LAUDATIO KONRAD ZUSE

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Introduction

We can characterize Zuse with the words of Bauer in his foreword to Zuse's autobiography : "Zuse is the creator of the first fully automated, program-controlled and freely programmable computer using binary floating-point calculations". And we could go on by situating him in the history of computing in the line from Averroes, Raymondus Lullus, Pascal, Leibniz, Jacquard, Babbage, Venn, etc. This is a historically important and interesting subject. To an important extent as is the case with all major developments we have partly parallel, but independent, developments. But we also have subtle, sometimes very indirect, interrelations and influences. For the developments between 1930-1945, the release — if ever — of spionage reports on the matter can be of relevance. But anyway it is clear that Zuse has in innovation and performance been ahead on his contemporary colleagues-developers concerning the hardware as well as the software perspectives. The impact of his realizations and thoughts on the computer developments, from 1945 to the present, is another matter of discussion, again very intriguing and complex as a lot of influences — as is mostly the case in scientific and technological circles — were very informal, through the 'invisible colleges and communities'. As we know from many other studies, the credit for an idea is rarely given to the contributor. Even in science, where quotations are considered essential, these quotations consciently or unconsciently are made in view of honoring the person who made the quotation. In this line one will prefer to quote an academically recognized person, rather than an academic outsider or marginal person (e.g. a starter).

All this to say that concerning the contemporary history of computing still a lot of work has to be done. However, in this laudatio of Zuse we do not intend to go into this interesting matter into detail. In the history of science, the contribution of Zuse is — it is true — a vital and decisive one, but he has however still much more significance. Although the impact of these other aspects of his contributions to humanity are not yet that clear, still we want to make use of this occasion to go into these matters as well. After a short sketch of the person and his life, we want to dwell on his ideas and lessons on the problems of scientific evaluation, scientific politics and on his ideas on the computer germs.

The person

Konrad Zuse was born June 22nd, 1910 at Berlin. Two years old, he left Berlin with his parents (his father became postmaster in Braunsberg). There he followed the gymnasium and was able to pass the Abitur when only seventeen. This means that he was roughly two years younger than his classmates, which — I quote — "gave me bit of an inferiority complex. Above all, I felt physically inferior to those who where two years older. I got beaten up more often too (p. 5-6)."

In the fifth year of the secondary school, as his father has become chief postmaster in Hoyerswenda, Konrad went to a gymnasium there. There was a lot of interest in school reformation. Here already he started to be critical on school procedures. I quote : "Arbeitsunterricht was the slogan of the day. Practical instruction : when one speaks and all others sleep was our commentary ..." (p. 7).

For his senior project he already showed a lot of originality with his design of Metropolis, a city of some 35 million inhabitants along traffic engineering lines (Fig. 1).

In 1927 he began his studies at the Technical University Berlin-Charlottenburg. He had a hectic student life dividing himself between science, technological inventions, politics and student life. Concerning his inventive genius : he was active with photography, cinema, projection technology, vending machine with change-giving mechanism.

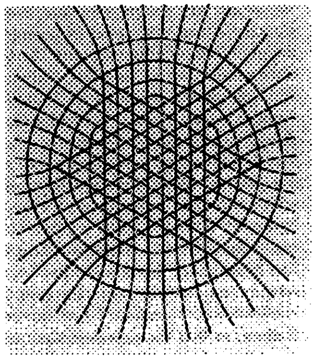

Fig. 1 : Metropolis — a radial street system resolves itself at the center into a uniform 60° system (school project by Zuse)

After completing his studies, in 1935, Zuse became a structural engineer with Henschel Aircraft Company. He soon left his job to set up an inventor's workshop in the apartment of his parents. He wanted to be able to devote himself entirely to the computer. On this he writes : "Of course, my parents were not exactly thrilled with the idea, but they had such faith in my abilities that they supported me as far as they could. Later, they even let me build my first, still rather bulky machines in the largest room of their apartment. My friends at the university also pitched in. They gave me money, sums which might seem modest today, but without which I never would have been able to obtain the necessary materials for my work. My first financier was my old school friend from Braunsberg, Herbert Weber. My sister was also among the first contributors, and, of course, my parents also helped again and again. Each gave what he could, and in the end several thousand marks had been collected. Others who had nothing to give worked alongside me in the workshop. All of these helpers and co-workers of the first hour contributed their fair share to computer developments (K. Zuse, 1993, The Computer — My Life, p. 34-35)."

