2 Advances in Man-Machine Play

D. Kopec

2.1 Introduction

In 1968, *Mac Hack Six* (Greenblatt, Eastlake and Crocker 1967) became the first program to compete at the level of the average U.S. tournament player. At that time few people took the entry of programs into tournaments seriously. The programs were viewed primarily as a curiosity and, perhaps, a slight bother. Inevitably, the terminals on which the computer's moves were relayed to the tournament site were noisy, disturbing the other participants. Hence special arrangements had to be made for computer programs in tournaments such as separate rooms or tables. Fortunately, with the exception of a few vocal opponents, most people felt that the machines provided an interesting addition or sideshow to a tournament. Albeit relatively weak, computers scored a few points against humans in chess tournaments in the early 1970s. This started to cause some bad feelings from humans who lost points to the computers, feeling that they had been adversely affected by the participation of the programs.

The fascination with trying to develop a computer program to play strong chess has stemmed from the belief that if you can get a program to play chess well, then there may be no boundary separating man's creative abilities from those of machines (Leithauser 1987). Thus chess playing by computer was an early preoccupation of researchers in artificial intelligence. However two schools of thought have evolved within the artificial intelligence community, both driving research and progress in their own ways. One is performance (or technology) driven (see Chapter 16 *Perspectives on Falling from Grace*) and the other is problem (or competence) driven (Lehnert 1988; Rich 1983). Computer chess has for many years been successful in terms of performance with regard to the Elo rating system (Elo 1978). By and large Elo ratings have been a reliable way to measure the chess strength of both humans and programs. This has been both fortunate and unfortunate for computer chess. Since 1975, when *Chess 4.7* became the first program to break the expert (2000) level, improvements in playing strength appear to be linear with increases in the depth of tree searches, as Figure 2.1 shows. This increase in strength with search depth does slow down as ratings rise over 2200, since the rating system becomes logarithmic from that point on[1]. It is regrettable that there is little to say about how a top

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[1] Throughout the chapter, United States Chess Federation (USCF) ratings are used. When International (FIDE) ratings are used, they are indicated appropriately. USCF ratings are roughly 100 points higher than the equivalent FIDE rating.

program decides on a move beyond the power of the alpha-beta minimax algorithm (Knuth and Moore 1975). Yes, the programs do know something about king safety, pawn structure, piece activity (mobility), center control and absolute values for pieces and pawns. Some programs know more about certain chess concepts than others, depending on the chess strength of the programmers and chess consultants. Various refined techniques are employed to make the search more efficient including parallel algorithms (Marsland and Campbell 1982) and singular extensions (Anantharaman, Campbell and Hsu 1988) but, due to the competitive priorities of most programs, little is revealed about how a program finally selects one move over another. This largely explains why computer chess has appeared to advance primarily as a competitive sport (performance driven) rather than as a science (problem driven).
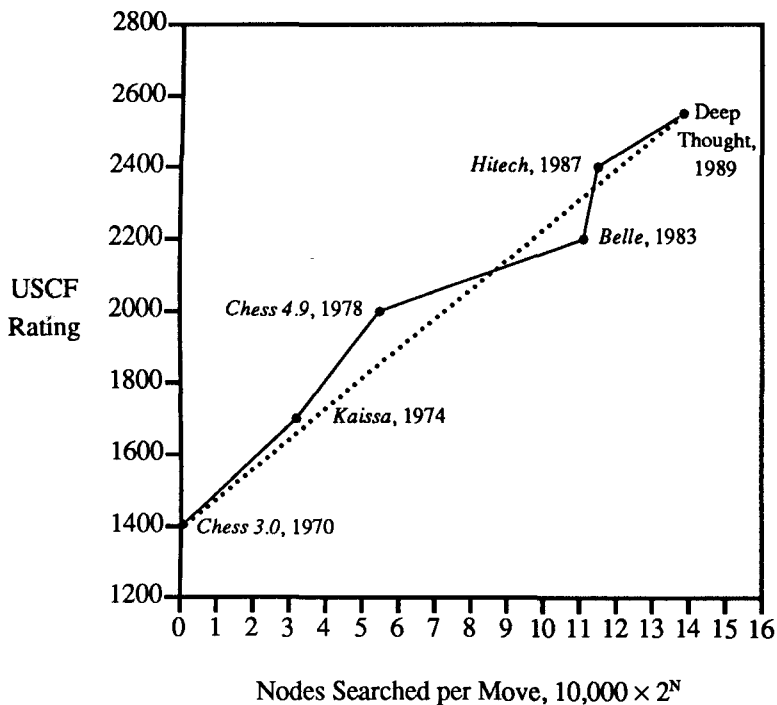

Figure 2.1: Increasing program performance (Newborn 1989).

This chapter reviews the major events in man-machine chess play. The emphasis will be on recent progress in the field. A detailed history of the early years of computer chess is provided by Frey (1977) and Newborn (1975).

2.2 Early Progress

The 1970s were highlighted by the reign of the *Chess 3.X* and *Chess 4.X* series of programs from Northwestern University, authored by David Slate, Larry Atkin and Keith Gorlen. Their programs won every ACM North American Computer Chess Championship in that decade except in 1974 (*Ribbit*) and 1978 (*Belle*). In 1978, *Chess 4.7* won the The Twin Cities Open in Minnesota with a perfect 5-0 score, raising its rating to an unprecedented 2040. The program was performing as well as a competent expert and was scoring regularly against human experts. The successes of *Chess 4.7*, its predecessors and successors, are well documented by Frey (1977).

The dominant human player in the United States in the 1970s was Grandmaster Walter Browne. In 1977, Browne had won the U.S. Invitational Championship three years in a row and was rated 2560. At this time he was full of energy and brimming with the success of a nationwide tour involving a series of 17 exhibitions, where he had only lost two games and drawn six. So it was only natural that *Chess 4.6* should be one of Browne's opponents in a 44-board simultaneous exhibition in Minneapolis. Michie (1983) contains a fully annotated description of that game. However, the game is so exemplary of the state of the art of computer chess play in 1978 that it is worth giving the score again here with light notes. *Chess 4.6* was running on the fast Cyber 176 computer, seeing over 2.5 million positions in three minutes of think time. Browne took his computer opponent seriously in this game, but it should not be overlooked that the handicap of playing 44 opponents did much to equalize the strength of the opponents. *Chess 4.6* does exhibit a few of the famed "computer moves," such as an inexplicable move (often with the king) in a perfectly normal position. These mistakes are probably due to the computer's inability to find another move which it believes could improve its position. Although at this time computers were reputed to be weak endgame players, *Chess 4.6* weathers the technical difficulties of the endgame through its tactical abilities, disguising its lack of special-purpose knowledge.

