Appendix
CHESS 4.5: Competition in 1976

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The Northwestern chess program entered two tournaments in 1976. The first was the Fourth Annual Paul Masson American Chess Championships held in California on July 24 and 25. The second was the Seventh Annual ACM Computer Chess Championship held at Houston on October 19–21. The same version of the program which had competed in the 1975 National Computer Chess Championship at Minneapolis (see Chapter 1) was entered in both tournaments. In 1976, however, the program was run on a more powerful computer, a large scale Control Data Cyber 170 system.

These tournament games are of interest for two reasons. First, it is worthwhile to determine if the quality of play improves by a significant amount when a chess program is run on a more powerful machine. Second, both tournaments involved competition against human opponents. The only previous games for CHESS 4.5 against a human opponent were those against David Levy at Minneapolis (see Chapter 1).

The Paul Masson American Chess Championships

CHESS 4.5 was entered in the B section of the California tournament. It played against 5 human opponents with USCF ratings ranging between 1693 and 1784. The program had a perfect 5–0 score. Nobody was more surprised at this outcome than the authors, David Slate and Larry Atkin. They have consistently maintained that the program is about C class in strength. One of the human opponents at the Paul Masson tournament remarked that the program was the "strongest 1572 player that he had ever seen." Three of the games from the California tournament are presented.

Paul Masson, Round 1

WHITE CHESS 4.5		BLACK Neil Regan (1693)	
1. P–K4	P–QB4	2. N–KB3	N–QB3
3. P–Q4	PxP	4. NxP	P–KN3
5. N–QB3	B–N2	6. B–K3	N–B3
7. B–QB4	Q–R4	8. O–O	O–O
9. N–N3	Q–B2	10. P–B3	P–Q3
11. N–N5	Q–N1	12. Q–K2	P–QR3
13. N–B3	B–Q2	14. P–QR4	N–QN5
15. B–N6	Q–B1	16. N–R5	N–B3
17. NxN	QxN	18. P–R5	R/R–B1
19. B–Q5	NxB	20. PxN	Q–B5
21. QxP/K7	B–N4	22. QxP/Q6	B–Q5+
23. BxB	QxB+	24. R–B2	R–B3
25. Q–R3	R–B5	26. R–Q1	R–K1
27. RxQ	R–K8+	28. R–B1	RxR+
29. KxR	RxN+	30. K–B2	RxQ
31. PxR	Resigns		

Paul Masson, Round 4

WHITE Wesley White (1742)		BLACK CHESS 4.5	
1. P–K4	N–QB3	2. P–Q4	P–Q4
3. P–K5	P–B3	4. P–KB4	B–B4
5. N–KB3	P–K3	6. P–QR3	N–R3
7. B–Q3	PxP	8. P/BxP	B–K5
9. O–O	BxN	10. RxB	NxP/Q5
11. B–N6+	PxB	12. QxN	P–B3
13. Q–Q3	N–B4	14. P–KN4	B–B4+
15. K–B1	N–R5	16. P–N4	NxR
17. QxP/N6+	K–Q2	18. PxB	Q–KB1
19. B–B4	RxP	20. N–B3	NxP/K4
21. Q–N5	N–B2	22. Q–N6	R–R8+
23. K–N2	RxR	24. N–K2	RxP/R6
25. N–Q4	R–K1	26. P–N5	N–R1
27. NxP/K6	RxN	28. Q–R7	QxB
29. QxP+	R–K2	30. QxN	R–K7+
31. K–R1	Q–KB8 Mate		

Paul Masson, Round 5

WHITE CHESS 4.5		BLACK Herbert Chu (1784)	
1. P–K4	P–K3	2. P–Q4	P–QN3
3. N–KB3	B–N2	4. N–B3	B–N5
5. B–Q3	N–KB3	6. B–KN5	P–KR3
7. BxN	QxB	8. O–O	P–KN4

9. Q–Q2	N–B3	10. P–QR3	B–K2
11. N–N5	B–Q1	12. P–K5	Q–N2
13. Q–K3	P–R3	14. N–B3	P–N5
15. N–K1	B–N4	16. P–B4	B–K2
17. P–B5	PxP	18. BxP/B5	NxP/Q5
19. BxP/Q7+	KxB	20. QxN+	K–B1
21. N–Q3	K–N1	22. Q–Q7	Q–N4
23. RxP/B7	Q–K6+	24. K–R1	B–Q1
25. QxP/N4	K–R2	26. P–K6	B–N4
27. R–K1	R/KR–KN1	28. RxQ	BxR
29. R–N7	R/R–KB1	30. P–KR4	Resigns

ACM Computer Chess Championship, 1976

At Houston, the annual battle between computer programs followed a familiar script. At the end of the first three rounds, two programs had a perfect 3–0 record. One was CHESS 4.5 and the other was CHAOS. Both programs were running on powerful machines: CHESS 4.5 on an advanced CDC Cyber 170 system at Minneapolis and CHAOS on an Amdahl computer at the University of Michigan.

ACM, 1976, Round 4

WHITE CHESS 4.5		**BLACK CHAOS**	
1. P–K4	P–QB4	2. N–KB3	N–QB3
3. P–Q4	PxP	4. NxP	N–B3
5. N–QB3	P–K3	6. NxN	P/NxN
7. P–K5	N–Q4	8. NxN	P/BxN
9. B–Q3	P–N3	10. O–O	B–KN2
11. Q–K2	B–N2	12. P–QN3	Q–K2
13. P–QR4	Q–N5	14. B–R3	Q–B6
15. P–B4	P–B3	16. B–Q6	P–B4
17. P–R5	K–B2	18. Q–B2	B–KB1
19. BxB	R/KRxB	20. Q–R4	Q–B4+
21. K–R1	K–N2	22. P–QN4	QxP/N5
23. R/R–N1	QxP/R4	24. RxB	Q–R5
25. B–N5	Time Forfeit		

During the tournament, CHESS 4.5 played several "blitz" games against interested spectators. Special rules were adopted. The human player had 5 minutes of clock time for the entire game. The machine was set to average 5 seconds of computation time for each move. In tournament play, the machine usually averages about 80 seconds per move. If the human player had not exhausted his 5 minutes by the 60th move, he automatically won. Two of these "blitz" games are presented below.

ACM, 1976, Demonstration

WHITE Englebretson (2039)		BLACK CHESS 4.5	
1. N–QB3	N–QB3	2. P–K4	P–K3
3. P–Q4	P–Q4	4. P–K5	P–B3
5. P–B4	Q–Q2	6. N–B3	Q–B2
7. B–N5	P–QR3	8. BxN+	PxB
9. O–O	R–N1	10. Q–K2	N–R3
11. K–R1	B–K2	12. PxP	QxP
13. N–K5	R–N3	14. Q–R5+	N–B2
15. B–K3	RxP/N7	16. NxP/B6	RxP/B7
17. NxB	KxN	18. N–R4	N–Q3
19. N–B5	N–B4	20. B–N1	NxP
21. BxN	QxB	22. N–N3	Q–B3
23. R/B–K1	QxP	24. R–KB1	R–KB7
25. RxR	QxR	26. Q–N5+	Q–B3
27. Q–N3	P–K4	28. R–QB1	P–B3
29. P–KR3	R–B1	30. N–R5	B–Q2
31. Q–R3+	Q–Q3	32. Q–KN3	K–B2
33. N–N7	Q–K2	34. N–B5	P–K5
35. NxP/R6	K–N1	36. R–K1	P–B4
37. N–B7	P–Q5	38. N–Q5	Q–K3
39. N–B4	Q–QB3	40. N–R5	Q–KN3
41. QxQ	PxQ	42. N–N3	P–K6
43. K–N1	R–K1	44. K–B1	P–Q6
45. K–N1	P–Q7	46. R–Q1	B–R5
47. R–N1	P–B5	48. N–K2	B–B7
49. R–R1	P–Q8=Q+	50. RxQ	BxR
51. N–B3	P–K7	52. NxP	RxN
53. P–QR4	P–B6	54. P–R5	P–B7
55. P–R6	P–B8=Q	56. P–R7	Q–B3
57. P–R8=Q+	QxQ	58. Resigns	

ACM, 1976, Demonstration

WHITE Brieger (2131)		BLACK CHESS 4.5	
1. P–K4	N–QB3	2. P–Q4	P–Q4
3. P–K5	P–B3	4. P–KB4	B–B4
5. P–KN4	B–K5	6. N–KB3	NxP/Q5
7. NxN	BxR	8. P–K6	P–QR3
9. B–Q3	P–QB4	10. P–N5	Q–Q3
11. Q–R5+	K–Q1	12. Q–B7	K–B2
13. N–B5	Q–N3	14. N–N3	B–B6
15. N–B3	PxP/N4	16. PxP/N5	P–Q5

17. B–KB4+	K–B3	18. B–K5	B–Q4
19. NxB	QxP	20. R–Q1	KxN
21. Q–B5	K–B3	22. Q–K4+	K–N3
23. Q–Q5	Q–N5+	24. K–K2	P–R3
25. Q–Q7	PxP	26. Time Forfeit	

Second Appendix
CHESS 4.5 and CHESS 4.6: Competition in 1977 and 1978

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Early in 1976, there were very few knowledgeable individuals who would have wagered that a computer chess program could hold it own against a strong human player (USCF rating above 2000). Slate and Atkin, in particular, estimated the strength of their program at this time to be about 1800 on the USCF scale. Although it is no small achievement to develop a program which can play at this level, a rating of 1800 is not particularly impressive in world-class chess. This level of skill is clearly inconsistent with the claim that a machine will soon be the world champion.

In the last two years, improvements in the program and the availibility of more powerful computing equipment have led to a reassessment of machine chess ability. After a period of high expectations and relatively little progress in the early 1970s, these recent developments are quite encouraging. The first signal came in July, 1976 when CHESS 4.5 won the Class B section of the Paul Masson American Chess Championship in California. The message became louder in February, 1977 when CHESS 4.5 won the 84th Minnesota Open Tournament against expert and high Class A players. One of the games in particular demonstrated that CHESS 4.5 could play an entire game of reasonably good chess. The game with Charles Fenner, in fact, was one of the best games ever played by a computer.

84th Minnesota Open, Round 2
February 19, 1977

WHITE CHESS 4.5, CYBER 176	BLACK Charles Fenner (2016)	Computing Time
1. P–K4	P–QB4	Book
2. N–KB3	P–K3	Book

3. P–Q4	PxP	Book
4. NxP	P–QR3	Book
5. P–QB4	N–KB3	Book
6. B–Q3	Q–B2	Book
7. O–O	B–B4	110
8. N–N3	B–R2	67
9. N–B3	N–B3	64
10. B–N5	N–K4	83
11. BxN	PxB	128
12. Q–K2	P–Q3	59
13. K–R1	B–Q2	47
14. P–B4	NxB	59
15. QxN	O–O–O	345
16. R/R–Q1	B–B3	99
17. P–KB5	B–N1	95
18. P–N3	P–KR4	99
19. PxP	P–R5	62
20 RxP	PxP/6	71
21. QxP/3	R/Q–N1	88
22. PxP	QxP	67
23. RxQ	RxQ	161
24. N–Q5		197
Fenner offers a draw, 4.5 declines		
24.	B–K1	
25. N–N6+	K–Q1	67
26. RxP/7	B–B3	266
27. RxB+	K–B2	67
28. R–QB8+	RxR	1
29. PxR	BxP+	102
30. K–N1	R–KR1	269
31. N–Q5+	K–B3	173
32. N–R5+	Resigns	204

96 seconds per move average

In March, 1977, Donald Michie attempted to set up an official match between CHESS 4.5 and David Levy to determine if a computer was capable of defeating the International Master. If Levy lost, Kozdrowicki, Michie, McCarthy, and Papert would be able to collect on their famous wager. If no program beats Levy by September, 1978, then Levy will collect. Although Slate and Atkin were not optimistic about their program's chances, they consented to the match and David Cahlander arranged for the CYBER 176 to be available at Control Data headquarters in Minneapolis. The match was held on April 1, 1977 at Carnegie-Mellon University in Pittsburgh.

Levy Challenge Game
April 1, 1977

WHITE CHESS 4.5, CYBER 176	BLACK David Levy	Computing Time
1. P–K4	P–QB4	Book
2. N–KB3	P–Q3	Book
3. P–Q4	PxP	Book
4. NxP	N–KB3	Book
5. N–QB3	P–KN3	Book
6. P–B3	B–N2	Book
7. B–K3	O–O	Book
8. Q–Q2	N–B3	Book
9. B–QB4	P–QR3	Book
10. NxN	PxN	70
11. O–O	N–Q2	209
12. P–B4	N–N3	193
13. B–K2	B–K3	80
14. P–QN3	N–B1	59
15. P–QR3	Q–R4	163
16. P–QN4	Q–B2	93
17. P–B5	B–Q2	121
18. B–R6	Q–N3+	644
19. K–R1	Q–Q5	115
20. QxQ	BxQ	75
21. R–B3	B–N2	118
22. BxB	KxB	143
23. R–QN1	N–N3	107
24. R/3–B1	R/B–QN1	153
25. R/N–Q1	P–B3	46
26. P–QR4	P–QR4	129
27. P–N5	PxP/N	68
28. PxP/5	R–QB1	134
29. R–Q3	R–B4	143
30. R–N3	R/1–QB1	243
31. R/1–B3	P–R5	118
32. P–R4	P–R6	64
33. PxP	PxP	391
34. R–K3	B–K3	249
35. P–R5	P–N4	245
36. N–Q5	P–R7	75
37. R–QR3	BxN	142
38. PxB	RxP/7	148
39. B–Q1	R–Q7	318
40. K–R2	R–B8	137
41. B–N3	P–R8=Q	118
42. RxQ	RxR	63
43. R–K3 and resigns		

122 seconds per move average

This convincing win gave notice that Levy is not planning to lose his wager. It would appear that Levy's considerable experience with computer chess is an important asset when he competes against a machine. His playing style in this game clearly took advantage of the machine's inability to make long-range plans.

During the spring and summer of 1977, several changes were made in the Northwestern chess program in preparation for the Second World Computer Chess Championship to be held in August in Toronto, Canada. As a reflection of these changes, the program's name was altered from CHESS 4.5 to CHESS 4.6. One of the modifications was the capacity to "think" on the opponent's time. While the opponent is thinking or calculating, CHESS 4.6 works on a reply to the move which seems most likely. If the opponent subsequently makes this move, the machine is prepared to make a quick reply. If not, then CHESS 4.6 starts afresh and calculates a reply in the normal fashion.

In addition, several coefficients in the evaluation function were changed (the primary change involved a heavier weighting for King safety), the quiescence search was expanded to include additional checking moves, and the efficiency of the transposition table was enhanced. A new option was also introduced which permits moves to be entered in algebraic notation.

CHESS 4.6 had a successful tournament at Toronto, winning all 4 of its matches. The major event of the tournament was expected to be the game between CHESS 4.6 and the Russian program, KAISSA. Unfortunately, the tragedy of Stockholm reoccurred, except this time in reverse. KAISSA was unexpectedly beaten in the first round by DUCHESS, an American program written at Duke University. Because of this loss, KAISSA never had enough points to be paired with CHESS 4.6. In a replay of Stockholm, a demonstration match between KAISSA and CHESS 4.6 was arranged after the regular tournament.

Demonstration Game, Second World Computer Championship
August 8, 1977

WHITE—KAISSA (USSR)	BLACK CHESS 4.6 (USA)	Computing Time
1. P–K4	N–QB3	Book
2. N–KB3	P–K3	Book
3. P–Q4	P–Q4	Book
4. B–Q3	PxP	222
5. BxP	B–Q2	288
6. O–O	N–B3	65
7. R–K1	NxB	78
8. RxN	B–K2	84
9. P–B4	P–B4	67
10. R–K1	O–O	77
11. N–B3	P–B5	74
12. Q–Q3	Q–K1	196

13. P–KN3	PxP	135
14. P/RxP	Q–B2	215
15. B–B4	P–KN4	84
16. P–Q5	PxP	329
17. NxP/Q	PxB	61
18. NxB+	NxN	343
19. QxB	N–N3	300
20. QxQ+	RxQ	286
21. P–KN4	R–Q2	349
22. R/R–Q1	R/1–Q1	84
23. RxR	RxR	242
24. K–N2	K–N2	70
25. N–N5	R–Q7	75
26. R–QN1	R–B7	118
27. P–N3	N–K4	216
28. R–KR1	RxP/R	221
29. R–R4	N–Q6	77
30. N–R3	R–N7	413
31. P–N5	K–N1	233
32. NxP	RxP/7+	411
33. K–N3	RxN	216
34. RxR	NxR	83
35. KxN	K–B2	148
36. P–N4	K–K3	161
37. K–K4	P–QR3	185
38. K–B4	K–Q3	158
39. K–K4	P–B4	179
40. PxP+	KxP	143
41. K–Q3	P–QR4	174
42. K–B3	P–R5	135
43. K–Q3	K–N5	137
44. K–B2	KxP	115
45. Resigns		

163 seconds per move average

On the basis of the tournament results, Levy concluded that "American computer programs dominate the world scene even more than Eastern European chess players dominate the human circuit" (*Chess Life and Review*, Jan., 1978, p. 33).

