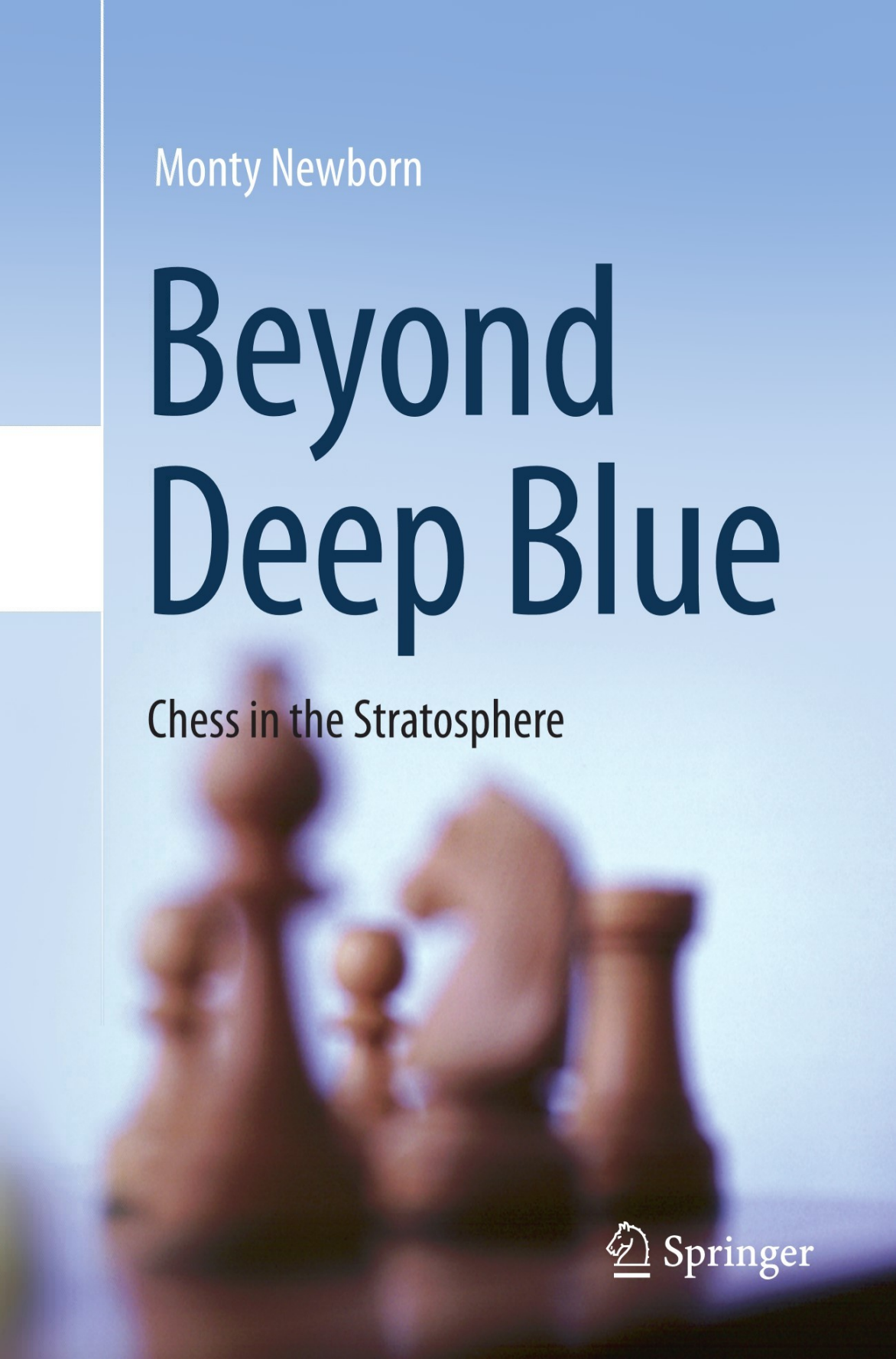
Monty Newborn

Beyond Deep Blue

Chess in the Stratosphere



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Preface

Thirteen years have passed since IBM's Deep Blue stunned the world by defeating the human world chess champion at that time, Garry Kasparov. The purpose of this book is to initially reconsider Deep Blue's achievement and then to survey subsequent milestones in the world of computer chess. Following Deep Blue's retirement, there has been a succession of better and better chess engines, that is, computing systems programmed to play chess. Today, there is little question that the world's best chess engines are stronger than the world's best humans. We have seen a steady progression of talent, from Deep Blue to Fritz and Junior and Shredder to Hydra and Zappa and Rybka and …. There are now a number of chess engines better than the world's best human.

Each of the 21 chapters in the book — except the final one — covers a milestone of some sort. There are 20. The first chapter looks back at Deep Blue's matches with Garry Kasparov in 1996 and 1997. Ten other chapters are concerned with the ten World Computer Chess Championships that have taken place: in 1999 and then yearly beginning in 2002 and ending in 2010. Three chapters are concerned with man–machine matches: between Fritz and Kramnik (2002), Kasparov and Deep Junior (2003), and Fritz and Kramnik (2006). Three historical matches between the leading engines each occupy a chapter: Hydra versus Shredder in 2004 in Abu Dhabi, Junior versus Fritz in 2007 in Elista, and Zappa versus Rybka in 2007 in Mexico City. Lastly, there are three chapters covering the three most recent Internet Chess Club's Computer Chess Tournaments held in 2008, 2009, and 2010. These three events are each covered in late chapters and are included to give the reader a few more games between the leading engines in recent years. The final chapter makes a number of general observations.

There have been other important competitions for chess programs in recent years. These include, in particular, the yearly Dutch Computer Chess Championships, the International CSVN Tournaments, and the International Paderborn Computer Chess Championships. Games from these competitions are not presented in this book, though pointers to them appear in the references.

Information on the computing systems used in the competitions is given in most chapters. Of interest are processor speeds, memory sizes, and the number of processors used. You should be able to see the correlation between the progress in technology and the improvement in the engines.