White: GM Walter Browne (2560 FIDE) – Black: *Chess 4.6*/Cyber 176 (2070)
Simultaneous Exhibition
1. d4 Nf6 2. c4 c5 3. Nf3 cxd4 4. Nxd4 e5 5. Nb5 Bc5 6. N1c3 *This variation was popular at the time. However, Chess 4.6 is now out of its book.* **O-O 7. e3 d6 8. Be2 a6 9. Na3 Nc6 10. Nc2 Bf5 11. O-O Qd7 12. b3 Kh8 13. Bd2 Rg8 14. Na4 Ba7 15. Bc3 h6** *Browne always tries to find active continuations and at the same time is trying to trade off the passive knight on c2. Browne, as a Grandmaster, always tries to find the "correct" move in a position. If he had a better understanding of the tendencies of computer play, he might have made a waiting move, expecting Chess 4.6 to weaken itself with g5.* **16. Rc1 Rad8 17. Nb4 Nxb4 18. Bxb4 Qc7 19. Qe1 Bc5 20. Bf3?! Bd3 21. Bxc5 dxc5 22. Be2 Bf5 23. f3 e4 24. f4 Bd7 25. Nc3 Qa5 26. Qh4 Bc6 27. Rc2 b5 28. g4 b4 29. Nd1 Rd6!** *Demonstrating the soundness of black's last three moves.* **30. Nf2 Rgd8 31. Rd1 Rxd1+ 32. Bxd1 Rd6!** *At this point Chess 4.6 had used 2 hours*

and 44 minutes of computation time to Browne's 22 minutes! **33. Qg3 Qd8** *Now Chess 4.6 correctly predicts Browne's next 11 moves.* **34. Rc1 Rd2 35. g5 hxg5 36. fxg5 Nh7 37. g6 fxg6 38. Qxg6 Qh4!** *Now white is in great difficulty. Browne spent a long time thinking, for the endgame after 39. Qg3 Qxg3 40. hxg3 would be hopeless for white.* **39. Qf5 Bd7** *Leading to a won ending, but even stronger was Ng5!* **40. Qf4 Qxf4 41. exf4 e3 42. Ne4 e2 43. Bxe2 Rxe2 44. Nxc5 Bc8** *Lacking special-purpose endgame knowledge, Chess 4.6 gets into a little trouble. More aggressive is Bh3!? with ideas of mate.* **45. Rd1 Re8 46. a3?! bxa3 47.Ra1 g5?!** *A dubious move because it offers to trade more pawns.* **48. fxg5 Re5 49. b4?!** *49. Nxa6 Bxa6 50. Rxa3 would lead to the ending rook, bishop and knight versus rook which is a theoretical win. However, the white queen-side pawns might cause problems and it is questionable whether Chess 4.6 would have the technique required in any case.* **a5 !? 50. Nd3 Rxg5+ 51. Kf2 axb4 52. Nxb4 Ra5 53. Ke3 Be6 54. Kd4 Ng5!** *This piece ends up playing a vital role.* **55. Nc2** *Browne offered a draw which the Northwestern camp turned down in the "interests of science."* **a2 56. Nb4 Ra4! 57. Kc5 Ne4+! 58. Kb5 Bd7+! 59. Nc6 Nc3+! 60. Kc5 Bxc6 61. Kxc6 Rxc4+ 62. Kd6 Rd4+ 63. Ke5 Rd1 0-1.**

2.3 The Power of Brute Force

If there is one lasting scientific impression left by chess programs, it is the power of brute force. Brute-force tree searching methods have already accomplished a lot more in terms of chess playing strength than many well-educated writers would have opined (Hearst 1983; Michie 1983; Dreyfus and Dreyfus 1986). When the Northwestern Chess series reached the expert level in the late 1970s the skeptics were surprised. To many, it was as much of a revelation as a disappointment to realize that the beauty in a forcing tactical sequence of moves (a combination) could be reduced to efficient tree searching with the alpha-beta algorithm. That is, the creative element in chess can be matched by a computer's computations (Leithauser 1987). The accomplishments of brute-force methods served to make us aware of how humans play strong chess, of the importance of coming to grips with the hierarchical, heuristic, probabilistic decision making which makes chess so appealing to us, and of the clear trade-offs between knowledge and search. As the number of nodes searched by the best programs increased, so did the number of surprises which resulted from exhaustive brute-force searches of 5-ply and beyond.

A famous example occurred at the 2nd World Computer Chess Championship in 1977 when, in Figure 2.2, *Kaissa* (black) against *Duchess* (white) played 34 ... Re8 (!) instead of the "normal" 34 ... Kg7. This left an audience of 500, including a former World Champion, quite perplexed for a few minutes. What they had all overlooked was easily found by *Kaissa*'s brute-force search: 34. ... Kg7 is met by 35. Qf8+!! Kxf8 36. Bh6+ Bg7 37. Rc8+ and mate! Hence 34. ... Re8 was black's best chance for survival (Michie 1983).
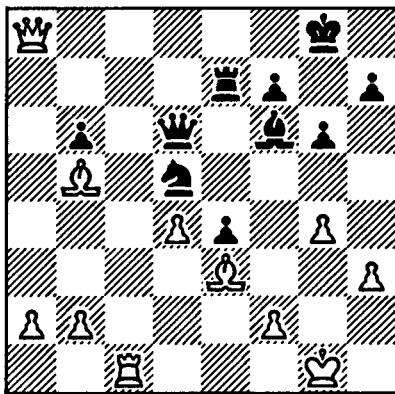
Figure 2.2: *Duchess – Kaissa* (black to move).

2.4 The Contributions of Endgame Databases

In 1977, at the 2nd World Computer Chess Championship, Ken Thompson came armed with a surprising weapon: his database for king and queen versus king and rook (KQKR). By having a search back up terminal positions with known values, Thompson was able to exhaustively enumerate all possible positions for any 4-men endgame. His database recorded all these positions and was able to determine whether any position for white or black was a win, draw or loss. If the position was won, the database provided the number of moves required to win given optimal play by both sides.

For the KQKR endgame, chess books allude to the technical difficulties involved in winning with the queen against a good defender of the rook's side. For example, Fine (1941) comments on a position that "This is a win, but from the general position the process is rather complicated." The stronger side tries to force a zugzwang position (one in which a side must move against its will relinquishing material or ground) whereby the rook must move away from the vicinity of its king. The only advice generally given to the defender is to "keep the king and rook together," avoiding any skewers or forks which might pick up the rook. Understandably, International Masters Hans Berliner and Lawrence Day were quite perturbed when, after about 20 minutes or so of trying with the queen's side, they were unable to win against Thompson's database. Furthermore, the database employed defensive techniques which were inexplicable. In particular, the program disregarded conventional wisdom and separated its king and rook, almost seeming to defy the human masters to find a forcing tactical sequence, which of course did not exist. This has been referred to by Donald Michie as "The Strange Case of Thompson's Table" (Michie 1983).

Ken Thompson was so convinced of the difficulties involved in winning KQ versus KR (the longest wins require 31 optimal moves) that he sought to test it against the strongest players. Grandmaster Robert Byrne declined, but Grandmaster Walter Browne thrust himself into the thick of things by agreeing to a bet for $100 to win with the queen's side against the database. Browne was given a time limit of 2.5 hours to play up to 50 moves, the maximum number of moves allowed by the laws of chess for this ending. However, challenged with a position that required 31 moves to win, Browne was unable to succeed against the database in the required number of moves, thereby losing the bet.

Browne's fighting spirit and ego were challenged by this experience. He carefully studied the computer's play and learned much about the KQKR endgame from his experience against it. A few weeks later he played a rematch from another 31 move position with the chance to regain his $100. This time he won, but exactly on move 50! (Actually Browne was allowed 5 extra moves in the rematch.) Play proceeds from Figure 2.3.
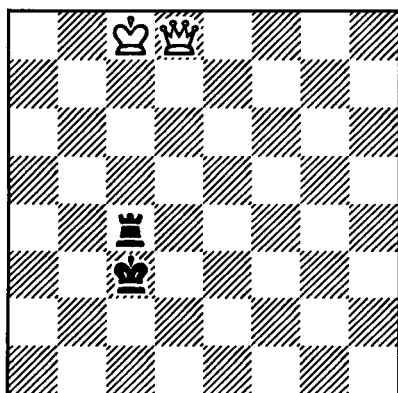

Figure 2.3: Walter Browne – KQKR database (white to move).

