Goodyear welted footwear

The Goodyear welted footwear construction is one of the oldest methods of footwear manufacture still used today. Although often perceived as being only for men's high-quality all-leather footwear, it is also commonly used for the mass market. LYNNE BRENT reviews.

The traditional Goodyear welted construction was developed during the 19th century in America, where Charles Goodyear Jnr revolutionised modern shoemaking by introducing a line of machinery to overcome the shortcomings of then-existing methods of manufacturing footwear.

Goodyear's process consisted of a special insole channelled to provide an upstanding lip or rib. The upper was pulled over the last to this rib and temporarily held in place by tacks, wire and staples. A flat strip of leather, called a welt, was then sewn in to combine the welt, upper and lining to the rib using a chainstitch. After the welt was sewn in, the shoe bottom was then joined to the outsole by sewing through the welt and the outsole with a lockstitch.

The Goodyear welted construction prevented stitching holes completely penetrating from inside the shoe through the outsole (as had been normal in the Blake sewn construction, which was the most common method of footwear manufacture at the time), consequently improving the footwear's water resistance. It also meant that heavier upper leather could be used than was previously selected for another common method, called the turnshoe construction (figure 1).

The Goodyear welted construction also offers the distinct advantage of a sole that can be completely replaced without damaging the upper. To this day, the highest-quality welted manufacturers still offer sole replacements on their footwear, and have recently reported significantly higher numbers of repairs.

However, compared to modern methods of construction – for example, flat lasted or cemented – the welted process is more labour-intensive and requires a significant amount of additional machinery.

Goodyear welted manufacture today

Over 100 years after Charles Goodyear Jnr introduced his machinery, welted footwear is made in much the same way as it originally was, with some differences in machinery, components and methods of sole attachment, depending on the manufacturer. It is interesting to note that in recent years the name 'Goodyear' has often been dropped, with the construction simply described as 'welted'. This is potentially misleading, as other forms of welted construction exist. Different permutations will usually depend on the size of production unit, as well as the quality and price of the end product. For example, there are certain bespoke shoes where the welts and soles are hand sewn by highly skilled craftsmen. Elsewhere, highly water-resistant welted footwear is produced with the addition of membranes to the uppers and sealing of the welt sewing.

Goodyear welted footwear is now produced worldwide (including in India and China) by the same methods as the traditional producers in Europe and the USA. In fact, many