In 1975, I published my first book entitled *Computer Chess*; it surveyed developments in the field to then. Three books, coauthored with David Levy, followed: *More Chess and Computers* in 1980, *All About Chess and Computers* in 1982, and *How Computers Play Chess* in 1991. These books surveyed the period when computers were rapidly developing and the programs were reaching grandmaster level. *Deep Blue: Computer Chess Comes of Age* was published in 1997; it covered the overall history of computer chess, focusing on Deep Blue's first encounter with Kasparov. *Deep Blue: An Artificial Intelligence Milestone* was published in 2003 and covered the story of Deep Blue, focusing on the Rematch. As said previously, this current book surveys the years since the two Deep Blue versus Kasparov matches.

Initially, I started out to write a book focusing on the three man-machine matches that constitute Chaps. 4, 5, and 8 to show that Kasparov's problems in 1997 were repeated in the three major contests in 2002, 2003, and 2006. However, as I gathered material and began to write, it became clear that the real story was the chess engines, themselves, and their steady improvement to the point now where there is little question whether man or machine is best. The issue is which engine is best now, how good it is, and, perhaps, how much better it can get.

This book may be most appreciated by chess players and aficionados of the game. A total of 118 games are included, mostly between the top engines. The games of 17 different engines are included. Analysis of the games is a risky business, as criticizing a player whose strength surpasses the world's best players is often a mistake. However, there is an attempt to examine the play nevertheless. One could write pages of analysis on each game, but a choice was made to include more games than extensive analysis. If one were to write a book about great poets or artists, it would be necessary to include examples of their writings and paintings. And here, too, the games of these great men and machines tell the story. The games are not necessarily the best games played. Our purpose is to provide a comprehensive history of their play, good and bad and mediocre.

With each game, the opening used is specified as given on the chessgames.com Web site. A tree of the openings to a depth of ten moves is given in Appendix 1. Some games have the time taken for each move, the score assigned to the move by the search engine, and the expected reply. This information is included for historical purposes and to give additional insight into the capabilities of the engines. Most often when the time indicated for a move is zero seconds, the move was thought out on the opponent's time.

There have been many games played between the top grandmasters and the top computers in recent years, but only those involving Kasparov and Kramnik are presented. Omitting those played between Hydra and British Grandmaster Michael Adams in 2005 in London was a difficult decision as the match perhaps marks the first major match in which a top grandmaster was really taken to the cleaners by a chess engine. All the games presented in this book appear in a number of places. It is their publication in one place, showing the great progress made from year to year, that distinguishes this book.

I would like to thank Frederic Friedel of chessbase.com for permission to use a number of photos. Similarly, I would like to express thanks to IBM and to the Deep

Blue team members for permission to use a photo of their team. Gian-Carlo Pascutto, Amir Ban, Bob Hyatt, Tord Romstad, Anthony Cozzie, Chrilly Donninger, Frans Morsch, Jeroen Noomen, Stefan Meyer-Kahlen, Vasik Rajlich, Zach Wegner, and Johannes Zwanzger also provided greatly appreciated background information and photos for this book, and I extend my thanks to them.

October 2010 Monty Newborn

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Deep Blue Establishes Historic Landmark

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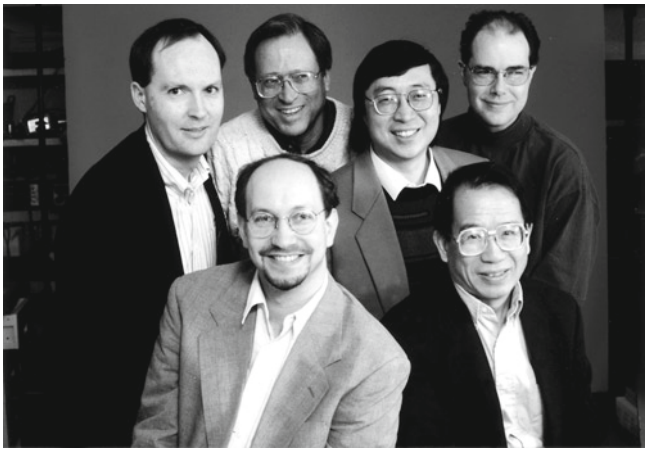
On May 11, 1997, IBM's Deep Blue stunned the world when it defeated the best human chess player – possibly the best human chess player ever! – on planet Earth, Garry Kasparov, in the final game of their six-game Rematch, thereby winning the match by a 3.5–2.5 score. The victory gave Deep Blue the right to call itself the world's best chess player. But was the claim legitimate? Was Deep Blue really better than Kasparov? Was the victory a one-time fluke? Would Kasparov – or one of his kind – set the record straight in the coming months or years? We'll see in the following chapters. But first, let's review Deep Blue's two matches with Kasparov beginning with its victory in the Rematch.

The IBM Deep Blue Versus Kasparov Rematch, held May 3–11, 1997, took place in New York's Equitable Center, located at 52nd Street and Seventh Avenue,



The IBM Deep Blue Team, 1997.
Top row: Murray Campbell, Jerry Brody, Feng-Hsiung Hsu, Joe Hoane;
Bottom row: Joel Benjamin, Chung-Jen Tan.
(Photo courtesy of IBM Corporation)

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adjacent to the city's world-famous Theatre District. Kasparov and Deep Blue faced each other in a TV production studio on the building's 35th floor, while an audience of 500 followed the games one floor below ground level on large closed-circuit TV screens. By the final game, people around the world were glued to their TVs watching half-hourly reports on CNN. The event had become the largest Internet happening in history to that time with millions following the games on IBM's website.

Leading up to the final game, each side had won one game; they had played to three other hard-fought draws. The match was tied at two-and-a-half points apiece. Deep Blue had the white pieces in the final game, giving it better chances than if it had the black ones. Except for winning the first game, Kasparov failed to have his way with his opponent thereafter. He lost the second game, being uncharacteristically befuddled by Deep Blue's play. He was unable to win any of the next three games despite seeming to have chances. He might have best settled on playing for a draw in the final game and on splitting the $1.1 million prize. But he evidently preferred to gamble on a line of play he thought Deep Blue wouldn't understand, one that involved a sacrifice by Deep Blue leading to a position in which it would dramatically self-destruct. However, the game didn't go according to his plans. Tactical complications arose in which Deep Blue consistently came up with better moves than Kasparov anticipated. The world champion resigned on the 19th move, thus losing the greatest chess match in history.

Even though Deep Blue won the match, few were ready to accept the fact that it was the better player. Certainly Kasparov wasn't. The match was only six games, and Kasparov was only one point behind at the end. In tennis, you have to win a game by two points! World championship chess matches usually consist of many games, with more than half ending in draws. Six games were far too few to decide something so important.

