Dap Hartmann (1989)
Gallery of the Dutch
chess programmers: Ed Schröder

"You take bus 1 from the station, and get off at the shopping centre. Then you're near the Merel," Ed Schröder told me on the phone. "Which mall?", the bus driver asked me when I asked him to give me a signal at that stop. "The shopping centre near the Merel", I tried. "Does anyone know De Merel?", the driver consulted the other passengers. Someone tipped him off. After having crossed half of Deventer, the bus drove through a new housing estate with single-family houses. I got the hint to get out of there, and then, like an amateur ornithologist, move through the street. "I have been living here for three years now anyway, and I'm not quite sure yet but I think it's where the Koperwiek ends", helped a helpful local resident. The Blackbird was where the Koperwiek stopped: I had found Schröder's nest.

The beginning

Ed Schröder was born in The Hague in 1950. He lived in this city until he was 28 years old. After three years of lyceum he decided to become a professional soldier. That was a short term undertaking, and after leaving the company he went into business. He ended up at an insurance company where he first came into contact with computers. After internal training, he worked as a computer operator for a period of five years. In 1974 he married Lies, and together they would start a family. This prompted him to change jobs, as Ed had been working exchange shifts until then. From then on he became a programmer, and in that capacity wrote administrative programmes in NCR, a COBOL-like programming language. Four years later, he moved to Deventer, because he could get another job there, which, as a pleasant side-effect, brought with it better housing. Again he was an administrative programmer, this time for a manufacturer of cans. This turned out not to be a success, and even before the probationary period had expired he had another job. This time at a software house. Since then Ed changed employers a number of times, but always remained a programmer for software houses. That way it had become a kind of free-lance work environment. The last employer was PANDATA.

The computer experience was therefore present at an early stage (from 1970). How did the connection with the game of chess grow? In 1980 Ed bought one of the first chess computers, a **Fidelity Chess Challenger Voice**. Although he is not a strong chess player, the fun of playing against that device was soon gone: it was simply far too weak. In order not to get into a situation where he had to buy a better model every year to get a little resistance, he decided to buy a Personal Computer. It would then be able to run chess programs that were much cheaper than the chess machines. But a Personal Computer at that time was a rather primitive device. The choice was extremely limited, and like so many computer enthusiasts of the time, the machine purchased became a TRS80.

This machine, which is based on a Z80 microprocessor, was very popular at the time, but quite expensive. There were two reasonable chess programs for that device: **Sargon II** (of the Spracklens) and **Gambit 80** by Wim Rens. Alras turned out that the level of these programmes was not resounding either. Fortunately, however, a home computer was more than just an instrument for playing ready-made games. Ed also started programming himself. Initially these were games such as Monopoly and Barricade. Eventually he conceived the plan to write his own chess programme. Certainly in those days this was the ultimate challenge for an (amateur) programmer. Although we are talking about a period that lies less than ten years in the past, it is now almost unimaginable how primitive personal computer systems were in those days.

Ed Schröder bought a TRS80 and started programming himself.

Currently the market is flooded with Pascal, C, Modula and BASIC compilers. Then there was a built-in BASIC interpreter, and an Assembler that could be loaded via a cassette tape. Floppy disk drives were priceless, PC hard drives did not exist, RAM memories were very small (standard 4 or 6K), and processor speeds were low (1.7 MHz). Ed therefore chose to write his first chess program in BASIC. He had read almost nothing on the subject. Only a number of articles by Wim Rens on generating moves were known to him. Tree searching was something he would develop himself, without using, for example, the Alpha-Beta algorithm.

A BASIC program that only performed a 1-ply search process...

The first programmes

About half a year after the start, the first version of the first Rebel was completed. A BASIC program that performed only a 1-ply search process. Producing a move from the start cost the program... 30 minutes! Not what you might call an impressive achievement, but also Einstein once started learning the table of 3. The most important thing was, and still is, for anyone who set out to write a chess programme of their own, that proof was provided that such a thing is possible. Seeing that your programme makes an intelligent decision autonomously in a complex domain such as chess is an emotional reward that is particularly stimulating. If it can be done this way, then it can be done better.

