Gymnastics' Latest Twist? Robot Judges That See Everything

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, which examines technological, economic, social and cultural shifts that happen as businesses evolve.

STUTTGART, Germany — The rectangular gray boxes arrayed around the floor at the gymnastics world championships this week are easy enough to ignore.

But these little boxes, 30 of them in all, hold outsize significance: According to Morinari Watanabe, the president of the International Gymnastics Federation, their presence at the worlds signals "the beginning of the new history of gymnastics."

The robot judges, in other words, have arrived.

Each of the gray boxes keeping watch in Stuttgart, designed by the Japanese company Fujitsu and about the size and shape of a Wi-Fi router, contained a set of three-dimensional laser sensors that tracked the movements of each of the 547 gymnasts from 92 nations participating this week. That data was fed to an artificial intelligence system, accessible to

the human judges, that measured and analyzed skeletal positions, speeds and angles — some of them unavailable or simply missed by the judges — as the athletes went through their movements.

Thanks to all this, Watanabe explained, no longer would gymnasts — many of whom, he noted, had started gymnastics as young as age 3 and had trained competitively for more than a decade — risk having their efforts unceremoniously wasted by human error or interference.

“This is a step toward the challenge of justice through technology,” Watanabe said.

The debut of such technology at the biggest gymnastics meet outside the Olympics represented a meaningful milestone in a sport periodically marred by judging controversies and often wracked with questions about political influence in scoring decisions.

In gymnastics, at least, humans very much remain in control. For now.

At the world championships, the artificial intelligence system instead has served a supporting role, available to judges to confirm difficulty scores in two circumstances: in the event of inquiries (when gymnasts formally challenge the judges’ score) and blocked scores (when there is a large deviation between the sets of judges). And the technology, officially, remains limited to a few events: pommel horse, rings and men’s and women’s vault.

Butcher said judges were separately reviewing a large portion of the exercises through the Fujitsu system for the purposes of verification and education.

Despite the fanfare of the system’s introduction and its potential effect on scores, athletes and coaches said they were not paying too much attention to the A.I. judges. Laurent Landi, who coaches the American star Simone Biles, said that it was too early, and the procedures not sufficiently integrated, to fully ponder the implications of the technology. But he said once the computers proved their accuracy, they could represent a big, positive step for the sport.

“We all know how subjective scoring can be,” Landi said.

Others expressed wariness, arguing a computerized system contradicted the human heart of the sport.

“We shouldn’t turn it over to robots because, to be honest, I think that’s a little weird,” said Yul Moldauer, a member of the American men’s team. “I think we should always have human beings being the judges.”

Before this year's competition, Moldauer and the hundreds of other competitors were asked to participate in what Butcher called a "body dimension measurement" procedure — effectively a precise scan of their bodies and movements — so that the analyses could proceed with maximum accuracy.

The precompetition measurements were voluntary, but Butcher made sure to point out that several athletes who had agreed to be scanned this week later benefited during the championships by having one of their scores increased upon review.

Takehiko Ishii, a manager for Fujitsu, estimated that more than 90 percent of the athletes had agreed to participate. Those who did not were evaluated using standardized body dimensions, but, he said, "some gymnasts have thick muscles, and some gymnasts are thin, so it's better to have the body dimension measurements."

Amid all the other minor concerns, however, most discussions about the so-called robot judges have tended to lead to a larger, simpler question: Will there come a time when human judges are eliminated completely?

Ishii said the A.I. was not yet sophisticated enough to take over fully for humans. But one day it might, he said.

Coaches and gymnasts were more skeptical about an artificial intelligence system's ability to ever fully evaluate a nuanced gymnastics routine.

"The computer cannot understand artistry, mastery, cannot understand the feeling in the movements you make," said Enrico Casella, an Italian coach. "It can see all the angles better than judges, but the artistic part is impossible."

Fujitsu and F.I.G. said they envisioned a future in which the 3-D laser sensors were used not only in competition, but to enhance the viewing experience for fans. The federation and a Japanese broadcaster experimented this week with integrating the data into television broadcasts. Coaches, meanwhile, were considering their value as a training tool.

"Once we learn about — we're calling them robots — once we determine what the robots can really see, then it could absolutely dictate the direction of coaching for us," said Tom Forster, the high-performance team coordinator for the American women's team. "The human eye can't pick up everything."