Othello: Game of the Century

By Murakami Takeshi

Millions devote much of their lives to playing chess, *shôgi* or go, fascinated by the seemingly small but actually infinite universe of these age-old games. But how many of these people know Othello? It is relatively new, yet it has the power and glamour to grip people in the same way its predecessors have.

I was captivated by the game of Othello as a high school student in 1981, and often enjoyed a quick game of Othello between classes with my friends. All those around me regarded Othello as a children's game, very simple and nothing at all like shôgi or go, the popular Japanese games that attract hundreds of thousands of players for their profound complexity. But Othello had a peculiar charm unlike that of any other board game.

The concept was so easy that even young children could easily learn to play. Yet no one, not even grownups, could be quite sure of the correct strategy: The objective is to see who can get the most discs, but since so many discs are flipped with each move, you never know which side is really winning until the very end.

Playing it casually with my classmates, I felt as if I were standing before a cave, which, disguised by the simplicity of its rules, held a hidden inner dimension beyond the ken of human intelligence. I was pushed into the labyrinth by my first, devastating encounter with a *dan*-holder. Dan are ranks based on skill, as in martial arts, shôgi and other Japanese sports and games. The ninth dan is the highest, and holding even the first dan suggests a considerable degree of skill. Having played many games with my friends, I had gained some skill at Othello—at least enough to beat everyone around me.

But not this man, Shimonosono Kôzô, a second-dan holder who was a member of the Japan Othello Game Association, playing simultaneous exhibition games at a department store in my hometown. He demolished me: I had fewer than 10 discs on the board when the game ended. This defeat was the real start of my career as an Othello player. As I read strategy books, played in local tournaments and finally beat Shimonosono, my objective was becoming clear: Yes, someday, I would be the World Champion of Othello!

The game of Othello was invented in 1973 by a Japanese, Hasegawa Gorô. More than 20 years earlier, he had first come up with the idea for the game while a junior high school student, when he had a go board but, not knowing go rules, wanted a simpler game. He then revived it for his wife and friends, who also had difficulty learning go. His father Hasegawa Shirô, a professor of English literature at Ibaraki University, saw certain similarities between the game his son had made up and *The Tragedy of Othello, the Moor of Venice*, the play by William Shakespeare.

Murakami Takeshi is the 20th (1996) and 22nd (1998) World Champion of Othello. He holds the 8th dan *(second-highest rank) in Othello. He teaches English at Azabu High School in Tokyo.*

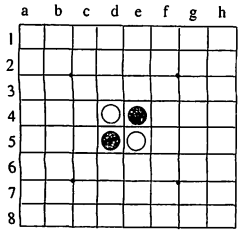


Figure 1: Black to play

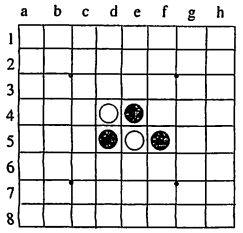


Figure 2

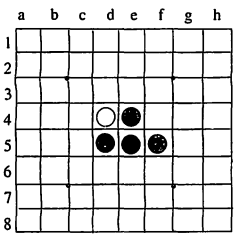


Figure 3: White to play

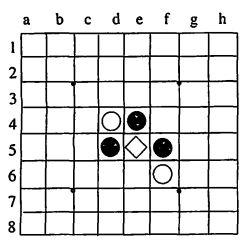


Figure 4

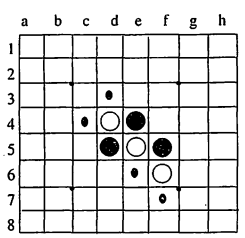


Figure 5: Black to play

In the game, the black discs (General Othello) and the white discs (Desdemona) fight dramatically until the battle culminates in the endgame in the most suspenseful manner. Hence the name of the new game. Othello caused a sensation in Japan. An estimated 1 million sets were sold in its first month of commercial release. No other board game had ever spread so widely and so rapidly in Japan. Tsukuda Original Co., which started making and marketing Othello in 1973, has since sold about 21.5 million sets. And sales have been so consistently strong that it is hard to find a Japanese who has not heard of the game. There are an estimated 90 million players worldwide. An estimated 15 million Othello sets have been sold outside Japan, under license from Anjar Co., since the game was introduced in the United States in 1976. This includes videogame cartridges, standard and travel sets, hand-held electronic versions and CD-ROM computer software.