One of the surprising discoveries in computer chess is that a full-width program can compete effectively at speed chess. In fact, the evidence suggests that these programs may be better at speed chess (relative to humans) than at regular tournament chess. Because the machine cannot manipulate the chess pieces,[1] special rules are employed for speed chess. The human player has 5 minutes total time as usual. The machine is set to average 5 seconds per move. If the machine has not given mate or announced mate

[1] Slate and Atkin are working on a robot arm which may correct this limitation.

by move 60, it loses on time.

An interesting example of blitz chess played under these special rules occurred in September, 1977 in London at the Aaronson chess tournament. The opponent was Michael Stean, a grandmaster with a rating of 2485. David Levy moved the pieces for the program.

Blitz Chess against Michael Stean in London
September 18, 1977

WHITE CHESS 4.6, CYBER 176	BLACK Michael Stean (2485)	Computing Time
1. P–K4	P–QN3	Book
2. P–Q4	B–N2	2
3. N–QB3	P–QB4	10
4. PxP	PxP	3
5. B–K3	P–Q3	6
6. B–QN5+	N–Q2	6
7. N–B3	P–K3	3
8. O–O	P–QR3	2
9. BxN+	QxB	6
10. Q–Q3	N–K2	8
11. R/R–Q1		
Stean: The damned computer has one of my pawns.		
	R–Q1	
12. Q–B4	N–N3	14
13. R/B–K1	B–K2	3
14. Q–N3	Q–B3	3
15. K–R1	O–O	9
16. B–N5	B–R1	6
17. BxB	NxB	5
18. P–QR4	R–N1	8
19. Q–R2	R–N5	3
20. P–QN3	P–B4	5
21. N–KN5	PxP	8
22. N/3xP	RxP/7	14
23. RxP	QxR	6
24. NxQ	RxP/N7	4
25. N/5–K4	R–N5	17
26. P–B4	N–B4	3
27. P–R3		3
Stean: This computer is a genius.		
	N–N6+	
28. K–R2		4
Stean: Help.		
	RxN	
29. Q–KB2	P–R3	20
30. NxR	NxN	5
31. Q–B3	R–N1	10
32. RxN	R–KB1	6
33. Q–N4	BxR	6

34. QxP/6+	K–R1	10
35. QxB	R–B3	4
36. Q–K5	R–QN3	5
37. QxP/5	RxP	9
38. Q–QB8+	K–R2	7
39. QxP	Resigns	3

7 seconds per move average

Sometimes the computer makes moves which have a mechanical appearance. An observer might comment that only a dumb machine would play like that. There are other times, however, when the program makes moves which are quite creative and seem to be alarmingly human. In the following match, which has been dubbed the "game of symmetry," the machine seems to be hiding an impish smile.

The Twin-Cities Open
April 29, 1978

WHITE Bill Elger (1668)	**BLACK CHESS 4.6, CYBER 176**	**Computing Time**
1. P–QB4	N–KB3	Book
2. N–QB3	P–Q4	Book
3. PxP	NxP	Book
4. P–K4	N–N5	Book
5. P–Q4	QxP	55
6. QxQ	N–B7+	145
7. K–Q1	NxQ	51
8. B–KB4	P–QB3	74
9. B–K5	N–K3	66
10. N–B3	N–Q2	52
11. B–N3	P–QN4	77
12. P–QR3	P–N4	104
13. B–Q3	N/2–B4	379
14. B–B2	B–KN2	292
15. P–R3	B–N2	65
16. R–K1	R–Q1+	64
17. K–K2	B–QR3	80
18. K-K3	B–R3	200
19. N–K5	P–KN5+	121
20. P–B4	PxP e.p.+	100
21. K–B2	R–Q7+	165
22. Resigns		

100 seconds per move average

In May, 1978, CHESS 4.6 entered a simultaneous exhibition sponsored by the Minnesota Chess Association. Walter Browne, current United States champion, took on 44 different opponents at one time. In a simultaneous exhibition, the grandmaster proceeds from one board to the next in steady

procession and each opponent is required to move when the grandmaster reaches his table. In this environment, successive moves may be separated by rather long breaks, especially during the middle-game. Because of this arrangement, CHESS 4.6 had more time to calculate each move than normally would be the case in a regular tournament. Walter Browne also had the considerable handicap of playing 43 other opponents at the same time. Despite this, Browne indicated before the exhibition that he fully expected to beat the machine. The result did not fulfill this expectation; in fact, CHESS 4.6 played a remarkably solid game.

Walter Browne Simultaneous Exhibition
May 6, 1978

WHITE Walter Browne (2547)	BLACK CHESS 4.6, CYBER 176	Computing Time
1. P–Q4	N–KB3	Book
2. P–QB4	P–B4	Book
3. N–KB3	PxP	Book
4. NxP	P–K4	Book
5. N–N5	B–B4	Book
6. N/1–B3	O–O	162
7. P–K3	P–Q3	142
8. B–K2	P–QR3	158
9. N–R3	N–B3	248
10. N–B2	B–B4	241
11. O–O	Q–Q2	255
12. P–QN3	K–R1	395
13. B–N2	R–KN1	356
14. N–R4	B–R2	458
15. B–R3	P–R3	272
16. R–B1	R/R–Q1	503
17. N–N4	NxN	254
18. BxN	Q–B2	70
19. Q–K1	B–B4	527
20. B–KB3	B–Q6	395
21. BxB	PxB	410
22. B–K2	B–B4	426
23. P–B3	P–K5	535
24. P–B4	B–Q2	468
25. N–B3	Q–R4	364
26. Q–R4	B–B3	349
27. R–QB2	P–QN4	285
28. P–KN4	P–N5	387
29. N–Q1	R–Q3	517
30. N–B2	R/1–Q1	302
31. R–Q1	RxR+	295
32. BxR	R–Q3	357
33. Q–N3	Q–Q1	511
34. R–B1	R–Q7	255

35. P–N5	PxP	460
36. PxP	N–R2	560
37. P–N6	PxP	486
38. QxP	Q–R5	226
39. Q–B5	B–Q2	330
40. Q–B4	QxQ	292
41. PxQ	P–K6	319
42. N–K4	P–K7	248
43. BxP	RxB	203
44. NxP	B–B1	176
45. R–Q1	R–K1	139
46. P–QR3	PxP	116
47. R–R1	P–N4	176
48. PxP	R–K4	85
49. P–N4	P–R4	92
50. N–Q3	RxP+	69
51. K–B2	PxP	61
52. NxP	R–QR4	115
53. K–K3	B–K3	72
54. K–Q4	N–N4	81
55. N–B2	P–R7	79
56. N–N4	R–R5	45
57. K–B5	N–K5+	118
58. K–N5	B–Q2+	90
59. N–B6	N–B6+	67
60. K–B5	BxN	48
61. KxB	RxP+	90
62. K–Q6	R–Q5+	52
63. K–K5	R–Q8	31
64. Resigns		

Many observers (including Levy) have remarked that computer programs are especially weak in the endgame. The play of CHESS 4.6 in the last 15 or so moves of this match is anything but weak. It may be that this game is an exception to the rule or it may be that the endgame weakness theme has been overplayed.

At the present time (July, 1978), David Slate is working on a new version of the Northwestern program, CHESS 5.0. The new program is written entirely in Fortran and can be easily converted to run on other machines. In addition, the new program has a cleaner structure than its assembly-language predecessor and can be modified more easily. If completed by the end of August, this program is destined to compete with David Levy to conclude the famous wager. If present plans are fulfilled, CHESS 5.0 will run on one of the most powerful computers, the Cray-1. The match late this summer may be interesting.

Appendix to the second edition

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A great deal has transpired in the world of computer chess since 1978 when the first edition of this book was published. The technical aspects of chess programming have not changed very much and thus the information provided in the original chapters is still current. Despite the lack of progress in theory, hardware modifications and software finesse have definitely produced a noticeable improvement in across-the-board play.

Here we present a selection of games played by computers in organized competition since the publication of the first edition. Some of these games were chosen because they represent exciting chess and are enjoyable for that reason alone. Others illustrate trends that have developed over the last few years, such as the ascendance of super-brute-force chess computers using custom-made chess-specific hardware, and the proliferation and marked improvement of microprocessor-based programs. In addition, a few games were selected because they demonstrate problems in chess programming or problems with the way that computer chess tournaments are currently run.

It was very difficult to make this selection. There have been many tournaments and many interesting games. A comprehensive record of computer chess play is available through the newsletter published by the International Computer Chess Association (ICCA). The interested reader can receive additional information by writing directly to the ICCA at Vogelback Computing Center, Northwestern University, Evanston, Illinois, 60201, USA.

Game 1: 1978 North American Computer Chess Championship Round 2, December 3, 1978, Washington, D.C.

Belle (White) vs. Chess 4.7 (Black)

Belle consists of specially constructed computer-chess hardware driven by a DEC PDP-11 computer. It was designed, built, and programmed by Ken Thompson and Joe Condon of Bell Telephone Laboratories in Murray Hill, New Jersey. Ken is an officer and active participant in the ICCA. A description of the most recent version of Belle appears as one of the two new chapters that were prepared for the second edition of this book.

Chess 4.7, by David Slate of Northwestern University and Larry Atkin, formerly of Northwestern, was the reigning world champion at the time this game was played. Chess 4.7 had developed a reputation as the most successful example of the "brute-force" tree-searching techniques, examining an average of 3600 positions per second on the Control Data Cyber 176. In this game, it became a victim of brute force, losing a tense tactical battle to Belle, who at this time weighed in at about 5000 positions per second.

Notes accompanying the game score are by Hans Berliner (HB) of Carnegie-Mellon University, and by David Slate (DS). David's remarks include information from the machine records which were printed at the tournament site by Belle and Chess 4.7.

White Belle	Black Chess 4.7
1. e2–e4	Nb8–c6
2. d2–d4	d7–d5
3. Nb1–c3	

HB: This is undoubtedly the best move against this frequently essayed opening of Chess 4.7. Black is forced to play 3. . . . e7–e6, after which he gets a cramped French Defense position because c7–c5 cannot be played immediately. If instead Black played 3. . . . d5xe4, White would reply d4–d5 with an advantage.

3.	e7–e6
4. Ng1–f3	Bf8–b4
5. e4–e5	Ng8–e7
6. Bc1–d2	Ne7–f5
7. Nc3–e2	Bb4–e7
8. c2–c3	O–O
9. Ne2–f4	f7–f6

HB: White has achieved a slight space superiority and Black must now break here in order to alleviate the pressure since the usual c7–c5 requires too much preparation.

10. Bf1–d3 f6xe5
11. d4xe5

HB: After 11. Nf3xe5 Black can play Be7–f6 with a satisfactory game.

11. . . . . g7–g5!

HB: A fine, though antipositional idea. Black must create some room for himself on the K-side before White gets too strong there. The weakening of the K-side is two sided as White must also weaken himself or submit to the loss of a pawn.

12. g2–g4!

HB: Best. After 12. Nf4–h5, g5–g4 followed by Nc6xe5 Black will gain enough time and space to be able to overcome any adverse effects due to his open king's position.

DS: Belle's 12. g2–g4 was predicted by Chess 4.7.

12. . . . . Nf5–g7!
13. Nf4–g2 b7–b6?

HB: Here I suspect most Masters would play the "automatic" 13. . . . Rf8xNf3, 14. Qd1xRf3, Nc6xe5, 15. Qf3–e2, Ne5xBd3, 16. Qe2xNd3, e3–e4. This results in settling upon White a very inferior pawn position and inactive minor pieces against Black's fine center and active minor pieces; cetrainly worth half a pawn. In view of what transpires, Black's play must be judged inferior. In any case, White is not interested in preventing this line.

14. Qd1–e2 Bc8–b7
15. Rh1–g1

HB: Probably White does not play the beckoning 15. h2–h4 because of Rf8xNf3, 16. Qe2xRf3, Nc6xe5, 17. Qf3–e2, Ne5xBd3+, 18. Qe2xNd3, g5xh4, which gives Black two pawns for the exchange; however, it would be appropriate for White to prepare for this thrust along the rook file by 15. O–O–O. If above, 17. Bd3xh7+, Kg8xBh7, 18. h4xg5+, Kh7–g8, 19. Qf3–h3, with a wild position that White need not let himself in for. The text is weak.

15. . . . . a7–a5

HB: Both sides are hard put for a good idea. On this and the next moves, Rf8xNf3 is stronger than ever before, and White should castle on the queen's side.

16. a2–a4	Kg8–h8
17. h2–h3	Kh8–g8
18. Rg1–h1	h7–h6
19. h3–h4	d5–d4

HB: Why has Black not tried this obvious move before? The answer is that it leads to a ferocious attack for White. White should now play 20. Qe2–e4!, Rf8xNf3, 21. Qe4–h7+ (not Qe4xRf3, Nc6xe5 with a good game for Black), Kg8–f8, 22. Bd3–g6!, Be7–f6!, 23. e5xBf6, Qd8xf6, 24. h4xg5, h6xg5, 25. Bg6–e4, Rf3xf2, 26. Bd2xg5 with a winning position for White. Black, seeing much danger, but not being able to see to the end of all this, considers this to be his best chance. He would have been better advised to have played 19. . . . Rf8xNf3 (better late than never), 20. Qe2xRf3, Nc6xe5, 21. Qf3–e2, Ne5xBd3+, 22. Qe2xNd3, e6–e5, 23. Qd3–g6, Qd8–d6, 24. Qg6xQd6, c7xd6, with Black having somewhat the worst of it.

DS: Here Chess 4.7 did predict 20. Qe2–e4, Rf8xNf3 as Hans suggests, but then predicted the inferior continuation 21. Qe4xRf3, Nc6xe5, with slight advantage to Black.

20. h4xg5?	Nc6–b4!!

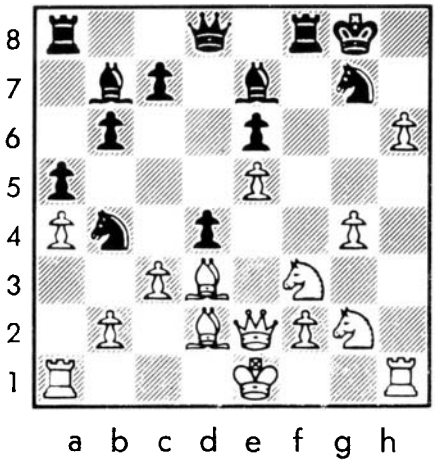
HB: A tremendous move which now makes White play correctly to save himself. After the correct 21. c3xNb4, Bb7xNf3, 22. Bd3–h7+, Kg8–h8! (not Kg8xBh7, 23. Rh1xh6+, Kh7–g8, 24. Qe2–d3, Bf3xNg2, 25. Qd3–h7+ leading to mate), 23. Rh1xh6! (not 23. Qe2–d3, Be7xg5, 24. Qd3–g6!, Bf3xNg2, 25. Bd2xBg5, Qd8xBg5 and Black has a decent position), Bf3xQe2, 24. Bh7–b1+, leading to a draw by repetition. Less exact would be 21. Rh1xh6?!, Rf8xNf3!, 22. c3xNb4, Be7xg5, 23. Rh6–h2, a5xb4, with a wild position which appears to favor Black.

DS: Here Chess 4.7 did a six-ply search and predicted an eight-ply (remember the quiescence search) principal variation which exactly matched the moves actually played through 24. Nf3xd2. This included the blunders by both sides: 21. g5xh6??, Nb4xBd3+??. Unfortunately, Chess 4.7 scored this line as only a small advantage for White, not realizing the power of White's resulting attack, and not seeing the strength of the alternative 21. . . . d4xc3.

21. g5xh6??

HB: A blunder that should lose because now the attack on the rook file is gone.

DS: Belle predicted 21. . . . Nb4xBd3+, 22. Qe2xNd3, Rf8xNf3, 23. h6–h7+, Kg8–f7, 24. Qd3xd4, with a small advantage for Black.



21. . . . . Nb4xBd3+??

HB: Black returns the compliment and lands in an irrevocable loss. From the theoretical point of view this must be the worst move ever made by any version of the Northwestern program; it turns a sure win into a sure loss. From a practical point of view the situation is anything but easy. 21. . . . d4xc3 wins by force as White then has three pieces *en prise* and cannot begin to save all of them. If 22. B–h7+, Kg8xBh7, 23. h6xNg7+, Kh7xg7, 24. Bd2–h6+, Kg7–g8, 25. Ra1–d1 (Bh6xRf8, Qd8xBf8 leaves Black in complete control), Bb7xNf3!!, 26. Rd1xQd8, Ra8xRd8, 27. Bh6xRf8, Bf3xQe2 and Black wins. Less precise is 21. . . . Bb7xNf3, 22. h6xNg7!, Bf3xQe2, 23. g7xRf8=Q+, Be7xQf8, 24. Bd3–h7+ and White still has many chances. After the text move, NxB, however, Black is hopelessly lost.

DS: Chess 4.7 changed its predicted line, but still saw only a small advantage for White, and, of course, missed 21. . . . d4xc3. It thought for 888 seconds, and had to terminate its eight-ply search before completing it. The principal variation it found was 22. Qe2xNd3, d4xc3, 23. Qd3xc3, Rf8xNf3, 24. h6–h7+, Kg8–h8.

22. Qe2xNd3

DS: Belle predicted 22. . . . d4xc3, 23. Qd3–g6, c3xBd2+, 24. Nf3xd2, Rf8–f7, 25. h6–h7+, Kg6–h8, 26. Qg6xRf7 with slightly more than a pawn advantage for White.

22. . . . . d4xc3

DS: Now Chess 4.7 calculated an advantage of nearly two pawns for White.