Rebel was now able to complete a 2 ply search within three minutes...

Dutch championship

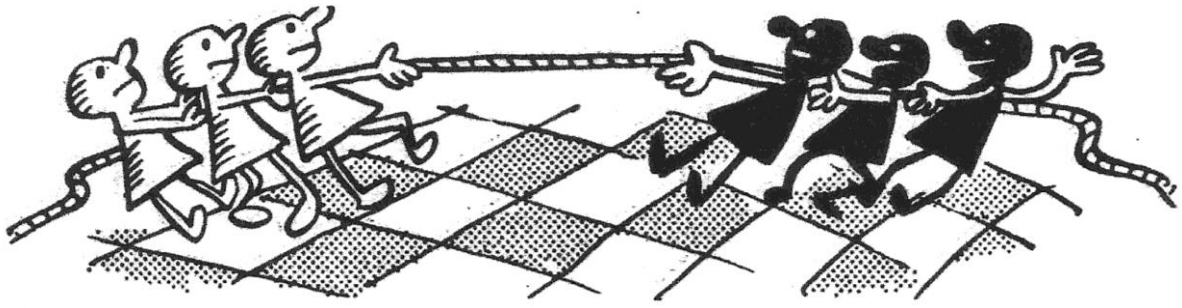
Meanwhile, Ed had learned that a first Dutch computer chess championship would be organised by the brand new CSVN (Computerschaak Vereniging Nederland). He made many efforts to boost Rebel's performance. He succeeded just in time, and he applied for the first NK. At that time Rebel was able to complete a 2 ply search process within three minutes. Truly an impressive improvement. There has never been a stricter admission policy for participation in the Dutch Championship than for the first NK. Of course, nothing was known of most of the registered programmes. That is why a telephone test match had to be played against a commercial computer operated by Jan Louwman.

Depending on the impression a programme made, it was or was not admitted to the tournament. For Rebel this procedure was disastrous: the program was found to be too weak. Moreover, a program written in BASIC 'could be nothing'. Deeply disappointed Ed saw the first championship of the Netherlands pass by. However, he was determined to take revenge. They would see what he had to offer ...

The maximum ply depth at which the new programme could search was now 6...

The first step to improve Rebel was taken by learning assembler. BASIC is much slower than assembler anyway, but since at that time it was also done with an interpreter instead of a compiler, the difference was a factor of 1000. The program was transferred to assembler. That is to say, the computation-intensive parts were translated in this way; the I/O part remained in BASIC, because that was much simpler, and required hardly any computation time.

Ed had still read little about the experiences of other programmers, and the structure of his programme can be called unconventional to say the least. Instead of a search algorithm contained in a single subroutine that can be invoked with different search depths, Rebel had a different routine for each search depth. The maximum ply depth at which the new program could search was now 6.



It was a programme that sought selectively after the first ply. Ed developed some of the mechanisms to select at that time, and he continues to use them to this day. The method of tree searching he had developed himself, and looked like nothing described in the literature until then. He did not use Alpha-beta. Instead, it was an alternation of trying a move, checking its feasibility, and in the event of insufficient success, selecting another move to go through the same control procedure. He attempted to describe this method in two articles published in 1983 in the magazine Computerschaak.

The maximum search depth of the programme has now been set to 8 ply...

Today, experts are still puzzling over what genius inspiration the author has tried to explain. The assembler programme was ready in time to take part in the second Dutch championship in 1982 in Wageningen. Rebel was finally divided second there, with 6½ out of 9. This came as a huge surprise to Ed Schröder himself. "I was completely excited by the result", he says even now. With much enthusiasm he started working on the programme again. The TRS80 had meanwhile been upgraded to a clock frequency of 3.5 MHz and the RAM memory was extended to 32K. The maximum search depth of the programme was now set to 8 ply laid down. Not that the programme always calculated so deeply, but, as has already been pointed out, it has been laid down. Mentioned, the search at different depths was housed in different routines. So the previous version of Rebel could not possibly search deeper than 6 ply, even though time allowed it.

