The PTO drive shafts produced by Benzi & Di Terlizzi.

FOCUS ON TECHNOLOGY

Benzi & Di Terlizzi: An Overhead Conveyor Turns the Coating Line into a Highly Digitised System Capable of Integrating Subsequent Production Phases

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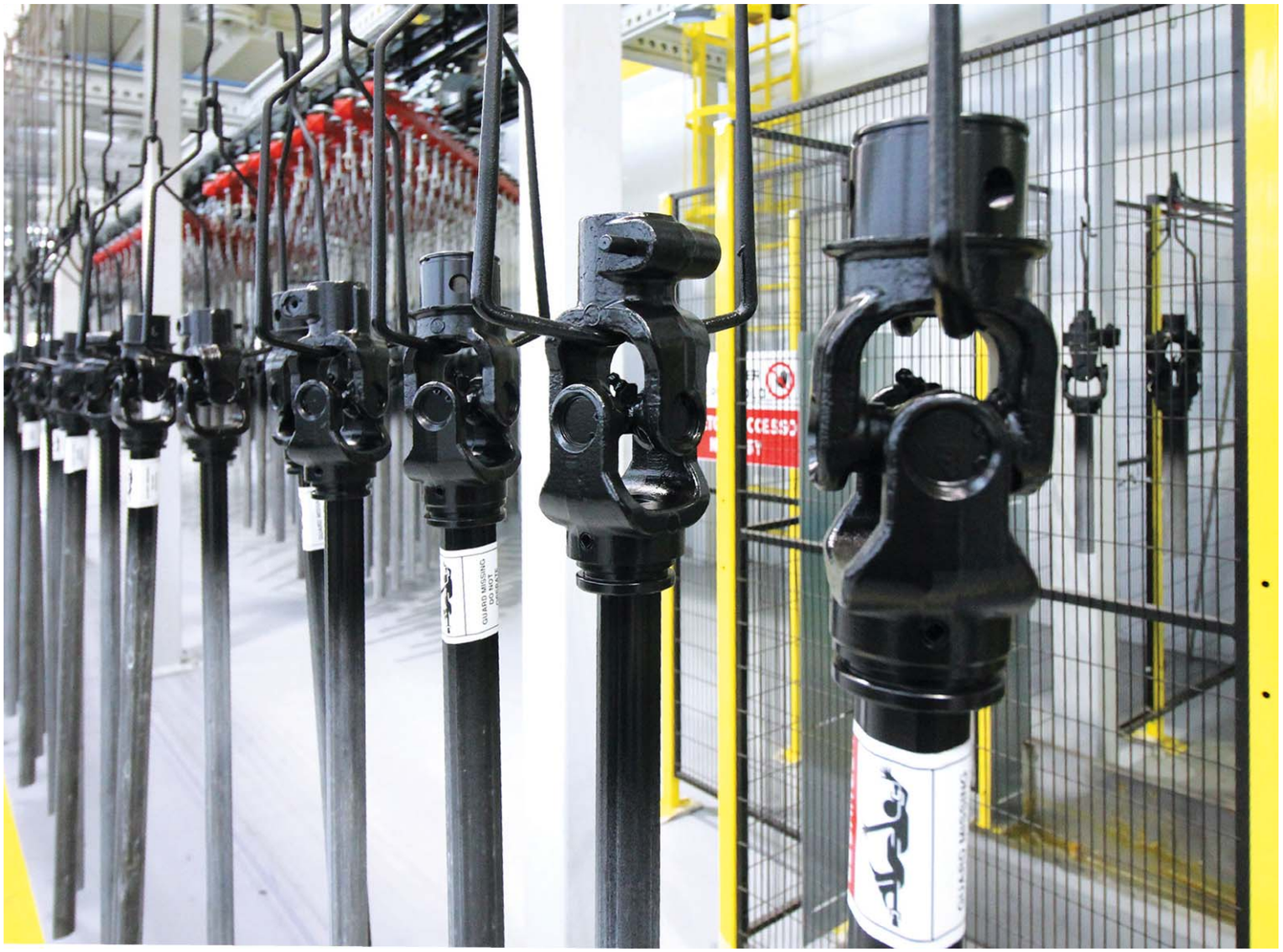
Benzi & Di Terlizzi, a company specialising in the production of PTO drive shafts for agricultural machines, has recently installed a modern, Industry 4.0-oriented coating system equipped with a two-rail conveyor, which has enabled the integration of the assembly phase directly in-line thus maximizing production efficiency.

