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Opening photo: A semi-trailer produced by Menci.



FOCUS ON TECHNOLOGY

Robotic Electrostatic Application of Water-Based Coatings for Semi-Trailers and Tippers: Menci's Revolution

Alessia Venturi **ipcm**[®]

Mechanical stresses, wear through weathering, and heavy loads are the daily operating conditions of semi-trailers, movable floors, and their equipment, such as tippers and tanks (ref. **Opening photo**).

The world of transport expects maximum performance from these, including sturdy design and reliable finishes guaranteeing the necessary corrosion protection over time. Semi-trailers can exceed thirteen metres in length and present considerably complex-shaped

components and numerous weld joints. These two characteristics, combined with the high quality coating requirements imposed, significantly complicate the painting process, which is traditionally carried out with liquid products and manual operations.

The sector of trailers and their equipment is also an important test bed for new coating products and plant technologies: for example, several companies switched from solvent to water-based paints already many years ago and the ones choosing the latter now account for the majority. The transition from manual to robotic electrostatic application techniques and the digitisation of the coating process have been two further hot topics in the last few years, thanks to the incentives that have been offered to anyone investing in Industry 4.0 throughout Europe.

These trends also correspond to the evolution of the paintshop of Menci, one of the main manufacturers of semi-trailers, tippers, and tanks for the agricultural and industrial sectors. In the last few years, its production flow has actually been revolutionised and its focus has shifted towards process automation, as evidenced by the recently installed robotic welding stations. The revolution was completed in 2018

and it has been effective for about six months now. It required the creation of a development team involving CMA Robotics (Udine, Italy) and Wagner SpA for the application elements and Inver¹ Sherwin-Williams for the fine-tuning of the water-based coating system. Although not completely free of problems, the transition from manual to automatic processes was quick and easy: Menci has already transferred approximately 50% of its semi-trailer coating operations to the automatic booth.

Menci: excellence in the machining of aluminium

Its ability to treat aluminium has characterised the development of Menci and the evolution of its offer: from tanks to quarry and construction tippers, the use of light alloys is the trademark of this manufacturer. MENC I & C. SPA was established in Castiglion Fiorentino (Arezzo, Italy) in 1927 by Geremia Menci, a skilful metalworker who produced machines and equipment for agriculture, especially ploughs.

This specialisation was maintained in the following years without any particular innovation. Not even the involvement of his three sons Adriano, Luciano, and Francesco in the Sixties led Menci to abandon the agricultural sector. However, in the Seventies, precisely this specialisation led to the creation of the company's first fodder transport tank, which marked the debut of Menci in the world of industrial transports and opened new horizons for this firm.

The quality leap occurred in the Nineties, due to a period of crisis in the agricultural sector that forced the company to enhance its production intended for road use. The processing of fodder transport tanks helped the company's workers develop remarkable aluminium welding skills. This, in turn, allowed revolutionising the production

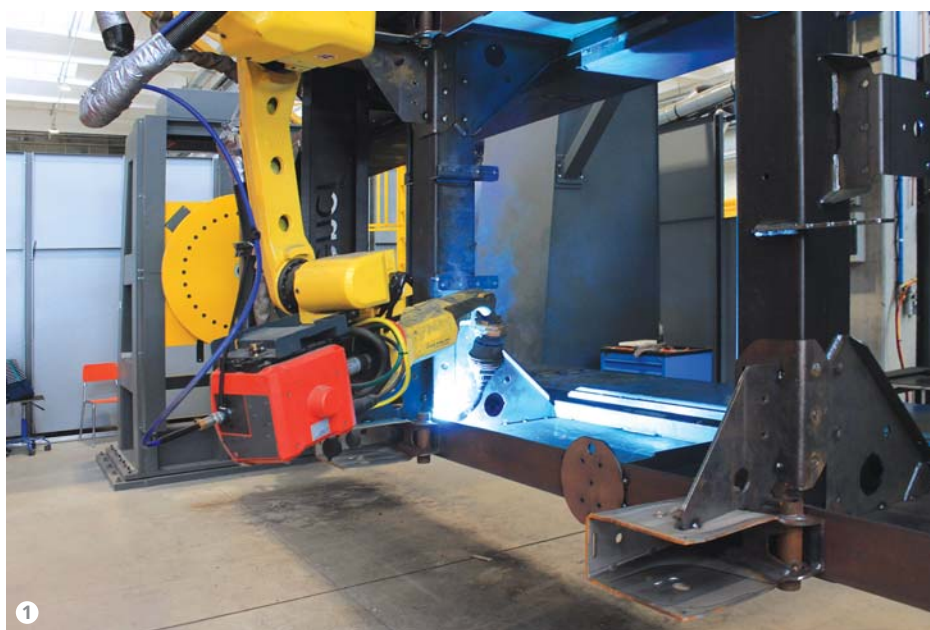


Figure 1: A robotic welding station.

