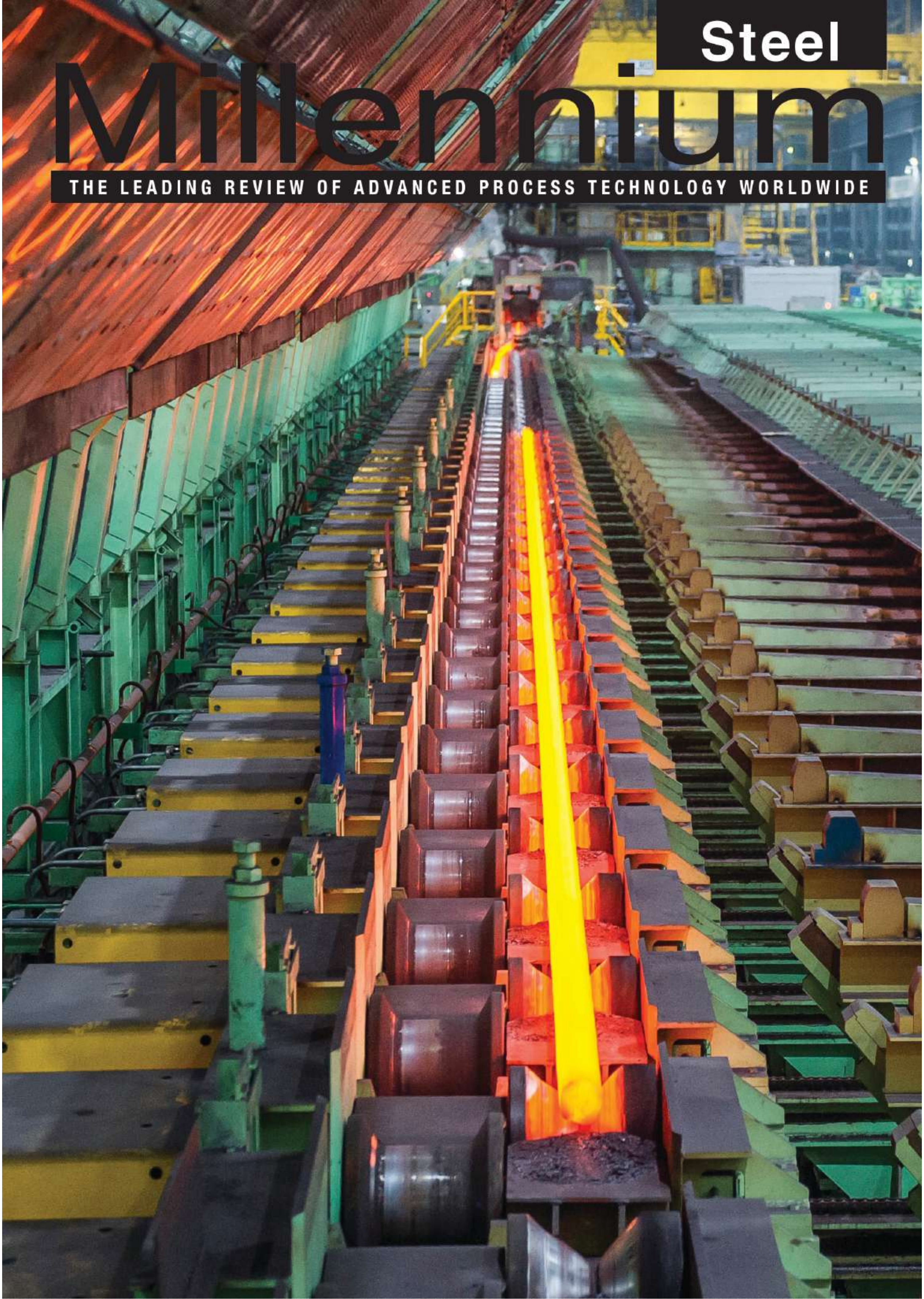
Steel Millennium

THE LEADING REVIEW OF ADVANCED PROCESS TECHNOLOGY WORLDWIDE



Automatic material handling solutions for the steel industry: robotic tagging applications, tying machines, safety fences and cranes

AIC Group has developed automatic materials handling solutions that can be deployed on a wide range of finished and semi-finished products. The applications and machinery have been shown to significantly increase productivity, with accurate material tracking and user-friendly data interfaces. These automation and mechatronic state of the art solutions, can be smoothly integrated into existing mills and have a range of features to ensure secure and safe operation.

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INTRODUCTION

In recent years, many operations within the steel industry have been transformed toward automated production lines, increasing production capability, product traceability and the working conditions of the operators, while maintaining the highest levels of safety. Combining the principles of industrial automation, previous experience and modern components available on the market, AIC Group has developed automation and mechatronic state-of-the-art solutions to foster production process efficiencies for the finishing lines of long-product rolling mills, meltshops and casters, which are also optimized for Industry 4.0.