White: GM Walter Browne – Black: KQKR database
Exhibition

The number of moves to mate or win of the rook is indicated in parentheses. **1. Kb7 Rb4+ 2. Kc6 Rc4+ 3. Kb5 Rb4+ 4. Ka5 Re4 5. Qd6 Rd4 6.Qe5 Kd3 7. Kb5 Re4** (25) **8. Qf6 Ke3** (24) **9. Kc5 Rf4** (23) **10. Qg6 Ra4** (22) **11. Qg3+ Ke2** (21) **12. Qc3 Rf4** (20) **13. Kd5 Rh4** (19) **14. Qc2+ Ke3** (18) **15. Qd1 Kf2** (17) *Up to here Browne has played accurately and is making steady progress.* **16. Qd2+ Kf3** (17) **17. Qe1 Rg4** (19) **18. Qd1+ Kf4** (18) **19. Qe2 Rg5+** (20) **20. Kd4 Rf5** (19) **21. Qe3+ Kg4** (18) *Browne errs on moves 16, 17 and 19. Ken Thompson has found that lower rated players have trouble from a distance of 14 to 17 moves from the win. Usually the white king is trying to cross the "barrier" on the third or (as in this case) fourth rank. The books don't help here either.*

22. Ke4 Rf7 (17) **23. Qg1+ Kh5** (16) **24. Qg3 Rf8** (15) **25. Ke5 Rf7 26. Ke6 Rf8** (14) **27. Qa3 Rf4** (15) **28. Qh3+ Kg5** (16) **29. Qg3+ Rg4** (15) **30. Qe5+ Kh4 31. Qh2+ Kg5 32. Ke5 Kg6** (14) **33. Qh8 Rg5+** (14) **34. Ke6 Rg4** (14) *Browne has been stuck since move 26. He can only lose two moves now.* **35. Qg8+ Kh5 36. Qh7+ Kg5 37. Ke5 Rg3 38. Qg7+ Kh4 39. Qh6+ Kg4** (9) *Browne is now making steady progress but is still on a tightrope.* **40. Ke4 Rg2 41. Qg6+ Kh3 42. Qh5+ Kg3 43. Ke3 Rg1 44. Qg5+ Kh2 45. Qh4+ Kg2 46. Ke2 Ra1** (4) *Now 47. Qg5+ 48. Qh6+ 49. Qg7+ and 50. Qxa1 wins. Browne finds another way.* **47. Qe4+ Kh3 48. Qh7+ Kg3 49. Qg7+ Kh3 50. Qxa1 1-0.** *Browne just makes it within the normal rules and wins back his money.*

Despite the apparent tension, a little known fact is that the last 24 moves went exactly according to Browne's home analysis! Even though he thoroughly studied this ending for this re-match, he still made several mistakes, attesting to the difficulty of the endgame for human player.

As an addendum to this story, in 1895 the book *Analysis of the Chess Ending King and Queen Against King and Rook* authored by "Euclid" appeared. The author did the same kind of analysis as done by Thompson's program and arrived at the same conclusions: the longest win takes 31 moves (Sternberg, Conway and Larkins 1979). An insightful comment by the author was that:

> The view commonly held and expressed that there could be no practical difficulty in winning with queen against a rook was ... discarded as illusory. (Euclid 1895, pp. iv-v)

Clearly Euclid's book has been overlooked by both the chess and computer-chess worlds!

Another four piece endgame for which there already existed databases in the 1970s was king and rook versus king and knight (KRKN). Ströhlein (1970) developed such a database for his Ph.D. thesis. Between 1976 and 1979, considerable investigation was done into this endgame at the Machine Intelligence Research Unit, University of Edinburgh. Experiments with humans demonstrated that it requires a master strength player to hold a draw with the weak side (knight) and that it also requires a master level player to win with the strong side (rook) (Kopec and Niblett 1980). This research, combined with the KRKN database, helped uncover a number of errors in Fine's (1941) *Basic Chess Endings*. Many interesting KRKN positions required counter-intuitive separating moves between the weak side's king and knight to hold a draw. This was contrary to the standard advice from endgame texts to keep the weak side's king and knight as close together as possible.

More recently Thompson (1986) has extended this work to include all 5-men endings. This work has had great consequences for the game of chess as a number of special cases requiring more than 50 moves to win have been identified as a result of the database. These include: KBBKN, 66 moves; KQKNN, 63 moves; KQKBB, 71 moves; and KRBKR 59 moves. Thompson also made significant contributions to the knowledge about the endgame KQPKQ determining that in many cases more than 50 moves are required with best play. The few practical tests that have been done with the 5-men endings

indicate that the order of magnitude increase in computational complexity in going from 4 to 5 men, comprises a jump in complexity which passes the threshold of human scrutability. In these cases, accounting for symmetries, rotations and reflections, the database size increases from roughly 3 million possible configurations (for 4-men endings) to over 100 million possible configurations (for 5-men endings). Clearly this is not an area which humans can learn easily and efforts to decrypt the databases into recognizable goal patterns promise no guarantee of success (Michie and Bratko 1987). Roycroft's difficulties in trying to make progress with the KBBKN database give further evidence for this. The problem is that these databases are the supreme example of the brute-force approach; there are no explanations of how a result is obtained. The databases only provide moves and the length of the solutions, but no insight into how a human might break the endgames into recognizable patterns to ease the difficulty of solving them.

One 5-piece ending which could use some decoding is KRBKR, since it occurs relatively often at the international level (Kopec, Libby and Cook 1988). A few basic winning and drawing positions have been known for several centuries, but little has been done to relate the database's moves to these known positions. The longest winning sequence is 59 moves, implying that some winning positions cannot be won because of the 50 move limit[2]. The world chess governing organization (FIDE) has reacted to these findings for optimal move sequences in peculiar ways. First the number of moves in which the defender could suffer in KRBKR was increased to 100, then decreased to 75, and now its not clear what FIDE intends to do. Surveying a handful of international games, Thompson was able to discover many examples of KRBKR where IM's and GM's had gone wrong. An interesting data point is the game *Deep Thought* versus Alex Fishbein from the 1988 Software Toolworks Open. *Deep Thought* did not have the KRBKR database yet scored the full point in this ending. However, at times being able to lookahead 10 or more moves, it may hardly have needed the database.

2.5 Expert Chess Programs

David Levy made a reputation for himself by betting on his chess skills against any machine. In this way he encouraged research and progress in computer chess. His famous 1968 bet for £1250 (then $2500) against four computer science professors was that no program could beat him in a six game match by August, 1978. In 1978, when Levy defeated his last challenger, *Chess 4.7*, he was simply too strong for the program. It is clear that he could beat it almost at will, although the final score of 3.5-1.5 somewhat belied this. In 1977 he easily

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[2] The endgames KNNKP and KRP(a2)KBP(a3) also exceed the 50 move limit. More details on the KNNKP endgame can be found in Chapter 11 *Verifying and Codifying Strategies in a Chess Endgame*.

defeated the Russian program *Kaissa*. Then, just three weeks before leaving England for his match against *Chess 4.7*, Levy was challenged by Richard Greenblatt. His program, *Mac Hack Six*, had been supplemented with a hardware component called *CHEOPS*, which could analyze moves at the rate of 150,000 positions per second. A two game match was agreed on. Levy won the first game thereby rendering the second game unnecessary.

The first game of the match against *Chess 4.7* produced two surprises: the program's ability to find a piece sacrifice for two pawns and the outcome of the game, a draw. It was the first time that a program had drawn an international master under tournament conditions. However, Levy provoked his troubles with some passive opening play. This approach had proven successful in the past as computers never sacrificed against Levy and tended to weaken their position and beat themselves. *Chess 4.7* obtained a completely won game after the sacrifice but lost its way in the ensuing ending. Analysis of this famous game can be found in Levy and Newborn (1982).

The second game was more typical of the successful Levy formula for defeating chess programs: get them out of book early and into positions which depend more on understanding than tactics, and then exploit the weaknesses they have left behind.

