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Dieless cutting – an update

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Factories are not just made of men, machines and materials but also smells and sounds.

There was a time when, walking through the cutting room of any shoe factory in the world, one would have been overwhelmed by the repetitive click and thump of the swing beam presses being used to cut the leather and other materials used to make a shoe. Clicking presses, as these machines were generally called after the name given to the old hand cutters, together with travelling head presses and heavy duty beam machines, dominated the landscape of shoe factories for almost a century.

Visiting the same departments today is a very different experience. Gone are the old sounds to be replaced by the buzz of high frequency knives and the 'whoosh' of fast moving, modern

dieless cutting machines. A change perhaps not totally expected when the first prototypes appeared more than twenty years ago. Shoemakers had long wanted to be rid of the multiplicity of knives needed to cut every minute component for all the dozens of models they had in production and the many sizes that were involved. They were both a major cost factor and, very often, a time burden for companies which had to depend on busy die makers every time a new model was launched or a set of knives had to be repaired or replaced.

For almost the entire industrial era of shoemaking there were however no possible alternatives. Then the digital revolution came whereby information technologies and automation enabled a wealth of new technological solutions to be developed that effectively

reshaped the way in which certain phases of shoemaking were performed. The time between the mid-eighties and the mid-nineties of the 20th century saw the arrival of a plethora of new machines and manufacturing systems.

NUMERICAL CONTROL

First, numerically controlled die-cutting presses appeared which greatly improved throughput and material efficiency in many synthetic material cutting operations. Highly automated and advanced solutions were developed that, for a certain period, dominated the market. Yet these machines still needed dies and shoe companies were looking for something different influenced by the fact that production, particularly in the industrialised parts of the world, was rapidly changing in response to new

market demands. Flexibility, versatility and quick response times were the new keywords and a technology that could fully satisfy these new demands was badly needed.

NC (numerically controlled) dieless cutting was, at that time, in its infancy. The basic concept of moving a tool controlled by an appropriate electronic compound and following a cutting path generated digitally by then newly created CAD software applications was a relatively simple one as two-axis flatbed machines already existed in other industries which could be adapted to work for footwear. The real problem was how to physically cut the leather and many other materials that shoe companies have to work with.

In those pioneering times, there was virtually no cutting technology that was not explored, from simple trailing knives to high or low frequency oscillating ones and from water jet to laser. With the appearance of the first market offerings, shoe companies immediately appreciated the potential of these new machines, particularly in terms of flexibility and fast response for product development and sample making. The early generations of dieless cutting machines were therefore to be found in design departments and in sample making lines. For a long time it was assumed that their productivity was too low to really replace existing cutting presses on manufacturing lines and that the old and new technologies would work together side by side. This assumption was, in time, proved wrong and today's dieless cutters find their place more in production than sample making, having now almost completely replaced old cutting systems in most shoe factories in the western world at least.

WHERE ARE WE?

So, how far have die-less cutting technologies come, what is the current state of the art in die-less cutting and what is likely to happen in the future? We can start by looking at how leather and other materials are cut. Different techniques have been studied over time, each of which has shown both advantages and drawbacks of various kinds. The two that more than any others have characterised technological evolution in this area are the high-pressure water jet and the oscillating knife.

The first was long considered to be the fastest and most productive approach for cutting leather and other materials despite all the operational complications the technology presented. Its spread is now relatively limited as, although it is still presently employed by more specialised companies, its use is mainly confined to cutting synthetic materials for shoe components such as toe puffs, counters and insoles.

The method now preferred for cutting leather is the high-frequency oscillating knife or blade. The coupling of low amplitudes of oscillation with higher and higher frequencies has made this the dominant technical approach. The cutting heads of the latest machines make them comparable in terms of both versatility and speed with other systems such as water jet, traditionally considered as being much faster, but with lower purchase and running costs. It can therefore be said that the oscillating knife is today's benchmark for dieless cutting of leather for footwear as well as leathersgoods, furniture and car upholstery. The cost and throughput combination these machines have now achieved has brought companies to regard them as viable alternatives to die-cutting for both production and sample making.

CUTTING HEAD

There are some key features that are present in all latest generation machines that are worth examining and the first is versatility. The trend in shoe companies that adopted dieless cutters is to use them to process the largest possible number of different materials. This does not necessarily mean that all cutting operations are performed with a single machine which could, depending on production demand, cause unacceptable bottlenecks. Instead, the cutting task is concentrated on a single dieless technology but using a variable number of machines according to production volumes that are interchangeable and have clear advantages in terms of maintenance and spare part costs.

