

THE TECHNOLOGICAL PROBLEMS FOR THE LASTS IN THE SHOE INDUSTRY

Adina ALBU , Macedon GANEA , Marius ŞUTEU

University of Oradea, adina_victoria@yahoo.com

Keyword: Problems in last draw up technology

The last is a full spatial body, obtained from wood, plastic mass or iron.

It is the basic form for the constructive designing of shoes and the necessary form for obtaining them.

The last appeared simultaneously with the moment of producing shoes with special tools.

The anthropometric parameters determine the basic characteristics of the last.

The actual systems of assisted projecting on the computer of the lasts, 3D, permitted the realization of a large gamma of shoes, which we can see at the large producing firms as real fashion collections.

INTRODUCTION

The array of footwear types is given by the array of lasts used at producing footwear.

The last is an object made by wood, plastic or metal whose shape and dimensions are established considering the dimensions of the representative medium foot at the level of statistical population, dimensions calculated through anthropometrical measurements.

The last is the premise for projecting footwear, and in the same time, the necessary shape for obtaining footwear. On the last is being produced the superior and inferior ensemble and then finishing the footwear. With the aid of the last's parameters, the benchmarks of the superior and inferior ensemble are projected; the working parts of the machines used in the footwear industry and the utensils are built, by procedures such as injection or vulcanization of different components of the footwear.

The shape and the dimensions of the last, influence the interior shape and dimensions of the footwear and consequently, the interior comfort of this.

The appearance of footwear, initially used by primitive people, was generated by the necessity of protecting the foot against the harming factors existing in the environment. The most primitive form of footwear, consisting of a piece of leather or fur, fixed directly on the foot, did not need a last.

The development of the tools allowed the appearance of the last and was connected with the improvement of the shape and dimension of the footwear. Initially the lasts were made by chopping the wood and only beginning with 1815 these were mechanically produced, with the aid of the lathe, by Thomas Blanchard (from Sutton, Massachusetts), the one that brevetted this activity in 1819.

The appearance of the last was connected with the rapid evolution of footwear, depending on fashion and design. The fast development of science and technology during the XIX th century reflects in the activity of obtaining the last, which begins to consider the results of studies of anatomy, physiology and orthopedics, carried out in many countries of the world. These studies were first carried out by professor H. Meyer from the Medicine Academy in Zurich, Switzerland, who published two works: "The Rational Shape of the Footwear" (1858) and "The Shape of the Human Body" (1878), established to the rational construction of lasts and footwear. He draws up and developed methods of projecting the last. Later, studies of BIOMECHANICA were carried out by Erhard and Korsinevski, who were the first to show the physiologic function of shoe tap, and attracted the attention upon the possibility of using the ghips moulding for obtaining the optimum shape of the last.

At first, the last had an identical shape for both feet, and only after 1873 this was realized in an asymmetric way, initial for boots, then for other sorts of shoes. For the first time in that year it is mentioned in a specialty magazine in USA, the way of projecting the inner sole, different for the left foot respective the right foot.

In 1880, the first system of numbers of lasts was realized in New York by Edward and Simson, that contained dates for the size number, the toe perimeter, over the heel, for different categories of consumers (women, man, children). Tables with the dimensions of the lasts were official introduced in USA in 1887.

In Europe, before Second World War, the German society of the orthopedists, in collaboration with specialists in modeling the lasts, elaborated a new method of projecting the inner sole, known as the 'G' series. In the majority of the Europe states are formed new centers of research in the field, are developed studies referring to the shape and dimension of the lasts, which materialize in projecting and preparing materials and technologies of obtaining them.

