July 1984

# Squaring up to

ONE OF THE unique aspects of programming a computer to play chess is that concrete methods exist for calibrating the success or failure of the program. The quality of a computer program is usually conveyed in purely descriptive terms: the graphics can be described by a plethora of adjectives, the entertainment value of a video game program can be assessed subjectively by a reviewer, the usefulness of a spreadsheet package can be measured by a combination of the features offered and the limitations imposed on the user. But all of these methods lack objectivity to a greater or lesser extent.

## Strongest wins

In chess it is relatively easy to determine whether your program is stronger or weaker than someone else's. You simply play a series of games between the two programs and the program which wins the series can reasonably be assumed to be the stronger. In the same way it is possible to compare the strength of a chess-playing computer program with that of a human player.

Another method of quantifying the strength of a chess program is the numerical rating scale which is normally used to rate human players. Chess enthusiasts who play reasonably often in tournaments or other chess competitions will have a rating on a scale that ranges from around 1,000 to around 2,800. The average of all humans who know how to play chess has been estimated at 800 points on this scale, and at the other end of the range Bobby Fischer had a rating of around 2,800 when he quit active play in 1972.

One way of monitoring the progress of computer chess is to plot the numerical rating of the world's best program against another variable, which might be the year in which this rating was achieved or some indication of the computing power involved. Computing power could be measured in terms of the number of chess positions examined per second by the program, or it could be a function of the number of instructions per second executed by the computer.

For the past 15 years chess programmers have been aspiring to various clearly defined goals. One obvious target is to write a program that can win the human World Chess Championship, and this was once defined by a group of eminent academics as being one of the 10 fundamental aims in the science of artificial intelligence. So far this goal has always been at least a decade or two away but other goals have proved to be achievable.

An American foundation set up by Professor Fredkin at Carnegie Mellon University has offered various cash incentives to chess programmers. One of them was a $5,000 prize to the first program to achieve the rating of 2,200, which automatically qualifies human players as a National Master. This prize was collected last October by a program called Belle written by Ken Thompson and Joe Condon at the Bell Labs in New Jersey, which achieved an official U.S. Chess Federation rating of 2,203.

My own role as a target for chess programmers dates back to August 1968 when I started a bet that no program would win a match against me within 10 years. The bet was with Professors Michie, McCarthy, Papert and Welcher-Kozdrowicki. In August 1978 I duly played a six-game match against the reigning World Computer Champion, Chess 4.7, and won the match with three wins, one draw and one loss.

It seemed unsporting to remove the target that so many chess programmers had been aiming at for a decade, so shortly after the contest I decided to offer a prize of $1,000, which was augmented by another $4,000 from *Omni* magazine. The prize will go to the authors of the first program to win a match against me, no matter when that happens. The match must be played under strict human chess conditions, and must be of a reasonable length in order to reduce the possibility of luck being the decisive element.

## $1,000 bet

I also made another bet, that I would not lose such a match before the beginning of 1984. The bet was with Dan McCracken, a past President of the Association for Computing Machinery, who is famous for his prolific writing on Fortran and other computing subjects. This bet was for $1,000, and at the time I made it I considered it to be very much an even-money prospect.

At around the same time I gave up competitive chess against humans. During the five years or more that have passed since then I have not played one single competitive game of chess while the best chess programs have become stronger. In 1983 a program named Cray Blitz, written by Bob Hyatt and Bert Gower at the University of Southern Mississippi and Harry Nelson of Cray Research, won the World Computer Championship in New York in a very convincing manner, finishing with four and a half points from five games and standing one and a half points aloof from its predecessor, the redoubtable Belle.

Following the success of the program in New York, Robert Hyatt announced that he wished to challenge me for the $5,000 prize. I viewed the prospect with a mixture of interest and trepidation: I relished the challenge of trying to fight off the monster, but was very concerned that my five and a half years of inactivity would have left me so rusty that I might get wiped out by the program.

## London venue

After various attempts to find a suitable venue for the contest we agreed to play in London during the Advances in Computer Chess conference held in the middle of April. This was made possible by the sponsorship of *Practical Computing* and of GEC Dragon. The match was organised by Don Beal and play was via an open telephone line between London and Minneapolis, where the $15 million Cray XMP computer was located. The Cray machine is undoubtedly the world's most powerful commercially available computer, and when occupied with tasks less interesting than playing chess its time is charged out at $50,000 per hour. For the match two Cray processors were working in parallel for much of the time, so my one brain was struggling against two computer brains.

The first problem to face me as the match drew near was how to get back into practice overnight. I was fortunate to enlist the help of U.S. Master Danny Kopec, who is not only a player of international calibre but also an expert on computer chess. Danny agreed to act as my second for the match and arrived in London three days before the start to help me get match fit. We spent those days playing numerous speed games in which I managed to score no more than 25 percent, and we devoted a few hours to discussing my strategy for the match and what openings I ought to adopt.