23. Qd3–g6!

HB: This must be what was not appreciated by Chess 4.7. White's attack is now overwhelming and Black dare not capture any more material.

23.	. . . . .	c3xBd2+

DS: Chess 4.7 now sees White's advantage at three and one-half pawns. Its view of the impending disaster was 24. Nf3xd2, Rf8–f7, 25. h6xNg7, Rf7xg7, 26. Qg6xe6+, Rg7–f7.

24.	Nf3xd2	Rf8–f7
25.	h6xNg7	Rf7xg7
26.	Qg6xe6+	Rg7–f7
27.	Qe6–h6!	Rf7–g7
28.	Qh6–h8+	Kg8–f7
29.	e5–e6+	

HB: Winning the exchange and more; in effect, ending the game.

29.	. . . . .	Kf7xe6
30.	Qh8xRg7	Bb7xNg2
31.	Rh1–h6+	Ke6–d7
32.	O–O–O	

HB: After all these hours of indecision about where to take up a royal residence! The rest is silence. It is interesting that two such search-oriented programs whose strong suit is obviously tactics should make so many tactical errors. The answer is in the fact that the outcomes of the various tactical forays were far from easy to evaluate insofar as mating and material threats abounded even after a quiet move terminated the quiescence search. Thus even Chess 4.7, with its excellent judgment of positions, was fooled.

32.	. . . . .	Bg2–d5
33.	Nd2–e4	Kd7–c8
34.	Rh6–h8	Bd5xNe4
35.	Rd1xQd8	Be7xRd8
36.	Qg7–e7	Kc8–b7
37.	Qe7xBe4+	Kb7–a7
38.	Rh8–g8	Ra8–b8
39.	g4–g5	Bd8–e7
40.	Rg8xRb8	Be7xg5+
41.	f2–f4	Bg5xf4+
42.	Qe4xBf4	Ka7xRb8
43.	Kc1–d2	Kb8–b7
44.	Kd2–d3	Kb7–c8
45.	b2–b4	a5xb4
46.	Qf4xb4	Kc8–d7
47.	Qb4–b5+	Kd7–d8
48.	Kd3–d4	Resigns

(1–0)

This win for Belle was a portent of things to come. Chess 4.7 reflected a decade of progress for a particular philosophy of chess programming and had reached somewhat of an asymptote for this strategy as implemented on a conventional supercomputer. Belle incorporated this same philosophy but in a more powerful hybrid machine. In succeeding years, Ken Thompson and Joe Condon increased their speed advantage and the authors of Chess 4.7 quietly readied their creation for the museum. David Slate had already begun to work on a new program, Nuchess, which placed more emphasis on chess knowledge while still maintaining a powerful search component.

Game 2: North American Computer Chess Championship Round 4, December 5, 1978, Washington, D.C.

Blitz (White) vs Belle (Black)

This short game was a lovely display of the tactical power of Belle. The win gave Belle a spotless 4–0 record for the tournament and first place. Ken Thompson was very pleased with this game and he appeared at the following year's tournament in a custom designed tee shirt with the final position printed on the front and the game score emblazoned on the back.

Blitz, authored by Robert Hyatt of the University of Southern Mississippi, is also a search-oriented, brute force chess program. Although it fared poorly in this game, it was reincarnated two years later on a CRAY-1 to do some tactical crunching of its own.

The commentary for this game is provided by Hans Berliner of Carnegie-Mellon University, the former World Champion of Correspondence Chess. Hans described this game at the time it was played as "undoubtedly the most brilliant game of chess yet played by a computer." He added that "if Mikhail Tahl or Bobby Fischer had played it, the game record would undoubtedly be making the rounds of the chess journals."

White Blitz	Black Belle
1. e2–e4	e7–e5
2. Ng1–f3	Nb8–c6
3. Nb1–c3	Ng8–f6
4. Bf1–b5	Nc6–d4
5. Bb5–c4	

HB: White is best advised to head for the draw with 5. Nf3xNd4, e5xNd4, 6. e4–e5, d4xNc3, 7. e5xNf6, Qd8xf6 (not c3xd2+ because after Bc1xd2 White has an advantage), 8. d2xc3 with a known drawn position. This is why White seldom plays 4. Bf1–b5 in this opening. As the game shows, Black is prepared for this variation in its opening book and White is not. White can also play 5. Bb5–a4, but this cedes Black the initiative for a pawn.

5. . . . . Bf8–c5
6 Nf3xe5?

HB: Not advisable. This pawn cannot be held and the capture by White only furthers Black's development. White is under the illusion that he is winning something.

6. . . . . Qd8–e7

DS: So far, all of Belle's moves have been made from its predigested library of opening moves.

7. Bb5xf7+??

HB: This is already ruinous; the "attack upon" and "win" of pawns only loses pieces. However, after any knight retreat Black rapidly gains the upper hand with d7–d5 (a move that would not be possible if White had played 5. Bb5–a4). From now on it is all Black's show.

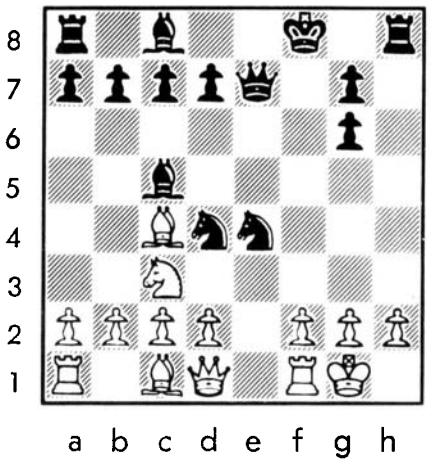
7. . . . . Ke8–f8

DS: At this point in the game, Belle predicted 8. d2–d3, Qe7xe5, 9. f2–f4, Qe5–e7, 10. Bf7–c4, d7–d6 with about a pawn advantage for Black.

8. Ne5–g6+?

HB: White probably thinks that after 8. . . . h7xNg6, 9. Bf7xg6, he will have three pawns for the knight. If he had looked a little farther, he would discover, however, that Rh8–h6 for Black snares the bishop. This probably accounts for his change of heart on the next move.

8. . . . . h7xNg6
9. Bf7–c4 Nf6xe4
10. O–O



10. . . . . Rh8xh2!!

HB: A "stock" sacrifice which in this case has some beautiful points. Black must have been able to see 7 ply ahead (including detecting mate on the last ply) in order to make this move. Not bad for a machine!

DS: Belle predicted 11. Nc3xNe4, Qe7–h4, 12. Ne4–g3, Qh4xNg3, 13. Bc4–d5 with an advantage of 3.38 pawns for Black.

11. Kg1xRh2

HB: If 11. Nc3xNe4 then Qe7–h4, 12. Ne4–g3, Qh4xNg3!!, 13. f2xQg3+, Nd4–f3 mate, with an even more beautiful ending.

11. . . . . Qe7–h4+

DS: Belle saw the mate here but did not predict that White would delay it as long as possible. Belle's principal variation was 12. Kh2–g1, Ne4–g3, 13. Nc3–e4, Qh4–h1 mate.

12. Kh2–g1 Ne4–g3!!

HB: The *coup de gras!* Now White can capture a piece giving check and threatening the queen, only to be mated on the next move. Very appealing to human eyes, but just good old search for Belle. Now, White delays the immediate mate one move. The two main lines are indeed very appealing.

13. Qd1–h5 g6xQh5
14. f2xNg3+ Nd4–f3!! mate

(0–1)

This game demonstrates the power of combining a comprehensive opening library with a competent search mechanism which sees far enough ahead to take advantage of tactical opportunities. Belle's developing moves in the opening in response to Blitz's pawn hunger probably reflect that Belle was still in its opening library. The beautiful mop-up at the end demonstrates the merciless precision of a full-width search mechanism when the opponent gets into serious trouble. The power of this exhaustive lookahead search becomes much more impressive as depth increases. The move 10. . . . Rh8xh2 was possible because Belle could see far enough ahead to appreciate its devastating impact. Programs which lack goal-directed search mechanisms or the ability to see as far ahead as Belle would probably not have initiated this continuation.

Game 3: 1979 North American Computer Chess Championship Round 3, October 29, 1979, Detroit, Michigan

Chess 4.9 (White) vs Duchess (Black)

Duchess, by Tom Truscott, Bruce Wright, and Eric Jensen of Duke University has been one of the stronger chess programs in tournament play since it first entered the competition in 1974. In 1977, Duchess tied for first place in the North American Championship.

The 1979 tournament was the last hurrah for Chess 4.X. It temporarily snatched the title back from Belle but in subsequent years could not match the additional depth that Belle achieved through hardware improvements. In this game with Duchess, Chess 4.9 played a nice combination to get a winning advantage.

The annotation for this game is provided by Mike Valvo, an International Master and David Levy's replacement as the tournament director in the recent major computer chess competitions. Mike's comments reflect his conversations with his technical consultant, Ken Thompson. Information from the machine record is also provided by David Slate.

White Chess 4.9	Black Duchess
1. e2–e4	d7–d5
2. e4xd5	Qd8xd5
3. Nb1–c3	Qd5–d6

MV: The center counter defense is not played very often by Black in tournament competition and this last move, Qd6, is so rare that theory only mentions one game in which it was tried. Its sole benefit seems to be that Chess 4.9 is now out of its extensive book on this line of play.

4. d2–d4	Bc8–f5
5. Ng1–f3	Nb8–c6?!

MV: Rather provocative; 5. . . . c7–c6 is more sensible.

6. Nc3–b5	Qd6–d7
7. Bc1–f4	Ra8–c8
8. Nf3–e5!	

MV: Tempting is 8. d4–d5 but White has no reply after 8. . . . Nc6–b4. For example, 9. Nf3–e5, Qd7xd5!, 10. Qd1xQd5, Nb4xQd5, 11. O–O–O, e7–e6!

8.	Nc6xNe5
9. d4xNe5!	

MV: The natural 9. Bf4xe5 allows Black to regroup. The point of 9. d4xNe5 is that the d4 square becomes available for the White knight.

DS: Chess 4.9 predicted 9. . . . a7–a6, 10. Qd1xQd7, Bf5xQd7, 11. Nb5–c3, g7–g6, 12. Bf4–e3, Bf8–h6, with about one-third pawn ad-

vantage for White. Chess 4.9 had previously predicted correctly Black's 6th, 7th, and 8th moves.

9. . . . . Qd7–c6

MV: Black is in severe difficulties, but alternatives offer little; for example, 9. . . . Qd7xQd1+, 10. Ra1xQd1, a7–a6, 11. Nb5–d4, Bf5–d7, 12. e5–e6!

10. Qd1–f3!?

MV: Not 10. Nb5xa7 because of Black's reply, 10. . . . Qc6–e4+, 11. Bf4–e3, Rc8–d8 and Black slips away. However, 10. Qd1–e2 seems best here: 10. . . . Qc6xc2, 11. Qe2xQc2, Bf5xQc2, 12. Ra1–c1, Bc2–e4, 13. Nb5xc7+, Ke8–d8, 14. e5–e6.

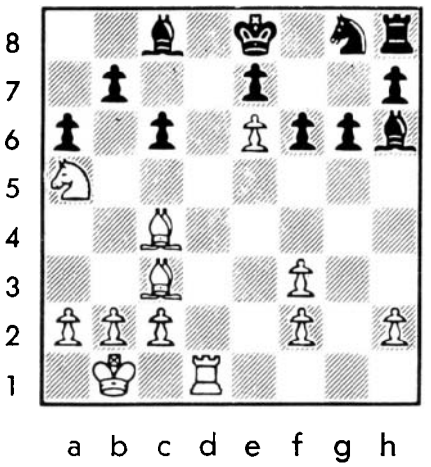
10.	Qc6xQf3
11. g2xQf3	a7–a6
12. Nb5–d4	Bf5–d7
13. O–O–O	g7–g6
14. Nd4–b3	Rc8–d8
15. Nb3–a5	Bd7–c8
16. Rd1xRd8+	Ke8xRd8
17. Bf1–c4	Kd8–e8
18. Rh1–d1	Bf8–h6
19. Bf4–d2	Bh6–g7?

MV: Black has defended well, but now lets the entire game slip. It is necessary to play 19. . . . Bh6xBd2+ and after 20. Rd1xBd2, e7–e6 Blacks stands well.

20. Bd2–c3 c7–c6

MV: Black should have played 20. e7–e6.

21. e5–e6	Bg7–h6+
22. Kc1–b1	f7–f6



23. Na5xb7!

MV: An elegant temporary sacrifice.

DS: In computing its previous move, 22. Kc1–b1, Chess 4.9 thought for ten minutes and foresaw the upcoming sacrifice, rating this line of play as 2.5 pawns in White's favor. The principal variation it saw at that time was 22. . . . f7–f6, 23. Na5xb7, Bc8xNb7, 24. Bc3–a5, Ke8–f8, 25. Rd1–d7, Bb7–a8, 26. Rd7–d8+, Kf8–g7, 27. Rd8xBa8. A terse message appeared on Chess 4.9's hardcopy at this time, "Be Careful."

23.	Bc8xNb7
24. Bc3–a5	Ke8–f8
25. Rd1–d7	

MV: The point of the "sacrifice." In order to avoid an immediate mate, Black must lose the bishop. The remainder requires no comment.

25.	Bh6–f4
26. h2–h3	Bf4–e5
27. Rd7xBb7	g6–g5
28. Bc4xa6	h7–h5
29. a2–a4	Rh8–h6
30. Ba6–c4	f6–f5
31. Ba5–d2	Rh6–g6
32. a4–a5	Be5–d4
33. a5–a6	Bd4xf2
34. a6–a7	Bf2xa7
35. Rb7xBa7	g5–g4
36. Bd2–c3	Ng8–f6
37. Bc3–b4	Nf6–g8
38. Ra7–a8+	Kf8–g7
39. Bb4–c3+	Kg7–h6
40. Bc3–d2+	Kh6–g7
41. f3xg4	h5xg4
42. h3xg4	Rg6xg4
43. Bc4–d3	f5–f4
44. Bd2–c3+	Kg7–h6
45. Ra8–f8	c6–c5
46. Bc3–e5	f4–f3
47. Rf8xf3	c5–c4
48. Rf3–f4	Rg4–g1+
49. Bd3–f1	Kh6–g5
50. Rf4–f7	Kg5–h6
51. Kb1–a2	Rg1–h1
52. Bf1xc4	Rh1–e1
53. Be5–g7+	Kh6–g5
54. Bg7–f8	Re1–e4
55. Rf7–g7+	Kg5–f6
56. Bc4–d3	Re4–a4+
57. Ka2–b3	Ra4–a7
58. Rg7xNg8	Kf6xe6

59.	Bd3–c4+	Ke6–e5
60.	Rg8–g7	Ra7–b7+
61.	Kb3–c3	Resigns

(1–0)

The mop-up by White is slow and methodical, with Chess 4.9 taking awhile to hit upon an effective plan. Despite this, the outcome is not seriously in doubt after the midgame foray in which White forced the win of Black's bishop. Down by two pieces and a pawn and facing a futile battle, Black properly resigned after White's 61st move.

Game 4: 1979 North American Computer Chess Championship Round 4, October 30, 1979, Detroit, Michigan

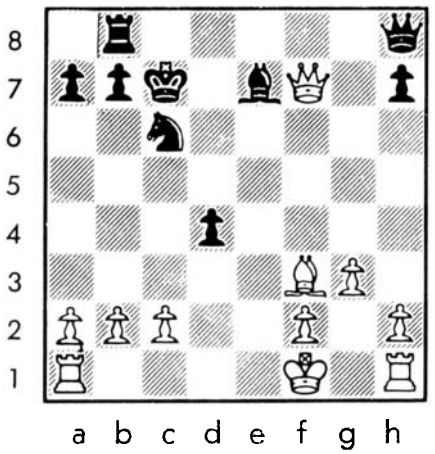
Duchess (White) vs Chaos (Black)

Chaos, a strong contender since 1973, currently hails from the University of Michigan. It is the work of Fred Swartz, Mike Alexander, Jack O'Keefe, and Victor Berman. In the 1979 tournament, Chaos ran on the powerful Amdahl V/6. The program has a more selective search and a more complex evaluation function than the "brute force" programs. Consequently, it searches many fewer nodes per second than most of the competition. The program is also characterized by its sheer size, taking up as much memory as half a dozen of its opponents.

This game is interesting because of its wild start and the tenacity that Chaos displayed fighting back from an early disadvantage. As a result of opening exchanges, Duchess (White) was up the exchange and two pawns. But then Duchess failed to find a winning idea, Chaos fought back, and finally an opposite-color-bishops endgame was reached in which, although still ahead by two pawns, Duchess could not find a way to make progress. Normally this type of game is adjudicated by the tournament director to reduce expenses and to prepare for the next round. In this case, the game was in the final round, and since both teams had continued access to their computers, the game was allowed to continue.

For the next 60 moves (about six hours), the two players shuffled pieces back and forth, a pawn was occasionally moved, and Duchess even succeeded in winning another pawn. In the end, the game was adjudicated as a win for Duchess even though there was little indication that she had found a winning plan. After 110 moves the patience of the spectators, the participants, and presumably even the programs, had been exhausted. The tournament director, David Levy, had already left to keep a London appointment. He had deputized two chess players to be awakened, if necessary, to adjudicate the game. Endgames which go on interminably have been a frustrating problem at many of the computer tournaments. A similar difficulty occurred at the 1981 Philidor vs L'excentrique game which also appears in this Appendix. Comments are by Peter Frey.