An essential element of this versatility is the cutting head that normally contains a large number of other tools in addition to the oscillating blade. Such configurations can hold as many as five to seven different tools simultaneously, ranging from small punches for the execution of holes and notches, to drills and pens. A sound design of the cutting head has a direct impact on two key factors in the actual cutting process: versatility and productivity.



Atom FlashCut 888L 30 UCP flatbed machine. CREDIT: ATOM

Versatility as the robustness of the oscillating blade, its adjustment capability and regulation according to the thickness and toughness of the materials to be cut, determine the range of thicknesses and types of materials the machine is able to handle.

Productivity depends both on the characteristics of the blade and the travelling speed and acceleration of the machine. Productivity is strongly influenced by the availability of special tools such as dies and punches that allow faster execution of geometric details that would otherwise require repeated deceleration and acceleration sequences which would have a marked impact on average cutting speed.

Looking more closely at the cutting head, the elements that characterise it are careful design, compactness, weight (the lighter it is the easier it is to move around quickly), robustness and, finally, the ease with which an operator can perform maintenance tasks or replace blades.

ARCHITECTURE

The quality of a cutting system is not only related to the efficiency of the oscillating blade or the design of the cutting head. Equally important is the way in which the various machine operations that make up the cutting sequence such as loading material, inspecting hides for defects, nesting patterns, actual cutting and then collecting cut pieces are organised and managed. Which and how many of these operations take place simultaneously and in what areas of the machine depends on its architecture as designed by its manufacturer. After several years of experimentation and consolidation, the solutions proposed by producers of cutting systems have somehow converged on two standard architectures.

Flatbed machines (horizontal or inclined) having a rectangular working area and lateral loading of the material. These are also known as dual-station systems where under normal operating conditions cutting is in parallel (hidden time) with unloading – nesting – loading. The placement of the patterns on the hide is interactive (performed by the operator) and assisted by the projection of the shapes on to the



Comelz CZ/L conveyor belt machine with two cutting heads. CREDIT: COMELZ

material by means of one or more LCD or other technology projectors to ensure high visibility on any type of material. There are several systems with this architecture, both with single and double cutting heads (a second head considerably increases potential productivity).

Conveyor machines are more automated as the material is loaded from the front and fed through the machine on a moving belt. This allows great operational flexibility thanks to the possibility of working with both front loading – unloading by executing in parallel the same operations as flatbed machines, cutting in parallel with unloading – positioning – loading and front loading and unloading from the back. In the last instance, the tasks performed in parallel are loading – nesting / cutting / unloading. Solutions of this type generally adopt a double cutting head and pattern nesting is interactive as in the previous case.

A third emerging architecture is one that we could call 'ultra-compact'. Dieless cutting started out with sample making and then evolved into a production technology. Many producers are now going back to developing specific, compact models designed to satisfy low production demands either in small workshops or design departments of larger factories. Mono stations with approximately the same footprint as an old clicking press and, in the case of the Comelz CZ/P

very much the same appearance, they are ideal for 'rapid prototyping' of shoes and low volume production.

SOFTWARE

Among the most important advantages of modern cutting systems is the ability to go rapidly from design to production. Once a new model or variant of an existing one is ready in the form of CAD 2D files, the necessary information is available for the various parts that make up the shoe to be cut without having to wait for traditional cutting dies to be made. An important element of this segment of the production chain is the ease or 'interoperability' with which the geometry generated by a CAD system is transferred to a cutting machine. The prerequisite for interoperability is the use of a standardised and common form of representation of geometric and process data, exchanged between CAD systems and cutting machines.

As an example of the relevance of this topic, the most important Italian manufacturers have adhered to a standard proposed by ASSOMAC, the Italian association of shoe machinery producers, to overcome this difficulty and the solutions they offer are more easily interchangeable and can be integrated one with another. In order for a machine to operate rapidly and efficiently, there are some key features in the software that controls it that are very important:

Comelz CZ/P mono station machine.

CREDIT: COMELZ



- Ease of aggregation of the patterns according to batch size or other criteria that influence the organisation of the cutting job.
- Integration of the machine software directly with the order processing system of the company through the direct import of cutting bills.
- Proper and efficient distribution of cutting tasks depending on the materials to be cut between different machines in the cutting room.
- Monitoring of cutting activities and of the instantaneous production throughput with a continuous and accurate overview of quantities actually produced.