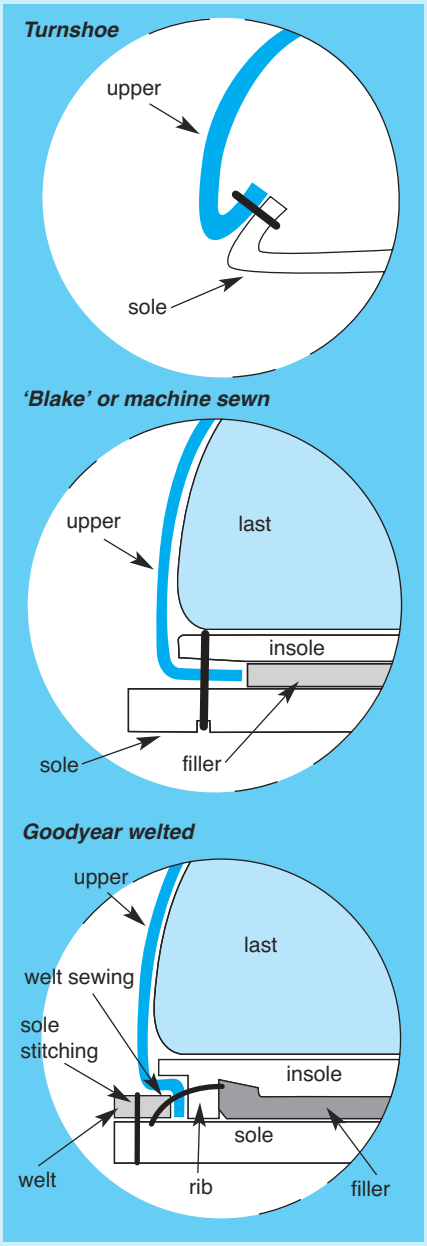
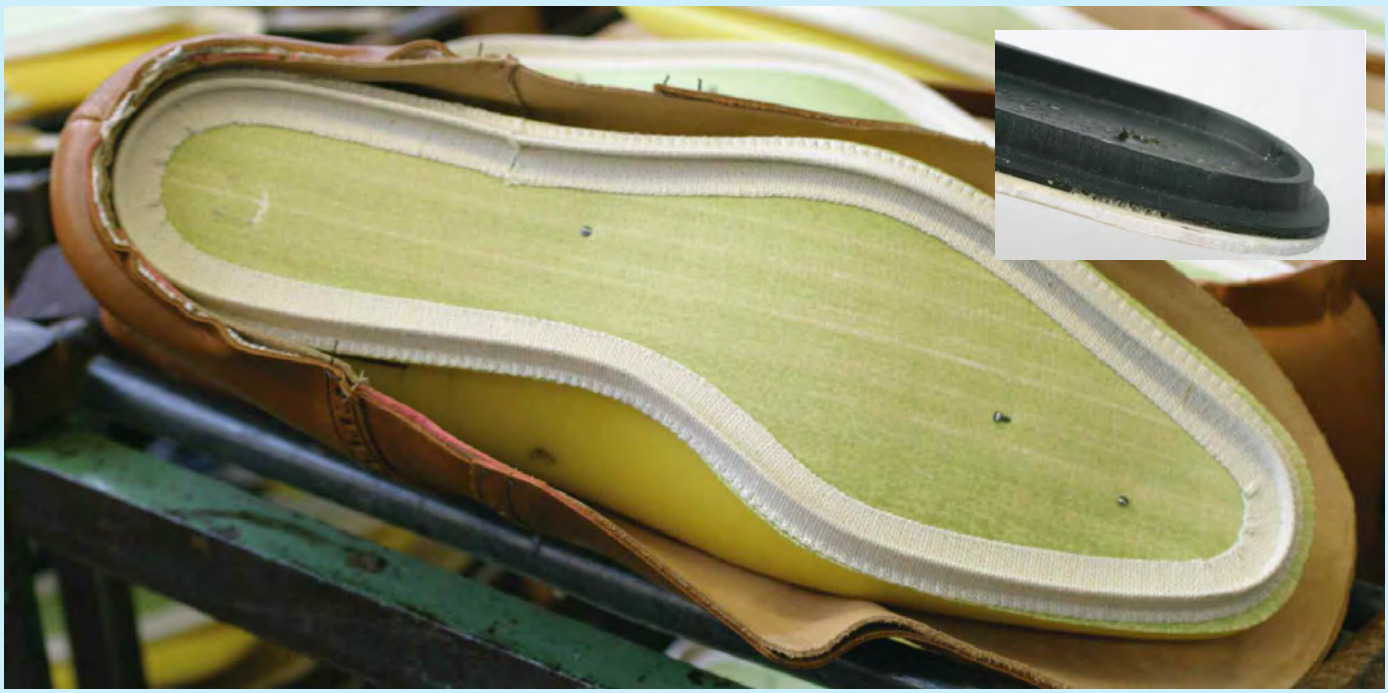


Figure 1: Turnshoe, Blake sewn and Goodyear welted constructions



Figures 2a and 2b (inset): Examples of ribbed insoles

of the new manufacturers have been set up and trained by experienced welted manufacturers from the UK.

In addition to producing men's high-quality all-leather footwear, some shoemakers use the Goodyear welted process to manufacture other types of footwear, including safety shoes.

Ribbed insoles

The ribbed insole is the foundation for Goodyear welted construction (figures 2a and 2b). Traditionally, a leather insole is used and a rib formed by channelling two lips around the insole perimeter. These two lips are latexed and drawn up together to form an upstanding wall or rib.

More commonly, a separate rib – usually consisting of a woven tape with a cellulose board core and an adhesive coat on its underside – is applied or 'laid' onto the bottom of a pre-cemented cellulose or nonwoven insole by machine. It is most important that the adhesion of the rib to the insole and the inherent properties (such as the laminar strength) of the insole are sufficient for the bond to remain intact throughout the life of the shoe. Peel and shear tests are recommended to assess these properties. A weakness of cellulose boards is that their properties will change when subjected to moisture, particularly causing a loss of strength. For this reason, it is important when testing cellulose boards that the tests are carried out in both wet and dry conditions.

It is essential that the insole rib is of suitable height and substance (thickness) and that it is located correctly on the underside of the insole. The distance between the insole edge and the rib needs to be adjusted for differing thicknesses of upper material and shape.

Latest developments in rib manufacture include a flexible rib, which enables manufacturers to produce ribbed insoles with greater flexibility in the forepart.

Some manufacturers use a conventional cut insole, which has a PVC rib moulded directly onto it. Alternatively, they may use a moulded PVC insole where the rib is an integral part of the moulding.

