Physik Anekdoten (11)

Konrad Zuse and Switzerland

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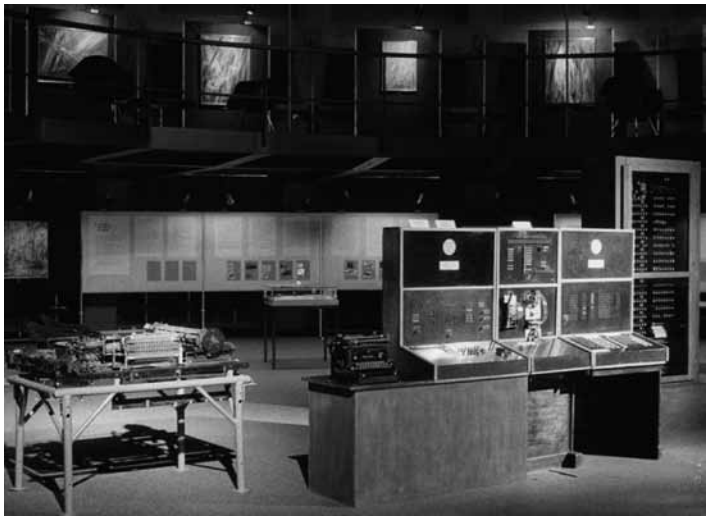
Konrad Zuse 1989 with a replica of the Z1
Quelle: Horst Zuse

In 2010 we celebrated the 100th anniversary of the birth of Konrad Ernst Otto Zuse, who was the greatest computer pioneer in Germany and perhaps in Europe. He had always lived in Germany, but nevertheless, he also had a significant relationship with Switzerland, especially with the ETH Zürich (ETH-Z), between 1949 and 1955.

Konrad Zuse was born in Berlin on 22 June 1910. After finishing school he studied civil engineering at the Technical University in Berlin-Charlottenburg, where he worked on the idea of an automatic, program-controlled computer. After graduation in 1935 he joined the Henschel Aeroplane Company in Berlin and worked there on calculations for the stability of wings. He resigned from the job after only eleven months and built his first V1 computer (Versuchsgerät 1, later called Z1) between 1936 and 1938 in his parents' living room. The Z1 was completely mechanical, based on the "mechanische Schaltgliedtechnik", a mechanical bit, which he had invented. Since the numerous parts of the machine were produced by rather primitive means, e.g. an electric fretsaw, the Z1 did not really work reliably [Cza 1979: 14]. Nevertheless, Zuse was funded by the Forschungsanstalt für Luftfahrt (Aeronautical Research Institute) and given a certain amount of support [Cza 1979: 89].

Zuse pursued his work and founded his own company, the "Dipl.-Ing. K. Zuse Ingenieurbüro und Apparatebau", in Berlin in 1941. His Z3, which was first presented on 12 May 1941 to visitors from the DVL (German Aeronautics Research Institute) [Zus 1993: 62], is regarded nowadays as the first worldwide program-controlled, general-purpose computer. The Z3 was a relay computer, where both the central processing unit (CPU) and the storage were built using relays and stepping switches, as used in telephone switching systems. During World War II, the Zuse company had to move several times due to the bombardment of Berlin, but by the beginning of 1945 about seven computers had been built. However, only the Z4 and the L3 *) survived the war [Zus 1946], and it was the Z4 which led to the cooperation between Zuse and the ETH-Z. The Z4 had been developed and built between 1942 and 1945. In March 1945 Zuse left Berlin and went via Göttingen, where the Z4 performed its first calculations, to Hinterstein in the Allgäu.

