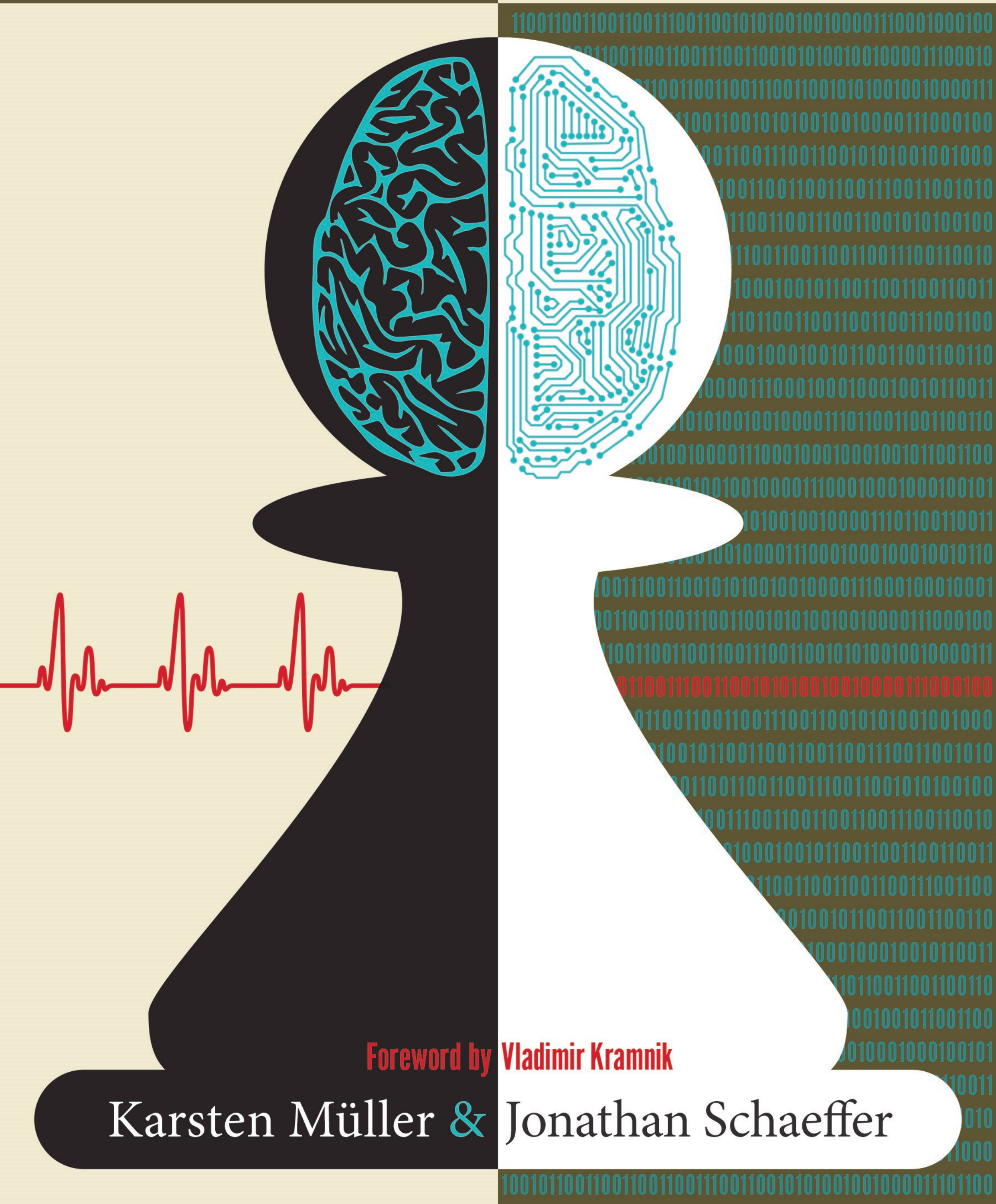
# MAN vs MACHINE

## Challenging Human Supremacy at Chess



Foreword by Vladimir Kramnik

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Special thanks to Pascal Simon of ChessBase and Lev Alburt.

Jonathan Schaeffer:

I thought my involvement with chess ended 25 years ago when I retired from competing in computer chess tournaments. However, Hanon Russell's idea for a book that told the story of computers challenging humankind for supremacy at chess was too good an opportunity to pass up. As a chessplayer myself, the chance to spend time playing over interesting games of chess, reading Karsten's wonderful annotations, diving into the historical literature, and reliving my experiences from the early days of this field was a lot of fun for me. This book was truly a labor of love – love for the game, love for the people in chess and computer chess that I have been privileged to know and work with, and love for the intellectual gratification (both from playing chess and researching computer chess). Thank you Hanon!

An important reason I decided to work on this book was the opportunity to collaborate with Grandmaster Karsten Müller. I have been a fan of his for many years, the result of reading his articles on ChessBase.com. I could not have asked for a better partner. Whatever I needed from his side, he was able to quickly provide it. Read his game annotations carefully – look for his insights and nuggets of gold. It has been a pleasure working with you Karsten.

Many people helped in the preparation of this book, and I especially want to single out the contributions of Elwyn Berlekamp, Murray Campbell, Frederic Friedel, David Levy, and Monroe Newborn.

This book is dedicated to Jennifer, my lovely wife and the source of my inspiration.

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Some quotes have been edited for consistency. This includes changing descriptive chess notation to algebraic notation, as well as standardizing spelling and punctuation.

All chess games given in this book were played using tournament controls (typically 40 moves in 2 hours), except where indicated otherwise.

The authors thank 14th World Chess Champion Vladimir Kramnik for agreeing to write the foreword for this book. We had an engaging hour-long conversation with him – a highlight for both Karsten and Jonathan!

Thank you to Monroe (Monty) Newborn for permission to use his photographs. All ChessBase photographs come courtesy of Frederic Friedel. The photos by Mde Vincente and Gerhard Hund are used under the Creative Commons License. Additional permission from IBM, Carnegie Mellon University, and Semen Karpenko are appreciated.

# Foreword

Technology has forever changed the world of chess. Today's player has access to… strong sparring partners whenever you want to play (and they never get tired); encyclopaedic opening books (that really aren't books); comprehensive games collections (that include virtually every game played by every player of note); and perfection in some endgames (that defy human understanding). As a young chess player growing up in Russia and honing my skills, I had access to none of these tools. I had to find willing opponents, annotate printed opening books, transcribe important games, and attempt to discover the mysteries of the endgames. I'm not complaining, just describing the not-so-distant past. Computers have changed so much in chess, as indeed they have transformed so much of the world today.

I was late to adopt computers into my training regime. At the beginning of my career I used computers only for their game databases. In 1995, while helping Garry Kasparov with his world championship match with Anand, I saw how important the use of computer applications were for his training. After working with Garry, I started to use computers quite regularly. However, it was mostly used for blunder checking. We were analyzing on the board and sometimes you could easily just simply blunder something, miss some cheap trick, and just make mistakes. At that time, the playing strength of the programs was quite weak, but still strong enough to embarrass us. Even Kasparov sometimes blundered in his analysis, and the computer was ruthless and impassionate about pointing out the mistakes. This was a humbling experience for a grandmaster! Simply having the ability to check for blunders was in itself a useful tool.