“The sector of trailers and their equipment is also an important test bed for new coating products and plant technologies: several companies switched from solvent to water-based paints already many years ago and the ones choosing the latter now account for the majority.”

flow of Menci, which has continued to grow by developing of light alloy welding technologies and other new innovative projects (Fig. 1). Since 2001, in order to meet some customers' need for steel heavy-duty semi-trailers, the firm's production began to also include this material, although just for tipping semi-trailers – a sector where Menci is now the European leader in the 22-60 m³ range in all possible combinations. The exponential growth of MENC I & C. Spa has occurred over the last ten years, transforming it into an Italian market leader with 1,800 semi-trailers produced

1 Inver is a brand of The Sherwin-Williams Company.



Figure 2: An already-coated tipper taken to the assembly area.



Figure 3: A frame within a drying oven.



Figure 4: The two coating robots installed in the 20-metre long dry application booth.

per year. In 2004, Menci began to export its products all over the world, starting with the whole European market and reaching the South American one a few years ago. In 2013, Menci further grew by acquiring the manufacturer Zorzi, with a factory in Treviso (Italy). The Group now also includes Menci Maroc and Menci do Brasil. It has a consolidated turnover of approximately 80 million Euros and 280 employees in Italy alone.

"We are particularly focussing on our internationalisation, especially in distant countries and emerging markets, for which we have specifically developed a tank that simplifies and reduces the impact of transportation on our products' costs," states Menci Industrial Director Francesco Cau. "This is an easy-to-build modular tank kit, whose structural elements are bolted and can be shipped in containers. We decided to launch a product line intended for developing countries that it is not only easy to build on site, as it does not require any welding operations, but also easy to maintain."

The production flow

Menci's production philosophy translates into robotic welding stations for all main components, state-of-the-art solutions to guarantee maximum quality and ISO 9001 compliance, and extreme attention to details for aesthetically perfect and functional products (Fig. 2).

The products that distinguish this company's offer are as follows:

- Tipping semi-trailers in light alloys and steel;
- Moving floor semi-trailers;
- Frames for tanks;
- Tanks for the transport of animal feed and flours for animal use.

"Our two Italian manufacturing sites stand out for their product customisation level. Here in Castiglione Fiorentino, we produce standard frames and tippers under the brand Menci, but the Treviso plant specialises in a highly customised production under the brand Zorzi, often starting from a blank sheet," explains Cau. "We produce frames in both steel, which accounts for 80% of our production (Fig. 3), and aluminium. Tippers and tanks can also be manufactured in steel, with round sections, or in aluminium, with square sections and greater volumes. The choice of the constructive material obviously depends on the type of load for which the vehicle is intended. The maximum size of our semi-trailers is 13.60 m, that of our tippers 11.5 m, and that of our tanks 12.5 m."

"Our production flow starts with aluminium extrusions, machined on two 5-axis centres, and with the folding of steel sheets. That is how we prepare the kits needed to assemble the first welded units. After the welding of the structure, we proceed with a manual sandblasting phase in two large booths that can accommodate frames, tippers, and tanks in both steel and aluminium," adds Cau. "We have fine-tuned an extremely



Figure 5: The programming and control devices of the two robots.

delicate sandblasting process for aluminium, using special pyramidal metal shots. Our aluminium movable floors, on the other hand, are sanded by hand. Typically, the aluminium tippers are not coated but, when they are, the sandblasting process is preceded by a chemical pre-treatment phase, that is, phospho-degreasing through a pressure washer. For the coating cycle, we use a three-coat, two-component, water-soluble liquid system, including two layers of base coat and a layer of enamel, supplied by Sherwin-Williams. It takes place in an area equipped with three manual booths, each linked to a drying oven, and with a new robotic booth featuring an automatic mixing device and an electrostatic application system, which was Menci's latest plant investment."

The coating system: adjusting a tailor-made product

The coating products used by Menci in its robotic booth are the same as those used in the manual systems. Inver has fine-tuned these last generation, two-component acrylic primer and enamel precisely to allow using them also in the automatic machine. "Thanks to the adjustment process carried out in our laboratory in Minerbio (Bologna, Italy), the transition from manual to automatic application operations has been very smooth," says Lorenzo Mori, CEO of Invercolor Toscana, one of the companies controlled by Inver in partnership with its sales representatives in order to capillarly supply a high quality service while maintaining the parent company's peculiarities.