Leading up to the match, Kasparov was unhappy that he didn't have access to games played by Deep Blue since their ACM Chess Challenge match in Philadelphia, February 10–17, 1996. He had planned to study them so that he could have some idea what to expect. The Deep Blue team argued that there weren't any games to give him. They contended Deep Blue had only played scrimmage games with several grandmasters, primarily Joel Benjamin, but also Miguel Illescas, Nick DeFirmian, and John Fedorowicz. IBM had acquired the services of Benjamin and these other top players following the Philadelphia match to add high-level expertise to the team. Murray Campbell, the team's top chess player, played at the level of a strong Expert, and Feng-Hsiung Hsu, the main brain behind Deep Blue was a couple of levels weaker; others involved in the project were weaker yet. To rival the world's best player, the team felt the need for help from significantly stronger individuals. Along with scrimmaging with Deep Blue, these players also helped with Deep Blue's opening book, which was under constant modification even during the match. The less of the book that Kasparov saw, the better. But the reality was that while Deep Blue had been improved during the year leading up to the Rematch, the great majority of its code was unchanged and its style of play was pretty much the same – some improved positional play as a result of improvements in the scoring function,

and improved tactical play as a result of using a system that searched twice as fast. However, not seeing recent Deep Blue games was most likely less of a handicap than Kasparov imagined.

During and following the match, Kasparov questioned the play of the computer, suggesting that some of its moves were inconsistent with his understanding of how computers were programmed to play. The implication was that Deep Blue was somehow receiving help. Kasparov seemed to have psyched himself out over these concerns, and his supporters contended his frustration affected his play. However, in most sporting contests, the psychic plays a big part. World class athletes often play with all kinds of distractions taking place. In baseball, some catchers jabber incessantly, trying to annoy the batter. When winning, an athlete can often handle distractions that would otherwise be a problem. Kasparov's concerns were never substantiated, and Deep Blue's victory stands today as one of the great scientific achievements of the twentieth century. In 2003, the movie, *Move Over: Kasparov and the Machine* appeared with Kasparov playing himself. The gist of the movie continued with the theme of suspicion, and while enjoyable, brought forward no new evidence to suggest Deep Blue was assisted during the games.

At the press conference following the final game, Kasparov said, "I personally guarantee I will tear it to pieces" in a third match. Several days later, he appeared on Larry King Live and told his host that he was willing to play the computer "all or nothing, winner take all." He had won the ACM Chess Challenge with a 4–2 score and now, after losing this one, he stood even with his opponent. Another match was appropriate. Of course, the loser of the third match, if it were Deep Blue, would be entitled to a fourth match, no? And then what?

Over the coming months there were talks between IBM and Kasparov, though no concrete action was agreed upon. The Deep Blue team spent a good deal of that time traveling the world and telling the story of their chess engine to IBM supporters and chess enthusiasts. Then some time near the end of the summer of 1997, IBM made a decision to retire Deep Blue. Perhaps the computer giant saw little to gain by continuing the project. Defeating Kasparov one more time had the potential of giving IBM more bad publicity than good. IBM evidently preferred to present an image of working alongside the human race rather than battling it! Moreover, the company must have felt the odds of a victory in the next match were in its favor. But outside IBM, there was great disappointment when the news came out. James Coates of the Chicago Tribune bemoaned the decision in his October 12, 1997, article:

> The geniuses who built a computer that whipped the world's best player fair and square in May need to learn here in October the first lesson that every back room poker player and pool shooter learns from the git go. I'm talking about the rule of threes. Say we're playing 9 ball or ping-pong, and you wipe me out. I ask for a rematch and barely beat you. Then I say bye-bye, I'm the better player and now I'm going home? Legs have been broken for less.

Not long after IBM decided to retire Deep Blue, the team broke up. Hsu left IBM, initially setting out to design a new Deep Blue equivalent to take on Kasparov; he is now with Microsoft's Research and Development in Beijing, China. Some time after leaving IBM, Hsu went as far as approaching Kasparov to set up a third match, but

neither the new machine nor a match ever materialized. Murray Campbell stayed on at IBM and now manages the Intelligent Information Analysis Department at IBM's T. J. Watson Research Center. Joe Hoane, who was responsible for the software that coordinated the many processors on which Deep Blue ran, left shortly after the Rematch. Most recently, he was with Sandbridge Technologies in White Plains, New York. Jerry Brody, whose responsibility was assisting with the hardware, retired. Chung-Jen Tan, the boss of the gang, is now the director of the E-Business Technology Institute (ETI) of the University of Hong Kong where he also holds the position of Visiting IBM Chair Professorship. Deep Blue, itself, the computer – better, the computing system – is currently in two museums, in the Smithsonian Museum in Washington, D.C., and in the Computer History Museum in Mountain View, California. How is that possible, you ask? Well, the SP2 on which Deep Blue ran consisted of two cabinets. One cabinet is now in the Smithsonian, and the other is in the Computer History Museum.

Now, back to the issue of the legitimacy of Deep Blue's victory. A year before the Rematch, the ACM Chess Challenge went to Kasparov, 4–2. But recall, the match was tied after four of the six scheduled games and maybe not as one-sided as some chess aficionados like to imagine. In Game 5, Kasparov chose to avoid his favorite Sicilian Defense, having been unable to win with it in the first and third games. This implicitly showed some recognition of and respect for his opponent's strength. Instead, he played the Four Knights Opening. Then out of nowhere, on the 23rd move, he offered a draw to his opponent. And why? Deep Blue thought it was behind by three tenths of a pawn, and the team was surprised by the offer. The rules of play permitted the team to decide whether or not to accept the draw, the only decision that could be made by humans on behalf of the computer. Kasparov was a bit short on time – about 20 minutes to make the next 17 moves, about a minute a move, in contrast with the rate of play that allotted three minutes per move on average. So, perhaps, he was playing it safe here, feeling he could defeat Deep Blue in the final game with the white pieces. However, given his inability to win a game other than the second to this point, his approach had potential risks.

The Deep Blue team huddled to discuss the offer. It huddled so long that Deep Blue played its 24th move, effectively rejecting the offer. If it had accepted, the match would have been tied going into the final game. Imagine, after five games and going into the final game, the match would have been dead even if the Deep Blue team had accepted a draw offer in a position in which the computer, itself, felt it was behind!

