the first 100 games was 5.88 points captured per game with average length 35.22. At game 200 the cumulative averages were 7.11 and 36.90 respectively. At game 300, 7.66 and 38.33. At game 400, 7.67 and 37.53 (after a rough spell). At game 500, 8.00 and 37.81. At game 578, 8.24 and 37.64.

There was a lot of interest shown by people observing the demo. For instance, we received over 25 requests for further literature. One observer noted that by the second day Morph had developed "a good sense of the position" and the games appeared "reasonable".

An exciting additional highlight of the Indianapolis demo was the interaction of Morph with novice-level chess-players. In seven games with children at various ages, Morph drew two games and won two. Against chess novice Emily Hollinberger of Indianapolis Morph went 2-1-1 and against her higher rated brother Drew, Morph lost two well-contested games. These games were played with a 1-ply search coupled with a database we had brought with us that had been produced in 4000 games of training by a Morph reaching 10.75 cumulative captured-piece average.

**Playing its trainer**

The following is a draw against GnuChess achieved by this database searching 1-ply in which Morph (White) overlooks a mate-in-2 (lacking the proper pattern):


The next immediate changes we plan for the Morph system will be to include additional refinements for Morph's new selective-search system, a new rote-learning mechanism for recollection of previously seen chess positions, and a major integration of Morph with the Peirce Conceptual Graphs Workbench that is currently being developed by a collaborative group of more than 80 researchers worldwide. It is expected that by this summer Morph will be defeating GnuChess on a consistent basis and will be strong enough to compete against rated human players.

**IBM DEEP BLUE IN COPENHAGEN**

**February 24-28, 1993**

_Feng-hsiung Hsu_

IBM T.J. Watson Research Center

Some time in late 1992, IBM Denmark talked with us about arranging chess exhibition matches, possibly in conjunction with IBM Sweden. At some point, there was talk about playing Swedish GMs as well, but the final arrangement was to play only in Copenhagen and only against Danish players.

Two separate official matches were scheduled, a 4-game match against GM Bent Larsen and a 4-game match against the Danish national team, with the last game against Larsen also counted as part of the team match. So, there are actually only seven official games. Five additional exhibition one-hour sudden-death games were also scheduled during the weekdays. The Copenhagen Chess Union co-sponsored the matches along with IBM Denmark.

The games officially started on February 24 (Wednesday). We arrived early on Friday February 19 in order to participate in a publicity event the next day with the human World Chess Champion Garry Kasparov. We had dinner with Kasparov and the organizers on Friday eve. During the dinner, we first learned about how well prepared the Danes were. Jens Nielsen, who created the Nielsen test set for chess computers (cf. _ICCA Journal_, Vol. 14, No. 1, pp. 33-37), had made a book for the Danish players containing the Deep Thought games,
various relevant articles, pointers about machines’ weaknesses, and so on. We were concerned, but the machine
could not be set up for match preparation over the weekend because of the prescheduled weekend events.

We started setting up the machine on the match site Monday, February 22. The machine room was not
adequately cooled (no air conditioning) and one of the processors overheated and died after a few hours. The
ventilation was improved Tuesday and a test game was played without further mishap.

The machine was referred to as Nordic Deep Blue by the organizers. It is actually a Deep Blue simulation
running on Deep Thought II hardware. The host computer was an IBM RS/6000 550 workstation, and 14
custom chess processors were housed in a separate box communicating with the host via a VXI cable. It
searches 4-5 million nodes/sec at peak speed. The total cost of all the chess-specific processors is about
$24,000.

Over the official 7 games of the matches, the machine scored 4 to 3. The average rating of the opponents is
around 2510-2530. The performance is therefore around 2560-2590 FIDE. Given the well-done preparation by
the opponents and the winning chances it had in some of the drawn games, I have to say that the overall result is
very encouraging. With the new hardware coming up this summer, things should get interesting.

Day 1 (February 24, Wednesday)

This was a disastrous day for us. It was also the first time we fully realized how serious our own lack of
preparation was and how well prepared the opposition was. Frantic work followed after the games.

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 you
will see later. Black’s opening preparation was also too superficial.

GM Bent Larsen - Nordic Deep Blue (NicKey KP 3.3)
Copenhagen, Denmark, 02/24/93 [40/2, 20/1, SD/30min]
Larsen match, game 1
Rf2 c5 20. Kg3 Qa5 21. h4 Qc3 22. Raf1 Rad8 23. g5 Bxb3 24. cxb3 Rxd3 25. Qe2 hxg5 26. hxg5 fxg5 27. Rd1
Ra2 36. Rxc7 Ra8 37. g3 Rf2 38. Ree7 Kh8 39. Rxe7 Rh2 40. e5 Rd8 41. Rh7+ Rxe7 42. Nxh7 Rg8+ 43. Ng5
1-0

After the first Larsen game, there were two exhibition SD/1 games against IM Bjarke Kristensen and IM Jens
Kristiansen; both again ended in disasters. The machine wrongly went after BR on a8, neglected its own king
safety and regretted it two plies later in the game against Bjarke. Jens played an excellent anti-computer game,
although our own opening preparation again has something to do with the bad play by the computer.