At the beginning of 1948 Professor Eduard Stiefel founded the Institute of Applied Mathematics at the ETH-Z. He was well aware of the development of automatic computers, and he and his assistants, Heinz Rutishauser and Ambros P. Speiser, studied the developments in the USA and Great Britain during extended visits in 1948 and 1949 [RSS 1951]. Stiefel was convinced that the future of applied mathematics meant the use of computers, and he was therefore eager to get one. At that time there was no computer industry but only single machines which were built at various places. These machines could not usually be purchased. Stiefel, Rutishauser and Speiser, who was an electrical engineer, decided to build their own computer [Spe 2000], which would take several years and a large amount of money. During this time, no computer-based mathematical research would be possible. In 1949 Stiefel heard of the Z4, which was at Hopferau, near Füssen, also in the Allgäu, and visited Zuse on 13 July 1949. As a test he dictated Zuse a simple differential equation, which Zuse coded and fed immediately into the Z4, and which, to Stiefel's satisfaction, computed the correct result. Stiefel knew the current state of computer technology, which at that time had already moved into the electronic era, i.e. beyond the technology of the Z4 where the storage was mechanical and where the CPU consisted of relays and stepping switches. Through Rutishauser and Speiser, who were still in the USA at that time, he contacted Howard Aiken, the inventor of the Mark series of computers, at the Massachusetts Institute of Technology (MIT). Aiken's reply was very critical [Spe 2000], but Stiefel nevertheless decided to rent the Z4 because it was the only functioning computer on the European continent at that time. The contract was finalized in September/October 1949 and stated that the ETH-Z would rent the Z4 for five years for 6,000 SFr per year [Mie 1949]. The rent was paid in advance and this money allowed Zuse to establish a new company, the Zuse KG, in Neukirchen in the northern part



The Z4 at the ETH-Z in 1981
Quelle: Horst Zuse

of Hessen.
In Neukirchen the Z4 was refurbished and some modifications were incorporated on the explicit request of Stiefel and his group. The most important of these modifications was the incorporation of the conditional jump. On 11 July 1950 the Z4 arrived in Zürich and was immediately installed in the Institute of Applied Mathematics. The inauguration took place in August 1950, and by September the tests were completed and the Z4 started its useful work, marking the beginning of the computer-aided era in Switzerland. In July 1955 a list of 55 projects, which were run on the Z4 between 1950 and 1955, was compiled [ETH 1955]. 23 of these projects were orders from industry, which shows that Stiefel was very eager to put applied mathematics into practice. Among those projects were the computation of the stress in the Grand Dixence Dam, the trajectory of a rocket, the passage of light rays through lens systems, the deformation of aeroplane wings, the critical speeds of turbines, and the control of the outflow of three Jurassic lakes. During this period, Zuse sometimes also did maintenance himself and, therefore, he went to Zürich several times. There, the Z4 even ran unattended through the night, and this prompted Konrad Zuse, who was a man with a good sense of humour, to remark: “In any event, while the Z4 rattled on, sleepy Zürich had a night life – if only a modest one” [Zus 1993: 121]. All in all, the Z4 executed about 15 million operations during its time at the ETH-Z. In 1955 the Z4 was moved from the ETH-Z to a Franco-German Research Institute near Basel.
For Zuse, the installation of the Z4 in Zürich led to other important business contacts. The Zuse KG built a series of calculating punches for Remington Rand in Switzerland, and later the optical company Wild and the Reaktor Aktiengesellschaft each purchased a Z22.
In 1981 the ETH-Z commemorated the work of the Z4 with an exhibition [ETH 1981] and, finally, it awarded Konrad Zuse a honorary doctorate on 23 November 1991.
The installation of the Z4 at the ETH-Z even had repercussions in Jena at Carl Zeiss, one of the important optical companies worldwide. On 17 May 1954 the CEO, Hugo Schrade, and the CTO, Herbert Kortum, presented a proposal for the building of a relay computer for optical calculations to their minister, Rau, in East Berlin. As motivation, they pointed out that some rival firms had already been using automatic computers for several years. Among others, they referred to the Wild company in Heerbrugg, which had presented a new objective for aerial cameras, the Aviogon, at the 7th International Symposium on Photogrammetry 1952 in Washington, which had impressed the people at Carl Zeiss in Jena very much. The developer of the Aviogon was Ludwig Bertele, whom the Zeiss people knew quite well because he had worked for Zeiss Ikon in Jena and Dresden between 1926 and 1942, and who was one of the most outstanding lens designers in the world. Herbert Kortum said that he assumed that Bertele had used the “machine installed in Zürich” for the development of the Aviogon [BACZ 23789]. The “machine installed in Zürich” is obviously Zuse’s Z4.
On 22 June 2010 the current author gave a talk “Konrad Zuse and Jena: Z4, Z5 ==> Oprema” [Win 2010]. During the preparation for this talk the author tried to check whether Kortum’s conjecture referring to the use of the Z4 by Bertele was true. Information supplied by Bernhard Braunecker (Leica-Wild emeritus) and Martin Gutknecht (emeritus at the Institute of Applied Mathematics of the ETH-Z) strongly suggests that it is not true: neither could find any hints in the archives. Martin Gutknecht found that an order from the optical firm Rodenstock in Munich had been executed in the study year 1951/52 [Gut 2010]. Additionally, the work that eventually led to the Aviogon had already been started in 1946 when Bertele joined Wild [Lei 1996].