Forepart lasting

Traditionally, the uppers were pulled over the last and secured at the drafting points with seven tacks. The upper would then have been staple side and seat lasted and finally toe

Figure 3: Toe lasting with a bed lasting machine

lasted with a bed lasting machine (figure 3). The upper was secured with a bracing wire, with this wire and tacks removed after welt sewing.

It is now common practice to use a modified forepart lasting machine for the production of welted footwear. For successful lasting, the linings should be laminated to the uppers in the stitching room and the uppers adequately conditioned or mulled.

On the most modern forepart lasting machinery, cement tracers are used to apply adhesive to the rib in precisely the right location. These cement tracers offer significant cement savings by eliminating excess compared to more basic machines, which imprint (inject) the hot-melt adhesive onto the insole as well as the rib. This attachment is regarded as temporary, as the permanent securing of the upper to the rib is achieved when the welt is sewn in.

A modern automatic forepart lasting machine (figure 4) can last up to 1,200 pairs in an eight-hour day.

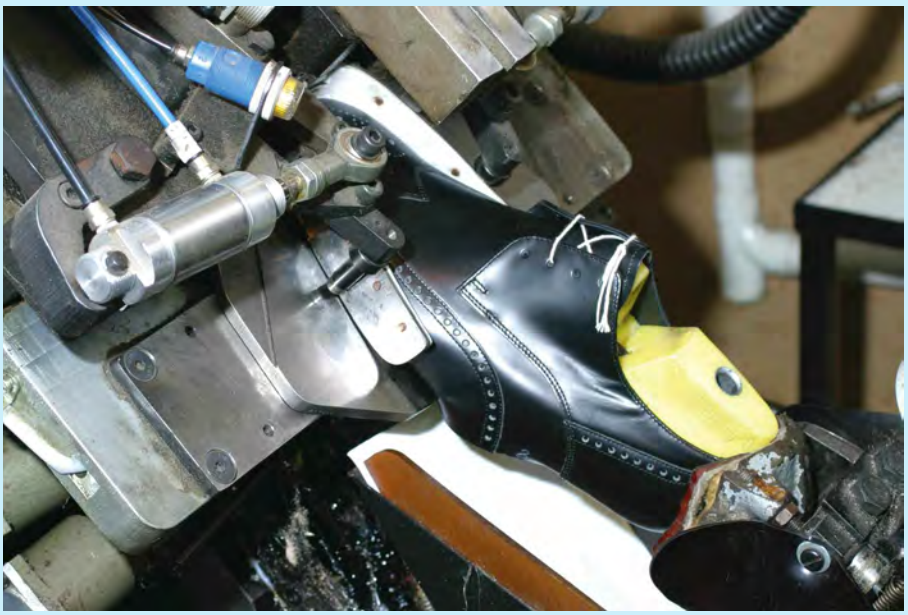


Figure 4: Automatic toe lasting increases production

Side and seat lasting

The rest of the temporary attachment of the upper to the rib is usually done with a stapling machine, which has changed very little over the last fifty years or so. The machine forms staples from a coil of wire and both drives and clenches them on the insole rib (figure 5).

Figure 5: Stapling by machine

Heat setting

Adequate heat setting should be considered vital to any lasting process, including welted. Heat setting is essential, as it relaxes the lasting strains and sets the leather to the shape of the last, thus improving the footwear's appearance not only at the point of sale, but also throughout its useful life.

Upper trimming

This method of construction is often criticised for being wasteful of upper material. This is because after the initial lasting operations, in high labour-cost countries, the surplus upper leather is trimmed away prior to welt sewing.

In Far Eastern factories, however, it is common practice to cut down the vamp pattern to the net size required to reach the rib and extend it back up to the original pattern size by butting up and stitching a strip of lower grade or waste leather or fabric to it, which is ultimately trimmed back off. This method would not usually be employed in the West, as the labour cost involved would outweigh any potential savings on leather cost.

Upper protection

When making welted footwear, it is advisable to cover the shoe with a plastic cover prior to welt sewing, to minimise damage and soiling of the upper. This is particularly important with light-coloured and delicate materials such as suede, nubuck and aniline leather.

A good method is to use the shrink-wrapping technique, which has been adapted from the food packaging business. A plastic envelope is placed around the lasted shoe and sealed by a machine with a hot knife. The shoe is then put into a heated tunnel for a few seconds, which quickly shrinks the plastic around the shoe (figure 6). The cover is removed with a hot knife around the feather edge or a revolving fibre disc, just prior to the final shoe rooming operations.

