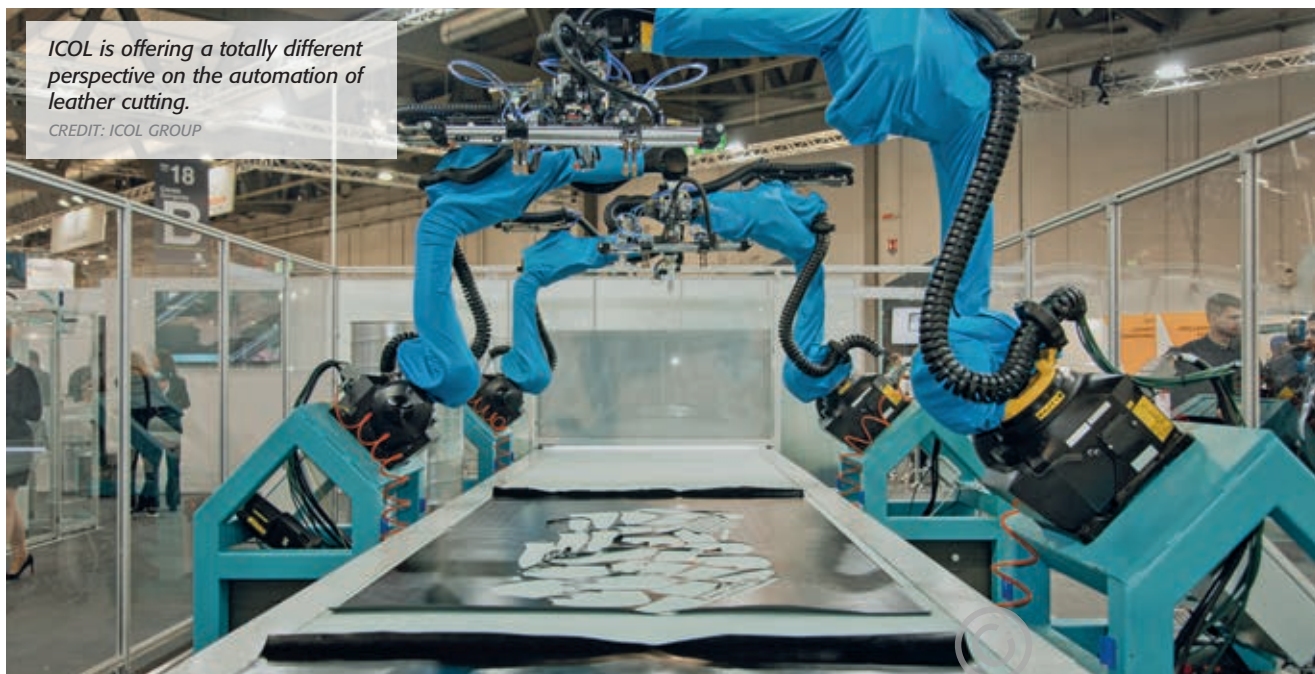


ICOL is offering a totally different perspective on the automation of leather cutting.

CREDIT: ICOL GROUP



Advancements in cutting

Sergio Dulio

Cutting is known to be one of the most important operations in shoe manufacturing. It deals with a variety of different materials, is vital for the quality of the finished product, allocates the highest share of the cost of the shoe. It was the subject of one of the most radical technological transformations when, almost three decades ago, dieless, computer-controlled cutting machines appeared. Since then there has been a real explosion of machinery designs differentiated by type and number of cutting heads, optimised for leather or synthetic materials, featuring specific material handling-systems and equipped with different kinds of projection devices.

Nevertheless, since their first appearance, these machines have not really changed, nor have they seen the addition of particularly new technological components. Recently, however, things have started to change and now we can see signs of greater design and development vitality, with explorations aimed at introducing a

wealth of modern technologies to complement the basic functions of the cutting machine itself. This article provides an overview of the most relevant technological trends that can be observed. We will focus on three main areas: software, human-machine interfaces, and automation and process integration.

SOFTWARE

Although all computer-controlled cutting machines are run by software from a very deep level and digital controls basically drive each operation of the machine up to the human-machine interaction level, there are two specific operational areas in which software could make a difference in the future. These are nesting and leather inspection. Both are connected to a specific area of leather-cutting that, not surprisingly, are most challenging because of the irregular and non-homogeneous nature of the material and its high cost.

At present, leather-cutting operations invariably start with an inspection of the good and bad areas

of the hide and identification and classification of its defects or flaws. This is typically performed by experienced workers, either on the cutting machine itself or on separate inspection stations where a digital map of the hide is created. A system capable of 'scanning' any kind of hide and automatically identifying and classifying defective areas has always been considered a kind of holy grail in footwear manufacturing technology. There have been plenty of research studies as well as initial market implementations to this end, but none of these attempts has proved to be really convincing and none has reached the state of wide industrial adoption.

