



The EUROShoe project of the early 2000s demonstrated the real potential for robotics in footwear manufacture.

CREDIT: SERGIO DULIO

An update on footwear robotics

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Robots are becoming a common topic in discussions about modern shoe manufacturing, both for their current applications and for the potential ones they may provide for our sector in the future. Their presence as ancillary equipment in direct sole moulding systems has relieved human operators from many repetitive and potentially dangerous tasks, with a great contribution in the improvement of the quality and reliability of the whole process.

Desma and Main Group Technologies, as leading companies in this sector, have shown the degree to which the adoption of these versatile machines can be taken and have demonstrated their capabilities in a series of original applications, both directly integrated with injection carousels or as autonomous cells performing upstream and downstream

tasks in the injection process.

In a special article last year we also described how robots can be combined in innovative ways to create complex setups or robotised footwear manufacturing lines, showing how these machines, together with other automatic devices controlled by appropriate software applications to manage and supervise manufacturing operations and in combination with advanced RFID tracking systems, can transform the typical layout of a shoe factory to completely change its manufacturing approach.

As a further support for these concepts, *The Economist*, in an April 2012 issue, published an extensive survey of what the magazine called the 'third industrial revolution' that, in the authors' opinion, is due to change dramatically the way manufacturing will be done in future. Their view is that one particular effect among many

others would be that manufacturing would be brought back to industrialised countries, a trend this magazine has also been monitoring as witnessed by another article in this current issue.

The Economist sees the roots of this revolution in three concomitant technological advances. First, there is the progressive 'digitisation' of manufacturing as in the ever growing role that ICT technologies are gaining in virtually all phases of product design and manufacture. Second, there are the further advances and widespread diffusion of direct manufacturing technologies with their implicit flexibility and versatility. Finally, there is process automation with a particular reference to the new generation of robots under development. This is a vision that we definitely share, having mentioned robots among the five technological revolutions that changed the world of shoe technology in the last

twenty-five years as profiled in the July/August 25th Anniversary issue of *World Footwear*.

STEP BY STEP TOWARDS THE FUTURE

The sector that sees the largest diffusion for robots in shoe manufacturing is injection moulding, with all its various differentiations including all plastic shoes and boots, and direct or indirect sole moulding. Conventional shoes, with the typical lasted upper and cemented outsole construction, are still to take full advantage of these machines, although indications of increased attention by both technology suppliers and the manufacturers of this type of footwear are there to be seen.

Robot-based bottom roughing and cementing cells (including the innovative system developed by Desma that uses lasers to perform the roughing operation) or outsole cementing cells are examples of this and represent an effective cross-fertilisation between different sectors of the footwear world. There are nevertheless operations that have always been considered too delicate or demanding to be performed by robots and for which human operators were considered, at least until today, as indispensable. In talking about the most recent advances in the use of robots for shoemaking we will give two examples of innovative applications. Interestingly enough, they refer to processing steps at the two extremes of the manufacturing sequence, upper lasting and shoe finishing.

AUTOMATED LASTING

Upper lasting, as we all know, is a crucial step in making a conventional, non-injected shoe. The operation is split into two separate phases; lasting the front part of the upper (toe or forepart lasting) followed by a second step in which the remaining part of the upper is pulled over the last and cemented and/or tacked to the insole (seat and side lasting). These operations are typically performed with state of the art, electronically controlled machines with full programming capabilities. While there is no doubt that toe lasting requires the skill of a highly experienced operator, there have always been discussions as to whether seat and side

lasting could be done fully automatically by the machine itself, with no contribution from an operator.

