



Tell fans definitive calls are an impossible goal

The electronic eyes that will watch football goal lines this summer may settle arguments, but they still depend on probability, says Nic Fleming.

Almost three years ago, the English footballer Frank Lampard scored a goal in a World Cup quarter final against Germany. The ball hit the crossbar and bounced down way over the line, before it was cleared by a grateful goalkeeper. The referee and his assistants failed to award the goal, because they could not be sure the ball had crossed the line.

Every fan of football (apologies to US readers but I refuse to use the term soccer) has their own story of a goal that should or shouldn't have been given. Those in charge of the game have finally bowed to public pressure and next month's Confederations Cup in Brazil will see goal-line technology used in an international tournament for the first time. In August, a similar system will be introduced into the English Premier League, the richest and highest-profile league in the world. The companies involved are already discussing how their machines could be applied to help football referees make offside, handball and other decisions. Sports officials in the United States and Canada are watching with interest.

Yet the introduction of goal-line technology to football is likely to perpetrate a mass deception on television viewers. It will miss a huge opportunity to educate people about the role of uncertainty in science. And it will exacerbate the approaching danger of fake computer-generated video footage.

Have you seen how a tennis player's challenge of a close line call is adjudicated by the Hawk-Eye system? I confess that until recently I was one of the vast majority who believed they were watching an accurate replay of reality. In fact, the system combines multiple high-speed camera images to estimate the ball's trajectory and position when it hits the ground. Nothing in the graphics indicates to viewers the inevitable uncertainty and potential for error in that estimation. As it stands, the same will apply to goal-line replays.

Fans are likely to share a misunderstanding that apparently reaches right to the top of the game. Announcing the introduction of Hawk-Eye to football in April, the Premier League's chief executive, Richard Scudamore, said that the technology would reveal "definitively" whether the ball had crossed the line.

Scudamore may not have read the 1726 edition of Isaac Newton's *Philosophiæ Naturalis Principia Mathematica*, which stresses the role of uncertainty in the scientific method. Measurement involves error. Results are accompanied by confidence limits and levels. With public opinion key to decisions on topics such as climate change, nuclear power and genetic modification, calls to spread awareness of uncertainty and probability in science are increasing, even if they are often drowned out by the comforting simplifications of certainty that characterize mainstream reporting.

NATURE.COM
Discuss this article
online at:
go.nature.com/3upjdk

In 2011, sociologists at Cardiff University, UK, published a paper on the use of Hawk-Eye in sports (H. Collins & R. Evans *Public Understanding of Science* <http://doi.org/frmw94>; 2011). The system introduced a "false transparency" in tennis, they said, and should be supplemented with visual error bars or numerical statements of confidence in the screened Hawk-Eye graphics.

Cricket fans already understand this. In leg-before-wicket decisions (sorry again US readers — look it up) there is a 'zone of uncertainty' where Hawk-Eye admits that it cannot be certain whether or not the ball would have hit the stumps. It defers to the judgement of the human umpire and this is acknowledged to television viewers with an 'on-field call' message. Football fans will be denied such information.

Both Hawk-Eye and the (separate) GoalControl technology that will be used in the Confederations Cup train seven high-speed cameras on each goal. Computer software then combines the two-dimensional images into three-dimensional representations of the ball and its position. Both systems can probably provide more accurate decisions than human referees. Hawk-Eye claims a minimum accuracy of ± 6 millimetres whereas GoalControl claims ± 5 millimetres. These claims cannot be verified as the International Federation of Football Associations refuses to release the test results, beyond confirming that both systems meet its minimum requirement of ± 3 centimetres in tests of balls moving at 70 kilometres per hour.

The public is largely aware that still images can be airbrushed, improved and otherwise manipulated. Many media organizations have strict codes governing digital tinkering. Earlier this year, North Korea was seemingly caught out cutting and pasting extra hovercrafts into an image to boost its apparent military muscle.

Moving images can seem more realistic. Yet we are rapidly approaching a time when computer-generated moving images will look as if they have been filmed. We will be able to create entirely faked video footage. This is useful to create an impressive mountain backdrop for a film. But what about when political propagandists or those with commercial motives start to exploit such technology?

If video footage is to retain credibility, we need greater transparency about visual representations of events, so we can distinguish replays from reconstruction. On-screen honesty on the limitations of goal-line technology would do this, and put a great many people in the picture about science and uncertainty. Football is only a game but it is a good place to start. ■

Nic Fleming is a freelance science and technology journalist in London and a Sheffield United fan.
e-mail: nicfleming106@hotmail.com