

Traditional shoe lasts were made from wood.



Footwear Fundamentals

Lasts

The earliest footwear in cold climates consisted of wrapping the foot in a piece of animal hide and securing it around the ankle, a concept that has survived as the moccasin. In hot climates, people either went barefoot or had simple sandals. Neither types of footwear required lasts. As constructions became complex a carved wooden shape or last came into use on which the upper and sole could be shaped and stitched together to form a finished shoe. These were however made as straights and not lefts and rights, so new shoes had to be 'broken in'.

In the late 1820s, a duplicating lathe for the manufacture of gun stocks was invented in the US and it was quickly realised that the guiding cam that followed the outline of the pattern model could be reversed and that this would enable left and right foot shoe lasts to be turned at the same time. Nevertheless, this did not have any real impact on shoemaking until mass production began in the latter part of the century calling for large quantities of lasts made as matching pairs and in accurately graded size intervals.

LAST TURNING MACHINES

Last turning machines need an original last to copy and this was made by a master model maker. After it was approved, additional wooden models per width had to be made for fit trials and special ones for production. These had the sharp edge or 'featherline' of the last bottom reinforced by metal tacks driven into the lasts and filed to shape. This was necessary as the machines not only duplicated the original size but also graded up and down a few sizes. The model was 'traced' by a copy wheel and the pressure this exerted on the last would quickly damage the sharp definition of the featherline.

The second reason for all these models was that the lathe could only grade two or three sizes away from the model size before there was significant distortion. Accommodation models were therefore made two or three sizes apart which would be reshaped by hand to conform to industry standards and the aesthetic qualities of the original model. Making and 'tacking' each model would often require as much

time and effort as the original master.

A tough and close grained wood was essential to make a smooth finish possible and to prevent cracking and splitting during the shoemaking process. Maple wood was favoured in North America and beech in Europe. Although up to two pairs of lasts could be turned at the same time on each machine, some 60% of the work needed to produce a pair of lasts was performed manually. This included finishing the toe and heel as these could not be machined because it was at these two points that the rough-cut blank was held in the lathe while being turned to shape.

Model makers were very highly skilled and it took several years for an apprentice to achieve the degree of competence needed to interpret a design and produce an accurate model quickly. Few now remain as many lasts are created using 3D software programs that avoid the need for a hard model as the design is transferred directly into grading software and from there to the CAD program controlling the actual machining of the last.

COMPU-LAST

In the 1980s, American last maker Jones & Vining came up with a revolutionary idea that eliminated this expensive and time consuming tacking. This involved digitising the master model and then digitally grading all other sizes from that data. No tacking or accommodation models were needed and there would be no distortion.

Compu-Last, as the new system was called, became the first commercially successful CNC last lathe system in the world. It allowed model makers to focus on the master models and, at the same time, opened the door for transferring this data around the world so that a model could be made on one continent and lasts quickly produced on another.

It was also the catalyst for the development of other systems that followed from companies such as Newlast, TRL and Palser. These CAM systems were also pivotal in accelerating the development of 3D CAD systems for making lasts. Now there were machines that could produce 3D last data productively in a factory and last making would never be the same again.

ACCURACY

Are these lasts as accurate as those produced by mechanical lathes copying wooden models or, perhaps, even more accurate? The answer depends on just how accurate you think a last should be. With the old system, no matter how accurate the original model, there were numerous opportunities for some or all of the sizes to deviate from it. With CNC lathes the digitised data of the original model can be reproduced as long as required. Whereas a wooden model can swell, shrink or be altered during the tacking process, a digital file never changes. Furthermore, if the machines are calibrated regularly and correctly, it really doesn't matter what type of CNC lathe is used as the results will be the same.

It must be realised however, that there is no such thing as an exact or perfect last. No matter how highly calibrated a machine might be, there is always a plus and minus tolerance factor, however small. But, what is a variance of a fraction of a millimeter compared to what could happen using a cloth or plastic last measuring tape marked in



A long apprenticeship was necessary to acquire the skills needed to become a last model maker. CREDIT: FAGUS

single millimeters or sixteenths of an inch? When it comes to sizing, no matter whether the model data is graded on the software that comes with a particular CNC lathe system or on a 3D CAD system and then sent to a lathe, the results are remarkably similar and certainly closer than could ever be detected with a last tape.