In the final game, Kasparov successfully led Deep Blue down a line that it didn't understand, and he slowly choked it to death. The ACM Chess Challenge thus ended with two Kasparov victories, convincing most of the top chess players that Deep Blue had a long way to go before it would reach Kasparov's level. But with a final score of 4–2, Deep Blue can be given credit for giving Kasparov an excellent run for the money – $400,000 specifically – that he carried away.

Chess players, both human and computer, are assigned ratings and categories based on their performance in formal competitions. Those rated over 2500 fall into the category of grandmasters, 2200–2500 are international masters, while 2000–2200 are experts. Kasparov, at the time of the two matches was rated approximately 2850. The difference in ratings between two players is correlated to the probability of the higher

rated player defeating the lower rated player as shown in the table below. The table shows that if one player wins two thirds of the points against an opponent, then he would be expected to have a rating advantage of about 125 points. Of course, six games don't give enough data for a definitive conclusion about the rating difference between Kasparov and Deep Blue.

Percentage of points won for given rating advantage

Rating advantage in points	Percentage of points won
0	50
25	53
50	57
75	60
100	64
125	67
150	70
175	73
200	76
250	81
300	85
400	92
500	96
600	98

Following the third game of the 1996 match, Kasparov gave Deep Blue credit for playing "in the 2700 range," although he observed that its strength varied widely from move to move, from as high as a "rating of 3000 to maybe 2300." It is not clear what he would have said following the final game after winning the last two games.

Deep Blue clearly improved from the first match to the second. Given that Deep Blue used a faster computing system with improved software for the second match, one might argue that during the ACM Chess Challenge, it performed just above the 2700 level and, during the Rematch, essentially at Kasparov's level. The point to be emphasized and contended in this chapter is that the 1996 match was fairly close, closer than generally recognized, and that the 1997 match saw the two stand essentially equal, although Deep Blue was the winner.

So the two Deep Blue versus Kasparov showdowns ended with one victory each. Kasparov, himself, held the title of World Champion three more years, relinquishing it to the third "K" in the series: Karpov, Kasparov, and then Vladimir Kramnik. Kasparov continued his chess career for several more years, remaining the top rated chess player. He officially retired in 2005 to devote his time to Russian politics where he became a vocal critic of the current Russian Prime Minister Vladimir Putin.

The computing system on which Deep Blue ran was the most powerful system ever used by a chess engine. It consisted of two six-foot racks containing 30 RS/6000 computers. Each of these contained 16 special chess-processor chips designed by Hsu, giving Deep Blue 480 processors searching in parallel for the best move to make.

Although the 480 processors did not yield the theoretical speedup over a single processor system of 480, the speedup was nevertheless significant.

Perhaps the most amazing aspect of the two matches was how Deep Blue's play was criticized, how it managed to exhibit bugs of all kinds, and yet obtained a score of 2–4 in Philadelphia and won the Rematch with a 3.5–2.5 score. In spite of a number of crashes and in spite of many moves criticized by the experts, Deep Blue won the Rematch. Amazing! It should be kept in mind that Deep Blue, when it played Kasparov, had played a small number of games when compared to the number played by other leading engines, such as, in particular, Fritz. With thousands of users, the programmers of the commercial engines received feedback from their users that far surpassed the effectiveness of the testing done on Deep Blue. Deep Blue's computer rivals were more solid with many more games under their belts and far more testing and debugging. One of the big shortcomings of Deep Blue – this wasn't really a bug – was its time control algorithm. Deep Blue was designed to play considerably faster than necessary as it had lost a few games leading up to the Kasparov matches on time. Rather than fix the time control algorithm to safely use all available time, the programmers designed in a big safety factor. If Deep Blue had consumed all available time, it would have played even stronger. If doubling processor speed leads to approximately a 100 point rating improvement, then taking twice the time should produce the same effect. While Deep Blue's powerful computing system was a big factor in its victory, its fragility was a major liability. In the succeeding years, far less substantial computing systems would play chess as well as Deep Blue and better yet.

The twelve games from the two matches follow, with the analysis especially pointing out Deep Blue's bugs and criticized moves, and the source of the criticism. In addition, of interest are comments made that suggest one side or the other is ahead or winning. Some of the annotations and comments that follow were extracted from the referenced books and papers and from Deep Blue logs on the IBM website.

ACM Chess Challenge, 1996: Scorecard

Name	Game 1	Game 2	Game 3	Game 4	Game 5	Game 6	Total pts
G. Kasparov	B0.0	W1.0	B1.5	W2.0	B3.0	W4.0	4.0
Deep Blue	W1.0	B1.0	W1.5	B2.0	W2.0	B2.0	2.0

IBM Deep Blue versus Kasparov Rematch, 1997: Scorecard

Name	Game 1	Game 2	Game 3	Game 4	Game 5	Game 6	Total pts
Deep Blue	B0.0	W1.0	B1.5	W2.0	B2.5	W3.5	3.5
G. Kasparov	W1.0	B1.0	W1.5	B2.0	W2.5	B2.5	2.5

The ACM Chess Challenge, February 10–17, 1996, Philadelphia

ACM Chess Challenge
Game 1, February 10, 1996
Deep Blue (W) versus Garry Kasparov (B)
Sicilian Defence: Alapin Variation. Barmen Defense Modern Line (B22)

With Kasparov at the table and the 3:00 PM hour signaling the start of the game, Deep Blue became temperamental, exhibiting the first of a number of technical problems. It was cured quickly, but it did suggest there might be other stumbles coming, as was the case [Glitch #1].

1 e4 c5 2 c3

Both players opened with their favorite moves. Deep Blue chose to continue with the Alapin Variation of the Sicilian Defense.

