

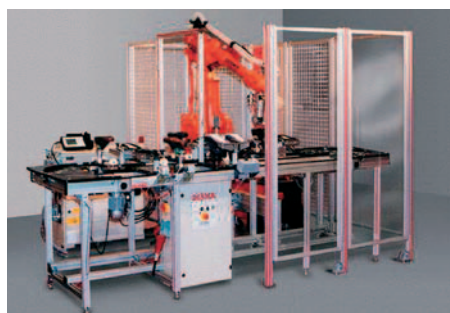
Robots are becoming more common place in modern shoe factories. Klockner DESMA GmbH has been working on the robotic processing of PU for footwear for many years and now has robots for more than 20 applications. In a paper presented at the API 2005 PU Conference in October, Bjoern Dormann and Christian Decker described many of these in detail. World Footwear takes a look at some of the points raised.

Automation concepts for PU footwear production

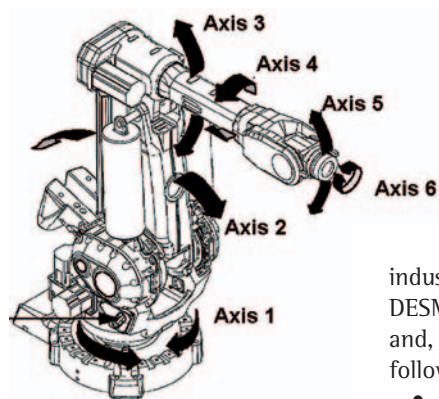
Almost all robot arms on the market today share the same general makeup. The most widely used is the six-axis type, which has six effective degrees of freedom and is therefore able to handle the most complicated applications. Accuracy is one of the most important aspects and a robot must be able to perform its programmed tasks day after day, year after year with the same degree of accuracy and repeatability. To achieve this, it needs reliable mechanical systems such as brushless three-phase current motors with integrated brakes.

The electronics must also be totally accurate and reliable as sophisticated control is essential to produce a well-made product. This is because of the specific way a robot has to be programmed. Each supplier has its own philosophy which must be adopted by the user or programmer of the robot, and this, in turn, means that there must be an appropriate interface between the machine and the user so that the robot can be programmed correctly. To achieve this, DESMA has developed a unique interface system called Graphical Robot Control (GRC) which provides the fastest and easiest way of programming without any interruption in the production cycle.

In economies such as the EU or USA where salaries are high, the use of robots has now become essential in many industries.



DESMA six-axis robot with conveyor belt



Typical six-axis robot

For a manufacturer to operate at a competitive level, this is best-achieved through highly automated production facilities using six-axis robots with specific applications. While controlling costs is important, quality is probably even more so and the quality of a product is determined by the way it is produced. Robots score well here too.

The shoe industry is different to almost every other in that there is not just one single part to be carried from one place to another. Many shoe sizes have to be handled in both left and right feet, different models pose different production requirements, and a wide range of materials has to be accommodated. The resulting number of possible permutations puts a huge strain on organisation and control and, in a modern shoe factory, this simply will not work without a degree of automation.

Applications

What are the principal applications in the shoe industry that can be carried out by robots? For over 20 years, DESMA has worked with many leading footwear companies and, in the process, has developed automation solutions for the following key operations:

- Roughing
- Cementing
- Kombi-RC (roughing and cementing)
- Kombi-RS (roughing and steel shank attaching)
- Spraying mould release agents
- Flash trimming
- Last slipping
- Last handling
- Sole extraction
- Insert handling
- Mixing-head handling

Shoe upper roughing

The bonding of polyurethane to the upper is not possible with a greasy surface, which is the norm for most leathers. ➤

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The perfect bonding of polyurethane to leather is also critical, especially in safety or military shoe production where demanding standards are built into footwear specifications. Upper roughing is a key factor in this as it lays the foundation for a truly effective adhesive bond. At first glance this appears easy but, on closer examination, the difficulties and special needs become more apparent.



Roughing robot

The shoe bottom is complex in terms of contours. Furthermore, penetration of the leather has to be sufficient and at just the right depth. This can pose problems on very sensitive leathers. To meet this and other potential difficulties, DESMA has developed its well-proven roughing robot.

It copes with all types of leathers by using a specially-designed roughing tool. This works by controlling the speed of the milling tool and varying its pressure on the shoe bottom to achieve different degrees of penetration and to react to irregularities. The roughing robot can be used on a rotary direct moulding machine or at the side of a conveyor belt as in the company's Amir-system.

Spraying release agents

The use of release agents cannot be avoided as when polyurethane begins to react, sooner or later it will stick to the mould. There are two main types: one has a high concentration of solids and the other is water-based. The agent is normally hand-sprayed into the mould by an operator, so a constant level of quantity and quality cannot be guaranteed. The result is either a huge waste of agent or damaged mouldings.

To overcome this problem, DESMA developed a release spraying robot which minimises the amount of release agent by ensuring a perfect distribution throughout the mould. The high solid type is the most widely used and can be applied with an electrostatic spray gun. This also creates high tension in the release agent so that it is able to reach into undercuts and hard to reach areas of the mould.