Biomechanics studies of the foot shown that if a shoe is made on a quality last, after its gyps molding, wearing them is not possible because of the longitudinal dimensions to little and the transversal dimensions to big of the shoe. Establishing the shape and the dimensions of the last it is influenced by many factors that impose some transformations of the anthropometric parameters of the foot, measured in static's:

- *the modification of the foot in dynamics;*
- *the acceptable limits of pressing the leg by the shoe;*
- *the type of shoe;*
- *fashion;*
- *the technologies of confectioning the shoe;*

The number of size of the last, expressed in cm, in the metric system of numbering (system utilized in Europe), represents the length of the foot for which the shoe is destined.

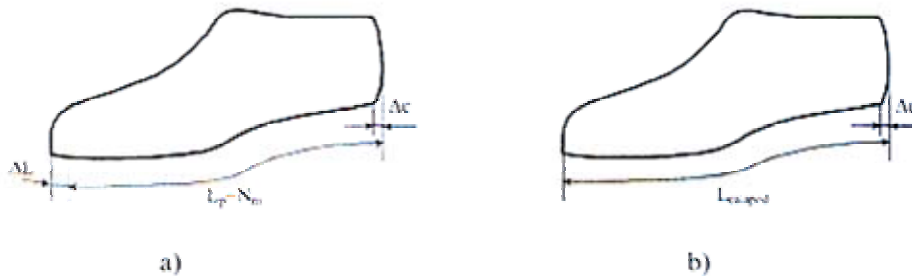


Fig. 1, [3] The semnification of number size of the lasts, numerotated in metric sistem (a), and french sistem (b)

The difference between the numbers is 5 mm at the metric system, and as a consequence the length of the last's foundation is increased by ΔL at the top, variable with the shape of the top of the last with values between 0-20 mm.

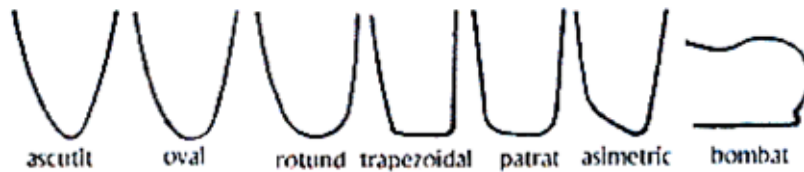
In other systems of numbering (French, English) the length of the last represents the length of the last's sole, to which the amplitude of the posterior curvature is added, which includes the variable value of the ΔL addition at the top, dependent on fashion.

The difference between two successive measures in the French system is of 1 stitch ($2/3$ cm=6.67 mm), and in English system is of $1/3$ inch (8.48 mm).

Considering the type of the footwear, the lasts are made for: sandals, slippers, clogs, shoes, boots, and high boots.

Considering the height of the heel, the lasts are classified as: without heel, low-heel (5-25 mm), medium-heel (30-45 mm), high-heel (50-60 mm) and very high-heel (>60 mm).

Considering the shape of the top the lasts are classified as: wide, round, sharp, asymmetrical, oval, convex, trapezium, undergoing major modifications related with the fashion's tendencies and clothes' design.



Sharp oval round trapezium squared asymmetrical curved
Fig. 2, [3] Shape of the top the lasts

The anthropometrically parameters that determines the main characteristics of the lasts **-size** and **width-** are: the length of the foot (L_f), the fingers' perimeter (F_p), the ankle's perimeter (A_p), the fingers' breadth (F_b) and the heel's width (H_w).

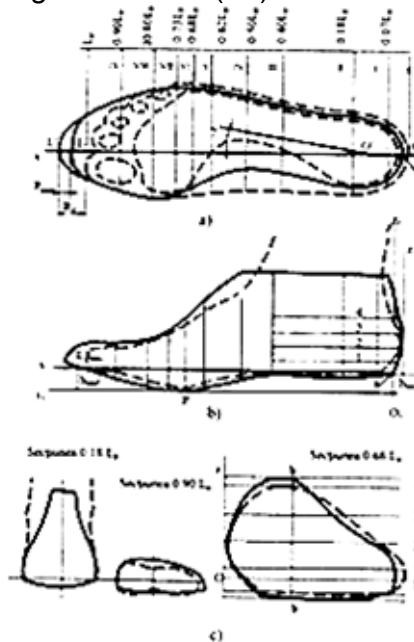


Fig. 3, [3] Lasts draw up process
a. Interior sole; b. Longitudinal profile; c. Transversal sections;