In the past few months, however, rumours began to spread about a return of interest in this topic, leading up to an announcement at SIMAC in February by ICOL Group, claiming its software to be capable of detecting automatically all leather defects with an unprecedented level of accuracy (see the related article in this issue of *World Footwear*). Should this prove to be true after the necessary market validation, it would certainly

represent a major step forward in the cutting of leather.

Something similar is happening in the domain of automated leather nesting. As we know, nesting is the operation where a software programme calculates the best layout of patterns (parts of the shoe upper) to achieve the highest possible material yield, while at the same time complying with the quality constraints of the final product whereby pattern and leather quality must be matched. This has so far been dominated by software modules based on classical, heuristic approaches that always struggled to obtain consistent yield results, comparable to those achieved by experienced workers. Recently, however, Italian company Teseo impressed the footwear world with the launch of NeMeSi, the first leather nesting with artificial intelligence in a cloud-based system.

For this purpose, the company says that it has developed specific artificial intelligence (AI) for nesting, with sophisticated recognition functions of leather, its qualities, strategy learning and comparative analysis between hides and products. This is based on the experience of nesting 100,000 hides and a database of more than 15 years. Its logic engine can now calculate adaptive nesting algorithms. NeMeSi has a specific AI for evolved nesting that allows it to select the best algorithm for the specific leather in use. It all sounds revolutionary and represents the first intrusion of AI techniques into our footwear world; let us hope it is not the only one.

HUMAN-MACHINE INTERFACES

Let us now move on to human-machine interfaces or user interface. This definition relates to components in the machine through which operators execute their tasks and command operations, and the machine itself responds, communicating its status. In relation to cutting machines and, specifically to cutting leather, one delicate area of interaction is the execution of the so-called interactive laying operation (an alternative to automatic nesting), where the operator 'nests' manually each individual piece of the shoe by moving its projection onto the hide in the desired position. This is a delicate task that the operator is called on to perform under conflicting requirements.

Operators must work fast so as not to affect the machine's throughput but, at the same time, they have to achieve the highest possible nesting efficiency. They must clearly see the projected shape which, with the current technology based either on LED projectors or laser systems, requires a relatively dim light; they can see the outline but at the same time must clearly see the texture of the hide to be able to detect defects. This last aspect normally poses great challenges on the selection and design of the projection system, and this is where AR/MR (augmented/mixed reality) can be of help.

This is a technology that, through the use of wearable devices, makes it possible to superimpose on real-world vision digital data and information that enrich its content and increase perception. For some years ATOMLab, the innovation division of ATOM Group, has been studying the use of this technology as a new user interface for the next generation of cutting systems. In this implementation, computer screens, keyboards and mice are replaced by holograms that users will see directly in front of their eyes as

projected by the device (in this case Microsoft's HoloLens) and by gestural and vocal commands given by the operator. This would remove the problem of the visibility of the projected shapes, no matter how the working environment is lit or how shiny the hide being processed, providing a system that is almost immune from the influence of ambient light.

In addition, the combination of vocal and gestural commands introduces a totally different interaction paradigm, with a shift that is comparable to the migration from old mobile phones with screens and keyboards to the touch screen smartphones of the current generation. Certainly there are caveats; the ergonomics of a device that workers would wear eight hours a day, the stability of the holograms with reference to the machine or the duration of the batteries for cordless devices such as HoloLens.

AR/MR, nevertheless, is among the fastest growing technologies (HoloLens is already in its second generation), so it is to be expected that current limitations will be soon overcome.

AUTOMATION AND INTEGRATION

Until today, we have been used to seeing cutting machines that perform the same sequence of operations, loading material to be cut, producing the best layout of parts to maximise yield (manual or automatic), cutting (with one or more cutting heads) the batch of patterns in the correct order and eventually sorting and collecting the cut parts prior to sending them to stitching. Most of the upstream steps of the process were to various degrees automated (especially when synthetic materials in rolls or sheets are processed). For some others, the path to automation has been slower. Picking up the cut parts is one of them, notwithstanding how time- and labour-consuming this specific task is. Recently, robotics made its appearance in this regard, with a few cutting-machine vendors presenting solutions in which robots replace workers in the execution of this very tedious and apparently trivial task.

As we know cutting, especially of leather, produces a large number of pieces of different shapes and sizes that must be



ATOMLab's add-on features two robotic arms equipped with grippers made up of individually controllable suction cups.

CREDIT: ATOM GROUP

carefully (and quickly) collected and grouped in order to facilitate the operations that follow in the manufacturing process. In high-productivity machines this operation can be critical, often becoming a bottleneck in the process or requiring a large number of workers. Recently, ATOM Group has responded to these needs by developing an automated cutting machine add-on, based on two Mitsubishi anthropomorphic robots equipped with a specially designed innovative gripper.

