Step 2 Sustainability

Online Course

UNIT 4
Sustainable Manufacturing Technologies and Processes

How to Implement Sustainable Manufacturing in Footwear
- New Occupational Profile and Training Opportunities -

Lifelong Learning Programme

Project number:
539823-LLP-1-2013-1-PT-LEONARDO-LMP

How to Implement Sustainable Manufacturing in Footwear - New Occupational Profile and Training Opportunities

Credits

Title
UNIT 4 - Sustainable Manufacturing Technologies and Processes

Coordination
ISC Germany

Layout and Editorial
Salto Alto CTCP criativo

Date
January 2016

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1. Introduction: Sustainability in the Footwear Industry

According to the latest available statistics, the world footwear production totalled 24.3 billion pairs in 2014. The footwear industry – at least to a great deal – produces fashion items. The ranges change at high speed; time-to-market from the first design draft to the availability in the shop is becoming faster and faster, while product life cycles are shortening. Most shoes will be worn only for a short period of time and will be replaced soon. Shopping is the main recreational activity for many consumers; the demand for new fashionable looks has been constantly growing so far.

Sustainable versus fashion?
To be honest: the concept of fast changing fashion is quite the contrary of the idea of sustainability. But things are changing: Consumers are more and more conscious about the environment and the conditions under which products are being manufactured. Sustainability represents an attitude that a growing group of consumers would like to reflect in all aspects of their lives, and also in the products that they buy. This is one of the reasons why the market for "green" shoes is rapidly expanding, in sport, fashion and high performance footwear. The European footwear industry needs to embrace the opportunity of this new consumer awareness while manufacturing more competitive products. Sustainability provides an added value to our products, and represents a powerful way of differentiation.

Already today, more and more footwear companies and their suppliers are making considerable efforts to make their products and processes more sustainable because they understand that sustainability also means improving quality and efficiency and that it is not at all contradictory to their economic goals. This evolution has been picking up momentum in the past years, which is very positive.

What does "sustainable manufacturing" mean?
All methods allowing to produce shoes in an environment-friendly way, with environment-friendly materials (such as biodegradable or recycled / recyclable materials), with less resources (in terms of operations, labour, materials, energy) can be called "sustainable".

Whether or not a shoe deserves the label "sustainable" does not only depend on the materials used but also on the construction method: in general, a shoe with a stitched-on sole is more sustainable than a shoe with a cemented sole because it can be repaired and is therefore more durable.

This course is intended for production technicians. Their task consists in organising a smooth production while ensuring the best possible product quality.

When a production technician starts his/her job, the decision which shoe designs will be produced (and which construction method will be used) has already been made and the materials and machinery are already purchased, they are "givens".

This online course aims to provide production technicians with skills and knowledge for their sphere of action to make footwear manufacturing more sustainable. And this means to put the emphasis on quality, to eliminate waste, reworks and rejects. It means to finish orders in time to avoid air shipping. It means to implement state-of-the-art processes, and to organise all operations and workplaces in a way to enable efficient handling and a smooth work flow, and it means being inventive when there is no off-the-peg solution.

If a shoe company wants to make its production more sustainable, it also means that the managers should listen to the needs and ideas of technicians to improve production processes. It will be necessary that all departments involved – from the design and the purchasing department to production management – establish a regular exchange in order to align their activities towards a sustainable strategy.

This training focuses primarily on the cemented method because this is still probably the most commonly used construction method (and the price is affordable for the majority of customers). Furthermore, the cemented method allows for the greatest diversity of shapes, materials, and looks.

Other construction methods are more sustainable, for example:

- moccasin
- San Crispino
- California
- Strobel
- all methods with stitched-on soles (by hand or by machine)
- even shoes produced by direct injection / with an injected sole can in some cases be called "sustainable"

Fig. 1 to 5 show new and sustainable shoe concepts respectively production concepts.

F.1 Example of a knitted upper (Clarks)

F.2 Examples of knitted uppers (Nike / Flyknit)

F.3 Example of a knitted upper (adidas / Primeknit)

F.4 Example of a shoe produced on a 3D-printer (Continuum Fashion)

F.5 Example of a shoe made from cheap, recycled, biodegradable materials claiming to contain no harmfull substances and minimum transport cost (Clarks)

F.6: Example of a shoe entirely produced with direct injection (Desma)

F.7 Biodegradable shoe (puma)

The contents of this training course / module are based on the results of a survey which was carried out in the framework of this research project ("How to Implement Sustainable Manufacturing in Footwear – New occupational profile and training opportunities" / Project 539823-LLP-1-2013-1-PT-LEONARDO-LMP) with the goal to establish the training needs of footwear companies in terms of sustainable manufacturing.

The survey analysis allowed for identification and ranking of a list of issues causing problems in production:

1. Poor technical design
2. Poor organisation of production process and workflow
3. Skill gaps in terms of resource-efficient best practices, e.g. how to perform operations, how to extend the service life of machines, spare parts, consumables etc.
4. Inadequate machine settings
5. Poorly organised workplaces
6. Rework
7. Reject
8. Overproduction
9. Insufficient knowledge / competences of workers and technicians
10. Inadequate utilisation of materials and machines
11. Poor knowledge about state-of-the-art materials and machines
12. Insufficient management skills to lead teams to better results

All these issues have an immense impact on whether a footwear production can be called "sustainable" or not.

The management of a company must imperatively understand the concrete needs on the production floor, i.e. the importance of a thorough production planning, of organising a constant and smooth production flow, and of the machines and tools needed to perform each operation. The focus should be set on delivery in time, without overproduction, and possibly without rework or reject.

When going through the production steps (such as cutting / stitching / making room), the emphasis will not only be put on quality, productivity, or energy saving but also on best practices, explaining the general machine set-up and how to execute the operations in a way to ensure a maximum service life of the machines and optimum work results.

For each department, we will firstly explain the decisions to take in terms of machines and work organisation and secondly how to properly adjust the machines. In doing so, we will look at two levels of recommendations:

- managerial (managing technician)
- operational (worker)

As mentioned above, this module will focus on the cemented construction method and its main operations and machines, because – among the more complex makes which involve a considerable number of process steps (we are not discussing direct injected sandals) – it is by far the most commonly used construction method.

Following the best practices which this course provides will help to make footwear manufacturing more sustainable.

Certainly this training course cannot cover all areas and all possible production environments; therefore the intention is to impart the right approach.

2. Preproduction phase

2.1. Product development

Saving resources in an efficient way starts with the product concept / product development. The design process itself should be organised in a way to reduce the number of physical samples to a minimum. Modern CAD systems allowing for virtual prototyping are of great help to save resources and speed up time-to-market (we will talk about this on the next page).

But not only the organisation of the design process is of importance. It is also key that designers know how to design shoe parts in a way to facilitate production, for example to enable optimum nesting of the shoe parts on the hide in the cutting department. Furthermore, a designer should refer to technological standards whenever possible. Designs as ordered by buyers should be modified if necessary.

Important technological standards are:

- front bottom curve
- waist bottom curve (shank shape) – for different heel heights
- back curve for different heel heights

Correct application of these standards will help to improve the quality of backpart moulding and toe lasting; it will reduce reworks and reduce the number of tools needed for these operations. For further explanation please see the descriptions of "Backpart moulding" and "Toe lasting".

Marketing and pricing today is very different from how it used to be in the past.

Formerly, the market price was calculated like this:

COST OF MATERIAL + LABOUR + OVERHEADS + MARGIN (PROFIT) = MARKET PRICE

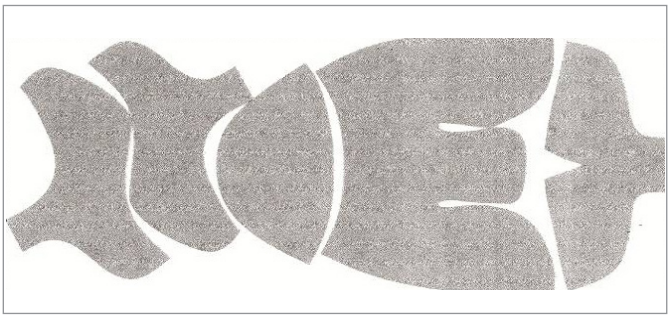
Marketing and pricing today is very different from how it used to be in the past.

Today – for the majority of companies – the price is imposed by the market and the profit is calculated like this:

MARGIN (PROFIT) = MARKET PRICE – (COST OF MATERIAL + LABOUR + OVERHEADS)

Today a company already knows the target price of a shoe model even before development starts, but they don´t use all the tools which are available to minimize the waste connected with shoe development. Already the initial stages reveal if a shoe is out of price.

Most CAD systems can immediately calculate the first waist.



F.8 Example of first waist calculation

Upper material, sole and lining together account for approximately 75 to 80 % of the cost price. If you know the first waist percentage as well as the unit prices of leather, sole and lining materials, you are instantaneously able to estimate the final price, meaning that the final look can be immediately discussed with marketing & sales and the decision whether to continue development or not can be taken immediately. A well trained team can save plenty of money if this process is systematically applied.

Photorealistic 3D CAD images of shoe designs can considerably speed up the range creation process and save a lot of effort and resources invested in developing and prototyping shoe models which will finally not be part of the range.

F.9 Photorealistic CAD images do not only help to speed up time-to-market; they also make the development process more resource-efficient, thus more sustainable

It is also essential that the departments of procurement and product development continuously stay informed about new materials (e.g. requiring lower processing temperature, less pressure, biodegradable). They should maintain close contact with the supplying industry, attend materials and components fairs, read the specialised press etc. This is just as important as to stay tuned on evolving process technologies and machinery for industrial shoe production.

CAM cutting tables can be a good option for prototype production. The reasons why companies decide to switch to CAM systems are the speed and quality of the process which does not even require tools.

3. Cutting department

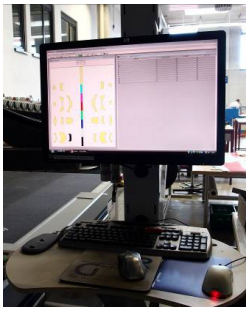
3.1 Cutting machines

3.1.1 Dieless cutting tables – CAM

Today, dieless cutting is state-of-the-art even in cheap-labour countries. The ratio between investment cost, running cost, speed, and flexibility of the traditional way of cutting with cutting dies should be calculated. CAM machines are mainly used for sample making because of their great flexibility. They are also used in companies which are unable to find qualified skilled workers for the traditional cutting operation.

The important feature is that the positioning / nesting of the parts to be cut can be changed several times until the final cutting layout is found. Cutting itself does not start until the operator is satisfied with the cutting layout on the hide.This is not possible with traditional cutting.

Most CAM systems allow for simultaneous marking, numbering, and punching of the parts. When comparing the return on investment of a traditional cutting machine and a CAM machine, the possibilty of grouping the above mentioned operations and the optimised utilisation of material to be cut must be taken into regard.



F.10 / F.11 Dieless cutting table (oscillating knife)

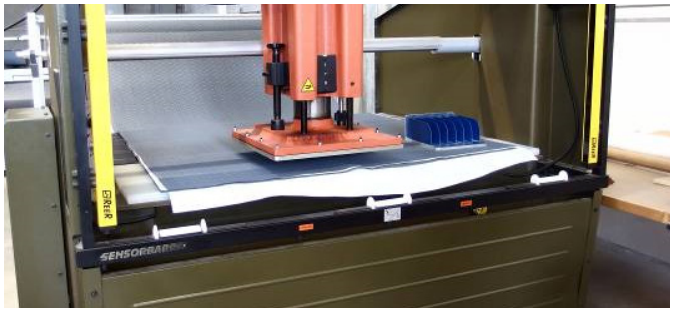
The CAD system communicates the geometrical data of the parts to be cut to the CAM cutting table. The material (leather hide) is placed on the working area of the cutting table and the parts are projected onto the material. The parts are placed using desktop and mouse. The number of finished parts and the number of parts left to be cut is automatically displayed.

3.1.2 Cutting machines with clicking dies

Several types of cutting / clicking machines require cutting dies. The first clicking presses were mechanical versions which used the force of a flywheel. These machines are not in use any more because it is not possible to guaranty the safety of the operating personnel.

Modern cutting presses are powered by a hydraulic pump. There are two basic builds: Beam presses, which are mainly used for cutting non-leather sheet materials, and swing arm types as they are commonly used for leathers. There are many variants of these two basic types.

F.12 Swing arm clicking press



F.13 Beam cutting press

3.1.3 Cutting dies and cutting boards

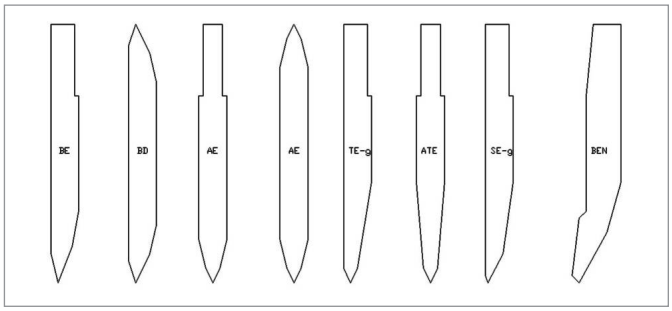
A sustainable approach to the die cutting process should focus on saving tools (i. e. cutting dies and consumables such as cutting boards).

- cutting dies are made from a specific steel quality which combines hardness and flexibility: Rule die steel (RDS). RDS has a specific hardness (body and edge) and a guaranteed bendability (angle and radius): body hardness 38 HRC
- edge hardness 50 HRC
- guaranteed bending angle of 60 degrees (enclosed angle at 2mm thickness)
- guaranteed bending radius 1mm

Cutting dies must have an appropriate profile and correct dimensions, which both primarily depend on the material to be cut. Also to be considered are: pattern size, degree of complexity, number of cutting cycles, expected cutting pressure, and whether the material will be cut in single or multiple layers. It is important to discuss the material to be cut and the intended cutting process with the die maker.

A large variety of different RDS profiles exists, from versatile types to very specific ones:

BE = single layer cutting (leather)
BD = single layer cutting, double edge for cutting left and right parts with one single die
AE = symmetric profile for splitting knives
AD = symmetric double edge steel
TE-g = multi-layer cutting (textile, fleece, lining, leatherette)
SE-g = rigid material cutting (insole)
ATE = cutting heavy textile materials in several layers
BEN = back clearing dies (outsole)



F.14 Different blade shapes

Cutting dies must be thoroughly produced. Upper and bottom edge must be parallel even without minimum load. They must be properly stored. The blades must not touch other blades nor other metal or other hard material (see fig. 15).

F.15 Correct storage of cutting dies is important

Cutting dies can carry punchers, prickers, or markers.

F.16 / F.17 Cutting dies can be equipped with punchers, prickers, or markers, which can make subsequent work steps redundant

Cutting boards

The prevalent plastic material for cutting boards is polyamide (PA) blended with other thermoplastics. The crucial properties of cutting boards are:

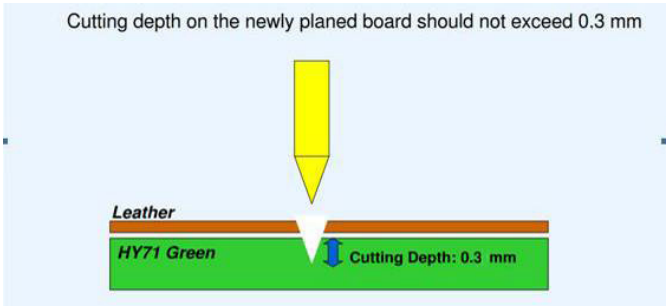
- hardness (expessed in Shore / °Sh)
- thickness
- size

The most important property of a cutting board is its hardness. Depending on the supplier, there are different approaches to choose the appropriate cutting board for each specific cutting press and each specific material to be cut. The following chart shows an example. Other suppliers may have different systems of how to select the right cutting board. What is crucial is that the technician knows that there are various possibilities and he/she needs to make the right choice.

T.1 How to select the right hardness of your cutting board (copy right: Hydroma)

CUTTING BOARD		
HARDNESS IN SHORE	USE	CUTTING MATERIAL
71	shoe, leather & paper industry	leather, leather board, paper, cardboard articles
72	shoe industry	leather, soft materials
73	multi-purpose cutting boards for swing-arm cutting machines	leather, insole materials
76	cutting board and cover plate for sandwich cutting on roller cutting installations	leather, foam plastics
78	cutting board for universal use, also as one-way cutting board of 3-12mm thickness	textiles, felt, fleece, foam plastics, leather, insole materials, rubber, foils and other soft materials
81	(with aluminium web circuit) on electronic contact cutting machine	leather, textiles
82	on bridge and roller type cutting installations	textile synthetics and other soft materials
71	shoe, leather & paper industry	leather, leather board, paper, cardboard articles
84	universal, especially on roller-cutting presses	textile synthetics and other soft materials

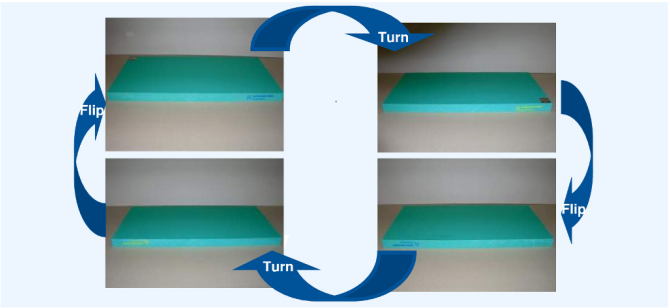
Cutting depth principle



F.18 How to properly adjust an hydraulic cutting press, cutting rules, and appropriate cutting dies (copy right: Hydroma)

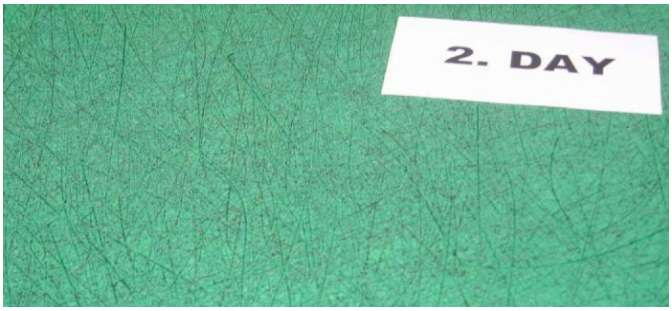
Flipping and turning to colour coding

The cutting boards are laterally marked with two different colours (fig. 19) to make sure that the boards are flipped and turned (180°) every four hours.



F.19 How to flip and turn a cutting board

Fig. 20 to 23 illustrate the wear of a cutting board after two / four / six / eleven working days when treated with care.



F.20 Wear of the cutting board after two working days: cutting depth 0.5 mm

F.21 Wear of the cutting board after four working days: cutting depth 0.7 mm

F.22 Wear of the cutting board after six working days: cutting depth 1.1 mm

F.23 Wear of the cutting board after eleven working days (one day before planing scheduled for day 12). The shoe factory used only one side of the cutting board for the pictures. Cutting depth almost 2 cm.

Storage

F.24 Correct (horizontal) and wrong storage (vertical) of cutting boards

3.1. 4 Recommendations for managers / maitenance

- check that the aluminium board of the cutting head and the steel table beneath are parallel
- check cutting knives and cutting boards for wear etc.
- motivate the workers for perfect interlocking / nesting of the parts
- check if cutting boards and cutting knives are properly stored
- organise the workplaces and visibly place the work instructions
- keep focussed on the process and try to achieve even minor improvements every day (which can possibly be the base for permanent improvements).

3.1.5 Recommendations for workers

- keep the workplace clean and organised according to the instructions of your superior technician
- follow the work instructions; focus on interlocking, knife storage, and flipping and turning of the cutting board
- perform the daily work order
- call technician in case of deviation from the best practice
- do not hesitate to express your ideas for improvement

4. Preparation for stitching

4.1 Splitting

Splitting is one of the most neglected operations; its impact on the further process is often ignored. Splitting helps to achieve more homogenous material properties. Particular attention needs to be paid to interlinings and other stiffeners.

In terms of adjustments, splitting machines rank among the most complex machines. Wrong adjustments cause material damage, and material damage equals waste of resources. Inhomogenous material requires e.g. additional pressing, ironing, hammering at lasting or creates problems at one of the subsequent operations. Poor splitting is one of the most common causes for rework or reject.

