PLANKALKÜL: NOT JUST A CHESS PLAYING PROGRAM

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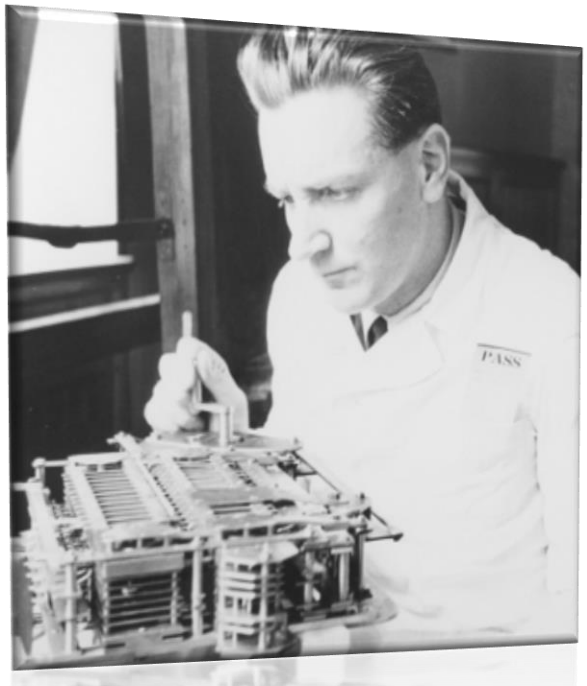
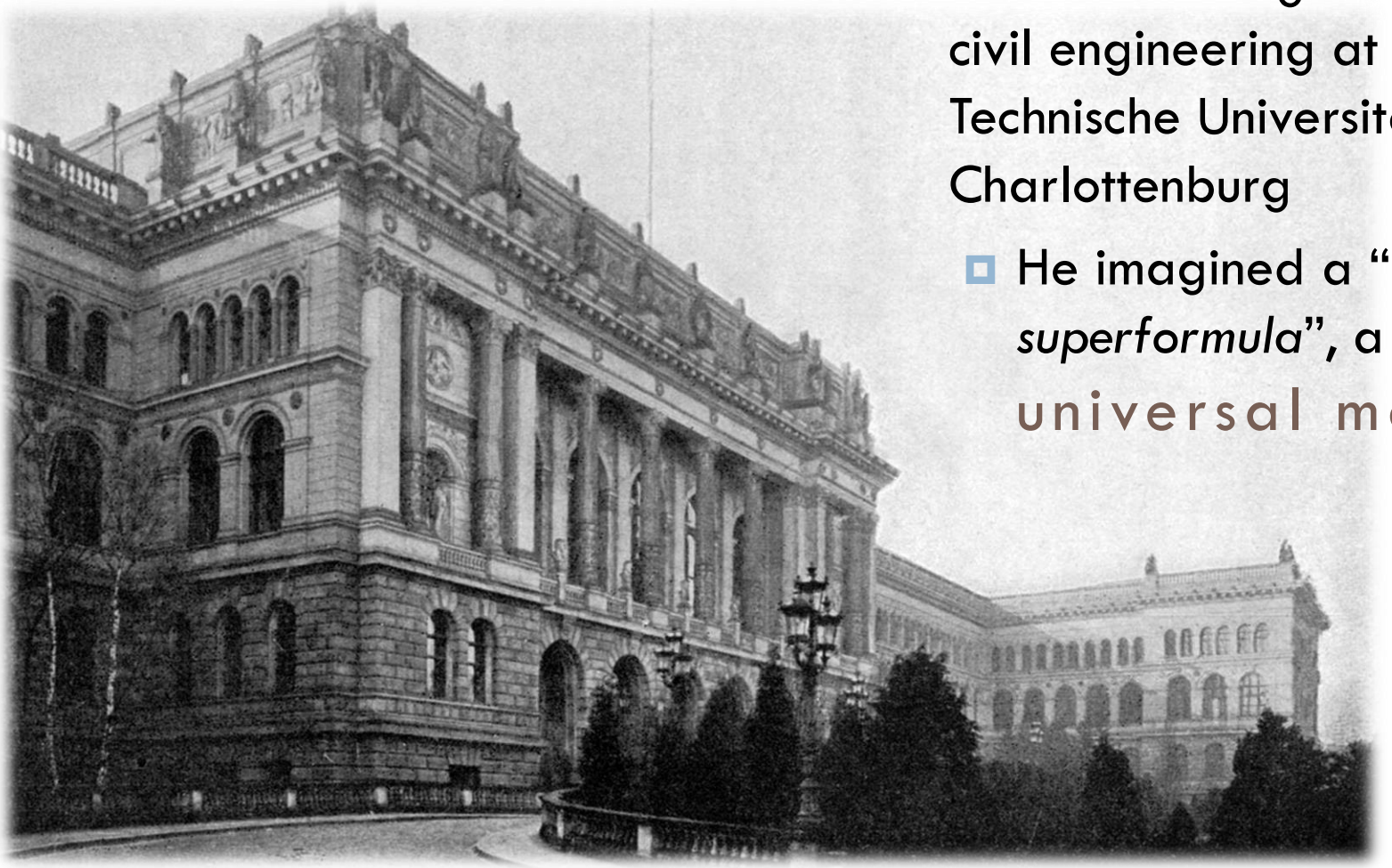
- A COMPUTER SEARCHES FOR DELINQUENTS.
- CYBERNETICS SOLVE THE GOVERNMENT'S PROBLEMS.
- COMPUTERS CONTROL A ROLLING MILL.
- A COMPUTER DOCTOR MAKES A DIAGNOSIS.
- THE GREAT DOCUMENT HEADQUARTERS RELEASES INFORMATION.
- A GIANT TIME SHARING SYSTEM SERVES AN ENTIRE CITY.
- WILL A COMPUTER BEAT THE WORLD CHESS CHAMPION?



