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Opening photo: In 1972, Berti Macchine Agricole (Caldiero, Verona, Italy) decided to specialise in the production of mulchers, whose range now includes 500 models.



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Berti Macchine Agricole. An Innovative Industrial Solution for the Coating Process of Its New Production Site.

Alessia Venturi **ipcm®**

The switch from manual-only operations to an automated, robotised, and digitised process; total traceability of the operating process; data collection; and diagnostics for preventive maintenance: these were the requirements

of a well-established Italian manufacturer of agricultural machinery for the redesign of its coating process by a group of plant engineering firms. Some of the main players in the sector accepted the challenge: by effectively collaborating

in all design and development phases, they created one of the most advanced finishing systems ever installed in the agricultural machinery sector. This new coating plant started in 2018 by Berti Macchine Agricole and born from

the collaboration among Savim, Futura Convogliatori Aerei, Gaiotto Automation, and Verind is compact, modern, extremely functional, and Industry 4.0-oriented.

The story of a company and a family

Berti Macchine Agricole was established by Livio Berti in Caldiero (Verona) in the early 1920s, as an artisan company in the field of agricultural implements. In 1972, the Berti family decided to specialise in the production of mulchers (ref. Opening photo), developing them at the technological level for over thirty years. More than thirty years have passed since the creation of the first vineyard and orchard mulcher. One of the company's main objectives has always been to build innovative machines specially designed for the professional maintenance and reclaim of urban, agricultural, and forest green spaces. Berti now offers a range of 500 products for all types of cultivation and ground conditions, applicable to any tractor or excavator. Its complete range of robust and high-performance equipment is divided into two product lines intended for two well-defined market segments. The "agricultural line" includes vineyard and orchard mulchers, mowers, in-line mulchers, hedge mowers, and forestry mulchers (with an installed power range from 15 to 300 HP). The "professional line", on the other hand, includes different earthmoving devices intended for maintenance and forestation operations, which are suitable for every kind of excavator (with an operating weight between 1.5 and 35 tonnes) and skid steer.

The production flow

"Our machining and welding operations are entrusted to a few contractors that work almost exclusively for Berti," says Sales Manager Filippo Berti (Fig. 1). "Until a few years ago, our work was seasonal:

seasons are reversed, our production is now steadier, as is the workflow with our contractors."

"We order all the productive material according to our technical office's instructions and all workshops operate with our know-how," says Filippo Berti.

"Our production flow is order-based: our main issue are delivery times, because the fact that the European dealers

operate with very little stock does not match well with the requests for 20-day deliveries now typical of this market. Indeed, there is now a trend towards a just-in-time production. That is why in 2015 we decided to start a corporate restructuring project involving our productive structure, and especially our downstream processes: assembly, coating, and storage. This investment and restructuring plan was mainly motivated by our will to switch from an order-based to a continuous-flow production. We currently have six assembly

lines, which will become nine in January and twelve at the end of 2019, of which five will be devoted to continuous production and seven to special machines."

"After assembly, we also focussed on our coating phase.

We already had a recently bought plant installed in a building specifically devoted to this operation.

However, it was a static system performing

a manual application process and using solvent-based paints. Luckily, the corporate growth of the last few years enabled us to invest in a new, technologically advanced automatic system and, at the same time,

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Figure 1: From left to right: Filippo Berti, Berti Macchine Agricole's owner, Maria Grazia Signorini, Finance Manager and Francesco Attuati, Purchase Manager.

production peaks were concentrated from February to July, while the last months of the year were dedicated to the preparation of the new season. By differentiating our target markets and also working overseas where



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Figure 2: A bird's eye view of the new coating plant supplied by Savim (Arbizzano, Verona).

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Figure 3: A detail of the plant.

to switch to water-based coatings," explains Filippo Berti.

"Using two-component water-soluble coatings was a business choice unrelated to any regional regulation," says Purchase Manager Francesco Attuati. "We assessed that the market is gradually abandoning conventional solvent-based products in favour of water-based systems with the same performance. Moreover, we are located in an urban environment: over the years, the town of Caldiero has practically developed around our plant. Therefore, switching to water-based coatings seemed the most natural choice for us, although there remains a small part of our production requiring solvent-based paints. Finally, in our new production area, we also added an automatic warehouse to favour the switch from an order-based to a continuous-flow production."

