Zuse, Konrad

German, 1910–1995

Konrad Zuse is popularly recognized in Germany as the inventor of the computer. He built a mechanical device, which he called "Z1", in the living room of his parents' apartment in Berlin. The construction of the Z1, the first programmable binary computing machine in the world, began in 1936 and finished in 1938.

After high school, Zuse began his studies at the Technical University Berlin-Charlottenburg. Being a very good painter, his first impulse was to study architecture. But he was also a tinkerer and an inventive model builder, capable of concocting astonishing machines just to impress his classmates. He eventually settled for civil engineering and earned his degree in 1935.

During his studies, Zuse learned how to perform the repetitive static calculations needed to build structures such as bridges, or indispensable to determine the stress on machine materials. Of his own account, this was the period in which he started considering the possibility of automating this task. Static calculations were performed by filling out forms in which all necessary formulas had been pre-printed. The engineer merely had to fill in his data and follow the prescribed computational path – surely a machine could do this work.

After graduating, Zuse started working for the Henschel airplane factory in Berlin. He was in charge of performing static calculations. However, he resigned a few months after having been hired and decided to turn into an "inventor". Zuse became an entrepreneur and his first creation was to be a computing machine. With his parents' help, he began to build the automaton which until that point had only existed in his imagination. Some friends assisted by working for him; others gave him small amounts of money so that he could finish the Z1. This might be the most important difference between Zuse and other computer inventors working at the time: while in the USA Atanasoff, Aiken, Mauchly and Eckert had the resources of universities or companies at their disposal, Konrad Zuse was working alone. The whole logical and mechanical design of the machine was his sole and own work.

The Z1 was operational in 1938. Zuse, ignorant of the internal structure of any type of calculator built at the time, started from scratch and developed a whole new kind of mechanical construction. Whereas contemporary desktop calculators were based in the decimal system and worked using rotating mechanical components, Zuse decided to use the binary system and metallic plates that could move only in one direction, that is they could only shift position. These plates were all what was needed for a binary machine, but some other obstacles had to be surmounted. It was not only necessary to design the complete logical description of the machine and then wire it accordingly – the mechanical components posed an ad-

ditional formidable challenge since every movement of one logical gate had to be coupled with the movement of the other gates. Linear shifts of the components had to be transformed to linear shifts in different layers of the machine, or shifts in perpendicular directions. It is safe to say, that from today's perspective, the mechanical design of the machine was much more challenging than the logical structure. Nobody, except Zuse, understood exactly how the machine worked, although many of his friends helped in cutting the hundreds of metallic plates needed for the apparatus. When complete, the machine was shown computing the determinant of a 3 by 3 matrix to several persons.

The time had come for a more ambitious project. The mechanical Z1 had proved that the logical structure of the machine was sound and now an electronic or electrical realization, using relays, could be contemplated. Helmut Schreyer, an electronic engineer and a friend of Zuse, suggested the use of vacuum tubes. Schreyer, in fact, adopted this as a Ph.D. project and developed some vacuum tube circuits for the electronic machine. Zuse himself was not really sure that vacuum tubes should be used. They promised extremely fast calculations, but he thought that vacuum tube machines could not be made to perform as reliably as relays or even mechanical components. Zuse had already been contemplating the possible uses for his machine, and was projecting its deployment in large or medium sized companies. His goal was the development of a programmable replacement for mechanical desktop calculators. The machines should be resilient and fault-tolerant.

Nevertheless, Schreyer and Zuse showed some of the electronic circuits to a small group at the university in 1938. They were asked how many vacuum tubes would be needed for a computing machine. When they said that 2000 tubes and several thousand other components would be necessary, the audience simply left in disbelief. The most complex vacuum circuits at the time used no more that some hundred tubes. The power necessary to keep the machine working was excessive. A few years later, the ENIAC would show to the world that vacuum tube machines were indeed expensive to build, yet feasible.

