

NEWS, INFORMATION, TOURNAMENTS AND REPORTS

AN INTERVIEW WITH KONRAD ZUSE June 13, 1990 in Hünfeld, West Germany

[Prof. dr. K. Zuse, the builder of the first computer, granted an interview to the Editor-in-Chief of this Journal. H.J. van den Herik's queries have been italicized. Prof. Zuse's responses appear in Roman type. The interview has been conducted in Hünfeld, West Germany, June 13, 1990, just before Prof. Zuse's eightieth birthday. The text reported below is a transcript of a tape recording. The interview is preceded by some background details.]

A Short Curriculum Vitae

Date of birth:	22 June 1910	Berlin (Wilmersdorf)
Education:	1916-1924	Gymnasium Hosianum in Braunsberg/Ostpreussen
	1924-1927	Reform-Real-Gymnasium in Hoyerswerda/Schlesien
	1928-1935	Study of Civil Engineering Technische Hochschule in Berlin-Charlottenburg
Profession and Research work:	1935	Statistical Work at Henschel-Flugzeug-Werke in Berlin-Schönfeld
	1936-1938	Work on the Z1 Machine
	1937	Cooperation with Dr. Schreyer
	1938	Z2 Machine
	1941	Z3 Machine (the first computer)
	1941-1945	Research on the first process-control computer
	1945	Development of Plankalkül
	1949	Foundation of Fa. ZUSE KG in Neukirchen
	1950	Demonstration Z4 in Zurich
	1959	Development of Graphomat Z64
From 1964	Consultant Siemens, publications and rebuilding old machines	
Awards of honour:	Honorary Professor at the University of Göttingen	
	Honorary Doctor of the Technical University of Berlin	
	Honorary Doctor of the University of Hamburg	
	Honorary Doctor of the University of Dresden	
	Honorary Doctor of the University of Reykjavik	

How did you pick up the idea of chess programming?

"When I began with the development of computers in general, at first I only had the intention to make a good tool for engineers and scientists to help them with their long branching calculations. In the course of this development I came in contact with mathematical logic and I saw that calculation or computing means much more than only number crunching as we say today. Then I had the idea that it should be necessary to use the mathematics in formulas for the problems of computing. Moreover, I had the idea that in chess playing, or in the game of chess, we have to do, in a very concentrated form, with very complex structures of data. The predicate calculus, relational calculus, propositional calculus and so on, were already very common just as mathematical logic, so that I could use it to formulate the rules of the game of chess and to make programs for chess playing. I only learnt playing chess by studying the game and its complicated rules. I formulated these rules in a language which was very similar to mathematical logic. Surely this was an algorithmic language as we would say today. I believe that this was a very good example because chess has many complicated rules and conditions. I thus succeeded in making an algorithmic language. I called it Plankalkül and then I was given to understand that, when it is possible with this Plankalkül to formulate prescriptions and programs for playing chess, this language should be very universal; even so universal that I could formulate with this language any problem to be calculated."

What time was it that you started with these ideas?

"I had the first ideas around 1935 to 1938. During the War I made some notes. In 1945, when I was sitting in the

alpine village Hinterstein I had the time to concentrate on the theoretical work and in 1945 I gave these ideas their final form, the so called Plankalkül."

Which ELO rating do you think the strongest program has at the moment?

"I know that ratings exist for Grandmasters, but I am not familiar with them."

Do you know for instance the ELO rating of Kasparov?

"I don't know exactly. You must see that with my first chess programs I had only in mind to develop a language for formulating chess programs but I had not the intention to find rules of how to play good chess."

Did you see games played by chess programs?

"No, I never saw such games. After 1945 the Plankalkül development was stopped; I had to do other things. Around 1950 to 1955, the first algorithmic languages appeared like Fortran, Cobol and Algol. In that time people to whom I spoke did not see the necessity of having an algorithmic language so universal that you can play chess. At that time it was not interesting. This may be the reason that my Plankalkül was lying in the drawers. I had other things to do. And only some years later the first idea of playing chess with computers appeared and then I asked myself 'How can you do this without Plankalkül?'. I never have had any contact with these people and therefore I never was involved in this field again after my first work of 1945."

Have you ever met Turing?