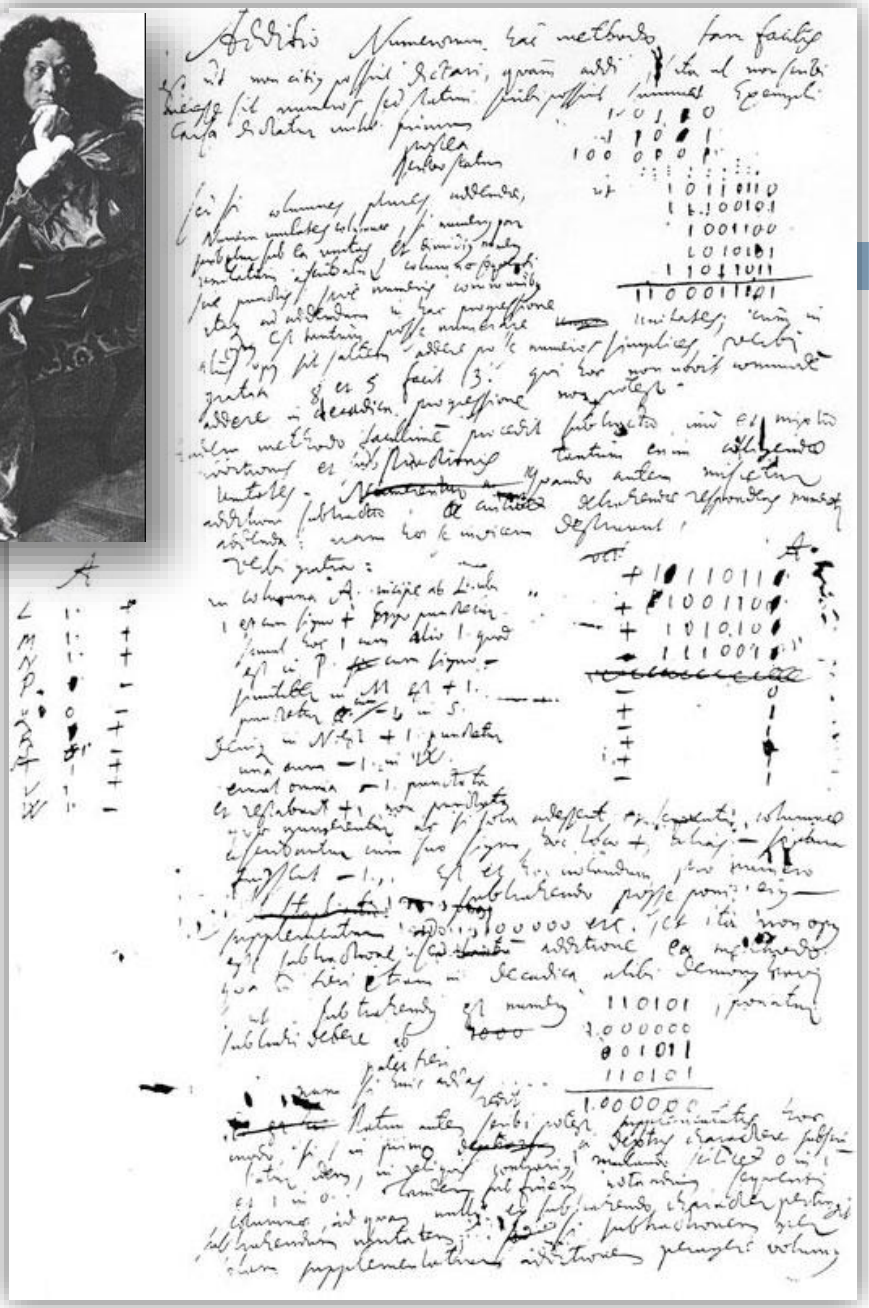
Zuse, K.: *Der Computer mein Lebenswerk*, Moderne Industrie (1970).