We could here give an overview of the several generations of computers : from Z_1 to Z_{30}. We will not do that. Let us just remark that originally they were called V_1, etc., V being short for 'Versuchmodell' : experimental model. Nor will we dwell in detail on the important task for Zuse of combining his role as an inventor, with those as manager and business man and how finally he became a teacher and a theoretical scientist, always combining his inventiveness and art skills and interest.

To end this very sketchy overview of Zuse's life, let me quote an anecdote which illustrates the importance of his work. Near the end of the war, when Wernher von Braun's team was moved, Zuse's team too was moved or managed to be moved to Oberjoch. Even von Braun was only able to bring over the hundred most important co-workers selected to from a team of many thousands. Zuse was able to have a brief discussion with von Braun. However, of the danger which hung above their heads he learned only much later, when reading Wernher von Braun's memoirs. An excerpt of the discussion between General Dornberger and SS Storm Troop Leader runs as follows :

> "What actually is your task, storm troop leader ?"
> "My orders are to protect you and the rocket experts in *Haus Ingeborg.*"
> "And from *whom* are you supposed to protect us ?"
> "From the Americans and the French, General," mumbled the leader of the SS commandos.
> "Do you really believe that you and your thirty men can hold back entire armies ?"
> "Of course not, General!" After a short pause, which he used to take another gulp, his final inhibitions vanished : "I have the express order, General, to shoot all of you to keep you from falling into the hands of the enemy" (K. Zuse, 1993, The Computer — My Life, p. 94).

Zuse's lessons concerning scientific evaluation and validation

Sarton — as is well-known — studied history of science in an attempt to make a better culture, a better humanity, a better world to live in. In this perspective he paid much attention to the evaluation of scientists. Who has more influenced the development of thinking, the technology, the world ? To reach his goal he developed elaborated tools based on quotation, on print and reprint. So Sarton is among others the founder of bibliometrics.

In our respect for Sarton, we don't want to question the science of bibliometrics and its relevance. It is a crucial tool among a lot of others to evaluate a scientist, an innovator, a human being. The bibliometric technology is a very good method for measuring the academic interactions, fashions, dominances, etc. However, the life and work of Zuse implicitly and explicitly illustrates that the bibliometric technology only brings up one dimension of the evaluation of scientific and technological actions, progress, results, work and contribution.

It is very significant that Zuse, with his work, was not accepted for a doctoral degree, although he later was awarded several honorary doctoral degrees.

It is also significant that although academics recognized his importance, insights and perspectives and made ample use of it, he didn't get ample funding to further and develop his ideas.

It is crucial that in the Sarton perspective the actional, organizational, developmental and creative dimensions are recognized as at least as important, if not more important than the meta-values of the academic pure sciences : systematization, coherence, esthetic representation. The lessons learnt from Zuse, Curie, Pasteur, and so many others, make it imperative to take into consideration to build a new paradigm for science and technological evaluation and validation, with bibliometrics as an interesting, but nevertheless humble aspect.

Zuse's computer germ metaphor

In some of his publications and notes, already at an early stage, Zuse brings forward the idea of self-reproduction by computers.

Let us quote his formulation : "Now indeed one should not interpret this investigation so narrowly that one would have to build a single machine that reproduced itself; instead one would have to start out with a whole workshop or factory, for only this offers the necessary variety of *individual parts and manufacturing processes*. The perspectives this opens up are today hardly foreseeable. The moment one reaches this stage, the growth of an industry is no longer a question of materials, and completely new social perspectives appear where the worker completely disappears from such branches of industry.

The thought can be carried yet further. With the self-reproducing workshop we are dealing with a homogeneous series in which the same form is continually produced in a cyclic rhythm. As soon as one has reached this stage in the technology, one can indeed easily influence the programmed course of this manufacturing process to create a series of production systems which become more complicated with every step. Then one comes to the problem of the technical 'germ cell' This question, which then has the greatest significance, is as follows : What is the simplest form of initial workshop required to allow the crystallization out from it of a complete industrial plant ?

A further thought is connected with this : The individual steps of a series of production units can also be varied in scale. If one succeeds in building a workshop that is capable of reproducing itself in half scale, one can create a series of such workshops which shrink more and more in size until they are so small that one can still observe the entire factory only under a microscope. Of course, this process will have natural limits. Above all it must be recognized that the style of the technology thereby employed from step to step must change. On a small scale one must use different manufacturing methods than on a large scale. A problem, that will assume the greatest significance in the future.

With this series of production systems changing in scale, the problem of the technical germ cell would become substantially more interesting. For now the problem is not only to find the practically and logically simplest form, but also the physically smallest. Only then would the real germ cell be created, from which then in reverse order the bigger factories would be built.