"I have heard of Turing around 1950. I had no idea of Turing's work when I developed my Plankalkül. It was perfectly independent of Turing. And I guess that what we call Turing computability may be of the same scope as the Plankalkül computability. "

But you never met him in person?

"There was a conference in about 1949 in Germany. There were some gentlemen from Britain and maybe Turing was among them, I remember the name Turing. And so maybe I met him there. At the time I was not aware of such a meeting."

Excluding your own work, what do you consider as milestones in the development of computer chess?

"Unfortunately I cannot say much about that. As stated before, after 1945 I was no longer directly interested in this field; I did other things. I sometimes heard about chess programs, and so on, but I never studied these things intensively."

What do you consider as milestones in the field of Artificial Intelligence as a whole?

"For me that is the same question. A real milestone is surely the work of Turing. The ideas of Turing, I think, are even today most important. But we can also go far back. Leibniz already thought that in the future it would be possible to calculate the outcome of a discussion.

The idea to use mathematical logic for artificial intelligence all goes back to Leibniz. Leibniz was the first, he had some successors in mathematical logic and so on. But all this was not directly connected to computers. Turing was the first who made the connection between logic and computers. But he approached it from a different angle than I. Turing was a mathematician and he used to work in the field of mathematical logic. But his idea was: what we need is a clear question which can be calculated. The computer is only a tool for the mathematical logicians. And his idea of this machine was only on paper. And I came from the other side." [cf. this issue pp. 55-68]

The Future of Chess

Nowadays we have a large amount of chess programs. Have you seen any chess program?

"No, I had a look at Botvinnik's book. But I did not study it intensively."

So you have also never played against a chess program?

"No, I myself was a bad chess-player, because I only had learned chess in order to make Plankalkül. I only know the rules of it. Then bringing the rules into a computer was already a breakthrough."

Have you any idea how strong the strongest chess programs are today?

"No, I only heard that Karpov did not succeed in defeating the strongest chess program."

Finally he won the game, but he indeed escaped from a drawn position.

"Today I only can follow with interest this development. When, in 1938, I was speaking with some friends about this problem I said to them: 'in 50 years the World Champion in chess will be defeated by a computer', but it did not happen."

No, not yet.

"So, I should have said in 60 years."

What do you think of the future of chess with respect to computers?

"Within the next 10 years it should be possible that a computer beats the World Champion. The main thing in my point of view is that up to now the programs, at least in the way they are made in the US, are based on so-called brute-force methods. They calculate any possibility. No human chess-player will or can do so. The chess-player goes more in the direction of real thinking. And as long as these programs are going the way to take bigger and bigger machines but with brute-force methods, that is not the real AI. But I have hope and I have heard of some developments which are going into the direction of the human chess-player."

How strong do you think the programs will play in the future?

"In what time?"

I mean when are they stronger than the World Champion?

"I cannot say how far we will go. I guess, it is self-evident that the computer is soon stronger than the best human chess-player. And one day, 20 or 50 years further on, the computers will play with each other and they will laugh about the fact that they have the means to call themselves human, and they mean they can speak and play chess too."

Do you think that the computer can solve the game? For instance, White plays and wins, or Black can always draw?

"I don't think that, because the number of the variations in the positions and the possibilities to react on it are so large that even the best and biggest computer will not be able to solve it. In the smaller games however it is possible, such as in Nim and Muhle."

When we have two programs which play better than the World Champion, we can let them play against each other and then maybe we can raise the level.

"I think that this question cannot be answered today. And I think it is very difficult to answer this question. There is no logical way to decide, because the problem is too complex even for very good computers which are stronger than the humans. I think it will never be possible to answer this question in relation to the final outcome."

Probably we could raise the level when we would let them play against each other?

"Yes, that would surely be possible. Even today I guess we have programs which are learning from the way humans play. Every chess-player learns from his games and he will learn by every game. We need programs which learn by themselves".

Do you have any respect for the chess programs?

"Surely I have. In my opinion we are in the middle of the development. We must make the step from the brute-force methods to the real artificial-intelligence methods. It is just now that we have begun to make this step. I am convinced that the artificial-intelligence methods (which are similar to the human-thinking methods) will be developed in the years to come and in the field of chess these methods will also lead to computer programs which are stronger than men."