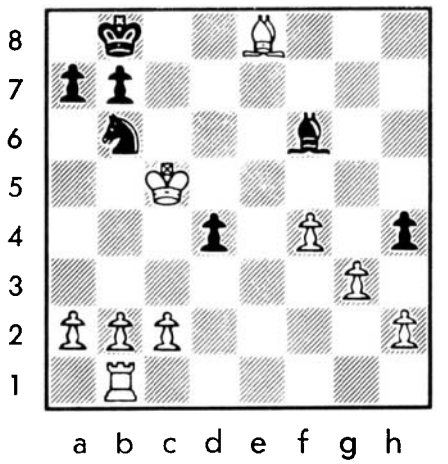
White Duchess	Black Chaos
1. e2–e4	c7–c5
2. Nb1–c3	Nb8–c6
3. g2–g3	e7–e6
4. Ng1–f3	d7–d5
5. e4xd5	e6xd5
6. d2–d4	Bc8–g4
7. Bf1–e2	Ng8–f6
8. Bc1–g5	Bg4xNf3
9. Be2xBf3	Qd8–e7+
10. Ke1–f1	c5xd4
11. Nc3xd5	Qe7–d8
12. Qd1–e2+	Ke8–d7
13. Qe2–b5	Ra8–b8
14. Nd5xNf6+	g7xNf6
15. Qb5–f5+	Kd7–c7
16. Bg5xf6	Bf8–e7
17. Bf6xRh8	Qd8xBh8
18. Qf5xf7	



At this point in the game, the contest seems to be all but over. White has treated Black's Sicilian opening with very little respect. Black has two fewer pawns than White and is down the exchange with little compensation. Given this miserable start, the Chaos programming team was all but ready to pack up and get an early start for home. After her powerful beginning, Duchess continued to make progress for the next few moves but in the long run, failed to seize upon a winning plan.

18.	Qh8–g8
19. Qf7xQg8	Rb8xQg8
20. Bf3–e4	Rg8–h8

21.	f2–f4	Nc6–a5
22.	Kf1–e2	Na5–c4
23.	Rh1–b1	Be7–f6
24.	Ke2–d3	Nc4–b6
25.	Rb1–e1	Kc7–b8
26.	Ra1–b1	Nb6–a4
27.	Be4–f5	h7–h5
28.	Bf5–g6	Na4–c5+
29.	Kd3–c4	Nc5–d7
30.	Re1–e8+	Rh8xRe8
31.	Bg6xRe8	Nd7–b6+
32.	Kc4–c5	h5–h4



Computer chess is often viewed as a research paradigm for machine intelligence, especially for investigations of long-range planning. In this particular game, Duchess seems determined to demonstrate that machines have no facility for planning ahead. In this position, almost any chess amateur would proceed to activate White's pawn majority on the king side and march on bravely until Black had to sacrifice material to prevent an aspiring pawn from being promoted. After 32. . . . h5–h4, Black gives White the opportunity to create adjacent passed pawns, a truly formidable advantage in a situation like this. Instead, White chooses the immediate gain of a pawn at the expense of preserving its powerful pawn formation on the king side. In pawn and minor piece endings, many of the strong chess programs are unaware of simple strategic ideas that most class D human players have mastered.

33.	g3xh4	Kb8–c8
34.	h4–h5	Kc8–d8
35.	Be8–b5	Kd8–c7
36.	h5–h6	a7–a6
37.	Bb5–d3	Bf6–h8

38.	Bd3–f5	Nb6–a4+
39.	Kc5–b4	b7–b5
40.	Kb4–a5	Kc7–b7
41.	Bf5–e4+	Kb7–a7
42.	h6–h7	Na4–b6
43.	h2–h4	Nb6–c4+
44.	Ka5–b4	Ka7–b6
45.	c2–c3	a6–a5+

With three pawns, a knight, and a bishop, Black is launching a fierce attack. With six pawns, a rook, and a bishop, White is running for cover. What is going on here?

46.	Kb4–b3	d4xc3
47.	Rb1–d1	Nc4–d2+
48.	Rd1xNd2	c3xRd2
49.	Kb3–c2	b5–b4
50.	h4–h5	Kb6–c5
51.	Kc2xd2	Bh8xb2
52.	h5–h6	Bb2–h8

Black's attack on the queen side has netted two pawns and a rook at the cost of one pawn and a knight. Black has also generated a promotion threat and White must now play carefully.

53.	Kd2–e3	Kc5–c4
54.	Be4–c2	Kc4–d5
55.	Bc2–b3+	Kd5–c5
56.	Ke3–e4	Kc5–d6
57.	Ke4–f5	Kd6–d7
58.	Kf5–g6	Kd7–e7
59.	f4–f5	Bh8–e5
60.	Bb3–c2	Be5–f6
61.	Bc2–e4	Bf6–h8
62.	Be4–f3	Bh8–e5
63.	Bf3–c6	Be5–f6
64.	Bc6–e8	Bf6–e5
65.	Be8–b5	Be5–h8
66.	Bb5–c4	a5–a4
67.	Bc4–g8	Bh8–f6
68.	Bg8–d5	Bf6–e5

The kings have moved to the king side and White is attempting to advance his pawns. The Black king is aiding his bishop in a blocking action while the White bishop waltzes gaily about to a tune that only he seems to hear. If White has a plan here it is far too sophisticated for flesh and blood players to understand.

69.	Kg6–g5	Be5–f6+
70.	Kg5–f4	Ke7–f8
71.	Kf4–e4	Kf8–e7

72.	Bd5–e6	a4–a3
73.	Ke4–d3	Bf6–h8
74.	Kd3–c4	Bh8–c3
75.	Kc4–c5	Ke7–d8
76.	Kc5–d6	Kd8–e8
77.	Be6–b3	Bc3–b2
78.	Kd6–e6	Bb2–h8
79.	Bb3–a4+	Ke8–f8
80.	Ba4–d1	Kf8–e8
81.	f5–f6	Ke8–f8
82.	Bd1–b3	

After the White king probes Black's defense on the queen side he returns to the king side for another round there. Finally, White activates its pawn on the *f*-file and places its bishop to defend the a2–g8 diagonal. White now appears to have a simple win: f6–f7 followed by a march by the White king to devour Black's remaining two pawns in exchange for White's two pawns on the *h*-file. After this exchange, White can advance its pawn on the *a*-file and Black can only defend by sacking its bishop for the pawn. White should then be able to promote its remaining pawn with little difficulty. Unfortunately, this plan requires a lookahead search which is considerably deeper than any current computer program can see.

82.	. . . . .	Kf8–e8
83.	Bb3–a4+	Ke8–f8
84.	Ba4–d1	Kf8–e8
85.	Bd1–b3	Ke8–f8
86.	Bb3–c4	Kf8–e8
87.	Bc4–b5+	Ke8–f8
88.	Bb5–a4	b4–b3
89.	Ba4xb3	

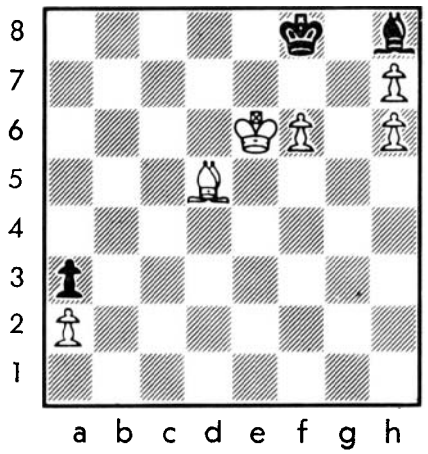
White has won another pawn and is in even better shape to initiate the plan mentioned above. With the current position, this plan forces Black to trade its last pawn for one of White's pawns on the *h*-file. With passed pawns on both side of the board, White should win easily.

89.	. . . . .	Kf8–e8
90.	Bb3–c2	Ke8–f8
91.	Bc2–d3	Kf8–e8
92.	Bd3–b5+	Ke8–f8
93.	Bb5–a6	

If the White bishop remains on the a4–e8 diagonal, the Black bishop can capture the pawn at f6 with impunity. The White king dare not recapture since this will produce a stalemate.

93.	. . . . .	Kf8–e8
94.	Ba6–d3	Ke8–f8
95.	Bd3–e2	Kf8–e8

96.	Be2–h5+	Ke8–f8
97.	Bh5–g4	Kf8–e8
98.	Bg4–f3	Ke8–f8
99.	Bf3–e4	Kf8–e8
100.	Be4–g6+	Ke8–f8
101.	Bg6–f5	Kf8–e8
102.	Bf5–e4	Ke8–f8
103.	Be4–b1	Kf8–e8
104.	Bb1–f5	Ke8–f8
105.	Bf5–c2	Kf8–e8
106.	Bc2–a4+	Ke8–f8
107.	Ba4–d1	Kf8–e8
108.	Bd1–e2	Ke8–f8
109.	Be2–f3	Kf8–e8
110.	Bf3–c6+	Ke8–f8
111.	Bc6–d5	



With the White bishop wandering about aimlessly, the participants and observers finally gave up. The game was concluded with the result to be determined by best play adjudication. This gave a win to White since a win clearly is present. The fact that White seems totally incapable of finding the win in no way influences this decision. This would appear to be a questionable rule. If White cannot find a win on its own, why should the tournament rules specify that White be given the win?

Game 5: Chessmates Grand Prix Round 1, June 7, 1980, Evanston, Illinois

Ken Mohr (White) vs Bebe (Black)

Many people have wondered if a programmer has to be a very good chess player himself in order to create a strong chess program. No one has a

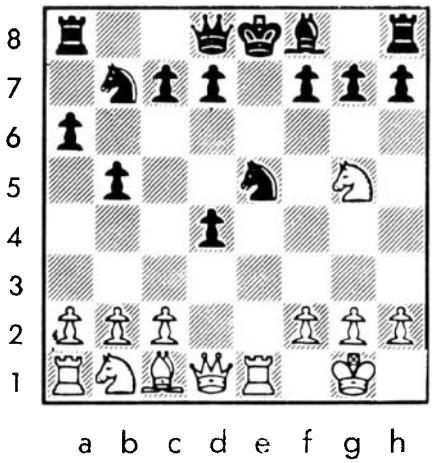
definitive answer to this question and there are reasonable arguments for both sides of the question. The performance of Bebe, a newcomer to the computer chess scene, indicates however that a person unfamiliar with chess can produce a very formidable program. Bebe is the creation of Tony Scherzer of SYS-10, Inc., a small computer company in Hoffman Estates, Illinois. Tony, who has both software and hardware experience, decided one day a few years ago that it would be fun to build a chess playing machine. His lack of either chess or computer-chess experience did not concern him and he proceeded, in the spirit of Belle, to design and build a special chess-playing machine. He started by designing a 16-bit computer with a microprogrammed, pipelined, bit-slice architecture which executed instructions at 6 million per second. He then wrote a program of the brute-force variety in the general purpose set of instructions for this machine. In order to increase execution speed, he recoded time-critical functions in machine microcode. Eventually he built special hardware to do move generation and position evaluation. The result of this effort was a new machine which was similar in many ways to Belle. It was somewhat slower (about 22,000 positions per second) but also less costly.

The name Bebe is short for "black box," a colloquial term for a machine whose internal workings are mysterious and hidden from inspection. This was appropriate for Tony and his assistants because very early in its development the machine surpassed them in chess-playing ability and they no longer felt competent to evaluate the results of their further modifications of Bebe. To demonstrate the flavor of this interesting creation, we have selected one of Bebe's earliest tournament efforts. The opponent was a human player with a USCF rating of 2086. The game is very typical of the wild tactical battles that a computer can generate when its opponent attacks aggressively.

Early in the game, White gives up two pawns in an attempt to catch Black with a piece pinned to its king. Black successfully defends its material so White tries a new idea, attacking the vulnerable king position. True to computer form, Black cooperates by ignoring the threat and showing more interest in capturing pawns than defending its king. White, unable to find a clear win, makes a rook sacrifice to force the Black king into the open. With his queen and rook, White chases Black's king merrily about the board but fails to deliver a fatal blow. Finally White forces Black to trade its queen for a rook but this is too little, too late. Black's king evades White's remaining checks and escorts a pawn to the eight rank and to victory.

Shortly after this game, David Levy visited the Chicago area and paid a visit to Tony Scherzer. He was so impressed by Bebe's performance that he immediately invited Bebe to the World Championship in Linz, Austria. In this European tournament, Bebe distinguished itself in a very unusual way; it managed to draw all four of its games. Comments on this game are by Peter Frey.

White Ken Mohr	Black Bebe
1. e2–e4	e7–e5
2. Ng1–f3	Nb8–c6
3. Bf1–b5	a7–a6
4. Bb5–a4	b7–b5
5. Ba4–b3	Ng8–f6
6. O–O	Bc8–b7
7. d2–d4	e5xd4
8. e4–e5	Nf6–e4
9. Bb3–d5	Ne4–c5
10. Nf3–g5	Nc6xe5
11. Bd5xBb7	Nc5xBb7
12. Rf1–e1	



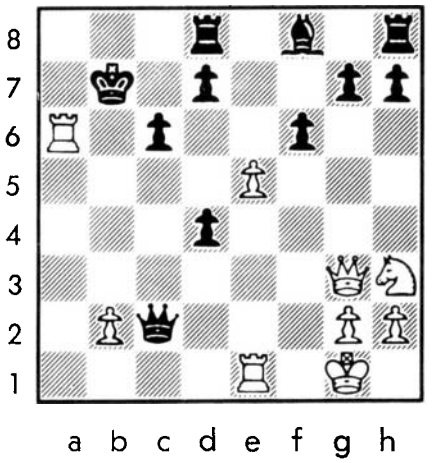
12.	f7–f6
13. Qd1–f3	Nb7–d6
14. Bc1–f4	c7–c6
15. Bf4xNe5	Qd8–e7
16. Qf3–g3	Nd6–c4
17. Nb1–d2	Nc4xBe5
18. f2–f4	O–O–O
19. Ng5–h3	Qe7–b4

Black is putting up a spirited defense. At times it is unclear who is attacking and who is defending. White is hard pressed to find a way of turning his positional pressure into a clear advantage.

20. f4xNe5	Qb4xNd2
21. a2–a4	b5xa4
22. Ra1xa4	Qd2xc2
23. Ra4xa6	Kc8–b7

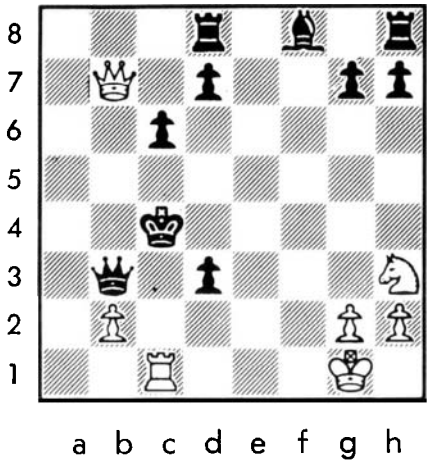
Black's amazing courage indicates that he is clearly not your standard flesh and blood chess player. After giving up most of his pawn cover, the

Black king boldly sallies forth to attack the offending White rook. To paraphrase a familiar line, the computer enters where angels fear to tread.



24.	Ra6–a1	f6xe5
25.	Qg3xe5	d4–d3
26.	Re1–c1	Qc2–b3
27.	Ra1–a7+	Kb7xRa7
28.	Qe5–c7+	Ka7–a6
29.	Rc1–a1+	Ka6–b5
30.	Qc7–b7+	Kb5–c4
31.	Ra1–c1+	

White has launched a blistering attack on the Black king. Black currently enjoys a material advantage, but it is not clear whether the Black king will live long enough to benefit from these extra troops. Even if the Black king can avoid being mated, his escape may come at the expense of several major pieces.



31.	. . . . .	Qb3–c2
32.	Qb7–a6+	Kc4–b3
33.	Qa6–b6+	Bf8–b4
34.	Rc1xQc2	d3xRc2
35.	Qb6–e3+	Kb3xb2
36.	Qe3–d4+	Bb4–c3
37.	Qd4–b6+	Kb2–a2
38.	Qb6–a6+	Ka2–b1
39.	Qa6–d3	Kb1–b2
40.	Qd3–e2	Rd8–e8
41.	Resigns	

The White queen has run out of checks and the Black pawn at c2 has become an unstoppable threat. With the Black rooks coming into play, all hope for White has evaporated. After observing the tactical resourcefulness of the computer in this game and the weak long-range planning of Duchess in the previous game, why should a human player try to shoot it out with any of the stronger chess programs? A quiet positional battle is much better fighting turf for humans.

Game 6: Third World Computer Chess Championship Round 2, September 26, 1980, Linz, Austria

Nuchess (White) vs Belle (Black)

This tournament marked the official debut of Nuchess, by David Slate and William Blanchard. Nuchess is a completely new program which aspires to combine chess knowledge with the strength of a powerful search mechanism. To make programming easier, it is written in FORTRAN rather than assembler as the previous Northwestern University chess programs. By using FORTRAN, Slate and Blanchard hoped to be able to add a more sophisticated evaluation function and quiescence search without the tedious effort that assembly language would require. A style of coding was selected which made it easier to add chess-specific knowledge without sacrificing too much of the efficiency which had become a trademark of the earlier Chess 4 series. At this early stage of its development, Nuchess differed from Chess 4.9 in being slower (2000 positions per second vs 3600) and having a slightly better understanding of threatened pieces and passed pawns in its quiescence analysis.