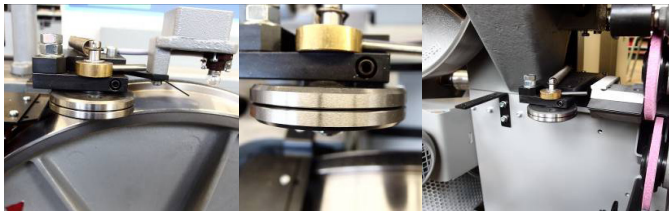
4.1.1 Important adjustments

There are many producers of splitting machines, but some general settings are common for any type. Please wear cutproof gloves as a safety precaution when adjusting or changing the knife. For perfect adjustment, a special distance measuring tool is needed which is capable to measure +/- 0.05 mm. You need to adjust:

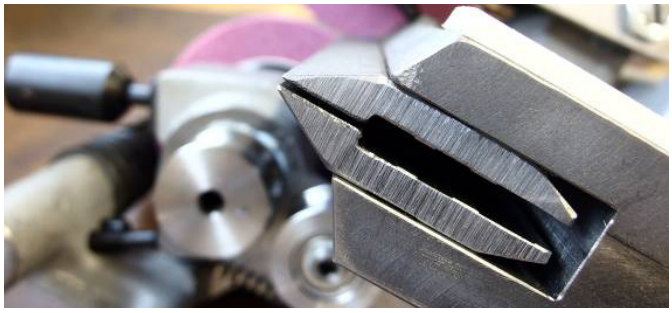
- blade width
- equal distance of blade to left and right driving wheel
- distance of blade to upper and bottom clamps according to the specifications in the manual
- exact position of the blade to the bearing block
- exact gap between blade presser bar
- minimum splinting thickess
- minimum scrap thickness

Fig. 25 to 31 illustrate some important skiving machine parts and provide useful tips.

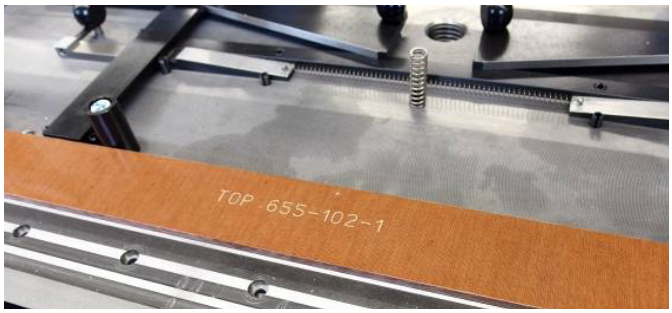
Please note: Each machine supplier has his own construction method. It is important to adhere to the machine-specific adjustments as described in the manual.



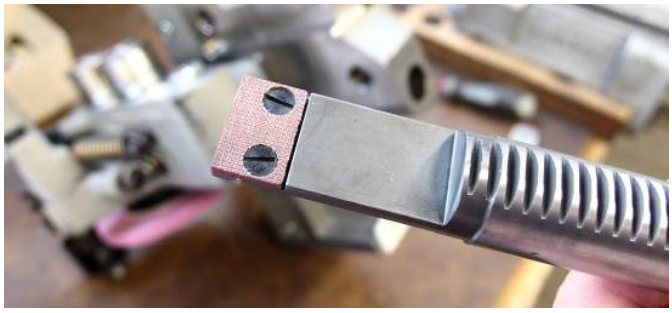
F.25 a - b - c The wheel holders maintain the necessary distance of the blade from the edges of the driving wheels



F.26 These clamps keep the upper and bottom position of the bell knife

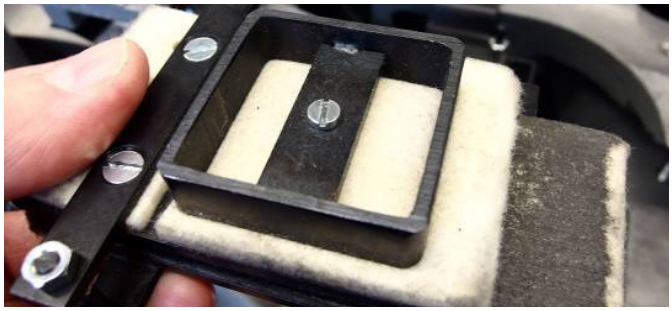


F.27 Upper pushing bar which pushes the back of the knife towards the front guide

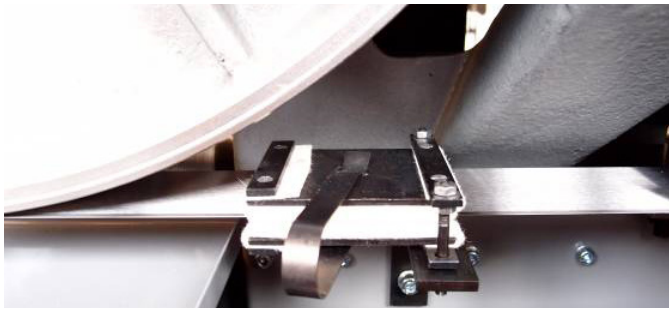


F.28 The blade back side bottom pushers exerce a constant force on the back of the bell knife in the bottom position. The position of the knife is determined by the bottom front guide.

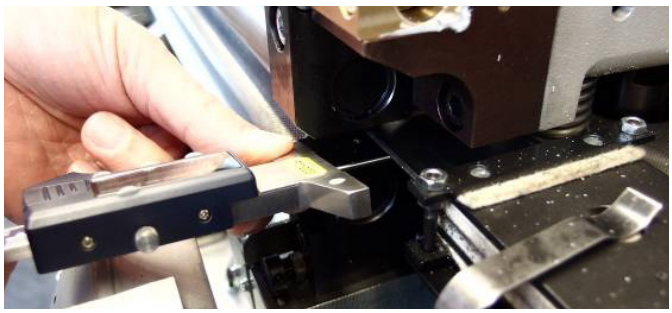
F.28 - *Left* **Surface knife cleaning.**



Right **Part for knife lubrication. Needs to be refilled with oil.**



F.30 **This part cleans the knife after splitting and after grinding**



F.31 **Professional measuring tool for optimal adjustment**

4.1.2 Recommendations for managers / maintenance

- adjust the machine according to the general setting advice as mentioned above and settings as recomended by the producer
- check the parametres at least once per week depending on the quantity of parts processed
- make sure that the weights on the knife back part pushing mechanisms can move freely
- oil the lubrication felt
- check and – if necessary – replace the cleaning felts
- check that both upper and bottom grinding stones wear out equally (both stones must keep the same diameter)
- always change knife and grinding stones at the same time (their life time is approximately the same). The grinding operation was not properly carried out if the grinding stones are worn down but not the knife OR if the knife is worn down and the grinding stones are hardly used

4.1.3 Recommendations for workers

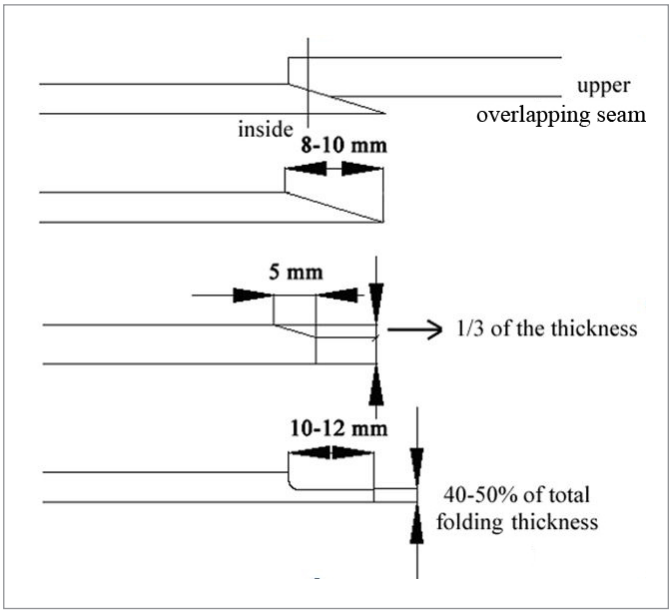
- adjust the grinding stones in such a way that they always slightly touch the knife (the movement of the grinding stones to the knife and back must be exactly the same)
- move the grinding stones away from the knife before stopping
- check twice a day that the blade width is the same on both sides (about 4 mm for leather) and that the blade remains in the correct position

4.2 Skiving

Skiving also is an operation which is often underestimated. Skiving prepares the material edges for further processing.

The following factors are decisive for skiving:
- purpose of skiving: fancy or functional
- type of skiving?
- thickess of the material
- structural strength of the material across its thickness

Frequent mistakes:
- sharp skiving (for underlays)
- folding skiving (for folding edges)
- raw edge



F.32 Examples of skiving. From the top: Underlay = sharp skiving which shows on overlapping parts. Sharp skiving = look of skived part. Raw edge skiving = fancy skiving ("cleaning" the leather edge after cutting). Skiving for folding.

Faulty skiving will become apparent as damaged stitching either at backpart moulding or – even more frequently – at toe lasting.

A proper result can be achieved with a basic machine (manual adjustments) or using the semiautomatic mode of a fully automated machine.

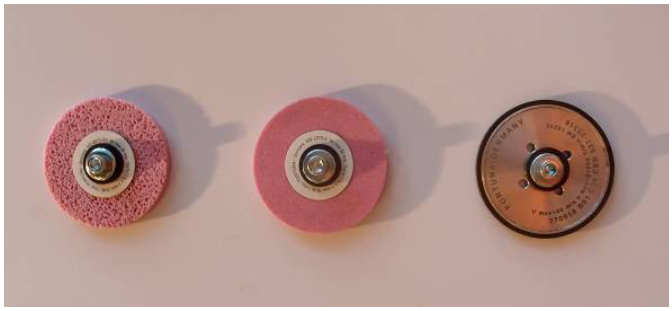
The advantages of automatic machines:

- they deliver a guaranteed work result and a guaranteed quality
- they eliminate the need for manual adjustments and do not require to be operated by staff having the necessary know-how to make adjustments
- they increase productivity compared to non-automated machines
- several different skiving operations can be grouped (which saves three or even four handlings).
- the step motor system is directly connected to a bell knife with a short shaft, guaranteeing a very smooth rotation of the bell knife and allowing to skive even very thin lining materials
- automatic machines often have only one set of tools so the only parts to change are the feeding rollers. In conventional machines more tools need to be adjusted and changed.

Many companies are unaware of the importance of skiving and therefore risk reworks or even rejects of uppers mainly at toe lasting. Fig. 34 to 39 visualise tools and adjustments for different materials and different skiving operations.

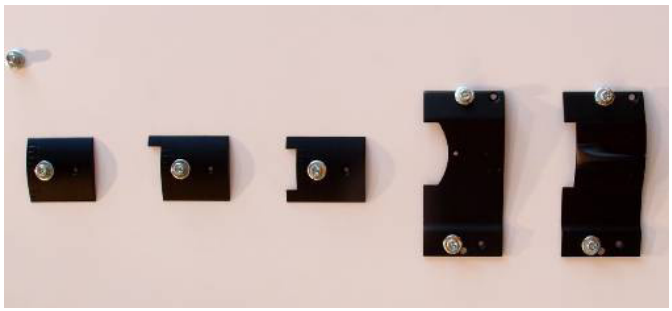
F.33 Presser feet

F.34 Feeding rollers

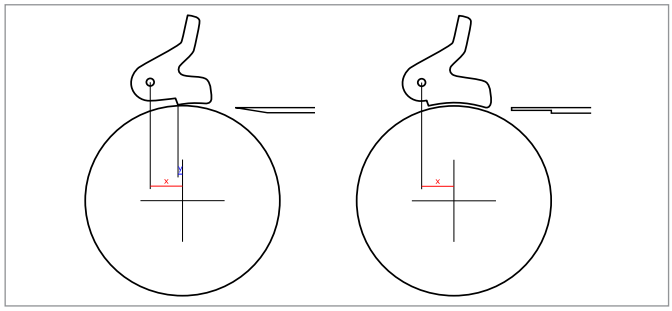


F.35 Grinding stones

F. 36 Width adjustments

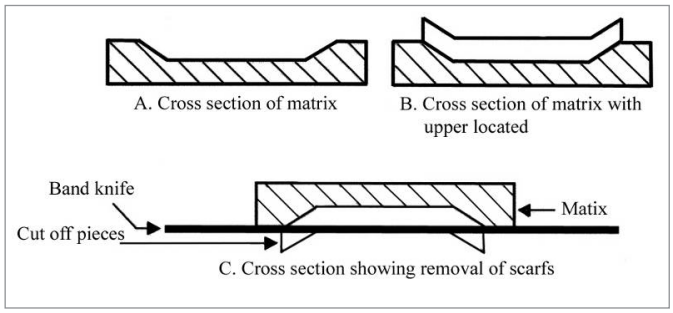


F.37 Covers



F.38 Different presser feet are recomended to for sharp skiving and folding skiving. x is the distance to the holder. x is identical for both skiving types. For the sharp skiving (left) it is important that the starting point of the presser foot is as close as possible to the middle line (distance y). For folding skiving (right) it is important that the curve of the preser foot matches the curve of the bell knife.

It is even possible to skive large pieces with different types of skiving, or to skive a central area of a part using a splitting machine and a matrix. Another method, which is not widely used because it is rather unknown and because it requires precise adjustment of the splitting machine as mentioned in the chapter on splitting, is illustrated in Fig. 39:



F.39 Skiving done on spliting machine

Another possibility to achieve a good quality level and to increase productivity is to organise a standing work station combining two skiving machines with each of them adjusted to carry out a different skiving operation.

4.2.1 Skiving machines

There is a great variety of skiving machines. In order to make the right choice, it is necessary to be aware of the exact requirements of each production line. What is also of great importantce is the fact whether the supplier is able to deliver spare parts and do maintenance work just in time. This is important to consider with all investments. The best machine without a specific introductory training and without support has a diminished utility value.

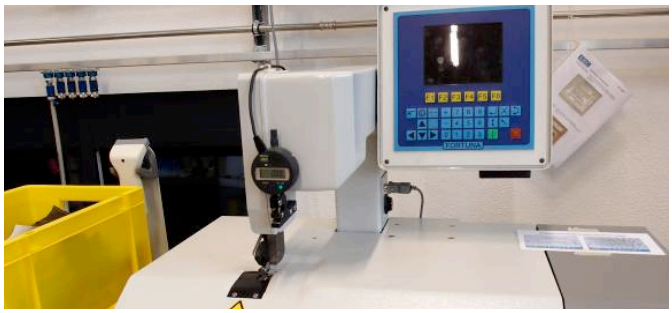
The basic adjustments to achive optimum results are:
- holder for
- separator inside the bell knife

F.40 Skiving done on spliting machine

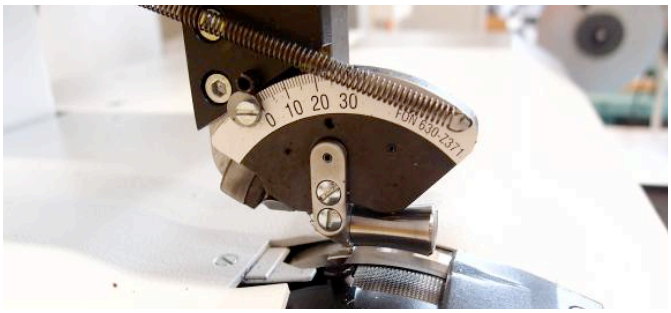
F.41 a - b Separators (important for proper dust exhausting and to protect the inside of the bell knife from skiving waste)

F.42 A holder keeps the dressing tool in its correct position and the edge of the grinding stone flat and not rounded. This guarantees efficient exhausting and proper grinding.

Skiving machines with an open frame on the left, as shown in 42, are less efficient in terms of dust exhausting and grinding stone sharpening.



F.43 Automatic skiving machine



F.44 Working area of an automatic skiving machine

Furthermore, the speed of the bell knife is an important parameter. Skiving type and width are controlled by a step motor. Some machines even automatically correct differences in thickness between skived parts.

Skiving of thermoplastic materials requires metal feeding rollers and a system to protect the bell knife from melted material residues. The simplest solution is to use water as shown in fig. 45.

F.45 Skiving machine for thermoplastic heel counters and toe puffs

4.2.2 Important adjustments

There is a number of important adjustments for an optimum skiving result: Some are general for every type of skiving and some are specific. The adjustments depend on the type of machine and its construction method. A technician should know what tools to use and how and why to adjust them:

- selection of the appropriate feeding roller
- position of feeding roller
- distance between feeding roller and bell knife
- pressing power of feeding roller against the material to be skived
- selection of the appropriate presser foot
- proper position of the selected presser foot
- bring the blade of the bell knife in the exact position with the back of the presser foot
- adjust the skiving width
- select the appropriate grinding wheel
- adjust the correct distance of the edge of the spreader from the edge of the bell knife blade

4.2.3 Recommendations for managers / maintenance

- specify the type and width of skiving
- select the type of presser foot and feeding roller
- check the general adjustments, distances, constant pressing force
- confirm all adjustments in a trial using a piece of waste material

Important: Rotational speed of the feeding roller

Please make sure that the workers adapt the same rotational speed of the feeding roller as tested in the trial. A different rotational speed leads to a different blade angle and induces a different skiving result. The construction angle of the blade is different from the "technological angle" of the blade, which depends depends both on the rotational and the feeding speed.

4.2.4 Recommendations for workers

- work with adjusted tools and parametres or adjust the tools according to the instructions of your manager
- work with the recommended speed
- assure regular grinding
- clean the grinding stone with the dresser tool when needed
- adjust the proper distance of the back of the presser foot and of the blade of the bell knife
- check if the skiving result corresponds to the sample given with the instructions

4.3 Ironing

Ironing is an operation to apply reinforcing materials on upper parts. The reinforcements usually are equipped with a sintered layer of a thermoplastic adhesive.

It is used in order to:
- correct the leather tension
- keep a given shape
- levelling thicknes differences

Ironing is an operation which makes it possible to use even low grades of natural upper materials. Knowing when and how to apply reinforcents prevents failures at toe lasting. Toe puff pressing is an ironing operation to apply a reinforcing piece onto the upper which helps to retain the (fashionable) shape.

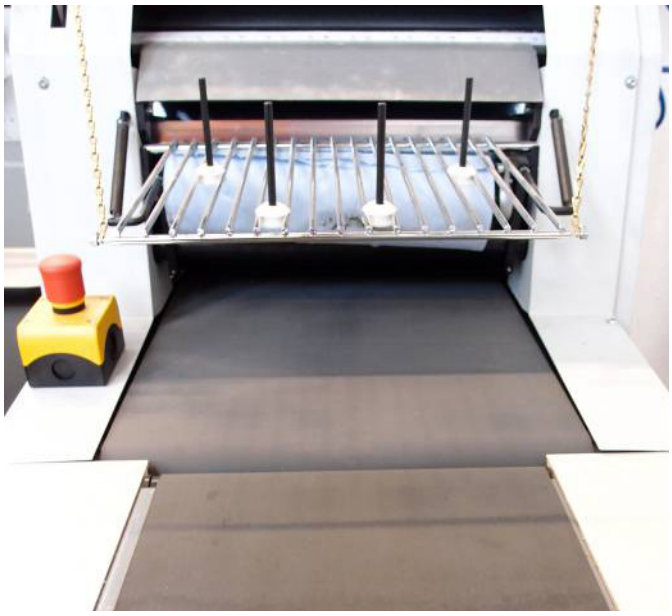
Poor bonding or wrong positioning will again cause problems, which will usually show at the lasting operation. Having to do rework at the stage of lasting is time consuming and means a big loss in productivity.

F.46 Toe puff ironing machine (work station can be organized both for standing or sitting)

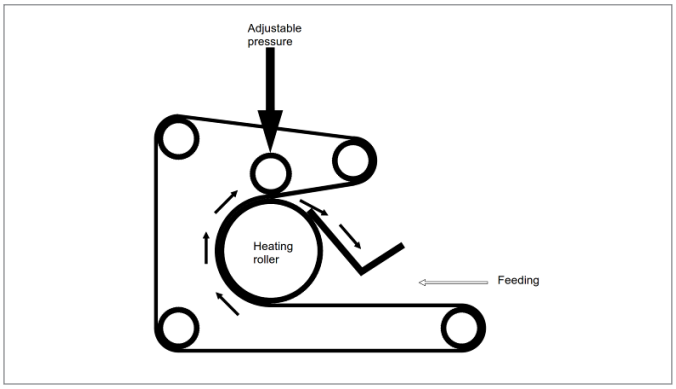
Fig. 47 to 49 show different ironing machines for interlining.

F.47 **Ironing machine with a rotating table**

F.48 **Ironing machine with moving shelves**



F.49 **Conveyor-type ironing machine which can be operated by one worker. Insertion and output are on the same side. This machine is ideal for high-speed bulk production.**



F.50 **Functional principle**

4.3.1 Important adjustments / checking

The basic adjustments for ironing machines are the settings for temperature and time. Most adhesives are pressure sensitive, but the pressure is often not stated in the material data sheet. In general, a pressure of 4 bar is recomended for ironing operations.