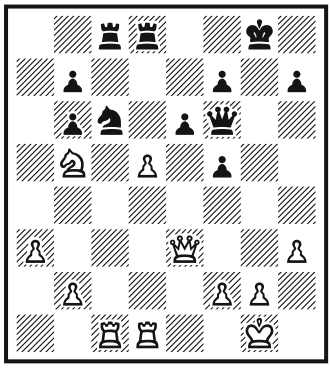
2 ... d5 3 exd5 Qxd5 4 d4 Nf6 5 Nf3 Bg4 6 Be2 e6 7 h3 Bh5 8 O-O Nc6 9 Be3 cxd4 10 cxd4 Bb4 11 a3 Ba5 12 Nc3 Qd6 13 Nb5 Qe7

Some thought Kasparov would test Deep Blue's willingness to play for a draw here: if he had played 13 … Qd6 and Deep Blue replied 14 Nc3, Kasparov would have concluded that the engine's contempt factor was programmed to play for a draw in fairly equal positions. But Kasparov's curiosity about this issue wasn't as strong as his interest in playing on and testing his opponent in other ways to prepare him for later games. Yasser Seirawan, one of three commentators at the match, felt Kasparov would use the first two games to learn what he could about Deep Blue's decision-making procedures and priorities. According to Seirawan who got word straight from the Deep Blue team, Deep Blue would indeed have gone for the draw if Kasparov had played 13 … Qd6.

14 Ne5 Bxe2 15 Qxe2 O-O 16 Rac1 Rac8 17 Bg5 Bb6 18 Bxf6 gxf6 19 Nc4 Rfd8 20 Nxb6

Perhaps Kasparov learned something about Deep Blue's scoring function here. Deep Blue liked to double and isolate its opponent's pawns. It had managed to do so here and on its earlier 18 Bxf6.

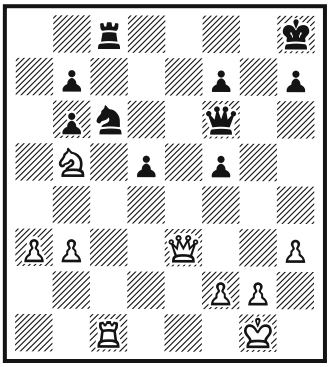
20 … axb6 21 Rfd1 f5 22 Qe3 Qf6 23 d5



Position after 23 d5.

Again, Deep Blue's scoring function was occupied with weighing the tradeoff of its d-pawn for Kasparov's pawn on b3, giving Kasparov an isolated, though, passed, pawn on the d-file but doubled pawns on the f-file. Seirawan said his "belief in Black's position was growing." In Michael Khodarkovsky and Leonid Shamkovich's book, Kasparov said that he "was stunned" by Deep Blue's move.

23 … Rxd5 24 Rxd5 exd5 25 b3 Kh8



Position after 25 … Kh8.

Kasparov plotted an attack on Deep Blue's king, either mistakenly underestimating Deep Blue's looming attack or feeling he had no better alternative.

26 Qxb6 Rg8 27 Qc5

Deep Blue found one strong move after another, stalling Kasparov's kingside attack.

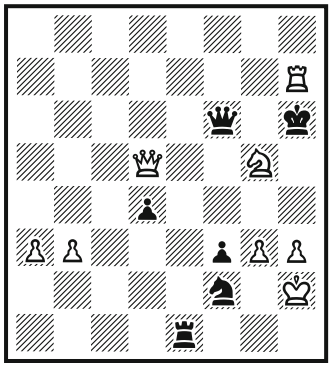
27 … d4 28 Nd6 f4 29 Nxb7

The blood pressure of those watching jumped through the roof on this move. Could Deep Blue actually grab this remote pawn with Kasparov pushing his pawns down the engine's throat and blasting away at its king with more and more attackers?

29 … Ne5 30 Qd5 f3 31 g3 Nd3 32 Rc7 Re8 33 Nd6 Re1 34 Kh2 Nxf2

Both sides slugged away at one another like two Japanese sumo wrestlers, pulling and pushing each other near the edge of a high cliff: one must eventually fall off. Kasparov threatened mate-in-one and continued to do so until Deep Blue nailed down a victory. Most mortals would have been shaking in their boots, but Deep Blue stayed cool, one move ahead of its opponent to the end. Deep Blue, and chess engines more generally, are at their best when defending against checkmate in complex positions.

35 Nxf7+ Kg7 36 Ng5+ Kh6 37 Rxh7+ Black resigns.



Position after 37 Rxh7+, Black resigns.

In the final position, Kasparov had no choice but to play 37 … Kg6 to which Deep Blue could have delivered check on g8; 38 Qg8+ and then 38 … Kf5 39 Nxf3 would have eliminated Kasparov's mate-in-one threat and would

have left him with too many problems to consider continuing.

This game was a historical milestone; it marked the first time a world human chess champion lost a tournament game to a chess engine where the time controls were those used in human world championship matches. One remarkable aspect of the game was that Deep Blue took far less time than Kasparov to make its moves. Kasparov had only five minutes on his clock to make his next few moves to the 40-move time control, while Deep Blue had about an hour. This had ominous implications for Kasparov and for the future of the human race's efforts to stay ahead of their chess-playing creations, where faster processors come out every year or so. Time is a great equalizer of chess talent.

ACM Chess Challenge
Game 2, February 12, 1996
Garry Kasparov (W) versus Deep Blue (B)
Zukertort Opening: Grünfeld Reversed (A49)

Perhaps Kasparov had taken Deep Blue too lightly in Game 1. He may have been testing his opponent, but that doesn't mean going as far as losing to it. He almost seemed to be saying by the first game that he was going to beat Deep Blue at its own game – a tactical struggle. A lesson was learned though, and this game and subsequent ones were steered toward long-term strategic situations. The chess players of the world all felt that perhaps Kasparov would fight back in this game, take it more seriously, and show Deep Blue who really is boss. That he did!

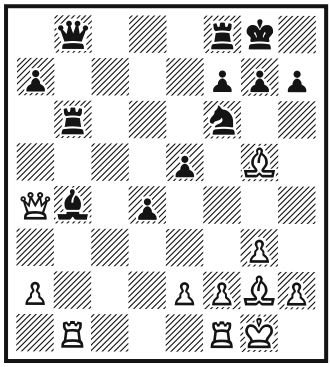
1 Nf3 d5 2 d4

Deep Blue didn't respond immediately to Kasparov's 2 d4, as another glitch surfaced. Deep Blue was out of book, using valuable time to calculate moves that should have taken negligible time. [Glitch #2].

2 … e6 3 g3 c5 4 Bg2 Nc6 5 O-O Nf6 6 c4 dxc4

Hsu misread the computer screen on this move and played 6 … cxd4. After Kasparov replied 7 Nxd4, Murray Campbell, who was watching in the IBM Operations Room and observed the mistake, rushed into the Game Room to tell Arbiter Mike Valvo of the error. The game was reset to the correct position, probably much to Kasparov's exasperation though his demeanor didn't show it.

