What makes a good ball?

Our cut-out-and-keep series to assist retailers with product knowledge.

Words: Trudi du Toit. Compiled with information supplied by Ian Savage, Gilbert's ball development engineer, adidas *Jabulani ball development* document, www.irb.com *Laws of the Game 2008*, www.fifa.com *Laws of the Game 2008/9*, www.internationalnetball.com/netball_rules, www.sportstechreview.com/Rugby.

Every four years, before and during a World Cup, the performance of the new official ball is scrutinized and criticized or praised by just about every striker or kicker to take the field. The ball is more often than not blamed for missed goals or bad line kicks – but, strangely, hardly ever credited for goals scored!

Can design elements in new team balls really influence performance to such an extent? And are the players correct to blame design changes when the ball does not behave as they expect.

In a skills game like soccer, they judge the ball on the trajectory of its flight. Every striker wants to *bend it like Beckham*. But in handling sports like rugby and netball, a good grip and a predictable flight – going where the goal kicker or shooter aims it – determines how well the ball is liked.

There are many factors that influence the performance of a ball. Ball spin and aerodynamics can be affected by factors from the stitching and panel designs to air swirls in the stadium that the spectators may not even be aware of.

Some of the obvious design changes that will influence how a new ball will perform are:

Air retention

A bladder assists the ball in travelling more consistently and accurately, and the air retention of the bladder is therefore the first factor that will determine ball performance. During a top level game as many as 6-8 balls can be used and it stands to reason that pressure differences between the balls used in one game can play havoc with performance.

Manufacturers are constantly devising new methods (e.g. layers) and bladder materials to enhance better air retention. Latex rubber bladders offer the best response, but micro pores slowly allow air to escape. The more expensive butyl bladders offer excellent air retention – but have less resilience so do not perform to the same level.

Ball manufacturers have different pressure guides for their balls. The IRB guide is 9.5-10lb/sq inch for rugby balls (the Gilbert World Cup and international match balls are pressurized to 9.5). FIFA specifies a pressure of 8.5-15.6 lbs/sq inch.

Over- and under-inflation can change ball performance. A harder ball will usually go in the direction it is sent to – which might not be the place you actually want it to go.

- A softer ball has more time to deform and reform – it therefore travels further and high level players can control the ball whilst on the foot.
- A ball that comes out of a bag feels different to the one that has been kicked before, *warming up* balls is therefore as important as *warming up* players.

The valve

The placement and shape of the valve can also influence the flight of the ball – most rugby ball manufacturers therefore nowadays place the valve in the seam to prevent its weight from affecting the ball's balance and thus ensuring a more accurate goal kicking trajectory. This has several benefits – the ball can be off-target, but through rotation the valve in the seam will self-correct by 10-15%, ensuring a longer, more accurate flight.

Also, it means that the kicker can align the valve towards the target, and use the weight to keep the kick on line. More importantly, it means that the kick energy enters the ball at the weakest point – the seam – given greater energy transfer.

Before inflating a ball, place a couple drops of silicone oil or lubricant spray or glycerine oil into the valve to prolong its life and make it easier to insert the inflation needle. Also moisten the inflation needle before insertion.

Weight and size

A consistent weight is another important factor when several balls are used in a match. This is achieved by ensuring that each panel used for every ball is exactly the same size and weight. In the manufacturing of top-end match balls individual panels are weighed to ensure that their weight does not deviate more than 2-3gm, and the carcass is again weighed after it is stitched to make sure that every ball is within 5gm of each other.

- The IRB Laws of The Game specifies that a rugby ball must weigh 410-460gm and must have four panels. Heavier balls are more accurate. A smaller ball may be used for younger players.
- In *The Laws of the Game 2008/9* FIFA specifies that a match ball must weigh 410-450gm at the start of the match in dry conditions. The circumference must be between 68-70cm. FIFA does not specify how many panels soccer balls should have. They come in the following sizes:
  - Size 3 balls are the smallest and are generally used for children under the age of 8. They do not weigh more than 350gm;
  - Size 4 balls for players between 8-12 years, are also used in Futsal. They weigh 350-390gm;
  - Size 5, the international standard match ball for players older than 12, must weigh 410-450gm.
- In netball a size 5 ball is used for adults and a size 4 for younger players. The regulation netball size (5) is basically the same as for a soccer ball, namely 68-71cm in circumference, weighing 400-450gm.

Ball surface

When you compare a rubber beach ball to a performance match ball, it is obvious that the smooth surface of the beach ball is fine for lobbing it to friends during a game … but try scoring a stylishly curving goal or catching it when it is wet! Even the most skilful player will come short.