The evaluation function was improved, and an opening book of a few hundred lines was created. With this version Ed registered with high expectations for the third championship of the Netherlands, in 1983 in Leiden. However, there he got the sock on the head: with 3½ out of 8 Rebel was very disappointingly divided ninth. The expectations to come out with a stronger programme after a second place the year before, and thus perhaps to perform even better, were dashed by the fact that the competition had not stood still either. Rebel would not be present at the next two tournaments for the Dutch championship. Ed Schröder had defined computer chess (they thought!).

Commercial career

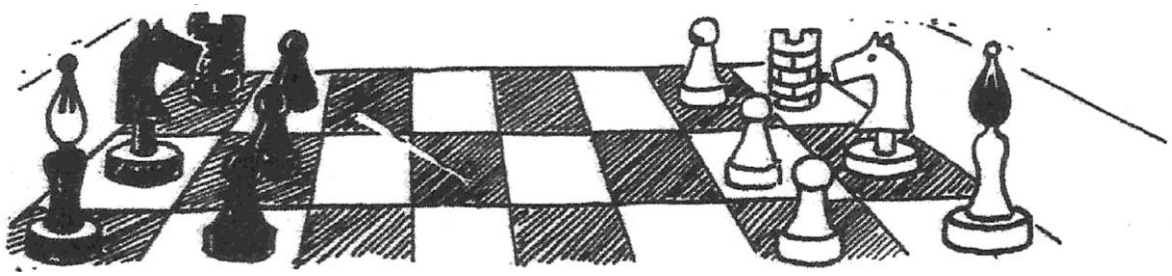
Ed set to work again. This time he rewrote the programme from the ground up. The messy, inflexible structure had long been a thorn in his side. Still on his TRS80, in a year and a half he wrote a completely renewed Rebel that would make you forget the old one. In addition to the intended more efficient coding, the programme had also become much faster and, partly as a result, better.

He borrowed a **Fidelity Chess Challenger Super 9** chess computer from Jan Louwman to test the program against. With the help of the well thought-out method of selective searching and the speed of 400 positions per second, it appeared to be able to win regularly from the commercial computer. When Louwman called to enquire about the course of events, he was impressed by the enthusiastic messages Ed gave him.

At that time, Frans Morsch was already working for the company Hegener + Glaser (Mephisto). This chess computer manufacturer informed Louwman that they had a vacancy for a few more programmers. Judging by the promising results of Ed Schröder, Louwman let it be known that he had someone in mind. A meeting was then called at Louwman's home. There, Manfred Hegener came to see what was true about the promise. Ed took his computer under his arm and travelled to Rotterdam to give a demonstration. In front of Hegener, Rebel won 1.5-0.5 of the **Mephisto MM I**.

"I was amazingly lucky, but who cares. My programme beat a computer from the Mephisto stable in front of the producer. I couldn't run out of luck," says Ed Schröder. Some time later, Ed travelled to Germany to enter into a contract with Mephisto. In six months he would develop a program for a 6502 computer with 32 KByte ROM and 4KByte RAM. It would have a clock frequency of 3.7 MHz. Until now he had only been programming the Z80, a fundamentally different processor than the 6502. Hegener + Glaser made an Apple computer available to develop the program. It could then be inserted into an EPROM to be placed in the chess computer. The task was too big to complete this job within six months.

Apart from getting used to a new microprocessor with its own set of instructions, there was an additional problem for Ed. The version of Rebel as played by Louwman made use of 12 KByte of variables. Only 4 KByte was available to him for the programme to be developed. A factor of three down in the use of variables is no small task. After six months the programme was not ready, and the new **Mephisto MM II** computer was equipped with a programme of Ulf Rathsman.

