

# Making the **grade**

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**In the 1980s, the footwear industries of the major Western economies began to feel the impact of inexpensive shoe imports from Asia and other areas. The cost of manufacturing was on the rise and the struggle to battle the cheaper imports on a playing field that was anything but level was looking more and more like a 'fixed' fight.**

The problem was not limited to shoe manufacturers. No one felt this need to increase productivity more than the extremely labour-intensive last industry. Any given style of last could have as many as thirty-five manual operations performed during the production process and model rooms typically had an aging staff with fewer candidates to fill vacancies.

## A TACKY PROBLEM

Lasts were traditionally made in a process that involved an initial wooden sample model being made by a master model maker. After this was approved, two or more additional wood models per width were made for fit trials or production. Two factors made these additional models both necessary and costly.

For production, a model was used in a specialised lathe that duplicated the original size and also graded up and down a few sizes. The model was 'traced' by a copy wheel that looked similar to a modern-day inline skate wheel. The pressure on this was between 23-30 psi (pounds per square inch), which meant that only two or three cycles could be run before the sharp featherline on the model started to lose its definition. To eliminate this problem, the feather edge was painstakingly replaced with a series of metal tacks and a toe plate. These were filed to blend into the contour of the bottom and the sides were filed to fit the original bottom pattern. While this strengthened the feather edge, humidity and normal wear required more touch-up and eventual replacement.

The second reason for 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—usually 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.

## RELIEVING THE PRESSURE

By 1986 it was obvious that model room costs were disproportionate to other areas of overhead in a last factory. In an attempt to try to eliminate some of these, Jones & Vining began to search for a way to eliminate the tacking operation, which not only consumed man hours but also slowed the development of trainee model makers as they were usually the ones to whom this job fell. J&V enlisted the services of CMI (now Shafir Production Systems, Ltd.), an Israeli engineering company, to develop a system that would replace the heavy pressure copy

Newlast lathes in the new Jones & Vining factory at Dong Guan



wheel with a light pressure stylist that would eliminate the need for tacking. CMI suggested 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. Compu-Last was the catalyst for the development of other systems that followed from companies such as Newlast, TRL, Palser and others. 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.

## A PERFECT FIT?

It's been nearly two decades since we started producing ➤

Compu-Last CL-300, the first combined last digitiser/lathe for prototypes (1991)



## WORLD FOOTWEAR

lasts digitally and most last factories that are doing any reasonable volume have CNC capabilities. But, are these lasts as accurate as the ones produced by mechanical lathes copying wooden models? Or, are they more accurate? The answers may depend on just how accurate you think a last should be.

The problems intrinsic to the wooden models and mechanical lathes previously described make it obvious that regardless of how accurately the model maker created the original, there were numerous opportunities for some or all of the sizes to deviate from it. So, let's dissect the process of creating a size range digitally and see how it compares.

Once a master model is completed, it is digitised (no tacking needed) and from that data, lasts can be reproduced on a CNC lathe for as long as you want to use that style. Rather than a wood model swelling or shrinking or being altered during the tacking process, a digital file will never change. And, thankfully, if the machines are calibrated often and correctly it really doesn't matter what type of CNC lathe you use as the results will be the same.

It is important to point out here that there is no such thing as an exact or perfect last. No matter how highly calibrated a machine is, there is always a +/- tolerance and, with the proper tools, you will be able to find flaws. Considering that up until now we've measured lasts using cloth or plastic tapes marked in single millimeters or sixteenths of an inch, I think we can tolerate a fraction of a millimeter here or there.

Now let's look at the sizes that will be graded from the master size data. Whether these are graded on the software that comes with a particular CNC lathe system or they are graded on a 3D CAD system and then sent to a lathe, the results are remarkably similar and certainly closer than we could ever detect with tapes.

As someone with a background in last model making I am familiar with a number of standards for the grade to be used between sizes on various fit points such as the normal girth grades, ball width, heel width and arch length, etc. One has to wonder just how closely we adhered to those values on the accommodation models when we typically had few sophisticated measuring tools with which to locate the points we were measuring and then had to take it with a tape of questionable accuracy. If the measurement was supposed to be 9 7/8" and it looked like it was just shy of 9 15/16", a slightly harder tug on the strap and/or a minuscule adjustment to the location and the problem was solved. Not very scientific but it worked.

