – after 12 years of service – during a small ceremony on November 9, 1972.



Back then, many scientists wavered between being excited about these novel calculation machines and rejecting them. A working group of astrophysicists in Heidelberg asked the computer scientists from Göttingen to calculate the trajectory of a newly discovered asteroid using the G2. At the same time, the Heidelberg team had around 20 secretaries perform the same calculations with the help of small tabletop calculation devices.

Ultimately, the results produced in Göttingen diverged significantly from those in Heidelberg, leading the astrophysicists in Heidelberg to believe that the calculation engine in Göttingen had failed. It later turned out that it was, in fact, not the machine that had been too inaccurate, but the calculations from Heidelberg. "It wasn't until the 1960s that people started realizing how important mainframe computers are for conducting research," says Hertweck.

In 1958 the Max Planck Institute for Physics moved from Göttingen to Munich and was renamed the Max Planck Institute for Physics and Astrophysics. In 1960 the G2 was superseded by the G3, which was already capable of performing between 5,000 and 10,000 operations per second. That was also the time when the world's first commercially available mainframe computer, the IBM 7090, was launched on the market. Heinz Billing was the one who always advised the Max Planck Society in all matters regarding the purchase of these machines, which cost several million Deutschmarks at the time. He was thus elected chairman of the Advisory Committee for Computers founded in 1968.

Even though computer pioneer Heinz Billing was ahead of his time, he never went on to become a major manufacturer of commercial computers. But that wasn't necessary. "I believe he was absolutely content that his machines paved the way for countless scientific projects," says Friedrich Hertweck. By the time more and more industrial mainframe computers became available on the market, Billing returned to his original area of expertise: physics. He now worked as an astrophysicist, seeking to prove the existence of gravitational waves – the cosmic echo of the Big Bang – postulated by Albert Einstein.

Today, Heinz Billing lives in Garching. Around the time of his 100th birthday in April 2014, American scientists researching in Antarctica claimed to have detected gravitational waves for the first time ever – though that was an error, as it later turned out. But perhaps Heinz Billing's great passion is mainframe computers after all. "Sometimes I hear my father talk in his sleep," says his son Heiner Billing. "Just a few days ago he said: 'Now we have to recalculate which algorithms we can use to multiply two large numbers.'"