



DESMA amir system in operation. Courtesy of Hotter Comfort Concept

Industrial robots first appeared in the footwear industry some twenty years ago and, since then, have played an increasingly important role in reducing costs and improving quality. During this time, German machinery company Klöckner DESMA has developed many specific robotic applications. More recently, it has brought all these together to form a complete production system called amir (automated machinery and material flow technology with integrated robots).

Shoemaking in the future

The amir system is based around a rotary direct-injection moulding machine and a transport system which feeds in uppers and removes completed shoes as well as performing all pre-treatment and finishing operations. Careful location of the various processes has resulted in a shorter 'actual' cycle time on the machine itself. In addition, by creating buffer zones, the machine is always working at maximum efficiency and productivity increases of up to 30% have been claimed compared to previous technology.

Basic concept

The key to amir is the removal of the last from the moulding machine by means of a detachable connection in the mould carriers. This allows the last to run through the rest of the manufacturing processes that are connected by the transport system completely independently. By isolating these other operations, buffers can be created in order to avoid breaks in the moulding machine's cycle so that it is able to operate at its optimum level and without interruption.

Isolating these other operations also

makes it possible to introduce extra processes such as moistening and drying of the upper, and cooling of the sole to improve final quality. The shoe spends more time on the last and so gains better shape retention. This is not possible when the lasts are fixed to the rotary moulding table. Further advantages include the table remaining accessible for robotic handling devices if required and, as well as speeding production, isolating these other processing stations also improves safety.

In conventional moulding machine technology, one last belongs to one ➤

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Special last developed by Fagus



mould. In the amir system, there are several identical lasts which all belong to a single mould, the number depending on the cycle time of the last (the number of separate operations and their duration). There will normally be at least three lasts per mould, one on the machine and two circulating on the transport system. This, in turn, calls for extremely accurate and sophisticated lasts.

New type of last

This new generation of plastic lasts is totally CNC milled and the digitised data of the master model is the base for both the last manufacturer and the mould maker.

Because both last and mould are based on exactly the same data, an extremely high degree of accuracy is made possible. Furthermore, the lasts are equipped with a metal 'top-plate' which not only provides the gripping point for the handling robot but also enables adjustment on the machine and the external processing stations. Development of these special 'automation' lasts has been achieved through close collaboration with German last-maker Fagus.

In conventional last production, finishing the toe and heel and fitting the metal top-plate are manual operations. With these lasts, the top plates are pre-fitted to the plastic blanks, which are then milled starting at the centre (last-peg) hole and moving outwards to include both toe and heel. Starting from the exact same reference point and using the exact same data, each last of the same size and fitting will be identical in every respect. Further advantages for the shoe manufacturer include:

- Better quality as the last perfectly fits the mould
- No problems with moulds and lasts manufactured by different suppliers
- Adjustment of last support after mould change is not necessary as the lasts are milled starting from the centre hole
- Standardised last supports for automated handling and processing
- Reduced delivery times due to parallel production of moulds and lasts

- No problems with repeat orders as CAD data is stored digitally
- All robots can be automatically programmed

Controlling the system

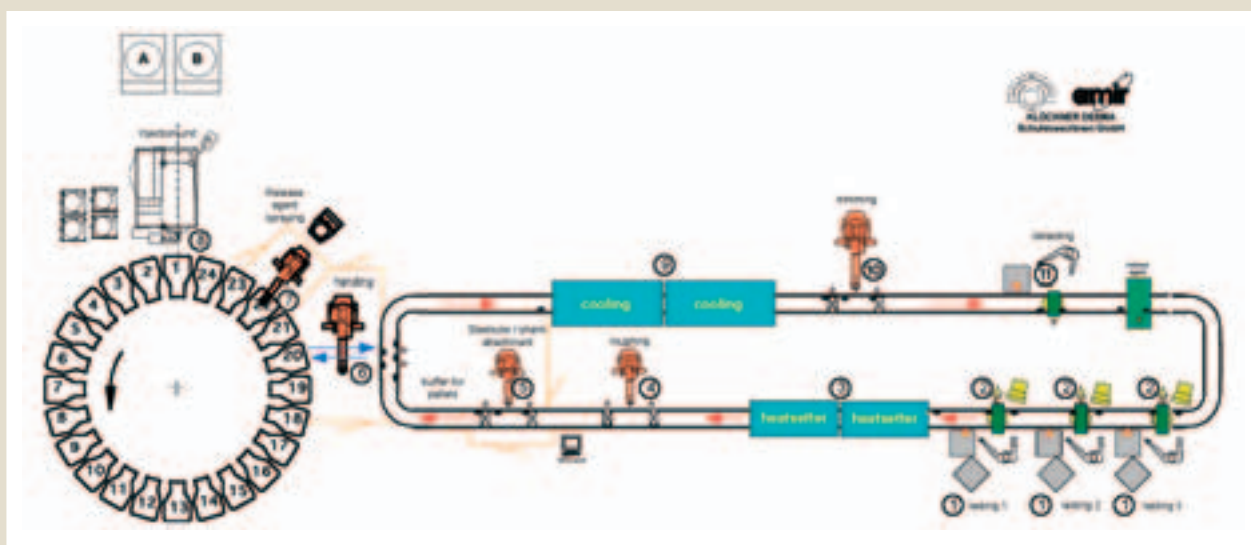
Clarity and ease of operator input are probably the most important factors in fully automated production. DESMA has considerable experience in controlling separate processes centrally through touch screen visualisation and the same concept is used in amir. The transport system and its related components can be centrally operated via a single terminal which can display new instructions, the tooling on the moulding machine, its operational status and that of each individual last.