Belle had also been completely redesigned for this tournament. At the end of 1979, Ken Thompson announced that he was going to build an incredibly fast machine with a speed approximating a million nodes per second! Belle did not achieve this goal for the tournament at Linz, but did come in at an impressive 160,000 positions per second. Note that this is an 80 to 1 advantage over Nuchess.

This game, a king's gambit accepted by transposition, soon lands in murky waters. White wins back his pawn and another to boot, but Black

works against White's pinned *d*-pawn and awkwardly placed pieces forcing White to lose the exchange. White has aspirations of winning another pawn as compensation but has not looked deep enough. In trying to hold onto its material, White allows Black's rook to penetrate to the eight rank and attack the king. In an apparent attempt to intensify its attack, Black gives back the exchange for a pawn. Black's aggressive behavior causes little trouble for the White king but does succeed in winning another White pawn, evening up the material and producing a sharp position in which both sides have active pieces and passed pawns. After considerable maneuvering in an attempt to win, White is forced by Black's dangerous passed *a*-pawn to settle for a draw by perpetual check. Notes are by David Slate based on Nuchess' hardcopy.

White **Nuchess**	**Black** **Belle**
1. f2–f4	e7–e5
2. e2–e4	e5xf4
3. Ng1–f3	d7–d5
4. e4xd5	Ng8–f6
5. Bf1–b5+	c7–c6
6. d5xc6	Nb8xc6
7. d2–d4	

This is the first move out of book for Nuchess. Its 5-ply search predicted 7. . . . Qd8–a5+, 8. Nb1–c3, Bf8–b4, 9. Qd1–d3, Bc8–f5, 10. Qd3xBf5, Bb4xNc3, 11. Nf3–d2, and scored the final position as a quarter pawn advantage for White.

7.	Bf8–d6
8. O–O	O–O
9. Nb1–c3	Bc8–g4
10. Bb5–c4	Bd6–b4
11. Nc3–e2	Bb4–d6
12. Ne2xf4	

A 4-ply search evaluated this position as a 0.38 pawn edge for White and predicted a series of captures: 12. . . . Bd6xNf4, 13. Bc1xBf4, Bg4xNf3, 14. Rf1xBf3, Qd8xd4, 15. Qd1xQd4, Nc6xQd4. The exchange which followed, however, was not quite as bloody.

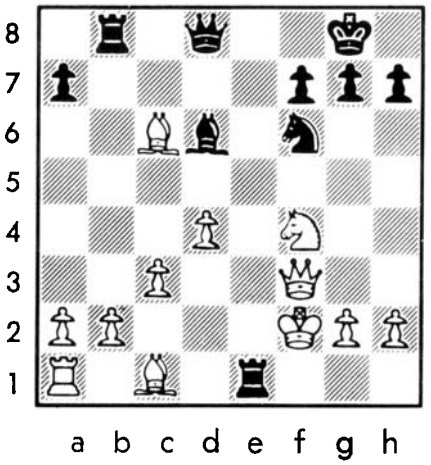
12.	Bg4xNf3
13. Rf1xBf3	

Nuchess did a 6-ply search before making this move and foresaw giving up the exchange on f3 as well as the capture of Black's pawn at b7. Its principal variation matched what actually happened except for 16. . . . Bc5–d6.

13. . . . . Bd6–c5
14. c2–c3

At this point in the game, Nuchess' evaluation reached its most optimistic value, over one pawn ahead. Its principal variation matched the moves actually played through 17. . . . Ra8–b8.

14. . . . . Nc6–e5



15. Bc4–e2 Ne5xRf3
16. Be2xNf3

The evaluation dropped to +0.54 pawns as Nuchess began to see the problems posed by 17. Ra8–b8.

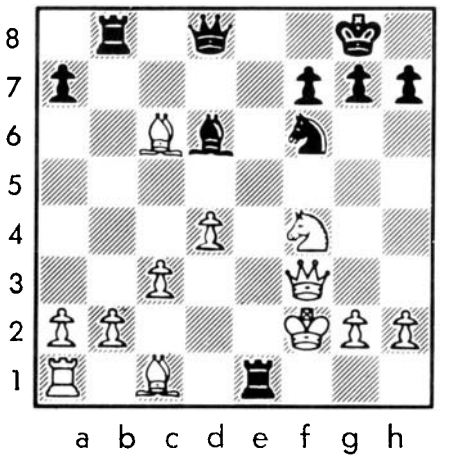
16. . . . . Bc5–d6
17. Bf3xb7

The score continued to drop, this time to −0.35 pawns, as Nuchess predicted having to give up its own pawn at b2.

17. . . . . Ra8–b8
18. Qd1–f3

Nuchess improved its outlook to a little better than even, predicting that it would hold its pawn at b2 while allowing Black's rook to check on e1.

18. . . . . Rf8–e8
19. Bb7–c6 Re8–e1+
20. Kg1–f2



20.	Re1xBc1
21. Ra1xRc1	

Nuchess had not predicted that Black would give back the exchange. In calculating for 21. Ra1xRc1, White scored the position as a 0.29 pawns in its favor and foresaw all the moves that were subsequently played through 24. . . . Rb2xa2.

21.	Rb8xb2+
22. Kf2–g1	Qd8–c7
23. g2–g3	Bd6xNf4
24. g3xBf4	

At this point, Nuchess thought that Black would play g7–g5, since White's *f*-pawn is pinned to the pawn at h2. Despite this potential tactical shot by Black, Nuchess was still happy about the position.

24.	Rb2xa2
25. Rc1–b1	Qc7–d6
26. Bc6–b5	Qd6–b8
27. Bb5–d3	Qb8–e8
28. Kg1–h1	a7–a5
29. Bd3–b5	Qe8–d8
30. Bb5–c4	

Nuchess' evaluation had been rising for the last several moves and now reached a value of +0.84 pawns. After this, however, it started to drop again.

30.	Ra2–c2
31. Rb1–b7	Qd8–a8
32. Bc4xf7+	Kg8–h8
33. Bf7–d5	Qa8–e8
34. Rb7–b1	Nf6xBd5
35. Qf3xNd5	Rc2xc3

The Black rook has won White's valuable passed pawn. The White queen dare not capture Black's passed rook pawn because of 36. . . . Qe8–e4+ forking the White king and rook. This tactical shot by Black improves its position considerably. Without the adjacent passed pawns, White no longer has a clear advantage.

36. Qd5–e5	Qe8–a8+
37. d4–d5	Rc3–c8
38. Rb1–g1	

A 7-ply search by Nuchess evaluated the position at +0.18 pawns with a principal variation of 38. . . . Qa8–b7, 39. f4–f5, Qb7–f7, 40. Qe5–e6, Rc8–f8, 41. Rg1–f1.

38.	Qa8–b7
39. f4–f5	Qb7–f7
40. Rg1–b1	

A more aggressive alternative at this juncture for White would be 40. Qe5–e6.

40.	a5–a4
41. Rb1–b8	Rc8xRb8
42. Qe5xRb8+	Qf7–g8
43. Qb8–e5	a4–a3
44. f5–f6	

An 8-ply search by Nuchess evaluated the position as 0.19 pawns in White's favor with the following lengthy prediction: 44. . . . h7–h6, 45. f6xg7+, Qg8xg7, 46. Qe5–e8+, Kh8–h7, 47. Qe8–e4+, Qg7–g6, 48. Qe4–e7+, Kh7–g8, 49. d5–d6, a3–a2, 50. Qe7–d8+, Kg8–h7, 51. Qd8–c7+. Note that Nuchess did not anticipate that Black would steer toward a draw by repetition with, for example, 47. . . . Kh7–h8, as Black actually played. The reason for this is that Nuchess has a "weariness" factor, which causes the program to become more and more willing to draw as the game "drags" on longer and longer. This "weariness" factor depends on the move number and the number of consecutive "reversible" moves made up to the current position. It is a dynamic factor in the draw score as

opposed to a static rule such as the "contempt" factor discussed in connection with Game 7 in this series. By move 44, the weariness factor had reached a third of a pawn, which was more than Nuchess thought its advantage was. Nuchess, however, does not attribute, "weariness" to its opponent and so while it steered toward the draw, it did not assume that Belle would try for the draw also.

44.	h7–h6
45. f6xg7+	Qg8xg7
46. Qe5–e8+	Kh8–h7
47. Qe8–e4+	Kh7–h8
48. Qe4–e8+	Kh8–h7
49. Qe8–e4+	Kh7–h8
50. Qe4–e8+	

drawn by repetition
(1/2–1/2)

This game is interesting in that it could easily have been played by two strong amateur human chess players. There were no obvious "computer blunders." The two programs played quite similar games. Nuchess, in fact, did a fairly good job of anticipating Belle's moves. Belle made 43 moves after Nuchess departed from its opening library. Of these 43, Nuchess anticipated 26. With this tendency to "think" alike, it is not surprising that each program tends to correctly anticipate the other's potential threats.

Game 7: 1980 North American Computer Chess Championship Round 4, October 28, 1980, Nashville, Tennessee

Challenger X (White) vs Belle (Black)

Challenger X was an experimental chess computer from Fidelity Electronics. A similar machine was eventually sold commercially as the "Champion Sensory Challenger." Its authors are Dan and Kathe Spracklen, who previously developed the Sargon chess program which runs on several popular microcomputers. For this tournament, the Challenger program was loaded on special equipment which ran the 6502 processor at 4 megahertz (as compared to 1 megahertz on the Apple computer). Even at this faster speed, the Challenger only has a small fraction of the computing power of Belle. Despite this, the Challenger had Belle in serious trouble and nearly drew the game. Challenger finished the tournament with a very respectable 2.5–1.5 record.

In addition to demonstrating the improvements in microprocessor-based chess programs, this game illustrates an interesting problem in

games between computers and humans and between two computers: how to evaluate a chance to draw. Most modern chess programs are able to recognize situations in which one or both players may claim a draw. In addition, many programs detect such conditions during their lookahead search which enables them to play towards or away from a draw depending on how they evaluate the alternatives. The easiest solution is to count a draw as equivalent to an "even" position, so the computer will play for one if it thinks it is otherwise behind and avoid one if it thinks it is ahead. But there are other possibilities. For example, one might, in advance of a game, inform the program that its opponent is weaker (or stronger) than it is. This can be done by defining a "contempt" factor which biases a stronger program to avoid a draw even when the current score shows it to be behind, or vice versa for a weaker program. This strategy is discussed in Chapter 4 of this book.

In this game with Belle, Challenger would have been well advised to set a negative contempt factor, i.e., play for a draw even when slightly ahead, indicating proper respect for Belle's considerable crunching power. For this tournament, Challenger X was hardwired into a memory module which allowed no possibility of changing this factor which was set so that the program would refuse to seek a draw unless it were at least a half pawn behind. In fact, Challenger had an opportunity to draw by repetition in the game; it declined that opportunity and then went on to lose.

There are at least two interesting lessons in this game. First, even a microprocessor-based program can sometimes outplay a powerhouse like Belle and reach an advantageous position. Second, although a lowly micro may on occasion outplay Belle, it is ill-advised to treat such a beast with contempt. For this arrogance, Belle deals out swift and certain punishment.

The commentary on this game is by David Levy, a long-time devotee of computer chess, an International Master, and the tournament director for all the major computer chess tournaments during the first decade of this new pastime. Additional notes are provided by David Slate from the printed record that Belle produced at the tournament.

White **Challenger**	**Black** **Belle**
1. e2–e4	e7–e5
2. Ng1–f3	Nb8–c6
3. Bf1–b5	a7–a6
4. Bb5–a4	Ng8–f6
5. O–O	Nf6xe4

DL: The Open Variation, which leads to very lively play, has long been a favorite of Viktor Korchnoi, and was used by him several times during his 1978 World Championship match against Karpov.

6. d2–d4	b7–b5
7. Ba4–b3	d7–d5
8. d4xe5	Bc8–e6
9. c2–c3	Bf8–c5

DL: Up to now both programs have been following well-known opening theory, taken directly from their opening books. Now, however, Challenger is out of book and at once makes a serious strategic mistake.

10. Bc1–e3?

DL: This allows Black to saddle its opponent with doubled, isolated pawns. Normal here is 10. Nb1–d2.

10.	Bc5xBe3
11. f2xBe3	Ra8–b8
12. Nb1–d2	Ne4–c5

DL: Threatening 13. . . . Nc5–d3, forking the pawns on e5 and b2, as well as the slower plan of 13. . . . O–O, followed by . . . Nc5–d7, . . . Rf8–e8, . . . Nd7–f8, and . . . Nf8–g6, when the White pawn at e5 would soon be lost.

13. Qd1–e1	Nc5–d3
14. Qe1–g3	O–O
15. Ra1–b1?	

DL: Perhaps it is a little unfair to give this move a question mark, since the correct continuation requires a depth of analysis well beyond the scope of Chess Challenger, but from the pure chess point of view, White should be criticized. The correct move was 15. Bb3–c2, when Black would almost certainly have played 15. . . . Nd3xb2, allowing the combination 16. Bc2xh7+, Kg8xBh7, 17. Nf3–g5, Kh7–g8, 18. Qg3–h4, Rf8–e8, 19. Qh4–h7+, Kg8–f8, 20. Ng5xf7, Be6xNf7, 21. Rf1xBf7+, Kf8xRf7, 22. Ra1–f1+, Qd8–f6 (not 22. . . . Kf7–e6 because 23. Qh7–f5+, Ke6–e7, 24. Qf5–f7 mate), 23. e5xQf6 and White will win.

DS: In its calculations for its 14th move, Belle, with an 8-ply search, anticipated that White would respond with Ra1–b1.

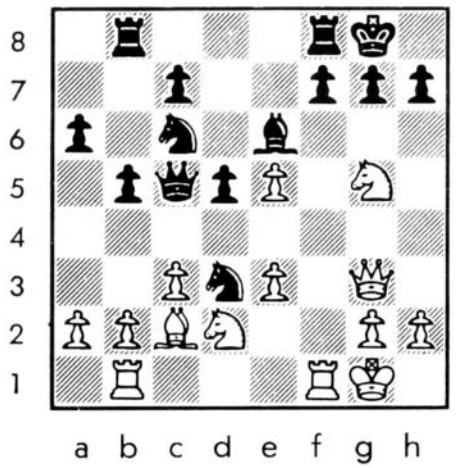
15.	Qd8–e7?
16. Bb3–c2	Qe7–c5

DL: Belle had pinned all of its hopes on this move when making the previous one, but a better plan would have been 15. . . . h7–h6. Now

White cannot capture on d3 because of . . . Qc5xe3+, but there is something better for White.

DS: Belle predicted 17. Nf3–g5 with an 8-ply search and scored the position as equal. Up to this point it had evaluated the game as a little in its favor.

17. Nf3–g5



17.	. . . . .	Nc6xe5
18.	Ng5xh7	Rf8–d8

DL: Not 18. . . . Kg8xh7, 19. Qg3xNe5, winning both of Black's knights.

DS: Belle anticipated 19. Nh7–f6+ and rated the position as 0.4 pawns advantage to White. This was based on an 8-ply search.

19.	Nh7–f6+	Kg8–f8
20.	Bc2xNd3	Ne5xBd3
21.	Nf6–h5	g7–g6
22.	Nh5–f6	Be6–f5?

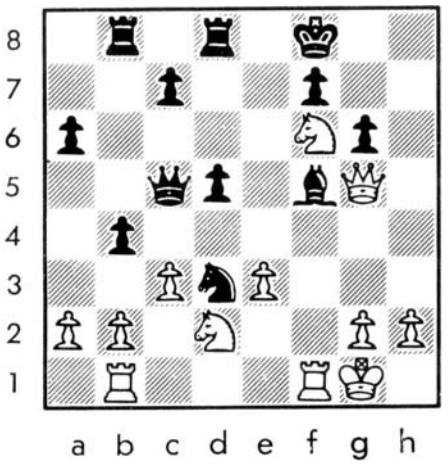
DL: This move soon lands Black in trouble. There were numerous alternatives, such as 22. . . . b5–b4.

DS: Belle did a 7-ply search here, predicted 23. Qg3–g5, and judged the position as 0.2 pawns in White's favor.

23.	Qg3–g5	b5–b4
24.	Nf6–h7+	Kf8–e8
25.	Nh7–f6+	Ke8–f8

DL: Here, and for the next few moves, White could force a draw.

DS: Belle saw no way to prevent the draw but thought that White should try to do better. It predicted 25. Nd2–b3 instead of Nh7–f6+.



26. Nd2–b3 Qc5–c4

DS: Belle predicted 27. Nb3–d4 with an evaluation of 0.38 pawns advantage for White.

27. Nf6–h7+ Kf8–e8
28. c3xb4 Rb8xb4

DS: Belle did an 8-ply search on this move, predicting 29. Nb3–d4 with an advantage for White of 1.12 pawns.

29. Nh7–f6+ Ke8–f8
30. Nf6–g4 Rd8–d6
31. Ng4–h6 Qc4–e4!

DL: A dual purpose move, putting pressure on g2 (see later) and supporting the king side.

DS: Belle's 8-ply search predicted 32. Nh6xBf5 and judged that White had an advantage of about one pawn.

32. Rf1xBf5!?

DL: An interesting sacrifice that gives up the exchange and, unfortunately for White, simply fails. If White had vacillated, however, Black could have played . . . Bf5–e6 or . . . Nd3–e5 followed by . . . Ne5–g4, when Black has the more active game.