The History of a Discovery



- **1930**: Zuse began to study civil engineering at the Technische Universität Berlin-Charlottenburg
  - He imagined a "*universal superformula*", a kind of universal machine

Leibniz

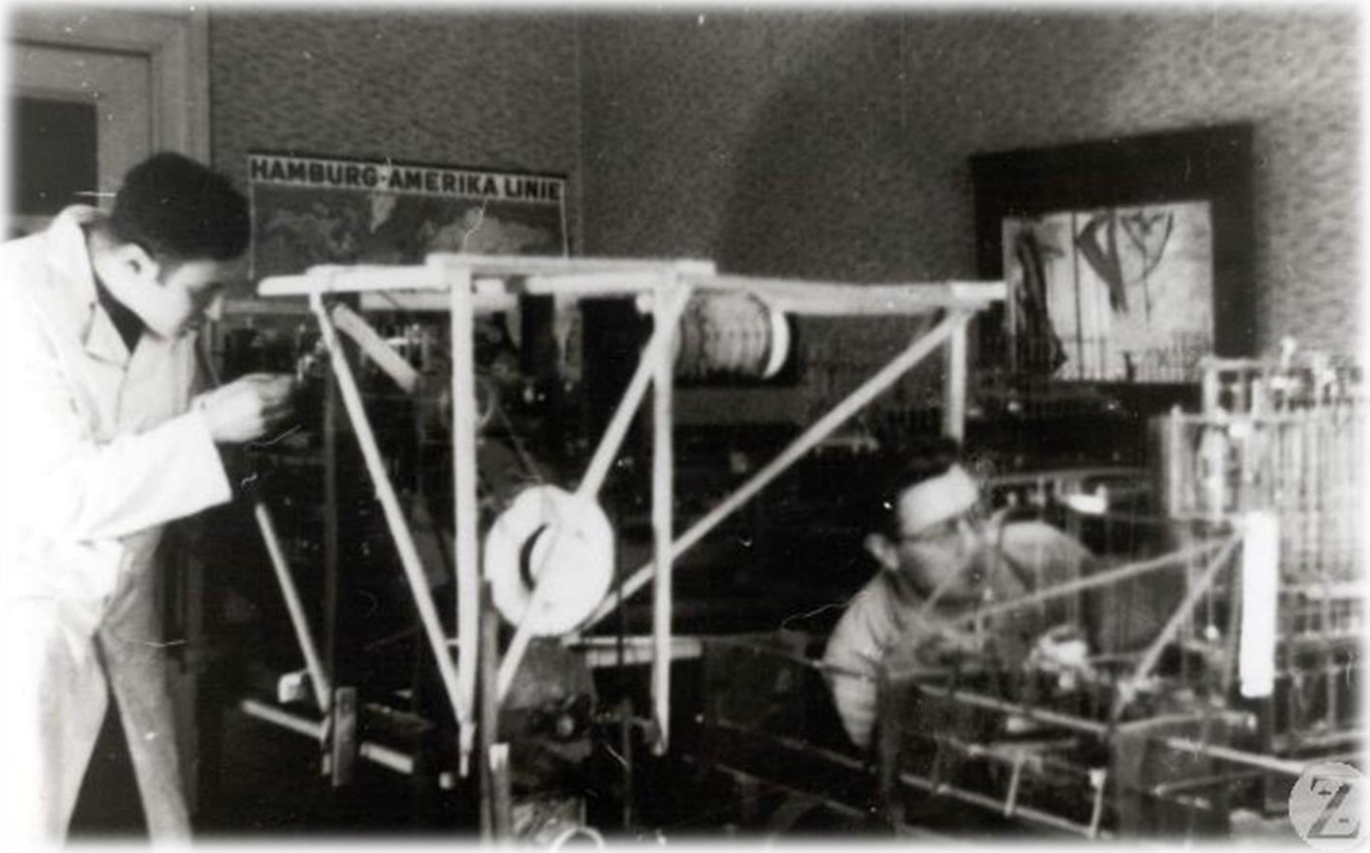


- Zuse is expressly inspired by Leibniz
- He proposed a sort of "math logistics" that turned out to be equivalent to Boole's propositional calculus

- *Einführung in die allgemeine Dyadik* of 1938

The Z1 Machine

In the humble living room of his Berlin house, Konrad Zuse devotes himself to the design and construction of a binary, programmable machine.