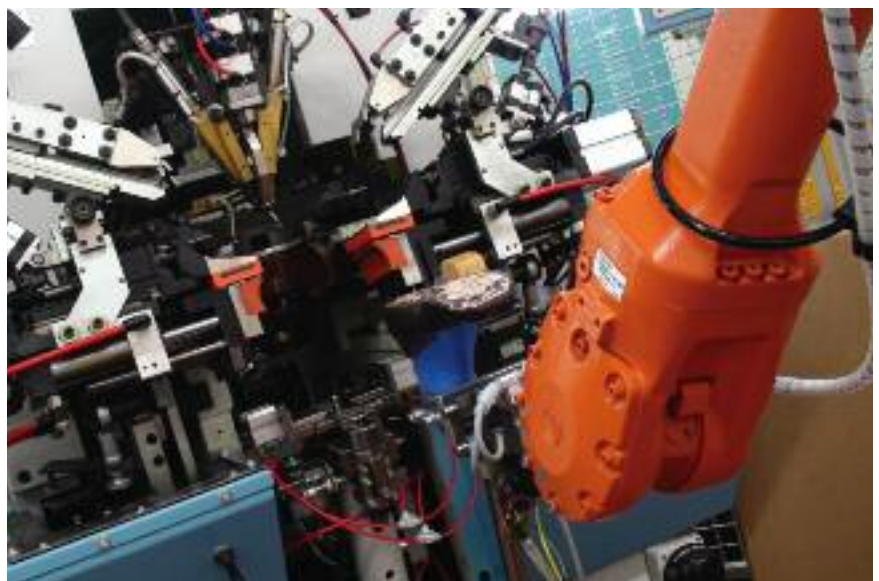
In principle, provided some important preconditions are fulfilled such as careful and accurate toe or forepart lasting, the use of high quality components (in particular a precisely built insole) are followed and the machine is well programmed, the latest generation of machines can perform the task almost by themselves. The operator will only need to load the shoe into the machine and select the appropriate lasting program from its memory. Here are two tasks we can think of automating completely, thus obtaining a global reduction in the number of workers employed in the lasting section of the making room.

This would need a programmable machine and an automated system where the operator of the toe lasting machine takes the shoe from the machine at the end of the lasting sequence and places it on an exchange station. The robot picks it and uploads it onto the seat and side lasting machine and then unloads it at the end of that sequence. A first attempt to prove the feasibility of this approach was made in the EUROShoe project, in which a modified Molina e Bianchi machine was fully integrated in an original manipulation and transportation system, allowing it to work unattended. More recently a different approach was used in the IDEAfoot research project, where an off-the-shelf ABB robot takes

the role of the operator in tending the machine.

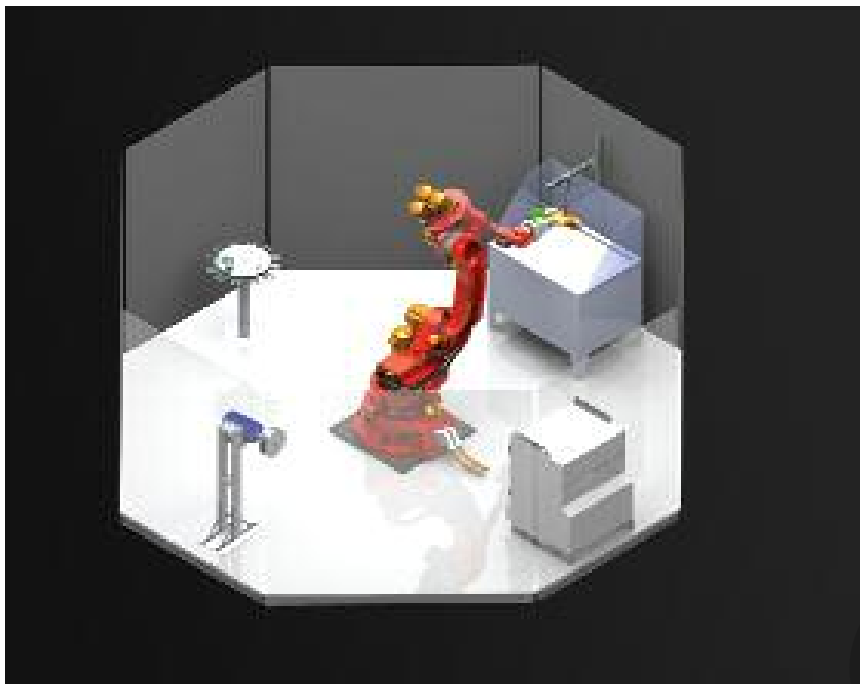
This EU-financed research project was led BZ Moda, a shoe company in the Riviera del Brenta district of Italy, that clearly indicated the kind of footwear targeted by the project: high quality, high fashion ladies shoes. It involved a considerable number of technology suppliers including Politecnico Calzaturiero and Brustia Alfameccanica from Italy, Spanish research institute INESCOP, Desma from Germany which supplied a large part of manufacturing cell and the research institutions University of Padua and ITIA – CNR in Milan. The goal of the project was to develop an automated production line that was versatile enough to handle shoes with cement sole attaching and featuring different styles, uppers and heel heights ranging from simple ballerinas to high heel boots. As a prerequisite, the seat and side lasting machine was designed to operate unattended with a robot to replace the operator for the loading and unloading tasks.