32. . . . . g6xRf5
33. Qg5–g8+ Kf8–e7
34. Qg8xf7+ Ke7–d8
35. Nh6xf5 Rd6–c6
36. h2–h4

DL: A typical computer move, and not a bad try. In many variations White only just fails to promote this pawn.

DS: Belle did not expect this move. It had been expecting 36. Nb3–d4 or 36. Qf7–g8+. After the pawn move, Black's evaluation improved to an even game.

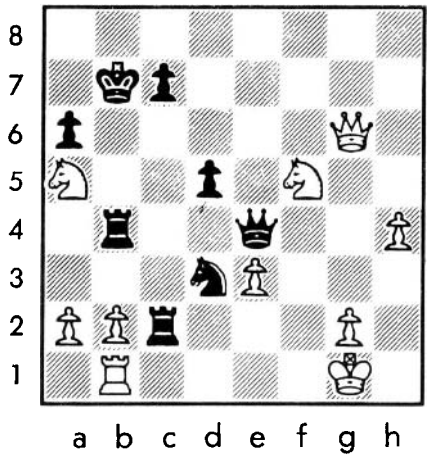
36. . . . . Rc6–c2!

PWF: The Black king is fearless. He has dismissed his defending troops from the royal chamber and apparently plans to deal with the wrath of White's attack on his own.

37. Qf7–f8+ Kd8–d7
38. Qf8–f7+ Kd7–c8

DS: Belle's 7-ply search predicted 39. Qf7–g6 and now judged the position to be a one pawn advantage for Black.

39. Qf7–g6 Kc8–b7
40. Nb3–a5+



40. . . . . Kb7–a8!!

DL: A very profound move. Black gives up a pawn with check in order to cause its opponent to lose a tempo (a move). White then finds its queen on the wrong flank, and in bringing it back to the K-side White hands over the initiative for just long enough.

DS: Belle searched 7-plies, predicted 41. Qg6xa6+, and judged the position as advantageous to Black by 1.1 pawns.

41. Qg6xa6+ Ka8–b8
42. Qa6–g6

DL: This move is forced. White has to prevent mate on g2.

42.	Nd3–e5!

DL: A deadly blow. Threatening the queen as well as . . . Rc2xg2+.
DS: Belle did an 8-ply search before selecting this move and judged the position as a three pawn advantage for Black.

43. Qg6–g8+	Kb8–a7
44. Rb1–f1	Rb4xb2

DS: At this point, Belle saw an overwhelming edge for Black. After failing to make its brave attack stick, White is in very serious trouble.
DL: White could well resign here, to save further embarrassment.

45. Kg1–h1	Rc2xg2
46. Na5–c6+	Ne5xNc6
47. Qg8–a8+	Ka7xQa8
48. a2–a4	

DL: Having delayed mate for as long as possible, White finally runs out of checks and can find no further defense. With victory at hand, Belle surprisingly displays a bug.

48.	Ka8–b8?
49. a4–a5	Kb8–a8?
50. a5–a6	Ka8–a7?
51. h4–h5	Ka7–b6?
52. a6–a7	Rg2–g1+

DL: At last!

53. Kh1xRg1	Qe4–g2 mate

(0–1)

DL: This has to be one of the most exciting games in the history of the ACM tournaments.

Game 8: Fredkin Prize Incentive Match November 14, 1980, Carnegie-Mellon University

Belle (White) vs Gibson (Black)

This was the second Fredkin Prize Incentive Match. The first had been held a few months earlier between Chess 4.9 and a human player with a USCF rating of 2050. That had ended in a tie with each player winning

a game. In this match, Belle was paired against a human player with a rating of 2132. The first game of the match ended in a draw. We present here the second game, which gave Belle a 1½ to ½ victory and offered further evidence that Belle was nearing master strength.

Belle's win in this game did not result from an obvious blunder by its opponent or from a single devastating tactical shot. Instead, Belle used tactical threats to skillfully immobilize the opponent's pieces and then steadily increased the pressure until Black could no longer hold the position. Hans Berliner was especially impressed by Belle's ability in this game to maintain control of the dark squares in such a way that Black's lone bishop was much less useful than White's knight. This type of play by Belle is significant since it is a side effect of the search process rather than being produced by special knowledge which might have been programmed into the evaluation function.

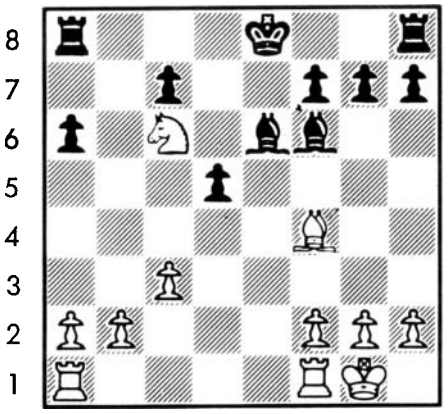
White **Belle**	**Black** **Gibson**
1. e2–e4	e7–e5
2. Ng1–f3	Nb8–c6
3. Bf1–b5	a7–a6
4. Bb5–a4	Ng8–f6
5. O–O	d7–d6
6. Ba4xNc6+	b7xBc6
7. d2–d4	Nf6xe4
8. d4xe5	d6–d5
9. Nb1–d2	Bc8–g4
10. c2–c3	Ne4xNd2
11. Bc1xd2	Bf8–e7
12. Qd1–a4	Qd8–d7
13. e5–e6	

DS: This move was selected by the 8-ply search but none of the shallower searches. Belle predicted 13. . . . Bg4xe6 and scored the position as 0.1 pawns advantage for White.

13.	Bg4xe6
14. Nf3–e5	Qd7–d6
15. Bd2–f4	Qd6–c5
16. Qa4xc6+	Qc5xQc6
17. Nd4xQc6	

DS: Predicting 17. . . . Be7–c5 and judging the position as slightly advantageous to Black. Belle's evaluation reached its lowest point in the game with this move.

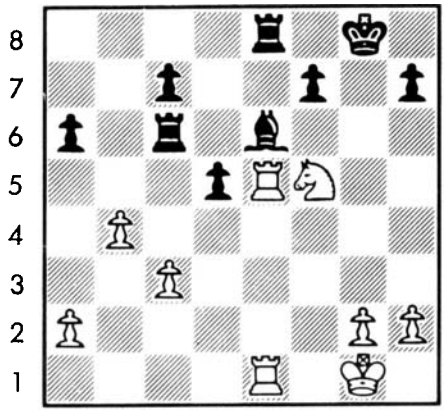
17.	Be7–f6



18.	Rf1–e1	O–O
19.	Bf4–e5	Bf6xBe5
20.	Nc6–e7+	Kg8–h8
21.	Re1xBe5	Rf8–d8
22.	Ra1–e1	Rd8–d7
23.	Ne7–c6	Rd7–d6
24.	Nc6–d4	Ra8–e8
25.	b2–b4	

DS: Belle's 8-ply search predicted 25. . . . Kh8–g8 and scored an advantage to White of 0.28 pawns.

25.	. . . . .	g7–g6
26.	f2–f4	Kh8–g8
27.	f4–f5	g6xf5
28.	Nd4xf5	Rd6–c6



29.	Re1–e3	Kg8–f8
30.	Nf5–d4	Rc6–d6

31. Re5–h5	Kf8–g8
32. Re3–e5	c7–c6
33. Re5–g5+	

DS: Belle's 8-ply search predicted 33. . . . Kg8–f8 and judged the position as 1.2 pawns in White's favor. This is the first point at which Belle thought it was winning material. The 2- and 3-ply iterations wanted to play Re5–g5+ but did not realize that it would win material. The 4-ply search selected Rh5–h6 because it did appear to win a pawn. The selection of Re5–g5+ by the 8-ply search occurred because Belle foresaw the pawn capture and judged the resulting position as better than that resulting after 33. Rh5–h6.

33.	Kg8–h8
34. Rh5–h6	Re8–g8
35. Rg5–h5	

DS: Now Belle sees winning two pawns. It is interesting that all the iterations wanted to play 35. Rg5–h5 but not for the same reasons. The 2-ply search thought it was good positionally. Iterations 3 through 6 thought it would win one pawn. Iterations 7 through 9 saw it winning two pawns.

35.	Rg8–g6
36. Rh6xh7+	Kh8–g8
37. Rh7–h8+	Kg8–g7
38. Rh5–h7+	Kg7–f6
39. Rh8–a8	Kf6–e5
40. Ra8xa6	

DS: At this point, Belle realized that she would soon safely acquire a third pawn.

40.	Ke5–e4
41. Ra6xc6	Rd6xRc6
42. Nd4xRc6	Be6–d7
43. Rh7–h4+	Rg6–g4

PWF: Not Ke4–d3 because Nc6–e5+ and Black loses his bishop.

44. Rh4xRg4+	Bd7xRg4
45. h2–h4	f7–f6
46. b4–b5	Ke4–d3
47. Nc6–e7	Kd3xc3
48. b5–b6	d5–d4
49. b6–b7	d4–d3
50. b7–b8=Q	d3–d2
51. Qb8–b3+	Resigns

(1–0)

DS: In this game, Belle correctly anticipated its opponent's move 22 times. Discounting the moves from the opening library when no prediction is made, this approximates 50%.

Game 9: Fredkin Prize Incentive Match
Second game, August 26, 1981, Vancouver, B.C.

Belle (White) vs Storey (Black)

Carl Storey, a Canadian with a USCF rating of 2206, defended the honor of human masters everywhere against the upstart computers by winning both games against Belle and a $2500 prize. He may have read a book or two on computer chess before the match. His playing style could be called "textbook" anticomputer technique: Play careful, quiet, positional chess, and wait for an opportunity to lure the machine into an endgame it doesn't understand. Probe the machine's defenses until it makes a strategic error and then infiltrate and mop up.

The commentary for this game is based on comments by Hans Berliner published in the ACM Sigart Newsletter, April, 1982, and from Belle's printed record as analyzed by David Slate.

White Belle	Black Storey
1. e2–e4	g7–g6
2. d2–d4	Bf8–g7
3. Ng1–f3	d7–d6
4. Nb1–c3	Ng8–f6
5. Bf1–e2	O–O
6. O–O	c7–c6
7. a2–a4	Qd8–c7
8. h2–h3	e7–e5
9. Rf1–e1	Nb8–d7
10. Be2–f1	Rf8–e8

HB: Both sides have followed standard book openings so far.

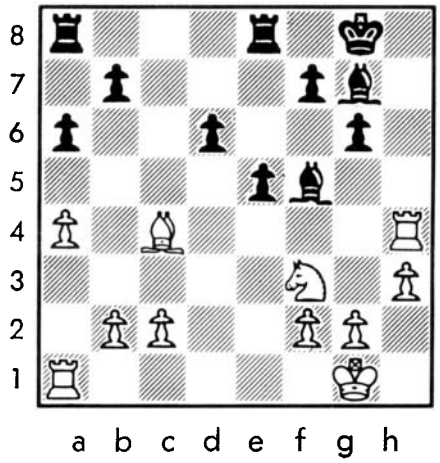
11. d4–d5	a7–a6
12. Bc1–g5	

HB: This is an unusual move for White.

12.	h7–h6
13. Bg5–e3	c6xd5
14. Nc3xd5	Nf6xNd5
15. Qd1xNd5	Nd7–f6
16. Qd5–c4	Qc7xQc4
17. Bf1xQc4	Nf6xe4

HB: The position already favors Black somewhat; however, 17. . . . Bc8–d7 would have been even stronger for Black.

18.	Be3xh6	Bg7xBh6
19.	Re1xNe4	Bc8–f5
20.	Re4–h4	Bh6–g7



HB: Belle's best chance here is 21. Nf3–g5, Re8–e7, 22. Ng5–e4, with tactical chances.

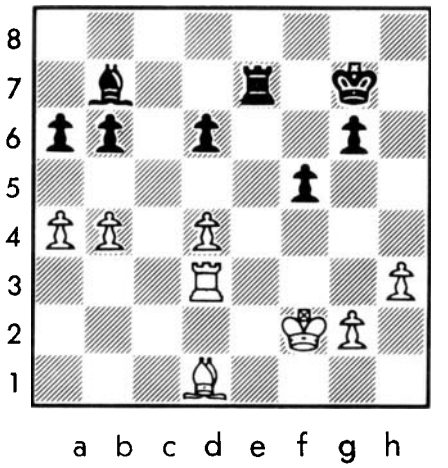
21.	Bc4–d5	Re8–e7
22.	c2–c3	e5–e4
23.	Nf3–d4	Bg7xNd4
24.	c3xBd4	Kg8–g7

PWF: The game to this point is very instructive. Storey selected a quiet opening and has managed to trade pieces and pawns without entering into any wild tactical battles. The material is equal and Black seems to have a slight positional advantage. Compare this middle game to the shoot-out in Game 5 where the human opponent lost to Bebe.

25.	Rh4–f4	Ra8–e8
26.	b2–b4	Bf5–c8
27.	Ra1–a3	f7–f5
28.	Ra3–g3	e4–e3?

HB: A better move for Black would have been 28. . . . Kg7–f6.

29.	f2xe3	Re7xe3
30.	Kg1–h2	Re3xRg3
31.	Kh2xRg3	Re8–e1
32.	Bd5–b3	b7–b6
33.	Rf4–f3	Re1–e4
34.	Rf3–d3	Bc8–b7
35.	Bb3–d1	Re4–e1
36.	Kg3–f2	Re1–e7



PWF: Who is winning here? Certainly an amateur chess player would not know. What should White do? Not an easy question at all. Belle's problem is that there are no obvious short-range goals and therefore even a relatively deep lookahead does not find anything useful to do. To play this position properly, the program has to possess special knowledge about this type of endgame position. Computer chess programs currently do not have such knowledge.

37. Bd1–f3?

HB: This move is suicidal; after this move the only hope for White is 38. g2xBf3. Even then it is doubtful that the position could be saved.

DS: All iterations chose this move, but only the last one (9-ply) correctly anticipated that Black would trade the bishops. Belle saw only a small (0.13 pawns) advantage for Black at this point.

37.	Bb7xBf3
38. Kf2xBf3	Re7–c7
39. Rd3–b3	Rc7–c4
40. a4–a5	b6–b5
41. Kf3–e3	

DS: After a 10-ply search, Belle concluded that it was a pawn down. But this score oscillated over the next few moves between about minus one pawn and minus one-half pawn.

41.	g6–g5
42. Ke3–d3	Kg7–f6
43. Rb3–c3	Rc4xRc3+
44. Kd3xRc3	

DS: All of the iterations chose this move, but the deeper Belle looked, the worse its evaluation became. The 3-ply search scored it as −0.09 pawns. The 13-ply search scored it as −1.38 pawns. It is clear that Belle's static evaluation function was unable to see the hopelessness of its situation, but the deep lookahead search began to get the idea.

44.	. . . . .	f5–f4
45.	Kc3–d3	Kf6–f5
46.	d4–d5	Kf5–e5
47.	Kd3–e2	Ke5xd5
48.	Resigns	

(0–1)

HB: This game provides an apt demonstration for the computer chess community that going 11 plies deep in an endgame is not enough for Master play unless the terminal nodes are evaluated with a lot of knowledge.

Game 10: 1981 Mississippi State Championship Round 4, September, 1981, Hattiesburg, Mississippi

Joseph Sentef (White) vs Cray Blitz (Black)

Cray Blitz was developed at the University of Southern Mississippi by Robert Hyatt and Albert Gower. Previously known as Blitz (see Game 2), the program was modified in 1980 to run on the CRAY-1, one of the most powerful computers ever built, and has been a formidable brute-force chess player ever since. In September, 1981, Cray Blitz became the first computer to win a State championship in the United States. It went 5–0 in the Mississippi State Championship tournament but was ineligible to accept the title.

The game presented here was against Joseph Sentef, a master and former State champion with a USCF rating of 2262. The game is another example of the wild, hair-raising tactical battles that often result when human players try an aggressive approach against one of the stronger computer chess programs. The computer miraculously survives an attack on its king and then wins quickly when its opponent blunders under time pressure after the long tense struggle.

The commentary on this game is based on an annotation by Robert Hyatt. He provides interesting technical data on the program's performance, including the number of nodes examined, the machine's evaluation, and the reply it anticipates. Hyatt also includes occasional remarks as the game progresses.

White Sentef	Black Cray Blitz
1. c2–c4	Ng8–f6
2. Nb1–c3	c7–c6
3. Ng1–f3	d7–d5
4. c4xd5	c6xd5
5. d2–d4	Nb8–c6
6. g2–g3	Nf6–e4

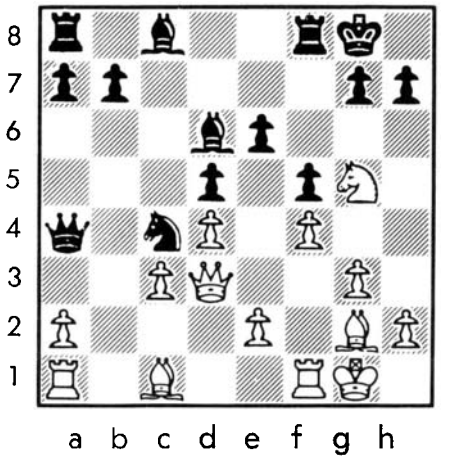
Cray Blitz has a limited opening library on the English opening. In selecting this move, it examined 384,000 nodes, expected White to reply with Bf1–g2, and evaluated the position as 0.18 pawns in Black's favor.