### OLD GOALS GET NEW CONSISTENCY

It is a fact that until the advent of digital lasts we were using crude and inconsistent methods to measure our lasts and yet the results were acceptable if not verifiable. Because digital data is not subject to the physical changes that wooden models go through over time and because all of the measurement points can be precisely located within the system and transferred proportionally to the exact same spots in other sizes, an argument can be made that lasts produced on digital systems are extremely consistent, both in reproducibility of a size and also in grading throughout the range.

But what about those standards we tried to adhere to? Do

digital lasts, all graded from one master model, maintain the same standards on all of the fit points as lasts graded from three or more models per width? One of the most surprising things I've found is that all of the grade standards that had seemed to be so arbitrary over the years actually come very close to what you get when you grade a last digitally. There are, however, at least two exceptions: waist and instep girth measurements and ball (bottom) width. While I will explain this by using grading standards widely accepted in the USA, I am sure the same differences hold true in other systems with slightly different results.

The standard grade per whole sizes in the USA for ball girth is 1/4" (6.35mm). It was also traditionally considered to be the grade for the waist and instep. When accommodation models had to be made, the waist and instep would be adjusted to conform if they were out of line. However, to think that a form shaped like a last would maintain the same grade on all of these girth points, as far apart as they are, makes no sense. Only if the body of the last was shaped like a tube with cross sections at these points all being shaped and measuring alike would this be true. The last, however, is a free flowing shape that is not symmetrical and has no blueprint. It therefore stands to reason that the waist and instep would grade proportionally to the ball and, after extensive testing, I am satisfied that this is indeed true.

Girth sections from Lectra's Romans CAD software showing the different shapes of the measurements showing why they should not all have the same girth grade



Grading a last in Lectra's Romans CAD software (it could be any system) and using the standard ball girth grade, the waist and instep consistently grade not at 6.35mm per size but proportional to their relationship to the ball. If the waist is 98% of the ball girth it will grade roughly 98% of 6.35mm or 6.22mm

per whole size. If the instep is 106% of the ball girth it will grade 6.73mm per whole size because 6.73mm is 106% of 6.35mm. This is important as it maintains the look and proportions of all the girth measurements throughout the size range so that size 15 will look the same as size 5. More importantly, the fit that was achieved in the master size will not be lost in extreme sizes because the design has not changed.

The other area where digital lasts vary from the traditional grade is bottom width. Again, using USA standards, the traditional ball width (not girth) grade between whole sizes was 1/12" or 2.12mm. However, if you look at the proportions you can see that this was an arbitrary grade that restricted the natural growth of the bottom. The ball width grade of 2.12mm is 33% of the 6.35mm ball girth grade. In order to keep all sizes looking proportional, this formula would only work if the ball width of the original model was 33% of the ball girth. This hardly ever happens.

So, if you grade lasts in a digital system using only the usual length and ball girth as control points, the last will maintain its proportionality throughout the sizes. If size 6 has a ball girth of 203mm and a ball width of 77mm each size graded will have that same 38% proportion of ball width to ball girth. This is good as many upper patterns need a break in the width grade on larger sizes to give more lasting allowance because the standard grade does not leave sufficient for good lasting.

Why is this? With the old standard width grades, the bottom has not been allowed to grow naturally and maintain the same proportions throughout the size range. This problem was addressed previously in the USA with a ball width grade called the 'B Grade'. It was mainly used on men's welted shoe lasts which had more contoured and therefore wider bottoms. Without the wider grade increments of the B Grade, you could hardly turn one size away from the master model before the bottom pattern would no longer fit the last.

If, however, because of existing tooling or simply no desire to change methods, a company wants to maintain the old grade standards in either ball width or waist and instep girths, special functions in some CAD systems will allow different areas to be graded with different rules. Or, accommodation models could be made as before and digitised to run specific size ranges from each model's data.

Unfortunately, this only exploits a small part of the powerful digital last making tools that are available and model makers are not becoming any more plentiful.

My suggestion, therefore, is to use the tools we have and keep things consistent and in proportion. Accuracy and fit are always to be strived for but we have to remember that the feet going into the shoes change in shape and size dramatically during the day. Quibbling over the displacement of a fraction of a millimeter in the waist girth is really rather a waste of time. 



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