

Typical cup sole sports shoe.

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REDUCING COSTS ON SPORTS SHOES

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Klößner Desma is well known for its sophisticated moulding machines for both direct and indirect bottoming applications using PU, TPU and various, often complex, combinations of soling materials. One of its key targets has always been to seek new ways to replace labour intensive processes by more automated means that not only improve the quality and performance of footwear, but also reduce the cost of manufacture. It has successfully used a combination of robotics and advanced materials to create new production concepts to the point where it is now the sole supplier of completely automated systems to the industry.

The increasing need to turn to automation as a solution to rising manufacturing costs in a highly competitive global footwear market is driving research in many quarters into how some of those costs can be lowered without reducing either quality or performance. One of the areas in which Desma has seen an opportunity is the traditional assembly process where uppers and soles are brought together to

complete the shoe. This is mostly performed by essentially manual processes in low labour cost countries. The solution is to find a way to reduce labour content, save on materials, improve quality and, if possible, make it practical to move production back to higher labour cost countries.

DEVELOPING TRENDS

Manufacturers producing polyurethane-based goods of any description are being increasingly forced to reduce carbon content and strive for totally 'green' production systems. Footwear manufacturers are therefore more receptive than ever before to new processes and technologies. New solutions must however satisfy a wide range of new strategic needs and current trends demand we consider factors such as sustainability, 'greenness', carbon footprints, renewability, recycling, the fact that domestically made products are gaining in importance, brand trust, shipping times and costs. In fact, it is only now that the full impact of globalisation is becoming clear to producer and

consumer alike.

Any new production processes must therefore be developed with all these factors in mind and geared towards some new challenges:

- Reduced environmental impact, VOCs, material and energy consumption, cost of production and transportation
- Individual production with high flexibility and potential for mass-customisation
- Innovative design
- Maximum performance

NEW AUTOMATED TECHNOLOGY

Desma has, for a number of years, been developing new technologies aimed at large scale production of all kinds of footwear. One of the main targets has been the easy user interface which is a key point in any automation solution. Much development work has therefore been focused on reducing its inherent complexity and improving software so that customers find these technologies much easier to use than before. One problem still remains in regard to advanced robotic automation: reluctance on the part of many manufacturers to invest in such systems or pay the highly skilled operators sometimes needed to man them. Sergio Dulio also touched on this in his article on cooperative robotics in the November/December 2010 issue of *World Footwear*. Desma therefore changed direction and developed a totally self-programming system that does not need any operator for either programming or creating parameters.

With regard to hardware solutions, the company has developed a robotic cell for the treatment of shoe soles or components with primers and adhesives. Intelligent control of the cell, combined with the appropriate sensors, generates the required software data for the robot all by itself. It is referred to as the 'Black Box' as, rather like a conjurer's magic box, something that is fed in one end comes out the other fully treated and without any apparent human involvement.

Programs are generated automatically and are used only once. An added bonus is that the cell can compensate for any variations in shape all by itself so that quality remains at a constant level. The first application tried was spraying

adhesive on to the shoe bottom without any physical contact. In the prototype cell, spray equipment was used to treat the surface with a boundary ribbon of heat-activated PU-based reactive hot melt adhesive. Various overall spraying patterns were also tried but the initial boundary ribbon line delivered a more than adequate bond as well as being faster and using less adhesive (*Figure 1*).

A Continental size 43 (UK size 8) shoe bottom can be coated in less than eight seconds, while a UK size 9 sole will only need approximately 1.5 grams of hot melt adhesive. In the case of a textile upper, this has only to be cleaned, the

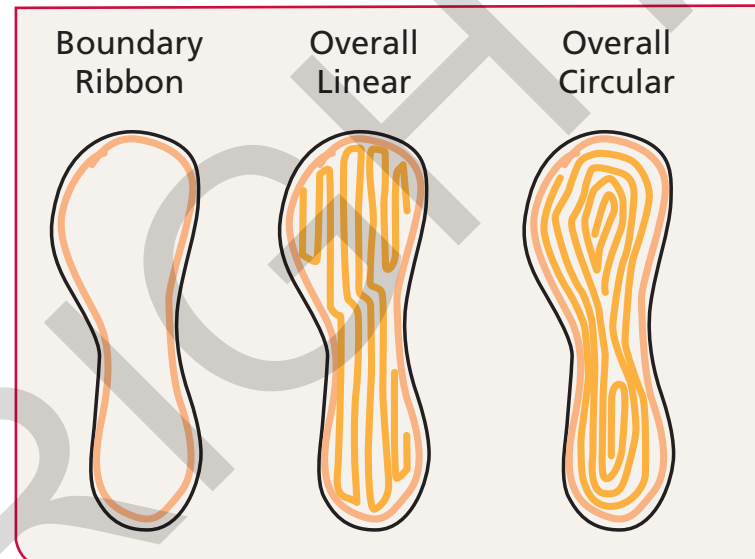


Fig 1 – Adhesive coating patterns.