Then came Kasparov's famous matches against Deep Blue. Frankly, I was not taking computers too seriously at that time. Even though I understood that it was not that simple to beat the computer, I was sure that Garry was going to win both matches. Of course I analyzed the games. I found it unsurprising that he won the 1996 match by a score of 4-2 – the games were normal and logical. The 1997 match was dominated by a lot of PR that distracted Garry (but not Deep Blue) and this may have played a role in the final result. But I'm absolutely convinced that Garry was still a much stronger player than Deep Blue. The final result was bad luck on Garry's part, that he lost his nerves at some point. Even so, he was the better player.

My own fights with the machines also started around that time. I don't really know when I lost my first game against a machine. I was not a big fan of playing training games with computers, but I probably lost one such game. My first tournament with a computer participant was probably a rapid chess event in Mainz around 1999. My first classical chess game against a computer was in 2000 in Dortmund. This was a grandmaster round-robin tournament and the computer's participation was controversial. Some players were against including the machine; I didn't mind so much. I won the game in my first classical man-machine encounter.

Then I prepared for my first match against Deep Fritz, which was planned for 2001. The first step in my preparation was to analyze all the 1997 Kasparov-Deep Blue games, with Fritz running on my laptop. Just a laptop – no special chess chips analyzing 100s of millions of positions per second. To my extreme surprise, Fritz was simply playing better than Deep Blue. I was shocked. I couldn't understand how Garry managed to lose this match. When moves involved deep calculation, Fritz made the same moves as Deep Blue nine times out of ten. When a move choice was based on a positional decision, Fritz usually made a slightly better move than Deep Blue. I was puzzled -- I was expecting Deep Blue to be much stronger. I was even a bit frightened that I was going to play against Fritz but with it using more computing power. After doing this analysis, I was really surprised that Gary managed to lose the match to Deep Blue.

The first match with Deep Fritz actually took place in 2002. It started very well for me with two draws and two wins. I was extremely happy. But then in game five I blundered a piece in basically one move. In game six I was leading by one point and so I sacrificed material. So in the end the match was drawn and the question of whether man or machine was the better player remained open. In my second match with Deep Fritz in 2006 things did not go as well and I ended up losing.

It was already difficult, but still not totally impossible, for a human to beat a top computer program. But within maybe two or three years it became completely impossible. I think by around 2010 there was no chance anymore for the human side. In the history of computer chess, there were three chapters. First the humans were better for a long time. Then the interesting chapter, where man and machine were close in strength, lasted maybe 10 to 15 years. And now, the final chapter, computers are stronger for good.

Computers have changed the game of chess, the world of chess, and even my profession. There are many pluses to what computers have brought to chess. Of most value is that they improved our understanding and appreciation of the game. The minuses are obviously that there is much less opportunity for the human side – less room to be creative. We must not forget that chess is, after all, a game between two humans. Computers may now be stronger than the human World Champion, but this achievement does not change the real value of the game: the pleasure that we humans get from playing one another at this beautiful intellectual game. And that will never change.

When I chose chess as my profession, I never imagined that one of the legacies of my career would be as a contributor to the field of artificial intelligence research. Both Garry and I put our titles and reputations on the line in the interests of Science. We both had early victories and eventually suffered painful defeats. I have no regrets. I enjoyed the challenge of playing against technology.

Grandmaster Karsten Müller and Professor Jonathan Schaeffer have managed to describe the fascinating history of the unequal fight of man against machine in an entertaining and instructive way. It evoked pleasant and not so pleasant memories of my own fights against the monsters. I hope that their work gives you as much pleasure as it has given me.

Vladimir Kramnik

14th World Chess Champion

# Table of Contents

# 6
# 2650 (1990-1996)

One way to maximize your chances of winning a game is to prepare for your opponent. By replaying their games, you might discover useful information that can be leveraged to your advantage. For example, what kind of positions does he/she seem to like? Dislike? How strong is their tactical vision? Positional play? Endgame skills? What are their opening preferences? The elite chess players study all their potential opponents and often adopt opponent-specific strategies. For example, it might not be a good move to challenge Mikhail Tal to a tactical melee, nor would you want to question Tigran Petrosian's positional understanding. Simplistically, you should consider playing a quiet positional game against Tal (he might get impatient), and mix it up against Petrosian (tactical complications instead of positional subtleties).

It should not come as a surprise then that with computers playing at the level of a strong international master and even grandmaster strength, humans began to intensively study their games looking for weaknesses. The computer's strengths were obvious. Some of the more important ones included:

- Tactics *par excellence*. The programs are calculating monsters, analyzing forced sequences of play many moves into the future, often much deeper than many strong players can foresee given the constraints of a ticking clock. Woe unto him or her who pits their tactical analysis against the computer's deep search.
- No obvious blunders. A program that searches, say, eight-ply deep (ignoring search extensions) will not make a blunder that can be found within four moves aside.
- Unbiased. Computers are not subject to human biases as to what strong chess should look like. Computers can (and do!) play unorthodox moves that perhaps initially appear weak but turn out to be strong. By considering all possible moves, the computer does not eliminate unorthodox moves from consideration.
- The machine never gets tired. Humans get tired as the game progresses. Not much we can do about that!

Now, what about weaknesses in the computer's play? Clearly every program is different, but analysis of computer play suggest that the shortcomings fall into several categories:

- Closed positions. Here the strategic element is to maneuver the pieces behind the pawn wall waiting for the right moment to break the position open. This requires long-range understanding of where the pieces need to be to achieve maximum impact.
- Positional sacrifices of material. Most chess programs of this era would rarely allow positional considerations to outweigh the value of a pawn. Thus you might see a program accept a pawn, even though it destroyed its pawn structure or weakened its king's position. More extreme cases were also sources of computer difficulties, for

example in positions where a knight was more valuable than a rook.

- Many types of endgames proved challenging to a computer. For example, deciding whether to transition into a rook-and-pawn endgame might require a deep understanding of the position. For a human, much of this is pattern based (known formations that are good or bad), but for a computer it often comes down to what can be seen within the search horizon.
- Trapped pieces and permanent features. Computers have difficulty understanding that some position features will not change. For example, consider a Black fianchetto position with the bishop on h8. If White has pawns on f6, g5, and h4, there may be no way out for the trapped piece. Although nominally Black has a bishop on the board, the value of the piece must be discounted.
- Quiet positions. Some humans adopt a do-nothing strategy, patiently waiting to see what the computer might do. Oftentimes the computer will make aggressive and/or weakening moves that lead to a long-term disadvantage. Many small mistakes can eventually add up. David Levy used such a strategy in his CRAY BLITZ match – "do nothing but do it very well" (Kopec, 1990).
- Getting the computer out of its opening book. By deviating from well-studied lines of play, one can force the computer to use its own analysis instead of just repeating published or pre-computed move sequences. The computer may not "understand" the resulting position, increasing the chances of a positional mistake being made.

With the success of HITECH and then DEEP THOUGHT, chess grandmasters took computer chess programs seriously and studied their games looking for weaknesses. This is the sincerest form of flattery and a tremendous accolade for the developers of strong chess-playing programs.

From 1986-1997, the Dutch organized an annual tournament in The Hague to assess computer program strength. These Aegon Man-Machine competitions (named after the sponsoring company) were organized as a Swiss tournament. There were an equal number of human and computer participants, with all games being a man-machine pairing. The human side was initially all local players, including some who prided themselves on their ability to beat computers using anti-computer strategies. For the early years of the event, a few International Masters led the human side; that was more than sufficient to produce decisive victories over their electronic opponents. For example, in 1988 there were 16 humans and 16 computers participating. The result was a 53 – 43 victory for the humans.