In the first game of the match our opening strategy proved successful. I achieved a position which although objectively inferior from the human point of view, was very difficult for the program to understand. It made one or two errors which relinquished its advantage and then accepted my offer of a pawn, after which I

*(continued on page 84)*

David Levy, a retired chess Master, is now chairman of Intelligent Software, which has produced chess programs for popular micros and dedicated chess computers

# the Cray

**This spring David Levy fended off a challenge from the World Champion chess program. Here he tells how he did it, and why humans should still have a year or two at the top.**

## Game 1

**April 14, 1984**

**White: Cray Blitz**
**Black: David Levy**

*MODERN DEFENCE*

| | | |
|---|---|---|
| 1 | e2-e4 | a7-a6 |
| 2 | d2-d4 | g7-g6 |

Taking the program out of its openings book at about the earliest possible stage. This was part of our pre-match planning, designed to take advantage of the fact that programs do not understand the finer points of chess opening strategy. The program's next few moves are natural but stereotyped.

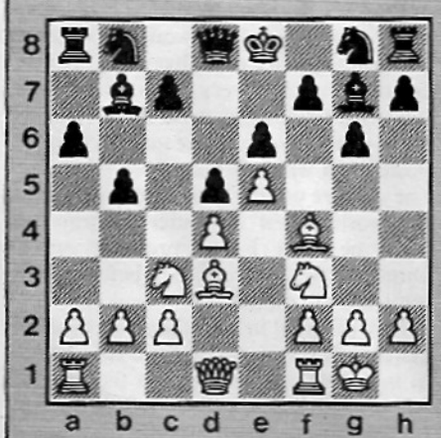
| | | |
|---|---|---|
| 3 | Ng1-f3 | Bf8-g7 |
| 4 | Nb1-c3 | |

Possibly inaccurate. In our pre-match analysis we had considered 4 c2-c3 to be best, supporting the d4 pawn and depriving Black of any Q-side counterplay based on the thrust . . .c7-c5. However, we had expected Cray Blitz to play the text move, which develops a minor piece.

| | | |
|---|---|---|
| 4 | . . . | b7-b5 |
| 5 | Bf1-d3 | Bc8-b7 |
| 6 | 0-0 | d7-d6 |
| 7 | Bc1-f4 | e7-e6 |
| 8 | e4-e5 | |

Part of Black's wierd-looking opening idea is to develop his knights on e7 and d7 and to meet the advance e4-e5 with . . .d6-d5, followed by an eventual . . .c7-c5, or the advance d4-d5 with . . .e6-e5, followed by an eventual . . .f7-f5. With the pawn centre locked the program will find itself in the type of position it handles least well.

| | | |
|---|---|---|
| 8 | . . . | d6-d5 |



| | | |
|---|---|---|
| 9 | b2-b4! | |

When the program played this move my first reaction was that it had to be a mistake, since it cedes Black control of the c4 square and creates long-term prospects for the g7 bishop along the h8-a1 diagonal. But on closer inspection I realised that Cray Blitz now had a clear positional advantage, partly based on the coming plan of a2-a4 and partly because of the possibility Nf3-d2, Nd2-b3 and Nb3-c5 — or Nb3-a5 in some positions.

| | | |
|---|---|---|
| 9 | . . . | Nb8-d7 |
| 10 | Qd1-d2 | Ng8-e7?! |

Better might have been 10 . . .h7-h6 first, and only then . . .Ng8-e7.

| | | |
|---|---|---|
| 11 | a2-a4! | c7-c6 |

There are now three ways for White to handle the tension on the Q-side. (a) Maintain the tension by keeping the pawn on a4 and preserving all options. In this case I had intended . . .Ne7-c8 and . . .Nc8-b6. (b) Closing the position with 12 a4-a5 in order to kill any prospects of Q-side play for Black. (c) Release the tension at once, and at the same time give Black's b7 bishop a new lease of life and leave White with a potentially vulnerable c-pawn on the half-open file. Cray Blitz chooses the third and weakest of these possibilities.

| | | |
|---|---|---|
| 12 | a4 × b5? | c6 × b5 |
| 13 | Bf4-h6 | 0-0 |

On 13 . . .Bg7 × h6?? 14 Qd2 × h6, Black has no way to save the h-pawn against the dual threats of Qh6-g7 and Nf3-g5.

| | | |
|---|---|---|
| 14 | Bh6-g5? | |

Wasting a tempo. White should probably have traded bishops on g7 in order to try to set up an attack on the dark squares around my king.

| | | |
|---|---|---|
| 14 | . . . | Rf8-e8 |
| 15 | Ra1-a3!? | |

Another occasion on which my first reaction was that Cray Blitz was floundering, but the real point of this move lies not in any attempt to control the a-file but in the possibility of switching this rook to h3 as part of an assault on my king.

| | | |
|---|---|---|
| 15 | . . . | Nd7-b6 |
| 16 | Nc3-d1 | Nb6-c4 |
| 17 | Bd3 × c4 | d5 × c4 |

Now that my b7 bishop has real scope, White must take care. 18 Nd1-e3 would allow 18 . . .Bb7 × f3 19 g2 × f3 Qd8-b6, with a perfectly reasonable position for Black.