White: *Chess 4.7* (=2100) – Black: IM David Levy (2300 FIDE)
1978 Match

1. Nc3 c5 2. e4 Nc6 3. f4 a6 *To take the program out of book.* **4. Nf3 g6 5. d4 cxd4 6. Nxd4 Bg7 7. Be3 d6 8. Nxc6?** *A typical error which programs have been making on the white side of the Sicilian Defense for many years. White relinquishes his well placed knight and strengthens black's center at the same time.* **bxc6 9. Be2 Rb8 10. Qc1 Qa5** *Black is already somewhat better.* **11. Bd2 Qb6 12. Na4 Qa7 13. Nc3 Bd4 14. Nd1 Nf6 15. c3 Bb6 16. Qc2 Ng4 17. Qa4 O-O 18. Bxg4 Bxg4 19. Qxc6** *Naturally the program goes after a pawn, but black has plenty of compensation in the resulting awkward position of the white king.* **Bxd1 20. Kxd1 Be3!** *See* Figure 2.4. **21. b3 Bxd2 22. Kxd2 Rbc8 23. Qa4 Qf2+ 24. Kd3 Qxg2** *Black now has a completely won game.* **25. Qd4 Qf3+ 26. Kc2 Qe2+ 27. Kc1 e5 28. fxe5 dxe5 29. Qxe5 Rfe8 30. Qg3 Rxe4 31. Qh3 Rd8 32. Qf1 Qd2+ 33. Kb1 Re2 0-1** *on move 54. It is worth adding that in the following years, computer-chess programmers have completely avoided playing the white side of open variations of the Sicilian Defense.*

Levy also won games 3 and 5, but experimented in game 4, allowing the program to emerge victorious.

In the late 1970s there were several instances of computer programs defeating strong players, including Grandmasters, at blitz chess. Not surprisingly, since this form of chess is primarily based on a quick and accurate tactical assessment, computers perform better than they do in slow tournament chess. Nevertheless, the differences in overall chess understanding, especially in the endgame, rendered top humans far superior to the top programs even at blitz chess.
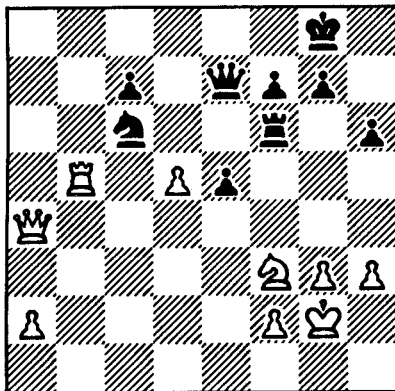
Figure 2.5: Steve Stoyko – *Belle* (black to move).

Although both sides made errors, this was a legitimate draw.

The source for the *Belle* game scores presented above is Welsh and Baczynskyj (1985) and some of the notes are based on Baczynskyj's comments.

To provide a balanced view of matters, a game from the 1981 Fredkin Challenge Match is presented below. *Belle*'s opponent, Carl Storey, won both games of a two game match for which he received $2500.

White: *Belle* ($\approx$2100) – Black: Carl Storey (2206)
1981 Fredkin Challenge Match

1. e4 g6 2. d4 Bg7 3. Nf3 d6 4. Nc3 Nf6 5. Be2 O-O 6. O-O c6 7. a4 Qc7 8. h3 e5 9. Re1 Nbd7 10. Bf1 Re8 11. d5? *Not knowing any better, Belle plays this uncalled for move. It soon drifts into an endgame with few prospects.* **a6 12. Bg5 h6 13. Be3 cxd5 14. Nxd5 Nxd5 15. Qxd5 Nf6 16. Qc4 Qxc4 17. Bxc4 Nxe4 18. Bxh6 Bxh6 19. Rxe4 Bf5 20. Rh4 Bg7 21. Bd5 Re7 22. c3** *Belle does not realize that its rook is misplaced on h4. Rb4 was necessary and good.* **e4 23. Nd4 Bxd4 24. cxd4 Kg7 25. Rf4 Rae8 26. b4 Bc8 27. Ra3 f5** *The rook is trapped!* **28. Rg3 e3** *Better is Kf6.* **29. fxe3 Rxe3 30. Kh2 Rxg3 31. Kxg3 Re1 32. Bb3** *If 32. Rf3, then Rc1 33. Re3 Kf6 and black is still better.* **b6 33. Rf3 Re4 34. Rd3** *Rc3 is not played because of Rxd4!* **Bb7 35. Bd1 Re1 36. Kf2 Re7 37. Bf3?** *Not knowing much about rook endings, Belle drifts into a lost one. Better is Rc3.* **Bxf3 38. Kxf3 Rc7 39. Rb3 Rc4 40. a5 b5 41. Ke3 g5 42. Kd3 Kf6 43. Rc3 Rxc3+ 44. Kxc3 f4 45. Kd3 Kf5 46. d5 Ke5 47. Ke2 Kxd5 0-1.**

2.7 Cray Blitz versus David Levy

In 1983, *Cray Blitz* won the 4th World Computer Chess Championship, scoring 4.5 out of 5. The program ran on a Cray X-MP, world's fastest computer, and searched over 30 million positions in 3 minutes of think time. In 1984, the *Cray Blitz* team (Robert Hyatt, Albert Gower and Harry Nelson) challenged David Levy to a match during the 4th Advances in Computer Chess Conference.

This match was an indirect consequence of Levy's 1968 bet. The challenge was renewed with the support of OMNI Magazine, offering $5,000 (including $1,000 from Levy) to the first program to defeat David Levy at any time. For the match, opening and middlegame strategies were designed to befuddle the program which could search to 8 ply and beyond. Although he has never been rated more than 2375, David Levy's experience in playing against chess programs gave him a decided advantage.

As it turned out, *Cray Blitz* suffered from both communication and hardware problems causing it to fall into severe time trouble. Levy played surprisingly well after a 5 year layoff from chess, capitalizing on his "do nothing but do it well" strategy to score a 4-0 shutout. The complete details of the match and the games are well described by Levy (1986a) and by Welsh and Baczynskyj (1985). Levy and I, acting as his second, did extensive match preparation and planning. A position from the first game of the match is indicative of the success Levy had with this preparation. Levy chooses an opening which, although objectively unfavorable, proves difficult for *Cray Blitz*. White is drawn into a position with a blocked center where positional themes in the sub-center and wings become critical. *Cray Blitz* makes a number of serious strategical errors, and the position in Figure 2.6 arises:
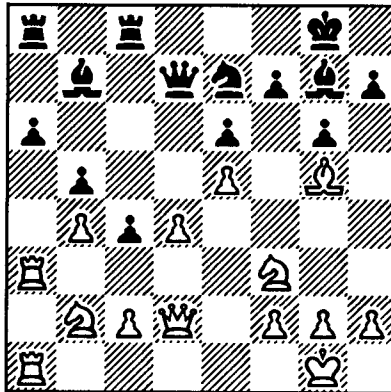

Figure 2.6: *Cray Blitz* – IM David Levy (white to move).