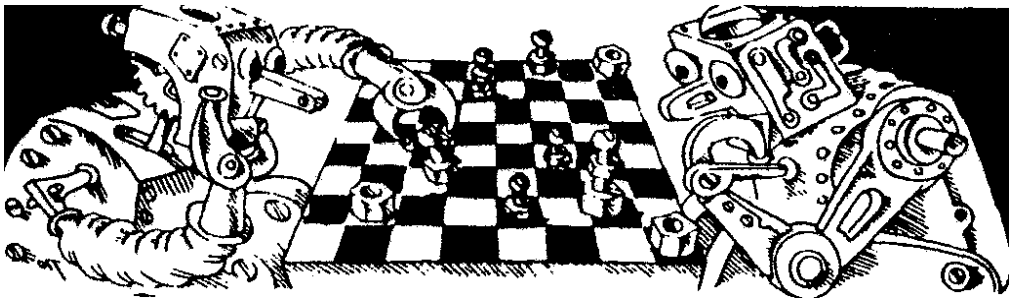


Ed, however, did not lose heart. If he were to develop a good playing programme, he would certainly be interested in it. With this motto in mind he started all over again. This time he had delved into the existing literature, especially with regard to the various tree searching techniques. It turned out to be simply impossible to implement his own ideas for tree searching in just 4 KByte of RAM. But even the transition to the regular alpha-beta algorithm was not enough to keep the program variables within the set RAM memory. "Give me 8 KByte and I'll get it done", Ed asked the manufacturer. He got it, and went back to work. At the beginning of 1986 the program was ready. Would it be as strong as the Z80 program that Hegener had seen?

Rebel was running in Cologne on a 10 MHz bit-slice 6502 computer...

World news

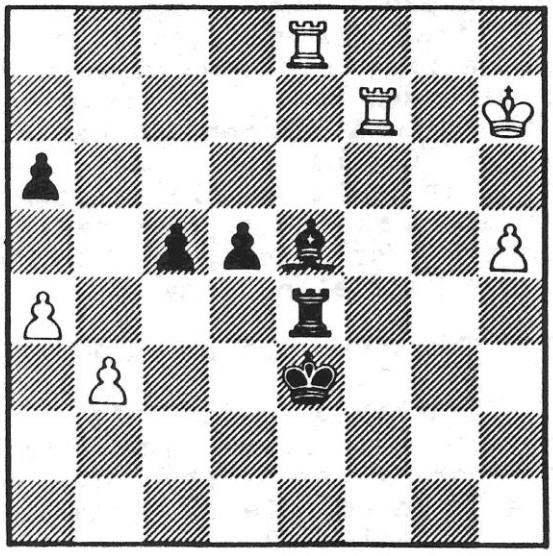
After the 1983 Dutch championship, it had become quiet for the outside world around the person of Ed Schröder and his programme Rebel. Until he suddenly showed up at the 1986 World Championships for 'big computers' in Cologne. Together with **Dutch**, **Shess** and **Nona**, Rebel was one of the Dutch programmes that went on between the supercomputers. So there was no chance beforehand, as had already been demonstrated for years. Chess programs on microsystems cannot withstand the brutal computing power of supercomputers. Rebel ran on a 10 MHz bit-slice 6502 computer, and gave his first official performance there. Of course, Ed Schröder and Jan Louwman already knew for some time what the participants and spectators could experience during the tournament, namely that this version of Rebel was a twisted strong one. Several commercial devices had already been tested, and the results were very positive. Just before participating in the WC Ed had sold this program to Hegener + Glaser. However, it was not yet on the market.



In der letzten Runde der 5.Computer-WM (Köln 1986) trat Rebel gegen das Programm Bebe von Tony Scherzer an. Bei einem Sieg wäre Rebel infolge der besten Buchholz-Wertung Weltmeister geworden.

