Physics of Bowling

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The Physics of ... Bowling

It takes a good machine to really get a handle on axis, rotation, friction, inertia, speed, and spin By Fenella

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The world's first bowling robot hunkers down in an alley in Muskegon, Michigan, plotting its next strike. Ten feet high and 20 feet long, with an arm the size of a howitzer and springs like rocket launchers, Throbot weighs more than eight tons. Stored in its Pentium-powered brain are tens of thousands of throws by dozens of human bowlers, their exact spin, velocity, and position recorded by video cameras, ultrasonic and infrared sensors, and a computer-aided tracking system. "It's kind of scary," says Bill Orlikowski, a professional bowler whose throws the machine often imitates. "I sit behind it and get the same feeling as when I'm bowling."

Scarier still, to the average weekend player, may be the sheer scientific sophistication of modern bowling. Once upon a time, even a Neanderthal might have enjoyed hurling small boulders at sticks. But professional bowling now requires space-age equipment--urethane balls, plastic-coated pins, lanes laser-inspected for smoothness--and true success is measured in thousandths of inches. The very simplicity of the sport has made it ripe for technological innovation. The key to getting strikes, of course, is slamming the ball into the "pocket"--for right-handers, the space between the first pin and the one angled behind it to the right. But that's only the beginning. A ball that hits the pocket straight on will deflect away from the pins, rather than ricocheting through the pyramid. To knock down every pin, it should hit the pocket after veering six degrees from its original path, says Roger Dalkin, executive director of the American Bowling Congress. "But you have to hit a target one inch wide that's 60 feet away, and more hook equals less accuracy."

That's where science and technology can help. Beneath a bowling ball's urethane shell lies a dense core of polyester infused with calcium carbonate or barium sulfate. This structure lowers a ball's inertia by concentrating its weight in the center, thus helping the ball to roll faster and more easily. A slightly off-center, irregularly shaped core also lends itself to sidespin, which makes a ball curve down the lane. To see what works best, bowling engineers use computers to model balls.When a prototype is ready at the Brunswick Bowling research center in Muskegon, Throbot gets it. Not long ago, Bill Wasserberger, Brunswick's director of high-performance bowling ball research and development, placed one of his creations into Throbot's paw--a U-shaped chuck, set at a 10-degree angle--and set it spinning. When the ball reached 300 revolutions per minute (the forward rotation an average bowler can achieve), the giant arm swung back, locked with a thunk, and then slowly tightened its springs. "A solid professional bowler has about an inch and a half variation five feet down the lane," Wasserberger said. "Throbot has between two and four tenths of an inch." By the time the arm hurtled forward and the ball blasted out at a programmed height and angle, a strike seemed preordained. Yet even Throbot can't control every variable.
To help maintain a ball's speed, bowling lanes are usually coated in mineral oil once or twice a day, Wasserberger explained. In a typical bowling alley, the edges of the lane are lightly oiled, and the last 20 feet are left dry. That way, a ball with sidespin can better grip the lane, curving clear of the gutter and hooking into the pocket at the end. But lane oil is hardly a constant. Alley owners can slather their lanes with various types and quantities of it. Professional lanes are coated with an even layer of oil across their entire width, but they still suffer more from patchy distribution as balls spread the oil around. Because a bowler can't see the oil pattern from the top of the lane, his first toss is a blind trial. After that, he can adjust his throw, try a different ball or, as a last resort, sand or polish his original ball to alter its coefficient of friction.

In order to get rid of some of the guesswork, Wasserberger's engineers had given the ball he was testing an arrow-shaped core and a shell made of a new kind of urethane called Proactive. The core made the ball change its axis as it rolled, so a dry part of the ball touched the lane on every turn, thereby improving its grip. "By the time the ball gets to the back part of the lane, you get an increase in hooking action," Wasserberger said. Whenever the ball hit an especially oily patch, special particles in the urethane shell (Wasserberger wouldn't reveal their composition) increased the ball's traction. To demonstrate the difference such small changes can make, Wasserberger had Throbot try the exact same throw with a more traditional ball. This time, it swung short of the pocket.
In theory, there is no limit to how precise and powerful a bowling ball could be made. But the American Bowling Congress and the Women's International Bowling Congress keep a sharp eye on innovation. In one room at the congresses' joint testing center in Greendale, Wisconsin, 16-pound balls are weighed to make certain that their balance isn't off-center by more than an ounce. In another room, a ball rolls down a ramp and through an archway strung with

fiber-optic infrared sensors. When the ball hits a pin, both the ball speed and the pin speed are measured to ensure that no more than 35 percent of the ball's energy has been transferred to the pin. Nearby, a ball on a conveyor belt continually climbs another ramp and then knocks down sets of newly manufactured pins. If they give higher or lower scores than regulations allow they won't be accepted.
Bowling lanes have their own strict specifications to meet: They are not supposed to have dips, peaks, or crosswise tilts of more than forty thousandths of an inch. But John Davis, president and chief engineer of the Kegel Company in Sebring, Florida, thinks there is still room for improvement. Forty thousandths of an inch may be less than the thickness of a quarter, he says, "but that amount of tilt can affect how a lane plays." One machine Davis has designed scoots down a lane, stopping every two feet to check the surface topography with a laser at 80 separate points across the boards. Another of his inventions uses microprocessors and fluid measuring devices to apply as little as one thousandth of an ounce of oil to each board of the lane. "Maybe it doesn't matter on the recreational level," Davis says. "But why wouldn't you want the same conditions as the competitive level to compare yourself to the stars?"

There's only one catch: The more perfect our bowling technology, the less excuse for our imperfect bodies. That sad fact is apparent even among the aspiring pros at Kegel's bowling school--the only such facility in the world. Although every throw is tracked by computer and every move digitally filmed, although lanes are glass-smooth and equipment close to ideal, success or failure lies in human hands. "Ninety percent of the game is behind the foul line," says Parker Bohn III, record holder for the highest average score on the Professional Bowlers' Association Tour. Release the ball too late, and the excess loft will kill its momentum. Drop your shoulder too low or forget that little leg slide at the end, and you may still get a split. Wasserberger, the father of Throbot, knows that better than anyone. "All the technology in the world," he says, "can't help you if you stink."