20. c3? *White's position has been steadily declining and the threat was simply 20. ... c3. Best for white is probably Nd1. Instead, after the text the white knight on b2 never gets back into play and white's position literally becomes split into two halves.* **Bxf3!** *Levy initiates an ideal pawn sacrifice. White's king-side pawn structure is permanently shattered, black obtains long-term positional compensation and an initiative which the program finds difficult to evaluate properly.* **21. gxf3 Nf5!** *The P on a6 could not be defended anyway, and black's king-side initiative is about to begin.* **22. Rxa6 Rxa6 23. Rxa6 Qb7 24. Ra5 Qxf3 25. Rxb5?** *This is the culmination of the combination which began with 20. ... Bxf3!!. Levy knew that Cray Blitz would continue its greedy ways.* **h6 26. Bf4 Qh3 27. Bg3 h5 28. Rc5 Ra8 29. Qc1?** *Ra5 was the only defense.* **h4 30. Bf4?** *This was white's last chance to put up resistance by Qf1, although it gives up a piece.* **Qf3! 31. h3 Qxh3 32. Rxc4? Qf3 33. Bh2 h3 34. Qf1 Ra1! 35. Nd1 Rxd1 36. Rc8+ Kh7 37. Rh8+ Kxh8 38. Qxd1 Qg2 mate 0-1.**

2.8 The Reign of Hitech

In 1984 it was hard to foresee that *Cray Blitz* would soon be overtaken by another program. At the 4th Advances in Computer Chess Conference in London, Hans Berliner presented a paper on his "Five Year Plan for Computer Chess at Carnegie Mellon University" (Berliner 1986). The approach presented seemed a sensible hybrid of brute-force search and knowledge-based approaches. He recognized the need for a powerful and deep exhaustive search, but also advocated the development of a large incremental store of pattern-based chess knowledge. Essentially, he had a clear plan for what had to be done, some powerful methods for accomplishing his goals, a team of people which he could rely on and work with (Carl Ebeling, Gordon Goetsch, Andy Palay, Murray Campbell and Larry Slomer), and the support of an excellent university (Carnegie Mellon) behind it. However, many remained skeptical since Berliner, although having initiated his research into computer chess around 1970, had never developed a strong program and even seemed to discontinue his work in the area several times. His earlier software program, *Patsoc,* did not perform particularly well at the 4th World Computer Chess Championship in New York, 1983.

Any remaining skepticism was completely dissolved when *Hitech* won the 1985 North American Computer Chess Championship with a perfect 4-0 score. Its rating quickly rose well into the master class. Between 1985 and mid-1988, *Hitech* was clearly the world's best program and in 1988 became the first program to achieve a senior master (2400) rating. *Hitech* has won the Pennsylvania State Championship three years in a row (1987, 1988 and 1989) and is ranked amongst the top 150 players in the United States at 2413. More details about *Hitech* and its performance can be found in Chapter 6 *Hitech.*

Since *Hitech* matured in 1987, with debugged software and more pattern recognition capabilities, it has achieved a large plus score against masters. It is generally regarded that *Hitech* plays the most human-like chess of the strong programs. The following game represents the highest rated player that *Hitech* has scored against and was quite an upset at the time. The play is wild with chances for both sides and illustrates what resourceful defenders the top programs can be.

<center>White: IM Michael Rohde (2602) – Black: *Hitech* (≈2350)</center>
<center>1986 World Open</center>

1. d4 Nf6 2. Nf3 g6 3. c4 Bg7 4. Nc3 d5 5. Qb3 dxc4 6. Qxc4 O-O 7. e4 Bg4 8. Be3 Nfd7 9. Qb3 Nb6 10. Rd1 Nc6 11. d5 Ne5 12. Be2 Nxf3+ 13. gxf3 Bh5 14. Rg1 *White has more space from his big center but black has no weaknesses.* **Qd7 15. Rg3 f5!** *An active move which creates weaknesses but also emphasizes some of the weaknesses in white's position.* **16. Bd4 Bxd4 17. Rxd4 Kh8 18. Rd1** *It's not so easy to suggest how white should continue because 18. e5!? f4 followed by 19. ... Rf5 may prove the white center pawns weak. Black starts to get some counterplay now.* **f4 19. Rg1 Qh3** *This looks offside, but black has just adequate resources for such a venture.* **20. Nb5 Qxh2 21. Rf1 c6 22. Qc3+ Rf6 23. Nc7 Raf8 24. Ne6 Ra8 25. d6!** *One senses that Rohde now feels he can win at will and he becomes just a little over-confident.* **Kg8 26. d7** *This should win, but perhaps 26. Qb3 first might be even stronger, virtually forcing exd6 27. Rxd6 etc.* **Nxd7 27. Rxd7 Rxe6 28. Bc4 Kf7 29. Ke2!?** *Again one gets the feeling that white thinks the game is over. Qe5 looks more effective, although after Qh3 30. Bxe6+ Qxe6 31. Qxe6+ Kxe6 32. Rxb7 Bxf3 black has plenty of play in the ending. Instead white could play 29. Rxb7.* **Qh3 30. Rxb7 Rd8** *Hitech has definite counterplay for the exchange, stemming from the bishop on h5.* **31. Rb3 Rd5!!** *An excellent defensive resource as the white king now becomes more of a target than its black counterpart.* **32. Ke1 Qg2 33. Bxd5 cxd5 34. Qh8 Rxe4+** *Forcing a draw which white could force in any case.* **35. fxe4 Qxe4+ 36. Kd2 Qe2+ 37. Kc3 Qc4+ 38. Kd2 ½-½.**

The play by *Hitech* in winning the next position is a wonderful technical and creative achievement and decided the 1988 Pennsylvania State Championship in *Hitech*'s favor.

<center>White: IM Edward Formanek (2461) – Black: *Hitech* (≈2390)</center>
<center>1988 Pennsylvania State Championship</center>

In Figure 2.7 *Black is up a solid pawn but it is not an easy position to win because the white knight is powerfully posted on d4 and the bishop is bad on b7.* **34. Rb1 Rc7 35. Rb6 Kf7 36. Re6 Qg5 37. Qg3 Rc2+!** *Forcing further simplification into a bishop versus knight ending which can only bring black closer to victory.* **38. Nxc2 Qxg3+ 39. Kxg3 Kxe6 40. Nd4+ Ke5 41. Kf3 h5 42. h4 g5 43. g3 Bc8 44. Nc6+ Kd6 45. Nd4 Bg4+ 46. Kf2 Ke5 47. Nb5 Bd7 48. Nd4 Ke4 49. Nc2 Bb5 50. Nd4 Ba6 51. Ne6 Bc8 52. Nd4 Bd7** *It appears the position is coming around full circle. Nevertheless, black is making steady progress in improving its position.* **53. Nc2 gxh4 54. gxh4 Bg4 55. Nd4 f5 56.**
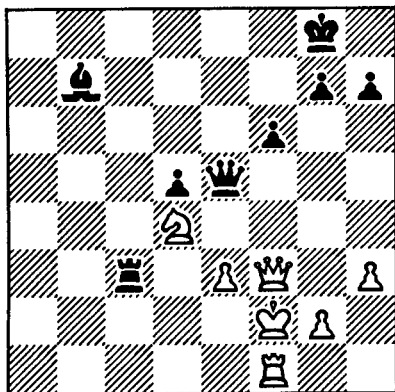
Figure 2.7: IM Edward Formanek – *Hitech* (white to move).

Ne6 f4!! *Such a wonderful move deserves a diagram*, Figure 2.8. *Hitech sees deeply into the position, as after 57. Nxf4 d4 58. Ng2 d3 59. Ke1 Kf3 wins.* **57. Nc5+ Kf5 58. Nd3 d4!!** *Transposing into the winning line described above.* **59. exd4 Ke4 60. Ne5 Kxd4** *A nice point is that if 61. Nxg4 hxg4, the black king can still stop the white pawn.* **61. Nf7 Be6 62. Ng5 Bd5 63. Nh3 Ke4 64. Ng1 Kf5 65. Ne2 Kg4 66. Kg1 f3 67. Nc3 Bc6 68. Kf2 Kxh4 69. Nd1 Kg4 70. Ne3+ Kf4 71. Nf1 h4 72. Nh2 h3 73. Nf1 Bb5 74. Ng3 h2 75. Nh5+ Kg4 76. Ng3 Bf1!** **0-1.** *A beautifully played endgame.*
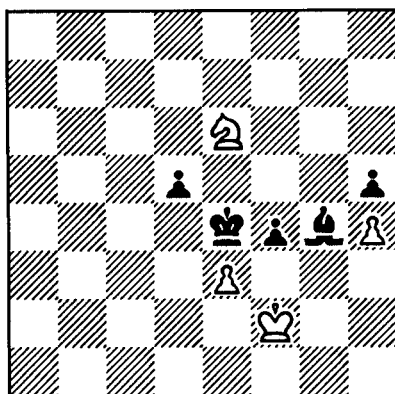

Figure 2.8: IM Edward Formanek – *Hitech* (white to move).