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Figure 6: A rendering of the bearing structure equipped with the two robots.

“The two products are applied in three layers with a total thickness between 120 and 130 microns. Many colours may be applied, because Menci’s production is highly customised in terms of finishes and the customers can choose any type of tint, even fluorescent ones,” adds Lorenzo Mori. “Inver also supplies colours from the Scania, Volvo, and DAF ranges, since every tank must guarantee the perfect colour match with every tractor.”

“The peculiarity of Menci’s coating system is that its base coat has been developed to ensure the optimal distension of its enamel layer. Although these products are applied with high thicknesses on sandblasted surfaces, they give the surfaces optimal aesthetics and guarantee a salt spray resistance value of 700 hours,” says Giuliano Grandi, Area Manager and Invercolor

“Inver has kept pace with the entire development of water-soluble liquid paints, which were created in the 1970s as products for immersion application operations. This firm, however, immediately started testing them for spraying processes: despite some initial disastrous results, as the raw materials available at that time were not suitable, it carried on. It is now among the most experienced companies in the field of water-soluble technologies, and water-based liquid coatings with a low cosolvent content account for approximately 80% of its production.”

Manager at Sherwin-Williams. “This excellent result depends on the surfaces’ refinement degree, resulting in little absorption of enamel and therefore in excellent finishing results. Moreover, both the base coat and the enamel employ the same isocyanate catalyst, which further favours adhesion among layers. Until two years ago, the tanks were sanded by hand after the base coat application: a whole day was needed for this operation alone. Now, thanks to the fine-tuning of its coating system, Menci can automatically perform a wet-on-wet cycle with a flash-off stage of approximately 2 hours between one coat and the other, and a final flash-off stage of at least 40 minutes at 30 °C to let all water evaporate; the final drying in the oven lasts 1 hour at 50 °C. The final flash-off stage is crucial to reach the required film quality level,” states Mori.

"This company works with internal specifications that can be customised according to the demands of the market or of individual customers.

For example, some require total thicknesses up to 350 microns.

For these particular needs, Inver provides a water-soluble epoxy base coat able to reach a dry thickness of 250-300 microns with two coats," says Giuliano Grandi. "Inver has kept pace with the entire development of water-soluble liquid paints, which were created in the 1970s as products for immersion application operations. This firm, however, immediately started testing them for spraying processes: despite some initial disastrous results, as the raw materials available at that time were not suitable, it carried on.

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Figure 7: The robots feature Wagner GA 4000 AirCoat automatic guns.



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Figure 8: The paint mixing and feeding occur through the separated AquaCoat system.

Robotic electrostatic application: an operational revolution

"We started automating our coating process six months ago, although continuing to work with the manual booths at the same time," explains

Francesco Cau from Menci. "We have not fully mastered the robot activation phase, yet, due to the variability of our products in terms of shapes and dimensions: the coating programs' generation and testing

take a long time. In fact, we are about to hire a person who will take care of the coating and welding robots' programming. However, we already manage to paint four or five frames per day and we are fine-tuning the coating of the first tippers."

The two CMA Robotics coating robots are installed within a 20-metre long and 7-metre wide dry application booth with an air intake plenum device on the roof, a suction system on the floor, and three filtration levels i.e. roof, floor, and walls (Fig. 4). This automation project was aimed at enabling the coating of several large-sized frames and tippers, with a length of 4 to 13.6 metres.

The CMA GR6100 robots used have a very wide work area, they are ATEX Zone 1, Category 2G certified, and they can be programmed off-line (Fig. 5). Their wrists are hollow to allow space for the paint feeding pipes and access narrow areas more easily. Indeed, the frames to

“ WAGNER provided Menci with an application system developed based on the experience gained in forty years of activity in the field of electrostatic systems and water-based coatings. A completely insulated device favours the creation of the electrostatic effect, crucial to help cover geometrically complex parts. The high voltage paint is also attracted by areas that are difficult to reach with the guns, thus guaranteeing perfect workpiece coverage and overspray reduction.”