7. Bf1–g2	Ne4xNc3
8. b2xNc3	e7–e6
9. O–O	Bf8–d6
10. Qd1–c2	O–O

The machine's deliberation included 508,000 nodes and produced an expectation of Ra1–b1 with an evaluation of 0.12 pawns for Black.

11. Nf3–g5	f7–f5
12. f2–f4	Nc6–a5
13. Qc2–d3	Qd8–d7
14. Bc1–d2	Na5–c4
15. Bd2–c1	Qd7–a4

This move was selected after considering 356,000 nodes. The machine expected a reply of e2–e3 and judged the position to be 0.22 pawns in Black's favor.



16. g3–g4	h7–h6

White pondered for 30 minutes before launching his attack on the king side. Cray Blitz was totally unaware of what was to come. It examined 378,000 nodes, thought it was winning a pawn (1.24 pawns in Black's favor), and expected g4xf5.

17. g4xf5	h6xNg5
18. f4xg5	Bd6–a3
19. g5–g6	Ba3xBc1
20. Ra1xBc1	Nc4–d6

Cray Blitz is starting to perceive the danger and recalls its knight for defensive work close to home. The evaluation dropped to 0.89 pawns and the 11-ply principal variation anticipated that the game would continue 21. Qd3–h3, Rf8xf5, 22. Qh3–h7+, Kg8–f8, 23. Qh7–h8+, Kf8–e7, 24. Qh8xg7+, Ke7–d8, 25. Rf1xRf5, Nd6xRf5. This is exactly what happened.

21. Qd3–h3	Rf8xf5
22. Qh3–h7+	Kg8–f8
23. Qh7–h8+	Kf8–e7
24. Qh8xg7+	Ke7–d8

At this point, the machine senses the potential trouble which is ahead. After examining 359,000 nodes, it judges the position as being in White's favor for the first time (−0.43 pawns). It predicts 25. Qg7–h8+, Kd8–e7, 26. g6–g7, Nd6–f7, 27. Rf1xRf5, e6xf5, 28. Bg2xd5.

25. Rf1xRf5	Nd6xRf5

White is under time pressure and decides to capture immediately at f5. Cray Blitz recaptures with his knight and now judges the position as favorable (+0.41 pawns). The White pawn at g6 now looks less dangerous.

26. Qg7–f6+	Nf5–e7
27. g6–g7	Qa4–e8
28. Bg2–f3	Kd8–d7
29. Rc1–f1	Ne7–g8

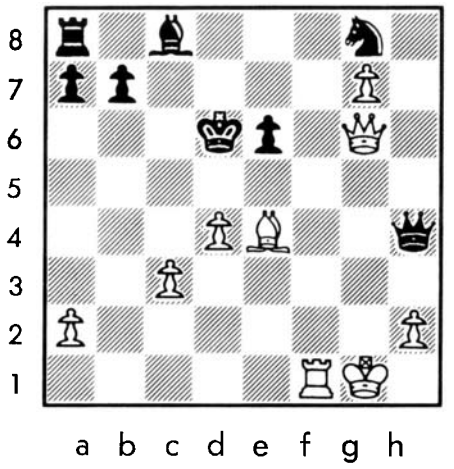
The machine believes it will be able to hold the position. It judges that it is still slightly ahead (0.31 pawns) and anticipates 30. Qf6–g5 followed shortly by a queen exchange.

30. Qf6–g5	Qe8–e7
31. Qg5–g6	Kd7–d6
32. e2–e4	d5xe4

White took ten minutes before making the pawn advance to e4. He is now in serious time trouble. Black did not expect this move. It now judges

the position as favorable to White (—0.22 pawns) and anticipates 33. Qg6–g3+.

33. Bf3xe4 Qe7–h4



34. Qg6–g3+ Qh4xQg3+

Cray Blitz examined 610,000 nodes before capturing at g3. It now judged the position as clearly in White's favor (—1.46 pawns) and anticipates 35. h2xQg3, Bc8–d7, 36. Rf1–f8, Ra8–c8, 37. Rf8xRc8, Bd7xRc8, 38. Be4–h7, Ng8–e7, 39. g7–g8=Q, Ne7xQg8, 40. Bh7xNg8.

35. h2xQg3 Bc8–d7
36. Rf1–f8 Ra8–c8

The machine looked at 1,395,000 nodes and judges the position as —1.31 pawns. It anticipates 37. Rf8xRc8. White has less than 8 minutes to make his next 14 moves.

37. Be4–h7 Rc8xc3

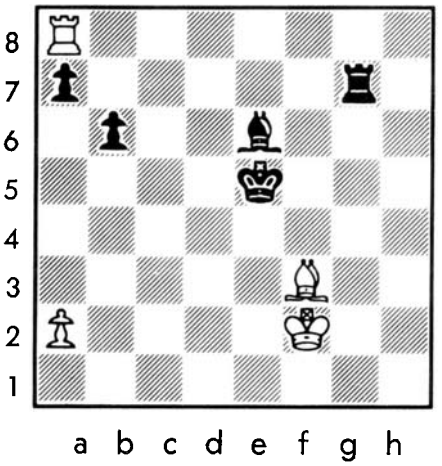
Blitz's outlook suddenly improves. It now judges the game as dead even.

38. Rf8xNg8 Rc3xg3+
39. Kg1–f2 Rg3–g5
40. Bh7–e4 b7–b6
41. Kf2–e3 e6–e5
42. Rg8–a8 Rg5–g3+

White now has one minute to make his next eight moves. Cray Blitz judges the position in its favor (+0.64 pawns) and anticipates 43. Be4–f3.

43. Ke3–f2 Rg3xg7
44. d4xe5+ Kd6xe5
45. Be4–f3 Bd7–e6

The smoke has cleared and Black has an extra pawn. The machine now evaluates the position in its favor by 0.76 pawns and predicts Ra8–e8.



46.	a2–a4	Rg7–f7

Cray Blitz's evaluation improves by almost a pawn. It now judges the position at +1.66 after examining 733,000 positions. The principal variation was 47. Ra8–e8, Rf7–f4, 48. a4–a5, b6xa5, 49. Kf2–e3, Kf4–f7, 50. Bf3–e4.

47.	Kf2–e3?	Rf7xBf3+

White's mistake under time pressure ends the battle. The machine now evaluates the position as +4.09 pawns. White is down a bishop and a pawn no matter what he does.

48.	Ke3xRf3	Be6–d5+
49.	Kf3–e3	Bd5xRa8
50.	a4–a5	Ba8–e4
51.	Ke3–d2	Ke5–d4

The machine now perceives the pawn promotion. Its evaluation jumps to +10.87 pawns.

52.	Kd2–c1	b6–b5
53.	Kc1–b2	Kd4–c4
54.	a5–a6	b5–b4
55.	Kb2–a2	Kc4–c3
	Resigns	

(0–1)

After 55. . . . Kc4–c3, Blitz announced mate in 6.

Game 11: Second World Microcomputer Chess Championship Round 2, September, 1981, Travemunde, West Germany

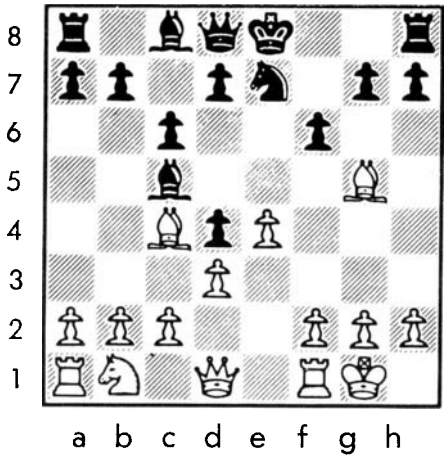
Fidelity X (White) vs Princhess 2.9 (Black)

Microcomputers that play chess, unheard of only a few years ago, now have their own tournaments. The better programs even give the mainframes a tough battle. The surprising ability of current microcomputer programs seems to indicate that in a few years just about anyone will be able to afford a chess computer which plays at a very respectable level.

The game presented here is between two of the better programs. Fidelity X, the eventual winner of the tournament, is a more recent version of Challenger X which participated in Game 7. It is a small unit designed specifically for chess. The program was produced by Dan and Kathe Spracklen. Princhess 2.9 is the creation of Ulf Rathsman of Sparga, Sweden. It finished second in the tournament with a 5–2 score.

Fidelity X won a pawn early in the game with a simple tactical shot. Princhess fought back, however, and finally evened the material in the endgame. But then, apparently underestimating the importance of a passed pawn, Princhess let Fidelity X push its pawns while ignoring its own. This finally led to its downfall. Commentary by Peter Frey.

White Fidelity X	Black Princhess 2.9
1. e2–e4	e7–e5
2. Ng1–f3	Nb8–c6
3. Bf1–b5	Nc6–d4
4. Nf3xNd4	e5xNd4
5. O–O	Bf8–c5
6. d2–d3	Ng8–e7
7. Bc1–g5	c7–c6
8. Bb5–c4	f7–f6?

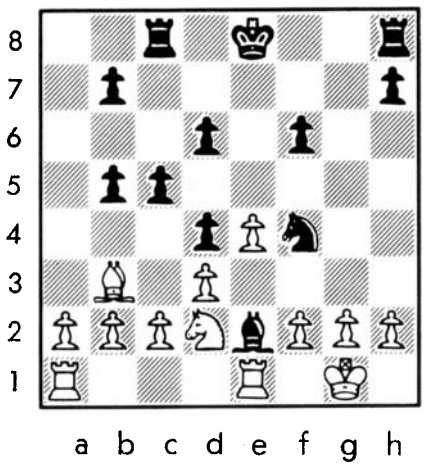


Black's opening moves are notably weak. Its attempt to dislodge the White bishop at g5 by 8. . . . f7–f6 is bad for two reasons. It weakens the king's position and at the same time opens the door to a simple tactical shot for White.

9.	Bg5xf6	g7xBf6
10.	Qd1–h5+	Ne7–g6
11.	Qh5xBc5	Qd8–b6
12.	Qc5xQb6	

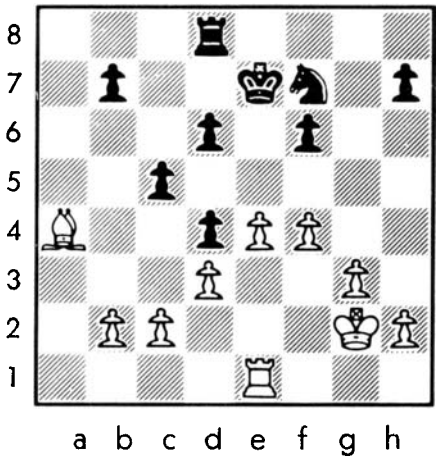
With the Black king trapped without pawn cover, White should keep its queen in order to mount an attack on the vulnerable Black monarch. Trading queens at this juncture is very beneficial for Black. A stronger move for White would have been 12. Qc5–d6.

12.	. . . . .	a7xQb6
13.	Nb1–d2	d7–d6
14.	Nd2–f3	b6–b5
15.	Bc4–b3	c6–c5
16.	Bb3–d5	Ng6–f4
17.	Bd5–b3	Bc8–g4
18.	Nf3–d2	Bg4–e2
19.	Rf1–e1	Ra8–c8

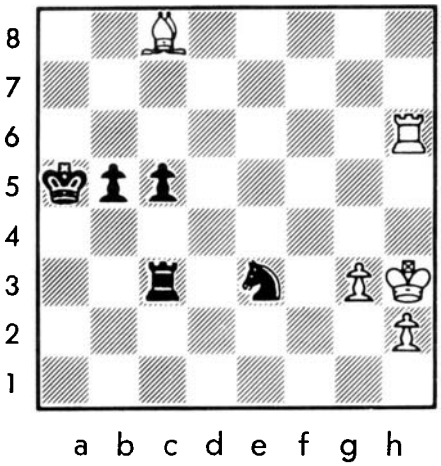


White has been playing passively and now finds itself short of space. Careful play is now required or Black's aggressiveness may begin to pay dividends.

20.	g2–g3	Nf4–h3+
21.	Kg1–g2	Be2–g4
22.	f2–f3	Bg4–d7
23.	Bb3–d5	Rc8–c7
24.	a2–a4	b5xa4
25.	Nd2–c4	Ke8–e7
26.	Nc4–b6	Nh3–g5
27.	Nb6xBd7	Rc7xNd7
28.	f3–f4	Ng5–f7
29.	Bd5–c4	Rh8–a8
30.	Bc4–b5	Rd7–d8
31.	Ra1xa4	Ra8xRa4
32.	Bb5xRa4	



32.	. . . . .	b7–b5
33.	Ba4–b3	Nf7–h6
34.	e4–e5	f6xe5
35.	f4xe5	Nh6–f5
36.	Re1–e4	Nf5–e3+
37.	Kg2–h3	d6xe5
38.	Re4xe5+	Ke7–d6
39.	Re5–e6+	Kd6–c7
40.	c2–c3	Rd8–d6
41.	Re6–e7+	Kc7–c6
42.	Re7xh7	d4xc3
43.	b2xc3	Rd6xd3
44.	Rh7–h6+	Kc6–c7
45.	Rh6–h7+	Kc7–b6
46.	Rh7–h6+	Kb6–a5
47.	Bb3–e6	Rd3xc3
48.	Be6–c8	



After an interesting battle, the material is equal. The game has become a contest to see who can promote a pawn first. Although both sides have opportunities, Black has the more favorable position.

48.	Ne3–d5
49. Rh6–a6+	Ka5–b4
50. Kh3–g4	Rc3–c4+
51. Kg4–g5	Rc4–e4
52. h2–h4	Re4–e5+
53. Bc8–f5	Nd5–e3
54. g3–g4	Ne3xBf5
55. g4xNf5	

The White pawns are on the move. The Black pawns are passive spectators.

55.	Re5–e4
56. f5–f6	Re4–e5+
57. Kg5–g6	Re5–e3
58. f6–f7	Re3–g3+
59. Kg6–f6	Rg3–f3+
60. Kf6–g7	Rf3xf7+
61. Kg7xRf7	Kb4–c3
62. h4–h5	Resigns

(1–0)

This game between two of the strongest microcomputer programs indicates that there is still a significant difference between microcomputer chess and mainframe chess. Fidelity X played a steady if not spectacular game. Princhess was notably weak in the opening, aggressively strong in the middle game, and woefully uninformed about what is required in the endgame. With the rapid advances in computer miniaturization and with small-system programmers gaining chess experience, one can be optimistic about future improvements in this area.

Game 12: 1981 North American Computer Chess Championship Round 3, November 9, 1981, Los Angeles, California

Philidor (White) vs L'excentrique (Black)

Philidor, running on an Osborne-1 microcomputer, is the creation of David Broughton, Mark Taylor, David Levy, Mike Johnson, and Kevin O'Connell, and was represented at the tournament by David Levy. This marked a major change of roles for the British master. In the past, Levy had been the director of almost all of the major computer chess tournaments and had gained considerable publicity by betting that no computer could beat him in a tournament-style match. Perhaps Levy is hedging his bets on the philosophy that if "you cannot beat them, you might as well join them." At ACM 81, Philidor did very well for a micro, scoring 2.5–1.5.

L'excentrique, by Claude Jarry of McGill University in Montreal, is an efficient implementation of the brute force strategy, searching 20,000 nodes per second on an Amdahl V7. The program is almost devoid of chess knowledge and emphasizes deep search with minimal time spent evaluating terminal nodes. Monty Newborn, who was Jarry's advisor at McGill, says that L'excentrique is compact, clean, and simple. This approach appears to have some merit because the program has performed well in tournament competition, including a win over Chess 4.9 at the world championship in 1980.

The game came down to a king and pawn ending in which, despite its two-pawn advantage, Philidor could find no way to make progress. Both sides began to make aimless king moves. At the prearranged adjournment time, the tournament director assessed the situation and determined that White had a won position and awarded the game to Philidor. Commentary on this game is by Mike Valvo.

White Philidor	Black L'excentrique
1. e2–e4	c7–c6
2. d2–d4	d7–d5
3. e4–e5	Bc8–f5
4. Ng1–e2	e7–e6
5. Ne2–g3	Bf5–g6
6. Bf1–d3	h7–h5?

In this variation of the Caro Kann opening, either 6. . . . Bg6xBd3 or 6. . . . c6–c5 are to be preferred.

7. O–O

White could have gained a positional advantage by 7. Bd3xBg6.

7.	. . . . .	h5–h4
8.	Ng3–e2	Bg6xBd3
9.	Qd1xBd3	Nb8–d7
10.	Nb1–d2	Bf8–e7
11.	c2–c3	Qd8–c7
12.	Nd2–f3	

The thematic break initiated by 12. f2–f4 is more than adequately met by 12. . . . g7–g6.

12.	. . . . .	O–O–O
13.	Bc1–f4	b7–b5?

"Beauty is skin deep, but ugly goes clean to the bone." After this, Black's game is technically lost.

14.	a2–a4	Qc7–b7
15.	b2–b4	

15. a4xb5, c6xb5, 16. Ra1–a5, a7–a6, 17. Rf1–a1, Nd7–b8, 18. b2–b3! and White has excellent attacking prospects.

15.	. . . . .	b5xa4

15. . . . a7–a6 offers better defensive prospects. White can, however, triple on the *a*-file and coupled with knight maneuvers to c5, force Black to concede.