The shoemaking line is currently undergoing an intensive phase of production tests at the BZ Moda factory. A top-of-the-range seat and side lasting machine from Brustia Alfameccanica was extensively modified both mechanically and electronically. The front assembly was redesigned to introduce additional movements so as to assist the robot in passing the shoe to be processed to the machine itself. Its



Seat and side lasting machine with attendant robot for loading and unloading the shoe.

CREDITS: BZ MODA



Digital image of a robot-based finishing cell. CREDITS: INESCOP

around it in pre-defined locations. A CAD program tells the robot both which devices to follow for the correct finishing procedure required for the particular shoe model concerned and which trajectories to follow to execute the specific steps involved.

WHAT COMES NEXT?

These are certainly two interesting and innovative applications that seem to demonstrate that robots can be used in a wide variety of tasks to replace humans in all those activities in which the added value of their intelligence and expertise is not really needed. They also indicate a growing interest from both technology suppliers and shoe companies for a more widespread adoption of robots in the manufacturing of conventional shoes. So what can we expect from the future in terms of new and more advanced robotic applications?

In the *World Footwear* 25th anniversary review of the future technological trends we referred to 'human-robot close cooperation' as one of the most important evolutions in the way robots will be seen in the factories of the future. Rather than being simply replaced by robots, workers will be assisted and helped by them. A new generation of low cost, smart robots is under development in research centres in different parts of the world. They will be based on new architecture and on new operational standards that will allow them to work safely alongside humans. They will be able to understand voice commands issued by their human counterparts. Like clever and efficient servants they will perform a variety of tasks such as fetching and transporting parts, carrying components, holding things, delivering tools, sorting and picking up parts, while sharing the same space as all the 'other' workers.

In the future, robotics may therefore see a higher density of machines of a new generation, re-establishing the balance between labour and capital intensity in a way that will possibly induce companies to revise their outsourcing policies in favour of market proximity and local manufacturing. In such a futuristic scenario, we cannot but share *The Economist's* view that we are at the dawn of a new industrial revolution. 🌀

electronic unit then takes care of identifying the specific shoe model and last by reading an RFID tag mounted on the last fixture and of retrieving the appropriate lasting program that is then executed automatically. At end of the process, the machine hands over the lasted shoe to the robot that then transfers it to the downstream stations.

A complex manufacturing step is therefore executed with no manual intervention to the lasting machine which is perfectly integrated with all the other elements of the automated manufacturing line. An interesting example that proves two important assumptions: a programmable seat and side lasting machine, if properly integrated, can work unattended and robots can be used as intelligent manipulators to tend this type of machine.

AUTOMATED FINISHING

The second example brings us much further downstream in the shoe manufacturing process to the finishing phase. This, together with upper stitching, is a highly labour intensive step in shoemaking. The shoe, completely assembled, must be cleaned, polished, waxed and, eventually, finish up with all those components and accessories that contribute so greatly to its final look. If we observe how these operations are performed in a shoe factory, we can see a high number of repetitive

manipulation tasks in which the shoe is handled by an operator in conjunction with various polishing brushes and attendant waxing heads or spray guns. So, the question technicians asked themselves, was whether these movements could be done in a repetitive and reliable way by a robot with the express purpose of reducing labour content in this final yet important shoemaking phase.

Once again, a first 'proof of concept' was given in the EUROShoE project where a robot was used to retrieve the shoe from the transportation line and to perform a number of finishing operations following a 'recipe' defined model by model and trajectories designed into the CAD. This turned out to be an almost unsustainable challenge, especially when finishing trajectories had to be traced on the shoe and for which no specific design tools and background knowledge existed.

Almost ten years later, the same problem was addressed in another EU research project (Robofoot) and INESCOP, based in Elda, seems to have reached the goal in a more effective and convincing way. In the robot-based finishing cell that the Spanish institute will exhibit at SIMAC in October, a robot stands in the centre where it receives the shoe to be processed from an exchange station and then performs a series of finishing steps using a number of dedicated 'devices' positioned all