Rebel-Bebe (Benoni)

1.d4 Sf6 2.c4 c5 3.d5 e6 4.Sc3 exd5 5.cxd5 d6 6.e4 g6 7.Lf4 a6 8.Sf3 Lg4 9.Le2 Db6 10.Dd2 Lg7 11.0-0 0-0 12.h3 Lxf3 13.Lxf3 Sbd7 14.Tad1 Tfe8 15.b3 Se5 16.Le2 Db4 17.Dc2 Te7 18.Lg3 Tae8 19.Tfe1 g5 20.Tf1 Kh8 21.Tc1 h5? Eine gefährliche Lockerung der schwarzen Königsstellung, die Rebel in der Folge kraftvoll ausnützt. Nach dem solideren 21.-h6 wäre Schwarz gut gestanden **22.f4! gxf4 23.Txf4! Sg6 24.Tf5 Sxe4 25.Sxe4 Dxe4 26.Dxe4 Txe4 27.Lxh5 Se7 28.Txf7 Ld4+ 29.Kh1 Sxd5 30.Txb7 Td8 31.Lf3 Te3 32.Lh4 Sf6 33.Tf7 Te6 34.Ld5 Sxd5 35.Lxd8 Sb4 36.a3 Kg8 37.Tcf1 Sc2 38.Tf8+ Kg7 39.a4 d5 40.h4 Se3 41.T1f7+ Kg6 42.Tc7 Sd1 43.Tg8+ Kf5 44.Tf7+ Ke4** Weiß steht noch immer auf Gewinn, aber der d-Bauer wird jetzt gefährlich **45.g4 Kd3 46.h5 Te1+ 47.Kg2 Se3+ 48.Kg3 Le5+ 49.Kh4 Th1+ 50.Kg5 Tg1!** Schwarz verteidigt sich geschickt **51.Kg6 Txg4+ 52.Lg5 Tb4 53.Lxe3?** Besser 53.h6 Tb6+ 54.Kh5, aber noch ist nichts verdorben **53.-Kxe3 54.Te8 Tg4+ 55.Kh7 55.Kf5! Tf4+ 56.Ke6 Txf7 57.Kxf7 Kf4 58.Txe5 Kxe5 59.h6** hätte leicht gewonnen **55.-Te4** (Diagr.)



56.Ta7?? Dieser Zug kostete Ed Schröder den Weltmeistertitel! Der Gewinn war greifbar nahe: 56.Tfe7 Kd4 57.Txe5 Txe5 58.Txe5 Kxe5 59.Kg6 d4 59.h6 und der weiße Bauer geht mit Schach zur Dame. Nach dem Textzug entscheidet hingegen der Vormarsch des schwarzen d-Bauern. **56.-d4 57.Txa6 d3 58.Tg6 d2 59.Tg1 Kf2 60.Teg8 Te1 61.T1g2+ Ke3 62.Txd2 Kxd2 63.Tc8 Ld4 64.Tb8 Te6 65.Tb7 Kc2 66.b4 c4 67.b5 c3 68.Td7 Kd3 69.b6 c2 70.b7 c1D** und Weiß gibt auf: nach 71.b8D Dh6+ steckt der weiße König im Mattnetz.

Damit wurde Bebe geteilter Erster zusammen mit Cray Blitz, Hitech und Sun Phoenix (je 4 aus 5). Der Titel ging nach Buchholz-Punkten an Cray Blitz.

Dap Hartmann's article also appeared in the Austrian magazine Modul of September 1989 (Modul 3/89 S. 18). This magazine came with a historical supplement. The historical game from the 5th world championship computer chess 1986 in Cologne, in which Rebel would have become world champion if he had won. Unfortunately it just didn't come to that...

The first round immediately brought a great surprise: Rebel crushed Jonathan Schaeffer's strong main-frame program **Phoenix**. It wasn't just a win; **Phoenix** was thrown off the board. The second round brought sensation. Rebel beat **Lachex**, Burton Wendroff's program, which runs on a Cray supercomputer. Until then, something like that was unheard of. A micro beats a Cray! The rest of the story is well known. Rebel had almost become world champion. In the last game against Bebe, the victory was so terribly close. "When you consider that the later commercial version would have slickly won that game, you only realise how close the title actually was at that moment. But well, that shared second place was already so beautiful, I was absolutely delighted. I never expected that. I knew that my programme was strong, but that it beat those super programmes, no, I would never have dared dream of that beforehand.

