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Professors explore science of placekicking

A team of Sacramento State researchers has launched a ground-breaking study on the art of football's placekick, using the University's newly acquired, state-of-the-art system of 3-D motion-capture cameras.

The findings, which could be years in the making, will tell coaches the specific factors that contribute to a successful placekick.

"It's pioneering work that segues from a lot of research that's been done in soccer, but most of that has been two-dimensional until recently," says Michael Nave. "The motion-analysis capture is our way of breaking down the components into its parts."

Nave and fellow professors Rodney Imamura and David Mandeville have converted a section of the Biomechanics Lab, within the Department of Kinesiology and Health Science, into a mini football field. They hung a nylon football net from the ceiling and outlined the kicker's target, a narrow rectangle, in fluorescent-orange webbing. They laid down indoor-soccer turf to simulate grass.

The "football field" can be set up and dismantled quickly to accommodate classes held in the lab.

"A lot of research has been done with ball speed and how hard you can kick a ball, but very little has been done on accuracy," says graduate student Robert Walsh, who is helping with the study.

The team did all sorts of math equations, calculations and basic tangent formulas to create a mini football field model that mirrors its real-life counterpart. The target is just five yards from the spot where the kicker makes contact with the ball. And for him to boot it high enough to clear what would be onrushing defenders during a game and make the equivalent of a 35-yard field goal, he must hit the marked target that's a mere 31 inches wide and rises 8 feet, 9 inches from the floor.

One of the study's early test subjects is Nave's son Andrew Nave, a Sacramento State freshman and former kicker for Sacramento's Jesuit High School.

On a recent afternoon, the 19-year-old pre-business major is outfitted in a pair of compression shorts and 34 featherweight silver spheres, known as markers, which are adhered to his body at the joint centers and to his football shoes. Four additional markers are stuck to the football he blasts into the net.

Eight 3-D infrared cameras suspended from an overhead truss will track the kicker in action in real time, but record him at the super-slow speed of 240 frames per second. Those captured details flow into a nearby computer, where a sophisticated software program reproduces the split-second movements into a series of red and green lines. A skeleton-like “skin” is laid atop the animated image, making it easy for the professors to discern every lift, twist, turn and bend of the kicker’s body for analysis.

The researchers also can rotate the image to view the skeleton-kicker from all sides and angles, and top and bottom.

“We think that tiny issues are really key. It’s a lot more complex than we thought,” says Imamura. “Coaches are good biomechanists, but they don’t have the technology to help them. High speed is critical to slow down and see the minute details in the body’s movement. Hopefully, at the end of all things, we can set a baseline and a language that coaches can follow and go beyond what we call ‘qualitative observations.’”

The researchers have asked kicking coaches around the country to rank the top five factors they believe contribute to a successful placekick. Their responses: hip position, foot plant, ankle lock, angle of the kicking foot and the chest or torso position at the point of ball contact. The Sacramento State team will incorporate that information into their work. They are concentrating initially on possible differences in kinetic variables (displacement, velocity and acceleration) associated with the kicking motion between made and missed field goals under accuracy conditions.

Imamura and Mike Nave began the placekicking study five years ago, conducting two outdoor trials at Hornet Stadium. They invited five kickers, including Andrew Nave and then-Sacramento State standouts Juan Gamboa and Chris Diniz. The professors quickly realized that performing 3-D analysis outdoors was difficult and time-consuming. So they went into the lab.

“The law of 3-D analysis says that at least two cameras need to be on one (marker) at any given time, so here we have eight, to be sure that at least two cameras are seeing a point,” says Imamura. “Once that’s possible, it’s digitized into the computer, real-time, which is clearly a benefit. If we had to manually digitize, which is taking each frame – in this case 240 pictures per second – it would take a long time. This real-time system is the latest technology.”

Mandeville is heading up two additional studies that will take advantage of the capture-analysis system: knee osteoarthritis in menopausal women and gait performance among the elderly population and their likelihood of falling.

The placekicking study could take more than a decade. The professors have contacted 18 Sacramento-area high school coaches to inquire about bringing varsity kickers into the lab before the end of the year, and they plan to expand the trial pool to include college-level, free-agent and, they hope, NFL kickers.

"Using science to see what will help kickers get better and finding more effective ways to improve is exciting," says Michael Husted, who spent most of his nine-year NFL career with Tampa Bay and is now a kicking coach and consultant in San Diego. He helped the Sacramento State research team develop the kicking-target model and the coaches' survey.

"I have my own theories that I've developed, but they're just theories," he says. "Using science to identify accuracy will prove certain techniques and find a more effective way to help kickers get better."

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