viously disjointed country (the world as seen from a moving train), Muybridge's "instantaneous photography" both excited and unsettled observers with its ability (in the phrase of the day) to "annihilate space and time." Muybridge improved upon his static photographic sequences with the zoopraxiscope, a complicated, fidgety device of his own invention that could project a moving image onto a wall: the prototype of the motion picture. The "river of shadows" of the book's title is the artificially reconstituted reality whose uncanny imitation of natural motion amazed and delighted viewers who flocked to Muybridge's lectures.

By inventing this projector, and, more significantly, by creating the sequential images of bodies in motion that it relied on, Muybridge played a key role in the transformation of visual experience in the late nineteenth century. This technological accomplishment is only half of the Muybridge story, as Solnit presents it. The other half is his act of witnessing and recording images of a disappearing West—the ill-fated Modoc Indians and the new national parklands, such as Yosemite—that were attractive to prospective purchasers in the East only when safely corralled and controlled. If there is a gap in Solnit's narrative, it is between these two sides of Muybridge's story. In trying to link Muybridge the technologically robust inventor with Muybridge the nostalgic witness to the past, Solnit reaches for a familiar teleology: "Did the Modocs make way not only for settlers and miners," she asks, "but for a new idea of California?" This new idea encompasses Hollywood as well as Silicon Valley, the delightful play of images upon a wall, and the technological reconstitution of a disappearing, troubling, or otherwise distant reality. But it does not meaningfully inform Muybridge's own life. By representing the photographer's actions as emblematic of his time, Solnit is left trying to account for one man's biography in terms of the grander transformations of the nineteenth and twentieth centuries. More compelling is her identification of the fascinating ruptures in Muybridge's narrative, both in his personal life and in the ministories he told with his camera.

Toolmaker, Brain Builder

BEHIND BIG BLUE:
BUILDING THE COMPUTER THAT DEFEATED THE WORLD CHESS CHAMPION

By Feng-Hsiung Hsu. Princeton University Press.

$27.95.

Reviewed by DAVID SHENK

When the inscrutable silicon behemoth known as "Deep Blue" beat world chess champion Garry Kasparov in a formal match in 1997, the media coverage inevitably veered toward the heartlessness of it all. MACHINE OUT-THINKS MAN was the inevitable headline, and the press supported this not unreasonable assertion with ominous accounts of a giant, black, steel-frame structure that could silently—creepily—calculate two hundred *million* positions *per second* and play for thousands of hours on end without any breaks or even so much as a cup of coffee. It was unfeeling and virtually unbeatable. HAL had come to life.

But computers do not truly generate their own intelligence—not yet, anyway. Everything about their brute strength and profound decision-making capabilities is conceived, designed, and sweated over by particular human beings. Feng-Hsiung Hsu's new how-I-built-it memoir reminds us that Deep Blue was a deeply human accomplishment, not just in the general sense that computers are a human creation, but also in the way that this project was fueled by a potent mix of chutzpah, grit, patience, and vanity. Nothing simply *happened.* Creating Deep Blue was like building Frankenstein, with Hsu and his team custom-designing and redesigning and re-redesigning and re-re-redesigning tiny silicon "chess chips," porting them with miscellaneous bits of computer hardware and setting

David Shenk, author of *Data Smog* and *The Forgetting,* is writing a cultural history of chess.

them to more than 100,000 lines of software instruction code. It took more than ten years to get it right, and they were tinkering right up to the first day of the 1997 match.

Their quiet monster wasn't so much a genuine thinker as it was an extraordinarily speedy and intricate rule follower, "choosing" moves according to weights and ranks assigned through a convoluted series of program codes. Essentially, the Deep Blue team had to *mathematize* chess, converting a game with an almost infinite number of variations into a sort of algebra with equation names like "king safety evaluation logic," "repetition detector," and "fail-high singular extension." Along the way, they played the machine thousands of times against other strong computer chess programs and human players of various strengths. Singly, not one of those players could have beaten Garry Kasparov, but their combined efforts made for a higher group intelligence, a machine that could play better than the sum of its inputs. As Hsu rightly states, the contest of Deep Blue versus Kasparov wasn't so much man versus machine as it was "man as performer versus man as toolmaker."

