



# A well-rounded ball

**T**he days when soccer balls were made of leather are long gone. The introduction of synthetic materials represented a significant advance in ball technology which enabled them to become lighter, resistant to wet conditions and more accurate in their dimensions. The overall properties of soccer balls have been continuously improved ever since.

Designers have now come up with a pioneering breakthrough. The outer skin of the adidas +Teamgeist, the official ball for the 2006 World Cup, is no longer made up of 32 pentagons and hexagons but instead features 14 large panels with shapes resembling propellers and turbines. Special measures have also been taken to protect this novel new surface and it is claimed that this contributes to the superior play properties of the +Teamgeist ball.

An aliphatic polyurethane (PU) topcoat formulated using raw materials from Bayer MaterialScience essentially places the outer cover and its special printed design 'under glass' and makes the surface extremely resistant to abrasion. Polyurethane products from Bayer MaterialScience are also used to improve the

overall performance of the +Teamgeist.

Bayer's Thomas Michaelis from its Coatings, Adhesives and Sealants Business Unit says, "Our mission was to find a coating that could be applied evenly to the new panel shapes. It could not be sticky and also had to ensure that the ball would retain its unique appearance for a long time." The coating technology developed by his team satisfies all of these requirements. The topcoat of Impranil ELH-A is primarily responsible for the abrasion resistance, while the aliphatic intermediate coat of Impranil HS 85 LN makes the ball very durable and extraordinarily elastic.



*adidas +Teamgeist, the official ball for the 2006 World Cup.*



### Secrets of smoothness

The total length of the panel lines of the +Teamgeist is more than 15% shorter than on the previous model. And this is one of the reasons why the outer skin of the World Cup ball is so smooth and perfectly round. Measurements of the diameter at 16 different locations per ball show that the deviation between the largest and smallest diameters is no more than 1%.

Another important factor for the exact curvature is that the thickness of the layer with the polyurethane foam of Impranil has been increased from 0.9mm to 1.1mm compared with the Roteiro ball used for the 2004 European Championships. This foam is comprised of evenly-sized and resilient gas-filled microcells that make the new ball dimensionally very stable. It is also responsible for the ball's high shape recovery properties, which help to guarantee a more precise trajectory.

"The rounder the ball, the more balanced it is in flight and thus the more accurately it can be kicked. The +Teamgeist is extremely consistent regardless of where it is struck," says André Pectold, project leader of Technical Development at adidas. This was demonstrated in part by tests at the adidas testing lab, in which the ball was 'kicked' repeatedly at a target by a high-tech robotic leg with precisely adjustable force and at a precisely adjustable angle. Pectold claims that with the new ball, the range in variation of the trajectory is one-third smaller than with the previous model.

### A ball for all conditions

Soccer is played in just about any weather and only a few of the stadiums that will feature in the World Cup in 2006 have roofs that can be closed at the push of a button. The new ball therefore has to retain its excellent properties even if it rains or the grass is wet. It is, in fact, practically impermeable to water. When placed in a tank filled with water and rotated 250 times, its weight increases by a maximum of 0.1%. This easily exceeds the strict standards for a 'FIFA Approved' quality seal, which permits a weight gain of up to 10% in this test.

The materials experts at Bayer, who have been supporting adidas in the development of World Cup soccer balls since 1984, played a major role in the weather-resistance of the new ball. "One factor for the low water absorption is the properties of the Impranil raw materials in the coating. Furthermore, the Thermo-Bonding technology used (as against traditional stitching), makes the +Teamgeist essentially seamless," says Michaelis. This new bonding technology has been developed and patented by adidas and, once again, a Bayer product is used in the form of a heat-activated adhesive based on a waterborne polyurethane dispersion from the Dispercoll U product line.



### How do we know a ball is round?

A football is round—or at least it is supposed to be. Everybody agrees on this, but is it necessarily true? Is every football perfectly round and how do you know that it is?

Any football certified to FIFA's International Football Standard has to undergo certain tests, one of which is the measurement of its spherical accuracy. The traditional method has been to inflate the ball to 0.8 bar pressure then draw a line around its centre and divide one half of the ball into 16 measurement sections of the same size and the same distance apart. The diameter between each section and its exact opposite point on the other side of the ball is then measured using a digital calliper with an accuracy of 0.01mm—a much higher resolution than is really needed.

The data is then typed into an excel computer program which calculates the values. If the maximum variation between the highest and the lowest readings is within 0.2%, the ball is considered to be round. The machine is hand operated and it takes between two to three minutes to test one ball, which means that only seven are normally tested regardless of the volume produced as this is all that the FIFA test standard requires. It is not meant to be a test method for manufacturing purposes, so time is not important and, in any case, the detection of any manufacturing defect is also reliant on visual human inspection.

For large scale testing, the German footwear institute, PFI, has developed an automatic system capable of 100% inspection in an assembly line. One ball after the other can be inflated automatically to 0.8 bar pressure and then moved to the next station where the diameter is measured by means of a 3D laser scanner. Measuring is based upon the principle of optical triangulation and utilises a novel new system developed from foot and leg scanners. Specially designed new software transforms the results into the required quality parameters, such as roundness, and depicts them as an image which can be stored in different formats.

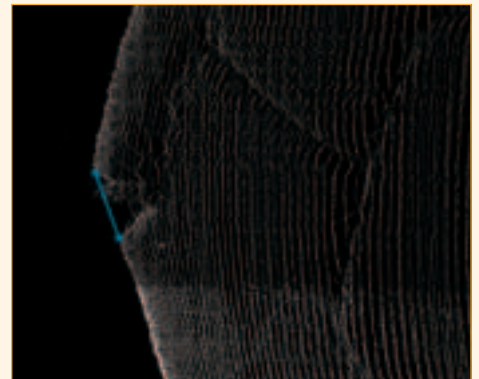
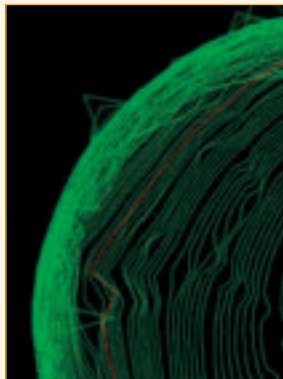
*Measuring roundness.*



Geometric manufacturing faults, such as deficient seaming, will be also detected when the laser recognises a ball that is not completely round. For example, the open seam error is clearly seen on the scanned image and the ball can be immediately removed from the production line. The system's resolution in the region of 0.1mm is sufficient and the main advantage is, as a result of the high measurement speed, that each ball can be automatically inspected before being delivered.

While this means that the manufacturer can be sure that what he delivers is correct, seven balls would still have to be tested in a certified lab such as PFI, to gain official certification. This would have to be in accordance with the current standard, which requires the hand operated system. It would appear that once again, computers have stolen a march on the human operator, but whether FIFA accepts the scanner test remains to be seen.

The skill of the players at World Cup standard is beyond question. They are also extremely expensive. Furthermore, a great deal of national pride is at stake, so nothing can be left to chance. Making sure that the ball offers the best that design and technology can provide is therefore logical and we are fortunate that sophisticated raw materials are available to make this possible. At least we can now avoid arguments about the behaviour of the ball. 



*Perfect ball - ways in which a seam fault can be detected.*

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