Figure 6: Shrink wrapping minimises damage to the upper

Figure 7: Recently-developed welt sewing machine with touch screen interface

Welt sewing

This is one of the most skilled and difficult operations in the sequence, whereby the welt is stitched to the upper and the rib by means of a chain stitch. The thread is passed through a heated wax pot so that it is coated with molten wax. The wax not only lubricates the thread, but also helps to lock the chain stitch, in addition to damming and sealing the stitching holes.

Some footwear styles are welted from heel breast to breast. Others are welt sewn all round with the welt joined – that is, butted up, usually over the inside heel breast.

Traditional welts are leather and others are PVC. Whereas leather welts are tempered (moisture introduced to make them more pliable prior to stitching), PVC welts need to be heated to soften them in order to aid the stitching operation. This can be done by immersing the length of PVC welt in a tank of warm water behind the welt sewing machine. The welt is then fed directly from the tank to the guide.

It is essential when welt sewing, that the chainstitch is located through the welt bevel into the welt groove. This ensures that the seam is tight with the welt correctly positioned to the inseam. The needle should pass through the bottom of the rib wall to avoid a loose 'grinning' seam.

With traditional machinery, the operator needs to be able to handle the work accurately at speed, as well as being able to set up and make adjustments to his machine to accommodate different work. It is worth noting that there have been significant recent developments in welt sewing machinery. There are now machines available which incorporate a touch screen interface, giving the operator full control of all major functions including pre-programmed progressive speeds (figure 7). This is a major step forward, as the traditional machines had clutch motors which meant, as a consequence, that operators had little control over the speed. This made training particularly difficult.

Inseam trimming

This machine uses a rotating knife that cuts off surplus materials to just above the sewn welt seam (figure 8). This reduces the cavity between the insole

and the sole, and improves the flexibility of the finished product. Although this operation may appear simple, it is extremely important that the seam is trimmed to the correct level – however, this cannot be carried out successfully unless the welt has been sewn in correctly and is still in a mellow or pliable state. If the knife is too low, the stitches may be cut and the whole bottom of the shoe could detach during wear. If it is cut too high, the seam will show through the insole, excessive bottom filler will be needed, and the shoe will be too rigid. Traditional machines have been updated to improve safety for the operator by guarding the knife to reduce the risk of injury, and with the inclusion of a vacuum system to remove the scrap.

Welt beating and butting

As with inseam trimming, the welt should still be in a mellow or pliable state when this operation is carried out. The welt is beaten by a machine to bring it out at right angles to the shoe, effectively completing the hinging effect of the rib. If the style has only been welt-sewn heel breast to breast, the two ends of the welt are skived at an angle, so that they marry up with the seat lift. On PVC welts, the two ends are welded together with a hot knife.

Shank fitting and bottom filling

The shank (often wooden) is attached to the waist of the insole, usually with hot-melt adhesive. The resultant cavities are then filled to make the bottom of the shoe flat prior to the sole being attached. Granulated cork, in the form of an adhesive paste, has been used as bottom filler in traditional welted leather-soled footwear for many decades. It provides the perfect filler for the variable profile of the ribbed underside of the insole and prevents unsightly lumps or undulations in the sole. This cork filler, together with the insole, readily conforms to the wearer's feet, providing comfort and insulation against extremes in temperature (figure 9). In some cases, bottom fillers such as expanded rubber, chip foam, soft EVA and felt are used.

Methods of sole attaching

The soles – whether leather or polymeric – are attached using a suitable adhesive system. Leather soles are wetted and tempered beforehand to aid the process and give a smooth bottom to the shoe.

Once the sole has been attached, the sole and welt are rounded down and, at the same time, a channel or groove is cut into the bottom of the sole to accommodate the sole stitching (figure 10). For rubber soles and less expensive leather-soled footwear, a groove is used, with a small section cut out of the sole so that the stitching is visible on the finished footwear. For more expensive leather soles, a channel is used. An angled cut is made into the sole, with the resultant lip lifted, before the sole is stitched and stuck back down afterwards to cover the stitching.

Footwear which has a PVC welt and sole may have the soles heat welded to the welt by means of a hot knife.

Sole stitching

Traditional Goodyear welted footwear has the sole attached to the welt by means of a lockstitch (figure 11). Continuous filament polyester is currently the most common thread choice for welted footwear, although linen is still used by some manufacturers.