At each delivery of reinforcing materials, the ironing parametres should be checked. The temperature shown on the machine display is not necessarily the actual temperature on the material. The temperature on the workpiece should be measured with a special sensor or with temperature measuring strips. The quality of the work result will only be satisfactory if the parameters are respected, i.e. exact temperature, activation time, and the correct pressure (4 bar). Overheating, poor heating or low pressure will result in reworks or rejects.

5. Stitching (closing) department

"Stitching department" does not necessarily mean that all operations are executed on stitching machines. There are many other manual or automated operations such as folding, rivetting, rubbing down etc.

A sustainable approach is to concentrate on operations which add value and which maintain the logical order of the work flow.

F.51 Example of a sustainable way of toe-puff application with hotmelt adhesive

F.52 Work result in the shoe upper

The machine shown in fig. 51 makes the following work steps (and some machines) redundant and therefore contributes to make a production line more sustainable:

- production of sheets of thermoplastic materials
- delivery of the sheet material to the shoe factory
- pruduction of cutting dies (for cutting the sheet material)
- cutting of toe puffs
- waist (no cutting waste)
- skiving process
- ironing to the upper

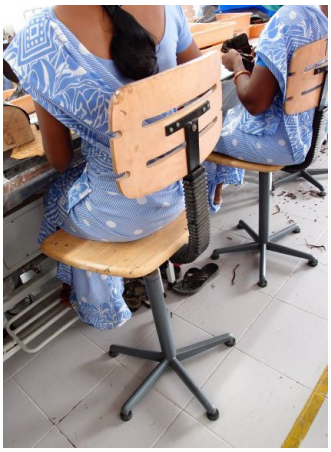
The list of savings is so amazing that one could ask why this it not the only way of toe puff application. The answer is: This is not an universal solution for all materials, shapes, and requirements.

Another important point to be considered is workplace organisation. The pieces of work in progress must get to each work station in a manner which facilitates picking them up and putting them down again. Tools or auxiliary materials should be placed in a way that they can easily be identified and handled. Standard working tables often need to be enhanced by adding holders (for materials, tools or cleaning agents), extensions, surfaces, shelves, supports, waist disposal bags etc.

F.53 Example of a simple solution to organise toe puffs: Each size is stored in a dedicated compartment

F.54 Example of a skiving workplace: The skived parts can easily be put down without risking to fall down

It is also worth taking the time to check the seats: You can not expect optimum performance and work quality if all workers in the closing department are seated on the same type of standard chair. Adjustable chairs which ideally support each individual person have about the same importance on performance and work result as clean workplaces.



F.55 Basic chair

F.56 Simple adjustable chair

5.1. Stitching: Needles and threads

The beginning of this chapter focuses on the tools, i.e. on threads and needles.

The initial questions are:

- Which material shall be stitched?
- What type of seam is required for your shoe model?
- Which thread is the best for your shoe model (depending on material to be sewn: would a core-spun thread meet the requirements best, or e.g. a continuos filament)?
- Which needle size and which needle point shall be used?
- What is the required resistance of the stitched bond?
- What shall the number of stitches per cm be?
- What shall the distance of the seam from the edge be?
- What is the appropriate strength and elasticity of the thread (high elastic threads bear a higher risk of breakage at high speed stitching)?

Do not get confused by the different thread numbering systems.

T.2 Different thread numbering systems

Nm	Nf	Ne_B	NE_L	Td	tex (approx.)
1	0,5	0,5905	1,654	9000	1000
2	1	1,181	3,307	4500	500
3	1,5	1,772	4,961	3000	340
4	2	2,362	6,614	2250	250
5	2,5	2,953	8,268	1800	200
6	3	3,543	9,921	1500	170
7	3,5	4,134	11,57	1286	140
8	4	4,724	13,23	1125	125
9	4,5	5,315	14,88	1000	110
10	5	5,905	16,54	900	100
11	5,5	6,496	18,19	818,2	90
12	6	7,086	19,84	750	84
13	6,5	7,677	21,5	692,3	80
14	7	8,268	23,15	642,9	72
15	7,5	8,858	24,80	600	68
16	8	9,449	26,46	562,5	64
1	0,5	0,5905	1,654	9000	1000
1	0,5	0,5905	1,654	9000	1000
1	0,5	0,5905	1,654	9000	1000
18	9	10,63	29,76	500	56
20	10	11,81	33,07	450	50
25	12,5	14,76	41,34	360	40
30	15	17,72	49,61	300	34
35	17,5	20,67	57,87	257,1	28
36	18	21,26	59,53	250	28
40	20	23,62	66,14	225	25
45	20	23,62	66,14	225	25
50	22,5	26,57	74,41	200	22
55	27,5	32,48	90,94	163,6	18
60	30	35,43	99,21	150	17
65	32,5	38,39	107,5	138,5	15
70	35	41,34	115,7	128,6	14
75	37,5	44,29	124,0	120	13
80	40	47,24	132,3	112,5	12,5
85	42,5	50,20	140,5	105,9	12
90	45	53,15	148,8	100	11
95	47,5	56,1	157,1	94,74	10,5
100	50	59,05	165,4	90	10
110	55	64,96	181,9	81,82	9,2
120	60	70,86	198,4	75	8,4
130	65	76,77	215,0	69,23	7,6
140	70	82,68	231,5	64,29	7,2
150	75	88,58	248,0	60	6,8
160	80	94,49	264,6	56,25	6,4
170	85	100,4	281,1	52,94	6,0
180	90	106,3	297,6	50	5,6
190	95	112,2	--	47,37	5,2
200	100	118,1	--	45	5

It is important to work with matching sizes of threads and needles.

T.3 Choose the right threads and needles according to each material

THREAD SIZE (METRIC)	NEEDLE SIZE	MATERIAL RIGIDITY
140, 120, 100, 80	75 80 90	Soft Medium Hard
75, 70, 60	90 100 110	Soft Medium Hard
50, 40	100 110 120	Soft Medium Hard
36, 30	110 120 130	Soft Medium Hard
25, 20	120 130 140	Soft Medium Hard
18, 16, 13, 12	130 140 160	Soft Medium Hard
10, 8, 7	160 180 200	Soft Medium Hard

What we are saying above can be found in many textbooks, but in practice the majority of the companies do not carefully apply these theretical basics.

In any case, production trials should be run before a shoe model is released for production, and work samples should be distributed to the workers to provide orientation.

5.2. Stiching machines

There are countless types of stitching machines. The differences start with the quality standards of the machine manufacturer, the design, and the quality of the materials used. Two functionally very similar machines from two different suppliers that are being maintained exactly the same way, that are being operated in the same production environment and even on the same shoe model, can quickly show huge differences in quality: One starts to rust, whereas the other is still all shiny and in excellent condition.

Please keep in mind when purchasing a (stitching) machine:

The price of a machine on its own should never be the decisive aspect. When purchasing a machine, please make sure that you get reliable information on its durability and that your machine supplier delivers the machine with a basic set of spare parts. In addition, you must be sure to be able to rely on the continuous availability of spare and consumption parts (and their price). These criteria, together with an initial training organised by the machine supplier and with the availabilty of a local customer service team, make operation and maintenance of a machine truly sustainable and should play an equally, if not even more important role in the purchasing process (or any other investment decision) than the price.

This appllies to ANY machine purchase.

One of the most common scenarios (most frequently causing mistakes) is that a company decides to buy a certain type of machine, and the general manager or the owner will purchase the machine on a fair. In those cases, the purchasing decision is mostly based on price, on a purely visual impression, and on the selling arguments of the commercial staff which cannot directly be verified.

Ideally, purchasing a machine should be a collective decision involving managers of the different departments concerned, i.e. design, maintenance, technology, and finance.

Fig. 57 to 61 illustrate different basic types of stitching machines.

F.57 Zig-zag machine

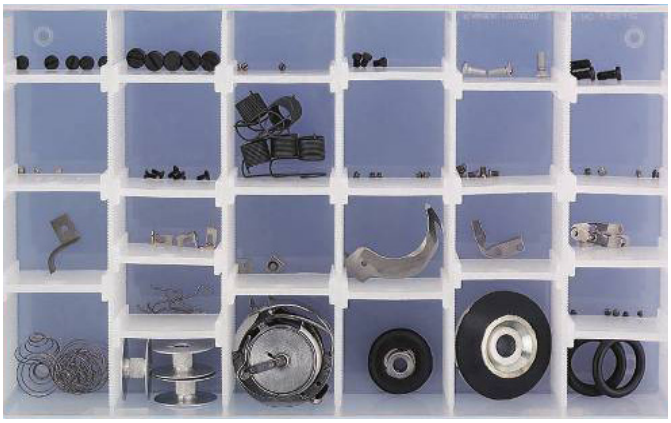
F.58 Flat-bed machine

F.59 Single needle post-bed machine

F.60 Double needle post-bed machine

F.61 Cylinder-arm machine

Stitching machines can feature many options which need to be thoroughly considered depending on the specific requirements. For example, there are clutch motors, step motors, and even programmable control panels. It is important to select the proper feeding system, the appropriate upper and bottom feeding rollers, upper and bottom feeding speed, the correct size of the stitching plate, guides, edge cutting, thread trimming, etc.



F.62 Examples of spare and special parts for a basic stitching machine

F.63 Upper and bottom feeding systems, stitching plates

Spare and consumption parts as well as special fittings strongly influence the efficiency of a sewing machine as well as the quality of the work result, and also whether the possibilities of a machine are fully exploited or not. Wrong choices concerning these "small" items can cause a considerable loss in performance.

The most commom mistakes are that expensive stitching machines are not properly adjusted and/or maintained, that cheap threads are used which break at elevated speed, or that cheap consumption parts are used instead of original ones.

Fig. 64 to 66 show typical and frequent "not sustainable" mistakes which drastically influence the performance of an expensive stitching machine and can reduce it to the level of a cheap second hand machine. A sustainable approach can have the opposite effect: Even old machines can perform well provided that they are properly maintained, regularly cleaned, fitted with proper parts, and that a decent thread quality is used.

F.64 Frequent mistake: The protection plate is not properly adjusted and the hook touches the needle.

F.65 This is an example of what to avoid: Cheap thread, dirty machine, badly adjusted hook – in consequence, the stitching result will be poor and the thread risks breakage.

F.66 This is an example of an expensive computer-controlled stitching machine which was not operated with the original bobbin. In addition company did not want to spend 1€ for the correct screwdriver to change the needle so the workers used the cheap bobbin for changing the needle.

Automated Stitching

Automated stitching machines probably represent the most sustainable solution for the stitching department. They can feature different sizes of stitching areas: Some automatic stitching machines have small working areas of 50x40 mm for stitching logos or fancy parts; some have stitching areas of 500x400 mm for functional stitching or even for producing complete uppers up to the final closing stitch.

Stitching automats with small working areas usually are equipped with easy-to-handle holding systems. Their programmation is fast and easy; these machines can be used for any shoe type and any production volume.

Large automats for functional stitching require special holders for each shoe size and for each type of stitching. These systems are used for big series, most frequently for occupational footwear or sports shoes.

An experienced designer knowing how to use centred parts for his/her shoe models (parts that are produced in one size and that can be used for two or three upper sizes) can – by doing so – save a certain number of holders and therefore increase the effiency as well as the sustainability of the process.

Three-dimensional stitching is another interesting development which is being used in garment production, but there are no 3D-stitching applications for footwear production which could be used on a large scale.

5.2.1. Recommendations for managers / maintenance

Beyond the initial recommendations mentioned previously, there are daily tasks for every technician:

- clean the entire thread path from the bobbin to the needle (fig. 67)
- check the functionality of the springs on the thread path and in the bobbin case (if the machine features this system)
- check the sharpness of the hook
- check the hook protection system
- select the optimum feeding type and size
- check the hole in the stitching plate (it needs to be changed if the hole is too big as the material will have the tendency to be pushed into the hole or to be lifted up whenever the needle moves upwards)
- clean the inside of the hole in the stitching plate
- clean friction clutches with a solvent (this type of clutches can get contamined by lubricants)
- create a routine of preventive checks of the above mentioned (adapted to your specific needs)
- prepare exact work instructions for each operation and give out hand samples to demonstrate the optimum work result as well as to create awareness of frequent mistakes.

F.67 **Threads paths**

F.68 **Inclined stitching machine for cleaning of the bottom parts**

5.2.2. Recommendations for workers

Each worker is supposed to:

- follow the instructions of his/her superior technician
- call the foreman in case that machines or materials do not comply to the given specifications / samples
- perform the operation smoothly and without excessive force
- clean the machine
- only use original tools for cleaning or for making operational adjustments

5.3. Manual operations – different gluing methods

Gluing (together with manual folding) is one of the most frequent manual operations in low-wage countries.

Firstly, the glue needs to match purpose and material. There can be differences regarding:

- drying time: faster / slower (forced drying using heat / drying at room temperature)
- activation method: temperature activaton or pressure activation (for the latter, the correct pressing time must imperatively be respected).

The majority of pre-stitching bonds are only temporary, so they do not necessarily have to be strong. However, in most production lines the focus is not set on handling. Poorly organized handling requires strong bonds. Strong bonds need additional drying time and a special place dedicated to drying, or they require activation time and pressing/ hammering. Clever handling delivers bonded parts which can be passed on from hand to hand.

Usually the parts arrive at a work station in a box and are returned into the box after completion of the operation. Alternatively, it can be more efficient to create a combined workplace where one worker applies the glue, gently presses the work pieces together, and directly hands them over to the stitcher; or the stitcher has a dedicated area where he/she can glue the parts together using fast glue (a glue that does not require drying time as the bond is functional immediately after glue application), and then stitches the parts together. Typical fast glues are hotmelts or traditional solvent or waterbased adhesives.

The tools for manual glue application must not necessarily be brushes.

F.69 Glue in a plastic

F.70 Glue in a similar plastic bottle with a textile tip bottle with a narrow tube

It is important to select the right brush featuring the right width and rigidity for each specific gluing operation. The goal is always to achieve an optimum coating result using only the strictest necessary amount of glue in order to stay as sustainable as possible and to avoid additional cleaning.

F.71 Example of a simple and efficient way to organise a gluing workplace

Fig. 71 shows a good example: The glue is applied onto the sole. The brush has exactly the size of the area to be treated, and it is rigid, which is ideal to rub the glue into the sole surface. Inclining the sole while applying the glue prevents any surplus of glue from running into the cavities between the ribs. The worker can check the regular application thanks to an additive which makes the glue coating fluorescent under a UV lamp. The worker is protected because the solvent vapours are being exhausted from below.

The efficiency of this rather basic solution can be compared with the efficiency of high-tech sustainable solutions which will be presented in the making room chapters.

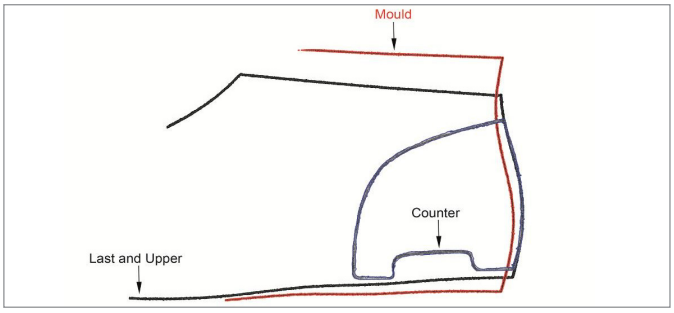
6. Making room / Assembly

The machines of the assembly room have a stronger impact on the final quality of a shoe than the machines of any other department. They require vast spaces and large amounts of energy. This is the reason why the key operations and machines of the making room will be described in more detail.

6.1. Back part moulding

There is a basic rule: The curve of the mould must be identical or very simillar to the last heel curve. If the curve of the activation mould is narrower or wider, this will create problems.

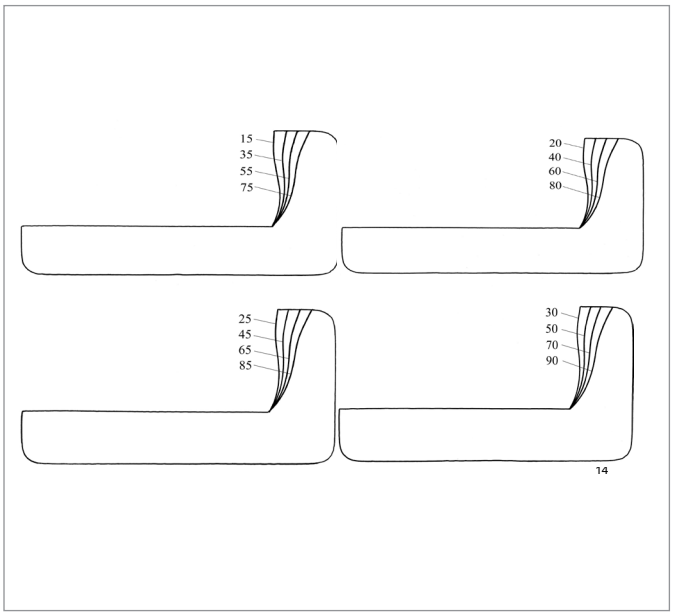
- clean the inside of the hole in the stitching plate
- clean friction clutches with a solvent (this type of clutches can get contamined by lubricants)
- create a routine of preventive checks of the above mentioned (adapted to your specific needs)
- prepare exact work instructions for each operation and give out hand samples to demonstrate the optimum work result as well as to create awareness of frequent mistakes.



F.72 Example of ideal mould, counter, and last heel shapes

Fig. 72 shows the ideal match of mould shape and last heel shape which will allow for the best possible work result. In addition, the shape of the premoulded leather board counter must match the profile of both mould and last heel. It is expensive to produce new sets of moulds for each new backpart shape. This money is lost if the correct mould is finally not used.

Working with standard last profiles is a solution to make this process more sustainable. Fig. 73 gives examples of professional standard backpart curves.



F.73 Examples of different standard last backpart profiles (the numbers express the curve related to the heel height)

Regarding heel curves and side profiles, the sustainable option is to define "technological" standard shapes instead of ever new fashionable shapes when it comes to ordering production lasts. In other words, of course you need certain fashionable shapes, but you can integrate technological standard shapes in any last design (e.g. for the bottom profile and for the heel curve). This avoids having to spend money and resources on new mould shapes and reduces the risk of reworks or even rejects.

F.74 Standard for a side profile

In addition, it is recommendable to constantly look for innovative counter materials (this type of products evolves quickly) featuring

- improved shape retention
- improved flexibitity
- lower activation temperatures
- the posibility to "reactivate" already finished backparts to correct a wrong positioning

Frequent mistakes:

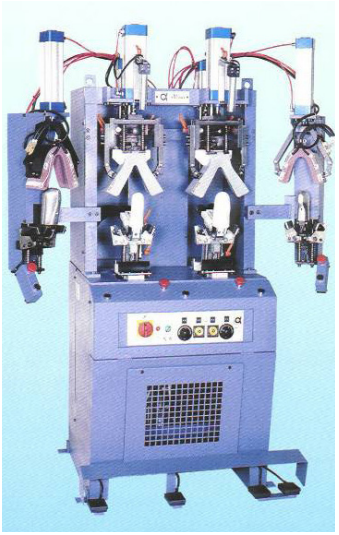
- not using the original heating bodies in silicon moulds leads to local overheating and mould damage
- exceeding the maximum temperature for silicome moulds leads to mould damage. Some moulds have a recommended working temperature of about 90 °C. Some moulds tolerate temperatures up to 120 °C.

F.75 Accumulation of frequent mistakes: The heating bodies are not the original ones and the recommended working temperature was exceeded.

6.1.1. Back part moulding machines

F.76 Basic backpart moulding machine for pre-moulded leather board counters with adhesive coating

In fact the upper material encumbers the counter moulding because of its thickness and rigidity. In order to increase productivity, it is advantageous to use only pre-moulded leather board counters coated with low-temperature activated glue. In this case, pressing at warm and not at hot temperatures is sufficient.



F.77 Hot and cold backpart moulding machine

Machines as shown in fig. 77 are ideal for thermoplastic counters which are inserted flat or slightly pre-moulded.

F.78 Rotating two-pair backpart moulding machine

Machines as shown in fig. 78 are used for heavy uppers which take some time to heat up or cool down. Advantage: activation and cooling times are longer, which is preferable.

F.79 Example of an universal backpart moulding machine which allows to change the "front-back" position of the mould and which can be used for different construction types

The machine in fig. 80 is recommendable for companies producing a huge variety of different designs.

There are many more construction variants. Each company should benchmark machines from different suppliers in order to identify the most suitable machine for their specific requirements.