It must be noted that games that have similar rules to Othello existed in the 19th century, such as reversi in England and *genpei-go* in Japan. But it was Hasegawa who established the name, design and rules of Othello, which, unlike its ancestors, was to prevail.

Why has Othello become so popular? The secret lies in the tag line printed on every Othello set: "A minute to learn, a lifetime to master."

The Rules of the Game

It is surprisingly easy to learn. An Othello set consists of a square green board, marked in eight sections each, horizontally and vertically, to total 64 squares, on which 64 discs—black on one side, white on the other—are placed. Black plays first in the starting position shown in *Figure 1*. Black plays to a square that puts at least one white disc between the black disc just placed and any other black disc already on the board (*Figure 2*). Here, black has placed a black disc on square f5. Black then flips over the white disc, which has been trapped between the black discs, to make it also a black disc (*Figure 3*).

Then it is white's turn. The player plays to a square according to the same rule. As *Figure 4* shows, a disc can be trapped diagonally. In this play, white plays to square f6, and flips over the trapped black disc on e5.

A player must play to a square that traps and flips at least one of the opponent's discs. As shown in *Figure 5*, black could now play to c4, d3, e6 or f7 (marked on the figure with smaller black dots). He cannot play to other squares, because such moves would not trap and flip any white discs. As shown in *Figures 6* and *7*, a player can capture more than two discs in more than two directions. For example, if white plays to d8 in *Figure 6*, white flips six discs in two directions as in *Figure 7*.

A player is not allowed to pass a turn while there are playable squares. A player must pass when there are no squares to which he can play. In *Figure 8*, black has no squares that would trap and flip any white discs. So black must pass until given some squares where he can play.

Black and white play in turns until all the squares are filled. The player with the most discs wins. In this game, in *Figure 9*, the game ends with 18 discs for black to 46 discs for white. White has won.

"A minute to learn" is not an exaggeration if you have someone who shows you how to play with a board and discs in front of you. Even the elderly, to

whom the rules of chess, shôgi and go are a bit too complicated, can learn how to play Othello quite easily. "A lifetime to master" is an understatement: It certainly takes more than a lifetime to master Othello.

In Othello, a player has on the average 10 options at each move. Since a game ends in 60 moves, there are roughly 10^{60} possible combinations. Although this is a very small number when compared to the 10^{120} for chess, or 10^{220} for shôgi or 10^{360} for go, it is still well beyond the range of human experience. One characteristic of Othello makes it very difficult for humans to play well, but I will come to that later.

This seemingly impossible coexistence of simplicity and complexity, only rarely leading to a draw, with little deviation of wins for either color—black and white have almost the same probability of winning—the fixed number (60) of moves and the beautiful design of the set with its thick black and white discs on a green board have made Othello uniquely qualified not only as a friendly home game, but as a game for highly competitive tournament play.

Which recalls the events of November 10, 1996. I was consumed by fever. My body was numb; my mind was clear, yet somehow not functioning properly. I had to struggle mightily to think. As I faced the green board, about half of the 64 squares were already occupied by black and white discs.

I knew what to do for the situation in *Figure 10*: play to b7, allowing white to take the a8 corner, and then play to b8. This would give white the whole west edge and most of the south edge and give the game to black (*Figure 11*). But why should I have to give white any edges at all?

Greed killed me: Instead of finishing white off with b7, I broke through white's wall at g6 (*Figure 12*). The sharp, fox-like countenance of Garry Edmead, a rising Othello genius from England, seemed to twitch a little, obviously sensing the wind shift as I failed to play the best move. He played to f8, rendering my b7 no longer effective.

My advantage suddenly vanished, and after many minutes of exhaustive and vain search for a win, I lost the game to Edmead, 31 to 33, with the outcome shown in *Figure 13* and *Figure 14*. I crumpled into a makeshift bed, made of eight chairs, in a room at the Palace Hotel, Tokyo, which overlooks the magnificent grounds of the Imperial Palace, and which was the venue for the 20th World Othello Championship. It was my second World Championship: In Paris in 1988, I had lost to Graham Brightwell of England in the semifinal.