7 Ne5 Bd7 8 Na3 cxd4 9 Naxc4 Bc5 10 Qb3 O-O 11 Qxb7 Nxe5 12 Nxe5 Rb8 13 Qf3 Bd6 14 Nc6 Bxc6 15 Qxc6 e5 16 Rb1 Rb6 17 Qa4 Qb8 18 Bg5 Be7 19 b4 Bxb4



Position after 19 … Bxb4.

According to Khodarkovsky and Shamkovich, Kasparov's 19 b4 and Deep Blue's subsequent capture "was a small achievement, but good enough for developing a decisive advantage."

20 Bxf6 gxf6 21 Qd7 Qc8 22 Qxa7 Rb8 23 Qa4

Seirawan said, "Now the win is easy."

23 … Bc3 24 Rxb8 Qxb8 25 Be4 Qc7 26 Qa6 Kg7 27 Qd3 Rb8 28 Bxh7 Rb2 29 Be4 Rxa2

Well, maybe not so easy. Seirawan said it has "become problematic."

30 h4 Qc8 31 Qf3 Ra1 32 Rxa1

Now, Kasparov's thrown "away the lion's share of his winning chances."

32 … Bxa1 33 Qh5 Qh8

In analyzing the position, Raymond Keene and Bryan Jacobs say in their book, "The smoke has cleared. … Deep Blue's position may not be lost but it is devilishly difficult to hold."

34 Qg4+ Kf8 35 Qc8+

Kasparov, in time trouble, repeated the position, knowing his opponent would be happy to do the same.

35 … Kg7 36 Qg4 Kf8 37 Bd5 Ke7 38 Bc6 Kf8 39 Bd5 Ke7 40 Qf3

Seirawan "was beginning to doubt that the computer could save the ending."

40 … Bc3 41 Bc4 Qc8 42 Qd5 Qe6 43 Qb5 Qd7 44 Qc5 Qd6 45 Qa7+ Qd7 46 Qa8 Qc7 47 Qa3 Qd6 48 Qa2 f5

"The last mistake," according to Seirawan.

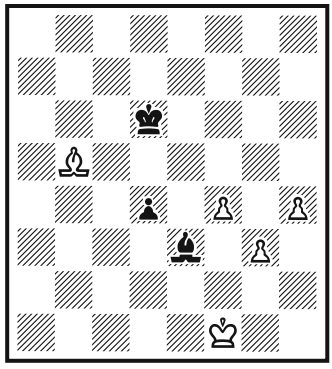
49 Bxf7 e4 50 Bh5 Qf6 51 Qa3+ Kd7 52 Qa7+ Kd8 53 Qb8+ Kd7 54 Be8+ Ke7 55 Bb5 Bd2 56 Qc7+ Kf8 57 Bc4

Kasparov said, following the game, that he "was pretty sure I was winning" after this move.

57 … Bc3 58 Kg2 Be1 59 Kf1 Bc3 60 f4

Seirawan said this was "a gorgeous move which seals the computer's fate."

60 … exf3 61 exf3 Bd2 62 f4 Ke8 63 Qc8+ Ke7 64 Qc5+ Kd8 65 Bd3 Be3 66 Qxf5 Qc6 67 Qf8+ Kc7 68 Qe7+ Kc8 69 Bf5+ Kb8 70 Qd8+ Kb7 71 Qd7+ Qxd7 72 Bxd7 Kc7 73 Bb5 Kd6 Black resigns.



Position after 73 ... Kd6, Black resigns.

ACM Chess Challenge
Game 3, February 14, 1996
Deep Blue (W) versus Kasparov (B)
Sicilian Defense: Alapin Variation. Barmen Defense Modern Line (B22)

1 e4 c5 2 c3 d5 3 exd5 Qxd5 4 d4 Nf6 5 Nf3 Bg4 6 Be2 e6

A repeat of Game 1 so far. Deep Blue previously played 7 h3 but castled this time. Deep Blue stumbled on move 5, requiring the system to be rebooted. Perhaps the change in moves from 7 a3 in Game 1 to 7 O-O here was related to this. Deep Blue Prototype crashed in 1995 at the 8th WCCC when making moves from the book, leading to its disastrous loss to Fritz in the final round. The circumstances were somewhat similar. In both cases, the engine seemed to have changed its mind from what it was thinking before the system problem came up to something different after the problem was corrected. Hsu, when commenting on the loss in Hong Kong stated the "loss is probably good for us in the long run. Book preparation will be taken far more seriously from now on." [Glitch #3].

7 O-O Nc6 8 Be3 cxd4 9 cxd4 Bb4 10 a3 Ba5 11 Nc3 Qd6 12 Ne5 Bxe2 13 Qxe2 Bxc3 14 bxc3 Nxe5 15 Bf4 Nf3+ 16 Qxf3 Qd5 17 Qd3 Rc8 18 Rfc1

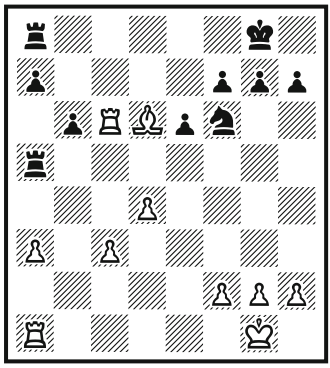
Seirawan said that "Benjamin could only groan after he saw this move."

18 … Qc4

Khodarkovsky and Shamkovich felt "Black had a slightly better position."

19 Qxc4 Rxc4 20 Rcb1 b6 21 Bb8 Ra4 22 Rb4 Ra5 23 Rc4 O-O 24 Bd6 Ra8 25 Rc6

Seirawan now "expected a draw, whereas minutes before I had absolutely believed the computer was losing its scalp."

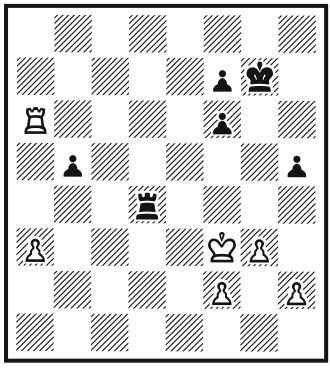


Position after 25 Rc6.