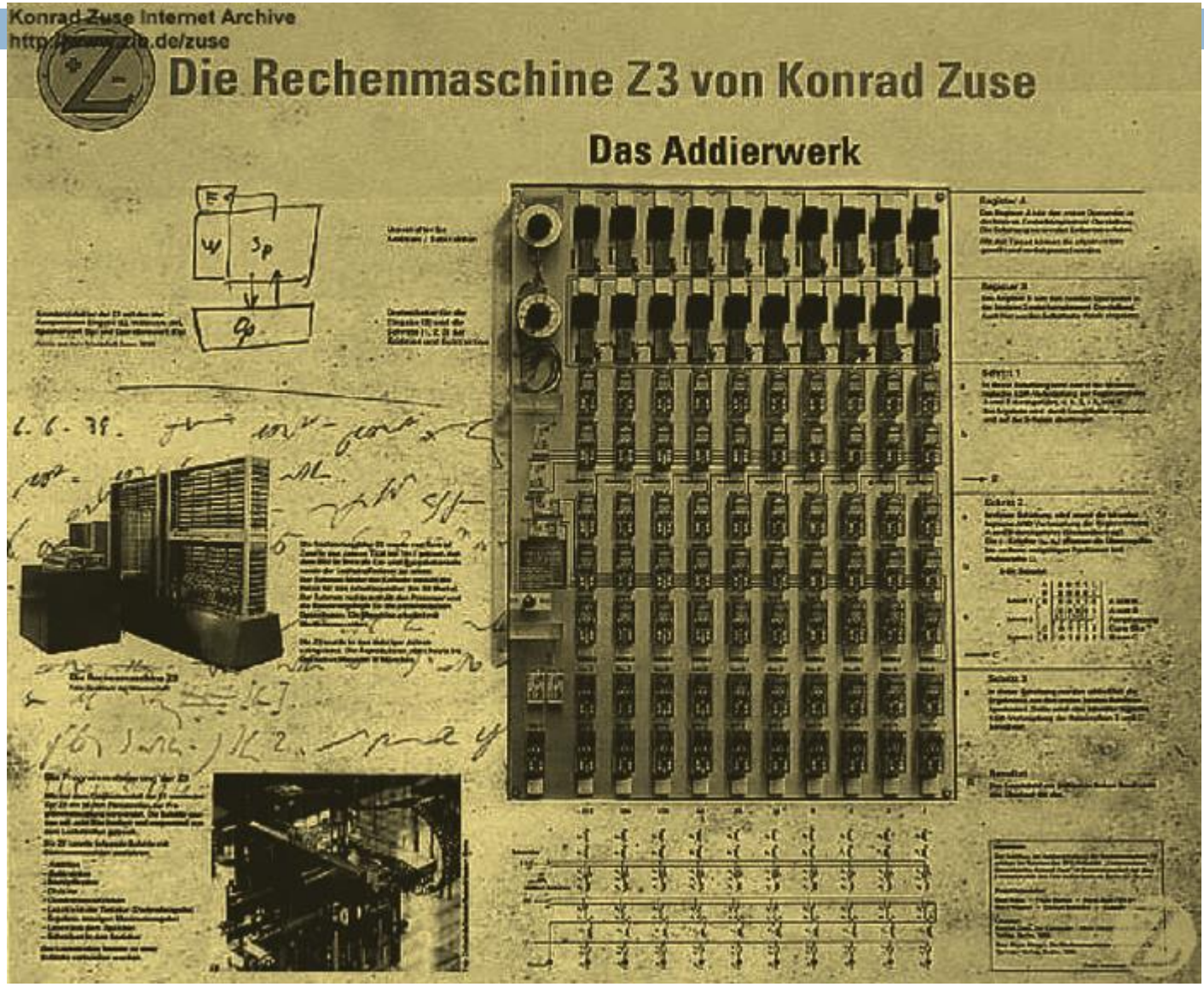


It was comparable to a large dining room table in size and was described by those who saw it as “something indefinable, composed of metal sheets, glass plates, cranks, gears and discs”.

Z2, Z3 and Z4

The Relays

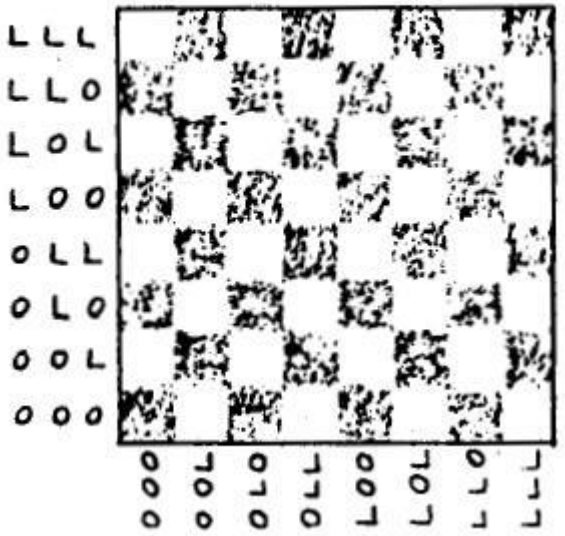
The Z3 was much more powerful than Z1 and Z2: Zuse had added 2,600 relays mounted on three racks, two for the memory and one for the arithmetic and control units



COMPUTER BEATS WORLD CHESS CHAMPION?

Koordinaten-Darstellung:

Zuse's 8x8 Board with three bit file, rank coordinates: a1 = 000, 000; e2 = L00, 00L