**) Experimental set-up to study a machine for logical operations (Hinweis von Horst Zuse, 09. April 2011)*

BACZ 23789	Reisebericht von H. Kortum vom 20.5.54; Kurze Zusammenfassung des Vortrags zur Oprema, gehalten vor Min. Rau am 17.5.54, vom 20.5.54; Aktenvermerk des Ministeriums für Maschinenbau, Sekretariat des Ministers, vom 19. Mai 1954 Firmenarchiv Carl Zeiss Jena
Cza 1979	Czauderna, Karl-Heinz: Konrad Zuse, der Weg zu seinem Computer Z3. R. Oldenbourg, München Wien, 1979. 3-486-23141-3
ETH 1955	Eidgenoessische Technische Hochschule, Institut für angewandte Mathematik, Zuerich: Liste der 1950 -1955 mit der programmgesteuerten Rechenmaschine Z4 ausgeführten Aufträge und mathematischen Untersuchungen. Zürich, 11. Juli 1955. Pdf von Martin Gutknecht, ETH, 2010Mai25
ETH 1981	Eidgenössische Technische Hochschule Zürich: Konrad Zuse und die Frühzeit des wissenschaftlichen Rechnens an der ETH. Dokumentation zu einer Ausstellung um die Z4 - den ersten an der ETH eingesetzten Computer (1950 - 1955), (ETH Zürich, 17.Juni bis 15.Juli 1981). Math. Seminar, ETH Zürich, 1981
Gut 2010	Gutknecht, Martin: persönliche Mitteilung an den Verfasser. 2010Jun07
HR 2000	Rojas, Raúl; Hashagen, Ulf: The First Computers' History and Architectures. MIT Press, Cambridge Mass. etc., 2000. 0-262-18197-5
Lei 1996	Leica AG: Leica Heerbrugg im Wandel der Zeit. Leica AG, Heerbrugg, Switzerland, 1996 http://www.leica-geosystems.com/media/new/product_solution/Jubilaeumsbroschuere.pdf ; Visited 2010Mai17
Mie 1949	Mietvertrag zwischen dem Institut für angewandte Mathematik der Eidg. Technischen Hochschule in Zürich und dem Zuse-Ingenieurbüro in Neukirchen, 22.Sep./8.Okt. 1949.

http://www.ethistory.ethz.ch/rueckblicke/departemente/dinfk/weitere_seiten/angewandte_mathematik/material_dokumente/1949_vertrag-z4.pdf ; Visited 2010Mai19

RSS 1951 Rutishauser, Heinz; Speiser, Ambros; Stiefel, Eduard: Programmgesteuerte digitale Rechengeräte (elektronische Rechenmaschinen). Birkhäuser Verlag, Basel, 1951

Spe 2000 Speiser, Ambros P.: Konrad Zuse's Z4: Architecture, Programming, and Modifications at the ETH Zürich. = [HR 2000: 263..276]

Win 2010 Winkler, Jürgen F. H.: Konrad Zuse und die Optik-Rechenmaschine in Jena. LOG IN Nr. 166/167 (2010) 130..134 (im Erscheinen)

Zus 1946 Zuse, Konrad: Übersicht über die bisher gebauten Zuse Rechengeräte. Handschriftliche Notiz vom 26. 3. 46. http://www.zib.de/zuse/Inhalt/Texte/Chrono/40er/Pdf/388scan.pdf, S.5. Visited 09 April 2011

Zus 1993 Zuse, Konrad: The Computer - My Life. Springer, Berlin Heidelberg, 1993. 3-540-56453-5