It had taken me a long eight years to win the All Japan Championship and to again qualify for the world competition, and I had spent a long two days, fighting the cold I had caught before the tournament while challenging the top 22 players from around the globe in the 13 rounds of preliminary games.

I had won 11 games and advanced to the last day of the tournament, where I fell to Edmead, losing the first game of semifinals just as I had done eight years before. As close to the top of Mount Olympus as I had ever been, I was failing again. To reach the pinnacle and reside as World Champion, I had to win the next two games straight to Edmead, and then win another two games out of three against whoever would advance to the final. The way ahead seemed impossibly long.

When the next game began, however, the fever ceased to torture me. Perhaps the medicine I took before the first semifinal was finally beginning to work. So

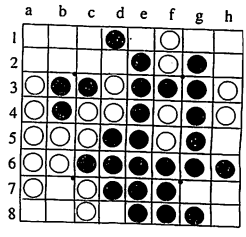


Figure 6: White to play

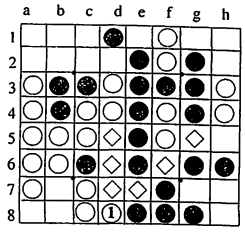


Figure 7

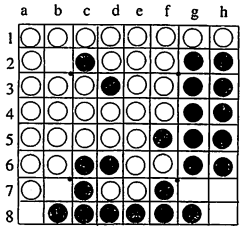


Figure 8: Black to play

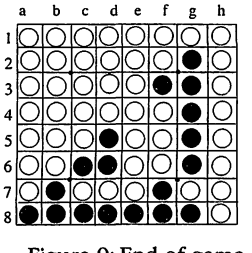


Figure 9: End of game

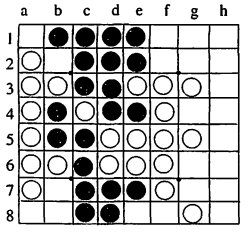


Figure 10: Black to play

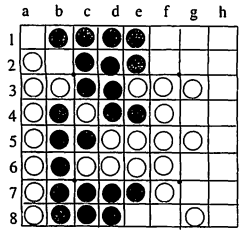


Figure 11: A winning position for black

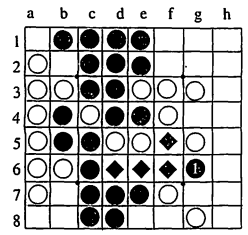


Figure 12

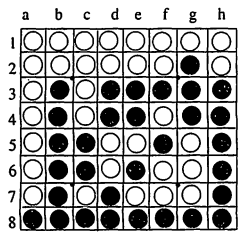


Figure 13

	a	b	c	d	e	f	g	h
1	52	35	22	24	27	56	55	58
2	26	47	9	11	17	54	60	59
3	21	8	3	4	10	19	34	57
4	25	13	5	○	●	6	46	42
5	16	14	7	●	○	1	36	41
6	15	29	12	2	18	28	39	48
7	20	53	30	32	31	23	45	50
8	51	44	37	33	43	40	38	49

Figure 14: 1996 World Championship, Game 1: Murakami (black) 31 Edmead (white), 33

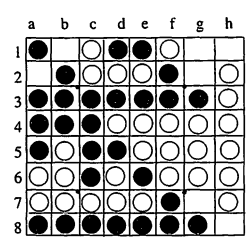


Figure 15: White to play

was my brain. I was able to see many moves ahead accurately, and was able to outplay Edmead to even the score. I was in a favorable position at the start of the third and decisive game. The game would have ended right in the middle game had it not been for Edmead's renowned tenacity. Edmead played his most brilliant defenses and never allowed me to strike a fatal blow.

The position evolved into a complex endgame in which the winning side was no longer clear, and by the time there were only seven squares to fill (*Figure 15*), both Edmead and I had less than two minutes left on the clock.

I was paralyzed by the extreme pressure. My mind could neither formulate nor calculate any lines of attack.

Then it came. As clearly as if it had been an oracle from the God of Othello: g7! (*Figure 16*) At first sight g7 is a terrible move. It lets black take the h8 corner, followed by h1, which gives black the entire east edge. Having already given black the south and the north edge, giving black still another edge seems suicidal.