When sole stitching, care must be taken to ensure that the stitching does not run into and damage the welt seam. This may occur if the operator tilts the shoe, thus causing an angled seam rather than a vertical one. If the welt sewing thread is damaged in this way, the welt could become detached from the upper during wear.

Stitch tension is crucial and needs to be adjusted to provide the correct stitch lock for the materials being

Figure 8: Inseam trimming

Figure 9: Cork bottom filler aids comfort and insulation

used. The correct lock position is two-thirds of the way up the thickness of the sole from the underside. This ensures that there is no shearing action between the welt and the sole, which will cause thread failure. Also, this will ensure that a reasonable amount of sole wear occurs before the seam is abraded.

Synthetic threads need to be as tight as possible to avoid grinning seams. We recommend that linen and polyester threads are never mixed in the same seam (as some people have tried to do), as it is impossible to get a good tension.

It is good practice to use a shuttle/bobbin thread that is the same size as the top thread to balance the seam, although it is common to use one ticket size lighter on the shuttle to reduce the number of changeovers.

The recommended thread/needle size and stitch density will depend on the thickness of the components and the type of footwear. For example, men's high-quality footwear will require finer stitching (more stitches per centimetre) than heavy boots. If a stitching channel has been used, it is latexed and laid down to cover the stitching.

Stitch wheeling, bottom levelling and heel attaching

The process of stitch wheeling in welted footwear construction is a purely decorative operation. It uses a machine fitted with a rotary table which is spring-loaded and floating, and that should be set to form an indentation in the welt between the stitches to emphasise them.

Leather soles are levelled on a machine with a roller, which is under pressure to roll the sole to the required contour. After sole laying, it is important that this operation is carried out promptly (before the components become too dry) and all work should be processed before the end of the working day or shift. The purpose is to make the sole conform to the bottom of the last and set it permanently in position, so removing all unevenness. This process also forces the sole towards the welt and the welt to its original position after welt beating. In other words, this operation consolidates the components and significantly improves the aesthetics of the finished footwear. The seat of the sole is permanently attached to the insole with nails and finally the heel is attached.

Finishing

Although the term 'finishing' is often used to refer to the finishing of the upper in the shoe room, the original meaning related to the finishing of leather soles and heels on welted footwear. Great care is usually taken with the finishing and shoe rooming of welted footwear, as it is a mark of its quality to the customer. These shoes are often presented in high-quality fabric bags or cloths within the shoe box, further influencing the customer's perception of both quality and luxury by improving the image.

Firstly, the heels are trimmed to size on a machine which has a pair of elliptical cutters mounted on a shaft rotating at great speed. The profile of the cutters determines the shape of the heel. They are then scoured with abrasive paper bands which are mounted on rotating felt pads. Care must be taken to avoid burning the leather during this operation.

The soles are then edge trimmed. Again, this is a very skilled operation where the excess material is removed from the sole edge by the use of high-speed profiled rotary cutters putting an attractive profile on the edge of the

Figure 10: Rounding down the sole and groove cutting

Figure 11: Channelled sole attached using a lockstitch

sole. The heel is lined up with the sole at the heel breast/waist by superfine heel scouring.

The leather heels are coloured using a special heel finish containing dye, which soaks into the surface of the leather after being applied by hand with a brush. After it has dried, the heel if buffed with a cloth-based abrasive band to give a firm polished base. A special top coat is then applied and allowed to dry.

The edges of the sole are inked with a water-based finish which contains pigments, waxes and gum. This ink is applied using a small bristle brush and the edges of the sole is 'set' by a machine which has a heated iron head that vibrates. The previously-applied wax is melted by this action, which forces it into the leather fibres of the sole/welt edge, to give a bright smooth compact finish which improves its water resistance.

The leather sole is scoured with a fine abrasive paper and a bottom finish applied, which may be transparent or coloured. Wax is then applied using a rotating mop to give an attractive sheen.

The final finishing operations can include seat wheeling to give a fine indentation around the top edge of the heel, sole branding by means of a heated embossing tool and bunking (or janking), which is a decorative process using a heated wheel to form a pattern around the edge of the sole surface to hide the sole stitching.

Shoe rooming

Shoe rooming, final inspection and boxing are the last operations in this complex process. The majority of welted manufacturers pay a great deal of attention and expense to this final process, ensuring that their products are displayed and protected in their box to the highest standard, reinforcing the quality of their products to the customer at the point-of-sale.

For further information on welted footwear, please contact Lynne Brent (footwear@satra.co.uk).

SATRA TECHNOLOGY CENTRE
www.satra.co.uk