The word 'machine' can have different meanings. One can define it as a set of elements connected together and meeting specific technological requirements, which generates an advantage and greater yield by using a certain force. With time and the advent of technology, the concept itself of machine and its appearance in our imagination have evolved, but its nature has never changed: a machine is made up of several elements and even the smallest and simplest mechanism actually plays a fundamental role for its operation.
It is not surprising that Benzi & Di Terlizzi has adopted this philosophy within its production, as it specialises in the production of drive shafts for the agricultural sector, which are a crucial mechanical part for power transmission in agricultural machines because they turn them into operating systems. This is why the company undertook an innovative project that required a synergy among several companies from the finishing sector. The result was a coating plant that goes beyond a mere succession of surface treatment phases, but rather integrates operations that are normally carried out at a later stage in production, such as assembly, in the line itself. It is a production machine in which all the elements interact with each other in compliance with the Industry 4.0 principles and that has generated significant advantages in terms of efficiency and production times. Its core is precisely the coating plant and, in particular, its overhead conveyor, which acts as the link among all process phases, thus enabling their integration into one production line.

Rolando Benzi and his wife Nunzia Di Terlizzi established Benzi & Di Terlizzi in Cassano d'Adda (MI, Italy) in 1955. The company specialises in the production of PTO drive shafts for the agricultural sector. In the 1970s, Benzi & Di Terlizzi gradually shifted from the local market and it made significant investments to open up to international markets, so much so that exports currently account for 80% of its production. Benzi & Di Terlizzi now operates in about forty countries and it has two commercial branches abroad, in France and the United States, and two production sites in Italy: one in Inzago (MI), where most production processes are currently carried out, and its first factory in Cassano d'Adda, performing the moulding of all plastic components used for the protection of PTO drive shafts.
Benzi & Di Terlizzi has recently undertaken an important restructuring project precisely in Cassano, investing in a new production site with the aim of reorganising the old building, redistributing production activities, and insourcing some processes. The first investment made for the new Cassano plant, currently in its full start-up phase, was a modern coating system jointly developed by various Italian sector players: Conveyors Nord (Inzago, MI), which provided the two-rail conveyor; Trasmetal (Milan), the supplier of the coating system; CMA Robotics (Pavia di Udine, UD), which installed two coating robots and a greasing one; and Comaind (Segrate, MI), a Graco distributor, which supplied the electrostatic dispensers and guns.

Benzi & Di Terlizzi's production

"Benzi & Di Terlizzi specialises in the production of drive shafts, the device necessary to transmit the motion of the tractor to an agricultural tool," explains Alessandro Benzi, the vice president of the company, belonging the third generation of the Benzi family. "However, we also produce all the components that relate to power transmission between the tractor and the tool, e.g. parallel axis units, reducers, etc.



Products manufactured by Benzi & Di Terlizzi.

The simplest PTO drive shaft can consist of about forty components, and these are not standard products, but highly specialised parts that can have different variables and reach 2 metres in length."
Benzi & Di Terlizzi's production starts from semi-finished products, mainly in steel. "We perform in-house most of the mechanical processes involving our drive shafts. In the last few years, we have worked hard to expand both our component warehouse, which is now able to make up for approximately three months of production and allows managing over 4,000 part types thus shortening production times, and our end products warehouses in Italy, but also in France and the United States, which have enabled us to reduce our lead time. In fact, timely deliveries are much appreciated in the agricultural sector," adds Alessandro Benzi. "We have embarked on a project aimed at growing our company and improving its competitiveness in international markets. This has actually led us to become one of the leaders of our industry. In order to do this, we have aimed at reducing our response time and increasing our production flexibility as much as possible. This is why we decided to restructure our production, starting with our coating plant.
The previous one was obsolete and no longer able to cope with our new production needs, although we had partially modernised it."