6.1.2. Important adjustments

Each machine must be properly equipped and adjusted. The most important points are:

- selection of appropriate moulds
- adjustment of the closing pressure of the moulds
- adjustment of the wipers according to the material thickness
- adjustment of the holding pressure of the pincers
- adjustment of the pulling force
- temperature setting for aluminium moulds and for "soft" moulds (such as silicone moulds): always respect the highest possible long-term temperature
- setting of the correct activation temperature and time
- setting of the correct cooling (moulding) time; the temperature is mostly the lowest possible sub-zero temperature
- use a peripheral pre-heating and/or cooling device for optimum shape fixing after moulding in case that the machine activation and/or cooling does not suffice (this is useful when the cycle time of the machine is below the optimum and the temperature below (for pre-heating) respectively above (for cooling) the optimum)

Rule of thumb for backpart moulding

There is a simple rule of thumb: The perfect bond between lining, counter, and upper material increases the final rigidity. Example: If each of these three materials has a rigidity of 1, then the final rigidity is 1 + 1 + 1, and the final result is a rigidity between 4 and 5. Therefore a sustainable approach is to purchase the best counter with the best "grip", but 0.2 to 0.4 mm less in thickness than the standard counter. The price of these counters should not differ from standard counters because there is less substance, but the look and the final quality of the shoe will definitely be improved.

6.1.3. Recommendations for managers / maintenance

Each manager should:

- create a system of parameters that need to be adjusted and keep record of how to adjust them for each individual design
- select the ideal counter material and verify the shape for all sizes
- check a small, a medium, and a big upper size to be sure that there are no problems with buckles, rivets, logos, or colour changes
- prepare new work instructions for each new design, or alternatively verify that the existing instructions can be applied for a new design
- prepare hand samples and make a list for the workers of what should be checked (motivate workers for self-monitoring)

6.1.4. Recommendations for workers

Each worker should

- check and change the moulds according to the design and to the instructions
- set the time, pressure, temperature etc. according to the instructions
- work with the correct counter and make sure to use the correct counter sizes for the different upper sizes
- check the quality of the work and clean the mould immediately whenever the first stain mark is visible because otherwise the mould will stain lining and/or upper materials
- shut down or switch off the machine at planned or unexpected breaks

6.2. Upper activation

In the cemented construction, the uppers undergo an elongation of 15 up to 20 % at the toe lasting operation; some fashionable designs elongate the front part even up to 30 %. To withstand this elongation, the upper leather must contain a certain humidity, and the toe puff material must be soft.

Important for Activation

Setting the activation time and temperature for a new design – just as other adjustments that require heat for a certain duration of time – should be done according to proven adjustments of similar designs and materials. The first approach to set the temperature should target a lower value than the expected value. The temperature is then gradually increased if it is not sufficient. The activation time is often pre-fixed.

Formula:
Heating time = cycle time – manipulation time – time reserve

A sustainable approach is to target the longest possible activation time according to the above rule, as well as the lowest possible temperature. Do not forget to go down with the temperature during breaks. For further information please refer to the manual of the activation device.

6.2.1. Machines for upper activation

There are two basic activation machines types with regard to how heat and water vapour are generated:

1 - Open system: Water vapour at 100°C; danger of rapid condensation on cold surfaces. This system could be improved by spraying the water vapour against an hot air blower (the hot air stream reaches up to 400°C).

2 - Closed system: water vapour is created in a pressurised container. The overheated steam penetrates the leather in a very homogenous way and does not leave water stains (which can be a problem, notably on sensitive leathers such as nubuck).

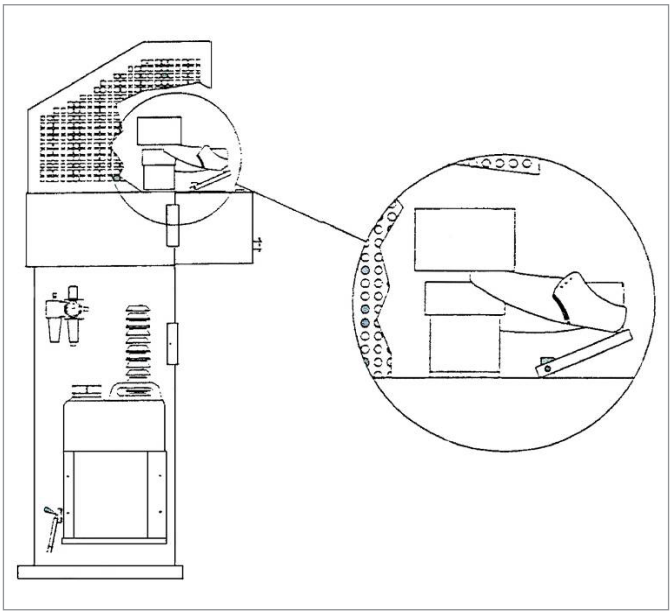
Both systems are energy-intensive. When purchasing an activation system, the decision should be based on price, energy consumption, and the requirements of the majority of uppers.

There are activation systems with lower energy profiles, such as induction water heating or preheating systems.

Some machines could be also sensitive to limestone.

Activation devices with clamp systems as shown in fig. 80 show good work results, but those can only be achieved if the original silicone foam moulds are used. The moulds are perforated and equipped with a protective felt which resists to higher temperatures while ensuring a high degree of air and moisture permeability. If the machine is not used with these original parts, the work result will be poor.

The sustainability of activation systems could be increased by re-using the hot air (keeping it within the system).



F.81 Drawing of the most frequently used clamp system

F.82 Activation system using overheated steam featuring the possibility to set different temperatures for different zones of the upper

F.80 Classic clamp activation system (available as pair or half-pair version)

F.83 Activation machine using induction heat featuring interchangeable tools for different upper types (e.g. for cemented construction, Strobel, moccasin, ...).

6.2.2. Recommendations for managers / maintenance

Each manager is responsible for

- preparing precise work instructions for each different design or material, always stating the lowest acceptable temperature
- the placement of the activation machine and the lasting machines: a sustainable approach necessitates that once the upper is activated, it shall be lasted as soon as possible, meaning that a "lasting island", where one upper is passed on from hand to hand, would be the most sustainable solution. Alternatively, one operator does all lasting operations. Long distances between activation and lasting machines imply a loss of activation energy: the activated upper can only be toe lasted. If the distance to side and seat lasting is long again and the upper cools down too much, the activation process needs to be renewed twice or even three times. This is the disadvantage of the conveyor system.
- setting the rules for checking the functionality of consumption parts and for preventive changes
- checking the actual temperature on the workpiece, record it, and compare it with the temperature indicated on the machine display

6.2.3. Recommendations for workers

Each worker should

- follow the instructions of his/her superior manager
- call the technician if he/she has the impression that temperature, time, or moisture quantity should be altered to achieve a better lasting result
- keep the machine clean

6.3. Toe lasting

This operation will be described in more detail as it is – along with backpart moulding and soling – the most important operation in the shoe making process.

The purpose of this operation is to stretch the upper in the vamp area (by pulling it over the last in order to shape it to the last), and to fix it to the insole.

Material elongation in toe lasting

During the toe lasting process, the upper is elongated in the vamp area 15 to 20 %; in some fashionable shapes the elongation is even over 25%.

6.3.1. Toe lasting machines

Toe lasting machines pull over the front part of the vamp and fix it to the insole in a single-stroke operation, while the upper is held and pulled by the pincers of the machine. It is lasted when the stretching stand lifts upwards. The pulling force of each pincer can be individually controlled to increase the degree of the upper elongation. Then nozzles or crown apply a thermo-adhesive from beneath onto the insole, an elastic mould encloses the upper and presses it against the last, and finally the wipers of the machine close the lasting edge and press it to the insole. The heel rest presses last and upper against the mould. The vamp rest (toe) presses against the last from the top, and the closed wipers hold the last. A higher pressure of the vamp rest mechanism has a stronger ironing effect on the lasting edge.

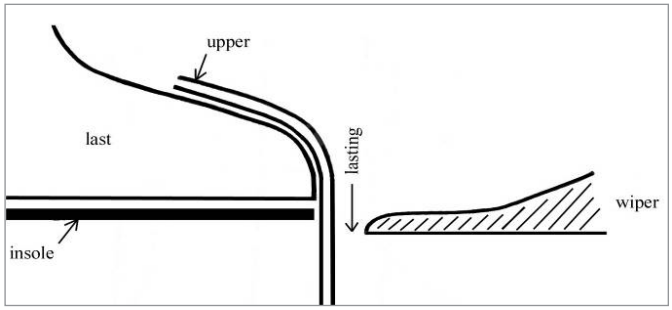
The most commonly used method for fixing the lasted upper to the insole is with hotmelt adhesive. Therefore, lasting machines can inject hotmelt adhesive, which comes in the form of sticks. Some companies prefer manual glue application. The thermo-adhesive is applied just before the wipers close. The wipers stay closed for at least 4 to 5 seconds. At the same time; the lasted front part is pushed upwards by the vamp rest.

At toe lasting, latent mistakes become visible, such as:

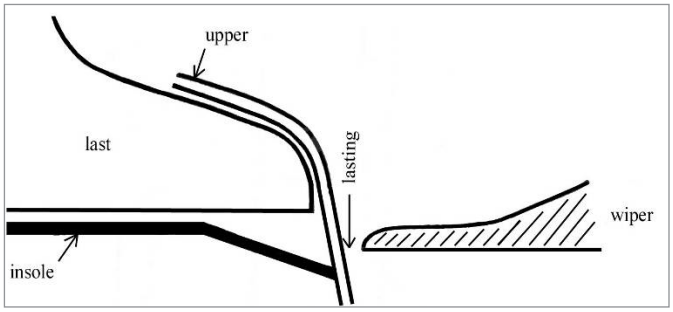
- poorly positioned lining, interlining or toe puff
- faulty splitting, skiving or stitching
- excessive tension in the upper materials or hidden mistakes in the leather structure

To achieve good lasting results, the insole must be properly shaped, meaning that it must have the same size as the last and that it matches exactly the shape of the last bottom (fig. 84 to 86).

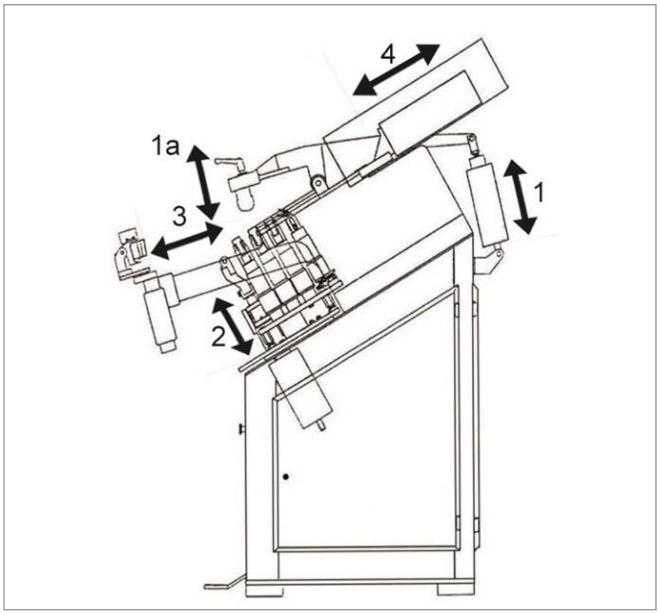
F.84 The bevelled insole must match the shape of the last bottom



F.85 Correct insole dimensions



F.86 If the insole is too long and projects beyond the last tip, this will inevitably cause problems



F.87 Main movements of the toe lasting machine (without glue application)

The quality of the lasting operation depends a lot more on the shape of tools (expecially the teflon band and the wipers) than on the specific type and the technical level of the lasting machine.

F.88 The Teflon band and the wipers are the most important tools for toe lasting

Example of a typical lasting cycle:

- the front pincer(s) clamp the upper with a pre-adjusted force
- the other pincers clamp the upper with a pre-adjusted force
- the stretching stand quickly moves upwards to its first position, and then continues to push with lower speed until it reaches the final position. Once the stretching stand is in its final position, the bottom of the insole must be positioned slightly above the edge of the wipers. The difference in height is about 20% less than the thickness of upper
- the Teflon band is pressed all around the vamp
- the seat support starts its movement towards the last with fast speed and low force, then slows down and continues its movement with low speed to the final position
- crown or nozzles (or both crown and nozzles) apply the adhesive
- the wipers start their movement and the pincers decrease the clamping force to the pre-adjusted value; the vamp support start its movement as soon as the wipers are positioned under the insole
- the wipers continue their movement and the crown (or nozzles, or both crowns and nozzles) return to their down positions
- the wipers take the lasting edge from the partly closed pincers (making the material slip out of the grip of the pincers)
- the wipers are completely closed, and both vamp and rear support press against the last bottom with augmented force
- progressive release of all pressing forces of all mechanisms
- the shoe is released after a pre-adjusted fixing time

There are two main preconditions to achieve an optimum toe lasting result with a perfectly flat lasting edge:

- the Teflon band must exactly match the last shape – each new last tip must have a dedicated Teflon band
- the shape of the upper curve of the wipers must exactly match the bottom curve of the last with the insole attached

F.89 **Perfectly lasted upper (no additional pressing or hammering)**

F.90 **Perfect lasting result (no additional pressing or hammering)**

F.91 **For a perfect lasting result, the bottom shape of the last and the shape of the wipers must match**

Sustainable approach to toe lasting

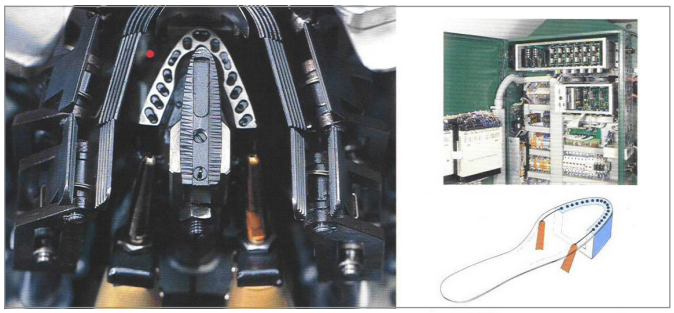
Create bottom standards and use them for every new last shape. This helps to save the energy which would be needed for ironing, pressing, or hammering. The result will be a perfectly flat lasting edge as shown in fig. 82 and 83.

The keys to zero rework or reject after lasting are:

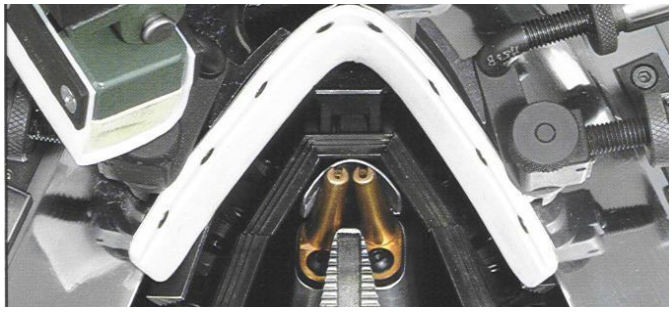
- chose the most appropriate components (linings, toe puffs, heel counters...)
- a good technical design followed in cutting and stitching
- standard profiles and perfectly fitted tools
- choice of the appropriate lasting machine and "clever" machine equipment (meaning to accept standards in technological shapes)
- choice of glue application method

For the most part, crowns can be replaced by nozzles. Today, hotmelts are more and more frequently replaced by water-based adhesives

F.92 PC-controlled glue application (respecting all sizes; the glue is applied in an exact distance from the edge for each size; requires only reduced heating)

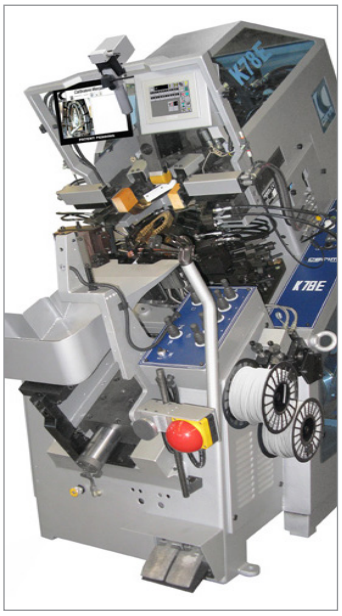


F.94 Combination crown with a small fixed adhesive applicator – thanks to this system, the toe lasting machine consumes less energy. Placing the applicator in the front can be an advantage to achieve a flatter lasting edge.



F.95 Toe lasting machine featuring a nozzle adhesive applicator. This system only requires energy to heat up the hotmelt adhesive. It can also process water-based glues which do not require heating.

F.93 The hotmelt application crown requires relatively large amounts of energy to heat the hotmelt and the metal piece up to ~ 200 °C



F.96 Toe lasting machine equipped with a camera and an additional screen. The first lasted shoe from each pair is photographed and the picture is displayed on the screen. At the moment of elongation of the second shoe, both vamp shapes appear on the screen. This system helps to produce identical lasting results for left and right shoes while keeping fast cycle times and simultaneously avoiding reworks and rejects.

6.3.2. Toe lasting machines There are two main

There are various types of toe lasters. They can be grouped according to their main actuation power

- Hydraulic: the first types of toe lasters for mass production were hydraulic systems. Their advantages lie in their reliability and strength. They work in any condition provided that there is electricity. Until several years ago, hydraulic valves were not sensitive enough to process thin, soft materials.

- Pneumatic: these machines represent the generation after hydraulic systems. They allow fine-tuning of movements, forces, timing etc. and permitted the invention of the "slipping*" function (when the wipers take over from the pincers), which was perceived as a "revolution" in toe lasting.

  [*"Slipping" in toelasting means the function that the pincers are not fully open at the moment when the wipers take over in order to wipe and press the upper material to the insole; the pincers just reduce their grip force, and the upper material is pulled out of their grip by the wipers. This is supported by the holding function of the Teflon band and helps to last even difficult materials or shapes.]

- Electric: these machines use step motors for the main movements, which enable accurate positioning, precise movements, and exact force and speed adjustments. All adjustments can be memorised. Electric systems are ideal for just-in-time production, where a high flexibility is required. They also offer the possibility to apply hotmelt or water-based adhesives by nozzles in a fixed or partly flexible way onto insoles of all sizes and shapes.This can be considered as the second "revolutionary" development in toe lasting.

- Hybrid systems: It is quite common to come across combinations of hydraulic systems that are additionally equipped with step motors.

The latest generation of lasting machines integrates new control systems such as proportional walves which allow for almost the same precision of adjustments as step motors.

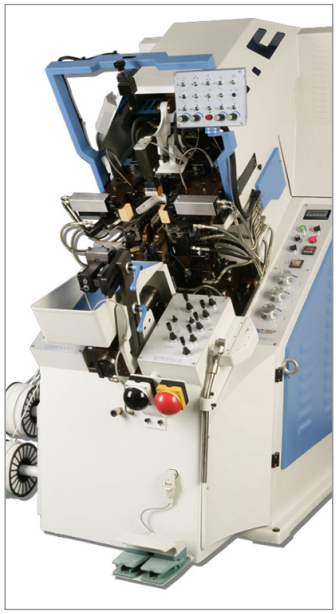
Key features of sustainable toe lasters:

- Productivity:
  – different types of programming units
  – fast change of tools and positions of working devices
  – use nozzles for glue application
  – work with shape standards

- Energy saving:
  – hotmelt application crowns replaced by nozzles which can process hotmelts, solvent- or water-based "cold" adhesives
  – lasting with solvent or water-based adhesives
  – work with standards and exactly shaped tools to reduce reworks and rejects
  – work with programable units which can memorise the settings
  – reduce idle times caused by repare (self-diagnostic systems)
  – programmable control units

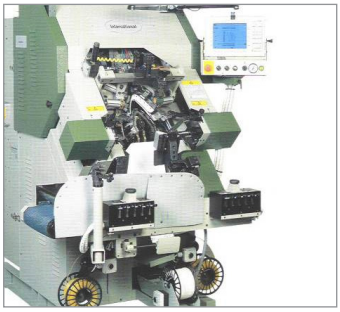
Important

What makes a toe lasting machine sustainable generally applies for any machine type. Each company must select the machine which is most suitable for their requirements. Even technologically rather basic machines, together with skilled technical design, well chosen components and a good work place and production flow organisation, can be more sustainable than the latest high-tech equipment when it is not supported by design, material choice, and organisation. Unfortunately many companies are lacking the necessary know-how in design, materials and organisation and therefore try to make up for this by buying technologically advanced machines.