As it turned out, however, this was in fact the only winning move I had in *Figure 15*. The rest of the empty squares filled rapidly. The hands of both players scurried across the board, deftly flipping the discs, sharply punching the timer buttons with each play. When I filled the last empty square, I had taken six more discs than Edmead (*Figures 17* and *18*). "Well played," he said, as we shook hands firmly.

The finals turned out to be less challenging than the semifinals. Stephane Nicolet of France, whose Othello tournament career was much shorter than mine, seemed partly resigned to defeat, and I was able to win two straight games.

Washed by the flash of cameras, I received the comfortable weight of the 20-year-old, supreme silver cup in my arms. I was overcome by the joy that I finally did realize the dream of a lifetime: I was the World Champion of Othello!

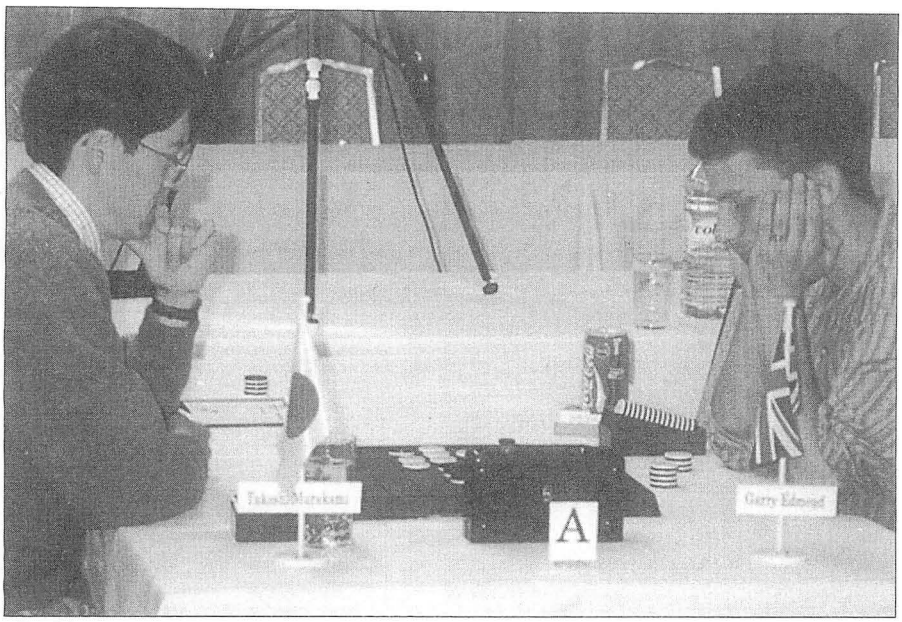
The first All Japan Championship for Othello was held in 1973, the year the game was invented, and has been held every year since then, drawing several thousand players annually. The All Japan Championship is played in five divisions: open, women's, boys' & girls' (15 and under), masters (40 and over), and blind.

The winners of open and women's divisions plus Meijin, the winner of another prestigious tournament, Meijin-sen (literally Master Tournament), go on to the World Championship.

The first World Championship was held in Tokyo in 1977, and the 23rd World Championship, held in Milan in October 1999, drew 34 top players from 15 countries (up to three players are allowed to enter the tournament from each country).

Since Japan has by far the largest number of serious tournament players, the qualities of play displayed by Japanese champions are accordingly high, and 18 World Championships out of 23 have been grabbed by the Japanese; the Americans have won three and the French won the other two.

As I was struggling to distinguish myself from the flock of top players around the world, a whole new challenge was taking shape in my path. "Human (Othello) players, sensing the potential for defeat, are refusing all computer



Shimonosono Kôzô

Murakami Takeshi, left, and Garry Edmead contemplate their respective situations in the 1996 World Othello Championship competition in Tokyo.

challenges." These were the words of Dr. Hans Berliner, a leading specialist in artificial intelligence at Carnegie Mellon University, in an article titled "Losing the Human Edge" for the May 1993 issue of the computer magazine *Byte*. After reading the article, sent by a French Othello player, I felt pure anger. True, computers had already become formidable adversaries for human Othello players. But as far as I knew, no Japanese top players had been invited by Dr. Berliner to play against his computer program, nor would we decline such a challenge out of fear of defeat.

