

Nothing But Net: The Physics of Free-Throw Shooting

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(PhysOrg.com) -- Pay attention, Shaq: Two North Carolina State University engineers have figured out the best way to shoot a free throw - a frequently underappreciated skill that gets more important as the game clock winds down.

To get a swish rather than a brick, you need the best possible conditions for releasing the basketball from your hand, say Drs. Chau Tran and Larry Silverberg, mechanical and aerospace engineers at NC State and co-authors of a peer-reviewed study.

The engineers used hundreds of thousands of three-dimensional

[computer simulations](#) of basketball free-throw trajectories to arrive at their conclusions. After running the simulations, Tran and Silverberg arrived at a number of major recommendations to improve free-throw shooting.

First, the engineers say that shooters should launch the shot with about three hertz of back spin. That translates to the ball making three complete backspinning revolutions before reaching the hoop. Back spin deadens the ball when it bounces off the rim or backboard, the engineers assert, giving the ball a better chance of settling through the net.

Where to aim? Tran and Silverberg say you should aim for the back of the rim, leaving close to 5 centimeters - about 2 inches - between the ball and the back of the rim. According to the simulations, aiming for the center of the basket decreases the probabilities of a successful shot by almost 3 percent.

The engineers say that the ball should be launched at 52 degrees to the horizontal. If you don't have a protractor in your jersey, that means that the shot should, at the highest point in its arc to the basket, be less than 2 inches below the top of the backboard.

Free-throw shooters should also release the ball as high above the ground as possible, without adversely affecting the consistency of the shot; release the ball so it follows the imaginary line joining the player and the basket; and release the ball with a smooth body motion to get a consistent release speed.

“Our recommendations might make even the worst free-throw shooters - you know who you are, Shaquille O’Neal and Ben Wallace - break 60 percent from the free-throw line,” Silverberg says with tongue firmly in cheek. “A little bit of physics and a lot of practice can make everyone a better shooter from the free-throw line.”

The engineers used a men's basketball for the study; it is heavier and a bit larger than basketballs used in women's games. They also assumed that the basketball player doing the shooting was 6 feet 6 inches tall, and that he released the [ball](#) 6 inches above his head, so the "release height" was set to 7 feet. The free-throw line is 15 feet from the backboard, a cylinder-shaped opening that is 10 feet off the ground. Though it looks smaller, the diameter of a regulation basketball hoop is 18 inches; the diameter of a men's [basketball](#) is a bit more than 9 inches.

More information: Optimal release conditions for the free throw in men's basketball, *Journal of Sports Sciences*, Volume 26, Issue 11 September 2008 , pages 1147 - 1155, [DOI: 10.1080/02640410802004948](#)

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