F.97 **Hydraulic toe lasting machine**

F.98 **Pneumatic toe lasting machine**



F.99 **Fully electronic toe lasting machine with step motors**

6.3.3. Important adjustments for toe lasting

- the pincers must be positioned in a way that follows the last shape; clamping way (1 or 3 pincers), initial clamping and slipping force must be defined
- set the initial and the final position of the last support together with the initial and the final speed of its upward movement (if this posibility exists)
- set the Teflon band pressure
- define speed and final position of the wipers, set the wiper heating temperature (if necessary), and the duration of the closing time of the wipers
- set the speed of the upper pressure device together with the ironing pressure
- set the rear support speed and pressure
- set the ironing time (i.e. the time when the wipers are fully closed)
- set the hotmelt heating temperature

Why recall the basic machine settings when talking "sustainability"?

Practical experience in many companies has proven that technicians are often not familiar with the basic lasting machine functions. It is a frequent mistake that the decision makers buy machines which are not suitable for the company's needs, or (and this happens even more often) they buy machines with too many functions for a very limited use. Technicians should use the bullet points above as a guideline to set up their own benchmark. It is impossible to cover all design variants, materials, and specific requirements in the scope of this publication.

6.3.4. Recommendations for managers / maintenance

Each technician should

- check the technical design, the properties of the components, the upper preparation before toe lasting
- select the "tools", i.e. wipers and Teflon band. The sustainable solution is to work with standards for last bottoms and for wiper shapes, as mentioned before, but the Teflon bands must be specific for each and every last shape.
- specify the temperature, the total activation time, as well as time and/or quantity of water vapour for upper activation
- specify all pressure values and all speed values of movements
- specify the initial and final position of the last stand (there are machines that are able to recognise its position)
- check the glue application path if the machine works with nozzles
- decide if you want to use the slipping option and if so set the initial and final slipping force
- let the worker know the limits of own adaptions
- define when preventive maintenence works shall be conducted and how the daily cleaning shall be carried out

6.3.5. Recommendations for workers

Each worker should

- follow the instructions of the superior technician
- fine-tune the adjustments during the work progress
- call the manager if the result does not meet the expectations
- keep the machine and the working place clean
- take care of the daily cleaning and carry out small preventive maintenance works

6.4. Seat and side lasting

For most of the cemented shoes produced worldwide, the final lasting steps are

- manual side lasting
- seat lasting by machine

There are different views on what is more sustainable

1 – Manual processes have a low energy profile
2 – Full machine lasting – if properly executed – can save up to 10% of upper material, meaning that a lot of money and resources can be saved
3 – Few companies really have the organisation, development, production preparation, material and components selection in place to fully take advantage of the possibilities that seat and side lasting machines offer

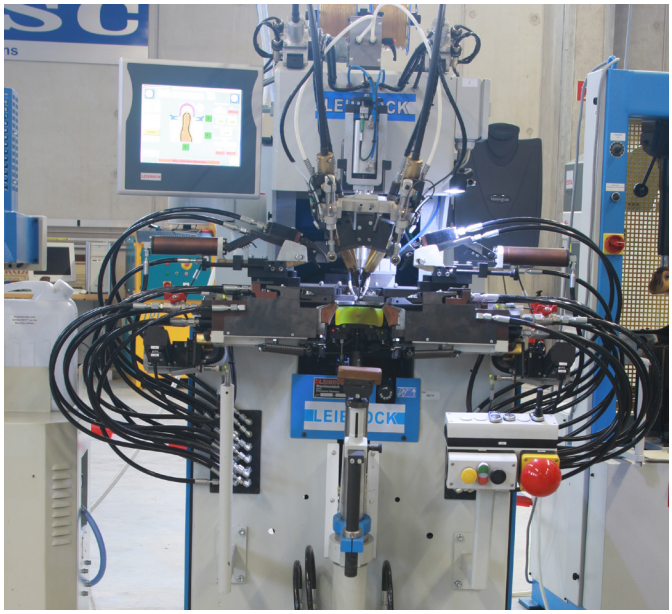
Each company has its own approach and will decide based on their specific needs.

6.4.1. Seat and side lasting machines

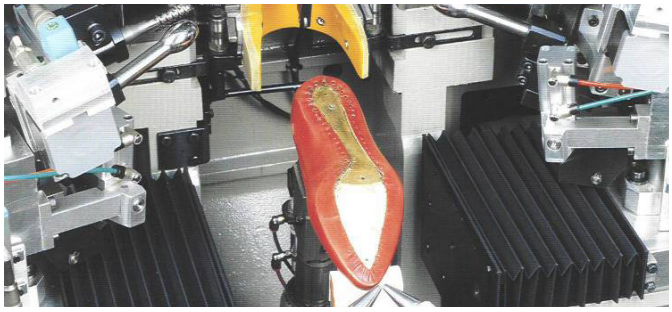
Seat and side lasting machine can work in a joint system, e.g.

- cement/cement, whereas "cement" often means "hotmelt". Alternatively a "cold" glue could be used
- nail/cement
- nail/nail
- combination of cement and nails

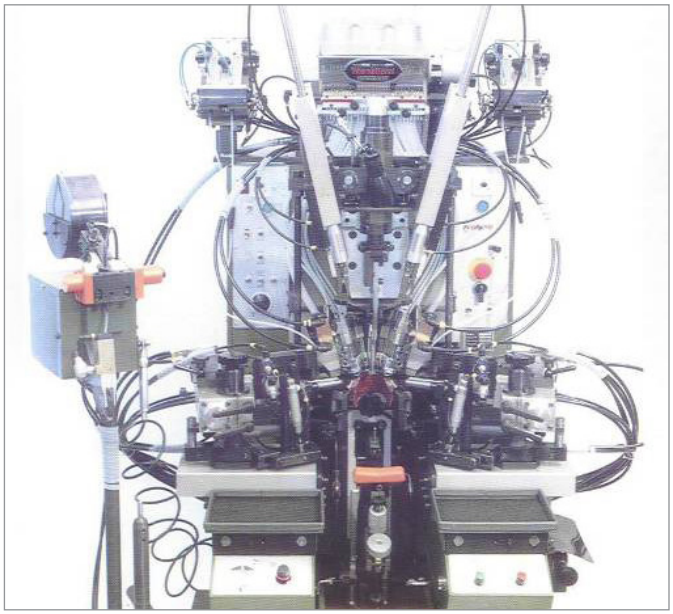
It is recommended to nail the seats when the upper materials are rigid. Seat and side lasting with nails is compulsory for high-heeled ladies' shoes. There is no preference in terms of energy consumption; the difference is just where the energy is spent.



F.100 Cement-cement seat and side lasting machine



F.101 Nail-cement seat and side lasting machine



F.102 Nail-nail seat and side lasting machine

Combined seat and side lasting machines are more complex and more expensive, they require a special training of the maintenance staff, and their spare parts are expensive.

It is difficult to say which solution is the most sustainable. Seat and side lasting machines are mainly used in high-wage countries. One machine replaces two manual side lasters, and at some companies with an output of up to 700 pairs per shift, one worker can take care of the complete lasting process if the technical design and the selection of components are appropriate.

There is another "high-tech" lasting solution where the toe, seat and side lasting machines are connected and share product data. As soon as the shoe is inserted into the toe lasting machine, the data about style, size, left or right are shared, and the seat and side lasting machine autoadjusts to the requirements of the product. This combination allows for an utmost production flexibility, but the price is so high that only very few installations can be found worldwide.

F.103 Seat lasting machine (with hotmelt or with "cold" cements applied by hand)

F.104 Side lasting machine

6.4.2. Recommendations for managers / maintenance

There are simple general recommentations

- select the correct heel band – this is very often not the case. Companies usually do not work with last standards and heel curve standards. When the heel height frequently changes, the workers often spend more time on heel adjustments than on performing the operation itself
- specify the nail sizes and the hotmelt temperature
- set the speed of movements
- define the movement of the nozzle or the nail attaching head
- set the pulling forces (in case that the machine has pulling pincers)
- define ironing force and ironing time
- specify when and how to perform preventive maintenence works and daily cleaning

6.4.3. Recommendations for workers

Each worker should

- respect the adjustments as specified by the superior technician
- properly adjust the last position (with the upper on it) before seat lasting
- perform the daily cleaning and small preventive maintenance works

6.5. Heat and cool setting, ironing

Heat and cool setters as well as ironing machines are charcterised by a high energy profile. There has been a considerable evolution in last 10 to15 years in terms of quality of the work result and energy saving.

The first reason for waisting energy is that companies do not know which temperatures are really required. They often work with much higher temperatures and longer times. Excess times or temperatures do not have any effect on shape retention.

Chilling (cool setting) is key for a good shape retention for all "non force-lasted" shoes such as moccasins, manually stitched-on soles, or the Strobel make. The most frequent problem is not a too low temperature but the energy loss due to poor insulation.

One of the solutions to save energy is to direct the energy exactly on the area where it is needed. In addition, a good insulation and returning energy to the system (i.e. heated or cooled air is being kept within the system to be re-used) also help to save energy.

Most recent heat setters work with induction heat. The heating power is concentrated on area where needed in order to minimise the energy loss.

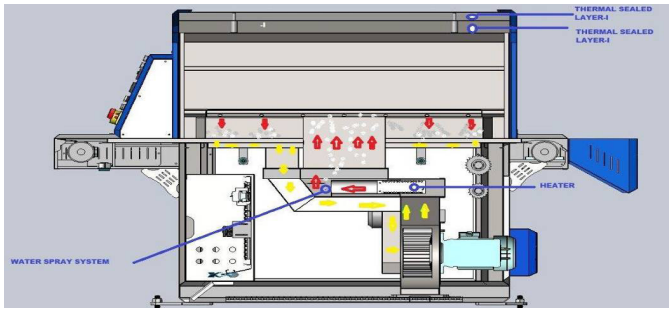
T.4 Adjustments for modern heat setters with high air speeds of 12 to 14 m/s

MATERIAL	ADJUSTMENT	TIME
Suede, nubuck, grain leathers	Moist air / 120 °C	2.5 to 3.5 min
PU coated leathers and splits	Dry air / 120 – 130 °C	2.5 to 3.0 min
PVC coated leathers	Dry air / 100 °C	2.0 to 2.5 min
PU coated fabrics	Dry air / 120 to 130 °C	2.0 to 2.5 min
PVC coated fabrics	Dry air / 100 °C	2.0 to 2.5 min
Fabrics	Dry air / 100 °C	2.0 to 3.0 min

6.5.1. Ironing machines, heat and cool setters

F.105 Ironing machine which reuses preheated air. This system can generate air temperatures up to 400°C.

F.108 Upper activation machine using induction heat



F.106 Heat setter which reuses preheated air

F.107 Chiller using an air recycling system. The longer the machines works, the less energy it needs.

6.5.2. Recommendations for managers / maintenance

Each manager should

- pre-set the temperatures
- specify the throughput times in conveyor type of machines
- specify the degree of humidity for heat setters and ironing machines
- specify when and how to perform preventive maintenence and daily cleaning

6.5.3. Recommendations for workers

Each worker should

- respect the adjustments as specified by their superior technician
- perform the daily cleaning and carry out small preventive maintenance work

7. Bottoming department

This chapter deals with the operations needed to finalise the lasted shoe and attach the sole. To start with, please always make sure that you do exactly know what kind of soling material you are confronted with and do not naturally accept what is declared.

T.5 How to find out what soling material you are confronted with

OUTSOLE MATERIAL	PVC	RUBBER	THERMOPLASTIC RUBBER	PUR	TPU	EVA
Visual examination				Expanded PUR: bubbles visible on the surface		Foamed, very light material
Beilstein Test: Copper in flame	Positive: green flame	Negative: no green flame	Negative: no green flame	Negative: no green flame	Negative: no green flame	Negative: no green flame
Contact with hot copper	Melts easily, then hardens again	Does not melt easily, then hardens again	Melts easily, then hardens again	Melts easily, resists, greasy, sticky	Easy melting, resists, greasy, sticky	Hardens
Sensitivity against organic solvents under tear stress	Negative: no cracks	Negative: no cracks	Positive: cracks	Negative: no cracks	Negative: no cracks	Negative: no cracks
Burn test	Burns in flame, self extinguishing out of the flame	Burns in flame (lots of black smoke)	Burns in flame (lots of black smoke)	Burns under melting and dripping, formation of bubbles in the liquid material, mostly no black smoke	Burns under melting and dripping, formation of bubbles in the liquid material, mostly no black smoke	Burns without melting, no smoke
Smell	Causes a slight burn in the nose	Typical rubber smell	Causes a slight burn in the nose	Causes a slight burn in the nose	Causes a slight burn in the nose	Causes a slight burn in the nose
State after burn test / cool-down	Melted part looks nearly the same as before	Black coal, dust of the burned part	Melted part looks nearly the same as before	Greasy, sticky, pasty mass	Greasy, sticky, pasty mass	Powder

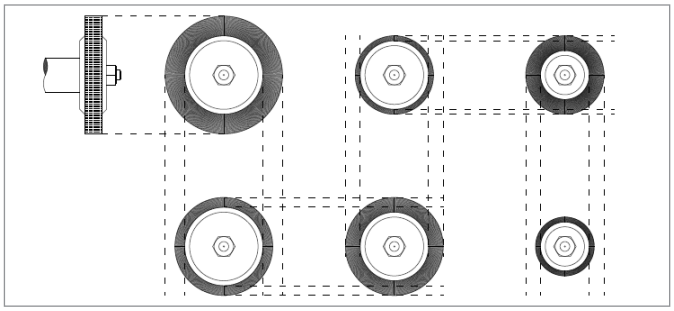
This chapter will focus on rather unknown procedures, and on the most frequent mistakes leading to reworks or rejects or can cause customer complaints. Statistically, about 70% of all customer complaints are due to a poor bond of the upper with the sole – the soles are coming off.

7.1. Roughing, washing, halogenating

The surface of soles and lasted uppers need a pre-treatment before gluing. The first preparational step is roughing. And the first frequent misunderstandig is: Roughing does not mean to deliberately damage the surface of soles or of the upper leather. The aim is to increase the surface for a stronger bond!

Steel brushes or sand papers are mostly used for upper materials. When selecting a steel bush, the important points are:

- select the proper steel wire / correct rigidity
- select the appropriate holding flanges
- protect the surface to be roughed (i.e. avoid that the wires of the roughing wheel get "vulcanised" by the sole rubber)



F.109 The brush should be about 14 mm longer than the flanges. When the brush is worn (down to 4 to 6 mm), the flanges must be changed in a way that the brush is again about 14mm longer than the flanges.

F.110 Example of a "vulcanised" wire brush

In any case, it is very important to protect the upper material from any damage through roughing.

Using sand paper is a safer method of upper leather roughing. The appropriate grade of sandpaper coarseness must be chosen. The use of "endless" sand paper is more sensitive than using individual sheets. If the upper material is really delicate, a two wheel roughing machine with endles sand paper helps to cool down the endless sand paper and prevents it from getting clogged up with melted particles.

PUR roughing

Roughing of PUR soles is safer in terms of creating a durable bond than washing the soles. PUR materials have the tendency that "damaged" sufaces slowly close back up. This is why the primer must be applied immediately after roughing.

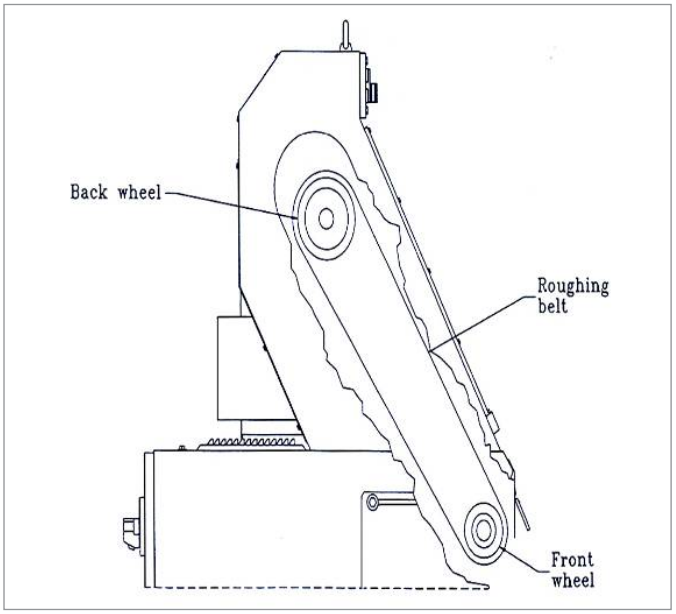
F.111 Special widia tool for 3D sole

F.112 Roughing result of the widia tool

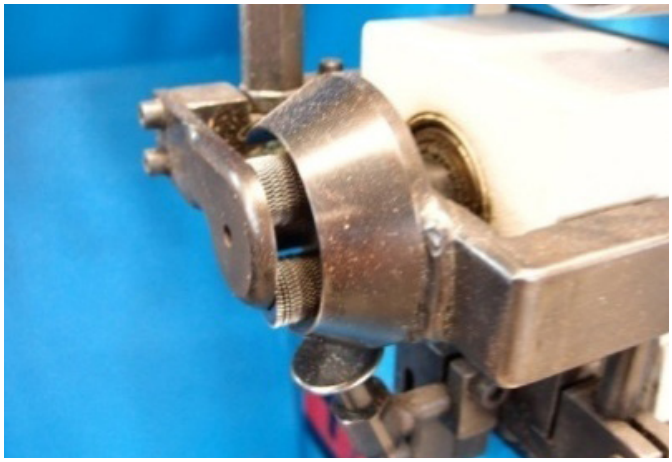
F.113 Example of a perfect roughing result. The structure strength of the upper leather is maintained and the contact area has been enlargened.

F.114 Example of an overroughed upper: the white interlining is shining through. The strength of the sole bond will now completely depend on the structure strength of the lining and interlining.

F.115 Another frequent mistake: When roughing dust remains on the surface, it will be covered with glue in the next step .... and will weaken the bonding strength.

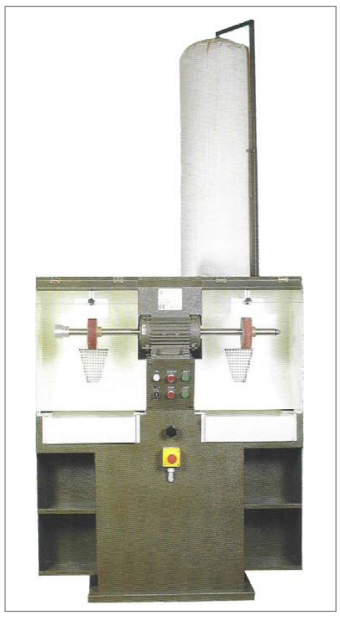


F.117 Principle of a rougning machine with "endless" sand paper. The durability of the endless sand paper is much better than in the system as shown in fig.116

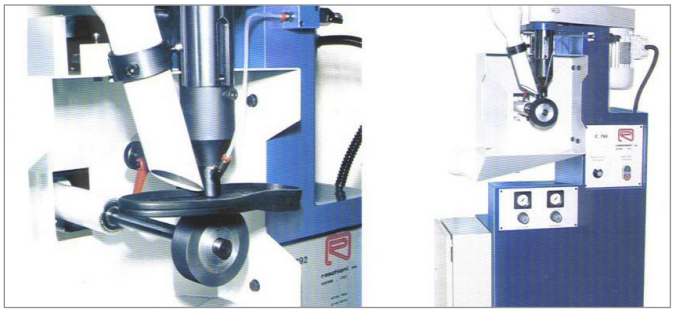


F.118 Oscillating wheels for roughing shell soles

7.1.1. Rouging machines



F.116 Basic sand paper roughing machine. Disadvantage: Can leave melted particles on the surface of the roughed upper



F.119 Roughing with widia wheels

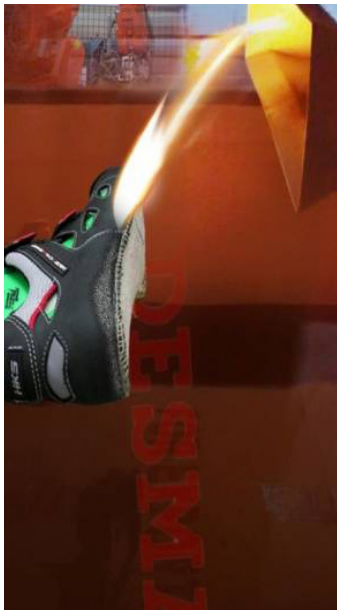
F.120 **Automatic roughing machine**

Automatic machines achieve perfect roughing results. Speed, pressure, exact position, force etc. can be exactly programmed and are precisely executed. The disadvantage is that the machine is unable to recognize shape deviations and will not react if a material presents, for example, different rigidities.

An operator will always be able to react to deviations, he can adapt focus and speed in case that the upper properties vary. If the upper materal has homogenous properties and if there are no shape deviations, an automatic roughing machine will always produce better work results than a human operator.