The Acceptance of Computer Chess in the Chess World

Do you think computers should be allowed to play in a normal tournament?

"I think they already do."

Do you think it will be possible to have them in national team championships?

"It is possible to do so. I think that this question should be decided by the people who make these competitions and teams and so."

The next step would be that computers play in the cycle for the World Championship.

"Yes. When the computer gets better and better, and the programs get better and better. Surely, it is possible to let them play against the World Champion. And there comes a day, perhaps in 10 or 20 years, that everybody knows when I play such a game between me as a human player and a computer – and the computer is good – then the computer will be the strongest anyway."

Don't you think all this would affect the chess-player?

"It is possible that perhaps the game of chess becomes less interesting than now, because the aim to become World Champion is felt as such only in the field of human players and not in the field of computers. There will be one day, say within 20 years, that no human player will be able to be stronger than the best computer; thus perhaps the interest in the game is getting lower."

Possible Influence on Chess as a Profession

What do you think might be the influence of computer chess on professional chess-players?

"I think that the professional chess-player will also in future have great interest in the game of chess. This may be the same thing as in the field of art or painting. For instance, today you can compare it to your famous Van Gogh. For his paintings they get prices and we say it is nonsense or not?"

There is the question of reproductions and originals. When you are standing before a picture, even if you are an experienced man, you can't say it is an original or not. Only when you use chemical methods or so, it is possible to make a statement. So the picture itself you can have for a low price. This is the same as with stamps. The stamp is one picture, it gets a high price when it is seldom. Only some people at the world have it. I assume that in the future the same thing will happen with chess. Since with computers we are able to be stronger than the World Champion, grandmasters are very eager to show that they can play chess too."

Do you have any idea why anybody chooses chess as a profession?

"When somebody chooses chess as a profession he must be a very good chess-player. I have a son, who plays very well. However, I am glad that he has studied physics; now he has a good position. Previously he himself has told me that he knew that he was a good player, but he thought that he never would reach the level of the World Champion. Therefore – he knows it himself – it would not be reasonable if he should have said: 'I will become a professional chess-player'. He knows himself that he will not achieve the high goal to have a living out of this job and to raise a family. The decision to become a professional chess-player is very individual and I guess that there are many good players, who have had the intention to be a professional player, who did not succeed. And that is a pity. Especially when he is a good player, but not so good that he can have a professional career, it is a pity."

Do you think that a person standing before a choice between studying at the university or becoming a chess-player will be influenced by the fact that he knows that there exist chess programs that play stronger than he ever will?

"My youngest son, Peter, is now living in Heidelberg. I have the impression that he knows very well that it is not reasonable to neglect the study, only to be a chess-player. I guess he has solved this problem for himself. He is a good player. He participates in tournaments. But I hope and have the impression that he is a good mathematician and programmer (he is always programming and working in this field). He knows very well what his limits are. He is practical and he puts his energy in this. It is of course very wise to play chess too."

Using a Computer for Preparation Analysis and the Like

Do you think it should be allowed to use a computer for preparation analysis?

"Surely, it is allowed. You can do that. If you can do that anybody will do that."

Also in theoretical reviews?

"Surely, I guess it will be very interesting, especially when computers increase in playing strength in the next

decade or so. It will be interesting to study why a variation is better than another. And perhaps even the best chess-players of the future are involved in this field by investigating: Why is this line better than that line?"

And for the adjourned games?

"Surely. However, the question is the same as computer criminality. I know that my son, for instance, played correspondence chess with chess-players all over the world. And surely up to now nobody can check the other side, whether he uses a computer. Anyway, it is a matter of confidence that they do not do so. And surely, this is in the future a danger for correspondence chess, much greater than it is now. You cannot check it."

What do you think FIDE should do about this in the future?

"FIDE can only forbid the things which can be checked. Surely, FIDE can say that some things are not allowed but FIDE must trust its members that they will follow the ruling. And this gets difficult."

May you use a computer for problem-solving competitions?

"Surely, from the side of the scientists, who see the game of chess in relation to a computer as a scientific problem. For correspondence chess, it is interesting when two players come into a situation, where none of them knows the best line. Then they are tempted to ask the computer, and for chess researchers it will be enormously interesting (not only to ask the computer for a move but why it is the best move). And then we come to the point where chess games perhaps transform into real science, yet more than today."