Ed Schröder (sitting on the right) in his fight against Sun Phoenix at the World Cup in Cologne in 1986. The game resulted in a victory for Rebel. (Photo: M.T. Fürstenberg)

When I came home I walked ten centimetres above the ground. My programme had performed so excellently, and everyone was full of it. The newspapers devoted whole pages to it. It was world news, and I was the cause of it. My children also had to share in the joy, of course. Daddy had almost become world champion! But one of the children said: "What kind of excitement is that? It's just a game, isn't it?" Yes, there you are again. With both feet on the ground. Luckily it was only ten centimetres."

Hegener + Glaser were naturally delighted with this unexpectedly good result. They were lucky: the contract had already been signed for the tournament. If it still had to be negotiated at that time, they probably would have had to delve much deeper into the scholarship. The impression Rebel had made on the producer can also be seen from the fact that the commercial version was given the name '**Rebel**'. Usually the manufacturer decides on the name, and the programmer is at most allowed to make a suggestion. In this case, Mephisto did not want to replace the already established name 'Rebel'.

7 ply brute-force calculations was only for supercomputers ...

The **Mephisto Rebel 5.0** was released in a 5 MHz version. At that speed the program looked at about 500 propositions per second. The strategy of selective search was as follows. The first plies were viewed in full (brute-force), after which three plies were selectively searched. In the midgame, Rebel calculated 4-ply brute-force + 3-ply selective. In total 7 ply, followed by the battles of the quiescence-search(1). The method of selective quiescence-search was inevitable: 7-ply brute-force calculations was for supercomputers only. If you could get to the same depth by a good selective search you had at least one more chance. That proved to be the case.

Yet there was a disappointment. Because of the results in the World Cup there was an enormous expectation of this programme. It would be a turning point in the battle between microphones and mainframes. The commercial version could not live up to all these expectations. Rebel was written so high that a decline in enthusiasm was inevitable. Ed himself believes that the results achieved in Cologne were also largely due to luck. That, combined with the frenzied eulogies of Louwman and other computer chess journalists, made the expectations too high. In the 1986 Dutch championship most were convinced that Rebel could not escape this title. Yet that happened. In the match with **Nona**, he proved to be the strongest, and won the tournament unbeaten. Rebel came second. Although the **Mephisto Rebel 5.0** was a commercial success, the original expectations had been higher. Still, as the first commercial success of a new Mephisto programmer, Ed Schröder was satisfied, and so was the manufacturer.

The show must go on

After Cologne Ed was commissioned to write a new programme. I asked Ed the following: If you've written a programme to the best of your ability, how do you go about creating a new programme?

"During the Cologne Tournament, and in many test matches, it was found that the freestyle evaluation was not particularly good. In that respect, that disastrous game against Bebe was worth its weight in gold. It gave me a good basis on which to continue. In the new programme, I have made the strength and shelf life of freebooters much better. It is nice if you can create a free pawn, but it should not be in the box after five moves. I have also constructed an improved evaluation for royal safety. The endgame was also improved.

Improving the evaluation function

It was something that Frans Morsch also assured me: there is still so much to be gained from improving the evaluation. Many people still assume that searching deeper improves your pro gramma. Not that this is wrong, but it is a misconception to think that this is the only way forward. Just think, if you had the perfect evaluation function, a 1-ply search process would suffice. Of course there is no such function, but it illustrates the importance of good evaluation.

(1) Quiescence-search = extension of the search until a "quiet position" is reached.
See: https://www.chessprogramming.org/Quiescence_Search

The programme was ready in June 1987. It was to be released as MM IV...
And in October 1987, the Mega IV programme was to be launched...

