Computer Chess: A Masterful Lesson

At best, Deep Thought's performance against world chess champion Gary Kasparov represents a learning experience. In the first ever confrontation between the champion of all chess computers and the world's premier chess mind, Kasparov crushed Deep Thought, decisively winning both games in this week's exhibition match in New York City. The games provided a striking indication of how much farther researchers have to go in developing a chess computer capable of beating all human players.

"This was a particularly clear demonstration of some of Deep Thought's weaknesses," says Murray Campbell, one of five graduate students at Carnegie Mellon University (CMU) in Pittsburgh who developed the special microelectronic processors and software that add up to Deep Thought (SN: 12/17/88, p.396). Campbell is now at the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y., working on a successor to Deep Thought.

Until this week's match, Deep Thought had an enviable record. Earlier this year, based on the results of about 50 games against human opponents (including several successes against players with grandmaster ratings), Deep Thought became the first machine to earn a rating, putting it into the top category of all chess players. Last May, it won the world computer chess championship — a remarkable feat for a machine less than two years old. In that time, Deep Thought had lost only a handful of games.

Kasparov, who resides in Baku in the Soviet Union, prepared for the match by studying the characteristics of Deep Thought's games. "Computers think very narrowly," Kasparov said before the first game, calling Deep Thought's strategies a little too primitive.

Kasparov played in an uncharacteristically deliberate fashion, avoiding the daring moves that typify his famous matches. Instead, according to CMU computer scientist and chess expert Hans Berliner, Kasparov played more like a stern schoolmaster setting a carefully crafted test designed to put a precocious but inexperienced student in his place. Unable to search far enough ahead to gauge the effect of key moves and distracted from making any kind of concerted attack, Deep Thought readily fell into the traps Kasparov set.

Although the games revealed the considerable shortcomings in Deep Thought's play at the beginning of a game, they also showed the computer's strengths — particularly in making the best of a seemingly lost cause. Faced with an unfavorable position so early in a game, a human player would either give up or try something drastic. The computer, however, can stave off defeat for a long time, making the best possible moves available while waiting for its opponent to make a mistake. Unfortunately for Deep Thought, Kasparov played flawlessly.

Campbell and his colleagues didn't expect Deep Thought to win, although they believed it had a chance to force one game into a draw. Indeed, they regard losing a game as more valuable than winning. "If you keep winning, you don't learn. You have to lose a bit to learn," says CMU's Thomas Anantharaman. "We will probably learn a lot from Kasparov."

During the second game, the CMU team identified at least one minor error in the Deep Thought program. The researchers are now checking the system for other problems that may account for some apparently inexplicable moves in the first game.

Berliner, who developed the chess computer Hitech, and other computer chess enthusiasts also hope to glean useful information from the Deep Thought-Kasparov match. They plan to have their chess machines evaluate the various positions that came up during the games to see how their computers would have reacted. Like human players, different chess computers have different strengths and weaknesses.

Chess originally attracted computer scientists because it provided a clearly defined problem that was neither so simple as to be trivial nor too difficult for a solution. Thus, chess programs are sometimes useful for testing new programming concepts that may prove handy in other applications. But the real driving force is pride in what the human mind can accomplish — either in playing chess or in programming a computer to play chess.

"Eventually, the world champion will lose to a computer. The question is when," says Feng-hsiung Hsu, a member of the CMU team and now at IBM. "I think it may be in three to five years."

Kasparov disagrees. "I think I can beat any computer ... perhaps to the end of the century, perhaps with a new strategy," he insists. "Chess is much wider than calculation. It's wider than logic. You need fantasy and imagination." — *I. Peterson*

Vaccine confers pertussis protection

An international scientific team reports this week that two forms of a genetically engineered vaccine protect mice from whooping cough, a respiratory infection caused by the bacterium *Bordetella pertussis*. That report may represent a significant step toward a safer pertussis vaccine for humans.

Whooping cough — which gets its name from the "whoop" sound victims make as they inhale after a bout of violent coughing — annually affects an estimated 60 million people and kills one million people worldwide. An effective vaccine, made from killed *B. pertussis* cells, has been available in the United States since the 1940s. But that vaccine commonly causes minor side effects and in rare cases causes brain damage and even death. Concern over the safety of the whole-cell vaccine has led to the development of so-called acellular pertussis vaccines, made by chemically inactivating a purified pertussis toxin. But those vaccines, now in U.S. clinical trials, can also cause side effects because the chemical treatment sometimes allows some pertussis toxin to regain its toxic activity.

Rino Rappuoli of the Sclavo Research Center in Siena, Italy, Joseph T. Barbieri of the Medical College of Wisconsin in Milwaukee and colleagues took a different approach. They altered the gene that codes for the pertussis toxin, a protein produced by *B. pertussis*. When inserted into a strain of *B. pertussis*, the altered gene led to the production of new toxins lacking the amino acids that cause toxicity. Yet these mutant toxins still triggered an immune response in mice, they report in the Oct. 27 SCIENCE.

The scientists used the altered toxins to make two experimental vaccines. They gave mice varying doses of both vaccines and challenged them 15 days later with an injection of virulent *B. pertussis*. Two weeks after the challenge, the mice showed 100 percent survival at vaccine doses causing no serious side effects.

Rappuoli and colleagues suggest their genetically engineered vaccine avoids the problems of previous vaccines because they've produced a permanently harmless pertussis toxin.

Rappuoli started testing the genetically engineered vaccine in 20 Italian volunteers aged 25 to 35 this week. If that pilot study indicates the vaccine is safe, Rappuoli plans to ask the Food and Drug Administration for approval to test the vaccine in a U.S. clinical trial by the end of 1989. — *K.A. Fackelmann*