As a player who believes in sportsmanship, I took Dr. Berliner's comments as an insult. I wrote to him, saying I would accept any challenge from any player, living or otherwise. Dr. Berliner tried to organize a match between the program and I, but because of his wife's illness and a lack of sponsors, the match never materialized.

In 1995, Dr. Michael Buro of NEC Research Institute in Princeton, New Jersey, asked whether I was still interested in a match against top software. His program, Logistello, had been developed in 1993, and, having won many computer tournaments, was now renowned as one of the very best Othello programs. We agreed to a match as soon as possible. In 1996, I won the World Championship. Buro called me a few days later. "Congratulations! How are you feeling?"

"Great! It's a dream come true."

He must have felt great, too, because the match was suddenly catapulted to "must" status, pitting his beloved program against the current world champion. He promised to invite me and my wife to the United States at the institute's expense for a match in August 1997. In May, World Chess Champion Garry Kasparov lost a highly publicized six-game match against IBM's Deep Blue.

These two unexpected events—my victory in the 1996 World Championship and Kasparov's historic chess defeat in mid-1997—propelled the Othello

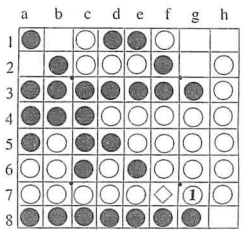


Figure 16

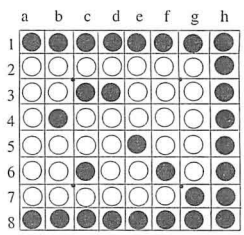


Figure 17

	a	b	c	d	e	f	g	h
1	53	57	34	35	31	32	56	59
2	58	48	23	28	30	33	60	26
3	49	39	38	22	17	9	27	25
4	37	43	36	○	●	4	7	14
5	47	24	6	●	○	1	12	13
6	40	29	19	15	3	2	5	10
7	52	46	18	20	8	11	54	44
8	51	50	21	41	42	16	45	55

Figure 18: 1996 World Championship, Game 3: Murakami (white), 35 Edmead (black), 29

	a	b	c	d	e	f	g	h
1	60	59	48	47	46	54	49	53
2	56	58	38	43	45	44	50	42
3	37	33	29	7	6	9	17	41
4	30	27	26	○	●	14	18	20
5	40	10	5	●	○	1	8	15
6	39	31	11	4	3	2	19	21
7	32	34	25	12	13	23	36	22
8	35	28	51	52	24	16	57	55

Figure 19: Game 4: Murakami (white) 9, Logistello (black) 55

	a	b	c	d	e	f	g	h
1	54	37	17	30	22	24	31	56
2	47	53	9	14	23	32	58	39
3	48	8	3	4	15	19	26	33
4	49	12	5	○	●	6	28	34
5	59	13	7	●	○	1	29	35
6	16	18	11	2	10	20	42	45
7	60	50	27	38	25	21	46	57
8	51	52	36	41	40	43	44	55

Figure 20: Game 6: Murakami (white), 27, Logistello (black), 37

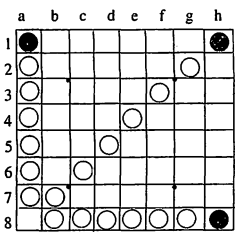


Figure 21: Black's move to a8 will flip 18 discs.

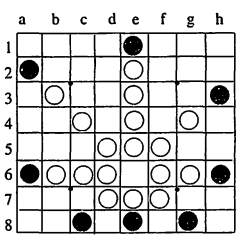


Figure 22: Black's move to e6 will flip discs in eight directions.

match between Logistello and I from a minor event of interest largely within the Othello community to one seized upon by the media.

Since Othello is especially popular in Japan, all six principal Japanese TV stations sent crews, joining hordes of newspaper reporters at the NEC Research Institute, site of the match. Many Japanese followed the progress of the six-game match, wondering whether yet another human champion would fall prey to the silicon terror, or whether he would hang tough and demonstrate the superiority of human intellect.

Before his matches, Kasparov had believed in his own superiority over Deep Blue. He still does and he is probably right. He would have won the match under better match conditions.

Studying the Combinations in Advance

But what were my odds? Before the match, I got transcripts of the sequence of play in Logistello's games in various previous computer tournaments. Analysis of these games and information about how Logistello works revealed the unerringly superhuman accuracy and strength of Logistello, which led me to believe I would have a very slim chance of prevailing. I had hoped to win at least one of the six games, but it was not to be.