From this point of view the shift from manual to digital cutting significantly increases the level of control over the process itself, the reliability and accuracy of the operations involved, as well as reducing the risk of errors or failures in production.

NESTING

If a multi-tool head and clever machine architecture to a large extent determine the versatility and productivity of a system, the cutting efficiency and therefore, ultimately, the cost of the finished product depends on how well the task of preparing the cutting layout is executed. When placing or nesting the various shapes on the hide, the aim is to achieve the best combination between the time

needed to perform the task and the highest possible material yield. In modern dieless cutting systems this can be performed by the operator with the help of software programs and normally referred to as 'interactive nesting' or either in whole or in part automatically by just the software itself which we call 'automatic nesting'.

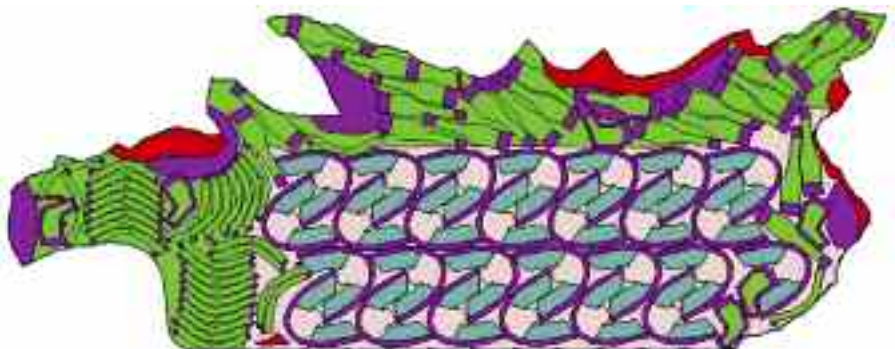
The most common nesting approach, at least for cutting leather, is the interactive one in which the operator uses their experience of products and materials to perform the task. The software facilitates and speeds up the work so that the operator can focus on the primary task of producing a layout with the minimum waste in the shortest possible time. In this operating mode, the typical advantages of automatic cutting are very clear as the operator is able to assess the quality of the layout overall rather than just progressively as in manual cutting where one pattern is

placed at a time. It is also possible to correct a wrong positioning or even the entire layout before starting to cut, which is impossible with traditional die cutting.

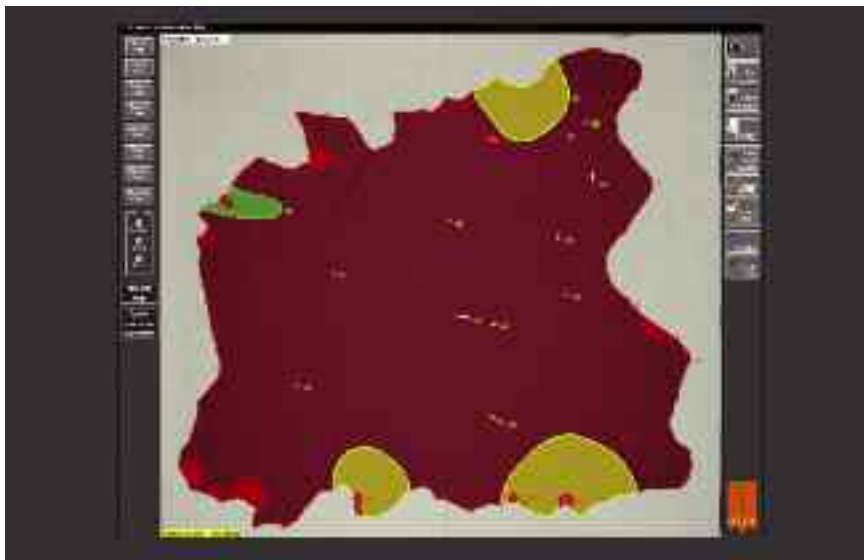
Thanks to this, the cutting efficiency that can be achieved with these machines is very high and at least equal to, if not better, than those obtained by traditional methods. The winning features of an interactive nesting software program are the simple and efficient importing and managing of cutting bills, rapid nesting and ease of use combined with an always clear view of the patterns projected on the hide. When the material to be cut is synthetic, typically in sheets or rolls, nesting is performed by automatic programs which calculate the optimal arrangement of shapes with very high levels of efficiency whether directly on the machine or off-line on a separate PC. The hardware resources of the machine which the latter method does not use can then be dedicated solely to intensive cutting.