If you summarize, in which fields would you say no to the computer?

"There is no law of the government. You cannot forbid anything. You may state that the use is allowed only in fields where FIDE says it is allowed. Only they can give some rules. It is the same thing as with football. But with football everyone can see the game, and see when something is against the rules. But when you have correspondence chess it is not possible. Perhaps in a chess tournament where it is assured that the players have no contact with the outside world and a computer (they play in a closed room) you can give a ruling on what is allowed. The rules of chess themselves are clear."

If you were FIDE and you had to decide upon the rules, what would you do? And what shall FIDE do?

"I am glad that I am not FIDE. I never thought about it. I think we should come to a real fair play. In any kind of sport we have rules and all sports have the intention to make the rules fair. It shall be a fair play. Every side shall have the same chance. There should be no activities which are not belonging to playing chess."

Possible Contribution of Chess-players to Computer Chess

Do you think that in the future there could be a relation between professional chess-players and the development of computer chess? That the professionals can help the programmer to incorporate the ideas?

"Surely, I think these programs are constructed anyway by good players, I guess."

You yourself were not a good chess-player, when you started with a chess program. Do you think that the major programmer of a chess program has to be a chess-player himself?

"It is sufficient that he knows the rules. When I was playing with friends, we were not good players, but we liked to play. In every game a position arose of which we later understood how foolishly we played. There are two distinct things: one is concerning a good theory and the other is to implement it."

Could the professional chess-players have some influence on chess programming?

"I don't think that we really have such a sharp dividing line between them. I guess, they are mixed, e.g. Botvinnik. He wrote a big book with very good ideas on chess programming and he was a good chess-player too."

Botvinnik is an exception. He is one of the few professional chess-players who is involved in computer chess.

"I don't know the situation. I don't know whether the gentlemen who are constructing these programs form a separate society. I don't know."

Some people are in both fields, but mostly they are a separate society.

"Yes, I can believe that the group of the chess-program designers are not the best players. I myself perhaps was a good theorist. When I made a wrong move I could see why it was wrong. But in practice it is quite another question. The group of chess programmers who make the programs, they are good players, they surely must play themselves, but they indeed will not have the level of professional chess-players. I agree that the pro-

fessional chess-players will in future help the chess programmers. At least there will be connections between them and in the near future perhaps the connections will get stronger."

Conceptual Background

For building a chess program you stated that it was not necessary to be a strong chess-player yourself, but you need to have a little understanding of the game? How strong do you think a programmer has to be in order to build a program?

When I made my Plankalkül, I was not a very strong chess-player. For instance when I was a soldier, we played during the march. Within my company I was one of the best players. Then I started to know some people who were much better than I was; for instance there was a friend of Van der Poel's whom I never succeeded in defeating.

In 1938, you stated that in 50 years there will be a chess program which will be stronger than the World Champion. But, in the 1950s there was a philosophical point of some people who thought that computers will never be stronger than men because you could never get more out of it than you put in it?

"This theory is false not only in the field of chess playing. I know this flaw of thinking. Just when the computers became known, and it was understood that they could do more than number crunching, there came sophisticated men, who said: "he can never do more than I put in it". And that is nonsense. Today we have, e.g., very modern theories, chaos theories. The theory is now that from some kind of preconditions one can develop much more complicated things. And this theory is surely right. I am convinced that today we have computers which are so flexible that I can make for a start, a situation from which I am not able to foresee what will happen. Some day they come to conclusions which are stronger than those of Man."

You also said that in the field of chess it was certain that the computer will be better than the World Champion. But then you also said, this will not be true in every field: And why is that?

"For instance, at the same time when I was thinking on Plankalkül and chess, I was thinking about the problem of translating one language into the other. And it was already at that time, about 1940, that this problem was much more difficult than chess playing. And for this problem we are far away from a really good solution."

But, do you think that it is in principle possible?

"Only in restricted domains; we have it already in limited fields. The computer should learn the same way as the child begins to learn. And only in the limited world you can make translations. Surely when you have economical problems the language (the words you use) is clearly defined. You know exactly what an account or a banking transfer is. All is defined in one language or in the other. Then perhaps you can make an automatic translation."