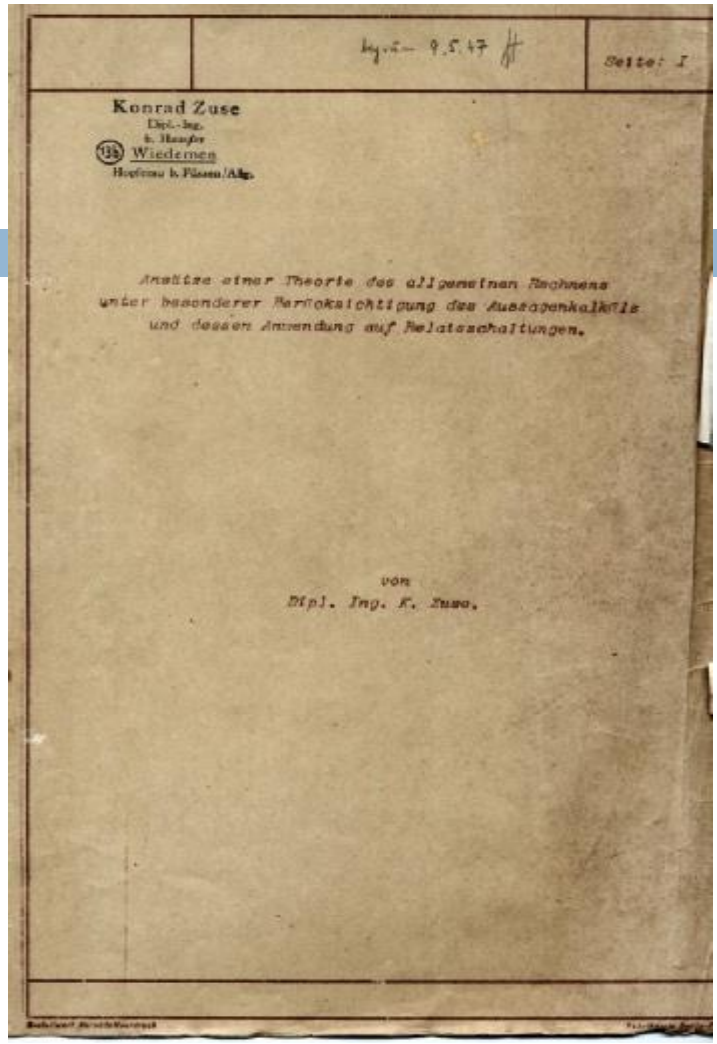
Die Punkte sind benachbart

	V ≠ V ∧ |V − V| ≤ L ∧ |V − V| ≤ L ⇒ R Δ .17							
V	0	1	0	1		0	1	
K			0	0		1	1	

Plankalkül, two squares (v0, v1) are adjacent, if they are not equal, and both absolute rank and file distance are less or equal than one (L), structural square indices written vertically

The *Plan Calculus*

"For a year and a half, I devoted myself to the progressive study of formal logic. I found within it many of my own thoughts [...]. Now, I aim to finalize the process of the *plan calculus*. To do this, I have to clarify a number of notions."


Konrad Zuse
Dipl.-Ing.
b. Hamfer
(13a) Wiedemen
Hopfgau b. Füssen/Allg.

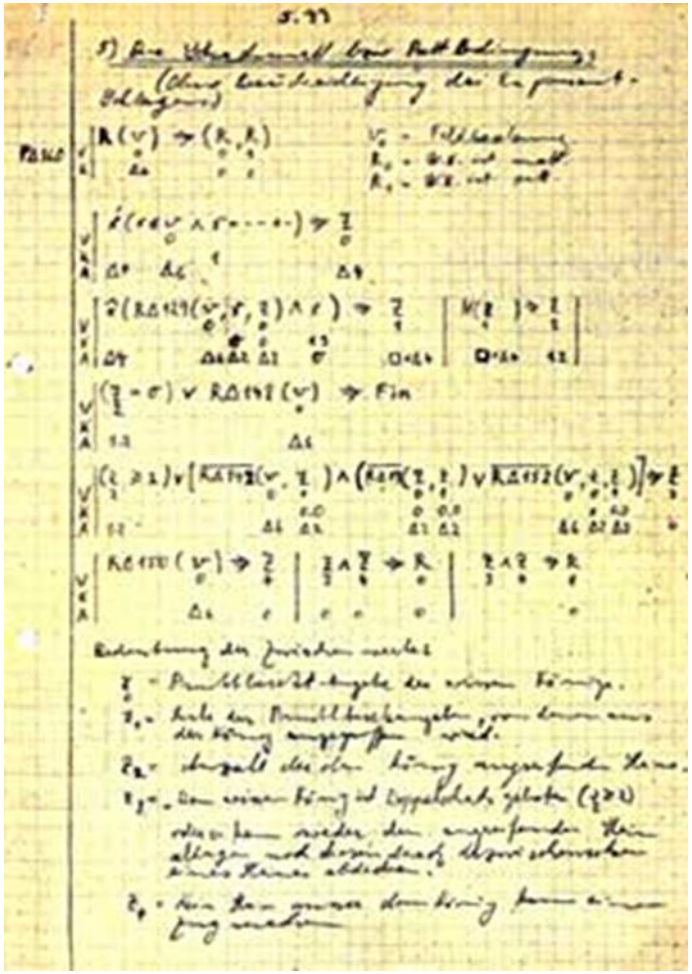
Ansätze einer Theorie des allgemeinen Rechnens
unter besonderer Berücksichtigung des Aussagenkalküls
und dessen Anwendung auf Relaisschaltungen.

von
Dipl. Ing. K. Zuse.