This section concludes with an example showing that humans are not to be out-done yet. Bear in mind that Kudrin is a Grandmaster and one of the twenty

highest rated players in the United States. He also specializes in the Dragon Variation of the Sicilian Defense.

White: *Hitech* ($\approx$2390) – Black: GM Sergey Kudrin ($\approx$2620)
1988 National Open

1. e4 c5 2. Nf3 Nc6 3. d4 cxd4 4. Nxd4 g6 5. Nc3 Bg7 6. Be3 Nf6 7. Bc4 O-O 8. Bb3 d6 9. f3 Bd7 10. Qd2 Rc8 11. O-O-O Ne5 12. g4 b5 13. g5?! *In some sense, this variation is an ideal choice by black against a computer. There is plenty of deep theory and machines are likely to grab a pawn not realizing the long-term dangers to their king. In the meantime white's attack against the black king never gets off the ground.* **Nh5 14. Ncxb5 Nxf3 15. Nxf3 Bxb5 16. Bxa7 Bc4 17. Qe3 Bxb3 18. Qxb3 Nf4 19. e5 Qd7 20. Bb6?! Rb8 21. Qe3 Qa4** *Black has an excellent attacking position.* **22. Kb1 Rfc8 23. b3 Qc6 24. Ba7 Ra8 25. c4 Ng2 26. Qf2 Qe4+ 27. Kc1 Rxa7 28. Qxg2 Bxe5 29. Rhe1 Bf4+ 30. Kb2 Rxa2+ 31. Kxa2 Ra8+ 32. Kb2 Be5+ 33. Nxe5 Qxg2+ 0-1.**

2.9 The Master Micros

Through the 1980s, manufacturers of microcomputer chess programs had intensely pursued the goal of developing a master level program. The major companies involved in this effort have been Fidelity International, Hegener and Glaser (manufacturers of the *Mephisto* series) and *Novag* (manufacturer of the *Constellation* series). In retrospect, progress through the 1980s was superb. In 1980 the programs were still quite weak, playing no better than Class B (1600-1800) chess. By 1985 the *Fidelity Par Excellence* was officially rated 2100. The transition from the 6502 chip to the faster 68,000 chip, with its extended assembly language instruction set, special endgame knowledge and efficient software were primarily responsible for enabling *Fidelity* to surpass the coveted 2200 threshold in 1987. *Mephisto* followed suit in 1988. For this the programmers Dan and Kathe Spracklen (*Fidelity*) and Richard Lang (*Mephisto*) deserve tremendous credit. Their ability to compete with the best programs despite severe handicaps in memory size and CPU speed clearly attests to their superior software. *Fidelity* scored the first tournament win ever over an International Master at the 1986 U.S. Open[3].

White: *Fidelity* ($\approx$2180) – Black: IM David Strauss (2533)
1986 U.S. Open

1. e4 d5 2. exd5 Nf6 3. d4 Nxd5 4. c4 Nb6 5. Nf3 g6 6. Nc3 Bg7 7. h3 O-O 8. Be3 Nc6 9. Qd2 e5 10. d5 Ne7 11. g4 f5 12. O-O-O fxg4 13. Ng5 *This is all part of an extended book line prepared by Boris Baczynskyj which ends here.* **g3!? 14. c5 g2 15. Bxg2 Nc4 16. Qe2 Nxe3 17. Qxe3 Nf5 18. Qd2 Bh6 19. Nce4 Nh4 20. Rhg1 Bf5 21. Bh1** *A human might get tired of defending white's position, but of course a program is unaffected by such feelings.* **b6 22. d6 c6**

[3] *Chess 4.7*'s win over David Levy was under match conditions.
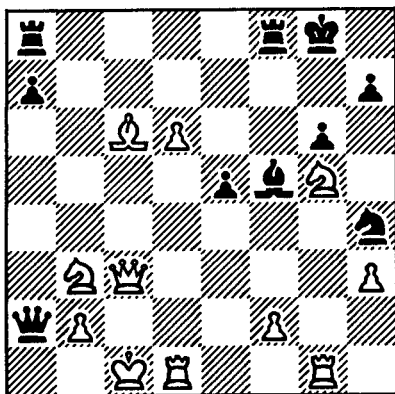
Figure 2.9: IM David Strauss – *Fidelity* (black to move).

23. Qe3 bxc5? 24. Nxc5 Qb6 25. Nb3 Qa6 *Strauss probably thought he was winning here.* **26. Qc3 Qxa2 27. Bxc6!** *See* Figure 2.9. *Computers know no dangers! A human would probably never dare to take this pawn.* **Rad8 28. Bd5+ Kh8 29. Nc5 Qb1+ 30. Kd2** *White now has a won game.* **Nf3+** *Black does not have enough for the piece.* **31. Bxf3 Rxd6+ 32. Ke2 Rxd1 33. Rxd1 Qc2+ 34. Qxc2 Bxc2 35. Rg1 Bf5 36. h4 Rb8 37. b3 Rc8 38. Nf7+ Kg7 39. Nd6! Rf8 40. Ra1 Kh8 41. Rxa7 Bf4 42. Nf7+ Kg8 43. Bd5 Kg7 44. Ng5+ 1–0.** *An efficiently played game by white.*

In 1989, a new man-machine event was christened, called The Harvard Cup. The 4 round event pitted four Grandmasters (Boris Gulko, Michael Rohde, Lev Alburt and Max Dlugy) against four computers (*Deep Thought*, *ChipTest*, *Hitech* and *Mephisto*). The games were played at the time control of 30 minutes sudden death. This seemed to handicap the computers more than the humans. The final score was 14.5 out of 16 in favor of the humans. In the following game, two-time U.S. Champion Alburt enters too many tactical complications and relinquishes half a point to *Mephisto*.

White: GM Lev Alburt (≈2696) – Black: *Mephisto* (≈2200)
1989 Harvard Cup

1. d4 e6 2. g3 Nf6 3. Bg2 Nc6 *Despite all their fine play, programs still often develop their knights in front of their queen's bishop pawns.* **4. Nf3 d5 5. O-O Be7 6. c4 O-O 7. Nc3 dxc4 8. e3 Na5 9. Qe2 c5 10. dxc5 Qc7 11. e4 Bxc5 12. Bg5 Ng4 13. e5 f6 14. exf6 gxf6 15. Bd2 Bd7 16. h3 Ne5 17. Nxe5 Qxe5 18. Qxe5 fxe5 19. Ne4 Bb6 20. Rad1 Ba4 21. Rc1 Bc6 22. Bc3 Rad8 23. Rc2 Rf5 24. Re2 h6 25. g4 Rf7 26. Bxe5 Rd3 27. Bc3 Kf8** *White now wins a pawn but lets black out of the bind.* **28. Bxa5 Bxa5 29. Nc5 Bxg2 30. Kxg2 Rd5 31. Nxe6+ Kg8 32. f4 b5** *With good technique white's king-side pawns should win, but Alburt makes the mistake of letting the game become an unclear and exciting*