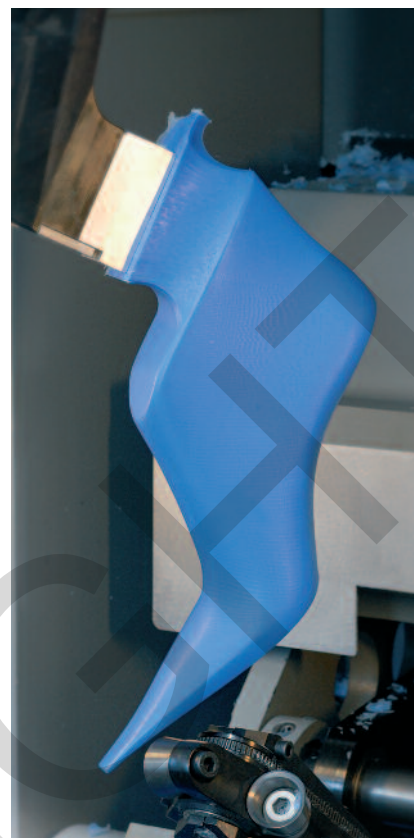
It is an acknowledged fact that, until the advent of digital lasts, the methods used to measure them were both crude and inconsistent, although the results were acceptable if not verifiable. Digital data is not subject to the physical changes that wooden models go through over time. All measurement points can be precisely located and transferred proportionally to the exact

same spots in other sizes. Lasts produced on digital systems should therefore be extremely consistent in size grading throughout the range. In fact they are and, in addition, the look and proportions of girth measurements throughout the size range and the fit achieved in the original model are not lost in extreme sizes.

A further factor in maintaining accuracy lies in the material used to produce the lasts themselves. Whereas they were once made of wood, they are now turned from moulded polypropylene blanks. No matter how dense the wood used, it would always be subject to a degree of expansion or contraction due to changes in temperature and humidity. Polypropy-



Polypropylene last made using the Compu-Last system. CREDIT: JONES & VINING



The Newlast NLS 1 milling machine holds the moulded blank at the top instead of at the toe and seat, then roughs and fine turns it in one sequence to produce a highly accurate finished last. CREDIT: NEWLAST GROUP

lene is not only totally homogeneous as a material but is also impervious to such atmospheric conditions.

FINER TOLERANCES

The demand for precise last accuracy, particularly in the direct soling field, has increased enormously in recent years. Minimal tolerances of around 0.2 mm are required for moulds and lasts to ensure no material is exuded during the injection of soling compounds and that the uppers are not pinched off. The latest generation of last making machines use special holding systems that allow the entire surface of the last to be milled including both toe and heel. Where even with the most skilled operators, 'toeing and heeling' could never be perfectly accurate or consistent, the new milling machines can produce lasts that are so precise that they can even be used for direct injection soling using low viscosity PU without the risk of flash.

OWN DESIGN

There is now only a handful of last manufacturers in the world with the capacity to design new lasts and modify existing ones in order to produce new

ranges. As a result, software programs such as Delcam's LastMaker 2010 have appeared that enable shoe manufacturers to create their own-design lasts. The process involves editing key areas of an existing digital last such as standard last length (SLL), heel to ball, arch, ball joint, instep, heel, entrance axis, cone and toe to be changed. Further adjustments can then be made to cross sections through the width of the last in order to adjust the inside and/or outside upper/bottom girth, width and circumference. The final shape is achieved by bringing together individual profile lines at all the key points and blending them all together to produce the new last.

At one time, lasts were often modified by physically splicing a replacement toe section into an existing last as a cheap way to make a new shape. LastMaker can do exactly the same thing so, if a factory has a well proven last and the heel height remains the same, seasonal styling changes can be met merely by blending in a new toe profile. Similarly, a shoe last can be converted into a boot last by changing the position of the ankle control plane between the cone and back curve lines to produce the

basic shape profile to the leg which can then be added in sections according to final height and width required a far cry indeed from the hours needed to create a solid model by hand.

The demands on last design nevertheless remain extremely high as it must also take into account the fact that every person's foot has varying shapes and sizes. If you think this contradictory, consider the following ways in which the foot can become different in shape and size depending on circumstance:

- In a high heeled shoe compared to a low one
- In the morning to the evening
- When weight-bearing than at rest
- When walking, running or jumping
- In illness than in health
- Summer and winter

Producing lasts on which to make shoes that can encompass such variations as this is demanding in the extreme. It is no wonder that last making has always been one of the most skilled aspects of footwear manufacture and, despite the sophistication of the technology now used, is likely to remain so into the foreseeable future. 📌