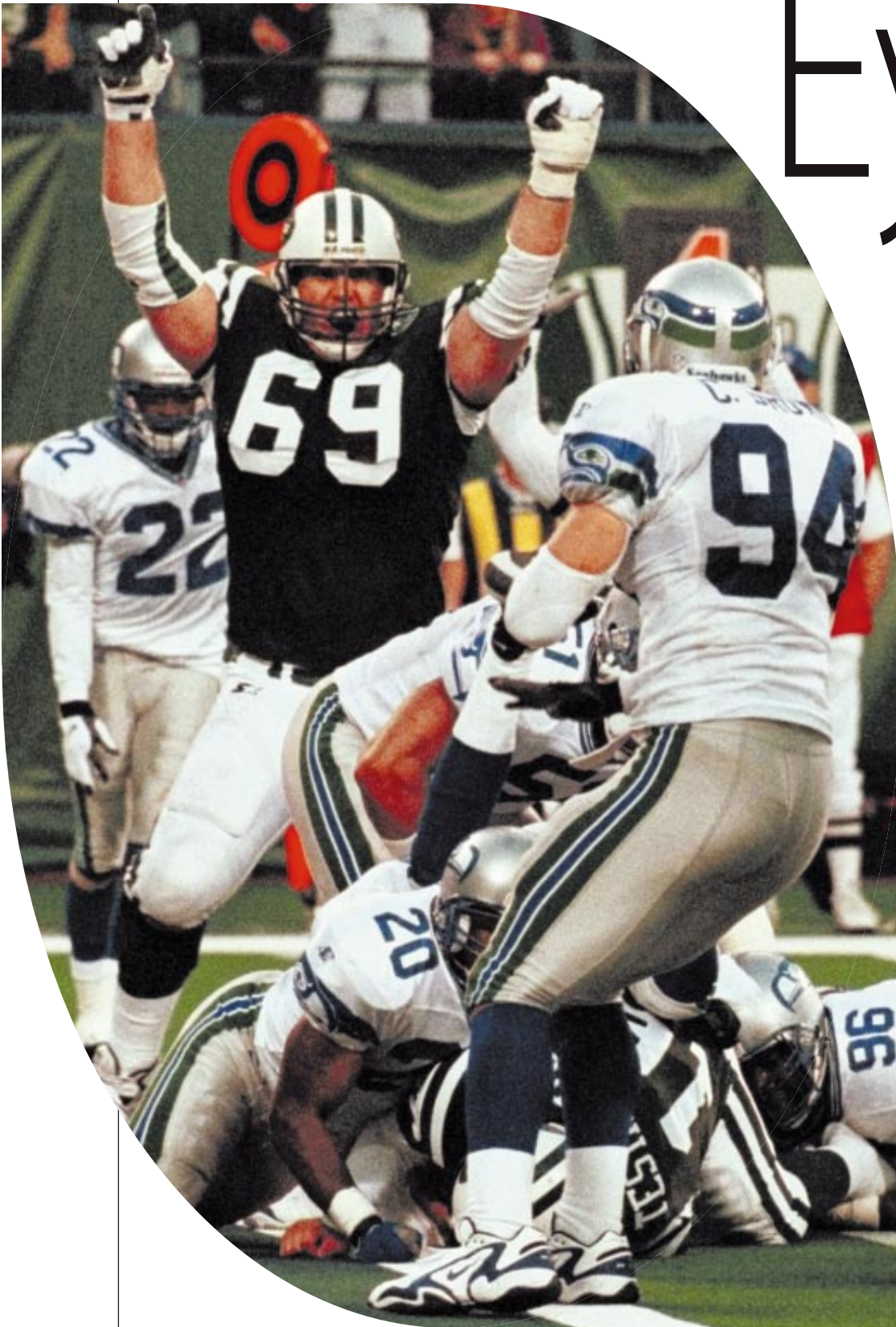


the Unblinking Eye



TOUCHDOWN... NOT:
Videotape replay in 1998 showed that a game-winning touchdown by New York Jets quarterback Vinny Testaverde (*on the ground*) was a miscall.