The 1989 event saw the first grandmaster participant, Hans Ree. Both HITECH and CHIPTEST participated that year, with each scoring less than 50%. Despite their presence, the computer side was crushed.

The next year saw a stronger human side, including Grandmasters Jerome Piket (four wins and two draws) and David Bronstein (four wins and two losses). The 67-year-old legendary Bronstein (1924-2006), Botvinnik's World Championship match opponent in 1951, had no reservations about putting his reputation on the line against a computer.

**1990: Checkers**

The program CHINOOK, developed by a team led by Jonathan Schaeffer (University of Alberta), comes second in the United States Checkers Championship, behind the winner World Champion Marion Tinsley. In the tournament, CHINOOK played Tinsley four games, all draws. Coming second earns CHINOOK the right to play Tinsley for the World Championship.

## Bronstein, David (2445) – HITECH

Queen's Gambit Accepted D20
5th Aegon Man-Machine competition, 05.10.1990

**1.d4 d5 2.c4 d×c4 3.e4 e5 4.♘f3 e×d4 5.♗×c4 ♘c6 6.0-0 ♗e6 7.♗×e6 f×e6 8.♕b3 ♕d7 9.♕×b7 ♖b8 10.♕a6 ♘f6 11.♘bd2 ♗b4 12.♕d3 ♗×d2 13.♘×d2** That White plays this move suggests his opening strategy (get the computer out of its book?) has been a failure. Black ruthlessly presses home the point. **0-0 14.a3 ♘e5 15.♕g3 ♘h5 16.♕h4** 16.♕×e5 fails to ♖b5 trapping the queen. Six of White's last nine moves have been by the queen. **16...♘f4 17.b4 ♘e2+ 18.♔h1 ♘d3 19.♘b3 ♕a4 20.♘c5 ♘×f2+ 21.♕×f2 ♖×f2 22.♖e1 ♕c2 23.♗g5 ♘g3+ 24.h×g3 ♖×g2 0-1**

The event was a resounding success for HITECH, with four wins (including against Bronstein) and two draws (including Piket). Hans Berliner was understandably jubilant (Carpenter 1990):

> HITECH, Carnegie Mellon University's chess-playing computer, scored what its handlers called "the greatest victory of its career" last month when it beat one of the world's highest-ranked chess players…
>
> "Everyone was utterly amazed," said Berliner. "It just burned up the track." …
>
> What made HITECH's victory over Bronstein particularly sweet was that it eclipsed previous wins by its more famous rival DEEP THOUGHT, another chess-playing computer also developed at CMU, Berliner said.
>
> DEEP THOUGHT, which uses speed rather than artificial intelligence to make its moves, beat International Master David Levy in [1989] and Grandmaster Bent Larsen in 1988, but Bronstein outranks them, Berliner said. …
>
> Can a computer have its good days and bad days?
>
> "Sure it can," Berliner said. "It had a couple of pretty good days in the Netherlands."
>
> "Or maybe David Bronstein had a bad day," he added. "At least he said he did."

Three years later, Bronstein took his revenge. He learned much about what to do – and what not to do – against computers. At an age when most grandmasters cannot compete at grandmaster strength, Bronstein played dominating chess to win the 1992 and 1993 Aegon events with a combined score of 11½ out of 12! The following game epitomizes his strategy for playing computers.

### Hitech – Bronstein, David (2405)

French Defense: Winawer, Poisoned Pawn Variation General C18
8th Aegon Man-Machine competition, 1993

Bronstein (1996) writes about his strategy against computers:

> Now computers are so clever they can make brilliant moves that pose problems even to grandmasters! They have no expectations, no joy, no disappointment. They never tire. They have no idea who they are playing against and are not even afraid of someone like myself who once fought for the crown.
>
> Conventional wisdom holds that the best way to beat machines is to construct dull, closed positions, and I cannot disagree. However, I aim to complicate positions as much as possible. Intuition and experience tell me that even if machines see far ahead, they don't always find the best way to conduct the game.
>
> Now I will tell you the secret of my play against silicon foes. I use sheer psychology! I make them "feel good" by giving up a slight material advantage, like a pawn. In my opinion this lulls their evaluation function into a false sense of security and entices them into making overoptimistic moves that in reality are unwarranted. While they are happy to have a material edge, I try to attack their king. In many cases, but not always, I succeed.

**1.e4 e6 2.d4 d5 3.♘c3 ♗b4 4.e5 c5 5.a3 ♗×c3+ 6.b×c3 ♘e7 7.♕g4 ♘f5 8.♗d3 h5 9.♕h3 c4 10.♗×f5 e×f5 11.♘e2 f4 12.♕f3 g5 13.♗×f4 ♗g4 14.♗×g5 ♕×g5 15.♕×d5 ♘c6 16.♘g3 ♗e6 17.♕f3 0–0–0 18.0–0 ♕g4 19.♕f6 h4 20.f3 ♕g6 21.♕×g6 f×g6 22.♘e4 ♔c7 23.♖ab1 b6 24.♖fe1 ♘e7 25.♖b4 ♖hf8 26.♘g5 ♗d5 27.♘h7 ♖f5 28.♘f6 h3 29.♘×d5+ ♘×d5 30.♖×c4 ♔d7** Hitech does not understand that the ♖c4 is trapped and cannot be extricated. Optically the material is balanced but, of course, Bronstein knows better. **31.f4 ♖×f4 32.e6+ ♔d6 33.g×h3 a5 34.e7 ♘×e7 35.♔g2 ♖df8 36.♖b1 ♘d5 37.♖e1 ♖f2+ 38.♔g1 ♖2f3 39.h4 ♘e3 40.♖×e3 ♖×e3 0–1**

Bronstein played in eight Aegon events (1990-1997), winning two of them and always scoring at least four points out of six. He was a spectator's delight; he could be counted on being entertaining over the board, in his analysis, and in his commentary.

Aegon became a regular and popular event on the tournament circuit. Over the years, the human side grew in strength as strong grandmasters enjoyed the challenge of playing the machines. Participants included Larry Christiansen, Vlastimil Hort, John Nunn, Susan Polgar, Yasser Seirawan, Gennadi Sosonko, and Rafael Vaganian, several of whom were at one time rated in the world's top-10.

But the computer side grew stronger too, and at a faster rate than the human side. Regular microcomputer competitors included Chess Challenger (Kathy and Dan Spracklen), Fritz (Franz Morsch and Mathias Feist), Hiarcs (Mark Uniacke), MChess (Marty Hirsch), Mephisto (Richard Lang), Nimzo (Chrilly Donninger), Rebel (Ed Schröder), Socrates (Don Dailey and Larry Kaufman), and The King (Johan de Koning) – a veritable who's who of the commercial computer chess world. Without the HITECH and DEEP THOUGHT advantage of special-purpose hardware, these program developers instead relied on their ingenuity and attention to detail. Search algorithms were refined, especially search extensions (when to search deeper) and search reductions (when to curtail the search). But the heart of what they did was to work with chess knowledge. A little bit of knowledge applied in the right situation could make a huge difference. Thus various teams meticulously analyzed all the endgames – how to play a bishop-and-pawn endgame was different than a rook-and-pawn game. They added patterns to the program that better understood common middlegame position features. They had their computers use all the available resources to analyze the openings, looking for new moves and tailoring their opening repertoire to match the computer's playing style. All of this took time, patience, and effort.