1. The length of the foot (L_f) - is the length measures in orthostatic position (mm);
2. The fingers' perimeter (F_p) - is the length of the shape of the last measured through the points that mark the finger's joint I ($0.72 L_f$) and the finger's joint V ($0.62 L_f$);
3. The ankle's perimeter (A_p) - is the length of the shape of the last measured through the middle of the arch ($0.48 L_f$) and the spot correspondent to the last's ankle;
4. The fingers' breadth (F_b) - is the size of the segment that joins together the spots from the line of the insole that mark the joints of the fingers I ($0.72L_f$) and V ($0.62 L_f$);
5. The heel's width (H_w) - is the length of the segment that joins together the spots front the line in the insole established by the perpendicular line on the (glenc) axis that passes through the centre of the heel ($0.18 L_f$)

The parameters mentioned earlier, permit the selection of the main dimensions for the lasts fated to the manufacture at a large scale of footwear's (STAS 29122 - 1986). A

series of footwear is made of lasts of the same form but with different sizes.

The serial lasts differ in dimensions, whose variation is dependent on several rules resembling to those established for the foot's dimensions.

When going from individual lasts to serial lasts is very important to know the measures with which the basic dimensions of the last modify on series of sizes and widths.

The gradation of the last is based on two main dimensions: the length of the foot and the fingers' perimeter, which **modify in dynamics**. Considering the growth of the foot when walking is obvious that the footwear (the last) has to be longer than the foot with the value of the addition at the front side of the last.

According to the principles of manufacturing lasts, the addition at the front side has two components: *the functional supplement* and *the extra spare* (dependent on fashion). The *functional supplement* for all sizes is virtually taken as cca 10 mm. The existence of this supplement in the length of the last provides the foot with unlimited space to move, when the length of the foot modifies, and also provides empty space in the interior of the foot. The *extra spare* is determined by the shape of the top of the footwear and varies between 0-15 mm, conditioned by fashion tendencies.

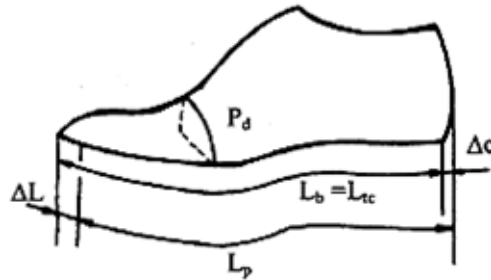


Fig. 4, [3] Last sole length L_{tc} , foot length L_p , the addition of the last top ΔL and the amplitude of the posterior curve of the last Δc

This excess assures, in a satisfying way, the free space in the shoe, necessary for the growing of the foot in length by walking and, also, the stretch under supplementary pressure, which takes action in time of different length. As a result, the connection between the length of the foot and the one of the last, respective of the inner sole, can be expressed with the relation: **$L_b = L_{tc} = L_p + \Delta L - \Delta c$**

The excess at the top ΔL includes the following components:

$\Delta L = \Delta L_1 + \Delta L_2 + \Delta L_3$, where: ΔL_1 - the reserve that takes the modifications of the length of the foot in orthostatic support bilateral;

ΔL_2 – the reserve that covers the medium growth of the length of the foot in 6 months;

ΔL_3 – the reserve that is dependent on the shape of the top;

Δc – the amplitude of the posterior curve of the last;

At the passing from the position of orthostatic support bilateral, during walking, the transversal dimension of the foot modifies, the most extensive being remarked in the phase anterior to the propulsion, in the zone of the metatarsal articulations. This fact imposes the correlation of all the parameters so that the foot will not be exposed to high pressure, fact that affects its functionality and can create traumatism.