Technologies that can see better than humans encounter a mixed reception on the playing field

by Bruce Schechter

Fans of sports and magic know that the hand is often quicker than the eye. Just ask Vinny Testaverde. In 1998 Testaverde, the New York Jets' quarterback, had brought his team to within striking distance of beating the Seattle Seahawks in one of the final games of the season. On fourth down, with 20 seconds left in the game and the ball on the Seahawks' five-yard line, the Jets needed a touchdown for victory. Testaverde carried those last five yards himself and was tackled just as he dove across the goal line. Head linesman Earnie Frantz signaled a touchdown, and Jets fans went wild.

It was a classic football moment—except for one detail. The referee was wrong. The videotape replay and newspaper photographs clearly showed that Testaverde went down before he ever crossed the goal line. For football fans it was the final straw. The Jets' unearned victory was the most egregious illustration of the occasional and unavoidable fallibility of human officials. Earlier that season the Buffalo Bills had been the victims of a couple of botched calls in a loss to the New England Patriots—and their owner was fined \$50,000 for complaining. Officials had even managed to foul up a coin toss in a game on Thanksgiving. These highly publicized mistakes finally forced league officials and team owners to reinstate the use of instant replays by officials, something they had been resisting for seven years.

Sports fans and athletes have always been critical, to say the least, of the impartiality and visual acuity of the umpires, referees, linesmen and others who are charged with making sure the rules of sport are observed. Until the 1960s, differences of opinion were simply that—fans and officials had to agree to disagree. Whether a pitch was over the plate or a foot was over the line was a fact writ in water. Then Rooney Arledge of ABC Sports began to experiment with new video technology and radically reshaped the experience of viewing sports. He liberated sports from time.

Arledge employed cameras to isolate and analyze, putting them in places they had never been before: on the sidelines, in the end zone, on cranes and even underwater. He also used the ability of videotape to freeze a moment or play it back in slow motion, revealing in unprecedented detail “the thrill of victory and

the agony of defeat.” This technology has its roots in experiments conducted almost a century earlier by English photographer Eadweard Muybridge. Muybridge had used a series of still cameras to capture the gait of a horse and to resolve the controversy in racing circles over whether all four feet of a galloping horse are ever simultaneously off the ground (they are). Arledge's instant replays cleared up one question—referees do indeed make mistakes—but also triggered an endless string of squabbles over disputed plays.

GOING BACK TO THE VIDEOTAPE

In 1986 the National Football League gave in to the increasing pressure from fans armed with proof of the fallibility of referees and began to use instant replay to help in disputed plays. Unfortunately, videotape technology was cumbersome and slow—it takes time to rewind and cue up a tape—and the camera angles sometimes made the replays hard to interpret. In 1991 a replay took over three minutes to review. In that season, 570 plays were examined, and 90 calls were reversed. League officials would later admit that of these at least nine were reversed incorrectly. It did not seem to the owners worth the trouble, time and expense. Besides, they reasoned, in the course of a season, mistakes should even out. So the NFL discontinued playbacks.

By 1998 it was evident that sometimes things do not even out. After the season of Testaverde's phantom touchdown, the owners voted to reinstate instant replay, an experiment that continues into the current season. In the intervening years, technology had caught up, making the process faster and easier to manage. Video could now be stored in computer memory, so no time was lost in rewinding. Cameras had gotten sharper. Still, replays took about two and a half minutes to review, so an elaborate set of rules was concocted to limit them: each team could demand only two replay challenges during a game (except in the final two minutes, when replays could be requested only by a “replay official”). If the replay showed that the field officials had made the right call, the challenging team would lose a time-out. So far the system has been judged to work well enough that it has been reinstated for the 2000 season. The NFL is also considering other gad-

gets, such as the Scanz Scannor, a palm-size wireless device that can download and display video directly to those on the field, allowing the field-level officials instant access to replays.

Such technologies will undoubtedly change the way football and other sports are played. Taken to the extreme, they raise the specter of a future without human judgment calls. Although it is easy to imagine that technology will make such a future possible, it seems improbable that sports fans would entertain such an abrupt break with tradition. Still, the fallibility of human arbiters will very likely preserve a place for digital video cameras and computers. Many will welcome the veneer of scientific objectivity that technology brings to sports, but others will insist that this objectivity is an illusion. Just as juries may continue to doubt DNA evidence, sports officials will question the interpretation of replays.

As Cincinnati Bengals president Mike Brown said of football's instant replay, "It still has to be operated by people. [When] you get into decisions made by people, that can go awry." And technology can go awry as well. To err is human, it seems. When a machine makes an error, forgiveness is not only divine, it is nearly impossible. Nowhere is this better illustrated than in the sport of tennis.