16.	Ra1xa4	f7–f5
17.	Bf4–e3	

Pointless. 17. Rf1–a1 wins material.

17.	. . . . .	Nd7–b6
18.	Ra4–a2	Nb6–c4

18. . . . Kc8–d7 offers prospects of defending the *a*-pawn.

19.	Be3–f4	

It is still not too late for Rf1–a1 with ideas similar to those mentioned earlier.

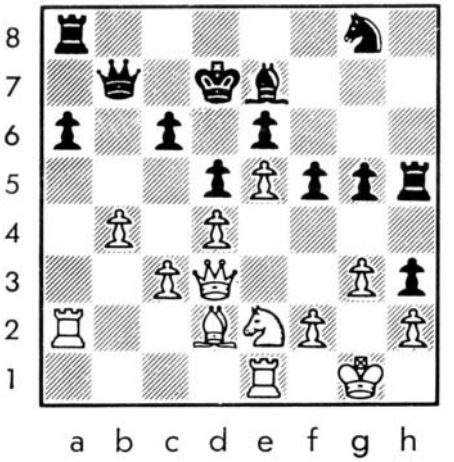
19.	. . . . .	Kc8–d7
20.	Ra2–a4	

White seems to have no idea about what's going on.

20.	. . . . .	a7–a6
21.	g2–g3	h4–h3
22.	Ra4–a2	Rh8–h5
23.	Rf1–e1	

Why?

23.	. . . . .	Rd8–f8
24.	Bf4–c1	g7–g5
25.	Nf3–d2	Nc4xNd2
26.	Bc1xNd2	Rf8–a8



Black is in trouble. 26. . . . Qb7–b5 is no better; 27. Qd3xQb5, a6xQb5, 28. Ra2–a7+, Kd7–c8, 29. Re1–a1 and White can then position his knight on a5.

27. Re1–a1

Finally!

27.	. . . . .	Qb7–b5
28.	Qd3xQb5	c6xQb5
29.	f2–f4	g5–g4
30.	Ra2xa6	Ra8xRa6
31.	Ra1xRa6	Be7–d8
32.	Ra6–d6+	Kd7–e7
33.	Bd2–e1	

The obvious move for a human here would be 33. Ne2–c1. Note that 33. Rd6–c6, Ke7–d7, 34. Rc6–c5, Bb6 does not win a pawn for White.

33.	. . . . .	Bd8–c7
34.	Rd6–a6	Ng8–h6
35.	Be1–d2	

The obvious move here is still Ne2–c1.

35.	. . . . .	Nh6–f7
36.	Ra6–c6	Ke7–d7
37.	Rc6–a6	

White realizes that Rc6–c5 fails as described before.

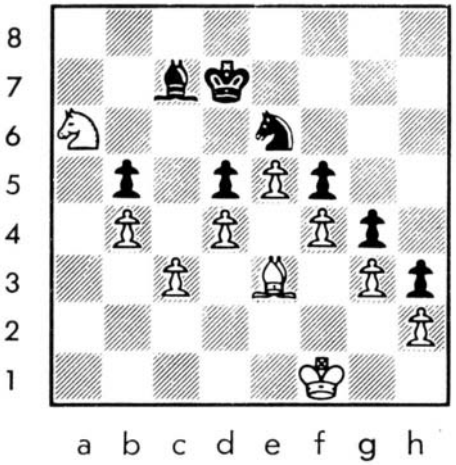
37. . . . . Nf7–d8
38. Ne2–c1

Finally!

38. . . . . Rh5–h7
39. Nc1–d3 Kd7–c8
40. Nd3–c5 Bc7–b8?

Black overlooks 40. . . . Rh7–e7, 41. Ra6–a8+, Bc7–b8, 42. Ra8–a5, Re7–a7!

41. Nc5xe6 Rh7–h6!
42. Ne6–c7 Rh6xRa6
43. Nc7xRa6 Nd8–e6
44. Bd2–e3 Bb8–c7
45. Kg1–f1 Kc8–d7



46. Na6xBc7

After this, the game is a draw. The only winning chance was 46. Na6–c5+.

46. . . . . Ne6xNc7
47. Kf1–e2 Nc7–a8

Humans would abandon this position as a draw. But Black has a losing plan beginning with this move.

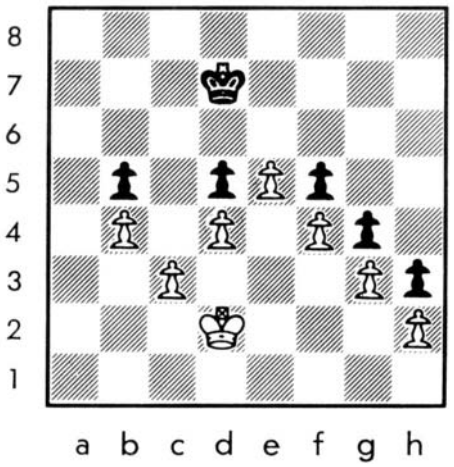
48. Ke2–d3 Na8–b6
49. Be3–d2 Nb6–c4
50. Bd2–c1

White avoids the exchange, preventing Black's attempt at hari-kari.

50. . . . . Kd7–e7
51. Bc1–d2 Nc4xBd2??

The purpose of the knight's migration and the only way to lose.

52.	Kd3xNd2	Ke7–f7
53.	Kd2–e3	Kf7–e7
54.	Ke3–f2	Kf7–d7
55.	Kf2–e3	Kd7–c7
56.	Ke3–d3	Kc7–d7
57.	Kd3–d2	Kd7–e7
58.	Kd2–e3	Ke7–d7
59.	Ke3–d3	Kd7–e7
60.	Kd3–d2	Ke7–d7



By prior arrangement, the game was adjudicated at midnight. Mike Valvo determined that best play for both sides would produce a win for White. It is extremely doubtful, however, that Philidor could find the winning sacrifice. This raises the question of adjudication by best play without regard to level of the players.

The uncomfortable outcome of this match is quite similar to that in the Duchess-Chaos match in Game 4. Adjudication by best play not only can give a win to a program which, in all likelihood, would never find it on its own, but also can lead to subjective decisions. Recent analysis questions whether the position above is a win for White. Black, with proper play, may be able to hold the position.

One of us (PWF) would like to see the tournament rules modified to hasten the rate of play and remove the need for matches to be adjudicated by the tournament director. One possible way to do this would be to set a 1 minute per move time control for the entire match and declare any game which is not decided in 100 moves a draw. The 1 minute time limit would decrease the depth of search by slightly more than one-half ply. This would decrease the level of performance slightly but the benefits of the change outweigh this negative factor. Against human opponents, the machines could adopt whatever time limit had been established for

that particular tournament. The 100-move rule would make it necessary for the programs to deal effectively with endgame play. The current rules allow some of the programs to essentially avoid dealing with this important aspect of the game. The 100-move rule would penalize programs very heavily for not being able to play efficiently in the endgame. This is desirable and fair.

With both of these rules in effect, the computer chess tournaments would not drag on late into the night for four consecutive days. The maximum length of time for any one game would be 3 hours and 20 minutes. It would be possible to play two games a day and finish a four-round tournament in a weekend. The telephone expense of the tournament would be reduced considerably and many teams would be able to maintain time on the mainframe of their preference if weeknight games were not required. From the point of view of the spectators, the matches would be more exciting with moves coming every minute or less in each game. With all games completed in less than 4 hours and with no problems over adjudication, the pairings for the next round could be done before the programmers started to make preparations for the next match. These benefits seem to outweigh the fact that the level of play would be reduced slightly.

Game 13: 1981 North American Computer Chess Championship Round 4, November 10, 1981, Los Angeles, California

Cray Blitz (White) vs Belle (Black)

This brute-force battle, which decided the 1981 championship, is both exciting and instructive. In spite of rumors to the contrary, even the strongest programs make tactical mistakes. The nature of an exhaustive, full-width search is such that brute-force programs tend to "see" all of the short-range (a few moves deep) exchanges, some of the middle-range tactics, but very little of the long-range (ten moves deep or more) tactical threats. Thus the computer has a definite horizon which is much sharper than that of the human player. Humans sometimes fall prey to a short-range shot but at the same time can apprehend some very deep tactical threats. When a computer wins by making a nice tactical combination, it is often because the relevant exchanges just happened to lie within its search boundary. The machine's horizon depends not only on the nominal depth of its full-width search but also on the nature of the quiescence analysis done at the terminal nodes. Programs typically search sequences of captures at the end nodes of the full-width tree and sometimes also extend the lookahead for certain kinds of checks and other threats. Also, some of the programs do not search all lines full-width to the same fixed depth. For example, Belle and Nuchess do not count checks as plies, so even a "5-ply" search may examine five checking moves by one side and the responses to them by the opponent. All of these factors influence a program's ability to calculate tactical variations accurately.

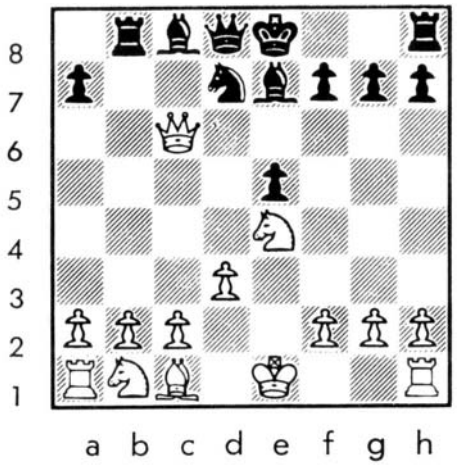
In this game, a crucial position arose after Belle's 27th move. Belle had calculated on its 26th move that Cray Blitz would play 28. Qe6xNb6 and Belle would then have mating threats that would force Blitz to sacrifice a queen for a rook. Belle expected to be slightly ahead after its 31st move. Belle completely missed the effectiveness for Blitz of 28. Bc1xh6. On the other side of the board, Cray Blitz also missed 28. Bc1xh6 and thought it was winning a whole piece after Qe6xNb6, failing to see Belle's threat. The game then went exactly as Belle had predicted through move 31 and both sides (especially Blitz) were surprised to find that Belle easily won the resulting queen vs rook and bishop ending. The reason that Cray Blitz did not perceive what was about to happen when it played 28. Qe6xNb6 is that it did "only" a 6-ply search and fell prey to the "horizon effect" produced by its own checks on moves 29 and 30 which delayed Black's mating threat and effectively pushed it past the 6-ply limit.

These two delaying moves, while not likely to confuse a human master, add 4 plies to the crucial variation and thus invalidated the accuracy of Blitz's 6-ply search. Belle, which does not count a checking move as a ply, suffered only a 2-ply delay in its search and was not so easily fooled. The importance of adding sophistication to the quiescence search is emphasized by submitting this position to Nuchess which has special heuristics for this aspect of the search. With a nominal 4-ply search which examined 29,411 nodes, Nuchess saw at move 28 what Blitz failed to see after processing 183,992 nodes. Nuchess, however, missed Bc1xh6 just like the other programs and evaluated the position after 31. . . . Qd3xRf1 as a close game just as Belle had done.

The evaluative commentary for this game is provided by Mike Valvo. The notes by David Slate are based on information from the machines' records.

White **Cray Blitz**	**Black** **Belle**
1. e2–e4	e7–e5
2. Ng1–f3	Nb8–c6
3. Bf1–c4	Ng8–f6
4. Nf3–g5	d7–d5
5. e4xd5	Nc6–a5
6. Bc4–b5+	c7–c6
7. d5xc6	b7xc6
8. Qd1–f3	Ra8–b8
9. Bb5xc6+	Na5xBc6
10. Qf3xNc6+	Nf6–d7
11. d2–d3	Bf8–e7
12. Ng5–e4	

DS: Until now both machines were playing from their opening book. After 12. Ng5–e4, Black is out of its book and has to calculate on its own for the first time.



12. . . . . Bc8–b7?

MV: This is the wrong move for Black. Instead, Belle should have played 12. . . . Rb8–b6!? and then 13. Qc6–a4, f7–f5, 14. Ne4–g3, O–O and Black has adequate compensation for the pawns with moves like Bc8–b7, Rb6–b4, and Be7–c5.

DS: After Black's unexpected move, White is now out of book also.

13.	Qc6–a4	Qd8–c7
14.	Nb1–c3	Bb7–c6
15.	Qa4–c4	Qc7–c8
16.	Nc3–d5	Bc6xNd5
17.	Qc4xBd5	Qc8xc2
18.	O–O	

MV: At this point, Black is simply a pawn down without any immediate prospects to win it back. Any attempt to play positionally on the weak white pawns is dealt with by either d3–d4 or f2–f4.

18. . . . . f7–f6?

MV: Now Black cannot castle. Black would have done better to play a pawn down with 18. . . . Qc2–c8 and 19. . . . O–O.

DS: Belle's computations for this move took 9 minutes and involved a complete 7-ply search and the first move of the 8-ply search. It judged the situation as a 1.05 pawn advantage for Blitz and expected 19. . . . Ne4–c3.

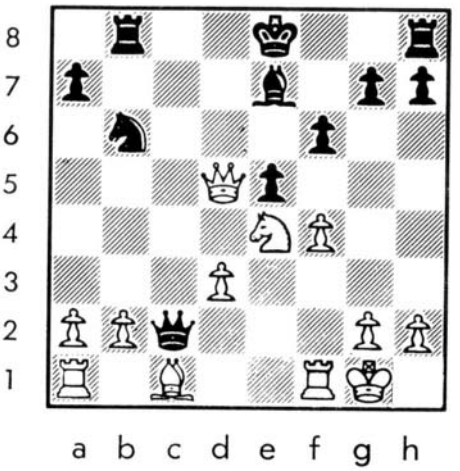
19. f2–f4?

MV: White would be better to consolidate with 19. Bc1–e3. The text allows Black to castle.

DS: Blitz completed a 5-ply search and the first move of the 6-ply

search. Its calculations took just 1 minute and produced an evaluation of 1.24 pawns in its favor with the expectation of 19. . . . Be7–c5+ leading to massive bloodshed on c5 and elsewhere.

19. . . . . Nd7–b6



20. Qd5–a5

MV: The win has already slipped away. If 20. Qd5–b5+, then Nb6–d7, 21. Qb5–c4, Rb8–c8 and Black has some compensation.

20. . . . . Qc2xd3
21. Qa5xa7 O–O
22. Qa7xBe7

MV: If Ne4–g3 or Ne4–c3 instead, Black has winning chances: 22. . . . Be7–c5+, 23. Kg1–h1, e5–e4.

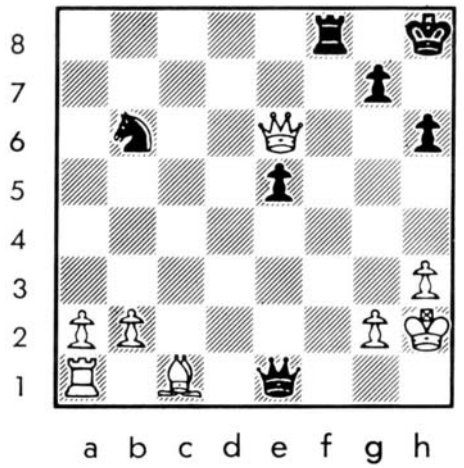
22. . . . . Qd3xNe4
23. Qe7–e6+ Kg8–h8
24. f4xe5 f6xe5
25. Rf1xRf8+

MV: White is already in trouble. Probably better to play 25. Bc1–g5, Qe4–d4+, 26. Kg1–h1, Qd4xb2 and White should survive.

25. . . . . Rb8xRf8
26. h2–h3 Qe4–e1+

DS: Belle did an 8-ply search in 3½ minutes, judged the position as 0.21 pawns in its own favor, and predicted 27. Kg1–h2, h7–h6, 28. Qe6xNb6, Rf8–f1, 29. Qb6–d8+, Kh8–h7, 30. Qd8–d3+, e5–e4, 31. Qd3xRf1, Qe1xQf1.

27. Kg1–h2 h7–h6



28. Qe6xNb6??

MV: White is totally lost after this move. Instead, 28. Bc1xh6!! forces at least a draw. For example, 28. . . . Qe1xRa1, 29. Qe6–g6, Rf8–g8, 30. Bh6–f4, Rg8–d8, 31. Bf4xe5, Rd8–d7 and White can draw with 32. Qg6–e8+ or attempt to win with 32. Qg6xNb6.

DS: In selecting this move, Blitz did a complete 5-ply search and the first move at the 6th ply. It evaluated the position as 4.11 pawns in its own favor and predicted 28. . . . Rf8–f2, 29. a2–a3, Qe1–f1, 30. Qb6–g6, Kh8–g8.

28.	Rf8–f1
29. Qb6–d8+	Kh8–h7
30. Qd8–d3+	e5–e4
31. Qd3xRf1	Qe1xQf1
32. a2–a3	e4–e3
33. Bc1xe3	

DS: Blitz perceives that the Bishop has to capture the pawn or the pawn will reach the eighth rank.

33.	Qf1xRa1
34. Be3–d4	h6–h5
35. Bd4–c3	g7–g5
36. Bc3–e5	Qa1–e1
37. Be5–c3	Qe1–f2
38. Kh2–h1	g5–g4
39. h3xg4	h5xg4
40. Kh1–h2	Qf2–h4+
41. Kh2–g1	g4–g3
42. Kg1–f1	Kh7–g6
43. Resigns	

(0–1)

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