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Footwear Fundamentals

ALL ABOUT LASTING

The word 'last' comes from the Old English word 'laest', meaning a footprint or foot shape and from the Old Norse word 'leistr', meaning a foot. A last is a three dimensional shape, which reflects the shape of the foot plus any fashion features that have been added by the last modeller and shoe designer. The process of lasting converts a two dimensional upper material into the permanent three dimensional shape of the last and prepares it for the attachment of the sole by whichever construction has been decided upon.

Leather is a unique material in that it has both 'elastic' and 'plastic' properties. These are vital both for the production of footwear and its subsequent comfort in wear. Leather is termed elastic because it will stretch and then recover its shape. Its plasticity means that once stretched, it can be held in the new shape and 'set' to keep that shape

either by leaving it on the last for a few days or by the modern equivalent of heat setting.

Another valuable characteristic of leather is that, as well as stretching, it can also be compressed within its own thickness without pleating. This remarkable quality lies in the fact that it is composed of bundles of collagen fibres which have the ability to re-align themselves under tension. It is this combination of features that has made leather the chosen material for shoemakers from the outset.

THE UPPER

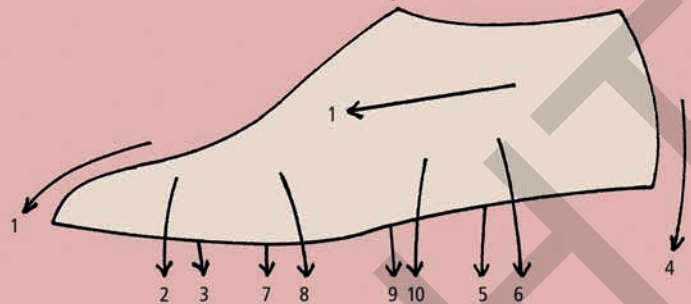
A shoe upper is not just composed of an outside and a lining; there are other vital components such as toe puffs (box toes), stiffeners (counters) and reinforcement tapes which all contribute to the final permanent shape of the shoe. The shape of the toe of the shoe is maintained by the toe puff.

“...as a matter of fact...”

Modern shoe making is a mix of high-tech machines and ancient craft principles, so when looking at fundamentals it is also good to consider old techniques and learn from them.

- 1 Length-wise (back part moulding)
- 2 - 3 Across the front (forepart lasting)
- 4 Secure centre of back (ditto)
- 5 - 6 Draft stiffener (back part moulding)
- 7 - 10 Joint & waist (waist & seat lasting)

This diagram shows the hand shoemaker's drafting sequence used for centuries to pull the upper down to the last and followed by its modern counterparts.



It is usually made from a laminated thermoplastic that can be warmed and softened before lasting and will then set to shape when cool.

The stiffener maintains the shape of the back in much the same way except that it is usually pre-moulded together with the back of the upper to perfectly fit the shape of the back of the last.

Reinforcement tapes prevent the topline of the shoe from stretching during lasting and in wear. They are also used to reinforce any areas of potential weakness that will come under stress when the lasting strains are applied.

PRINCIPLES OF LASTING

There are two basic stages in any method of lasting. The first is to form or stretch the upper to the shape of the last and then hold it in position. The second is to set it so that this shape is retained when the last is removed and subsequently during the life of the shoe.

One of three fundamental techniques will be used to achieve the first aim:

- Pulling the upper over a last and attaching it to an insole or runner
- Forcing it into an upper pre-formed into a bag by sewing in a sock
- Pre-forming either the complete upper or part of it

In practice, the first two methods nearly always use some elements of the third to help the process. The most widely used pre-forming device is the back part moulding machine. Forepart pre-forming is frequently used when shoes are to be force lasted, during which all the pulls are achieved simultaneously as the last is forced into the upper.

LASTING DOWN

A range of constructions can be made with this technique and the cross sectional diagrams illustrate those most frequently used.

Flat Lasted (Figure 1) - this method is very well developed and there are now extremely complex and sophisticated

machines that offer high output and consistent quality. In this method, the back part of the upper is first moulded to shape. The front of the upper is then pulled down using a forepart lasting over the last and insole and secured to the latter by hot melt adhesive. The waist and seat are then similarly secured by adhesive and/or tacks.

Goodyear Weltd (Figure 2) - this is an adaptation of the flat lasted method. The upper is backpart moulded, which has the effect of giving the necessary forward pull. It is then pulled down to the last with an adapted forepart lasting machine and the toe portion of the upper attached to the upstanding rib in the insole by adhesive. The sides and waist are then lasted using either adhesive or staples clenched horizontally through the rib and the seat with tacks.

Figure 1: Flat lasting.

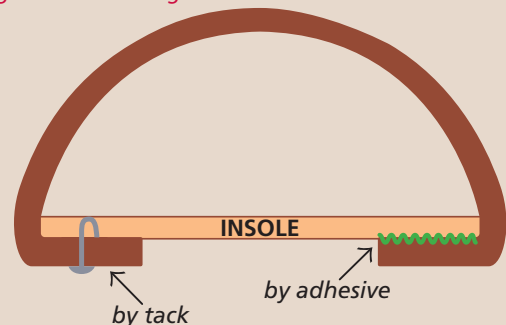


Figure 2: Weltd lasting.