It is completely clear to me that to reach this goal the work of at least one generation of engineers and scientists will be required, but there is no reason to doubt that we are moving in this direction. The technological scene has changed so decisively over the last hundred years from generation to generation that we must reckon with yet more bold prospects. So perhaps the engineers of the future will not build hydropower installations, aircraft factories or chemical refineries, but plant them. The whole logic of such an industrial plant will be concentrated in a small germ cell as a program, and the growth of the plant will depend only on the supply of raw materials and energy.

In this way we come a few steps nearer to nature, which has indeed already worked with these methods for a few hundred million years. Biologists will find parallels to the technical germ cell in their research on the growth processes of an organism from a seed. Today indeed we can already say that with the set of chromosomes in an egg cell we are dealing with a coded form of the living entity that develops from it, whose construction results from it as from a computer program" (K. Zuse, 1993, The Computer — My Life, p. 223-224).

It is typical that Zuse constantly refers to this as the Faustian aspect of science. In his Namur talk (22 August 1995), he dwelt at length on the diabolic dilemma of science. Starting with a synopsis of Goethe's Faust — Faust he considers as a typical representation of our cultural society : a typical scientist and researcher — Zuse concluded as follows : "Our modern society often is criticizing the progress of technology. So, we computer specialists are assumed to be allied with Mephistopheles. How can we free ourselves from this charge ? Goethe gives us a hint and a consolation at the end of his FAUST :

'For he whose strivings never cease
Is ours for his redeeming.'

It is our duty to face future problems in the scope of our civilization. Humanity and society cannot exist without Faust's technology or without the computer. Future problems of the West cannot be solved without the computer" (K. Zuse, 1995, Faust, Mephistopheles and the computer).

We think it is a major contribution of Zuse to have directed the attention so early on the bivalent value : use and abuse of the computer, and on the cascade — germ devolution — evolution which transforms the whole natural/cultural world.

In other words, it is crucial that we pay attention to the *new ecology*, in which next to and perhaps even dominant over the natural biological germs : species are the artificial 'germs' associated to and up to now produced and controlled and functionally beneficial to the natural — mainly human type — of germ devolution. A lot of science fiction writers have already elaborately treated this. Today do we have to think about ways to steer the evolution, taking the lesson of the ecological destruction caused by the 'human germ' dominance with its 'accidental', individual, economical values at the moment of its almost absolute dominance over most of the other germs. In such top-down ecological model, what will be the effect of the introduction of the computer germ as a supertop. What are the ways still open ?

The plea of Zuse against individual self-reproducing machines, but in favor of the factory model introduces also in the computer ecology, the species versus the individual dimensions. In the human species we know how strong the opposition is between individual and group or species benefit. In unconscious collective values a lot of group or species priorities and conditions for survival are embedded. Do we have to embed such collective values also in the computer germs ? Do we even have to embed some natural germ priorities in the computer germs as some science fiction authors even suggest ? But again, what is the stability and eventual success of such inbuild values in a self-transformation system itself imbedded in a quickly self-transforming world ? Moreover, how valid and serious is the differentiation between natural and artificial germs, both being the products of other individual beings in collective surroundings ?

All this illustrates that in our Faustian universe, all our points of reference are in transition and still we need to progress in this changing universe. But are we really that hopeless, without ground in a continuous changing world ? We think that traditional ecology can learn us a lot — not everything however — concerning the necessities in a computer ecology. Again the basic target has to be (1) *optimization* of a (2) *dynamic* (3) *equilibrium* growing towards (4) *more unity*, with growing (5) *pluralistic* (6) *diversity*. All these 6 features are essential for progress, happiness and survival. Naively looked at, these features seem contradictory if not excluding each other. Perhaps it is here that to use Zuse's words, to solve this challenge of combining these vital features for the survival of our ecosphere, we will need the computer germ. But we will have to be able to control, understand and integrate the computer germ.

Conclusion

Konrad Zuse is personalizing a new paradigm of science. The science of the third Millenium is not a systematization of beautiful idea's, it is not a clever construction permitting nice explanations. In the first place it is an action-oriented and action-based construction which supports people in their cooperation, it is multidimensional and pluralistic. This is antagonistic to the traditional academic science, which is an uni-dimensional, unidirectional symbolization oriented towards verbal symbolization and predicative structures. The history of science instructs us that this impoverished approach, although it is not without certain merits in some temporal niches, has to be complemented in the long run. Virtual and Augmented Reality technology today permits to generalize the action-oriented and action-based science approach — which up to today was only reserved for the happy few and the real great ones like Zuse.

For this reason, the attribution of the Sarton Chair to Konrad Zuse and his acceptation honors not only Zuse but also George Sarton, another great man in science, philosophy and their histories.

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