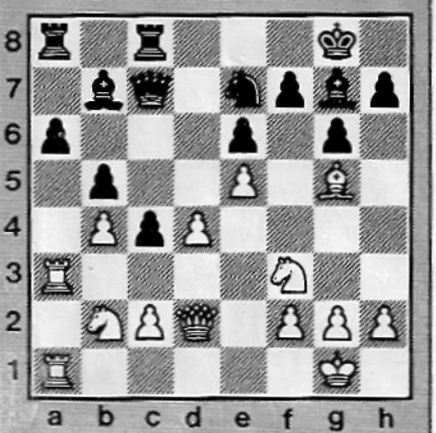
| | | |
|---|---|---|
| 18 | Nd1-b2?! | |

A strange square for the knight, and one from which it has no genuine prospects, but it is already difficult to suggest a good plan for White.

| | | |
|---|---|---|
| 18 | . . . | Qd8-c7 |

Now Cray Blitz has the unenviable choice between trading on e7, thereby giving me a potentially won endgame because of having two bishops against two knights, or permitting my knight to jump into play on f5 or d5.

| | | |
|---|---|---|
| 19 | Rf1-a1 | Re8-c8 |



Now 20 . . .c4-c3 is a serious threat, and 20 Bg5 × e7 is too late because of 20 . . .c4-c3 21 Be7-d6 c3 × d2 22 Bd6 × c7 Rc8 × c7 and 23 . . .Rc7 × c2.

| | | |
|---|---|---|
| 20 | c2-c3? | |

20 Nb2-d1 was forced, but it is easy to understand why Cray Blitz did not fear the ensuing continuation. Black can only capture on f3 at the cost of losing a pawn, which no materialistic computer program would ever sanction. An 11-ply search ending with 25 Ra5 × b5 would conclude that White was a pawn ahead, which is true but totally irrelevant.

| | | |
|---|---|---|
| 20 | . . . | Bb7 × f3 |
| 21 | g2 × f3 | Ne7-f5 |

Black cannot save both the knight and the a6 pawn.

| | | |
|---|---|---|
| 22 | Ra3 × a6 | Ra8 × a6 |
| 23 | Ra1 × a6 | Qc7-b7 |
| 24 | Ra6-a5 | Qb7 × f3 |
| 25 | Ra5 × b5 | |

Cray Blitz has won its pawn, but at what cost! Its K-side is full of holes and in the long term it will not be able to defend against the combined attack from my queen and knight.

Botvinnik once wrote that the chess player's greatest art lies in creating positions in which the normal relative values cease to exist. One can extrapolate from his assertion by saying that the art of defeating chess programs easily lies in creating positions where the program's evaluation function fails to account for the true relative values as perceived by a human chess master.

*(continued on next page)*

25 . . . h7-h6

The spectators now expected 26 Bg5-f6, when 26 . . .g6-g5! is very strong. The program finds a better defence.

26 Bg5-f4 Qf3-h3!

Since 26 . . .Nf5-h4 allows 27 Kg1-f1, I wanted to keep the white king under lock and key.

27 Bf4-g3 h6-h5
28 Rb5-c5! Rc8-a8
29 Qd2-c1??

This move protects the back rank against incursion by my rook at a1, and prepares for Qc1-f1, but the defence is inadequate. If the program had not been moving rather quickly it might have found 29 Rc5-a5!, when 29 . . .Ra8 × a5? 30 b4 × a5 leaves White with a dangerous passed pawn, while after 29 . . .Ra8-f8 30 Nb2 × c4 Bg7-h6 31 Qd2-a2 h5-h4 32 Ra5-a8 h4 × g3 33 h2 × g3, it is not exactly clear whether Black's extra bishop is more or less than a match for White's extra pawns. In a game against a computer program I would expect to win with Black, but against a human player I would be much more concerned about the hoardes of advancing pawns.

29 . . . h5-h4

After the game Danny Kopec pointed out the beautiful win 29 . . .Bg7-h6 30 Qc1-f1 Nf5-e3!! 31 f2 × e3 Bh6 × e3 + 32 Bg3-f2 Qh3-g4 + 33 Kg1-h1 Qg4-f3 + 34 Kh1-g1 Be3 × f2 + 35 Qf1 × f2 Ra8-a1 + etc. My move is far less exciting but just as effective.