The result of the match, held in Princeton from August 4 to 7, was a devastating 6-0 whitewash for Logistello. The best I could manage was a 27-37 outcome, as shown in *Figure 20*. In the fourth game, I had just nine discs left on the board as in *Figure 19*. I had never lost so completely and defenselessly against human players.

Othello offers more than 5 million possible combinations in the first 10 moves alone. Analyses of openings by top players run to the 20s, 30s and sometimes beyond, but human players check only a small fraction of the innumerable possible lines—only those that look promising.

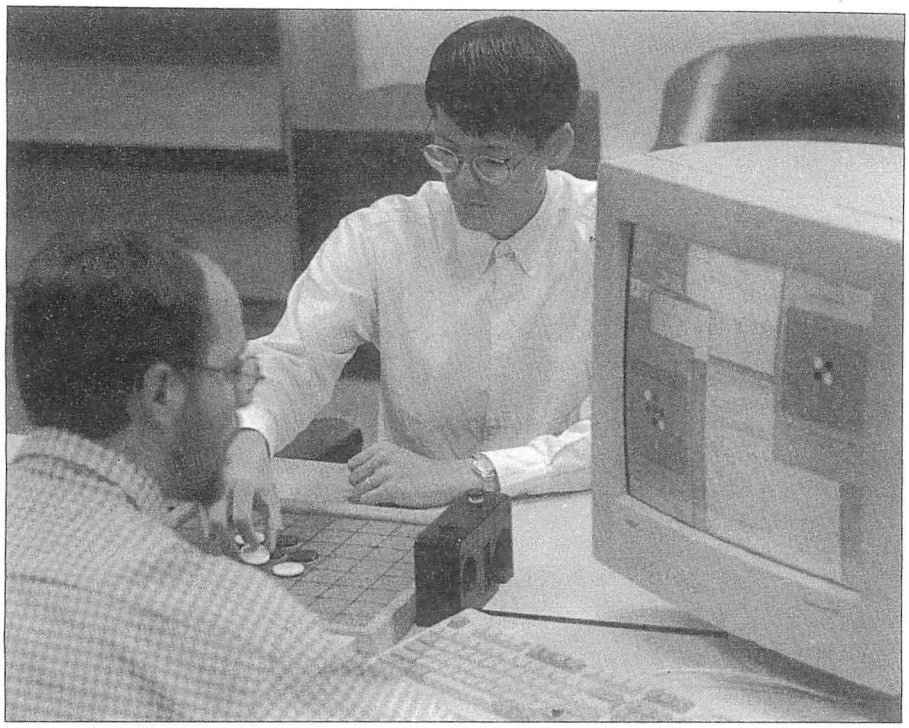
Logistello, on the other hand, has played against itself ever since it was developed in 1993, running 24 hours a day, 365 days a year, accumulating a huge database of game results.

The upshot is that Logistello has evolved countless new, effective openings that have either been overlooked or dismissed by human players as unpromising.

Humans have a very hard time reaching an even position, let alone a favorable one, in the opening against Logistello. In the middle game, Logistello's superiority becomes obvious. What makes Othello so difficult for humans is the fact that a move can flip up to 18 discs (*Figure 21*) in up to eight directions (*Figure 22*). This means that the configuration of black and white discs changes drastically with each move, making it extremely difficult for humans to visualize future positions.

This is probably what makes Othello unique compared to chess, shôgi, or go, where one move normally causes only one change over the whole configuration of pieces (although, of course, that one change can generate a huge strategic shift).

This characteristic of Othello, in which discs change from black to white and back again whenever a move is made, often leads even the best players to make "Oh, I thought I would have an access here!" "What!? Wasn't this disc



AP/WWP

Murakami Takeshi makes his move against Logistello, a computer version of Othello developed by programmer Michael Buro, left, in a series of matches conducted at the NEC Research Institute Inc. in New Jersey in 1997.

supposed to be black?" "Gosh, I didn't realize this move would also flip in that direction!" kinds of mistakes.

During this match, I was checking several lines, 10 to 15 plies ahead. This is about the limit for human players. But Logistello was checking *every* existing line into a 14-ply depth and 22 plies ahead if it found a promising line. The software has no difficulty visualizing future positions because, unlike humans, it has memorized its own board. This is like a human player having another board and set of discs to check future positions against it during the game. Of course humans are forbidden from using this approach.

