In baseball, bigger still better

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Adrian Bejan. Credit: Duke University

Max Scherzer leads Major League Baseball in wins. As a pitcher for the Detroit Tigers, he hasn't lost a game this season. His 6-foot, 3-inch frame is a telling example of constructal-law theory, said Duke University engineer Adrian Bejan. The theory predicts that elite pitchers will continue to be taller and thus throw faster and seems also to apply to athletes who compete in golf, hockey and boxing.

Studying athletes—since most sports are meticulous in keeping

statistics—provides an insight into the biological evolution of human design in nature, which Bejan terms the constructal-law theory.

Bejan has already demonstrated that runners and swimmers have gotten bigger and taller over the past century. Now he's applying his theories to other sports, including team sports. In those cases, forward momentum was a major factor in the athletes' successes.

What unites golf, baseball and hockey is the "falling forward" motion involved, whether it is a pitcher's arm or golfer's swing. Basically, the larger and taller the athlete, the more force he or she can bring to bear as his or her mass falls forward, Bejan said.

The results of his analyses were published online in the *International Journal of Design & Nature and Ecodynamics*.

"Our analysis shows that the constructal-law theory of sports evolution predicts and unites not only speed running and speed swimming, but also the sports where speed is needed for throwing a mass, ball or fist," Bejan said. "The sports of baseball, golf, hockey and boxing bring both the team and the individual sports under the predictive reach of the constructal theory of sports evolution."

The falling forward idea states that the larger and taller the individual, the more force can be applied as the ball is hurled forward. For example, former major leaguer Randy Johnson, a 6-foot, 10-inch pitcher, was a terror to batters during his career, notching two no-hitters, five Cy Young awards for best pitcher and the record for strikeouts by a lefthander.

"According to the constructal law predictions, the larger and taller machine, like medieval trebuchets, is capable of hurling a large mass farther and faster," Bejan said. "The other players on the baseball field

do not have to throw a ball as fast, so they tend to be shorter than pitchers, but they too evolve toward more height over time. For pitchers, in particular, height means speed."

In golf, despite the advances in ball and club design, taller competitors have been driving the ball farther than shorter golfers. In 2010, Bejan found the average golfer in the top 10 of driving distance was on average 2.5 inches taller than the average golfer in the bottom 10 of driving distance.

"This shows that height plays a definite role in the success of an athlete in golf," Bejan said. "The increase in driving distance with body mass is due to the fact that larger moving bodies are capable of exerting greater forces. Also, the increased size of clubheads has had a distinct affect on the game. The average driving distance on the Professional Golfers Association (PGA) tour has risen 30 yards in the past 30 years."

The same reasoning also applies to sports equipment, such as golf clubs and hockey sticks. Just as golf clubs have become lighter and more flexible to increase speed of swing, and thus distance, so have hockey sticks, Bejan said.

In terms of boxing, Bejan notes similar trends, even though boxers are classified and compete in specific weight classes. While height and arm reach help boxers, they cannot be too tall, because then they lose core strength, which lessens the falling forward force that powers the punches.

"We looked at the 25 greatest fighters in the lightweight and welterweight classes and found that these boxers have been able to maximize punching power by gaining size without going over weight limits," Bejan said. "They have done this by adding muscle and cutting water weight before a fight, and these techniques over time provide an

explanation for the improvement in boxers' size and knockout rates."

The work of Bejan's group was performed during the course "Constructal Theory and Design," developed at Duke with the support of the National Science Foundation. Other members of the team were Duke's Sylvie Lorente, James Royce, Dave Faurie, Tripp Parran, Michael Black and Brian Ash.

Provided by Duke University