The origin of the new coating plant 4.0

Since it used to perform only a manual painting process, Berti did not have any knowledge of coating systems. "In order to design the new plant (Fig. 2 and 3) and, above all, understand how our automation, productivity, and surface quality needs could be met, we did some technical research and spoke with people who had

already installed a coating system," says Filippo Berti. "We thus came into contact with Savim (Arbizzano, Verona), which then recommended all other technological partners for the handling, automation, and application aspects, i.e. Futura Convogliatori Aerei, Gaiotto Automation, and Verind. Under the coordination of Savim, we created a relationship of mutual esteem with all of them."

"The plant designed by Savim was undoubtedly the most suitable to our production needs and automation requirements," says Attuati. "Inver, our supplier of water-based coatings, also greatly supported us in the design phase. Understanding our coating requirements was crucial to design an optimal application system. In any case, the starting point for us was our will to create a new production

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Figure 4: A component at the entrance of the pre-treatment booth.

structure that was a linear, streamlined, efficient, automatic, and completely traceable at all times."

Characteristics of the coating line

The system installed by Savim is completely Industry 4.0-oriented. By interfacing with the automation and application systems, the management software package collects and checks all operating parameters, applied thicknesses, and consumption data. The project also included a thorough study of ergonomics, flexibility, and modularity, so that the new line meets every current and long-term future production need.

The maximum capacity of the plant is 4 m in length; however, two manual booths (primer and enamel) have been devoted to machines with larger dimensions, accounting for 15% of the total production. The plant management is based on barcodes.

The chemical pre-treatment is performed with a 3-stage process (Fig. 4 and 5) followed by an intermediate blow off and masking station. Berti coats fully assembled machines and, therefore, all delicate components must be protected. The coating application station features two dry booths with a floor filtration system, a robotised and a manual one, for both the primer and enamel application.

Savim chose to integrate these automatic booths with two manual ones (Fig. 6) to coat oversized workpieces, but also to perform accurate post-retouching operations on parts where particular masks may hinder uniform coverage by the robots and to treat the components that still require a solvent-based coating, accounting for 15% of production. The robots are equipped with electrostatic guns, whereas the manual booths perform a conventional application operation. The



Figure 5: The 3-stage chemical pre-treatment process.

application process includes a flash-off phase between the primer and enamel application stages and a final curing stage in a direct fired furnace (Fig. 7).

"We opted for the use of a water-based liquid system with an application and automation system that would allow us to industrialise and automate a process that used to be completely manual, little controllable, and hardly standardisable," states Francesco Attuati. "The goal was to improve the process, increase quality, decrease consumption and waste, and above all digitise operations as much as possible."

The products applied by Berti are the INVERPUR semi-matte

two-component anti-corrosion primer based on hydro-soluble acrylic resins and the INVERPUR/X SM 2K two-component water-soluble enamel based on acrylic resins, both in the company's distinctive orange colour. They are supplied by Inver, a brand of the Sherwin-Williams Group. The primer forms a film with good salt spray, chemical, and water resistance characteristics. It reduces the enamel brilliance very little and it is a suitable basecoat for iron, aluminium, and cathaphoresis products, as it has excellent adhesion and good corrosion protection properties.

The two-component enamel forms a hard and elastic film with excellent weathering resistance characteristics and it is suitable for high quality finishes on metal surfaces of various kinds, such as agricultural and earth movement machinery, machine tools, and industrial vehicles. It is applied with a viscosity (D4/25 °C) of 50-70" and with a final dry thickness lower than 50-60 µm.

"For the design of the paint application and feeding system, we

chose to rely on Verind, belonging to the Dürr Group, because its equipment range was the closest to our needs for 4.0-orientedness," states Filippo Berti. "In order to develop the best application system, Verind had a preliminary meeting with Inver to share a few technological choices. In fact, our two products could be applied with both the mixed air and low pressure technology: our coating quality depended on this choice."