Day 2 (February 25, Thursday)

The night before, a few modifications were made to the program. One of them concerned removing the
equivalent of surgical-knife-left-in-the-stomach from the machine’s search-extensions code.

Three more SD/1 exhibition games were played during the day against Bjarke, Jens and IM Svend Hamann
respectively. It drew Bjarke, beat Jens and lost to Svend from a completely winning position. The loss against
Svend had a position that is quite interesting. The machine needed 43 seconds to see the move that it played
loses, but had only 37 seconds allocated. We tried the same position on various commercial programs, and none
of them saw the problem in reasonable time.

The Danish team was probably using the exhibition games to look for additional weaknesses of the program.
We were using them to catch up on our preparations.
The second serious game and the first of the team match was played in the evening. Danielsen was surprised by several sharp moves by the machine, and after 15. Rab1?! was greeted with the unpleasant Bf5. 16. h3? without restraining the d5 Pawn first was probably the losing move, as 16. ... d4 wins material. Although had the machine been too greedy and grabbed the a2 Pawn with 18. ... Qa2, White would have adequate counter play. We slept a little easier this night.

**IM Henrik Danielsen - Nordic Deep Blue (NicKey QP 6.9.1)**

Copenhagen, Denmark, 02/25/93 [40/2, SD/1]

Danish team match, game 1

1. Nf3 Nf6 2. b3 g6 3. g3 Bg7 4. Bb2 0-0 5. Bg2 d6 6. d4 c5 7. 0-0 cxd4 8. Nxd4 d5 9. Na3 e5 10. Nf3 e4 11. Nd4 Nc6 12. c4 Nxd4 13. Qxd4 Bg4 14. Qe3 Qe7 15. Rab1 Bf5 16. h3 d4 wins material. Although had the machine been too greedy and grabbed the a2 Pawn with 18 .... Qa2, White would have adequate counter play.

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**1M Henrik Danielsen - Nordic Deep Blue (NicKey QP 6.9.1)**

Copenhagen, Denmark, 02/25/93 [40/2, SD/1]

Danish team match, game 1

1. Nf3 Nf6 2. b3 g6 3. g3 Bg7 4. Bb2 0-0 5. Bg2 d6 6. d4 c5 7. 0-0 cxd4 8. Nxd4 d5 9. Na3 e5 10. Nf3 e4 11. Nd4 Nc6 12. c4 Nxd4 13. Qxd4 Bg4 14. Qe3 Qe7 15. Rab1 Bf5 16. h3 d4 wins material. Although had the machine been too greedy and grabbed the a2 Pawn with 18 .... Qa2, White would have adequate counter play.

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Copenhagen, Denmark, 02/25/93 [40/2, SD/1]

Danish team match, game 1

1. Nf3 Nf6 2. b3 g6 3. g3 Bg7 4. Bb2 0-0 5. Bg2 d6 6. d4 c5 7. 0-0 cxd4 8. Nxd4 d5 9. Na3 e5 10. Nf3 e4 11. Nd4 Nc6 12. c4 Nxd4 13. Qxd4 Bg4 14. Qe3 Qe7 15. Rab1 Bf5 16. h3 d4 wins material. Although had the machine been too greedy and grabbed the a2 Pawn with 18 .... Qa2, White would have adequate counter play.

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Copenhagen, Denmark, 02/25/93 [40/2, SD/1]

Danish team match, game 1

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the only chess-player at the match site that did not think that Larsen was winning was the machine. If 13. ... e5, then Be7 is annihilating. Larsen could have won a Pawn by 14. Bd6, but might have to give up the attack. The attack petered out into a better ending for Black, but the QN vs QB ending would probably require the like of Karpov to win it.

**GM Bent Larsen - Nordic Deep Blue** (NicKey SD 1.2)
Copenhagen, Denmark, 02/27/93 [40/2, 20/1, SD/30min]

Larsen match, game 3

13. ... Bd6! is critical.
If 13. ... ed5, then Bc7! is annihilating. Larsen could have won a Pawn by 14. Bd6, but might have to give up the attack. The attack petered out into a better ending for Black, but the QN vs QB ending would probably require the like of Karpov to win it.

**GM Lars Bo Hansen - Nordic Deep Blue** (NicKey QO 3.6.7)
Copenhagen, Denmark, 02/27/93 [40/2, SD/1]

Danish team match, game 3

**Day 5 (February 28, Sunday)**

Larsen got into early trouble underestimating 14. f5. Machine probably had a winning edge at move 25, but it willingly went into another unlike-bishops ending without proper assessment. The resultant queen and bishop ending might be winnable had the Queen been traded and the KN Pawn (but not the KR Pawn) become passed. The machine, however, was trying hard to avoid trading the Queen. This time, it did not know that certain unlike-bishops endings are winnable.

**Nordic Deep Blue - GM Bent Larsen** (NicKey SI 14.3)
Copenhagen, Denmark, 02/28/93 [40/2, SD/1]

Larsen match and Danish team match, game 4

**Final result**: Larsen - Deep Blue: 2.5-1.5; Deep Blue - Danish Team: 3-1.