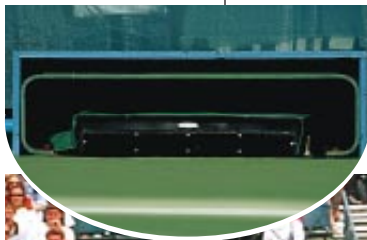
When a tennis ball served by Pete Sampras or another top pro hits the court, it is traveling at approximately 100 miles an hour. The ball will stay in contact with the court for about four milliseconds before bouncing off at about 60 miles an hour. All this is taken in by an official who must render a decision. With action so fast, professional tennis matches employ as many as 11 officials to monitor the players, watch the boundaries and the net, and keep score. Using technology to replace some of these officials has most likely been motivated more by economics than by a desire for greater accuracy.

In 1979 a device known as Cyclops was introduced at Wimbledon to monitor the service line and to decide if serves are in or out. The system resembles a burglar alarm. Beams of infra-

red light are directed just beyond the line. When the ball interrupts the beam—as it must if the serve is long by a small margin—an alarm goes off. For the most part the system works well, but it does have blind spots, which have angered some already temperamental players. Balls that are hit very far out never cross Cyclops's glare and can therefore be judged in. More troubling, the carpet on indoor courts can shift and expand as the day heats up and the players run and slide. This means that whereas Cyclops's beams are unmoved, the court lines can shift by an inch or two, so a ball that the system judges in is actually out (or vice versa). But from the player's point of view perhaps the worst thing about Cyclops is that it just sits there, beeping imperturbably. They would agree with Boris Becker, who once remarked, "I would prefer linesmen doing the job, because I cannot talk to the Cyclops."

For better or worse, Cyclops seems to be here to stay, if for no other reason than that electronic officials are cheaper than humans. Attempts to eliminate the other linesmen have been less successful. One system, invented by an Australian company, involved mixing magnetic particles in with the rubber of the tennis ball. Wires embedded in the court sense the passing of these metallized balls and determine their position. Unfortunately, at some of its first outings the device, known as TEL (Tennis Electronic Lines), malfunctioned and emitted random beeps, which was too much for already oversensitive players to bear. TEL technology is still not a part of the professional tennis circuit.

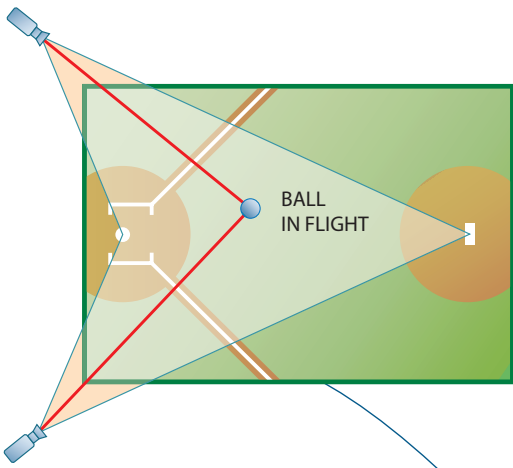
CYCLOPS:
The infrared sensor monitors the service line of a tennis court.



KEEP THE UMPIRES

In general, tennis fans are fairly forgiving, preferring to leave tantrums over questionable decisions to players. Baseball fans exhibit no such restraint. Scorn for umpires is almost as much a part of baseball as hot dogs or the seventh-inning stretch. A pitch takes about half a second to travel from the pitcher's fingers to the catcher's glove, so it is not surprising that umpires occasionally confuse balls and strikes. What is surprising is that although the technology exists to capture the trajectory of the ball in flight and to render an inhumanly accurate verdict on exactly where it crossed the plate, nobody is clamoring to replace or even supplement human umpires with computers. Not yet.

The system in question, which is marketed under the name SuperVision, was first introduced in the early 1990s by QuesTec, a small company in Deer Park, N.Y. Two cameras, one located on the first-base line, the other on the third-base line, follow the pitch. The cameras are fast enough to take 16 pictures of the ball along the way. A computer program isolates the ball and uses triangulation to locate its position at each of the 16 points to within an inch. "We are working on bringing that down to a half an inch," says QuesTec's Mike Russo. Using these positions, the computer constructs a three-dimensional graphic of the tra-



In or Out?