Silent and efficient exhaust systems are obligatory for a sustainable production. The protection of workers' health is also a must.

Each footwear producer will have to chose the most sustainable roughing method for his specific requirements.



F.121 **Automatic laser roughing machine**

7.1.2. Chemical roughing

A good sole bond takes more than mechanical preparation. In addition, a chemical process is required. The principle is based on the polarity of the materials and the used adhesive. There are almost neutral materials which have no significant polarity. They must be chemically modified to achieve an opposite polarity to the used glue. This method is called “chemical roughing”.

The substances used for chemical roughing are aggresive. They corrode not only the sole surface but they are also harmful for the health of the workers and the environment.

A sustainable approach necessitates the installion of a good exhaust system which filters the exhausted air before it is released to the environment.

7.1.3. Recommendations for managers / maintenance

Each technician must

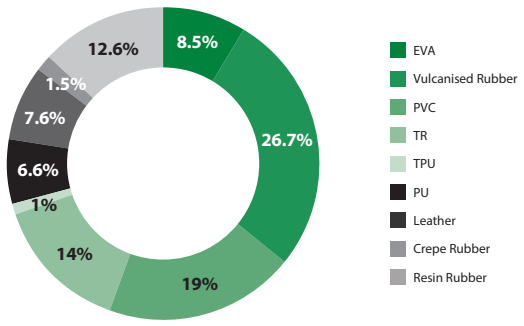
- decide which kind of machine and which kind of tool should be used
- perform tests together with the machine operator and prepare examples of good and bad work results
- check the level of noise and dust at the workplace and take the appropriate measures to protect the health of the worker
- prepare safety rules for the operator
- prepare safety and fire-fighting instructions for the case that the hot roughing dust catches fire
- specify preventive maintenence works and daily cleaning

7.1.4. Recommendations for workers

Each worker should

- follow the instructions of his/her superior technician
- be able to distinguish good and bad work results and adapt the operation to achieve the required results
- be able to carry out the daily cleaning and perform small preventive maintenance work

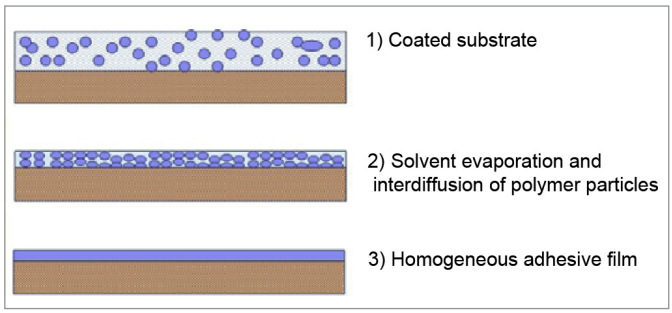
7.2. Gluing and pressing



F.122 Statistics on the global usage of different soling materials (source: ...)

Soles and uppers are bonded together by means of adhesives.

How to perform a gluing operation is basic shoe making knowledge. For a sustainable approach, you need to know that glues are solutions of polymers in solvents or water. Solvent-based adhesives contain about 80 % solvent and 20 % solids.



F.123 Stages of glue directly after application up to the stage of activation and gluing

As soon as 80% of the solvent (or water) have evaporated, the surface is ready for activation and gluing. 50% of the solvents evapotare within the first minute after application.

The final bond is up to 20% stronger if the glue is "whipped" instead of simply poured and spread. A thin glue coat actually creates a stronger bond than a surplus of glue.

Exposition to strong heat during the drying (evaporation) process can create a rather dry "shell" on the surface but underneath the adhesive is still fresh and not dry. This is a risk which concerns particularly hot and humid climates.

When using a two-component-glue, the hardener is only applied to one side of the two surfaces that are to be bonded together.

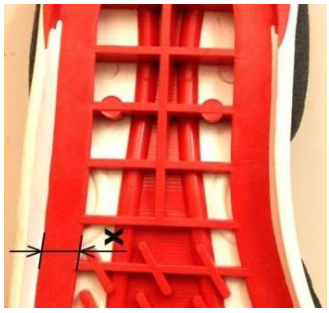
At least one of the two surfaces should be properly activated at the required temperature. Just in case that high temperatures may damage the upper material, it is not necessary to perfectly activate both sides. However, if feasible, a proper activation of both sufaces is recomended to obtain a perfect bond.

Excess amounts of halogenating agent can cause rapid aging of the soling material. Therefore avoid any surplus, and turn the sole upside down for some seconds after the application of the halogenating agent. Avoid contact with metal because metals can lower or totally foil the effect of halogenation.

Excess amounts of glue and solvent covered under a "shell" as shown in fig.117 can inhibit a good bond. The effects can show already few days after production, or several weeks or months later.

The sole design must provide a minimum of a flat surface (see fig. 118) for bonding. Sometimes the cost containment efforts leed to the mistake that the flat surface which is crucial to create a good bond is too small.

F.124 Excess of glue



F.125 It is crucial for a good bond that the sole has a flat area of a certain size

7.2.1. Selection of glues according to upper and soling materials

Before the actual gluing process, most soling materials require a pretreatment:

- **PUR:** cleaning or roughing, de-dusting, primer
- **TPR:** halogenating
- **PVC:** cleaning
- **Rubber:** roughing, de-dusting, cleaning,halogenating
- **EVA:** roughing, de-dusting, UV curing, primer
- **TPU:** cleaning, primer
- **Leather:** roughing, de-dusting, primer

Cleaning / Washing

Cleaning is done with solvents. Primers are special solvent-based glues which must be selected according to the soling material. Carefully read the paragraphs on harmful substances in the material data sheets before you decide which cleaning agent to use and how to protect the health of workers.

As soon as roughing is completed and the soles are prepared, the glue can be applied.

7.2.2. Gluing process (according to the shape and type of the sole and the machinery available for activation, drying, pressing...)

There are different methods of glue application. Fig. 119 shows a very basic and correct manual application. The brush is rigid and has the size of the area to be treated without leaving excess amounts of glue. Rigid brushes can rub the glue into the material. During glue application, the worker holds the sole slightly inclined to apply the glue evenly and to make sure that all corners are coated. The risk of a possible surplus of glue (which could run into the sole cavities) is minimised. The glue has a luminiscent additive which makes the quality of the glue application visible under the light of a UV lamp. The work area is exhausted from beneath because at room temperature solvent vapours are heavier than air.

F.126 Manual glue application

Robotic systems with shape (position) scanning devices have permitted the development of new glue application methods, for example this one:

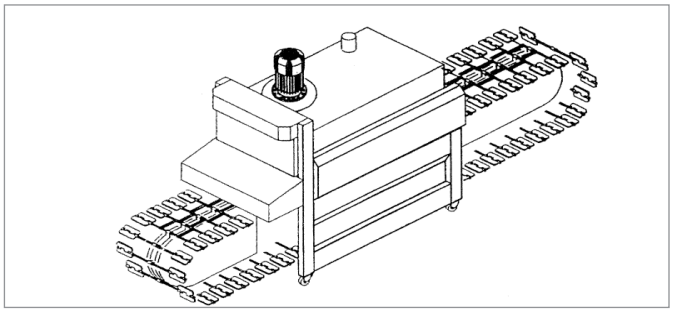
The sole is placed in a random position onto the active working area or on a belt. A scanning system recognises size and position of the sole. A robotic arm equipped with a spray head applies the exact quantity of glue exactly where needed. This system represents not only a new quality level of glue application but can almost 100% protect the worker from solvent vapours. Soles can even be treated in advance if no hardener is required and if the sole can be stored in an absolutely dust-free area.

F.127 Automatic gluing

Which gluing method is the most sustainable will depend on each individual company, its size, product types, production volumes etc.

The next step after gluing is drying. The worst solution is open air drying because it is difficult to control. The drying time is affected by temperature, humidity, and air movement, and harmful substances can be released in an uncontrollable way.

A glue dryer and activator as shown in fig. 129 is a solution to control the drying parameters and its environmental impact. It works the following way:

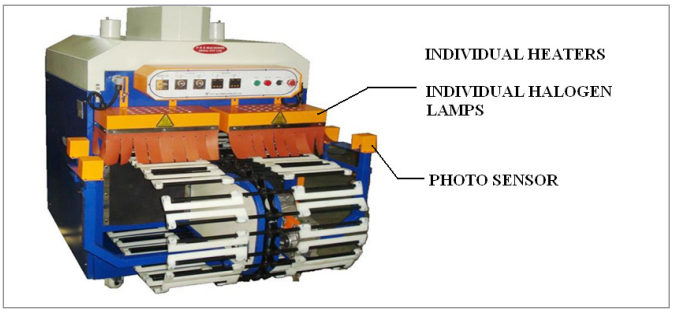


F.128 Drying and reactivation machine

After glue application, shoe uppers and soles are inserted into the drying tunnel. Inside the tunnel, the air (often heated air) circulates at high speed to dry the glue and to flash activate it at the end when the required glue activation temperature is achieved.

Important for glue drying

Rapid drying in a very humid environment can have an unwanted reverse effect. A type of "shell" forms on the glue surface and stops further evaporation. The glue under the shell stays liquid. Conclusion: Elevated temperature is not necessarily the best solution for glue drying but it is necessary for water-based glues to dry within an acceptable time span.



F.129 Typical example of a glue dryer and activator

Conclusion: The drying conditions are easier to control when the lasted shoe and the sole enter into a closed space – for example a glue dryer and activator – where they can dry and get activated under ideal conditions. Workers cannot speed up or delay the process.

Breaks require a specal arrangement. During a break, the shoes must not stay in the machine, meaning that either the operator who applies the glue starts his break earlier or the persons placing and pressing the soles start their break later.

Glue drying and activating systems consume a lot of energy. So called "closed" systems save energy but require special safety measures because if, for example, an air fan fails, the high concentration of solvent vapour risks to blow up.

Drying machines are often referred to as the ideal solution for the working environment but not many shoe technicians know that about 50 % of the solvents evaporate during the first minute after glue application. The entry area of drying machines, where the shoes and soles will travel at slow speed for about two minutes, is often not equipped with an exhaust.

Glue drying systems as they are used mainly for sport shoe production in East Asia represent an extreme waste of energy and space, but can – on the other hand – achieve high quality bonds and keep the evaporation of harmfull particles under control.

F.130 Sport shoes production in East Asia

Vacuum drying systems (fig. 124) represent an effective and compact drying solution especially for water-based glues. Air movement and elevated temperature are kept within a very restricted area. A reduced-pressure atmosphere surrounds each shoe and sole, which considerably accelerates the drying process. These compact systems could be a more sustainable solution and could replace the space-consuming and energy-intensive drying systems commonly used in Asian sport shoes productions.

F.131 Simple vacuum dryer

F.132 Drying line with vacuum dryers

Placing and pressing of the sole are the final steps of the sole bonding process. There are no harmful particles released. The operations do not offer possibilities to save energy. The main focus is on quality, i.e. on the creation of a durable bond.

The frequent mistakes start with activation: Technicians often forget that soles are three-dimensional objects and must be properly activated.

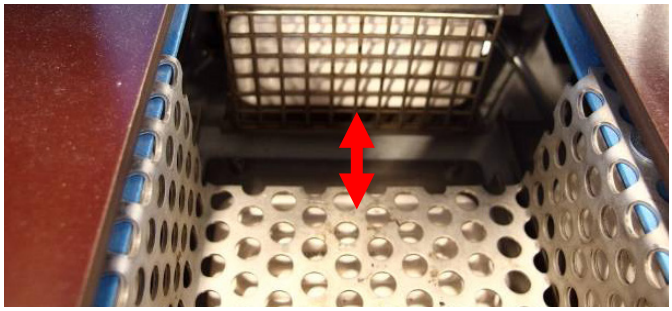
The temperature of the heating bodies in sole activating devices as well as their activation time are often fixed. The only variable left is the distance. Some activation systems can be adjusted in a way to achieve a similar distance for three-dimensional shapes and the whole size assortment. Two-dimensional heating bodies, where the only possible adjustment is to change the height of the sole support, are not necessarily the ideal solution for three-dimensional sole shapes.

Successful gluing

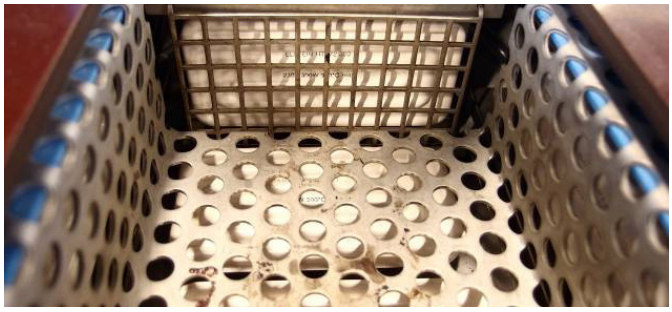
The colour and the type of surface of a material influence its ability to absorb radiation heat. Please review and test activation times and temperatures even for the same material in different colours!

F.133 Sole activation device

F.134 Adjustable height of sole support with separate adjustable heel support



F.135 Position of heating bodies / adjustable-position for big sizes



F.136 Position of heating bodies / adjustable-position for small sizes

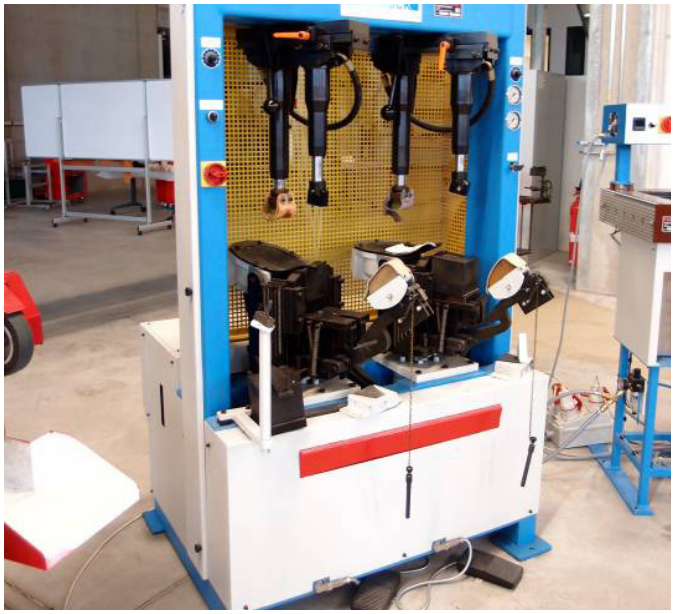
Sole pressing machines are either hydaulic or pneumatic. With hydraulic presses, you sometimes may face the problem of uneven pressure distribution, but they can create a higher pressure than pneumatic systems.

Pneumatic systems with a double membrane can process all kinds of soles. Certain sole types with high side walls and soft inserts in the midsole initially only require lateral pressure. The full pressure must only be applied when the sides are firmly fixed. This procedure guarantees that the soles do not move and that they are precisely placed within the marked and roughed surface where the glue has been applied.

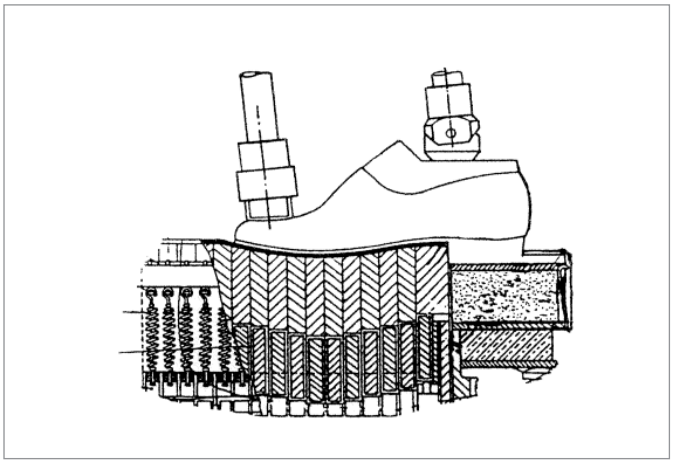
A frequent problem with membrane sole presses is the compressed air supply. Some shoe factories ignore the fact that these machines require an operating pressure of 7 to 8 bar and in addition large quantities of compressed air. The machines must be equipped with a compressed air connector of the required diameter. It is quite common that shoe factories use way smaller tubes which cannot deliver the required volume of compressed air. In consequence, during the major part of the time span where the sole is supposed to be under full pressure, the machine is still busy filling up with the necessary supply of compressed air. The full pressure is often only achieved few some seconds before the machine opens.

Rule of thumb for sole pressing

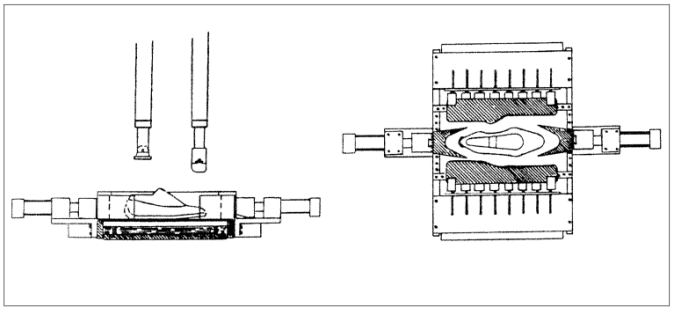
The "safe" settings for almost all soles presses is a pressure of 6 bar and a pressure time of 8 seconds. Some sole types achieve a good bond in less time and with less pressure, but if you want to be sure, work with 6 bar and 8 seconds for a durable bond.



F.137 Hydraulic sole press

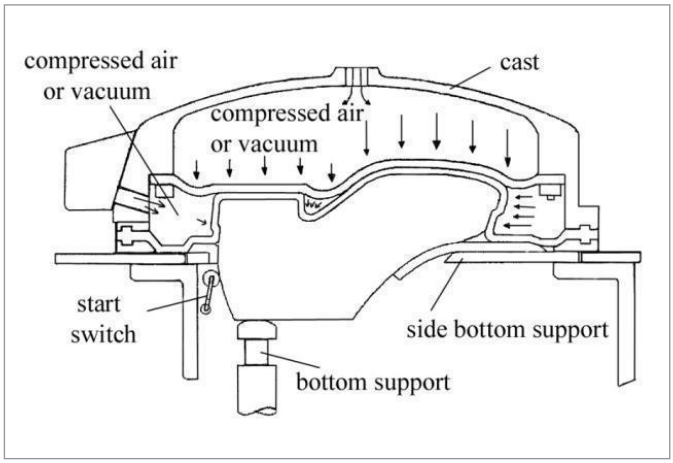


F.138 Two-dimensional hydraulic sole press



F.139 Three-dimensional hydraulic sole press

F.140 Double membrane pneumatic sole press with sole activation machine



F.141 Pressure distribution in the double membrane of a pneumatic sole press

F.142 Connector of a pneumatic sole press. The correct dimension is necessary in order to supply the machine with the required quantity of compressed air

7.2.3. Recommendations for technicians

Each technician should

- send each new sole and upper material to the glue supplier in order to carry out laboratory testing and to get recommendations for the gluing process to achieve a durable bond
- select the most suitable machines and devices
- carry out practical tests and prepare process instructions for the workers, i.e. specify
  – temperatures
  – duration of each proceses step
  – pressure
- specify the checking points and prepare documents to keep record of each check
- prepare a time-recording system especially for drying in case that a two-component glue is used
- check and re-check the drying process especially in a humid climate or if there is a temperature change
- specify a random test system to check the bond quality
- check the efficiency of the health protection of workers
- specify how and when to perform preventive maintenence works and daily cleaning

7.2.4. Recommendations for workers

Each worker should

- follow the intructions of his/her superior technician
- learn to recognise any deviation from the ideal process
- follow the instructions for health protection
- perform the daily cleaning and small preventive maintenance work

8. Finishing department

As regards finishing, the processes and measures which deserve to be called "sustainable" are already commonly known. The most important points are:

- always give preference to waxes and creams; avoid sprays because they represent a risk and necessite expensive exhaust systems (in addition, it is complicated to clean filters, tubes etc.)
- install efficient exhaust systems if solvents cannot be avoided
- preferably use water-based finish products

F.143 Spray finish booths with a strong exhaust system

F.144 Example of shoes made of natural-coloured crust leather

Use crust leather

There is one technique which represents a significant improvement in terms of environmental impact: It is possible to order crust leathers in a natural colour. Crust leather is finished regarding its physical and mechanical properties, but has neither been dyed and nor finished at the tannery. Finish products are only applied at the final stages of shoe manufacturing (see fig. 137). The advantage: the leather waste is free from finish products, which opens up wider possibilities to recycle it.

9. Process organisation

In order to increase productivity, the emphasis must be put on the organisation of the overall production flow as well as of each single workplace.