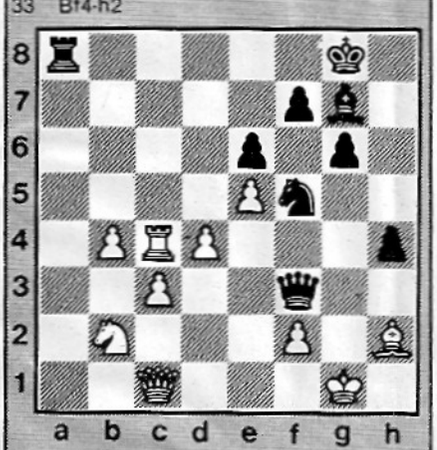
30 Bg3-f4 Qh3-f3
31 h2-h3

The only way to prevent 31 . . .h4-h3 without losing the bishop.

31 . . . Qf3 × h3
32 Rc5 × c4 Qh3-f3

Echoing the threat of . . .h4-h3, which this time cannot be stopped.

33 Bf4-h2



33 Kg1-f1 loses the queen to 33 . . .Ra8-a1! 34 Qc1 × a1 Qf3-h1 + , and 35 . . .Qh1 × a1.

33 . . . h4-h3
34 Qc1-f1 Ra8-a1
35 Nb2-d1 Ra1 × d1

White resigns.

# Squaring up to the Cray

*(continued from page 82)*

was able to launch a winning attack against its king.

When the second game was due to begin the computer was down, and after generously giving the program a five-minute period of grace, I started its clock. The computer did not come up during the next hour and so the program was declared to have lost by forfeit. The laws of chess state that the player who arrives at the board more than one hour late loses the game.

## Friendly match

About half an hour after the game was over the Cray came alive, and in the interests of science it was decided to play the game as a friendly encounter, without it affecting the score in the match. We played at a slightly faster than usual rate of 40 moves in 1 hour and 45 minutes rather than the normal two hours, and I was able to crush the program with a steady steam-rollering attack against its castled king.

After the second game was over the Cray Blitz programmers decided that they needed to discourage their program from allowing blocked pawn formations in the centre, as this had occurred in the first two games and was disadvantageous to the program. The point is that when the pawn structure is blocked there are no open lines on the board, and without open lines it is extremely difficult for a program to create play. In contrast, a strong human player can manoeuvre slowly in a blocked position, and open things up at just the right moment.

## Resigned

In game 3 I played in an almost identical manner to the first game. I varied my opening play very slightly, just in case the programmers had got a human expert to improve on the program's opening library in such a way as to take advantage of me. But soon it was clear that the program did not want to advance a centre pawn as it had done in the first game. I therefore decided to embark on a king-side expansion, and immediately the program made an unsound sacrifice which left me with a winning material advantage. A few moves later the computer crashed, whereupon the programmers resigned the game.

I was able to play the fourth game in quite a relaxed frame of mind as I had already won the match. I adopted the same opening strategy as in the third game, but with an extra move on account of having white. My first plan was to give the program the opportunity to make the same unsound piece sacrifice as in game 3, but when the crucial moment came it became clear that the programmers had discovered what was responsible and had altered the program overnight.

I allowed my king-side pawns to become ragged, in an attempt to create attacking changes against the program's king, and once again I reached a position which, from the point of view of a strong human player, was rather undesirable. I permitted the program to give up a piece for three pawns — an even material exchange which left the program with good long-term attacking prospects against my exposed king — but I had counted on the program being eager to trade queens since it thought, quite rightly, that it had the advantage.

What the program did not know was the reason that it held the advantage lay largely in the fact that with queens on the board my king was vulnerable, whereas without queens the position offered me excellent prospects in the endgame. The program duly exchanged queens at the first opportunity, and after that its position went steadily downhill.

## Vital training

I was pleased to have won the match four-nil, especially in view of my rustiness. The work that I did with Danny Kopec before the match had played a big part, and when the next challenge comes I shall again go into training for a few days. The four-nil score does not truly reflect the difference in strengths between the two participants, but it does show the extent to which a good knowledge of how computers play chess can help a human player. The programmers were unlucky to have had so many hardware crashes during the match and displayed great sportsmanship despite their disappointment.

But even without hardware problems, I don't think Cray Blitz would have scored any points against me. That it not because I consider myself so very much stronger than the program, but because it does not yet have the ability to create the type of position in which it plays best. The day is not yet here when I must finally admit that the world's best computer program can beat me, and I can probably survive another two or three years before paying out the prize money.

I am told that in 1986 there will be a Cray system 20 times as powerful as the one used in my match, in which case the program will be able to look another two or three ply further ahead. That may or may not be sufficient to beat me, but even if I do lose there are another 400 points to go before the world's best chess programs are as strong as the human World Champion.