Alternatively, the size of the dimples on a golf ball in relation to its size helps a golfer to drive it 200-300m down the fairway – **To p32**

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not the distance anyone wants to kick a rugby or soccer ball!

- The ball surface determines if the air flow during flight is laminar (smooth) or turbulent (uneven) across the ball surface. The behaviour of the ball — spin, trajectory and length of flight — depends on how, when and where the laminar air flow turns turbulent. As cricket fans know, the slightest rough patch causes spin.
- When the turbulent drag sets in too soon (e.g. when pimples are too high or panel shapes interfere), the ball will go off course. If drag sets in too late and the ball stalls before gravity sets in, it will drop off and not travel as far as it should. Turbulent drag will further affect a rugby ball differently when it is launched as a torpedo, to when it spins around. Spin and rotation improves distance and accuracy, as it helps the ball to fight through drag.
- Designers of team balls therefore constantly develop new ways of *channelling* the air around the ball to improve performance through the size, placement and shape of panels, pimples and grooves on the surface. The smaller the pimples, the less drag. If you want higher drag, raise the pimples.
- When they developed the previous IRB Rugby World Cup ball, the Synergie, Gilbert spent about four years researching the correct height, spacing and placing of the pimples on the outer — and eventually settled on star, square and round shapes in different heights placed in strategic positions.
- When they developed the Jabulani for the 2010 FIFA World Cup, adidas spent a lot of research time to ensure that the ball keeps its round shape so that its flight is more predictable. Aero grooves create a clearly visible profile on the ball's surface. The Grip'n'Groove profile circles round the entire ball in an optimal aerodynamic way, improving flight characteristics, making this the most stable and most accurate adidas ball ever.

Grip

The pimples or grooves on a ball surface not only influences the flight, but also improves grip, especially in wet weather.

The smaller the pimples, the less drag and water retention, but fewer pimples equals less grip. But, added moisture, therefore added mass, reduces the distance the ball will be kicked.

The trick is to achieve a balance between grip and aerodynamics. Consistency is critical.

- A ball that only has lots of small pimples or a big flat surface, will perform optimally in dry conditions. Many small pimples close together will improve the grip in wet weather without affecting the aerodynamics of the ball.
- In heavy rain raised pimples will still provide a good grip as the pimple is above the level of the water.

The ink from cosmetics and other printing on the surface can also affect the grip and therefore manufacturers of top end balls incorporate the colour into the rubber cover before making the panels. Adidas has, for example, developed a glass printing method to seal the eleven colours of the Jabulani ball into the cover material, reducing the amount of ink printed on the cover to the minimum.

Player influence

No matter how much research and development went into a ball, in the end some players will still praise it, while others will blame it. Much will depend on the type of ball players are used to playing with.

Rugby goalkickers usually have their own preferences for the best pressure level of a ball — another benefit of home games.

It depends on how they prefer to line the ball up — former Springbok Braam van Straaten, now the Wallaby kicking coach, for example, lines up the ball with the goalposts and then aligns his hip and shoulder with the lettering on the ball. England's deadly accurate Jonny Wilkinson, for example, lines the ball up off-centre.

Extensive studies of how differently a ball behaves when kicked by soccer players with different styles also showed:

- When a player strikes the ball with his instep straight in line with the ball's centre of gravity, it will travel in a straight line.
- When a player kicks the ball off-centre with the front of his foot at a 90° angle to his leg, it will curve in flight, because the ball will spin.
- The spin picked up by the ball depends on how much friction is created between the foot and the ball, and how far from the ball's centre of gravity it is struck.

Manufacturing a World Cup ball

The images below shows how the adidas Jabulani 2010 World Cup ball was made. *Photos: adidas*

After the fabric was stretched and laminated, panels are machine-cut to ensure they are all the same size.

Once the panels are stitched, the carcasses are weighed to ensure that all weigh the same. Bladders are weighed separately and with the carcasses to ensure uniformity.

After the bladders are inserted and the valves affixed with glue, the carcasses are inflated and shaped to check roundness and seams.

Logos are heat-transfered to the TPU sheet, which is cut in 8 pieces, on a print conveyor. They are then inspected. The 11 colours are printed with an underglass process

3D EVA panels, UV-treated to cleanse them, are vacuum bonded at high-frequency with the TPU, and trimmed. The backs of the panels are automatically glued.

The valve hole is punched and four panels each are used to form the two ball halves. The two halves are again weighed and the valve centred.

The carcass and ball halves are thermal-bonded in air-pressure and heated moulds. Balls are chilled and stored 24hrs.