Figure 9: The coating management unit.

be coated have very complex shapes and narrow spaces (Fig. 6). “In order to cover the entire length required by Menci, we matched the two robots, i.e. one per side, or one above and one below if needed, with two horizontal carts, each with a 18-metre stroke, which constitute the seventh axis,” states CMA Robotics Project Manager Daniele Donato. “We then fixed the carts + robots unit high up on a sturdy steel structure so as not to take up space on the floor, because the booth’s bottom is equipped with a suction device. This configuration enabled us to comply with the minimum booth size required by this customer, i.e. an internal width of 6.8 metres, a length of 20.9 metres, and a height of 5.7 metres (under the filter). The system has a retaining pin on the ground with a switch that signals to the robots’ control panel that the workpiece has reached its position,” states Donato. “It was designed to make sure that the carts are always in the correct position.



Figure 10: The control modules of the Wagner Intellimix mixers.

The plant coats through a Wagner Intellimix automatic electrostatic system, whose colour change operations are managed by the CMA dialogue interface.” “We provided Menci with an application system developed based

on the experience gained by Wagner in forty years of activity in the field of electrostatic systems and water-based coatings,” says Wagner SpA Area Manager Roberto Mattioli. “It applies a 2K water-soluble product with an air-aided high-pressure jet. The GA 4000 AirCoat automatic

guns on the robots’ arms use a low-pressure pulverisation air jet, but they deliver the product through high-pressure airless nozzles (Fig. 7). The paint mixing and feeding occur through the separated AquaCoat system (Fig. 8). A completely insulated device favours the creation of the electrostatic effect, crucial to



Figure 11: A coated frame.

help cover geometrically complex parts. The high voltage paint is also attracted by areas that are difficult to reach with the guns, thus guaranteeing perfect workpiece coverage and overspray reduction.” “The base coat and the enamel use the same catalyst, fed by one pipe. We also provided for the presence of a wild card colour in smaller barrels for non-standard productions,” adds Roberto Martinelli from Protek (Laterina Pergine Valdarno, Arezzo, Italy), the Wagner distributor that also dealt with the system’s



installation and service. "The mixing and control electronic system is connected to the flow meters via fibre optic cables to ensure it is insulated. The system guarantees precise catalysis ratios, in addition to providing information on consumption, cycle times, and plant productivity. The paints are taken directly from the barrels located in the coating management unit and provided with stirrers to maintain the required viscosity (Fig. 9). The Intellimix dosing machines receive them through high-pressure pneumatic pumps; through fibre optic measuring devices, they control the amount of product supplied to the guns, dosing the catalyst in the percentage required by the coating program (Fig. 10)."

"The colour change phase is the result of the communication between the Intellimix machine and the CMA robots," concludes Mattioli. "The process is automatic and takes about three minutes. The guns' automatic cleaning station is located in the middle of the booth and the robots are positioned on it when needed; this system also retrieves the cleaning product to avoid polluting the plant. Finally, we integrated a manual station with an electrostatic gun for any touch-up operations (Fig. 11)."

Increased productivity, quality consistency, and product saving

"The switch to robotic paint application was a very important change for Menci," says Menci Production Manager Maurizio Niquoziani. "Such large and complex plants pose equally large and complex problems, especially because it is necessary to

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Figure 12: At the head of the table, Francesco Cau. From left to right: Roberto Martinelli from Protek, Francesco Mori, Lorenzo Mori and Giuliano Grandi from Sherwin-Williams, Roberto Mattioli from Wagner Spa, Alessia Venturi from ipcm and Nicolas Berneschi from Protek.

manage their development with all the partners involved in the project and to find a compromise on the possible solutions, in order to obtain the most stable process possible with the required quality degree. We are very pleased with our choice, because the robots have enabled us to increase our productivity and, most of all, achieve

good quality consistency. Moreover, the paint saving guaranteed by the electrostatic application process is remarkable, about 20-30%, with benefits also in terms of emissions and maintenance. Of course, the optimal result, i.e. the possibility to treat all products in the robotic station and industrialise coating programs for every frame, tipper, and tank we produce, is still far away. However, only six months have passed since acceptance."

"The main problem will be adapting our production capacity," states Francesco Cau (Fig. 12). "We are currently working on two shifts in the manual booths and on two shifts in the automatic one, where the robots are used for both production and tests. Soon, the robotic booth will operate on two or three shifts, whereas the manual

stations will only treat non-standard productions, such as frames that we produce in minimum quantities and for which it is not worth developing specific coating programs. Certainly, during this industrialisation phase, the technical assistance service of our technological partners is proving very helpful, as well as the training courses that Inver has offered to our applicators on

procedures, defect management, and quality control, directly at their premises in Minerbio (Bologna)." "This is an exclusive service offered by Inver to its customers," says Giuliano Grandi, Area Manager and Invercolor Manager at Sherwin-Williams. "Our training program also includes an upgrade delivered directly at their premises every two years." ○