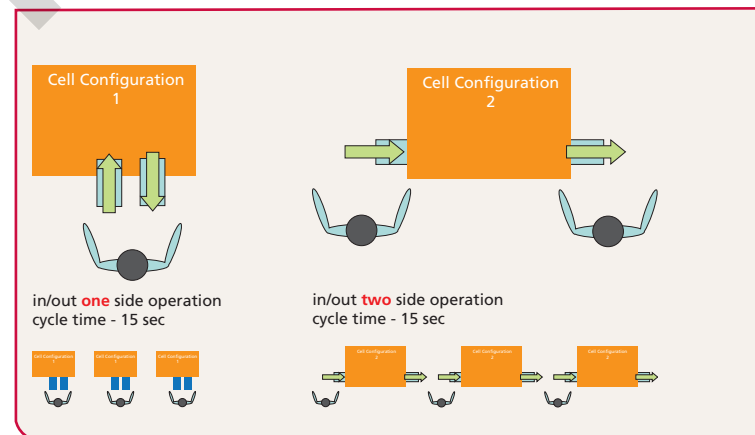


Fig 2 – Different cell configurations.

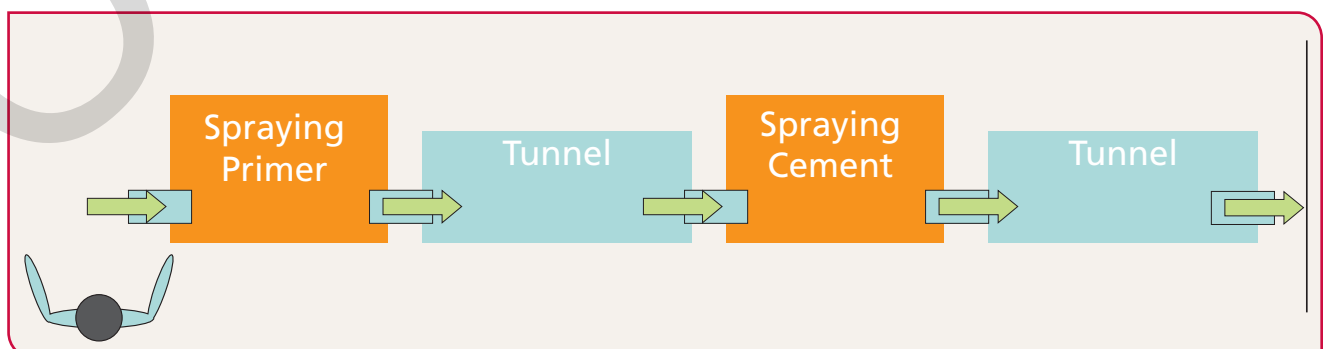
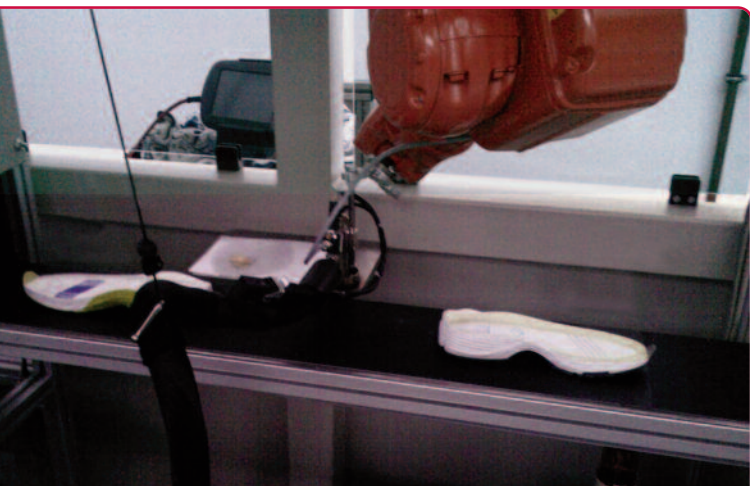


Fig 3 – Revised production layout.



The Black Box automation cell features flexible selection and orientation of products.

sole activated, manually applied to the shoe bottom and pressed for about two minutes in order to achieve a satisfactory bond. This simple process removes the need for the up to 20 operators needed to rough the uppers of sports footwear, and to prime and cement both them and the soles used on many production lines.