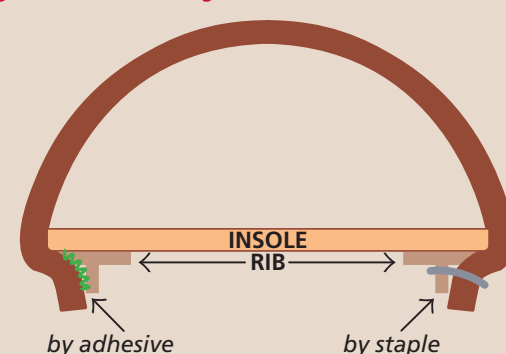


Figure 3: Veldtschoen lasting.

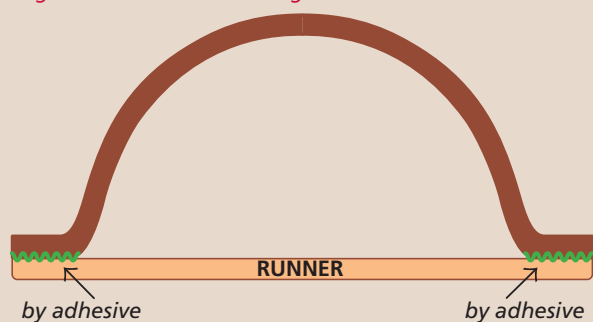
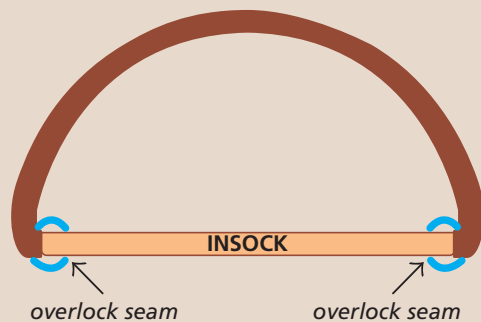


Figure 4: Sewn in sock



Veldtschoen (Figure 3) - the upper is backpart moulded but with the bottom edge at the seat flanged out rather than in. Adhesive is applied to a margin around the edge of both upper and runner, and the upper pulled down to the last and bonded to the runner using a modified forepart lasting machine. This type of shoe can also be produced by force lasting as shown in the next section.

FORCE LASTING

The big advantages with this approach are a lack of expensive lasting machines and the possibility to use less-skilled labour. There are five main methods.

Sewn in Sock (Figure 4) - in this construction the edge of the shoe upper is sewn to a non-stretch fabric or non-woven sock using an over-lock machine. It is the non stretch quality of this sock that provides the lasting pull. Strobel makes the most frequently used over-lock machine and the construction is very often referred to as 'Strobel Stitched'.

In many cases, the back part is moulded before sewing and the patterns cut to give some shape around the toe. The upper is steamed to soften and warm it and then pulled on to a last or moulding foot using either a hinged last or a big shoe horn. The method is widely used for sport shoes where multi-panel uppers allow the maximum amount of pre-shaping to be built in.

String Lasted (Figure 5) - a length of string is attached to the edge of the upper again using an over-lock machine. The upper is placed over the foot form of a direct injection moulding machine and the strings pulled by hand to effectively 'last' the upper over it. The strings are secured, the foot form swung round into the mould cavity and the sole injected on. This is a very simple and cost effective construction for low-cost footwear.

Figure 5: String lasted.

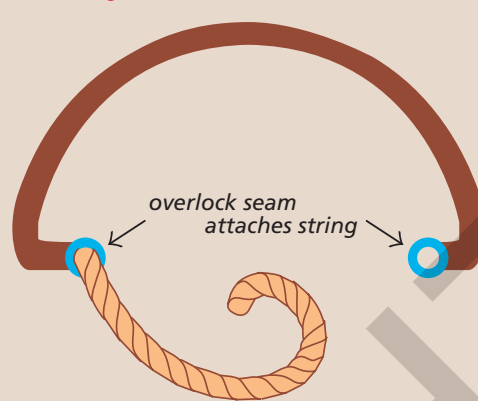
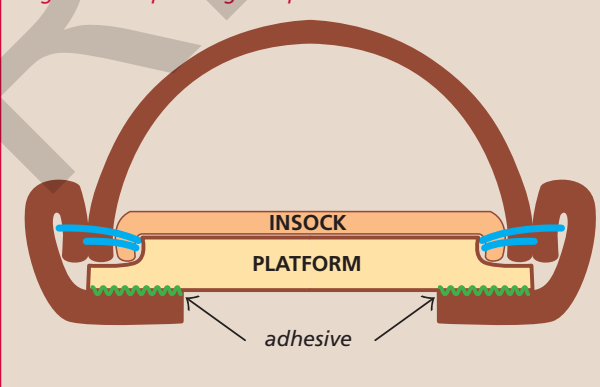


Figure 6a: Slip lasting—first stage



Figure 6b: Slip lasting—completed



Slip Lasted (Figure 6a) - the edge of the upper is first sewn to a non-stretch sock using a lock-stitch seam and a platform cover is sewn on with a second lock-stitch seam. After the last is forced into the shoe, the platform cover is flat lasted with adhesive, over a shallow platform and sometimes a wedge heel (Figure 6b). Open toe and heel sandals are ideally suited to this construction.

