

Hyper-cutters

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Cutting and its related technologies are among the topics that are most often cited as a demonstration of how shoe making has evolved since the dawn of the first industrial revolution; swing beam and travelling head presses were in time replaced initially by NC (numerical controls), die cutting machines and, more recently, by an all new breed of dieless cutting systems. When they first appeared, back in the early 1990s, these machines marked a clear departure from earlier and more traditional devices.

The old ones were mainly massive steel machines, with an electrically driven hydraulic pump to generate the cutting force that was necessary to press the die through the material (in single or multiple layers) to be cut. They were rather simple devices based on half a century of experience in the mechanical design of machines. The new systems were quite different. Although a robust mechanical design was still a good starting point and guarantee for a reliable and robust device, it was not the only relevant technological content as electronics played an equally important role.

The new systems were multi-axis (typically three) set-ups whose movements were controlled by so called NC-piloting servo drives capable of dashing the cutting head along very complex trajectories. And, as these trajectories were the result of an accurate calculation of where each single part of the shoe had to be placed in order to guarantee the necessary material yield and product quality, software was the third important element of their design.

Mechanics, electronics and software are the building blocks of any complex mechatronic device. NC-controlled dieless cutting tables also marked the evolution of footwear technology suppliers from essentially mechanical firms into interdisciplinary organ-

isations with a much wider set of skills and more modern design teams. As stated, this evolution started, at the beginning of the nineties, peaked at the turn of the new millennium and is somehow continuing today. It drove the search for the fastest and most affordable cutting technology, from the early water jet systems, when this approach looked like the only one capable of delivering the high cutting speeds needed to make dieless cutting competitive in terms of output, to the soon abandoned laser, and on to the current state-of-the-art high frequency oscillating blades.

A good indication of the design ingenuity that the specialised vendors exhibited is the enormous proliferation of machine architectures that included flat or inclined bed, table or conveyor belt, single-head or multi-head. The catalogues of the most important market players in this technological segment are full of models and variants, each one with its specialisation for cutting leather or synthetic materials, single or multiple ply, small or large cutting areas, with inline or offline software for calculation of the best pattern layout to obtain the optimal combination of high



The new Atom FlashCut 2H 1685 is typical of the latest generation of cutting tables.

CREDIT: ATOM

material yield and cutting throughput.

Current generation machines can handle virtually all types of materials normally used to build a shoe, from the most delicate and expensive leather to heavy duty ones such as plastic and board, that make up its more resistant parts. This is achieved through 'multi-tool heads' that feature a full range of different devices, from the universally adopted high frequency oscillating blades (with electric or pneumatic chuck), to milling tools, punches of different shapes, pens and, more recently, printing heads. This seems to indicate that versatility is what customers demand from these machines, that is being able to cover as many cutting applications as possible with the same kind of machine and least possible number of tool changes and set-ups. Size also plays an important role, both when synthetic materials in sheets or rolls are handled or when leather must be processed, with the need to accommodate hides of different size and shape that vary from less than a square metre to as much as four to five metres for the large hides used in car and furniture upholstery.

This gives a rather clear idea of the challenges machine manufacturers had and still have to face in order to keep ranges up to date and preserve their competitive edge. Last but not least, machines are also becoming more 'elegant'. The early models, properly called 'cutting tables', in fact looked just like big square tables with a very clumsy appearance and little or no attention to design finesse. Things are now changing and the latest models begin to exhibit more curved surfaces and a streamlined body that conceals all the machine's mechanisms and electronic components. It is a clear indication that technology is reaching a mature level in which function gives way to aesthetics, and a transformation that certain customers in more industrialised countries have begun to demand.

Is this the end of the evolutionary wave or what kind of other transformations can we expect to see in the future? There are indications that something is happening and there are at least three trends that deserve attention: robotisation, integration and hyper-cutting.

CUTTING SERVANTS

If we have to mention another technology that is enjoying a moment of great promotional hype, it is certainly robotics. New machines are being developed and new models are available with characteristics that are going to change our perception of them and of the way they can be integrated in a factory environment. They are becoming lighter, smarter and cheaper, easier in terms of programming their tasks and, above all, they incorporate new sensors and control features that allow them to be placed side by side with human workers. In a few words, it is ever more easy to integrate them with other machines and to be programmed to seamlessly complement tasks traditionally performed by human operators.

Let us take for instance picking and collection of the parts cut by the machine. In a typical leather-cutting job there might be several dozens of different shapes to be gathered after cutting, sorted in the proper order and stacked in their appropriate containers. This task is typically performed by one or more operators standing at the back of the machine and retrieving the parts as soon as they are cut and conveying them to the unloading area. This is a job for the new 'servants'. In a similar way, one or more of these lightweight robots could be mechanically and electronically integrated with the

cutting machine in a way that instructs the robot of where the parts are and what to do with them, leaving its intelligence to decide in which sequence and with which logic the picking mission should be executed.

Speed and dexterity are therefore the demands they should satisfy. Open communication protocols and a standard signal exchange bus are the prerequisites to enable this type of integration and there is intense work on this subject within ASSOMAC, the Italian association of shoe machinery producers, aimed at proposing an industry standard. Although there are already a few examples of this kind of application in production tests as well as much research work, it must not be forgotten that driving the robot to perform its picking mission is only a part of the solution. Choosing the right approach to pick up the cut part and cope with the diversity of shapes and materials to be handled is as important as telling the robot where to go and accounts for the same if not higher R&D efforts as the previous one.

We can therefore expect to see in the near future more and more cutting tables equipped with robot arms dealing with a number of tasks, from part collecting to material handling throughout the entire extended cutting process. New generation robots are a perfect match for these requirements, particularly as being designed to cooperate strictly with their human colleagues, they can be easily



Atom's complex printing head.