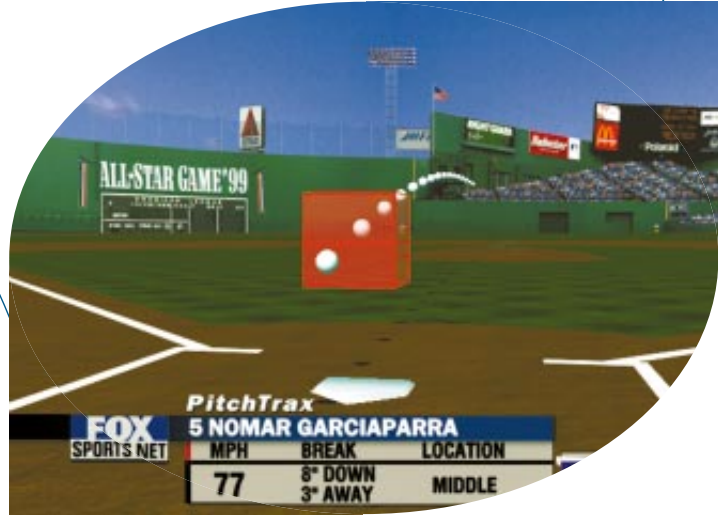
SuperVision uses triangulation (left) from video camera inputs along the path of flight to simulate whether a pitch to Boston slugger Nomar Garciaparra is a ball or a strike (below).

jectory that can be rotated and examined from any angle. SuperVision convinced any remaining skeptics that a curveball really does curve.

Baseball's adoption of the SuperVision system has been slow. As with any new technology, the first versions were expensive and balky. In 1996, for example, MSG Network in New York City gave SuperVision a spin. The commentators were impressed by its ability to distinguish curve from slider but were not equally wowed by its sense of pace. During one game, it declared that a ball that had left the pitcher's hand at 85 miles an hour arrived at the catcher's glove at the same speed. MSG announcer Jim Kaat turned to his producer and said, "I can't do this. A ball can't do that."

Russo claims that such problems are a thing of the past, eliminated by better software and hardware and by better-trained operators. Televised baseball games continue to make use of the technology. Still, this hidebound professional sport probably won't soon adopt SuperVision or any other system that replaces the umpires who call balls and strikes. Sport is about tradition as much as it is about competition. The reams of statistics so cherished by baseball fans testify to the powerful ties the game has to the past. Comparing today's players to the greats of seasons gone by adds a vital richness to a fan's appreciation. How could a perfect game pitched by David Wells and called by a human umpire ever truly be compared with the accomplishment of some future hurler whose strike zone was circumscribed by a machine? When a catcher fools the umpire into calling an outside pitch a strike, he is being no more dishonest than a runner stealing a base—a certain amount of guile is built into the game. Fooling a computer is not as easy, which makes it unlikely that one will be seen on the field anytime soon.

Off the field, however, technologies like SuperVision are quickly becoming part of the fan's experience of sports. "Everything we do in terms of technology is to embellish the broadcast of the game in the form of storytelling," says Arthur Smith, executive vice president of programming and production for Fox Sports Networks. Smith uses SuperVision, along with technologies such as robotic cameras and



telestrators, which allow commentators to draw directly on the screen, to enhance the coverage of a game. "With us it's always about trying to make the game more interesting. It's not how sophisticated a technology is, it's how you use it."

The designers of new arenas and stadiums are beginning to pay as much attention to data lines as to sight lines. Baseball fans sitting in a few hundred expensive seats at Tropicana Field, home of the Tampa Bay Devil Rays, or at Qualcomm Stadium, where the San Diego Padres play, can take advantage of ChoiceSeats, a computer system that floods them with information on the game.

Each ChoiceSeat is equipped with flat-panel touch screens from which computer-literate fans can call up instant replays from half a dozen camera angles or peruse player statistics. They can order food from the snack bar, play computer games or even go shopping for merchandise on the Internet. The game on the field just a few feet away could become little more than a distant, bright, three-dimensional display. But if we are lucky, the computer won't interfere with the pure enjoyment of watching the game, nor will it change the way baseball is played. So, for the immediate future, the umpire will remain a bum.

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FURTHER INFORMATION

An explanation of how SuperVision works can be found at www.questec.com on the World Wide Web.