Jürgen F. H. Winkler has been a full professor for programming languages and compilers from 1993 to 2008 at the Friedrich Schiller University in Jena (http://psc.informatik.uni-jena.de). During this time he worked on programming languages and mechanical program verification. His farewell lecture on 25 October 2008 "The Oprema: the Relay Computer of Carl Zeiss" presented the history and main technical properties of this early computer, which is rarely mentioned in the literature. On 22 June 2010, the 100th birthday of Konrad Zuse, he gave a talk on "Konrad Zuse and Jena: Z4, Z5 ==> Oprema" which detailed the influence of the Z4 at the ETH-Z on the genesis of the Oprema.

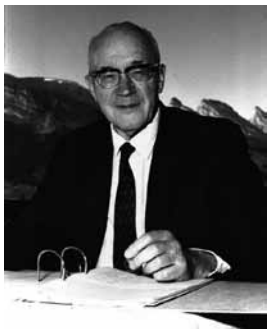
Physik Anekdoten (12)

Werdegang der industriellen Optikentwicklung in Heerbrugg: Vom Strahlen berechnenden Damenkollektiv zur Auswertung kollektiver Strahldaten

Bernhard Braunecker

Die Bertele Ära in Heerbrugg

Als 1946 der im vorangehenden Bericht erwähnte Ludwig Bertele bei WILD in Heerbrugg seine Stelle als Leiter der Optikentwicklung antrat, war das damals übliche Vorgehen im Optikdesign, dass eine Gruppe meist jüngerer Frauen im eigens geschaffenen Rechensaal mit Hilfe von Sinustabellen und Logarithmentafeln bestimmte optische Strahlen durch das noch unfertige Objektiv rechnete. Man kam bei komplizierten Objektiven auf gut fünf windschiefe Strahlen pro Stunde und vermutlich auf doppelt so viele, als mechanische Rechenmaschinen mit verwendet werden konnten. Das war in Heerbrugg noch bis 1957 der Fall! Der Optikdesigner musste aus den wenigen gerechneten Strahlaberrationen auf die hochgradig nicht-linearen Zusammenhänge beim Bildaufbau schliessen, um entsprechende Korrekturmassnahmen an der Linsenform und bei der Glaswahl zu treffen. Das erforderte neben analytischem Denken auch eine ausgeprägte Intuition, so dass Optikrechner meist auch Künstlernaturen waren. Man kann rückblickend die Leistungen von Bertele nur bewundern, der trotz der beschränkten Hilfsmittel mit den ‚Aviogons' eine völlig neue Klasse der grossformatigen Luftbildobjektive schuf und damit die moderne, flugzeuggestützte Luftbild-Photogrammetrie begründete.



Ludwig Bertele (1900-1985)

Kontakt zu Zuse

Der Bedarf an Rechenleistung bewog namhafte Optikfirmen wie WILD Heerbrugg frühzeitig, den Kontakt zu Computerbauern der ersten Stunde wie Konrad Zuse zu suchen. Ab 1959 kamen in Heerbrugg eine, später zwei röhrenbestückte Zuse Z22, bzw. Z22R Rechner in der Optikentwicklung zum Einsatz. Die Rechner hatten einen Ferritkernspeicher von 14 Worten à 38 Bit, einen Trommelspeicher von 8'192 Worten à 38 Bit und kosteten ca. 220'000 DM. Jede Operation wurde im Maschinencode durch ein 38 Bit Befehlswort beschrieben, wobei 13 Bit für die eigentliche Operation belegt waren, sowie 5 Bit für die Adresse des Kernspeicherelements und 13 Bit für die des Trommelspeicherelements, zwischen denen die Information verschoben wurde. Die Befehlsabarbeitung konnte man - zumindest bei der späteren transistorisierten Z23 - auch optisch gut kontrollieren, wenn man das Flackern der 38 Bit-Lämpchen des Befehlsregisters an der Kontrolleinheit mitverfolgte. Die Komplexität der Z22R-Hardware mit 400 Röhren, die zu Flip-Flops geschaltet waren, kann man erahnen, wenn man sie mit einem damaligen Radiogerät mit 4 bis 5 Röhren

Zuse Rechner Z22R in Heerbrugg (1960)