There is also a tremendous saving in primers and adhesives where, with conventional brush application, around 10 to 15 grams are used on every shoe. Furthermore, the cell can also be fed different products with changing sizes, colours, shapes and orientation. Although leather and some textiles will need roughing and priming, upper pre-treatment can be eliminated on synthetic materials making the process of particular interest for sports and athletic footwear featuring fully synthetic uppers. Because manufacturers' requirements vary depending on the type of shoes they are producing, Desma has two versions of the system which allow either for integration into existing production lines or operation as a totally independent stand alone solution (Figure 2).

It is also possible to combine the concept with conventional primer-cement systems to create a through-flow of feeding-priming-drying-cementing-drying. Integration into existing production lines can also reduce the number of operators and improve machine efficiency. Figure 3 shows a layout where the cell is just one part of the total equipment selection. This layout also includes another robot which prepares the upper by combining several processes that are normally performed by human operators:

- Bottom grinding
- Bottom roughing
- Contour roughing
- Upper cleaning
- Cementing of side by spraying
- Cementing of bottom by brush

The robot needs about 10 seconds per step or up to one minute for the whole sequence depending on how many of

them are required for the shoe being processed. At first glance, this seems slow; a second look, however, shows that total productivity is in fact much higher than on a traditional production line.

CUP SOLE SPORTS SHOES

It has long been accepted that sports footwear cannot be produced competitively in high labour cost countries. Those featuring a rubber cup sole form a significant proportion of total output but also call for many manual operations in their manufacture. To offer an alternative, Desma has developed a highly automated production line which is able to process this type of footwear quickly and to a high quality standard.

But, why use rubber? Rubber is one of the oldest soling materials next to leather. While, as far as possible, other less expensive materials, such as PU, TPU or TPR, have displaced it in many areas, they have not done so for athletic sports shoes. Why? It is simply because when it comes to properties such as slip resistance, cold and heat resistance, the best performer is still rubber. Indeed, where sports shoes are involved, there is very often no alternative as far as the outsole is concerned.

At the same time, sports shoe production constantly changes. They must now not only be modern, comfortable and practical, but also able to fulfill the orthopaedic requirements and dampen the effects of impact on the foot. The only way all these varying demands can be met is by combining the rubber outsole with other soling materials. A simple rubber sole on its own would simply not be the answer. The manufacture of sports shoes therefore depends heavily on the right combination of soling materials which, in turn, has a significant impact on the actual production method used. Although rubber is a heavy material, lightweight outsoles can be made, if they are formed as a shell and combined with lighter materials contained within that shell.

It is the material or materials used to make these 'fillers' or midsoles that not only provide all the extra comfort, orthopaedic and performance enhancing features of the shoe, but also directly dictate the production method that must be followed. The main difference lies between a conventional type of production where a pre-made sole unit is bonded to the upper using primarily manual labour and one where the sole is moulded directly on to the lasted upper. The former is difficult to automate, whereas the latter can be fully-automated with great savings in time and cost but without sacrificing quality.

PU VERSUS EVA

EVA is the midsole material of choice on almost all athletic sports shoes. While it performs well physically in wear, its natural dimensional inconsistency makes it unsuitable to be used in an automated system where



Cup soles are moulded in the form of a shell.



The PU midsole provides a comfort zone.

accuracy is paramount. PU performs almost as well in most aspects, exceeds it in terms of compression set and has many other factors in its favour as a midsole material:

- Ideal for casting and direct soling technologies
- Precise replication of mould surfaces
- High quality at low density.
- Exceptional bonding to other materials
- Lower compression set than EVA under dynamic load despite low density
- Positive energy absorption (soft-feel) under compression
- Longer life in wear due to high dimensional stability under dynamic load
- Requires standard PU processing only

Desma has now brought rubber outsoles and PU midsoles together in a fully automated system capable of producing highly sophisticated sports footwear. A lasted upper passes through a heat setting tunnel to ensure a tight fit to the last and is then roughed by a robot. Adhesive is applied to the roughed margin—again by robot—and automatically passed to an injection casting machine. A rubber cup sole that has been pre-prepared and cemented is heat activated to ensure good bonding between it and the PU midsole, placed in the mould and a robotic mixing head pours low density PU into it. This specially developed mould holds the cup sole in place while the polymer expands and bonds everything together. Once the reaction cycle of the PU is complete, the finished shoe is delasted, finished and packed. 🏃

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