race. **33. Re4 Bb6 34. Rfe1 Rd2+ 35. R1e2 Rfd7 36. Kf1?** *Inconsequential.*
Rd1+ 37. Re1 Ba5 38. Rxd1 Rxd1+ 39. Kf2 Bb6++ 40. Kg3 Rd2 41. a4 a6 42.
Kh4 Rxb2 *Somewhere in the next few moves black should play Kf7, but the*
machine can't anticipate white's mating idea. **43. Kh5 c3 44. Kg6** *See* Figure
2.10. **Rb4!** *The ending now becomes tactical.* **45. Nd4 Kf8 46. Ne6+ Kg8** *Ke8*
or Ke7 would be ideally complicated for Alburt's time pressure. **47. Re5 c2 48.**
Rd5?! *Rf5 looks like a better winning try, e.g. Bc5 49. Nxc5!?, but after c1=Q*
50. Rd5 Kf8 black may be winning. **c1=Q 49. Rd7 Qc3 50. Re7** *Amazingly,*
white still has a draw. **Qc2+ 51. f5 Rxg4+ 52. hxg4 Qc6 53. Rg7+ Kh8 54.**
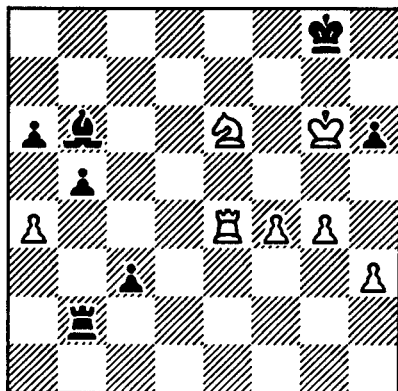**Rh7+ Kg8 55. Rg7+ Kh8 56. Rh7+ Kg8 ½-½.**

Figure 2.10: GM Lev Alburt – *Mephisto* (black to move).

2.10 Deep Thought Challenges Mankind's Best

In less than two years, *Deep Thought* has gone on a whirlwind tour through the
world of chess. Since the summer of 1988 its series of accomplishments,
including a number of Grandmaster victims and tournament victories, has been
remarkable. The program was developed by five researchers at Carnegie Mellon
University: Feng-hsiung Hsu, Thomas Anantharaman, Murray Campbell,
Andreas Nowatzyk and Peter Jansen. Hsu, Campbell and Anantharaman are
now working on a new *Deep Thought*, with the sponsorship of IBM. In the next
few years they hope that advances in parallel computing and VLSI technology
will enable *Deep Thought* to consider one billion moves per second, which
equates to an exhaustive search of about 14-ply. The version of *Deep Thought*
which played a match against David Levy in December, 1989, ran on four
processors in parallel and searched over 700,000 positions per second, or over
100 million positions (often over 10 ply) in 3 minutes. *Deep Thought*'s speed
comes from its special-purpose VLSI chips, with the main program running off a

Sun 4 workstation. Its evaluation function is tuned using a database of 900 IM/GM games. The program consists of 100,000 lines of code and is written in C. It evaluates king safety, mobility, development, etc. and employs an important search concept called singular extensions (Anantharaman, Campbell and Hsu 1988) to recognize moves which appear important enough to analyze them more deeply. More details can be found in Chapter 5 *Deep Thought*.

Deep Thought won the 6th World Computer Chess Championship (Kopec 1989; Chapter 3 *1989 World Computer Chess Championship*) with a perfect 5-0 score. Its current rating is 2551 USCF and there are now only a few players in the world strong enough to feel confident against the program. A few of *Deep Thought*'s major games are presented below.

The program made history by tying for first at the 1988 Software Toolworks Open with GM Anthony Miles, each scoring 6.5 out of 8. *En route,* the program scored the first tournament win by a computer over a Grandmaster, former World Championship candidate Bent Larsen. True, Larsen is no longer in his prime, but neither can he be called a pushover with his 2580 FIDE rating. The game score with annotations can be found in Chapter 15 *Brute Force in Chess and Science.*

Deep Thought's strength lies in its deep searches. Figure 2.11 shows a position that is bound to become historic in the annals of *Deep Thought*. It illustrates, yet again, the stupefying power of brute-force search and how it can lead to unexpected powerful, deep and devastating combinations.
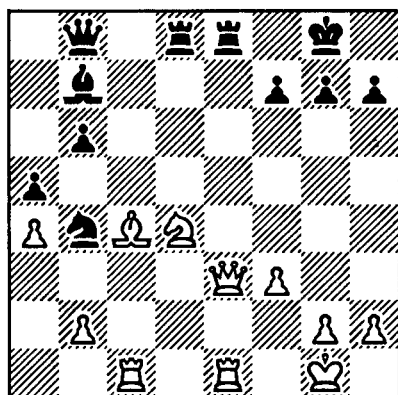

Figure 2.11: *Deep Thought* – Eric Cooke (white to move).

White: *Deep Thought* (2551) – Black: Eric Cooke (≈2250)
1989 Software Toolworks Open

White finds an unexpected and strong resource. **29. Qg5!!** *Prefaces the carnage that follows. If Rxe1+ 30. Rxe1 Rxd4 31. Bxf7+! Kh8 (Kxf7 32. Re7+ and mates) 32. Re8+ wins. The threat of 30. Nf5 is now menacing and if 29. ...*

h6 then 30. Qg6 wins. **Rxd4 30. Bxf7+ Kxf7 31. Rc7+!** *A beautiful move, based on a simple mating theme which brute-force programs can find routinely and humans can overlook easily.* **Qxc7 32. Qf5+ 1-0.**

One area where *Deep Thought*'s play is weak is in the opening. Hence, it is probably wrong to alter one's style of play just to avoid *Deep Thought*'s book. That is what seems to happen in the following game. Former World Championship candidate Robert Byrne finds that out after he chooses the inferior Owen Defense to get *Deep Thought* out of book. Overall, Byrne's play is passive and he makes a number of inaccuracies (Byrne 1989).

White: *Deep Thought* (≈2550) – Black: GM Robert Byrne (≈2540)
USA Sports Center Match

1.e4 c5 2. c3 b6 3. d4 Bb7 4. Bd3 e6 5. Be3 Nf6 6. Nd2 Nc6 7. a3 d6 8. Qf3 g6 9. Ne2 Bg7 10. O-O O-O-O 11. b4 cxd4 12 cxd4 Qd7 13. Rac1 Rac8 14. h3 Ne7 15. Bg5 Rxc1 16. Rxc1 Ne8 17. Bb5 Qd8 18. Qg3 h6 19. Be3 d5 20. f3 Nd6 21. Bd3 b5 22. Rc5! *Seizing the initiative.* **a6 23. Bf4 Nc4 24. Bxc4 dxc4 25. Bd6 Re8 26. Rc7 Ba8 27. Rc5 Nc8 28. Be5 Bxe5 29. Qxe5 Nd6 30. a4 Qd7 31. Qf4 Kg7 32. h4 Bc6 33. d5 Ba8 34. dxe6 Rxe6 35. axb5 axb5 36. Nf1 Nxe4!?** *Desperation.* **37. fxe4 Rxe4 38. Qf2 c3 39. Nxc3 Rxb4 40. Ne3 Bc6 41. Ned5 Bxd5 42. Nxd5 Rb1+ 43. Kh2 Qd6+ 44. g3 Qe5 45. Nc3 Qe1 46. Qd4+ Kh7 47. Nxb1 Qe2+ 48. Kg1 1-0.**
These two adversaries have since played each other twice more, each with a win.

There are still times when a strong human player can make *Deep Thought* look confused. Walter Browne again finds himself the center of attention by "upsetting" *Deep Thought* at the 1988 Software Toolworks Open. *Deep Thought* makes some peculiar bishop moves and then Browne finds a deep, long-term tactical theme based on white's weakness on the h1-a8 diagonal.