David Bronstein and John Nunn won the 1993 Aegon event with 5½ out of 6. Despite their success, for the first time the computer side finished ahead of the humans, by a narrow score of 98½-93½. The 1994 event featured a stronger human side (more grandmasters) but the competition ended in a draw with 114 points aside. The computers won the 1995 and 1996 events handily, and narrowly won in 1997.

An anti-computer strategy often included simplifying into an endgame and then waiting for the computer to err. Grandmaster and soon-to-be World Women's Champion Zsuzsa (Susan) Polgar finds out the hard way that generalizations do not always work.

### MCHESS PRO – Polgar, Zsuzsa (2545)

Sicilian Dragon B77
10th Aegon Man-Machine competition, 03.05.1995

**1.e4 c5 2.♘f3 ♘c6 3.d4 c×d4 4.♘×d4 g6 5.♘c3 ♗g7 6.♗e3 ♘f6 7.♗c4 0–0 8.♗b3 a5 9.f3 d5 10.♗×d5 ♘×d5 11.♘×d5 f5 12.♘×c6 b×c6 13.♘b6 ♖b8 14.♕×d8 ♖×d8 15.♖d1 ♖×d1+ 16.♔×d1 f×e4 17.♘×c8 ♖×c8 18.b3 e×f3 19.g×f3 a4 20.♖e1 ♖a8 21.♖e2 ♔f7 22.♗c5 e6 23.♖d2 ♔e8 24.♔e2 ♗e5 25.♔e3 g5 26.♔e4 ♗f4 27.♖g2 ♔f7 28.h4 h6 29.♗b4 ♖b8 30.♗c3 ♖a8 31.♗d4 ♖a5 32.h×g5 h×g5 33.♗c3 ♖a8 34.♗e5 a×b3 35.c×b3 ♗×e5 36.♔×e5 ♔e7 37.a4 ♖b8 38.♖×g5 ♖×b3 39.♖g7+ ♔d8 40.f4 ♖b4 41.a5 ♖a4 42.♔×e6 ♖e4+ 43.♔d6 ♖d4+ 44.♔×c6 ♖×f4 45.a6 ♖c4+ 46.♔b5 ♖c7 47.♖g8+ ♔d7 48.a7 1–0**

Grandmaster John van der Wiel's anti-computer strategy pays off. Here he plays a closed game and bides his time until he can break through.

### HIARCS – Van der Wiel, John (2570)

French Defense Winawer Variation C16
Aegon, 03.05.1995

**1.e4 e6 2.d4 d5 3.♘c3 ♗b4 4.e5 b6 5.♕g4 ♗f8 6.♗g5 ♕d7 7.h4 h6 8.♗f4 ♗a6 9.♗×a6 ♘×a6 10.♘f3 ♘e7 11.0–0 ♘f5 12.a3 ♘b8 13.h5**

**♘c6 14.♖fd1 ♖g8 15.♔h2 0-0-0 16.b4 ♗e7 17.♕h3 g5 18.h×g6 f×g6 19.g4 ♘g7 20.♗×h6 ♖h8 21.b5 ♘a5 22.♖h1 ♖h7 23.♔g2 ♖dh8 24.g5 ♘f5 25.a4 ♘c4 26.♘e2 ♗×g5 27.♘×g5 ♖×h6 28.♕c3 ♕e7 29.♘f3 ♕h7 30.♖×h6 ♕×h6 31.♘eg1 ♕f4 32.♔f1 g5 33.a5 b×a5 34.♖×a5 ♘×a5 35.♕×a5 ♔b8 0-1**

The Aegon tournaments were not a valid scientific experiment. There was too much variability in the man and machine lineups each year to be able to interpret and compare the results. However it was an invaluable contribution to the computer chess community, being one of the few events where a chess program could do battle with a grandmaster. Most importantly it was a fun competition and one that the participants – both human players and computer chess developers – looked forward to each year.

**Mikhail Botvinnik (1994)**
**Computer chess program designer and former World Chess Champion**

*Question:* What will be the influence of the computer on chess literature?

*Answer:* For the moment, none. Now the computer is a source of information, but nothing more. But in the future the situation will change. I hope that in a few months our chess program will be ready that was developed by my mathematicians in the Botvinnik laboratory. This is the only program in the world that doesn't use brute force. Instead of using brute force our program "thinks" in a similar manner as a chess master thinks. DEEP THOUGHT analyses one hundred and fifty million positions in three minutes. They are working on a program that will look at two billion positions in three minutes. However, my program looks only at twenty or thirty positions, just as a chess master would do. This allows the computer to show the player with whom it is playing everything it's been analyzing, because it only looks at a limited number of possibilities. Thus the opponent of the computer can learn to play chess while playing the computer. I hope that this program will be further improved in the future and that the computer will be able to make analyses. When that happens no one will publish analyses anymore without consulting the computer. This will drastically change the chess literature.

Not to be outdone, the Americans initiated their own version of an annual man-machine competition. The Harvard Cup was held annually from 1989 to 1995, with the exception of 1990. Unlike Aegon, this event restricted the human side to only grandmasters, an attempt to get meaningful insight into the relative strength of the computers. Further, to ensure that this was a spectator event, each side was given 25 minutes in which to play the game.

The first event in 1989 featured an exceptional lineup for both sides. The grandmasters – Lev Alburt, Maxim Dlugy, Boris Gulko, and Michael Rohde – were all in the upper echelon of US chess. The programs – CHIPTEST, DEEP THOUGHT, HITECH, and MEPHISTO – were unquestionably the elite of the computer chess world. A close match was expected in this battle of titans. To most people's surprise, it ended in a crushing victory for humankind: 13½-2½. The excitement caused by the spectacular tournament results of DEEP THOUGHT and HITECH now had a much-needed reality check.

Two years later the programs were stronger – and the humans better prepared. For the 1991 event, the top programs stayed away, perhaps a consequence of the previous debacle. Instead a team of microcomputers did battle with the grandmasters (substitute Patrick Wolff for Lev Alburt). Again, it was a resounding win for the human side: 12-4. In the following game, Michael Rohde outplays the Spracklen's program in the opening. Lack of development proves costly. This is a nice game by Rohde, marred only by the inaccuracies at the end likely a result of time trouble.

### Rohde, Michael (2550) – FIDELITY MACH 4

Reti Accepted A09
Harvard Cup, 05.03.1991

**1.♘f3 d5 2.c4 d×c4 3.♘a3 c5 4.♘×c4 ♘c6 5.g3 ♘f6 6.♗g2 ♗e6 7.b3 ♗×c4 8.b×c4 e5 9.0–0 e4 10.♘g5 ♕d4 11.♖b1 h6 12.♕b3 ♖b8 13.♗b2 ♕×d2 14.♘×e4 ♘×e4 15.♗×e4 ♕d6 16.♖fd1 ♕c7 17.♕a4 ♖d8 18.♗e5 ♖×d1+ 19.♖×d1 ♕×e5 20.♗×c6+ ♔e7 21.♖d3 ♕a1+ 22.♔g2 ♔f6 23.♖f3+ ♔g5 24.h4+ ♔h5 25.♗e8 ♕b1 26.♗×f7+ g6 27.♕d7 ♕e4 28.♗d5 ♖h7 29.♗×e4 ♖×d7 30.♖f6 ♖d4 31.♗×g6+ ♔g4 32.f3# 1–0**

The 1992 event saw a breakthrough. The microcomputer program SOCRATES, the work of Don Dailey (1956-2013) and IM Larry Kaufman, impressively won three of its five games (Patrick Wolff, Maxim Dlugy, John Fedorowicz). Despite this success, the computer side lost again, this time by an 18-7 score. Michael Rhode won all five of his games.