"Our choice fell on an airless air assisted application for the primer, in order to achieve the right thicknesses and application speed, and for a low pressure application for the enamel, in order to ensure maximum aesthetic quality," explains Verind Area Sales Manager Giovanni Benevelli (Fig. 8). "Therefore, we



Figure 6: One of the two manual booths.

"The application equipment of the primer (Fig. 11) and enamel booths are symmetrical," says Benevelli. "Each booth features an EcoDose 2K electronic dosing system. The automatic stations' systems are equipped with a remote station, fibre-optic volumetric counters, and insulated devices with high and low pressure pumps, whereas the manual retouching stations feature standard EcoDose 2K systems with high and low pressure pumps. A PLC manages an EcoDose 2K for the automatic application process of each robot and an EcoDose 2K for each manual station."

EcoDose is an advanced electronic system for the stoichiometric dosage and mixing of two or more water-based or solvent-based coating products. Its main technical features are as follows:

- direct dosing technology with two

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developed a flexible and modular system that combines an electrostatic application process with an automatic system for the dosing and mixing of 2K coatings through fibre-optic flow metres (Fig. 9). The coating management unit is equipped with three groups of lifts for the 200 kg-drums used for the storage of paints, level sensors, and Dürr circulation pumps for the primer and enamel. The remote coating management unit (Fig. 10) is located about 50 m of pipes away from the booths. Specific loading stations feed directly the process tanks of both the manual application stations and the insulated stations that contain the electrostatically charged pumping systems."



Figure 7: The curing stage in the direct fired furnace.



Figure 8: Left to right: Manuel Pesamosca, the Technical Sales Manager of Gaiotto Automation, Francesco Attuati, the Purchase Manager of Berti Spa, Alessandro Soba and Giovanni Benevelli, the Verind Area Sales Managers.

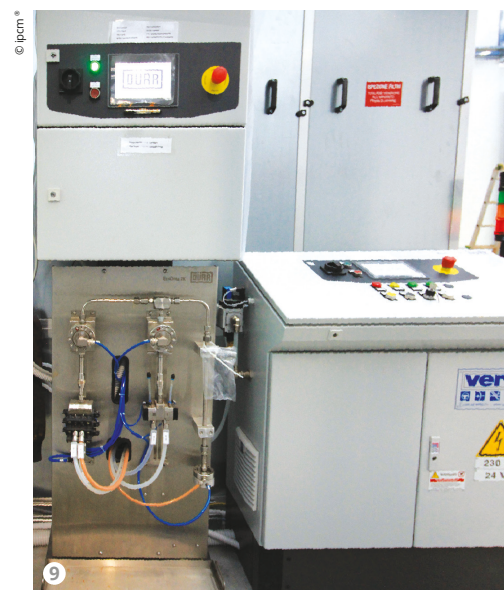


Figure 9: Verind's EcoDose 2K automatic system for the dosing and mixing of 2K coatings.

channels (A and B)

- view of actual flow rates, partial consumption for each program, alarms, diagnostics, VOC quantities, and consumption related to each model/colour for every application station
- connection to the line master for the automatic management of the style queue and the colour change operations
- management of the pot-life and pot-time parameters
- information to the operator for predictive maintenance on all application components, in order to avert downtimes.

Future-ready automation

Berti's new industrial coating line includes four GA25-P six-axis spraying robots provided by Gaiotto (**Fig. 12 and 13**), installed on a linear translation axis and complying with current safety regulations, especially the ATEX standard for explosive atmospheres. This robot was specifically designed and developed for paint spraying applications, with all the advantages of a system intended for a given type of automation and, above all, with high mechanical reliability. Its Human-Machine

Interface (HMI) makes the machine user-friendly and offers one point of command through which the operator can easily control the overall state of the machines and the exchange of data with the other systems operating within the plant.

"The four robots installed for Berti Macchine Agricole feature all three programming logics available: point-to-point, self-learning, and off-line, which is the main challenge in the field of industrial robotics of the last decade. In fact, the off-line programming method



Figure 10: The coating management unit for manual station with Dürr pump.



enables to create coating programs without stopping the line thus reducing productivity. In the last few years, Gaiotto has focussed a lot on this method, which allows the operators to design the painting programs only based on the geometry of the workpieces, without physically operating on them," says Manuel Pesamosca, the Technical Sales Manager of Gaiotto Automation. "During commissioning, we realised that the off-line programming method was best suited to Berti's needs, also because the company has the great advantage of having available all the 3D models of the machines produced. The integrated software package offers a process parameter control system, which makes it ideal for the industrial coating sector since it enables to check and modify the flow rate, the atomisation process, and the spraying fan. These parameters can all be defined directly during off-line programming, complete with simulations aimed at reducing time and waste."