Most companies believe that they already do the utmost to boost productivity by buying standard machinery and worktables as they are available on the market, and to organise operation by operation according to the technological standard.

Rule of thumb: Minimise work in progress

If you want to go beyond standards and improve productivity in a sustainable way, it is key to organise the entire production process in a way that minimises work in progress. Minimised work in progress automatically reduces the percentage of reworks and rejects because the final work result can be checked within 24 or 48 hours and corrective measure can be taken fast and in a very effective way.

The second area generally lacking efforts to achieve improvements is the organisation of the individual workplaces. Typically, workers lose time searching for the proper part, worktables are rickety, there is no well organised system to place materials, components or work pieces, the worktables are not spacious enough or, on the contrary, they are oversized, which complicates passing on the processed parts.

Process organisation should start with

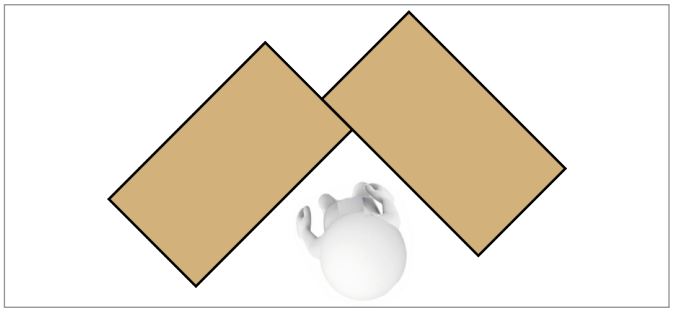
- organisation of the individual workplaces: Make it a guiding principle to add as much value as possible once a part is in the hand of an operator. Think about the best way of transition to the next work station, i.e. into the hands of the next worker. Always place the finished parts in an identical way when they are returned into a box because this facilitates the handling for the next operator.
- conduct time studies of each individual operation once it is organised in the best possible way
- organise the production flow using appropriate transport systems and machinery

F.145 Even with a basic old machine but with clearly organised materials, precise working instructions, and a good performance of the worker, the result can be just as good or even better than with a very recent high-tech machine

F.146 At this workplace, large skived pieces frequently fell down. A small box placed next to the machine solved the problem and increased quality and productivity

F.147 Some designs need a larger area to be placed on. This worktable extension (a simple board) is a cheap solution and saves a considerable amount of manipulation time

F.148 In this production, precise glue application by brush was problematic. A small bottle equipped with a textile tip and a larger can with a glue supply for 2 to 3 hours permits exact glue application and reduces the solvent evaporation in the working area.



F.149 Example of a standing workplace with two mechanical skiving machines, each adjusted for a different type of skiving and both being operated by one worker. This combination can replace an automatic skiving machine.

Any production planning starts with time calculation. In this context, there are three important terms you should be familiar with: Cycle time, production lead time, and takt time.

Cycle Time / Value Added Time

Cycle time describes how long it takes to complete a specific operation, i.e. when value is actively added (without the time the item being worked on is waiting on a trolley / transport times on a conveyor / handling times). Cycle time can be measured with a stop watch.

Manufacturing Lead Time

As we said above, cycle time is the time span during which a work piece is being worked on; it is referred to as value-added time. Preparation, transport, waiting and handling times are referred to as non-value-added times. The term "Production Lead Time" refers to the total time – value added and non value added – it takes a product to make it through a production line.

Value stream maps are excellent tools for determining the Production Lead Time (fig. 150).

Takt Time

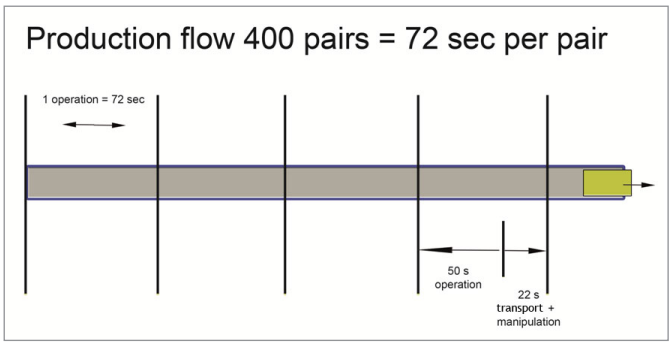
The word "takt" is German and signifies "pace" or "rhythm". Takt time is the production pace per item, meaning how many minutes it takes to produce one item. For example, the output of your stitching department is one upper every 72 seconds = 400 pairs in a working day of 480 minutes (see fig. 150).

Knowing takt time will enable you to estimate how long it will take to produce a customer order.

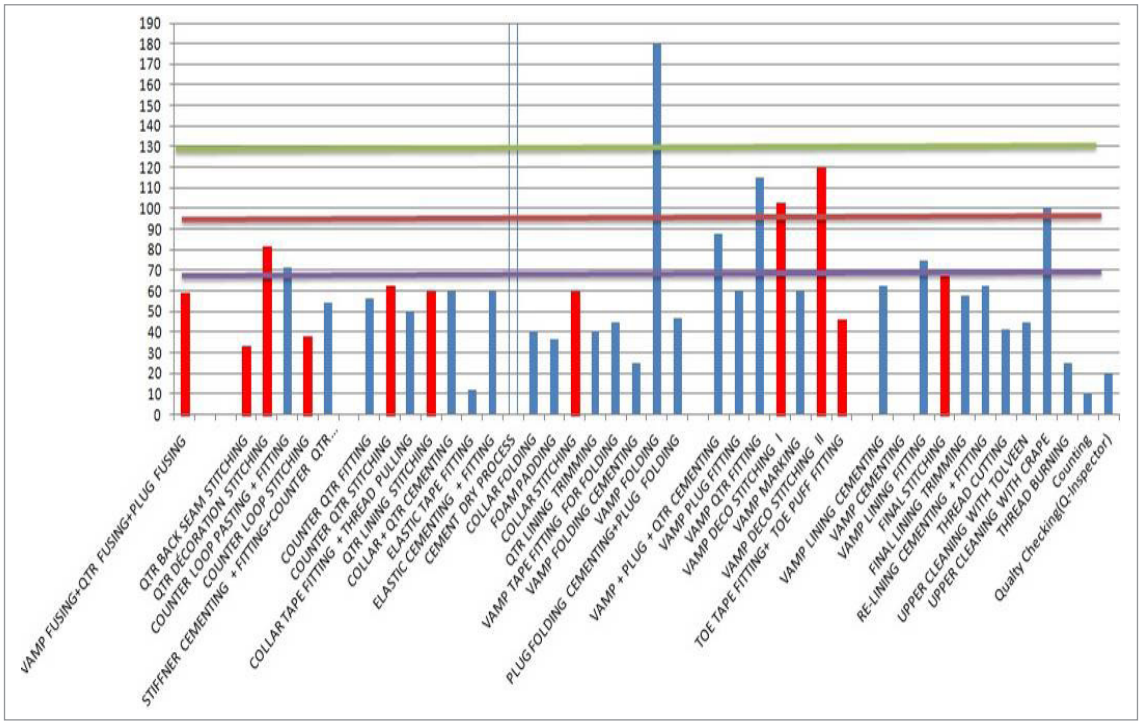
The formula for takt time calculation is:

Available production time / customer demand

Takt time cannot be measured with a stop watch. It can only be calculated.



F.150 Example of a basic takt time calculation



F.151 **Time studies can serve as a base to improve the production organisation**

There are different possibilities of how to organise the production process. As an example, we will look at the stiching department because of the diversity of operations.

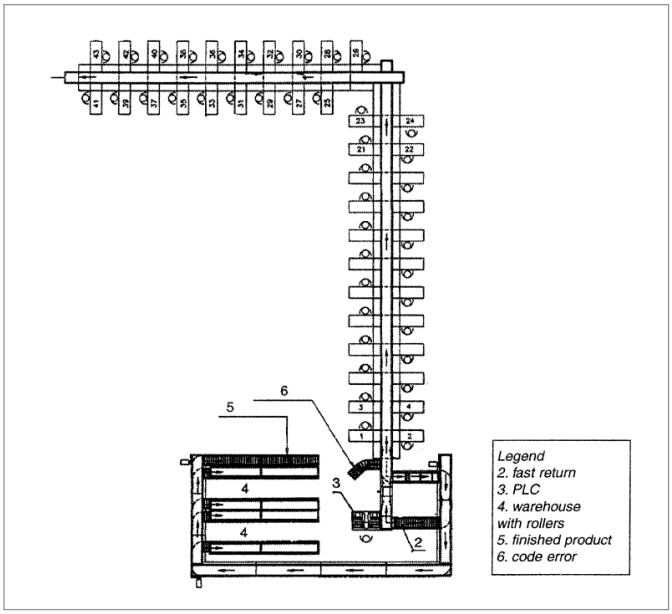
It is quite common that companies with bulk orders or combinations of several designs in parallel work with a system called **"Feeder-Operator-Feeder".**

The advantages of the **"Feeder-Operator-Feeder"** system:

- all machines and workplaces can stay in their positions. A conveyor system transports the workpieces in boxes from one workplace to another.
- several different shoe designs can be produced in parallel
- the line can be easily balanced by alterning the number of operators doing the same operation

Disadvantage of the **"Feeder-Operator-Feeder"** system:

- huge amount of work in progress
- limited possibility to check the quality of individual operators
- requires highly skilled operators who are able to self-monitor their work result

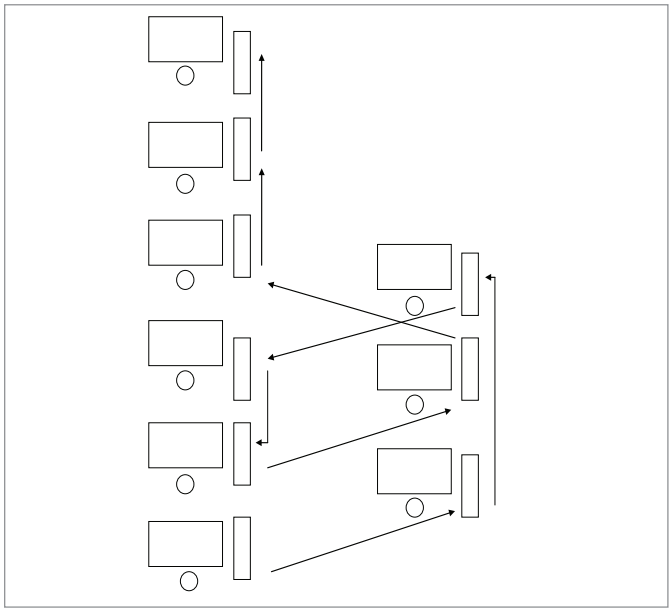


F.152 **Principle of the "Feeder-Operator-Feeder" system**

Another organisational principle is the **"Free feeding system".** Techicians move the work in progress from work station to work station on trolleys which carry the boxes containing the work pieces.

The **"Free feeding system"** has the same advantages and disadvantages as the Feeder-Operation-Feeder system, but presents additional advantages:

- as this is system does not depend on a conveyor, work stations can be grouped to "islands"
- as there is no need for a conveyor, the space can be organised in a more effective way
- the technicians moving the boxes with the workpieces can immediately check the quality



F.153 Principle of the "Free feeding system"

TTS – Toyota Stitching System

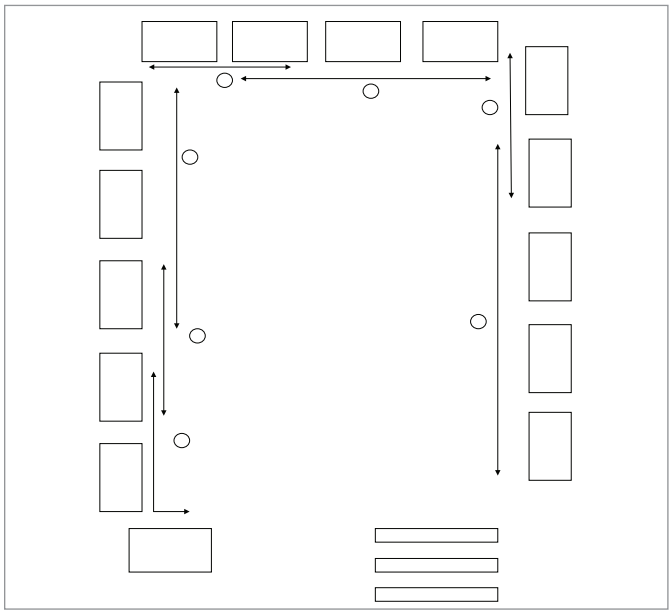
The Toyota Stitching System is is one of the most effective systems to achieve both high quality and high productivity.

Advantages:

- top productivity
- minimium work in progress
- a shoe can be completed from cutting to the box within 24 hours

Disadvantages:

- the system only functions with multi-skilled workers
- more machines are required because each operator works on several machines or workplaces



F.154 The Toyota Stitching System

Conveyor-type organisation

In the conveyor-type organisation, all workstations are placed along a conveyor belt. The length of the conveyor belt as well as the number of work stations are fixed.

Advantages:

- low-skilled operators are pushed to follow the flow
- the fixed speed partly replaces the function of an unexperienced foreman

Disadvantages:

- the operation with the longest duration defines the speed of the complete line
- the work in progress is high
- there is fixed idle time
- it is time-consuming to take the workpieces from conveyor and to place them back onto the conveyor once the task is´completed

F.155 **Circular conveyor-type organisation. Start and end position are identical**

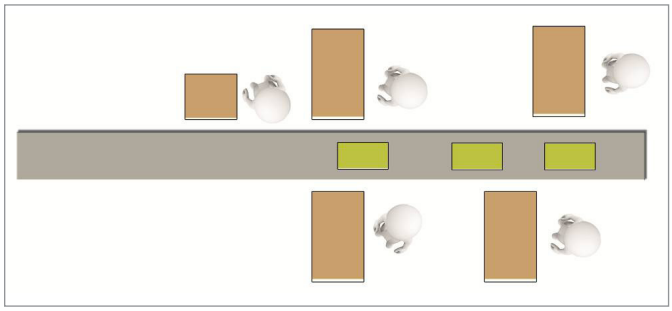
Zigzag line organisation

One of the simplest and most effective systems is the **"zigzag line organisation"** where the workers push the boxes with the workpices by hand to the next operation.

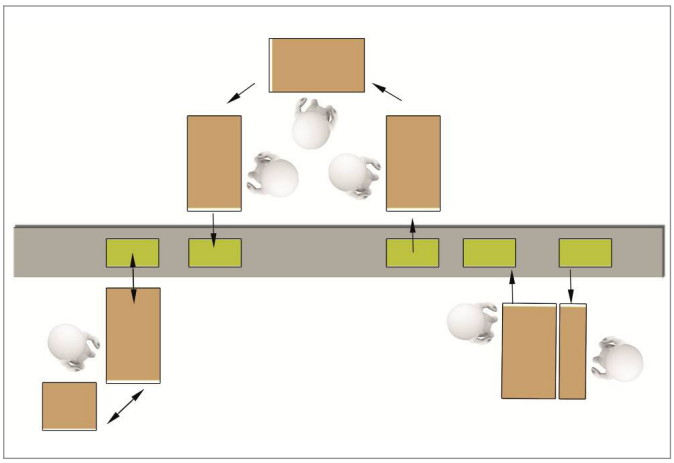
Disadvantages: none / not known

Advantages:

- the system offers many possibilities to balance the line, from sharing the same job to split complicated operations to left and right shoes, to two workers executing three and more operations, including working islands, letting one worker execute part of the following operation, etc.
- no fixed idle time. If the balancing is good, the manual pushing of the work pieces to the next position takes only very few seconds
- easy to identify bottle necks



F.156 **Principle of the zig-zag organisation**



F.157 **The zig-zag principle offers many different possibilities of how to organise the job and to balance the line**

10. Production planning

There are some general principles for production planning which help to stay flexible:

- minimise the work in progress in order to have less money blocked in production
- subdivide orders into small lots (100 or 144 pairs depending on delivery assortments)
- finalise the shoes as fast as possible (on the day of cutting or the next day)
- one box should carry one pair of shoes

If the quality checks detect problems in the first lot, immediate action can be taken to correct the mistake. The result is less reworks or rejects, precise planning and a fast production throughput.

For direct injection, is recommendable to divide orders into suborders to create small production lots. Direct injection also requires a precise planning of the mould changes.

T.6 Example of how to subdivide an order of 1450 pairs into small lots

36	37	38	39	40	41	42	SIZES
100	200	250	300	300	200	100	1450
14,5	14,5	14,5	14,5	14,5	14,5	14,5	Unit 100 pair
=	=	=	=	=	=	=	
7	14	17	21	20	14	7	Must be used 14,5 x 100
98	196	238	294	280	196	98	
-2	-5	-12	-6	-20	-5	-2	Balancing plan will start

11. How to achieve and maintain a sustainable production process

So far this publication has focused on the most commonly used production processes which are labour-, space- and material-intensive.

Our team believes that the newly developed production methods which could be revolutionary in terms of "sustainability" have not yet been able to come up with shoes offering the properties and look which would satisfy a significant number of customers.

Thus our aim is to focus on existing processes and start to eliminate waste. "Waste" in production means:

- overproduction
- high material consumption
- high energy consumption
- excessively large production spaces
- low productivity
- high percentage of rework
- high rate of reject
- late delivery / air delivery
- excessive raw materials consumption
- overemployment
- inventory
- waiting
- searching
- pollution.

We believe that a practical, solution-oriented approach and solid know-how are more important than working with the latest high-tech machinery (which are often only exploited to around 30 to 40% of their real abilities).

Our main conclusion after years and years of research and expertise gained working with many companies world-wide is: The technical management of a company has a way bigger impact on efficiency and sustainability than any non-professional investment in machinery.

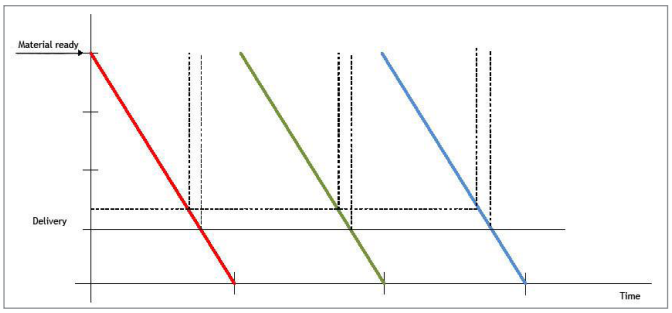
That is why we added a section explaining the most successful managing methods for any industrial process (some of them are applied beyond industrial processes).

11.1. Pull system

Pull System (Kanban)

The Pull System is a scheduling system for lean and just-in-time production and also serves as an automatic inventory system for internal use (in the factory) and between factory and suppliers. The aim is to work with a minimum of inventory. As soon as a material is consumed, it will be re-ordered.

This also permits an extraordinary visibility between suppliers and buyers. According to the Kanban principle, a company only works with validated suppliers. The cooperation rules define exactly when the goods should be ordered at the supplier to reach the company some time (buffer time) before production. Delivery is in small units and payments are settled only for the delivered quantity.



F.158 Graph visualising when a material must be available for production and when it must be delivered for the continuous production

11.2. Just-in-time (JIT)

"Just in time" means to organize the production in a so-called "pull"-system according to the delivery requirements of the customer.

The result of the "pull"-system together with Just-in-time production should be a closed circle. Production lots are subdivided into small units according to the ordered delivery quantities.

The majority of shoes are produced at huge distances from the destined markets. Components often have to be imported. Procurement (the purchasing department) is often reluctant to order according to JIT and prefer bulk oders. The decision making managers should always keep in mind that leathers and soles account for about 50 %, sometimes up to 70% of the material cost of a shoe model and that these materials are often sourced locally meaning that ordering these items according to the JIT principle definitely has an influence on cash flow which is not be underestimated.

11.3. Heijunka

Heijunka means to organize a **production mix** according to the time requirements of different buyers and different designs. The Heijunka principle has been conceived to produce small lots with a minimum loss of productivity.

It is a privilege of only few big brands to be able to place big order volumes at different factories therefore giving them the chance to produce the same designs over relatively long periods of time. If footwear manufacturers develop the ability to deal efficiently with small lots and frequent model changes, they become interesting for smaller brands to place orders. It is preferable to not dependend on only one or two main customers.

It is quite common that Asian shoe factories produce for one big customer; they are often fully booked for one season but cannot keep up a constant production flow for the following season, hence facing the problem of an underutilisation of their capacities.

11.4. Continuous flow

"Continuous flow" means to organise production with minimum or even no buffer (work in progress) between departments or individual operations. This is key to success for any production.

In footwear production, mistakes which are made in the beginning of the value-creation process (such as cutting, skiving or splitting) often only come to light at lasting or sole setting. Unfortunately, at this point about 80% of all operations are completed, and the capital bound in material, labour and energy risks to be lost.