In the following game, Fedorowicz gets into trouble in the opening and then succumbs to SOCRATES' precise handling of the tactics. It is not often that a grandmaster gets manhandled so easily. But then, maybe he should not have allowed the game to go in a direction that played to the computer's strength.

### Fedorowicz, John (2530) – SOCRATES

English, Four Knights, Kingside Fianchetto A29
Harvard Cup, 1992

**1.c4 ♘c6 2.♘f3 e5 3.♘c3 ♘f6 4.g3 ♗b4 5.♘d5 ♗c5 6.♗g2 0–0 7.0–0 d6 8.d3 ♘×d5 9.c×d5 ♘d4 10.♘d2 ♗g4 11.♖e1 ♕d7 12.♘c4 f5 13.♗d2 f4 14.b4 f×g3 15.h×g3 ♘×e2+ 16.♖×e2 ♗×f2+ 17.♖×f2 ♗×d1 18.♖×d1 ♕g4 19.♘e3 ♕×g3 20.♘f5 ♕×d3 21.♗f1 ♕a3 22.♗g2 ♕×a2 23.♗e1 ♕b3 24.♖a1 ♖ae8 25.♖f3 ♕b2 26.♗c3 ♕c2 27.♗h3 g6 0–1**

The 1993 competition was a six-round event with SOCRATES again leading the electronic side with three points (two wins, two losses, and two draws). Defeating 2500+ rating grandmasters with rapid time controls was no longer an exceptional event. Joel Benjamin scored 6-0 *en route* to a 27-9 win for the humans.

The next year saw an expanded event, with six humans playing eight computers.

Joel Benjamin again claimed top spot, conceding only three draws in eight games. WChess (David Kittinger) stunned the grandmasters by winning four games and drawing two. Despite this impressive result, the computer team lost, albeit by a closer 29½-18½ score. The event featured a playoff match between the top human and computer scorers, with Benjamin winning it.

### Shabalov, Alexander (2590) – WChess

Center Game, Berger Variation C22
Harvard Cup, 1994

**1.e4 e5 2.d4** An attempt to get WChess out of its opening book, a typical anti-computer strategy. **2...e×d4 3.♕×d4 ♘c6 4.♕e3 ♘f6 5.♘c3 ♗e7 6.♗c4 0–0 7.♗d2 d6 8.0–0–0 ♘e5 9.♗b3 ♗e6 10.f4 ♘c4 11.♗×c4 ♗×c4 12.♘f3 ♖e8 13.h3 b5 14.b3 b4 15.b×c4 b×c3 16.♗×c3 ♗f8** Role reversal! WChess gives up a pawn, with obvious positional compensation. Which player is the man and which is the machine? **17.e5 ♖b8 18.c5 ♕c8 19.♕d3 d×e5 20.f×e5 ♘h5 21.♘g5 g6 22.♕f3 ♖e7 23.g4 ♘g7 24.♖hf1 ♕a6 25.♘×f7 ♘e6 26.♕f6 ♕a3+ 27.♔d2 ♖d7+ 28.♘d6 ♘×c5 29.♕f3 ♕×a2 30.♔e1 c×d6 31.♖f2 d×e5 32.♖×d7 ♘×d7 33.♕c6 ♘c5 34.♗×e5 ♖b1+ 35.♔d2 ♗h6+ 36.♔e2 ♕×c2+ 37.♔f3 ♕d1+ 38.♔g3 ♕g1+ 39.♖g2 ♖b3+ 40.♔h4 g5+ 0–1**

### WChess – Benjamin, Joel (2585)

Ruy Lopez, Berlin Defense, Open Variation C67
Harvard Cup playoff, 1994

**1.e4 e5 2.♘f3 ♘c6 3.♗b5 ♘f6 4.0–0 ♘×e4 5.d4 ♘d6 6.♗×c6 d×c6 7.d×e5 ♘f5 8.♕×d8+ ♔×d8** Benjamin plays the solid Berlin defense, expecting the program to misplay this endgame. No such luck. **9.♖d1+ ♔e8 10.♘c3 ♗e6 11.b3 ♗b4 12.♗b2 ♗×c3 13.♗×c3 a5 14.♖d2 h5 15.♖ad1 ♔e7 16.h3 c5 17.♘g5 a4 18.♘×e6 ♔×e6 19.♖d5 b6 20.♖5d2 ♘e7 21.♖d7 ♖hc8 22.f4 h4 23.♔f2 a×b3 24.a×b3 ♖a2 25.♖1d2 ♘f5 26.♖7d3 ♖ca8 27.♔e2 ♖2a6 28.♔f3 b5 29.♗b2 ♖c6 30.c4 ♖b8 31.♗a3 b×c4 32.b×c4 ♖b1 33.♖d8 ♖b3+ 34.♖2d3 ♖×d3+ 35.♖×d3 g6 36.♖d8 ♖b6 37.♗×c5 ♖b3+ 38.♔e2 ♘g3+ 39.♔d1 ♘e4 40.♗a7 ♖g3 41.♖e8+ ♔d7 42.♖f8 ♔e7 43.♖c8 ♔d7 44.♖h8 ♖×g2 45.♖h7 ♔e6 46.♗b8 ♖g3 47.♗×c7 ♖×h3 48.♔e2 ♖c3 49.♖×h4 ♖×c4 50.♗b8 ♘g3+ 51.♔f3 ♘f5 52.♖h8 ♖c3+ 53.♔f2 ♖c2+ 54.♔f3 ♖c3+ 55.♔f2 ♖c2+ 56.♔f3 ½-½** Sometimes doing nothing well leads to, well, nothing!

The 1995 Harvard Cup turned out to be the last in the series. Benjamin and Rhode led the human side to another convincing victory, this time by the score of 23½-12½. The top computer was Virtual Chess (Marc-François Baudot and Jean-Christophe Weill) with 3½ out of 6 points.

Having scored 14 wins, five draws, and no losses against computers in his previous Harvard Cup appearances, Benjamin was the surprise of the event by losing to Chessmaster 4000 (Johan de Koning) in the first round. He roared back with four wins and a draw to again finish at the top of the crosstable. However, there was still blood to be spilled. The playoff match was played a few months later and Benjamin lost the first game, but came back to defeat VIRTUAL CHESS 2½-1½.

### Benjamin, Joel (2570) – VIRTUAL CHESS

English, Mikenas-Carls, Flohr Variation A18
Harvard Cup playoff, 05.01.1996

**1.c4 ♘f6 2.♘c3 e6 3.e4 d5 4.e5 d4 5.e×f6 d×c3 6.b×c3 ♕×f6 7.♘f3 ♗b4 8.♖b1 ♗d6 9.d4 h6 10.♗d3 c5 11.0–0 0–0 12.♕e2 ♘c6 13.♗e3 c×d4 14.c×d4 e5 15.d5 ♘b4 16.♗e4 b6 17.♖b2 ♗f5 18.♘d2 ♕g6 19.f3 ♖fd8 20.♗×f5 ♕×f5 21.♘e4 ♘a6 22.g4 ♕g6 23.h4 h5 24.♗g5 h×g4 25.f×g4 f6 26.h5 ♕f7 27.♘×f6+ g×f6 28.♖×f6 ♗c5+ 29.♔h1 ♕g7 30.♖g6 ♕×g6 31.h×g6 ♖d6 32.♕×e5 1–0**

Despite his uneven result at the 1995 Harvard Cup. Joel Benjamin had quietly built a reputation as a player who understood how to beat chess computers. Little did he know that this reputation would have a profound influence on his career.