Developments are now clearly gaining momentum. The new programme was ready in June 1987. It was to be released as the **Mephisto MM IV**. Ed started to make improvements again. The search process was accelerated and the evaluation function was improved, especially with regard to the pawn structure. October 1987 the programme was ready to be launched as the **Mephisto Mega IV**. The hardware was still the same as that of the Rebel programme. Meanwhile Ed Schröder had won the 7th Dutch Championship (1987). Again the mutual party decided with **Nona**. This time the balance went to the side of the **Mephisto MM IV**.

An iconic photo from my personal database. Aegon 1987: Ed Schröder as operator of the Mephisto MM IV against Corry Vreeken. If you look closely you see that Ed is testing his new programme with an old Mephisto ESB 6000 housing.

From that moment on Ed had good and frequent contact with the Austrian Helmut Weigel, who works at Mephisto. He entrusted Weigel with a number of ideas he had regarding a new concept for a chess computer. Schröder was given the freedom to work with 48 KByte ROM and 8 KByte RAM, and started to shape his plans. It resulted in an improved version of the **Mephisto Mega IV**, with a tremendous amount of new features. Below were features that were not yet available on any computer.

Mephisto Mega IV

This computer was accompanied by a manual written by Helmut Weigel and was christened the **Mephisto Academy**. Truly an appropriate name. In addition to the many possibilities in terms of opening choice and game levels, the Mephisto Academy contains a display of 32 characters in which an abundance of information can be made visible. A unique feature is the ability to set the programme to playing strength, which enables weaker chess players to use the computer as an increasingly strong opponent. The answer was "Secret"[(2)].

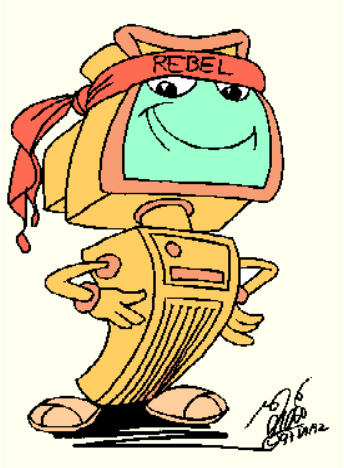
Dutch Championship 1988

Due to illness Ed was prevented from taking part in the 1988 Dutch Championship in person. The reigning champion was thus prevented from taking part. Jan Louwman, however, took the honours, and served Ed's programme during the tournament. Unfortunately, it was a test version of the programme, a version between the **Mephisto Mega IV** and the **Mephisto Academy**, which was not completely reliable. "That was very annoying. But yes, that's to be expected. Of course, I was the only one who knew what the right version was, and they had brought the wrong one with them to Leiden". Partly as a result of this, the programme came second. Of course it was again the party against the programme of Frans Morsch (**Quest**) that made the decision. For years, Schröder and Morsch have been the almost unreachable top of Dutch computer chess. They could fight the NK at home, so to speak, on a Sunday afternoon. They win from everyone, and still have to fight for the title among themselves. But fortunately they still play along every year among the 'normal' programmers.

(2) Secret? The most likely answer: by manipulation of the examined typesetting list...

Mephisto Academy by Ed Schröder.

Testing
Writing a chess programme is only part of the work, which has to result in a good playing programme. Just as important, and perhaps even more important, is testing the programme. In the first instance, the detection of errors. Then finding weaknesses, and finally polishing up the overall positional game. That takes a lot of time.



How does Ed Schröder test his programmes?
"In the beginning, I worked intensively with Louwman on testing. When I finished a new intermediate version, I burned it in an EPROM and sent it to him. Jan tested very intensively. He would play hundreds of parts, and he would call several times a day to ask certain things, or make comments. That made the work much easier for me. Of course I also tested, but - I didn't have time to play so many parts. Until February 1987, Louwman tested a great deal for my programmes. The last one was the **Mephisto MM IV**. There was a nasty incident at the time and I decided to test my programmes myself from then on. As soon as a programme was ready and put into production, Louwman was of course able to test it and he always did. But I have been testing all the intermediate versions myself since the beginning of 1987.