The overhead conveyor at the service of the production cycle

"The plant has a production capacity of over half a million hooks per year (on one working shift), adequate to our current business needs but also to our growth expectations for the coming years. Drive shafts are actually composed of two half-drive shafts, which require some assembly stages to be performed only after coating. Therefore, we needed a coating plant able to handle hundreds of thousands of workpieces, with different shapes and sizes," notes Benzi. "Moreover, PTO drive shafts are not standardised products. This raised several issues in terms of part handling and hanging. This is why the system was designed to manage a different coating program for each hook, depending on the characteristics of the product, with an approach 4.0."
"The new plant came into operation in the summer of 2019. It took three years of planning to find the ideal solution and meet the needs not only of the coating process itself, but also of the assembly and palletising phases, as well as space requirements. We wanted a system that would maximise the operational capacity not only of the painting phase but also of the subsequent assembly ones," states Benzi. "Therefore, together with Conveyors Nord, we developed a conveyor not only linked to the coating plant, but geared to becoming an integral part of the whole production system."
In collaboration with Trasmetal, Conveyors Nord thus installed a power & free overhead conveyor with a maximum load of 600 kg and featuring load bars with 14 hooks each, which goes through all surface treatment phases and also enables assembly and even the application of protective devices, before the drive shafts are unloaded from the coating line. "The conveyor ceases to be a mere chain to transport workpieces along the coating plant and it becomes a production tool that Benzi & Di Terlizzi can use to complete the assembly stages without further handling operations and without occupying other production areas," explains Conveyors Nord owner Giovanni Majer. "Moreover, our conveyor's handling software package interfaces with the ones of Trasmetal and CMA, which supplied, respectively, the coating plant and the painting and greasing robots. This makes sure that Benzi & Di Terlizzi always has the entire production cycle under control."

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Conveyors Nord's overhead conveyor has a capacity of 600 kg and each load bar is equipped with 14 hooks.

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The assembly area.

"In conceiving this system, we had to find a way to harmonise the coating process with the assembly phases. The layout was also designed to ensure that operators always have every process step under control, both digitally and visually. Indeed, they can manage each phase and its progress times through eight push-button panels that can be activated on command and enable the movement of the load bars. Each bar also records data on the hung workpieces, the job order to which they belong, and their matching coating program. The operator can therefore gather information on their related production order at any time. Thanks to Conveyors Nord's conveyor, we have basically created an assembly line with several stations that can be turned on or off depending on the production plan. This has given us extreme production flexibility," says Alessandro Benzi.

The coating cycle

The new Trasmetal coating plant starts with a 6-stage step-by-step nanotechnology pre-treatment station using the Henkel Bonderite conversion product. A condensing boiler heats the water necessary for pre-treatment. This is followed by a double drying phase to remove any water residue. Coating takes place in two booths equipped with multi-stage high-absorption dry filtration systems, developed in compliance with emission standards. The process includes an intermediate flash-off phase. The applied product is a one-layer, direct-to-metal, water-based, two-component acrylic system supplied by Franchi & Kim, custom-made for Benzi & Di Terlizzi and suitable for taking full advantage of the high productivity of the new automatic system. The collaboration

between Franchi & Kim and Benzi & Di Terlizzi for the development of this product started during the initial plant design stages, through tests on substrate preparation and performance, i.e. salt spray and humidistat tests. Each environmental and application value was parameterised and calibrated during the paint preparation and final control phases thanks to a testing laboratory arranged at the end of the coating line.
Two CMA Robotics GR-630 ST 6-axis robots apply the coating. They offer both self-learning and point-to-point programming methods: Benzi & Di Terlizzi chose the latter to set its coating programs. The robots' arms guarantee maximum manoeuvrability thanks to a coupling system and a perfect pneumatic balance, in addition to the use of special light alloys. The "ST" robot type is suitable for coating parts attached to overhead or floor conveyors either with a continuous or stepwise movement, while also guaranteeing the possibility of rotating the workpieces both when stationary and in motion. Additional flexibility is offered by the particular configuration of their wrists, which allow easily reaching any point of the part being processed through the 360° rotation of each axis. "When the components enter the coating booths, the hooks rotate at a controlled speed. The first robot applies the first coat and the second one completes it with the second coat through a wet-on-wet process. This guarantees a homogeneous finish even inside the most complex-shapes workpieces," says Alessandro Benzi.
The programs are stored and managed by means of a PC integrated in the control system. The selection of programs, sorted by alphanumeric code on a flash memory device, occurs automatically by remote control.
The industrial PC also manages the operator interface, based on Windows XP, calculates the robot's trajectories, and manages the PLC through of a Real-Time subsystem. The position and speed control of the robots' axes is carried out by digital drives featuring a DSP internal memory and able to update the axes' data every 400 microseconds. The industrial PC accesses the digital drives through an industrial Ethernet-based bus.
The robots are equipped with new generation electrostatic guns Graco Pro Xpc, provided by Comaind, which guarantee optimal paint transfer.
The guns were designed to be connected to their 100 kV power supply unit via a low voltage cable and they are equipped with an arc fault detection software program that automatically deactivates the electrostatic field when any part is near the gun.
Benzi & Di Terlizzi had also asked Comaind to develop a solution to apply Franchi & Kim's one-layer, water-soluble acrylic system and to only use mains water for cleaning, thus eliminating any additive/solvent that is usually employed to clean the (hydrophobic) catalyst line. Comaind therefore customised two Graco ProMix 2KE dispensers and it designed a remote mixer where the cleaning water never comes into contact with the catalyst in order to avoiding any possibility of crystallisation of isocyanate, the main component of acrylic catalysts. The ProMix 2KE dispensers guarantee greater reliability, ease of use, precise dosage, and excellent mixing quality for two-component paints, especially the water-soluble ones, thanks to their "Dynamic Dosing" option. Comaind finally completed this project with an interface that provides the coating system 'master' with data on the instantaneous and global consumption of the various plant components, meeting all Industry 4.0 requirements.
After coating, the parts undergo a

