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In This Soccer Match, Players Are Robotic But That's the Goal

'RoboCup' Is a Big Test For Artificial Intelligence; A World Cup Contender?

By SCOTT PATTERSON March 23, 2006; Page A1

During a national championship last year, a University of Pennsylvania soccer team was on the verge of a big upset. In the final game against Carnegie Mellon University, a group of players had battled to a 1-1 tie when disaster struck. A Pennsylvania forward booted the ball toward his own net by mistake. David Cohen, a trainer for the team, watched in horror as the orange ball rolled past the goalie, for Carnegie Mellon's second and clinching goal.

The culprit: a small electronic dog, one of the four Pennsylvania teammates competing in RoboCup, a soccer tournament for robots that's becoming a cult hit on college campuses.

The loss "was heartbreaking," says Mr. Cohen, 22 years old, an engineering student at Penn. "But it was also kind of hilarious."



Carnegie Mellon University Sony Corp.'s battery-operated Aibo dogs are the stars of the RoboCup soccer championship.

Blending artificial intelligence, robotics and soccer, RoboCup is an obscure competition known mostly to computer-science wonks at top universities around the world. Unlike the supercomputers that regularly confound chess grandmasters, soccer robots are still quite

crude. The players, mainly battery-operated dogs called Aibos, tend to wander out of bounds for no reason. They have trouble seeing the ball. Because battery life is short, they sometimes crumple to the ground in the middle of a match as if taking a nap.

Other RoboCup teams use human-like robots that stand on two feet. Those can barely move and often fall over after kicking a ball. There are also smaller robots that zip around on wheels. They look more like tricked-out toasters than world-class athletes.

Nevertheless, RoboCup, which is shorthand for Robot Soccer World Cup, has an eye-popping long-term goal. By 2050, it wants

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to create a humanoid robotic soccer team that can defeat the winner of soccer's real World Cup. This grand ambition "is a beautiful allegory" for the field of robotics, says Dean Kamen, creator of the Segway scooter: "Make a device that's functionally equivalent and indistinguishable" from a human being.

In June, more than 100 teams will square off in Bremen, Germany, for the 10th-annual RoboCup World Championship. The competition will coincide with the human World Cup, which is being held in Germany at the same time.

The idea to use soccer as a way to experiment with robots appeared in a 1993 paper called "On Seeing Robots," by Alan Mackworth, professor of computer science at the University of British Columbia in Vancouver. Mr. Mackworth thought soccer was a more intriguing challenge than chess because robots would need to see and interact with each other. He suggested soccer over other sports because it didn't necessarily require complex physical movements such as throwing.

The concept got a boost in the U.S. a year later when Peter Stone, then a computer-science postgraduate, saw Mr. Mackworth demonstrate soccer-playing toy cars at a conference on artificial intelligence.



Peter Stone

"I got excited," recalls Mr. Stone, who now heads the RoboCup program at the University of Texas at Austin. Mr. Stone, who has played semiprofessional soccer in the U.S., decided to make robotic soccer the topic of his Ph.D. thesis. At about the same time, scientists in Japan launched the first robotic soccer initiative, calling it RoboCup.

Since then, RoboCup has caught on with teams from nations as diverse as Germany and Iran. Eight separate robot categories include "small-size" and "four-legged." The tournament has also helped inspire other advances in artificial-intelligence research. For example, a related competition uses search-and-rescue robots that emergency personnel are testing in disaster situations like earthquakes.

Jim Moorhouse, a spokesman for the U.S. Soccer Federation, says "It all sounds like 'The Terminator,' " referring to the 1984 sci-fi movie about time-traveling, killer robots starring Arnold Schwarzenegger. Alexi Lalas, a member of the 1994 U.S. World Cup squad, says RoboCup's organizers underestimate the real sport's complexity. Mr. Lalas cites famous players such as England's Alan Shearer and Gary Lineker whose instinct in front of a goal, he says, is innate, not learned.

"There are tactics that go into soccer, but there's also a creativity about the game" that will be tough to duplicate with computer code, says Mr. Lalas, who is now president of the New York Red Bulls soccer team.

Today's robots are vast improvements over previous models. First-generation RoboCup participants were similar to remote-control cars. In a 1997 tournament in Nagoya, Japan, pitch-black smoke

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from a robot in the middle of a match, participants recall. Those early models, which sometimes caught on fire, "looked sort of like little time bombs," Mr. Stone says.

That changed with Sony Corp.'s 1999 introduction of the Aibo, a robotic "pet" dog. (Pronounced EYE-bow, it means "companion" in Japanese.) Japanese teams had already been using the Aibo during its test phase, and others soon realized the benefits of enlisting the robots as soccer players.

"Imagine a laptop with legs and a camera, that's what the Aibo is," says Manuela Veloso, a professor of computer science at Carnegie Mellon. Her university's team dominates RoboCup in the U.S., with Texas, Pennsylvania and the Georgia Institute of Technology making fast progress.

Armed with video cameras, infrared sensors and wireless Ethernet cards, Aibos process 30 pictures a second to create a virtual topography of their surroundings. The playing fields, roughly 12 feet by 18 feet, are surrounded by color-coded beacons that help orient the robots.

A computer chip stored in the Aibos tells the players what to do. For example, a complex series of algorithms calculates where a player should go -- and where it should kick the ball -- based on its position on the field and the location of its teammates. Goals are also color-coded to let the robots know where to shoot, though Aibos occasionally get confused.

At his RoboSoccer Lab in Austin, Mr. Stone, 34, is preparing for the fourth-annual U.S. championship, which is set to take place in late April in Atlanta. The professor is currently overhauling the software that runs his team, Austin Villa, named after Aston Villa of the English Premier League. He's working on last-minute, make-or-break adjustments -- tweaking robots' vision, for example, to account for variations in tournament lighting and flooring. So far, progress has been choppy.

In a recent demo, one Aibo spun in place like a dog chasing its own tail. "We're racing against the clock," Mr. Stone said, as an Aibo waddled crookedly toward an orange ball on a green field.

The Aibo teams have an even bigger challenge ahead of them. In January, Sony pulled the plug on the Aibo Entertainment Robot line. The robots, which cost about \$2,000, weren't profitable. That means no more new Aibos and no more dog-robot teams.

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