White: *Deep Thought* (≈2450) – Black: GM Walter Browne (≈2650)
1988 Software Toolworks Open

1. e4 c5 2. c3 Nf6 3. e5 Nd5 4. d4 cxd4 5. Nf3 Nc6 6. Bc4 Nb6 7. Bb3 d5 8. exd6 Qxd6 9. O-O e6 10. cxd4 Be7 11. Nc3 O-O 12. Re1 Nd5! *Getting Deep Thought out of book since the normal moves in this position are Bd7 and Rd8, as Browne writes in* Inside Chess, *March, 1989.* **13. g3!?** *Unnecessarily weakening.* **Qd8! 14. a3?! Nxc3!** *White is now saddled with a long-term weakness on c3.* **15. bxc3 b6 16. Qd3 Bb7 17. Bc2 g6 18. Bf4?!** *For the next three moves, Deep Thought gropes to find the right square for its queen's bishop.* **Rc8 19. Bh6?!** *This would have been more natural last move.* **Re8 20. Bd2? Na5 21. Ba4** *See* Figure 2.12. **Qd5!** *Browne finds a winning idea which is simply beyond Deep Thought's depth of analysis. Such long-term positional themes still separate top human players from the best programs.* **22. Bxe8 Rxe8 23. Kg2 Nc4 24. Bc1 g5! 25. h3 h5 26. g4 e5!** *All of black's forces join the attack.* **27. Qd1 f5! 28. gxh5 g4 29. hxg4 fxg4 30. Kg1 Qxf3 31. Qxf3 Bxf3 32. Bh6 Kh7 33. Bd2?** *Another futile move with the bishop, but the threat was Rf8-f5-h5-h1 mate!* **Rf8 34. Rxe5 Nxe5 35. Re1 Nc6 0-1.**
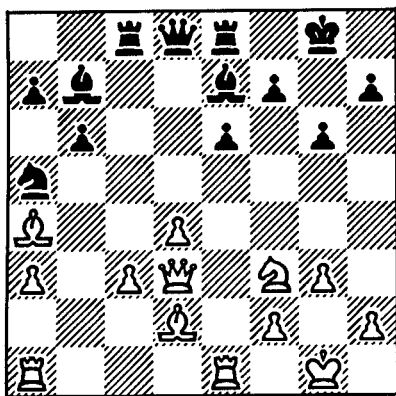
Figure 2.12: *Deep Thought* – GM Walter Browne (black to move).

In October, 1989, Gary Kasparov achieved the highest FIDE rating ever attained by reaching 2795 and eclipsing Bobby Fischer's mark of 2780. Shortly afterwards, Kasparov raised his rating over the 2800 mark. At the height of his confidence, he challenged *Deep Thought* to a two game match. Both sides played at the rate of two hours for all the moves. Kasparov took this challenge seriously (as he takes all chess-related matters) and prepared carefully for the match by studying *Deep Thought*'s games. Kasparov convincingly won both games; it all looked so easy. However, this should not belittle the virtuoso performance by the human World Champion.

In the first game, Kasparov demonstrated his superior understanding of positional chess; *Deep Thought* was ground down in 52 moves. In the second game Kasparov won handily. A pawn sacrifice is too much for a gullible program to refuse and *Deep Thought* quickly finds the tactics overwhelmingly against it. That Kasparov should so handily defeat the best computer program shows there is still a long way to go to reach the level of the human World Champion.

White: Gary Kasparov (2800 FIDE) – Black: *Deep Thought* (2551)
Exhibition match
1. d4 d5 2. c4 dxc4 3. e4 Nc6 4. Nf3 Bg4 5. d5 Ne5 6. Nc3! c6 7. Bf4 Ng6 8. Be3 cxd5 9. exd5 Ne5 10. Qd4 Nxf3+ 11. gxf3 Bxf3 12. Bxc4! Qd6 13. Nb5 Qf6 14. Qc5 Qb6 15. Qa3! e6 16. Nc7+ Qc7 17. Bb5+ Qc6 18. Bxc6+ bxc6 19. Bc5 Bxc5 20. Qxf3 Bb4+ 21. Ke2 cxd5 22. Qg4 Be7 23. Rhc1 Kf8 24. Rc7 Bd6 25. Rb7 Nf6 26. Qa4 a5 27. Rc1 h6 28. Rc6 Ne8 29. b4 Bxh2 30. bxa5 Kg8 31. Qb4 Bd6 32. Rxd6 Nxd6 33. Rb8+ Rxb8 34. Qxb8+ Kh7 35. Qxd6 Rc8 36. a4 Rc4 37. Qd7 1-0.

2.11 End of an Era

In December, 1989, in a match billed as "The Ultimate Challenge," *Deep Thought* challenged David Levy for the $5,000 OMNI/Levy prize. A decade of chess inactivity was difficult for Levy to overcome and, perhaps surprisingly, he was overwhelmed 4-0 by *Deep Thought*. The second game pretty much summarizes the match as Levy had his best chance to score (a draw) and still came up empty-handed.

White: *Deep Thought* (2551) – Black: IM David Levy (2300 FIDE)
1989 Match

1. c4 d6 2. Nc3 g6 3. d4 Bg7 4. e4 a6 *This gets Deep Thought out of book, but the match plan was to play Nd7 with c5 or e5 to follow.* **5. Be3 Nf6 6. Be2 O-O** *I would prefer c5 either here or on the next move.* **7. f4!?** *Throughout the match, Deep Thought seemed to loved to create quartets with its pawns.* **c6** *Much too timid.* **8. e5 Ne8 9. Nf3 d5 10. O-O Nc7** *Ten moves into the game and black has no pieces beyond the second rank!* **11. Rc1 e6 12. Qe1 b5?** *Too weakening on a wing where white also has more space. I prefer dxc4 with Nd7-b6-d5 to follow.* **13. cxd5 cxd5 14. Nd1! Ra7 15. Nf2 Nd7 16. Qa5** *Bd2 is very strong.* **Na8 17. Qa3?** *Trading queens followed by Bd2 was strong.* **Qb6 18. Bd2 a5 19. Qd6 b4 20. Rc6 Qd8 21. Rfc1 Bb7 22. R6c2 Ndb6 23. Qxd8 Rxd8 24. Be3 Rc8** *Black appears to nearly have equality.* **25. Rc5 Bf8 26. Bd3! Rd8 27. R5c2 Rc8 28. Rxc8 Bxc8 29. Ng4 Be7 30. Nf6+ Bxf6?** *Kg7 was essential.* **31. exf6 Rc7 32. Ne5 Rxc1+ 33. Bxc1 Bb7** *White's N/e5 and P/f6 are too strong.* **34. a3 Nc7 35. axb4 axb4 36. Bd2 Na4 37. Bxb4 Nxb2 38. Ng4!** *Announcing mate in 12!* **e5** *Desperation.* **39. Nh6+ Kh8 40. Nxf7+ Kg8 41. Nh6+ Kh8 42. f5 1-0.**

It was the end of an era in computer chess. The best programs are now playing at the strong master, weak Grandmaster level. Can it be long before advancing technology allows computers to successfully challenge Gary Kasparov?

Kasparov believes that he can "save mankind" for at least five years and probably ten. An unanswered question is how much of Kasparov's overwhelming success against *Deep Thought* was based on his preparation for the match and how much was based on his pure ability and technique? Kasparov believes that as computers become more of a threat to humans in the game of chess, so will humans learn new ways to exploit their weaknesses. This is undoubtably true, however the number of years where humans will be dominant must be very limited. In the meantime there will be some exciting chess battles ahead.