Moccasin (Figure 7) - the body of the moccasin is first attached to the plug or apron. This may be done by hand sewing or a specialist sewing machine. The upper is then steamed and pre-shaped on a moccasin forming machine before the last is forced into the upper to complete the lasting process. The waist and seat are often conventionally flat lasted on to a half insole.

This is an extremely versatile process which has been used to produce a wide range of footwear types ranging from top quality lightweight dress shoes, the classic 'boat shoe' right through to quite heavy weight 'brown' shoes for outdoor pursuits.

“...and it should be noted...”

When an upper is lasted, it is not only stretched but, in the case of hand lasting—and to a certain extent machine lasting—it is also compressed around the edge of the last. If the patterns have been cut so that there is too much ‘spring’ in the upper, there will be too much material to compress and a risk of pleating which will ruin the appearance of the shoe. If this occurs, the patterns should be deadened.

Where force or slip lasting is involved, shortening the bottom line to prevent this problem can be achieved by careful shaping and alignment of the upper seams. This does however call for an extremely high level of pattern cutting skills as there is little or no margin for error.

Figure 7: Moccasin.

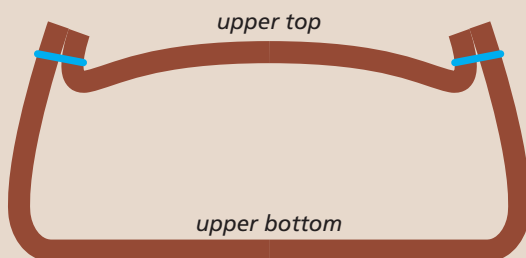
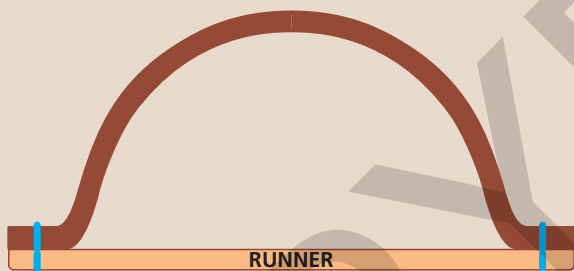


Figure 8: Force lasted veldtschoen



Veldtschoen (Figure 8) - the upper is back part moulded and flanged out as before and the forepart roughly shaped on a forepart pre-former. It is then stitched all round to a runner and the last forced in with a shoehorn. This method shows notable savings in upper material over the traditional method as there is no surplus upper to trim off.

SETTING THE SHAPE

When the shoe upper has been lasted or pulled down to the last and secured, the next important job is to ‘set’ the shape of the shoe, so that it will be retained throughout its life. There are two ways of doing this, plus a following operation that further helps the process.

Time - the old craftsmen would leave shoes on the last for seven days to permit all the stresses in the leather to subside, for moisture to dry out and for new linkages to take place in the fibre structure at molecular level. While this yields excellent results, it is not practical in the fast response environment of the modern shoe industry. Almost the same result can be obtained in five minutes using a heat setting machine.

Heat Setting - the lasted shoe is put on to a conveyor and where it first travels through a hot moist air section for two minutes to relieve stresses in the leather caused in lasting. It then passes through a high velocity hot air (HVA) compartment for a further three to five 3-5 at 120°C. Different temperatures are required for different materials with patent leather for example being set at no more than 100°C.

Steam is a very efficient carrier of heat and leather rapidly absorbs moisture, hence its use in setting leather uppers. Most synthetic upper materials do not, so moist heat therefore has very little effect on their heat setting behaviour. Special machines which blast hot air on to the uppers (forced convection) must therefore be used. The temperature and time profile of the setting operation must again be carefully matched to the upper material being used by balancing temperature and throughput speed.

Cooling - this further operation takes place after the soles have been attached and greatly assists in shape retention. While it has no setting effect on the leather fibres, it does cool down all the thermoplastic materials in the shoe, such as toe puffs and stiffeners, as well as the sole attaching adhesive itself. Today's rink or robotic conveyor systems are so fast that the lasted shoe has no time to cool naturally, so rapid cooling has become an essential part of modern shoemaking.

It is important to remember, however, that while heat setting and cooling—if carried out correctly—relieves the stresses put in during lasting and realigns the molecular structure of the upper leather into the new shape, it will not shrink the leather to the last shape and is not a substitute for poor lasting or bad patterns (Figure 9).

Figure 9: Potential results of poor heat setting.