What do you think about the Turing Test?

"In principle this test is good."

Will a computer ever pass the Turing Test or never?

"That depends on the man who is sitting on the other side of the computer. When he is limited it will be possible perhaps. "

Probably I could say that any man in one or another sense is limited?

"Surely, you have another world than I."

What do you think is the fundamental difference between the reasoning by a machine and the reasoning by a human being?

"The fundamental difference is that up to now the human brain is much more flexible and complicated than the best computer. You can't say all this is a matter of time. Perhaps we get computers more flexible and with more capacity. Then it may be possible that in special fields, such as the theory of relativity or mathematical theories, the computer is much stronger than the best mathematician."

It is amazing that our brain, which is more flexible than a computer's brain, is not able to grasp the game of chess and that we are outplayed by chess programs. So why could we not raise our level of chess-playing strength?

"I think the limit of the human chess-player has already been reached. Kasparov is not only the World Cham-

pion, but perhaps the Champion of all Champions who ever lived. As I see it the flexibility and the capacity of the human brain is limited anyway. So if there is a computer with a much greater capacity and flexibility it is impossible for men to reach this."

It is difficult to obtain the right reason why we could not raise our level. You said: we are at the limit but why are we at the limit? Because we have not solved the game? So there is still a real gap.

"Perhaps in the future, in cooperation with computer programmers, even human players will get more potential, or raise their playing strength. But anyway there will be a limit which is given by the construction of the human brain. Or some day comes a boy who makes a DNA design for a better brain. I do not hope so."

You said the limit is caused by the construction of the human brain. But I could argue for example that the limit is caused by the complexity of the game."

"That is the same. Because the complexity of the game is so high, I am only able with the complexity of my brain to reach a certain level."

What do you think is the impact of computer-chess research on other research fields?

"For me it was very obvious. I guess that in the field of AI it would be a very good idea that also in future we take the game of chess as an example for making good programs, to come to better programs for AI in general. I think that this will be very good, when also in future the people engaged in the field of AI are studying the game of chess and the rules of it."

In 1930 or 1940 you saw the importance of computer chess, but later on you said you were too busy to be involved anymore in computer chess. But when we now look back, do you consider it a pity that you never could implement your ideas?

"Yes, I think that it is the fate of all people who came too early. I was too early; in 1945 in Germany anyway it was impossible to publish a paper, nobody was interested. And when I was speaking for our contract with Professor Stiefel from the ETH in Zurich, many people were interested in my machine, the Z4 computer. Scarcely one was interested when I spoke of chess. Even Rutishäuser who was involved in the Algol report was not interested. When I said 'Some day we will make chess programs as a trial object', he said 'We have other things to do'. The problems which were lying directly on the table in that time were other problems than chess programs could solve. He said: 'We do not need this'. Then, I was about 50 years, I headed a factory and then it is a sin to do any thing beyond serving the factory. We always had to think: 'How do we get enough money next month to meet the payroll?'. So I had to sell machines. Surely you can make a chess program in the evening, but I could not honestly program such as design while I was busy in this field, because there was no need for it. I can give you another example. About 20 years ago I had contact with a carpet manufacturer and he told me that he would like to have automatization from the design of the artist to the machines which control the loom. 'Can you do that?' My answer was: 'The best will be when you begin with the design of the artist'. Then the contact was stopped. That was what we call today 'computer art'. To begin with carpets would be the best way because the problems are limited. But when you are running a factory, in that time – and I know it very well – if he had said yes, then we would have been forced to solve the problem and we would have succeeded. What we would have done is solving the first problem of computer art, but when there is no order for this, you cannot say 'how interesting, let us make this'."

I was given to understand that Plankalkül should have been your Ph.D. thesis?

"I wrote a doctor thesis, the forerunner of Plankalkül. That was "Ansätze einer Theorie des Rechnens unter besondere Berücksichtigung des Aussagenkalküls". I started this in 1938; in the War I have elaborated it and intended to make that my Ph.D. thesis. Prof. Walter from Darmstadt has agreed with this proposal, but unfortunately he died early, and then my work in the firm intervened. I did want to change it but I did not have the time, so I have never worked for a thesis. Plankalkül continued what I did then."