CREDIT: ATOM

installed in the proximity of the machines, straightforwardly integrated with their electronics and, if necessary, moved around and assigned to other tasks.

NO MORE 'LONELY' MACHINES

In the past we had cutting tables with one or more operators tending them and performing all necessary manual tasks such as loading hides, placing sheets of materials, locking roll holders stacked with textiles or other synthetics, using the software to generate the cutting layout and collecting the cut parts. Little attention or interest was shown as regards the upstream and downstream operations that occurred before and after the cutting task. The machines were an island that did not communicate with the other systems across the shop floor.

This is also changing. Although our earlier examples of the integration of robots with cutting tables hint at that, there is more, industrial cutting applications that show the way. Cutting being a general technology by definition, there are several applications of cutting machines originally designed for footwear processing that are used in sectors ranging from the classical converting industries to gasket manufacturing and to the automotive world. In the latter especially, the cutting step is just one of a very complex sequence of operations in which materials are taken to the machine, cut, post-processed and moved to the next operations.

Automatic devices of various kinds (including robots) take care of the mechanical integration under the supervision of SCADA (system control and data acquisition) software applications that monitor process data and perform all the necessary supervision and coordination activities. It is an important transformation from isolated, individual machines to open systems that can communicate with other modules of a complex manufacturing system.

If industrial applications are paving the way in this evolution, the trend is nevertheless also noticeable in the footwear and leather goods sectors whereby cutting machines (besides

robots) have begun to talk to and integrate with spreading tables for the preparation of multi-layer materials to be cut, with sheet stacking systems or with motorised roll holders. Some of these are simple examples of low level integration with components often designed and built by the same manufacturer as the cutting machine. In other cases, third party machines are connected and integrated, once again calling for data communication standards and system openness as already mentioned.

HYPER-CUTTING

We know that after having cut all the parts of a shoe, there are several other operations that must be performed on all such parts or merely some of them. Patterns are typically split, then skived along the edges, very often reinforced on the same edges; texts and letters are to be printed in certain areas or decorations executed in specific portions. While these are the most common, one can think of others, such as depositing layers of material in particular areas or according to a specific design. Until today, such operations were performed by

dedicated machines (when available) or manually at the cost of a series of manipulations of the cut parts that were collected and sorted after cutting, reprocessed one or more times, re-collected and sorted again. This involves a high number of manipulation steps, is highly time consuming and risks making mistakes, or forgetting or losing parts: in a word, inefficiency.

In any one of the modern cutting tables, parts are firmly held in place after cutting, lying flat on the machine surface so they lend themselves perfectly to receive additional processing. On the other hand, the number of different tools that their cutting heads can accommodate is growing ever greater and the double head architecture that many such machines possess allows them to dedicate one head to cutting and the other to corollary applications.

We can now think of configurations for 'hybrid' cutting machines capable of cutting and skiving, or cutting and spraying adhesive on to the entire cut part or along the edges. They could also deposit thin layers of material (low temperature melting TPU among



Further advances in cutting technology can only bring benefits to shoe making in terms of both quality and cost.

CREDIT: MICAM

others) on certain areas or follow a given design to improve either the aesthetic of the shoe or, more interestingly, to tweak the mechanical properties of that part in order to obtain a shoe with improved functionality.

Cutting machines develop new and enhanced abilities that go beyond their initial and simple original mission. As a hyper text link opens up to new content, such as pictures or video clips, so hyper-cutting expands the functions of the machines, linking their operations with other processing steps and collating in one single, multi-task system a variety of different missions. It looks like an exciting development, but should be examined more carefully. There are in fact advantages and drawbacks in adopting this approach. Having a number of operations performed on the same machine, instead of a multitude of them, certainly sounds more efficient and should also reduce overall costs as there are less handling steps and therefore a further move in the direction of a more streamlined manufacturing solution with fewer machines.

But there are drawbacks, notwithstanding the technical feasibility of some of the operations that have been mentioned. For example, if we need to skive the edges of a part, how do we cope with the fact that it lies on the cutting bed grain side up when skiving is normally performed on the flesh side.

There is one critical aspect above all others. Cutting, as any other type of processing done on single patterns, is strictly part by part, so it is perfect when you cut single layers as in the case of leather. If some of these operations are to be performed on synthetic materials, which are typically cut in several layers at the same time, we may lose important advantages in terms of overall productivity. In this case, a careful trade-off between the loss of overall throughput, related to the need of processing each part singularly, and the gain in efficiency thanks to the reduction of the total number of processing steps must be found.

CONCLUSIONS

The trends we have presented are at

a very early stage or perhaps in the domain of a futuristic vision, as in the case of hyper-cutting. Nevertheless, it is becoming more and more evident that, after a long period of galloping evolution followed by consolidation and a certain stagnation in terms of innovative ideas, cutting machines are approaching a new evolutionary phase that is somehow going to change their characteristics and their role in the shoe manufacturing process. In parallel with that, we have observed a curious phenomenon in market dynamics. Whilst the number of vendors decreased or, should we perhaps say, consolidated with a small group of market leaders and some courageous followers, the range of

machines and models on offer proliferated dramatically up to the point that there seems to be a machine for each single, minute application or manufacturing need. It is probably a good thing for the market, but certainly a nightmare for the manufacturers.

So what the future might bring is less of more: fewer models with more hyper-cutting functions, equipped with robot arms to automate all the necessary corollary applications and deeply integrated into the whole manufacturing flow. Certainly, no longer the relatively simple machines they evolved from but, instead, highly productive multi-purpose machining centres. 



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