The electrostatic spray gun offers a number of advantages over manual application:

- Very fine and uniform distribution of material
- Over-spray of release agent directed by electrostatic
- Very small consumption of release agent
- Smaller burden on the environment by using electrostatic power
- Small requirements on robot programmes
- Only one programme needed for several moulds/sizes

Consumption of the release agent can be decreased by up to six grammes per sole, imperfections such as shiny spots or surfaces are minimised, and environmental pollution is vastly reduced. These robots can be used on either direct sole moulding machines or casting machines for unit sole production. The following cost tables show the significant savings that can be made.



Trimming robot in action

Consumption of release agent

	Manual	Handling	DESMA
1 colour	4g / €0.06	3g / €0.045	1g / €0.015
2 colour	7g / €0.105	5g / €0.075	1.5g / €0.0225

Savings on release agent (1,000 pairs per shift)

Shifts/day	1 = 240 p.a.*	2 = 480 p.a.*	3 = 720 p.a.*
1 colour	€10.800	€21.600	€32.400
2 colour	€19.800	€39.600	€59.400

**Note: Cycle time of 15 seconds & 250 working days per year*

Flash trimming

The injection and pouring of polyurethane have one thing in common—flash after the material has finished its reaction. Flash trimming is therefore another unavoidable operation and one that is still normally done manually. However, like every manual task, quality and output cannot be guaranteed. DESMA's flash trimming robot overcomes this by using an oscillating knife which is able to cut the flash of many different sole materials including PU, TPU/PU and rubber/PU. As with the roughing robot, it can also follow difficult contours quickly and accurately. Different contours may also call for different knives, but again this is not a problem as the robot is equipped with a special fast tool changing system.

Rubber/PU

The material combination of a rubber outsole and polyurethane midsole in a one-step procedure is probably the most sought after soling combination in the industry today.



Sole extraction robot

These two materials unfortunately do not like each other and bonding them together is difficult. Several ways exist to tackle this problem, the most popular being to use a primer, with the use of a nonwoven insert in second place. Last but not least, the rubber outsole can be produced as a separate component, inserted into the mould and the PU injected directly. All three have serious disadvantages: primers are unhealthy, while nonwoven inserts and separate rubber outsoles require additional labour.

The best solution reached so far is to spray the vulcanised rubber outsole with a special adhesive. The PU and the rubber will both stick to it and an effective and reliable final bond is achieved. The finished product looks better than one with a nonwoven insert and there are substantial material and labour savings plus improved cycle times, particularly if a robot is used to spray the adhesive.

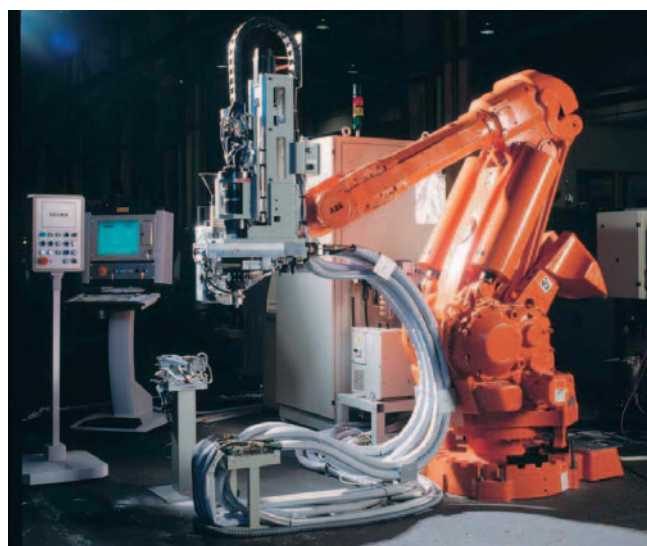
PU sole extraction

It is possible to have a moulding machine producing PU soles without an operator in constant attendance. A release agent robot sprays the release agent into the mould and the PU is poured into the open cavity. This can all be done mechanically, but what happens after the reaction time of the PU when the sole must be extracted from the mould? Enter the sole extraction robot. This is equipped with a multifunctional tool that can handle complex and difficult designs, extracting the sole and forwarding it to the next process.

In normal circumstances it is the operator that is the time consuming factor in sole moulding. This is not through any lack of ability, but due to the complexity of the products. Sole extraction in particular can become the most time consuming factor in single PU sole production and, once again, automation can offer surprising improvements to productivity.

PU-mixing head guided by a robot

In modern shoe production, the variety of different models is



Robot guided low pressure mixing head

huge and can also change rapidly. This means that reaction time must be short in order to stay competitive. This, in turn, leads to the obvious conclusion that the equipment must be able to serve all the needs of new designs. In order to handle this degree of flexibility, the low-pressure mixing head should again be guided by a robot. No matter whether a mould is for high heels, sandals or casual soles, the robot adds extra production flexibility to fast and modern shoe manufacturing systems. While not new, this method of pouring polyurethane into moulds is becoming increasingly important.

The design possibilities for PU shoes are tremendous and this calls for the most flexible machines available. For instance, the modern shoe is often equipped with inserts or some other marketing feature that must be inserted before injecting the polyurethane sole. This is yet another area in which DESMA has created robotic solutions. Indeed, having now sold over 800 robots, the company considers itself able to answer any automation requirement with regard to PU shoe production. 