I do that in different ways. I play test parts at the 3-minute level against the strongest competitors, such as the **Fidelity Mach III**. That provides a lot of information, and on the basis of that I improve the programme. I also use the so-called l-ply method, in which you assume that a move on l-ply (plus quiescence) must in any case be positionally correct. This gives you a rough indication of the stability of the positional game.

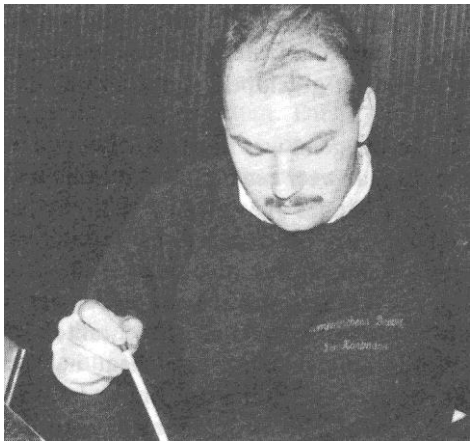
Furthermore, I have developed a number of tools to go through the programme step by step. These are rn methods that you can only use yourself. You descend into the structure of the programme, and you must therefore have a good understanding of what is happening there. Who can do this better than the programmer? For example, at a certain level you look at which moves are selected and why. I don't think you have to be a strong chess player to do this kind of test either. I think 1700 ELO points is enough".

"I used to work at home all the time, just in the living room. Some colleagues asked me how that was possible. A woman and three children around you, how can you ever concentrate? I didn't have much trouble with that. Nevertheless, I recently moved my workplace. I now work in an office, where I just go every day. That is much more pleasant. Not because I couldn't do it at home anymore, rather the opposite. I was just too busy with it. I got up with it and went to bed with it. Now I just consider it a nine-to-five job. I go away to work, and when I get home I am free. That's much better for your family too."

Future
How does Ed Schröder see the future? Will there continue to be work for chess programmers like him? Will the computer ever become world champion? "I think a new market is emerging. There will be computers with many features. I took the first step in this direction with the **Mephisto Academy**. I believe that Fidelity is already working on something similar. Of course, you always have to try to stay ahead of the competition. I see a bright future for myself. Mephisto is satisfied with me, and I am satisfied with Mephisto. That seems to me to be a healthy basis on which to continue. I am convinced that Richard Lang is the absolute number one. I have no pretensions to push him from that throne. We do not see each other as competitors, and therefore not as a threat to each other. You can see that the level of commercial programmes are getting higher and higher. Every year they get stronger again. I think that this will continue for some time to come, although the increase will be smaller and smaller.

I have no doubt that chess computers will eventually achieve great strength. But will they ever become world champions? I do not think so. The distance between an average grandmaster and Kasparov is so terrible. People make mistakes too quickly. Once a computer has 2500 ELO points, it only looks like two hundred as many points to Kasparov. But they have to be conquered point by point and I doubt it will succeed in the end. I don't think it will.

Finally,
Having visited Ed Schröder at home, I was not allowed to take a look at his current projects. After all, they were all in his office. A stray **Mephisto Academy** referred me within ten moves to the realm of mediocre chess players. After the interview, Ed accompanied me to the bus stop; that saved me the search for it. I was able to find the station myself.



Dap Hartmann: author of this article and co-author of the chess program Dappet which he wrote together with Peter Kouwenhoven.
https://www.chessprogramming.org/Dap_Hartmann

NB: This article appeared in the Dutch magazine Computerschaak of April 1989 as part 2 of a series on programmers. Part 1 appeared in December 1988, and was about Frans Morsch. Part 2 on Ed Schröder also appeared in September 1989 in the Austrian magazine Modul.

Related weblinks
https://www.chessprogramming.org/Ed_Schroder

https://www.chessprogramming.org/Rebel#Publications

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