In order to avoid this situation, the transversal basic parameter of the foot 'Pd', it is imposed to be corrected two times:

- Pd obtained through anthropometric measures, gets bigger with its growth, in dynamic conditions;
- The result obtained will get smaller with a value that corresponds to the pressure admissible, determined experimentally;

The limits admissible of reducing the toe perimeter (pressure expressed in % of 'Pd' measured in position of orthostatic bilateral support), are:

* Kids: 1-6years -0%; 7-8years 1.5-1.6%; 11-12years 2.35-2.4%;

* Adults: 3.2-3.4%;

On the basis of the results obtained we can determine the coefficients of transformation of the perimeter at the toes in the wide of the last (Pd in Pdc).

When raising the heel on the toe, the foot being situated on a tilt plan, appears its tendency to slip in front, fact that attracts the feeling of tight shoes.

In order to prevent this inconvenient, when using a stiletto heel, is necessary to diminish the lasts perimeter in the toes zone. It is recommended that the perimeter in cause, for heights of heel (ht) of 30-80mm, to be with 2-5mm smaller than the perimeter at the toes of the lasts with ht = 20mm. The modification is made upon the last by diminishing its wide at the heel, with 1-2mm for every cm of the tap.

The height of the heel of the last confronted by the horizontal plan of support, has values between 6-14mm, depending the destination, the type of shoe and the high of the tap.

The type of shoe influences the dimension and the shape of the lasts, way in which we can notice differences between lasts made for shoes, for boots and sandals.

Fashion is another important factor in establishing the shape of the last, this one determining the top shape of it. The intermediate zone and the heel zone of the last must not be influenced by the fashion; it can be standardized, with benefic effects on reducing the time necessary for conceiving new model of lasts.

The technology of mechanic manufacture of shoes, determines the appearance of some differences between the forms of the last the one of the foot:

- The dorsal and planetary surfaces of the last are continuous, without the imperfections we find studying the foot, for obtaining an nice aspect of the shoe;
- The planetary surface of the last is precisely delimited of the dorsal surface by pronounced edges, exception being the glenc zone, on its interior side;
- The superior platform of the last is narrowed and stretched in this region in comparison with the shape of the foot;
- The medium line of the platform and the top of the last must be situated in a vertical plan that goes through the center of the heel and through the half of the space between toe I and toe II, respective through a plan perpendicularly on the horizontal support plan. This kind of arrangement assures a high stability of the last covered with semi fabricated, in the device of supporting of diverse machines in which they realize the operations of technological process;
- The shoes made in the 'IF' system (flexible shoe), have the edge between the dorsal and the planetary surface cut in a diagonally way, under 45°, necessity imposed by the particularities regarding the extraction and put sole among this system;

From the observations made results that between foot, last, the interior cavity and the exterior one of the shoe, exists a series of differences under the report of sizes.

In this way it is imposed that the designer of lasts to take into consideration the relationship last-healthy foot, avoiding in this way the appearance of some functional and structural anomalies at the legs level of the ones wearing shoes made on that last.

CONCLUSION

Any new form of last must combine information from different fields, like: anatomy, physiology, biomechanics, the projection of lasts, the science of materials, technologies of making shoes and fashion.

The firms that produce lasts follow their own success in projecting and design, that leads to producing collections in tendencies with the fashion. The modification of the shape of the last in report with the fashion is being put in evidence in the top zone and glen. In the conditions of making some constructive reference points for shoes they do not do the same in modifying the heel zone.

Actual systems of assisted projection on computer '3D' of the last, has lightened significant this activity. This new technologies were developed by firms like: '3 Shape' (Denmark), 'Nike' (USA), 'Customatics' (UK), 'Digitoe'(SUA), 'Footmax'(China), 'Customshoeinserts' (Canada).

The principal problem in manufacturing lasts is finding some solutions of compromise between the necessities of obeying the anatomical physiological needs and the fashion tendencies, at a certain point.

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