That is not to minimize the event's importance. The news of Deep Blue's victory seemed to send a chill up the spine of every educated human being. It is one thing to build machines that can move earth or fly over the ocean or even recognize a face. Deep Blue's victory over Kasparov signals that we are now making machines that can conceivably compete with us. Kasparov's king dropping was the sound of the first shoe falling. Just how smart and powerful are these machines going to become?

If you casually follow advances in artificial intelligence, genetics, and nanotechnology, you already know that the shape of the twenty-first century will likely depend on what tools we decide to build and what instructions we impart to them. Many of the brightest technologists of our time—people like Danny Hillis, Ray Kurzweil, and Bill Joy—are confident that truly intelligent machines are a part of our future, and that vigorous competition between biological entities (humans) and artificial entities (robots) is inevitable. They do

not expect humans to come out ahead.

Deep Blue's contest with Kasparov gave us a bracing whiff of that impending rivalry, one that everyone could easily grasp because of chess's powerful hold on the human psyche. For more than fifteen hundred years, chess has been both a popular diversion and a powerful mirror reflecting our impulses, aptitudes, and limitations. You don't have to play regularly to have an intuitive appreciation of its enigmatic blend of childlike simplicity and astonishing complexity. A six-year-old can learn the basics in a few moments' time, yet the total number of unique possible chess games is 10 to the 120th power, or a thousand-trillion-trillion-trillion-trillion-trillion-trillion-trillion-trillion-trillion games. There are more —many more—unique chess games possible than there are atoms in the universe.

The game has existed in precisely the same form for more than five hundred years, and it existed for at least another thousand before that in only slightly different form. Since its invention—probably around 500 A.D., somewhere along the Silk Road trade route in or near northern India—chess spread like a cultural virus, infecting aristocracy, warriors, clerics, merchants, and peasants. By 1200 A.D., according to the early-twentieth-century historian H. J. R. Murray, chess was everywhere "from the Indus to the Atlantic and from the Sahara to Iceland." European moralists and philosophers had, by that time, gravitated to chess as a useful lens through which they could view society and discuss the social and moral responsibilities of its citizens. "For just as on the chess-board the men are arranged in rows, and move or stand by definite rules and restrictions," Richard of Ely wrote in 1177 A.D. ". . . here too some preside, others assist, and nobody is free to overstep the appointed laws." Jacobus de Cessolis's late-thirteenth-century *Book of the Morals of Men and the Offices of Noblemen*, a treatise on social dynamics as represented by a chessboard, was said to be second in popularity only to the Bible.

Since then, chess has been one of the most versatile and useful metaphors around, employed to represent the history of the world, the origins of man, the nuances of romance, various economic and mathematical concepts, TV ratings wars, the Cold War, and the workings of the brain. Chess was integral to the establishment of both cognitive science and artificial intelligence. The nearly fifty-year quest to build a computer that could play expert chess was far from a game to Artificial Intelligence scientists; it was the best way they could think of to mimic the brain.

You won't find much about chess's cultural resonance in Hsu's book, which is neither a surprise nor an indictment. But it is striking that the lay reader doesn't learn very much about computers or computer science from it either. After studying it carefully, I can't even conjure a basic image of how a chess chip works. The book is very easy to read, and Hsu is careful to dole out full names for dozens of engineering acronyms. But few underlying concepts are adequately explained. Instead, *Behind Deep Blue* turns out to be largely a thin, insecure account of the players involved in the long effort. As if delivering a very long acceptance speech, Hsu gives props to many partners, colleagues, and mentors, and shrewdly settles a few scores. It's hard to fault the author, who makes no claim to being a professional writer. But how this passed through Princeton University Press without more editorial prodding and poking is a mystery. The reader is left with the irony that the computer Deep Blue was the product of a tireless quest for excellence, while *Deep Blue* the book settles for much less.

Hsu left IBM shortly after Deep Blue's thundering achievement, and his machine was permanently dismantled. In the six years since, a handful of commercial programs with names like Deep Fritz, Deep Junior, and Shredder have emerged as worthy successors. None are as fast as Deep Blue, but they are said to have more chess knowledge and finesse. Also, each fits on a CD-ROM disc, costs less than $100, and can work on any contemporary Windows machine. The best players are sometimes still able to win games against these elite programs, but that too will pass. The toolmakers are winning the day. They're building tools that, in our lifetime, may start building their own tools.