The Harvard Cup produced results that were easier to interpret than those of the Aegon events. The human team was consistently composed of strong grandmasters. The computer team was mostly composed of the top microcomputer programs. The series of Harvard Cups showed an unmistakable trend of improved computer performance over the years. Further, given that the computer side mostly featured single-processor commercial products, the unanswered question was "How would the top programs have fared?" In 1989, we had the answer. DEEP THOUGHT, HITECH, and CHIPTEST were crushed. Circa 1995, when the last Harvard Cup was held, there was no good answer to the question.

Meanwhile, what had the DEEP THOUGHT team been doing all this time?

Peter Brown, the IBM employee who was studying at Carnegie Mellon during the time of the DEEP THOUGHT successes, knew a great opportunity when he saw it. He convinced IBM management that bringing the chess project to IBM had huge potential for the company: attracting an outstanding team of talented people, doing interesting research, and a massive media opportunity. IBM made the DEEP THOUGHT team an offer they could not resist: access to immense IBM resources with the goal of bringing the chess project to a successful conclusion. Given the impressive results achieved by the DEEP THOUGHT team with a paucity of resources at Carnegie Mellon, this was too good an opportunity to pass up. Hsu and Campbell joined IBM in the summer of 1989; Anantharman followed at the end of the year after defending his Ph.D. thesis.

IBM deserves a lot of credit for seeing the commercial potential from building a world-championship-caliber chess-playing machine. It was a gamble with a huge upside and a small potential downside. As Murray Campbell (2005) relates:

> *Interviewer*: When I look at the history, from a corporate perspective, if I were IBM, it seems like one of those kind of "steeples of excellence," if you like. It's kind of a point project, and it was very well defined. But it's unusual, and you think of IBM as a fairly staid, conservative company. I've always been intrigued as to whether they saw

> the public relations potential, or whether they had a genuine research interest, which I suspect is the case; they don't tend to waste their money. But I'm very interested in the business understanding, the business case, of sponsoring the DEEP BLUE Project, because it went on for quite a few years and took quite a few resources.
>
> *Campbell*: It did. It went on for seven years, which is unusual for a project that isn't leading to direct revenue and income. I think there were at least two factors that came into play here. One is that at the time the Watson Research Center was, and still is, one of the top research facilities in the world – industrial research facilities. They were always looking to hire good people, and they saw that in the team of us, independent of whatever project we worked on. I believe that they thought we were people that could contribute to IBM research, and so it made sense independent of that. But…somebody had the foresight to say this project is sort of win-win. We can bring some good people to IBM, we can do some research on parallel algorithms, high performance computing, and there is this potential payoff down at the end, if we're successful, where we'll get a lot of recognition. Part of IBM Research's mission is to generate this awareness of IBM – the term they use is luster – the prestige of accomplishing scientific goals and awareness in the scientific community. Somebody had the foresight to see that there was a chance for this happening.

With financial and technical support from IBM, computer chess research would be able to progress in ways that were not possible previously. For the first time, there were realistic expectations that the end of human supremacy at chess was not far off. Campbell (2005) puts this into perspective:

> *Interviewer***:** Did you feel when you went to IBM that just based on, say, the number of rating points that chess programs seemed to be improving by every year or every two years, that you could almost draw [a line on a graph showing chess rating versus year] assuming there were no singularities or strange, bizarre meteors or whatever you want to call them, that you could almost tell, to the year plus or minus a couple of years, when you'd reach certain levels?
>
> *Campbell***:** Well, that's an interesting story. I guess people would draw that line and they'd say "But there's a tailing off effect" and it's going to tail off around, I want to say, 2200, master level. Then when you passed master level they say "Oh, it'll keep going up for a while but then there'll be a tailing off effect around 2400," and then "2500." Then eventually as it surpassed each of those levels, people redrew this graph and always said that "There'll be a tailing off effect." I guess now we're seeing that they just keep going up. If you keep taking advantage of faster hardware and improving – it doesn't even have to be revolutionary improvements in the programming but evolutionary – things keep improving. There may in fact be a tailing off. I think there is. If you plot the year versus rating, it's slowing down. If you take out outliers, in a sense like DEEP BLUE, which sort of pushed ahead several years in terms of speed over the curve that present day PCs are on, I think it is continuing to go up. I don't see any reason to believe it won't continue to go up for a while yet.

There was an initial flurry of computer chess competitive activity in the latter half of 1989, with both the two-game exhibition match against World Champion Garry Kasparov and then the match that closed the book on the David Levy saga. But

Deep Thought was a media darling at that point, and new opportunities for games kept arising. Unfortunately, all this activity meant the team was concentrating on Band-Aid approaches to improving their current chess player, and not enough time to do the serious work required to build their next generation machine. Feng-hsiung Hsu (2002a) describes the change in reality as he moved from academia to industry:

> What I did not realize was that we could no longer take only a long-term view. Back at Carnegie Mellon, Deep Thought was not an official project and the faculty did not have high expectations abut how well we would do. Before we joined IBM, we had our own self-imposed milestones to meet, but we did not have to maintain a constant presence in the computer chess world. In theory, we could go back to the drawing board for years on end without showing up at any computer chess event. We did not have this luxury at IBM. Our arrival there was a high-profile one. Within two months, we were on the front page of the *New York Times* and *Wall Street Journal* as a result of the exhibition match with Garry Kasparov. Such a high profile came with a price. Providing short-term performance became an important concern for us even if it might be in conflict with long-term progress of the project.

So, when the opportunity to play someone of former World Champion Anatoly Karpov's caliber came along, the decision was a *fait accompli*. On February 2, 1990, Deep Thought played an exhibition game against Karpov. Few expected any result other than a decisive victory for the champion. Things were not quite as expected, as Hsu (1990) recounts:

> Both GM Ron Henley and IM Mike Valvo called it a moral victory for computers, but, of course, the machine knows nothing about morals.
>
> First, some personal impressions about the match and Karpov. … Karpov is a little bit more plump than I expected. During the press conference, he seemed to be somewhat nervous – his hands were twitching behind his back. Compared to Kasparov, Karpov appeared to be less comfortable with the press. His command of English is not as good as Kasparov's. Across the board, Karpov has a poker face, while Kasparov constantly shifts his expressions. Mike Valvo seemed to be able to tell Karpov's mood changes even from off the stage though.
>
> Before the match, we were expecting to toss a coin to decide the color. GM Ron Henley… had a different idea. Suggesting that Karpov had not slept for 24 hours during the trip, he would like Karpov to have White. The decision was made without our consent, but given that we were fully expecting to lose with either color, we had no serious objection.
>
> Karpov's play may have been hampered by the jet lag, but it was also evident that he was not as well prepared for the match as Kasparov. This might be in part due to [Deep Thought]'s selection of opening line. Over its entire career, it played Caro-Kann 3 times and none of the games have been widely circulated. Karpov might have been expecting Alekhine defense (surprisingly, the only Alekhine defense game that [Deep Thought] lost was the postal game against Valvo...). Valvo did tell Karpov the day before to expect Caro-Kann.
>
> A slower but safer hardware configuration was used for the Karpov match. The 6-processor version that played Kasparov had been found to contain serious software bugs; some of them were fixed, but more bugs showed up right before the Karpov

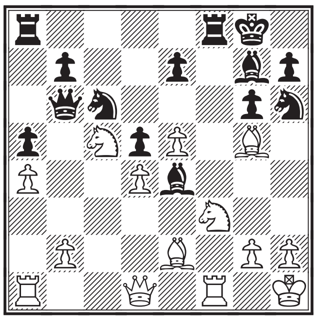
match, and the old 2-processor version was resurrected. The machine was operating from IBM T.J. Watson Lab.

