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#### SPRING FORWARD

"Superhuman performance is certainly what comes to mind."



It's a transhumanist speed demon's dream: the ability to run as fast as 46 miles per hour, unbridled by things like our own organic speed-limits. That sci-fi scenario just got one step closer to becoming a reality thanks to a theoretical exoskeleton that applies bicycle mechanics to *human legs*.

A <u>paper</u> released Wednesday in the journal *Science Advances* lays out a blueprint for a **SPRING-POWERED HUMAN EXOSKELETON** that could be attached to the legs of a runner. The paper's calculations suggest that such a skeleton would increase human running speed by as much as 50 percent, making human runners nearly as fast as human cyclists.

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The top speed would be somewhere around 20.9 meters per second or about 46 miles per hour, the paper posits. The top speed for a human cyclist (with air resistance), meanwhile, 13 22.6 meters per second, or about 50 miles per hour.

David Braun is the paper's lead author and an assistant professor of mechanical engineering at Vanderbilt University. He explains that these legs suggest that a brave new world of human performance is possible.



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"Superhuman performance is certainly what comes to mind when we look at these devices, [though] they're theoretical inventions at this point," he tells *Inverse*.



An illustration of how Braun's device would work. Science Advances

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In turn, making humans more like bicycles could open up an entirely new realm of sports. But if these "theoretical inventions" ever became a reality, they would also pose stark ethical === questions about how such technology should be used.

# A BRIEF HISTORY OF SPRING-LEGS AND HOW THEY WORK

For people who like to go fast on their own steam, the bicycle has been the pinnacle of performance. But it took humans a long time to figure out how to make the bicycle faster than a person.

Early bicycle designs from the 19th century actually show pedal-less devices, where lowseated riders propel themselves forward by scrambling their feet on the ground (imagine a grown adult riding a child's tricycle). They also weren't very fast.

The big innovation for bikes in terms of speed was the development of *pedals*. Pedals allow you to do work not only when your foot is pushing down, but also when it is pulling *up* (in other words, while it's suspended in the air).



The "Ladies" Hobby Horse bicycle, an early pedal-less prototype of the bikes we know today. Wikimedia Commons

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Even when the fastest runners in the world run (and achieve speeds as fast as 27.33 miles per hour, achieved by Jamaican sprinter Usain Bolt in 2011) they are limited by running mechanics. We accelerate by applying more force to the ground, which in turn pushes our foot into the air (where that force is useless). The faster we go, the less time we actually spend on the ground – we're spending more time in the air, where we can't gain any more speed.

"The disparity between cycling mechanics and running mechanics gave us the idea to hypothesize a device that allows the legs to do work in the air," says Braun. "And then use that energy later on – on the ground – to move the body forward."

The *clear answer* to the force question is spring-legs – or that's at least one that biomechanics enthusiasts have been pursuing since the 1890s when patents for such devices first surfaced. But those springs, while they could diminish a loss of energy that comes with every footfall, didn't help the leg do work in the air.

Braun explains that his device *somewhat* solves that problem.

### N. YAGN.

APPARATUS FOR FACILITATING WALKING, RUNNING, AND JUMPING. No. 420,179. Patented Jan. 28, 1890.



Extremely steampunk leg attachments could let humans run 46 miles per hour



An 1890 patent on a similar augmented running device, which served as inspiration for this new project. <u>Google</u> Patents

When it comes to Braun's intended invention, with each footfall, the leg compresses the spring, which stores additional energy. That doesn't allow us to spend more time in contact with the ground – a major limiting factor to human speed. But it does allow each step to contribute more.

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"The less time we have on the ground [means] we need more force," argues Braun.

# THE ETHICS OF SPRINGING FORWARD

But such springy devices could seriously hurt us if we're not careful.

A bicycle distributes a person's mass on a horizontal axis, not a vertical one. When we run, we tend to bounce up and down vertically. The faster we go, the faster we are accelerating the body upward until we crash back down to earth once again, placing additional pressure on the body.

"This is one of the challenges," says Braun.

And even then, runners may balk at the idea of using such devices. The Nike Vaporfly 4%, a running shoe that imparts a four percent improvement in running efficiency, is still legal for competition but has been likened to "tech doping" by critics.

Braun says his devices would provide a bigger advantage — so, the only clear answer would be to **CREATE ANOTHER KIND OF SPORT.** 

"Cycling is considered a new sport," he says. "Ice skating is considered a separate event at the Olympic games. As technology develops and performance becomes not comparable to

running, we might see this device being considered as an augmentation device that would initiate a new sport."

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As exciting as it is to look forward to a new realm of super-fast sports, there's always the chance such technology might be used non-recreationally. Braun is aware of the potential for misuse of his spring legs by law enforcement agencies (a group who may benefit from them, per the paper's abstract).

Braun likens the hypothetical use of his devices to the use of Segways by police forces. They allow for more mobility. But making sure they're used ethically, is still an open question.

"Everything could be used in a number of ways," he says. "It's up to the people, how they use the technology."

Still, spring legs are part of a *distant future* – it took bicycles centuries years to become today's speed machines. Braun hopes the learning curve for his devices is a bit more expedient.

At least we will have time to think about what a super-speed future can, and should look like.

**Abstract:** Technological innovations may enable next-generation running shoes to provide unprecedented mobility. But how could a running shoe increase the speed of motion without providing external energy? We found that the top speed of running may be increased more than 50% using a catapult-like exoskeleton device, which does not provide external energy. Our finding uncovers the hidden potential of human performance augmentation via unpowered robotic exoskeletons. Our result may lead to a new-generation of augmentation devices developed for sports, rescue operations, and law enforcement, where humans could benefit from increased speed of motion.

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