The start of the Second World War had immediate consequences for Zuse. He was called to serve in the army, where he stayed six months. With the help of Kurt Pannke, a constructor of mechanical calculators, Zuse tried to obtain a transfer to Berlin in order to continue his work on the next computing machine based on telephonic relays. Helmut Schreyer, who worked as an engineer at the university, also tried to obtain Zuse's discharge. He offered the military command to build an automatic air defense machine which could be operational in two years. The answer was a sardonic reminder to him that the war would be won in much less time. Finally, Zuse could arrange to be transferred to the Henschel airplane factory, where he was to make the calculations needed for the stability of the "flying bombs" (now called cruise missiles) that were being built in Berlin.

Zuse started working for the "special section F" at the Henschel fabric in 1940. During this time he developed two machines which could automatically measure some parameters of missile wings, transform the analog measurement into a digital number, and compute a formula based in this values. This could well have been the first analog-digital converter built for subsequent digital calculations. In 1940, he also built the machine "Z2", which used an integer processor built out of relays and a mechanical memory. The machine was shown to several persons and Zuse could convince the German Airspace Research Office (DLV in German) to partially finance the development of the computing machine "Z3", which would be built using only relays. The Z3 was operational in 1941 – it had the same logical design of the Z1, but used electrical components.

Zuse continued working for the Henschel factory, but started his own business in 1941. The "Zuse Ingenieurbüro und Apparatebau, Berlin" was the first company founded with the sole purpose of developing computers. The success with the Z3 brought Zuse a contract with the DLV to develop a still larger computer, the Z4. This machine had a very similar design to the Z3, but would have 1024 memory words instead of only 64. The machine was built and was almost ready in 1945, when Berlin was occupied by Russian troops. Zuse flew with the Z4 to South Germany, where he was later ordered to stay stationed. Some British and American military experts interviewed Zuse and inspected the machine after the war, but he was not among the scientists who finished their careers working for the allies.

After the war, Zuse continued working on two main projects: a) the development of an algorithmic language, which he called the "Plankalkül" (calculus of programs), and b) starting his company again. The Plankalkül can be considered to be the first high-level programming language conceived at the time, although no compiler or interpreter was ever written for it. Zuse's company was revived after Prof. Stiefel, from the Technical University of Zürich, saw the refurbished Z4 in operation and decided to rent it for his university. The Z4 was installed in Zürich in 1950 and was the first commercial computer in operation, some months before the first UNIVAC was delivered in the USA.

Zuse's company (with the new name "Zuse KG") flourished after the war and many other machines were built. They were all numbered progressively according to their introduction, i.e., Z5, Z11, Z22, Z23 etc. The dominance of the American computer industry in Europe, as well as the late adoption of a fully electronic design brought the Zuse KG in financial difficulties. The company was sold in 1962 to Brown Boveri and Co., and later to Siemens. Production of the Zuse series of computers was eventually stopped.

In retrospect it can be said that Konrad Zuse's greatest achievement was the development of a family of fully digital, floating-point, programmable machines, which were built in almost total intellectual isolation from 1936 to 1945. His

dream was creating the small computer for business and scientific applications. He worked single-mindedly during many years to achieve this objective. Obsessed with his machines, Zuse was mostly an apolitical person and continued being so after the war. His patent application of 1941 for the computing machine Z3 was definitively not granted in 1967 by a German judge, who declared it to lack "inventiveness". However, Zuse always considered himself the true inventor of the computer and his public interventions on this subject let always some bitterness transpire, until his death in 1995.

Biography

Born 22 June 1910, in Berlin, Germany. Studied at the Braunsberg High School in Braunsberg and later at the Technische Hochschule Berlin-Charlottenburg. Got a civil engineering degree in 1935. Konrad Zuse married in 1945, and later became the father of five children. From 1959 onwards, he received many honors and prizes from international associations and universities, as well as from the German government. His computer company, the Zuse KG, was liquidated in 1962. He died in Hühnfeld, Germany, in 1995.

References

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