Before the match, I predicted that the game would end in a clearly winning, at least to the titled players, endgame for Karpov and with me resigning for the machine somewhere between move 40 and 60. I was off by 5 moves and wrong about the nature of the endgame.

### Karpov, Anatoly (2730) – Deep Thought

Caro-Kann Defense B12
Harvard, 1990

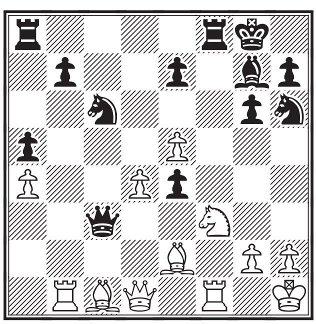
**1.e4 c6 2.d4 d5 3.♘d2 g6 4.c3 ♗g7 5.e5 f6 6.f4 ♘h6 7.♘gf3 0–0 8.♗e2 f×e5 9.f×e5 c5 10.♘b3 c×d4 11.c×d4 ♘c6 12.0–0 ♕b6 13.♔h1 a5 14.a4 ♗f5 15.♗g5** 15.♖a3!? **15...♗e4 16.♘c5**



**16...♕×b2?**

This greedy capture is problematic, as the queen cannot so easily come back. After 16...♘f5, Black is not worse.

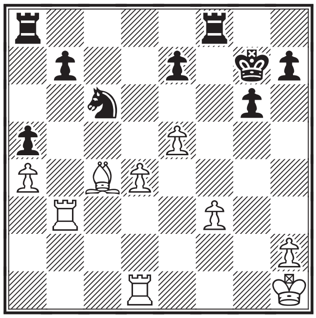
**17.♘×e4 d×e4 18.♖b1 ♕a3 19.♗c1 ♕c3 20.♗d2 ♕a3 21.♗c1 ♕c3**



**22.♖b3?**

Karpov heads for an endgame that is objectively drawn. He could exploit Black's wayward queen with 22.♗b2 ♕e3 23.♕e1 ♕b3 24.♗a1 ♕e6 25.♗d1 with a clear advantage.

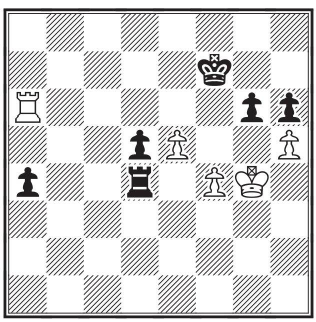
**22...♕a1 23.♗c4+ ♔h8 24.♗×h6 ♕×d1 25.♗×g7+ ♔×g7 26.♖×d1 e×f3 27.g×f3**



**27...♖a7** Hsu (2002a): "On the 27th move, Deep Thought played a move that a first sight looked quite ugly and the audience laughed. After the game, Anatoly commented that the ugly move was the only good move." But the active 27...♖ad8 28.♖×b7 ♖×f3 should draw as well.

**28.♗d5 ♖d8 29.♖b5 ♖a6 30.♗c4 ♖a7 31.♗d5 ♖a6 32.♖c5 ♖d7 33.♔g2 ♖b6 34.♗×c6** The resulting rook endgame is drawn, but there is nothing better and Karpov hopes to use his excellent endgame technique.

**34...b×c6 35.♔f2 ♖d5 36.♖×d5 c×d5 37.♖c1 ♖b4 38.♔e3 ♖×a4 39.♖c5 e6 40.♖c7+ ♔g8 41.♖e7 ♖a3+ 42.♔f4 ♖d3 43.♖×e6 ♖×d4+ 44.♔g5 ♔f7 45.♖a6 a4 46.f4 h6+ 47.♔g4 ♖c4 48.h4 ♖d4 49.♖f6+ ♔g7 50.♖a6 ♔f7 51.h5** A typical lever.



**51...g×h5+?!**

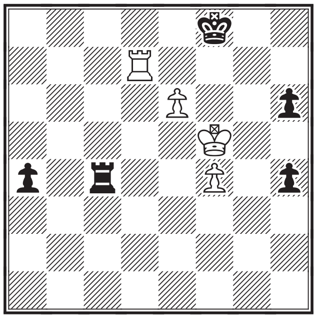
This is asking for trouble. 51...g5 52.♖×h6 ♖×f4+ 53.♔×g5 ♖f1 draws relatively easily. "The machine thought it was down for the first time in the endgame. g5!? may or may not draw at this point. Right after the game, Karpov thought he would still be winning. Afterwards, on the cab back to hotel, he changed the assessment to slightly better for white. After the game move, Black is theoretically lost. According to [Mike] Valvo, 'now he (Karpov) is happy.' Karpov at this time was down to his last few minutes, but it was easy for him from now on." (Hsu 1990)

**52.♔f5** Karpov's king comes to join the attack. **52...♚g7 53.♖a7+** 53.♖g6+!? was a dangerous try, but should also not win against best defense.

**53...♚f8 54.e6 ♜e4 55.♖d7 ♜c4?** 55...a3 56.♖a7 h4 57.♖×a3 ♚e7 58.♖a7+ ♚d6 59.♖d7+ ♚c5 60.♖h7 h3 61.♖×h6 ♜e3= **56.♖×d5 h4 57.♖d3?** 57.♖d8+ ♚e7 58.♖d7+ ♚f8 59.♔e5+− **57...♚e7?**

This invites White's attack. 57...h3 58.♖×h3 ♚e7 59.♖×h6 ♜c5+ 60.♔e4 ♜c4+ 61.♔e5 ♜c5+ 62.♔d4 ♜a5 destroys the attacking coordination and draws.

**58.♖d7+ ♚f8**



**59.♖h7?** Short of time Karpov misses 59.♔e5 h3 60.f5 h2 61.f6 ♜e4+ 62.♔f5+−.
**59...h5?**

The computer returns the favor as this just loses one valuable tempo in the race. 59...h3 60.♖×h6 a3 61.♖×h3 ♜a4 draws.

**60.♔e5 h3** 60...♚g8 61.♖a7 h3 62.♖a8+ ♚g7 63.e7+− **61.f5 ♚g8 62.♖×h5 a3 63.♖×h3 a2** 63...♜a4 64.f6+− **64.♖a3 ♜c5+ 65.♔f6 1–0**

Deep Thought was competitive, but made too many mistakes. But the short-term exhibitions enabled the long-term vision. As Hsu (2002a) quickly discovered, there was also a big upside to moving from academia to industry:

> As a graduate student, I was used to operating with the minimum amount of outlay. We had a nil budget for ChipTest, and a $5,000 budget for Deep Thought. You had better be frugal when you have a budget as tight as we did. To me, it was already a big surprise that IBM agreed to hire a full team immediately…

IBM added personnel to the team, including senior management, hardware design (to help Hsu with his chess chip work), software developer (Joe Hoane, replacing Thomas Anantharaman who left for Wall Street in 1990), and chess expertise (including a short stint with GM Maxim Dlugy).