11.5. TPS – Toyota Production System

The Toyota Production System maximises the ratio between added value time and idle time by eliminating overburden, inconsistency, and waste.

The principle is to add as much as possible value at the moment when the work pieces are held in hands. In consequence, this means that several machines, workplaces or devices are required for on worker.

There are mainly standing workplaces and the factory flooring needs to have shock-absorbing properties. The workers walk the work pieces from one work station to the next.

The need of more machines is compensated by a several times higher productivity than traditional production systems.

11.6. Gemba

"Gemba" is an approach reminding the management to focus on where the value is created: on the production floor. The reason why this principle was developed is the finding that managers risk to take wrong decisions when they are too distant.

"Gemba" recommends technicians on a managerial level to perform each operation in order to experience whether a process runs smoothly or needs improvement. "Hands-on" practical experience is often the only way to recognize and elimite problems.

The fig. 153 and 154 illustrate a case that really happend: A worker had been placed at a newly delivered machine. She could only stitch at very high speed and was unable to follow the line to be stitched. In consequence, she got shouted at by a supervisor. After one hour, a technician tried the machine and the problem was immediatelly discovered. The new machine had its speed pedal in a wrong position; something that nobody would ever have expected. Thanks to the practical trial of the technician, the problem was discovered and solved.

F.159 Wrong position of speed treadle

F.160 Speed treadle in correct position

11.7. Poka-Yoke

"Poka Yoke" is the name of an error proofing system. It is based on automatic or human detection of errors. The goal is error prevention.

The principle is the following: An experienced technician is able to spot the operations which need checking and can specify what should be checked, how it should be checked as well as what good work result looks like and what should be rejected.

The disadvantage of shoe production is that there is almost no chance to detect mistakes automatically. Nearly all checks require a person. It is highly recommended to train workers to be able to self-monitor their work and place additional quality control technicians only at key operations.

11.8. TPM – Total Productive Maintenance

"Total Productive Maintenance" is an approach to maximise operational time and to reduce idle time. It focuses on:

- operator training and machine maintenance
- preventive maintenance
- proper technological adjustment
- correct tools
- minimisation of temporary solutions

It is empirically proven that if this system applied in a factory with old machines, it will "beat" a company equipped with modern machines in terms of quality and productivity where the maintenance personnel is inactive while waiting for problems.

This system can be combined with a stock system of spare machines (mainly for cutting, preparation and stitching). In case of machine failure, the defective machine is immediately replaced. The maintenance person will stay and help at the worker at the changed machine until the new machine is fully operational.

11.9. SMED – Single Minute Exchange of Dies

"Single Minute Exchange of Dies" is the name of a system to reduce changeover times from one product to another to improve the production flow and represents an additional support to keep a good production flow even if the shoe models change frequently.

The methods used for this are:

- document all changeovers
- measure changeover times
- define actions to shorten changeover times
- implement actions
- run the production with shorter changeover times
- keep looking for possibilities to accomplish operations faster

11.10. Theory of Constraints

The "theory of constraints"-system identifies the most important limiting factors (bottlenecks) in order to improve the production flow and to eliminate the limiting factors.

Methods used:

- **Identify constraints**
- **Exploit:** quick action to improve the utilisation of existing resources
- **Subordinate**: review all other activities with constraints
- **Elevate:** if the constraint still exists, invest time and resources to improve it
- **Repeat** from "identify constraints"
- **Change** the system if there is no way to further improve the existing system

11.11. Short Interval Control

"Short intervall control" is a system to collect data to improve a process.

Methods used:

- collect real time production data
- identify causes of defects in the production based on these data
- share best practice
- solve problems
- new cycle

11.12. OEE – Overall Equipment Effectivness

Let's imagine the following situation: A problem has been identified by the technicians and the solution would be to buy a new machine. They manage to persude the general manager, the manager persuades the owner. Finally the owner and the general manager travel to an exhibition and buy a machine, often the cheapest version. This approach is not professional.

A professional approach requires:

- gather information on the equipment variations available on the market
- conduct a benchmark study of the effectiveness of your equipment
- calculate
  - availability of after-sales service
  - performance / productivity
  - quality
- write down the requirements of your own production

12. Management tools

To complete our list of influencing factors to make a shoe production more sustainable, we will take a look at managment tools to detect the potential for improvement.

12.1. Hoshin Kanri

"Hoshin Kanri" is a method to achieve strategic goals.

Basic rules:

- focus on five (or less) goals
- effectiveness
- doing the right things to take the company to the next level
- evolution vs. revolution
- goals should be achieved through permanent improvement = evolution
- top down / bottom up
- top managers should consult the middle management before taking strategic decisions
- wwn the goal
- each goal should have a specific owner

12.2. Improve the Production Today

This method applies to even low management levels on a daily basis.

The main questions are:

- Do we meet our shift target?
- What could be improved?
- Which action can be taken immediately?
- Which action should be taken to achieve permanent improvement?
- Documentation
- Share

12.3. Managers and leaders

A frequent managing mistake in small and middle sized companies is the concentration of responsibility and decision making. All problems are being reported to the same person. As a reult, solutions often do not come at all, the come late or they do not really solve the problem.

At big companies, the opposite problem occurs: Managers avoid to take decisions to not make mistakes and get fired.

To avoid problems of this kind, the solution is to establish positions of managers and leaders with the following tasks:

- Manager
  - Plan
  - Budget
  - Control
  - Problem solving

- Leader
  - Inspires team
  - Attracts members with new ideas
  - Promotes team action

12.4. Role of managers according to John P. Kotter

Here are some inspirational ideas from Harvard professor, business consultant and best-selling author John P. Kotter:

- identify opportunities and potential problems
- create the guiding coalition
- develop a vision and a strategy
- communicate the new vision
- give the power to change
- create short-term success
- support the gains – increase their power
- align the changes to the company structure and behaviour

13. Test of Knowledge

To test your knowledge on sustainable footwear manufacturing, please tick the best possible completion of the phrases respectively choose the correct answer to the questions listed below:

Q1. 3D CAD systems …

- ○ help to preselect the best design.
- ○ save grading time.
- ○ help to select upper materials.

Q2. CAM cutting machines …

- ○ reduce the number of cutting dies.
- ○ considerably speed up the cutting process (compared to a skilled operator working on a hydraulic cutting machine).
- ○ can be operated by unskilled staff after a brief introduction.

Q3. Cutting boards …

- ○ should be stored in a cool place (temperature < 30 °C).
- ○ must have a hardness of < 70 Shore for leather cutting.
- ○ must be stored in a horizontal position on a level surface.

Q4. Some cutting dies can complete additional operations such as …

- ○ punching and marking.
- ○ splitting and punching.
- ○ ironing and skiving.

Q5. Cutting boards …

- ○ punching and marking.
- ○ splitting and punching.
- ○ ironing and skiving.

Q6. Talking about splitting machines: What are the appropriate grinding stone diameters?

- ○ The diameter of the upper grinding stone should be about 10 mm bigger than the bottom grinding stone to keep an identical bottom and upper angle of the blade.
- ○ Both diameters should be identical.
- ○ The bottom grinding stone must be about 10 mm bigger.

Q7. What is the function of the metal separator on skiving machines?

- ○ It helps to exhaust skiving waste.
- ○ It protects the knife from melting.
- ○ It helps to keep the distance between feeding roller and knife.

Q8. **What is function of the dressing tool on skiving and splitting machines?**

- ○ To protect the operator from contact with the sharp blade.
- ○ To adjust the machines to the required thickness.
- ○ To clean the grinding stones and maintain their shape.

Q9. **Splitting machines can perform additional operations such as …**

- ○ skiving.
- ○ marking.
- ○ punching.

Q10. **What is essential to obtain an optimum skiving result?**

- ○ The correct distance between presser foot and feeding roller.
- ○ A low feeding speed.
- ○ Type and position of presser foot and feeding roller.

Q11. **Can the skiving speed influence the shape of the skived edge?**

- ○ No. The same adjustment of the presser foot guarantees the shape of the skived edge.
- ○ Yes. A different skiving speed creates a different skiving angle.

Q12. **Interlining materials are ironed-on in order to …**

- ○ improve insulation and water resistance.
- ○ ensure the correct upper tension and shape retention.
- ○ bond lining and upper material.

Q13. **Ironing presses usually work with pressures …**

- ○ between 5 and 7 bar.
- ○ around 4 bar.
- ○ between 1,5 and 2,5 bar.

Q14. **Hotmelt toe puffs (thermowire / hotmelt sticks) …**

- ○ can be used for all kinds of shoes without any restriction.
- ○ can make other operations redundant (if applicable).
- ○ do not have any practical use in shoemaking.

Q15. **Needle size 90 means:**

- ○ the length of the needle in mm.
- ○ possible speed of stitching, i.e. number of stitches per minute.
- ○ shaft thickness.

Q16. Which of the below listed parts belong to a stitching machine?

- ○ Upper and bottom feed, dressing tool, hook, stitching plate, bobbin.
- ○ Upper and bottom feed, hook, bobbin, needle heating device, bobbin case.
- ○ Upper and bottom feed, bobbin, hook, bobbin case, stitching plate.

Q17. The protection plate covering the bobbin case of a stitching machine …

- ○ helps to separate hook and needle.
- ○ protects the fingers during stitching.
- ○ keeps waste (threads, dust etc.) away from the clutch.

Q18. Which statement regarding the mould shapes of a back part moulding machine is correct?

- ○ The soft upper mould can have a universal shape and the aluminium part must have a shape of last.
- ○ The moulds for back part moulding must have the same shape as the production last.
- ○ The aluminium last can have an universal shape and the soft upper mould must have the last shape.

Q19. To activate thermoplastic counters …

- ○ any temperature which activates the counter within 8s is fine.
- ○ for soft moulds, the maximum temperature recommended by the machine producer must not be exceeded.
- ○ it is recommended to work with 80 °C according to the "EU Safety Regulations for Shoemaking.

Q20. A hot and cold back part moulding machine is preferably used for …

- ○ thermoplastic counters.
- ○ solvent activated counters.
- ○ moulded leather board counters coated with glue.

Q21. An upper activation machine is used …

- ○ for upper mulling and toe puff activation before lasting.
- ○ to dry the upper leather before lasting and to activate the toe puff.
- ○ after heat setting.

Q22. Which water heating system helps to save energy?

- ○ Pressurised boilers.
- ○ Open air heating.
- ○ Induction heating.

Q23. To ensure a correct execution of the lasting process (cemented construction), the insoles should be …

- ○ identical with the last feather edge in the front and 2 mm longer in the back.
- ○ 2 mm longer in the front and identical with the last feather edge in the back.
- ○ completely identical with last the feather edge.

Q24. The "crown" of a toe laster signifies a tool which …

- ○ applies the hotmelt.
- ○ closes the wipers with a rotating movement.
- ○ regulates the closing pressure of the pincers.

Q25. When talking about toe lasting, "slipping" designates a function of the …

- ○ rear support.
- ○ pincers.
- ○ wipers.

Q26. The curve of wipers …

- ○ should be identical with the bottom curve of the last with the insole attached.
- ○ is universal for all men's shoes.
- ○ is universal for children's and ladies' shoes.

Q27. At toe lasting, …

- ○ nozzles with thermowire (hotmelt sticks) require more energy than a crown because each nozzle is equipped with a separate heating unit.
- ○ machines featuring a crown need less energy than machines with nozzles because only one heating unit is required.
- ○ nozzles consume less energy than a crown.

Q28. A two-machine lasting system (cemented construction) …

- ○ needs more upper material then a three-machine system.
- ○ can work with less upper material than a three-machine system.

Q29. The final last shape retention is obtained after…

- ○ 8 to 24 hours on the last or in a heat setter adjusted between 100 to 120 °C.
- ○ 5 minutes in the heat setter at a temperature of 80 °C.
- ○ 4 hours on the last.

Q30. The purpose of roughing (cemented construction) is to …

- ○ prepare the surface for gluing.
- ○ roughen the upper material down to the lining.
- ○ clean the upper material from oil and colour stains**.**

Q31. Using endless sand paper for roughing is advantageous because …

- ○ it is the best roughing tool for textile upper materials.
- ○ its surface does not easily clog with melted parts.
- ○ it does not require an exhaust system as there is no dust on the roughed surface.

Q32. Glue with hardener …

- ○ can easily be reactivated.
- ○ is used to create temporary bonds in the stitching department.
- ○ creates a durable bond with the sole.

Q33. Thumb rule for creating a good bond:

- ○ Apply a small quantity of properly whipped adhesive to the surface.
- ○ The more glue you apply, the more durable the bond will be.
- ○ 3 to 4 coats of glue create the best bonds.

Q34. The solvent content of a glue is about 80 %. In order to create a bond, the solvent must evaporate. Evaporation …

- ○ could can be accelerated if the shoe is placed onto a chiller just after glue application.
- ○ 50 % of the solvent will evaporate during the first minute after glue application.
- ○ takes about 3 to 4 hours after application (in normal working conditions).

Q35. Using a vacuum in the gluing process …

- ○ helps to protect the surface (coated with glue) from roughing dust.
- ○ is one of the principles to dry glue in a rapid way.
- ○ is a rapid activation method.

Q36. A double-membrane sole press …

- ○ does not require glue activation before sole placing and pressing.
- ○ requires only 2 bar and 2s to establish a reliable bond.
- ○ is a very good way to achieve a good sole bonding.

Q37. Shoe orders …

- ○ should only leave each production department (cutting / stitching / making / finishing) once the complete order is finished and checked.
- ○ should be divided in small lots to achieve a rapid production throughput.
- ○ should be subdivided in smaller lots according to sizes and should then be completed size by size.

Q38. "Time study" means to …

- ○ transport all workers to the factory before production starts.
- ○ calculate the production time before an order can be delivered to the customer.
- ○ calculate the time required to perform each individual operation in the production process.

Q39. "TSS" stands for …

- ○ "Toyota Stitching System", which is an organisational system aiming to boost productivity.
- ○ "Testing Single Samples", a method to test the quality of the materials used.
- ○ "Technical Security System", a method to improve maintenance.

Q40. "Zig-zag" is a way of stitching two parts together, but also a method of …

- ○ organizing a stitching line.
- ○ how the workers should support each other.
- ○ organising technical meetings.

Q41. One of the biggest enemies of sustainability …

- ○ are big size orders.
- ○ is the production of sport shoes.
- ○ is fashion.

Q42. "Feeder-Operator-Feeder" is ...

- ○ a piece quality control system in shoe production.
- ○ a system of material delivery in the cutting department.
- ○ an organisational method in the stitching department using a conveyor belt to deliver boxes with workpieces to each workstation.

Q43. Some of the efforts to make shoes more sustainable focus on developing …

- ○ shoe materials which can be thermally exploited in home heating systems.
- ○ recycable or biodegradable materials.

Q44. "JIT / Just-In-Time" is …

- ○ an organizational system meaning that goods are only received when they are needed. It integrates all steps from order to delivery.
- ○ a principle meaning that all materials needed to produce an order are received before production starts.
- ○ a logistics system calculating the fastest way of delivery to the customer.

Q45. "TPS / Toyota-Production-System" is a …

- ○ system using robots for each operation.
- ○ system that aims to permanently increase the ratio between added value and idle time.
- ○ on-line monitoring system of work in progress.

Q46. "Gemba" is an approach …

- ○ meaning that each operation must be initially demonstrated by a technician.
- ○ to get managers focused on the points where the most value is added.
- ○ to adopt measures to enhance occupational safety.

Q47. "OEE / Overall-Equipment-Effectiveness2 is a …

- ○ principle of permanent benchmarking of the efficiency of machinery available on the market compared to one's own machinery.
- ○ principle to calculate the total energy consumption of each machine (such as electrical power, heat, compressed air) and calculate its share in the final selling price.
- ○ maintenance system using only high-quality consumption and spare parts to increase the machine efficiency.

Q48. "Hoshin Kanri" is a …

- ○ system to evaluate the degree of sustainability of products.
- ○ Japanese 3D foot measurement system connected to a CAD production system for individualised lasts.
- ○ managing principle to plan and achieve goals.

Q49. "Improve Production Today" is a …

- ○ software which collects the key data of each operation and spots bottlenecks.
- ○ method for production-floor managers to focus on small daily improvements.
- ○ quality control system spotting the operations with the highest quality risks.

Q50. "Theory of Constraints" is a

- ○ team building approach for different development projects in a factory.
- ○ system to identify and eliminate bottle necks.
- ○ economical principle giving investment recommendations for new tools and machinery.

Answer Key:

Q1.	help to preselect the best design.
Q2.	reduce the number of cutting dies.
Q3.	must be stored in a horizontal position on a level surface.
Q4.	punching and marking.
Q5.	must be regularly turned and flipped during each working day.
Q6.	Both diameters should be identical.
Q7.	It helps to exhaust skiving waste.
Q8.	To clean the grinding stones and maintain their shape.
Q9.	skiving.
Q10.	Type and position of presser foot and feeding roller.
Q11.	Yes. A different skiving speed creates a different skiving angle.
Q12.	ensure the correct upper tension and shape retention.
Q13.	around 4 bar.
Q14.	can make other operations redundant (if applicable).
Q15.	shaft thickness.
Q16.	Upper and bottom feed, bobbin, hook, bobbin case, stitching plate.
Q17.	helps to separate hook and needle.
Q18.	The moulds for back part moulding must have the same shape as the production last.
Q19.	For soft moulds, the maximum temperature recommended by the machine producer must not be exceeded.
Q20.	thermoplastic counters.
Q21.	for upper mulling and toe puff activation before lasting.
Q22.	Induction heating.
Q23.	completely identical with last the feather edge.
Q24.	applies the hot melt.
Q25.	pincers.
Q26.	should be identical with the bottom curve of the last with the insole attached.
Q27.	nozzles consume less energy than a crown.
Q28.	can work with less upper material than a three-machine system.
Q29.	8 to 24 hours on the last or in a heat setter adjusted between 100 to 120 °C.
Q30.	prepare the surface for gluing.
Q31.	its surface does not easily clog with melted parts.
Q32.	creates a durable bond with the sole.
Q33.	Apply a small quantity of properly whipped adhesive to the surface.
Q34.	50 % of the solvent will evaporate during the first minute after glue application.
Q35.	is one of the principles to dry glue in a rapid way.
Q36.	is a very good way to achieve a good sole bonding.

Answer Key:

Q37.	should be divided in small lots to achieve a rapid production throughput.
Q38.	calculate the time required to perform each individual operation in the production process.
Q39.	"Toyota Stitching System", which is an organisational system aiming to boost productivity.
Q40.	organizing a stitching line.
Q41.	is fashion.
Q42.	an organisational method in the stitching department using a conveyor belt to deliver boxes with work pieces to each workstation.
Q43.	recyclable or biodegradable materials.
Q44.	an organizational system meaning that goods are only received when they are needed. It integrates all steps from order to delivery.
Q45.	system that aims to permanently increase the ratio between added value and idle time.
Q46.	to get managers focused on the points where the most value is added.
Q47.	principle of permanent benchmarking of the efficiency of machinery available on the market compared to one's own machinery.
Q48.	managing principle to plan and achieve goals.
Q49.	method for production-floor managers to focus on small daily improvements.
Q50.	system to identify and eliminate bottle necks.

14. Image Sources

Branded products:
Adidas, Clarks, Continuum Fashion, Nike, Puma (all brands stated in captions: 1-7).

ISC: 8-13, 15-18, 38, 40, 43-45, 46-50, 53-56,Tab. 3, 64-66, 67-75, 84-86, 88-91, 103, Tab. 4, 109-115,118, 124-126, 130, 142-150, 159-161, 159-161

Desma: 9, 121, 127

World Footwear: 14, Tab. 1,122

Hydroma: 18-24

Fortuna+ISC: 25-31, 33-37, 41, 42

International School of Modern Shoemaking, Zlin / Czech Republic: 32, 39, Tab. 2, 81, 87, 117

Molina e Bianchi (leaflet scans): 51, 52, 80, 93-95, 98, 99, 101, 102, 103, 120

Dürkopp Adler (leaflet scans): 57-63

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Lifelong Learning Programme

Project Number:
539823-LLP-1-PT-LEONARDO-LMP

Project Duration:
30 months
October 2013 - March 2016

How to implement Sustainable Manufacturing in Footwear - New Occupational Profile and Training Opportunities -

The project *STEP to SUSTAINABILITY* aims at:

Developing a new qualification profile and correspondent training in the field of sustainable manufacturing.

Training technicians with knowledge and skills to implement manufacturing strategies envisaging the sustainability in Footwear and Leather goods.

www.step2sustainability.eu

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.