Logistello's dominance over human opponents is definitely the most secure in the endgame. Since the number of possibilities diminishes considerably as the game nears its end—in computer terms, of course, since humans often have trouble determining the best move with a mere five empty squares, and finding the best move with 15 empty squares is nearly impossible—Logistello calculates every possible line in the range of 24 empty squares within six minutes. Imagine that. When 36 of the 60 squares are filled, Logistello ponders for five minutes and determines the winner and the score that would result if all the rest of the squares are filled correctly. If the calculations favor Logistello, I have no chance, because it makes no mistakes. If the prediction favors me, I still have 12 moves to make, of which at least some are going to miss the mark. I have never seen a game between two humans in which each player played his or her last 12 moves perfectly.

In *Figure 23*, for example, in a preliminary game of the 1996 World Championship between Karsten Feldborg of Denmark and David Shaman of the United States, white has four options: b1, g1, g2 and h2. Feldborg played

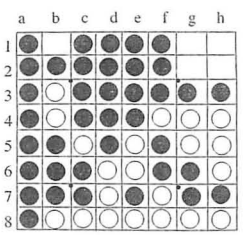


Figure 23: White to play

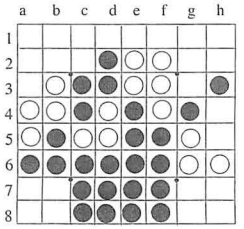


Figure 24: White to play

black and Shaman white.

Any computer could instantly determine that one of the options would win, two would draw and one would lose.

What about humans?

Shaman, winner of the 1999 World Championship, and then a past champion, having won the 1993 World Championship, concentrated for several minutes and still missed the best move. The best sequence is g2⇨h2⇨h1⇨pass⇨g1⇨pass⇨b1, leading to a 33–31 victory for white. The sequence as actually played was h2⇨h1⇨b1⇨g2⇨g1, for a draw at 32–32. Shaman did not blunder; most experienced players, myself included, would make the same mistake. The Othello endgame is simply so difficult for humans that we are destined to make mistakes.

Figure 24 shows the position I was in in the fifth game against Logistello. I had just made the 35th move to h3, and waited for Logistello's reply.

It started searching for a win—searching for a winning move takes a lot less time than the search for the best move—and, after about three minutes, played h5. It had calculated that with this move white would win 34–30. The only thing I knew at that point was that I seemed to be behind.

Kasparov must have felt very frustrated knowing that if he had been able to play his best, he would surely have beaten Deep Blue.

But I did not feel any frustration nor regret because I knew I had done my best, and that I would have lost even if I had been 10 times stronger. What I felt was a profound admiration and respect for Dr. Buro, who put many new ingenious ideas into Logistello to make it a state-of-the-art program.

Shimonosono Kôzô

A proud Murakami Takeshi holds the trophy symbolizing the accomplishment of his dreams: winning the 1996 World Othello Championship in Tokyo.

When I described my game situation to a reporter for *The Washington Post*, I told him, "I was like Carl Lewis competing with a motorcycle." In the story, though, I was quoted as having said, "I was like a car competing with a motorcycle."

Sigh.

Since then, I have often told my students about the misquote, to remind them that they should work on their English pronunciation.

When I accepted Dr. Buro's challenge, some Othello players in Japan tried to convince me that I should not play against Logistello. They feared that if I lost, people

around the world would think Othello is in fact as simple as it looks, and not worth serious play. My promotion to the World Champion underscored their concern. I shared their apprehension, but declined their advice.

I believed that nothing was going to degrade the authority of the champion more than declining a challenge for fear of defeat. I also thought that this match would be a good opportunity to let Americans and other people know about Othello, which, despite its overwhelming popularity in its home country, is still very little known outside Japan compared to chess, shôgi or go. I think I was right.

No matter how strong computers become, the joy and excitement of playing Othello among humans will remain. I know I have learned only a fraction of what can be learned about Othello, and that hundreds of lifetimes are needed to master it. But that's what makes Othello so interesting.

Using computers as a helpful teacher, I will enjoy the game and try to improve my play for the rest of my life.