*Deep Blue team. From left to right: Joe Hoane, Feng-Hsiung Hsu, Murray Campbell.*
*(IBM)*

IBM felt it was important to also keep in touch with the artificial intelligence research community. The Deep Thought team agreed to an exhibition game at the biennial International Joint Conference on Artificial Intelligence (IJCAI), one of the premier AI research events. Against a respectable Australian master, Deep Thought struggled, further evidence that serious work was needed to address the well-known weaknesses in its play.

### Johansen, Darryl (2465) – Deep Thought

English Opening A22
International Joint Conference on Artificial Intelligence, Sydney, 1991

**1.e3 e5 2.c4 ♘f6 3.♘c3 ♗b4 4.♘ge2 0-0 5.a3 ♗e7 6.d4 d6 7.d5!**

White's pieces are not particularly well placed to support this advance but Johansen is aware that Deep Thought (and all chess computers of that time) handled closed positions badly, being unable to form a long-term plan.

**7...c6 8.♘g3 ♗g4? 9.f3 ♗d7 10.♗e2 c×d5 11.c×d5 ♗e8?! 12.0-0 ♘bd7 13.♔h1 ♖c8 14.e4 a6 15.♗e3 ♔h8 16.♖c1 h6 17.♘f5 ♘c5**

Deep Thought has completely run out of ideas and almost all its moves between moves 15 and 22 could be criticized. The basic problem is that Black's only active plan in this type of position is the ...f5 pawn advance, a concept which cannot be taught to a calculating machine such as Deep Thought. However, Deep Thought's waiting moves merely ensure that Johansen's queenside attack can be built up until it is utterly decisive.

**18.b4 ♘cd7 19.a4 ♘g8 20.a5 ♘gf6 21.♕d2 ♖g8 22.♘a4 ♗f8? 23.♘b6 ♘×b6 24.♗×b6 ♕d7 25.♖×c8 ♕×c8 26.♖c1 a8 27.♗c7 ♘h5 28.♘×d6 ♗×d6 29.♗×d6 f6 30.♕e3 ♗a4 31.g3! ♖c8 32.♗c7 ♗e8 33.♕b6 ♗f7 34.b5 a×b5 35.♗×b5 ♗e8 36.d6 ♗×b5 37.♕×b5 1–0** Further material loss through 38.d7 is inevitable.

> **Jaap Van den Herik and Richard Greenblatt (1992)**
> **Computer chess program developers**
>
> *Van den Herik:* And how far do you think [computers] will reach [in performance]?
>
> *Greenblatt:* I do not think there is any reason why it should stop at any particular level.
>
> *Van den Herik:* So in the long run they will defeat the World Champion?
>
> *Greenblatt:* Sure.

> **1992: Checkers**
>
> CHINOOK loses the first Man-Machine World Championship to Marion Tinsley by a score of two wins and four losses in a 40-game match. The match was even closer than portrayed by the score; CHINOOK defaulted one game due to technical problems, and then lost the last game in an all-out attempt to win.

The chess machine continued to use the DEEP THOUGHT moniker despite the move to IBM. With the team developing a newer, faster computer chip and improved chess software, it was time to consider an appropriate name for the successor machine. An internal IBM naming contest led to the selection of the name DEEP BLUE – an obvious choice given IBM's nickname of "Big Blue," a reflection of the color of their logo and, some would say, the synonymous blue suits worn by company salesmen.

In 1993, the IBM chess machine was invited to play exhibition events in Copenhagen. What was the program to be called? DEEP BLUE was the name of the new machine, but the hardware was not ready. The games were played using the DEEP THOUGHT II hardware (14 chess chips) running parts of the new DEEP BLUE software – a DEEP BLUE prototype if you will. DEEP BLUE? DEEP THOUGHT II? In the end, the decision was made to call this hybrid machine DEEP BLUE NORDIC.

Copenhagen featured two events: four-game matches against Bent Larsen and the Danish national chess team. Here was a chance for Larsen to get revenge for his 1988 loss to the program. Robert Byrne (1993) summarized the event in the *New York Times*.

> DEEP BLUE, IBM's successor to its world leader in chess computers, DEEP THOUGHT II, won one match and lost another in Copenhagen, Feb. 24 to 28. DEEP BLUE defeated the Danish national team by a 3-1 score, but lost to the top Dane, Grandmaster Bent Larsen, by 1½-2½ in a second, individual contest.

DEEP BLUE's programmers had hoped for a better result, but explained that they had made several errors that handicapped their machine. Dr. Murray Campbell said: "We were afraid that since we had upped it to 14 processors from the original DEEP THOUGHT's 2, it might use too much time. So we limited its search depth in complex positions." It went wrong in the first game against Larsen and in practice games with the other Danes.

His fellow programmer, Dr. Feng-hsiung Hsu, added, "It was also failing to open diagonals for the bishops." Once the proper adjustments to the program were made, DEEP BLUE easily drew its following games with Larsen and finished with two victories and a draw against the other Danes.

Dr. Campbell said, "Overall, it has the potential to play very well, but it needs more endgame knowledge."

In Game 1 against Larsen, it gave its weakest performance in years.

## Larsen, Bent (2540) – DEEP BLUE NORDIC

Open Games Four Knights Variation C49
Exhibition match (1), Copenhagen, 24.02.1993

Hsu (1993):

Larsen adopted a very simple strategy that worked surprisingly well in the first match game. He traded off all the machine's knights, allowing the machine to have the bishop pair but without an open position to realize the potential of the bishop pair. This really should not have worked if the machine had been told explicitly to trade off some pawns to increase the scope of the bishop pair. This diagnosis, however, came a little bit late, as [in Game 2], Black's opening preparation was also too superficial.

**1.e4 e5 2.♘f3 ♘c6 3.♘c3 ♘f6 4.♗b5 ♗b4 5.0–0 0–0 6.♗×c6 d×c6 7.d3 ♕e7 8.♘e2 ♗g4 9.♘g3 ♘h5 10.h3 ♘×g3 11.f×g3 ♗c5+ 12.♔h2 ♗c8 13.g4 ♗e6 14.♕e2 f6 15.♗e3 ♗×e3 16.♕×e3 h6 17.a4 ♕b4 18.b3 b6 19.♖f2 c5 20.♔g3 ♕a5 21.h4 ♕c3 22.♖af1 ♖ad8 23.g5 ♗×b3 24.c×b3 ♖×d3 25.♕e2 h×g5 26.h×g5 f×g5 27.♖d1 ♖e3 28.♕b2 ♕×b3 29.♕×b3+ ♖×b3 30.♖d5 ♖a3 31.♖×e5 g4 32.♔×g4 c4 33.♖d2 ♖×a4 34.♖d7 ♖c8 35.♘g5 ♖a2 36.♖×c7 ♖a8 37.g3 ♖f2 38.♖ee7 ♔h8 39.♖×g7 ♖h2 40.e5 ♖d8 41.♖h7+ ♖×h7 42.♘×h7 ♖g8+ 43.♘g5 1–0**

Larsen had his moments of concern but was able to draw the three remaining games, scoring a nice 2½-1½ match victory. His post-match comment was (Larsen 2014) "You should not play computers in tournaments, but in laboratories and in circuses. I suppose this was a mixture of both." The venue was irrelevant – it was a most satisfying chess result for him!

**Bent Larsen (1993)**
**Grandmaster**

It's nonsense if they [the DEEP BLUE team] believe that they will be able to build a machine that can beat Garry Kasparov in 1994. Maybe in twenty more years.