25 … b5 26 Kf1 Ra4 27 Rb1 a6 28 Ke2 h5 29 Kd3 Rd8 30 Be7 Rd7 31 Bxf6 gxf6 32 Rb3 Kg7 33 Ke3 e5 34 g3 exd4 35 cxd4 Re7+ 36 Kf3 Rd7 37 Rd3 Raxd4 38 Rxd4 Rxd4

Kasparov offered a draw here, but it was refused.

39 Rxa6 Drawn by agreement.



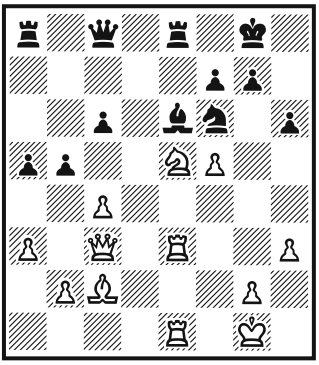
Position after 39 Rxa6,
Drawn by agreement.

ACM Chess Challenge
Game 4, February 15, 1996
Kasparov (W) versus Deep Blue (B)
Semi-Slav Defense: Quiet Variation (D30)

1 Nf3 d5 2 d4 c6 3 c4 e6 4 Nbd2 Nf6 5 e3 Nbd7 6 Bd3 Bd6 e4 dxe4 8 Nxe4 Nxe4 9 Bxe4 O-O 10 O-O

Goodman and Keene gave Kasparov credit for standing "slightly better out of the opening."

10 … h6 11 Bc2 e5 12 Re1 exd4 13 Qxd4 Bc5 14 Qc3 a5 15 a3 Nf6 16 Be3 Bxe3 17 Rxe3 Bg4 18 Ne5 Re8 19 Rae1 Be6 20 f4 Qc8 21 h3 b5 22 f5



Position after 22 f5.

22 … Bxc4

Deep Blue took a 20 minute dive while making this move. Before crashing, it was planning 22 … Bxf5, but after recovering, it preferred 22 … Bxc4, which turned out to be a better move. According to Khodarkovsky and Shamkovich, Kasparov's concentration was shaken by the episode and he lost "his mental focus." [Glitch #4].

23 Nxc4 bxc4 24 Rxe8+ Nxe8

Seirawan gave Kasparov credit for playing "an impressive game" thus far.

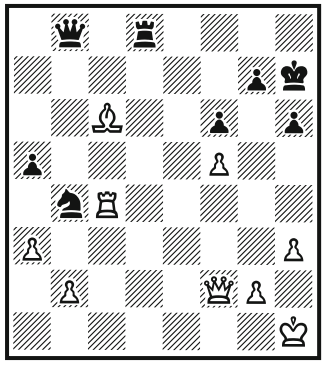
25 Re4 Nf6 26 Rxc4 Nd5 27 Qe5 Qd7 28 Rg4 f6 29 Qd4 Kh7

Deep Blue showed that it was out of ideas in a typically computer way.

30 Re4 Rd8 31 Kh1 Qc7 32 Qf2 Qb8 33 Ba4 c5

Seirawan observed "Kasparov, not only has had his advantage disappear, so had the time on his clock! He was now heading towards the precipice of defeat."

34 Bc6 c4 35 Rxc4 Nb4



Position after 35 … Nb4.

Even Khodarkovsky and Shamkovich saw Kasparov as having problems, now, saying that the last two Deep Blue moves "not only neutralized White's attack but created counter chances."

36 Bf3 Nd3 37 Qh4 Qxb2 38 Qg3 Qxa3 39 Rc7 Qf8 40 Ra7 Ne5 41 Rxa5 Qf7

The Deep Blue team refused an offer by a tired Kasparov to call it a drawn game. Deep Blue was indicating that it held a small advantage.

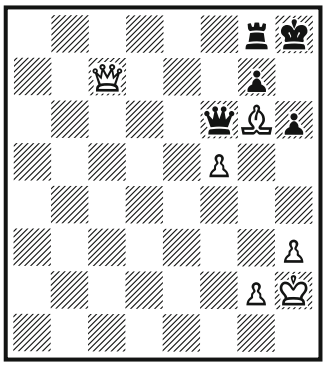
42 Rxe5 fxe5

Kasparov exchanged his rook for Deep Blue's annoying knight, satisfied Deep Blue had no way to gain a victory even with a material advantage of a rook for a bishop and pawn – and expecting Deep Blue to come to the same conclusion soon.

43 Qxe5 Re8 44 Qf4 Qf6 45 Bh5

Kasparov's hand shook as he made this move. He had been under pressure to meet time control on his 40th move. Moreover, this was his fourth game of chess in five days. None had been easy games, and he was showing the strain of the battle.

45 … Rf8 46 Bg6+ Kh8 47 Qc7 Qd4 48 Kh2 Ra8 49 Bh5 Qf6 50 Bg6 Rg8 Drawn by agreement.



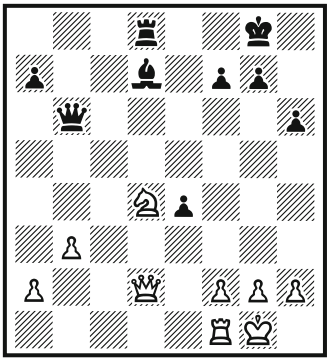
Position after 50 … Rg8,
Drawn by agreement.

At the press conference following the game, Kasparov said he was "quite happy that I escaped so narrowly in the end." He felt he spent "too much time on the opening," and that led to time control problems. He thought he had a "serious advantage" in this game, but "to transfer it into something concrete, it was not easy." After four games the match stood tied at two points apiece. Who would have thought that before the match began.

ACM Chess Challenge
Game 5, February 16, 1996
Deep Blue (W) versus Kasparov (B)
Four Knights Game: Scotch Variation. Accepted (C47)

1 e4 e5 2 Nf3 Nf6 3 Nc3 Nc6 4 d4 exd4 5 Nxd4 Bb4 6 Nxc6 bxc6 7 Bd3 d5 8 exd5 cxd5 9 O-O O-O 10 Bg5 c6 11 Qf3 Be7 12 Rae1 Re8 13 Ne2 h6 14 Bf4 Bd6 15 Nd4 Bg4 16 Qg3 Bxf4 17 Qxf4 Qb6 18 c4 Bd7 19 cxd5 cxd5 20 Rxe8+ Rxe8 21 Qd2 Ne4

Khodarkovsky and Shamkovich felt "the position was even" at this point.