The pre-treatment tunnel and the following blow-off station for the elimination of water residues.

The coating booths.

One of the two GR-630 ST 6-axis painting robots supplied by CMA Robotics, equipped with Graco Pro Xpc electrostatic guns.

flash-off phase at a temperature of 40 °C and they enter the curing oven, where they remain for an hour at a temperature of 90 °C. Afterwards, the shafts and internal joints of the PTO drive units are greased by a dedicated GR-6160 6-axis robot, also provided by CMA Robotics to automatise this previously manual operation. After greasing, the load bars proceed along the conveyor to enable the operators to carry out the assembly and protection operations. Two large storage buffers at the entrance and exit of the line enable to compensate for the different execution times due to the complexity of parts and the loading and assembly operations. "This is a fully Industry 4.0-oriented plant: all its elements are able to communicate with each other and to transmit all process and job order data in real time. Our operators can therefore check the compliance of the process with its specifications at any time, set different coating programs, and manage every step both online and offline. This enables us to continue producing even in the event of a malfunction," states Benzi.

The advantages brought by the new plant

"The market of agricultural machinery and components has become increasingly demanding both in Italy and on international markets, where our company has been active since the 1970s. Such trend, combined with the peculiarities of PTO drive shafts, which can vary a lot in terms of components and dimensions and can reach a high customisation degree depending on customer needs, has made it necessary to reorganise our production structure.

The coating management unit with Graco ProMix 2KE dispensers.

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CMA Robotics' greasing robot.

This included our coating plant, no longer able to cope with the new production and quality requirements," notes Alessandro Benzi.
"The main challenge of this project was designing a functional but compact layout that allowed always having the coating process under control with an approach 4.0, as well as a solution to handle all our different types of drive shafts without compromising their finishing quality degree. We worked closely with Trasmetal, which dealt with the plant engineering aspects, with CMA, which developed and supplied the centralised control terminal for part management, and with Conveyors Nord, which we chose precisely based on their extensive experience in this type of systems

All the system elements communicate with each other in compliance with the Industry 4.0 principles and they guarantee real-time control of all process and job order data.

and which proved a key partner for finding the most functional solutions for our project," says Benzi.
"Our plant is able to carry out a specific coating and greasing program for each individual hook, which is automatically recognised by the robots. Moreover, thanks to the power & free conveyor, we have managed to integrate the assembly phase directly in the line, thus optimising production times. In fact, the operators can stop the chain to complete the necessary operations without affecting the regular operation of the plant and the painting process. This enables us to work with a continuous flow. During unloading, the plant shows all process and order information, so that the operators can check that the process took place within the pre-established parameters and finally close the production order. Our next step will be making the system able to provide the operator with packaging instructions in order to complete the production order automatically up to the packing phase."
"Although the line has been running for relatively little time, its benefits have been immediately noticeable: our coating efficiency is higher and our process quality has improved – a very important factor, as finishes play a fundamental role for our customers, which gave us very positive feedback. Furthermore, the new Cassano site hosting the coating plant is improving our productivity. Finally, we have obtained significant benefits also in terms of eco-friendliness, such as a significant reduction in energy consumption and above all the possibility of using water-based coatings without any solvents," states Benzi.