The status of individual processing positions can be checked to decide whether they should be added or removed relative to demand. In addition to the functions given in the production sequence, further auxiliary operations such as pressing toe-puffs and soles—plus automation of other handling tasks—can also be added. A close look at the production process shows that all pre- and after-treatment of the uppers is carried out in isolation from the moulding machine cycle.

Production sequence

The transporter is a chain conveyor system with pallets which can be stopped and held at work stations as required. Speed is constant except in the areas of the

Schematic: the amir transport system



Visual lasting display



heat setter and cooling tunnel. It is easier to follow the sequence of operations as they are numbered in the schematic transport system illustration.

1. Steaming the upper under pressure mellows it (especially the toe and seat) and makes it easier to force-last.
2. Lasting is manual but, once again, everything is 'high tech'. An automatic device opens the last to allow the upper to be pulled on and then closes it so that final alignment can take place. Several lasting stations in sequence give the operator the flexibility to cope with varying cycle times.

Desma's total combination robot



Special pouring unit



A camera system allows the uppers to be positioned consistently and accurately by means of lines freely positioned on a display screen. It also allows more precise control over the toe area of the shoe that is so important in leisure shoes. The shoe itself is recorded by a barcode scanner and the production parameters stored in a RFID (Radio Frequency Identification) chip integrated in the last. A picture of the finished shoe on the screen makes it possible for the operator to control the application of the correct parameter set.

Chip reading or modification of last parameters can be carried out at each work station. Furthermore, the chip contains information about already completed processes, so it is possible to observe the actual status of the shoe by checking the last data.

3. A heat setter is positioned behind the lasting station and uses hot air to pull the upper further down to the last and works best when the latter has been steam-softened. The upper also becomes smoother and retains its shape better. The belt speed in the heat setter and subsequent dwell-time is adjustable depending on the requirements for that particular style.
4. A roughing robot roughs around the lasted the upper up to the bite line of the mould using a program contained within the RFID chip in the last. The roughing work station is positioned on the transporter system so as to avoid any roughing dust contaminating the moulding area and affecting quality. The robot works even when the table is turning and, by arranging two parallel work stations it can do so continuously and so reduce the moulding time-cycle by up to three seconds.
5. The next robot takes steel shanks or sole plates from a magazine and attaches them to the underneath of the lasted upper using hot-melt adhesive.
6. The lasted upper is then seized by a further handling robot positioned between the transporter and the moulding machine which, after removing the previous completed shoe from the rotary table, places it in position for the soling material to be injected.
7. Before the lasted upper is placed in the moulding position however another robot positioned directly next to the moulding machine, sprays release agent on to any mould surface that will come into contact with the injected PU. Electrostatic loading of the release agent and the accuracy of the robot allows the quantity of release agent used to be reduced to an absolute minimum.
8. The reaction pouring unit (RGE) is a low-pressure generator that compounds the PU system. Mixing is by a self-cleaning screw that needs no solvent. There is also an option for including additives or colours.
9. Dissipating heat from the sole in a cooling tunnel makes it more stable and removes the risk of permanent deformation caused when the shoe is delasted.
10. The trimming robot removes flash from the mid and/or outsole, again using a program activated by the RFID chip.
11. The final operation of delasting is very similar to that of lasting and again has an automatic last opening device for ease of operation. ➤

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Additional options

A pouring robot is recommended for use with DESMA S series machines. Replacing the conventional reaction-pouring unit by a robot-guided one ensures maximum performance due to superior maneuverability that gives optimum material distribution in even the most complex of moulds. Although it can be programmed like a normal robot, it does remove any additional setting possibilities for the pouring unit.

The pouring unit itself can be moved in three dimensions and, in addition, can be bent in all directions. Another important feature is its ability to operate on several cavities per mould. The pouring path itself is determined by a number of reference points so that it is capable of a large variety of movements and, as with a fixed unit, the addition of colours or granules is also possible.

Linking to other systems

It is also possible to install interfaces from the amir system to other preceding

or subsequent systems such as upper stock, upper feeding, final finishing and packaging. Due to the modular design, existing machines can also be equipped with amir technology to considerably increase their capacity.

The development of more operator-friendly robots has also made it possible for non-technical staff to do programming and program adjustment. The 'mysterious robot' no longer exists and robots have become as common in shoe factories as traditional machines for footwear production.

The future

The technology used in the amir system has demonstrated that a high degree of automation can be both reliable and a good way to achieve significant increases in production output and savings in cost. If the full system is implemented, operators are only needed for lasting, delasting and quality control.

UK comfort shoe brand Hotter Comfort

Concept installed an amir system at the beginning of this year. It has proved highly successful and the company reports that DESMA's claims in regard to increased productivity are quite achievable. Hotter was so impressed, in fact, that it is installing a second complete system. Clearly, if a company operating in a high-cost country like the UK can make automation pay, it has to be practical in any other high manufacturing-cost economy.

So much footwear manufacturing capacity has been lost in high-wage economies that most observers have written it off. Nothing in this world is ever permanent however and, with so many uncertainties around, things could easily change. One way that shoemakers in high-wage economies can fight back is to produce something unique as the UK's Goodyear welted manufacturers do. The other is to produce shoes in as fully-automated a manner as possible. DESMA's amir system appears to be a good way to achieve this. 

The amir system