This gripper uses a matrix of suction cups, each independently controlled and driven by special software that determines how many and which suction cups must be activated in relation to the geometry and position of the piece in the cutting layout. The robot must position itself and orient itself in order to pick up the pieces. The presence of two robots guarantees an adequate collection rate that matches the productivity of the machine. Anti-collision algorithms are needed to allow the two robots to operate simultaneously in the unloading area. Operation of the two arms is fully integrated into the work flow of the machine and can be programmed to follow different collection criteria (per size or per pair) and with different storage positions for the cut pieces.

So far, this robotic system is still at the prototype stage and is a separate module that can be added to various machines in the ATOM range, so it is more interfaced than fully integrated. It is easy to see where this line of development will ultimately lead, where robots of different types will become integral parts of the cutting machine, fully integrated into its mechanical structure and controlled at low level by the same electronic brain as the machine. They will become the dexterous arms of the new generation of cutting machines bridging the last gap in the complete automation of the cutting process.

And finally, integration. With the growth in complexity and size of the cutting operations of many companies, especially volume manufacturers in China and south east Asia, it is becoming clear that cutting machines can no longer work in isolation but must become part of a more complex process flow that starts with the preparation and

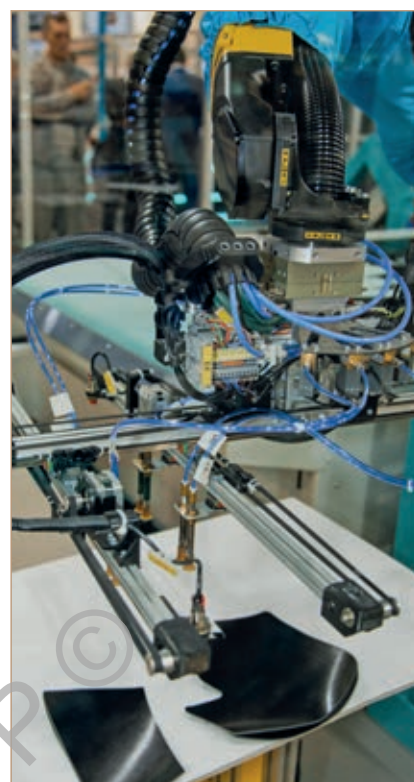
dispatching of the various materials, be it synthetic or leather, to each individual machine. There they will transform them into cut parts, balancing and optimising cutting operations between different models, distributing (via software) the workload between them, collecting the cut parts through robotics, transporting the sets of cut pieces to the other steps of processing and eventually to the warehouse.

It is a holistic view of the cutting operation where single machines become less important than the overall process and where the focus is moved from cutting per se to integration of each cutting station into a largely automated cutting process that itself is connected and integrated with the entire manufacturing process of the shoe. We are on the verge of this further evolutionary step and how strategic this change will be is becoming very much clearer, both for shoe makers who are in many cases leading the way in this direction, as well as for machine manufacturers.

UNCONVENTIONAL WAYS

It is interesting to note how this ultimate integration goal can be achieved in conventional or unconventional ways. Once again at SIMAC, ICOL Group showed how this result can be obtained in a totally unconventional way. It is as if their research and development team looked at cutting operations in a different way to obtain a new set-up that certainly looks different from others. Where traditional vendors build their machines on typical cartesian XY systems, ICOL has devised a solution in which there are only two elements, a flatbed on which the leather is laid automatically with a variety of corollary mechanical provisions (including vacuum where needed) and an industrial robot produced by FANUC that replaces the XY mechanism and is equipped with a wealth of different grippers that can execute different operations, and not only limited to cutting and automatic picking up of the pieces.

This certainly seems to offer an amazing level of modularity and simplification. Robots and cutting beds can be combined in different configurations to perform different operations on the patterns with each station connected by autonomous



ICOL's robots are not limited to just cutting and automatic picking of pieces.

CREDIT: ICOL GROUP

guided vehicles (AGV) transporting materials and cut parts from station to station and eventually out of the automated cutting room. This is something that looks very close to the almost abandoned concept of 'dark factories' that was popular some years ago.

However, there are aspects of this solution that are not totally convincing. The robots adopted appear to be over-dimensioned, the focus seems to be very much (or possibly solely) on leather cutting with no solutions presented for the processing of synthetic materials, no actual data are available yet on the manufacturing throughput the system is capable of because the first manufacturing lines were expected to go into production later this year (prior to the Covid-19 pandemic).

One thing can be said of these interesting newcomers: they have dared to tackle the whole problem of the automation of the leather cutting process from a totally different perspective and have delivered solutions that certainly do not lack originality. Perhaps this will also stimulate other vendors to think differently, fostering a transition into a new evolutionary phase of cutting footwear parts. 🔴