MAKING A CHOICE

A versatile multi-tool head, clever architecture and good nesting software are therefore the key ingredients for a successful dieless cutting system and the market now offers plenty of choices from which companies can find the optimal solution for their particular needs. The number of producers is also quite large. Italian company Teseo together with Zund from Switzerland were pioneers in the sector with bigger companies such as Atom and Comelz soon joining them, followed by Elitron, Torielli, Newlast and many others that in time expanded the group. Choosing between one producer and another and deciding which model to buy within the incredibly large choice available from



Interactive nesting uses the operator's experience to maximise cutting yield. CREDIT: ATOM



Detecting leather defects needs further attention. CREDIT: ATOM

these companies is not easy, so here is a 'checklist' of features to look out for when making a choice.

Consider the size of the machine's working area to see if it suits company needs. ***This is probably the first and most important choice criterion.*** If there are no space limitations in the factory that could force the adoption of mono station systems that have much lower productivity, choose one with a large cutting area that can accommodate even the biggest hides. A conveyor belt machine could offer a good compromise between the size of the cutting area and the compactness of the system. If the main use of the machine will be cutting sheets of synthetic material, compact mono station machines are preferable. Opt for a supplier that can offer a wide range of different solutions in terms of architectures and cutting areas.

Check the quality of the mechanical design of the machine. This is evident in the mechanical parts of the system which must be stiff and robust as this has a great impact on the quality of cutting; neither should they be exaggerated or over sized. Also check their quality and accuracy of assembly. This is particularly important in regard to delicate elements such as the cutting bed which must be perfectly flat as this is again crucial for high quality cutting.

Pay attention to the choice of all mechanical, pneumatic and electronic components. These must be of the highest quality and durability considering the intensive use that the machine will undergo during its life.

Test the vacuum system that holds the material to be cut in place as this is another crucial factor. An efficient vacuum system must be able to keep the material in position no matter in which area of the bed the head is moving and also when large sections of the cutting surface remain uncovered. Its efficiency is also important. Is it able to concentrate suction force only where needed as this depends on the size and power of the pump driving the system which, in turn, determines the amount and cost of electricity used.

Verify the number and type of tools in the cutting head as the more there are the less often will it be necessary to stop the machine to manually change one and so the higher its productivity will ultimately be. How robust is the oscillating knife, the thickness range it can operate with, its adjustment possibilities and, finally, the combined oscillating amplitude / frequency that eventually determines the cutting speed.

What is the machine's dynamic behaviour as expressed by its maximum linear speed (m/min) and rate of acceleration (g) as these are two factors combined that influence overall cutting performance the most in terms of pieces per minute.

Carefully assess (and possibly test) the machine's architecture as this, together with the other factors already mentioned, greatly contributes to the average production output of the whole system expressed as pairs per shift.

Test the effectiveness, ease of use and stability of the interactive nesting software. This element also influences

general machine performance. In fact, the more the operator is assisted with nesting, the faster they will work and the more likely it will be that nesting time balances the other operations to provide the best overall system performance.

Look at the range of different materials, thicknesses and formats (sheets or rolls) that the system can handle in relation to its cutting technology and architecture. The wider the range, the more possible it will be to concentrate all cutting operations on one single technology with all the related scale and maintenance advantages. And, think about a conveyor belt system as this again contributes to flexibility and overall performance.

WHERE TO NOW?

What can we expect in terms of future development in an area where it seems technological evolution has reached its maturity? Well, there are still some fields of ongoing development left and one of them is automatic leather defect recognition. Despite all the recent achievements, experienced operators are still needed in order to identify faulty areas and localised flaws in the hide and to digitally mark them in dedicated 'hide inspection stations' normally as part of an off-line nesting calculation. Although this area of investigation has not so far received much attention it is plausible that, thanks to the availability of new sensors and advances in computation techniques, it may be revitalised in the near future. Automatic nesting on leather is also not fully accomplished, with some effort needed to further improve the global performance in terms of yield the software can achieve.

A higher level of integration of upstream (material handling and synthetic materials with design features thought to optimise cutting) and downstream (robotised collection of cut parts) operations is also to be expected, with an evolution of the 'old' dieless cutting tables into more powerful and complete cutting systems. Despite affirmation of its viability as a production procedure, maturity of its design and dramatic technological advances, dieless cutting although now out of its infancy is still in its first youth and more growth is to be expected in the future. 📌