"Gaiotto's robots, with all their technological systems, operate at the core of the coating process, interfacing with both Verind's application systems and Savim's plant systems," says Pesamosca. "Together with Verind, we developed an operating interface between the robots and the spraying



Figure 11: The feeding system of the primer application booth for manual station with Dürr pump.

equipment to enable continuous collection of operational data, error reporting, operating status updating, predictive maintenance, and control over the quantities of coating consumed for each program or part type. In short, Verind's system sends all paint consumption data to the robots and the

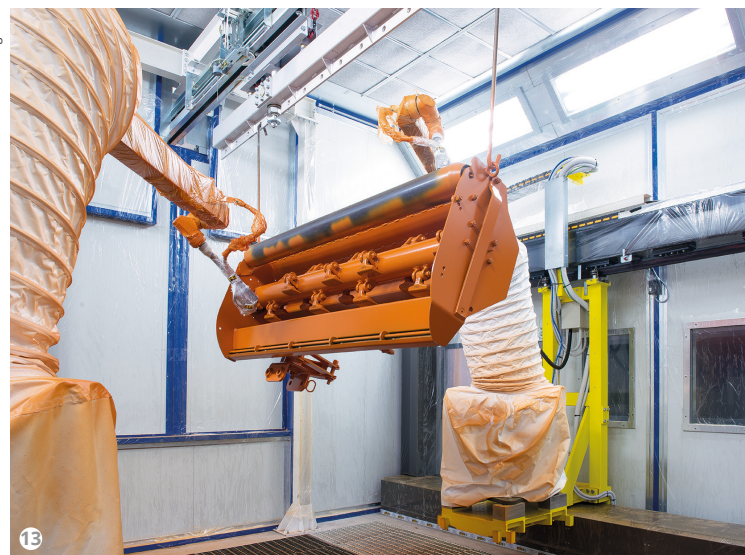
robots transfer them to Savim's management software package, which collects all the data from the automation systems."

"We could build a highly functional and compact smart architecture only thanks to the close collaboration of all the three partners involved, which operated in synergy since the

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Figures 12 and 13: Gaiotto's GA25-P six-axis spraying robots.

design phase," says Pesamosca.

Industry 4.0 principles and proven experience in the ACE sector

"Its ability to combine system engineering, know-how, and innovation was crucial for Verind to meet Berti Macchine Agricole's industrialisation requirements," says Verind Industry Sector Sales Manager Alessandro Soba. Berti's main objectives for its new Smart Factory were as follows:

- Implementing a digitised application/coating system, managed with integrated control and automation systems and interfaced with robot and manual retouch stations.
- Obtaining the best application and surface finish results with specific integrated automation, application, and robot systems

for the management of the various 2K products and of the process in its entirety.

- Monitoring all productivity information and any deviations from the standard, and make them available through a specific line interface for corrective actions.
- Integrating the EcoDose 2K electronic system in its remote version with fibre-optic flow metres, suitable for handling two-component water-based epoxy and polyurethane coatings applied with an electrostatic process (Fig. 14).
- Remote service, predictive maintenance, and remote assistance.

"Berti's coating process is very complex, with a significant number of variables. By focussing on innovation, we were able to ensure that this application management workflow contributes

to reduce production costs per unit while increasing efficiency," says Giovanni Benevelli.

A challenge won and an important industrial result achieved

"The joint and coordinated work of Savim, Gaiotto, and Verind has enabled the development of innovative and industrially sustainable solutions, oriented towards eco-friendliness, workplace safety, processing cost reduction, high surface quality, and industrial digitisation, with which we are very pleased," says Filippo Berti. ●



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Figure 14: The pumping and recirculation unit of the coating products created by Verind/Dürr.