The first reference to *Plankalkül*, the German expression used to indicate "calculation projects for a computer" probably taken as an extension of Hilbert's "propositional calculus" (*Aussagenkalkül*) and "predicate calculus" (*Prädikatenkalkül*).

Technical Characteristics

- Assignment, subscripts, expressions
- Types: integer, reals, arrays
- In a *Rechenplan* an identifier was a letter
  - **V** for variables
  - **C** for the constants
  - **Z** for the intermediate values
  - **R** for the results



Arithmetic operations

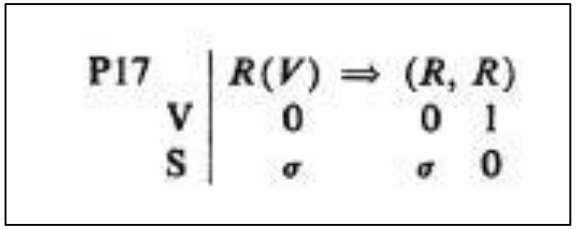
- Addition, subtraction, multiplication and division, can be easily performed using the intermediate variables (identified with **Z**)

	V	+	V	>=	Z
V	1		2		1
K	1		3		1
S	5.8.o		5.8.o		5.8.o

Originally Zuse used the symbol «>=» to denote the assignment operator; the modern symbol «⟶», was introduced later

Programs and suroutines

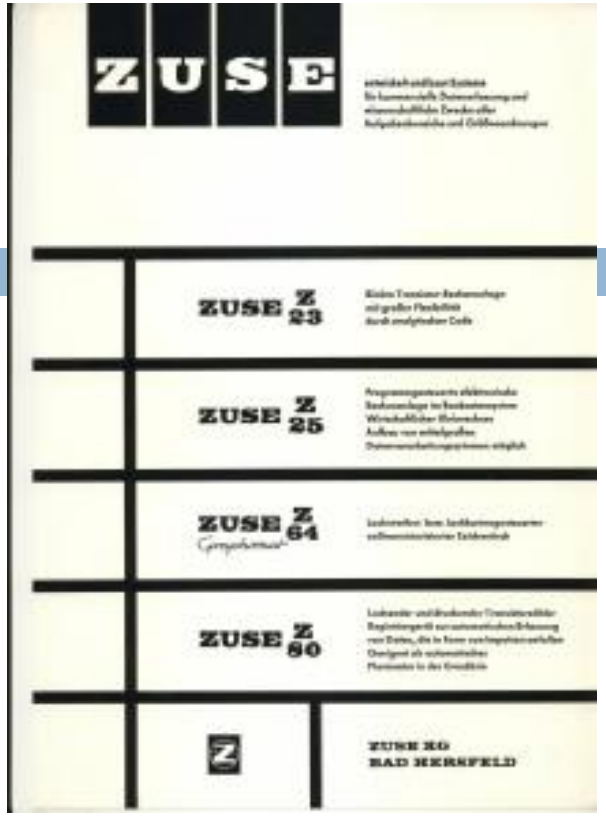
- Expressed in procedural form (*Rechenpläne*)
- They are prefaces by a specification part (*Randauszug*)
- Computatational rules described in the body (*Anweisungsteil*)



P17	$R(V) \Rightarrow (R, R)$		
V	0	0	1
S	σ	σ	0

- Special symbols for instructions, conditional branches and iterative cycles
- A “conditioned stop” ⇨ FIN

1964: Zuse KG


ZUSE
ZUSE Z 23
ZUSE Z 25
ZUSE Z 64
ZUSE Z 80
ZUSE KG
BAD HERSFELD


ZUSE KG · BAD HERSFELD
SONDERDRUCK


ZUSE K-G
Modell Z 11