Position after 23 … Rd8.

22 Bxe4 dxe4 23 b3 Rd8

Kasparov offered a draw here, but the Deep Blue team debated so long whether to accept or decline that Deep Blue made its move 24 Qc3, nullifying the offer. Deep Blue, though believing it had a small advantage at this point, was out of ideas on how to proceed, carrying out a dance of its queen to c3 then e3 then back to c3 over the next four moves, going from an opportunity to draw the game to a lost position. It couldn't see any tactical opportunities in this tame position. Kasparov's bishop was far stronger than Deep Blue's awkwardly placed knight.

After four and two-thirds games, the match stood even! Kasparov must have been counting on having White in the final game and winning it and the match, or, at worst, drawing the final game and having to be satisfied with a tied match. In either case, there would likely be another man–machine battle with IBM in a year or so. Drawing here would save energy for what would be the game of all games.

24 Qc3 f5 25 Rd1 Be6 26 Qe3 Bf7 27 Qc3 f4

While Kasparov had offered a draw several moves ago, he declined to opt for it here with 27 … Be6, gradually tightening the noose over the next 20 moves.

28 Rd2 Qf6 29 g3 Rd5 30 a3 Kh7 31 Kg2 Qe5

Seirawan felt "Now it is over … ."

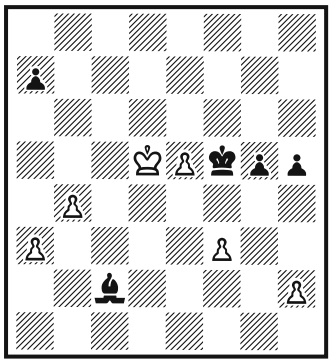
32 f3 e3 33 Rd3 e2 34 gxf4 e1=Q 35 fxe5 Qxc3 36 Rxc3 Rxd4 37 b4 Bc4 38 Kf2 g5 39 Re3 Be6 40 Rc3 Bc4 41 Re3 Rd2+

Now, it was Deep Blue who sought a draw through repetition of position – wishful thinking! Kasparov showed he

was not interested as victory was only a few moves away.

42 Ke1 Rd3 43 Kf2 Kg6 44 Rxd3 Bxd3 45 Ke3 Bc2 46 Kd4 Kf5 47 Kd5 h5 White resigns.

At the press conference following the game, Kasparov observed that "for the first time, we are seeing something intelligent."

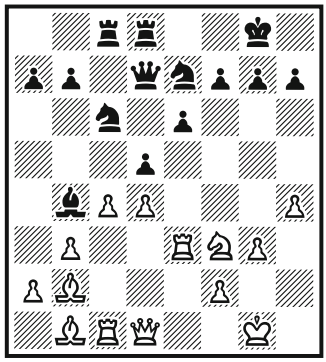


Position after 47 … h5, White resigns.

ACM Chess Challenge
Game 6, February 17, 1996
Kasparov (W) versus Deep Blue (B)
Semi-Slav Defense: Quiet variation (D30)

Kasparov could not lose the match now. But this final game brought out a number of weaknesses in Deep Blue's scoring function. They made Kasparov's life a bit easier, and he essentially coasted to victory, gradually putting a stranglehold on his opponent. He kept the position closed throughout the game, avoiding complicated tactical situations.

1 Nf3 d5 2 d4 c6 3 c4 e6 4 Nbd2 Nf6 5 e3 c5 6 b3 Nc6 7 Bb2 cxd4 8 exd4 Be7 9 Rc1 O-O 10 Bd3 Bd7 11 O-O Nh5 12 Re1 Nf4 13 Bb1 Bd6 14 g3 Ng6 15 Ne5 Rc8 16 Nxd7 Qxd7 17 Nf3 Bb4 18 Re3 Rfd8 19 h4 Nge7



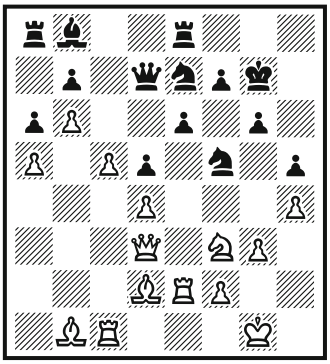
Position after 19 … Nge7.

Kasparov vividly illustrated his respect for Deep Blue's tactical play here when he was given the opportunity to play

20 Bxh7+, giving him "a strong attack" on Black's king, according to Khodarkovsky and Shamkovich, but opening up the position to Deep Blue's strength.

Hsu evidently entered erroneous information into the computer here, and Deep Blue took another dive, its last of the match. It was back on its feet in a couple of minutes. It was not Deep Blue alone that ran into problems; the computer operators added their share to frustrate Kasparov as well. This one, however, had little effect as Kasparov had matters well under control.

20 a3 Ba5 21 b4 Bc7 22 c5 Re8 23 Qd3 g6 24 Re2 Nf5 25 Bc3 h5 26 b5 Nce7 27 Bd2 Kg7 28 a4 Ra8 29 a5 a6 30 b6 Bb8



Position after 30 … Bb8.

"Losing," said Seirawan. "Desperate," said Keene and Jacobs.

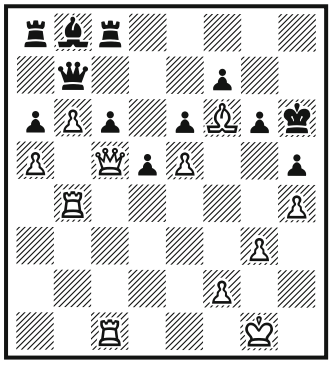
31 Bc2 Nc6 32 Ba4

Seirawan observed that "Now the game is over."

32 … Re7 33 Bc3 Ne5 34 dxe5 Qxa4 35 Nd4 Nxd4 36 Qxd4 Qd7 37 Bd2

Khodarkovsky and Shamkovich suggested that "Black should have resigned, as it is playing practically without a rook."

37 … Re8 38 Bg5 Rc8 39 Bf6+ Kh7 40 c6 bxc6 41 Qc5 Kh6 42 Rb2 Qb7 43 Rb4 Black resigns.



Position after 43 Rb4, Black resigns.