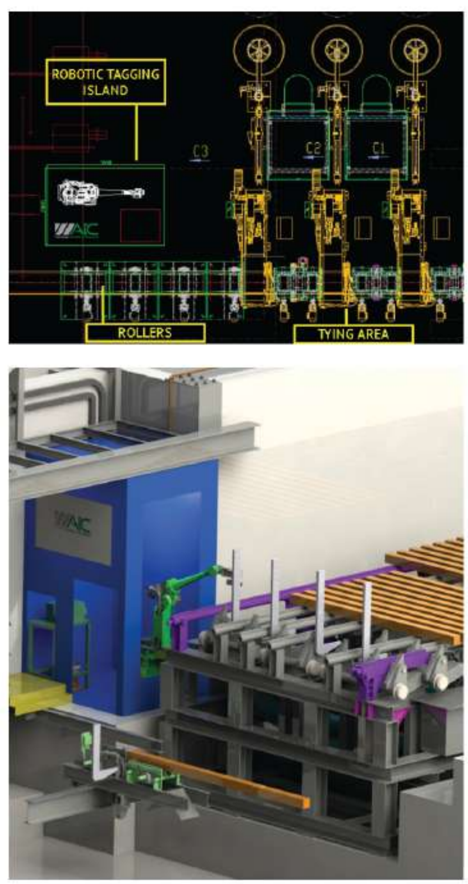
Solutions for increasing traceability and logistics include:

- Robotic Tagging Applications for bundles and stacks of metal products, billets, bars, blooms, slabs, wire rods and tubes (see *Millennium Steel America 2020/21*).
- Tying machines for bundles, stacks and packs of metal products and wire ties.
- Safety systems, area protective fences and cranes.

Since there are hazards associated with heavy equipment, roller tables and overhead cranes, the aforementioned applications increase the control of both material handling and product quality, minimize the direct intervention of operators in the production process and facilitate long-term cost reductions, due to advanced technologies which may include GPS for geo-localization, vision systems for data collection, fully finished product tracking systems at site and remote control.

ROBOTIC TAGGING APPLICATIONS

Robotic applications designed by AIC Group are installed in the finishing area of the process line, to automatically ▷



Ⓐ Fig 1 **Typical automatic tagging island layout and 3D model**

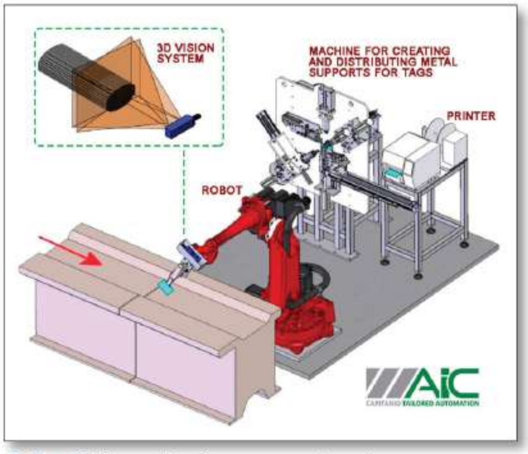


Fig 2 **Schematic of component parts**

Fig 3 **Robotic tagging for bars, billets and wire rods**

apply tags to semi-finished and finished metal products. The robot applies the printed tag to the bundle using a metal support supplied by the distribution machine. The best tagging place is detected by a 3D vision system that passes the coordinates to the robot for tag positioning. The robotic-tagging island has a small footprint and can be placed in a properly designed and engineered industrial container, housing all the machinery in an air conditioned and protected area (*Figure 1*).

A typical layout (*Figure 2*) of the robotic tagging application includes:

- Anthropomorphic 6-axis robot ('foundry' grade).
- Control unit and Safety PLC.
- 3D vision system installed on the robot wrist.
- Set of printers to ensure a seamless tagging process.
- Machine to create and distribute the tag supports.
- Welding machine (if required).
- Electrical panel that commands the complete island and includes the relevant HMIs for diagnostics and safety alarms.

Anthropomorphic robots are now well proven devices and are used in several different applications in the steel industry. Versatile 'foundry' grade models are available that are specifically designed to work in harsh environments (*Figure 3*).

Depending on the needs of consumers and the volume of production, AIC has created tailor-made solutions to fully cover the area. For instance, for large production lines or areas with limited space, the characteristics of the robots and their number can be customized. Robotic tagging stations can be integrated into an existing production layout. This could include mounting the robot on guides or trolleys above several production lines for tagging on both sides, or two separate robots could be installed (*Figure 4*).

The 3D vision system adopted by AIC is composed of a double camera system specifically engineered for hazardous or hot areas, and which does not require a laser beam (*Figure 5*). As a result of advanced technologies, the system is able to recreate a cloud of 3D points (the 3D profile of the product) simply by taking a picture and without additional scanning. The sensor is a matrix sensor, which is not used for profilometry. In this way, no special movements of the robot are needed to finalize the material scan, and only the bundle positioning conveyor is required. Measurements have been taken on a rebar rolling mill where the robotic tagging application was run at 180tph with a cycle time of 8 seconds and where the bundle was stopped on the conveyor for tagging. The time required for a 3D scan of the bundle was 1.2 seconds.

The 3D vision system can automatically detect the type of products without any specific setting, thanks to advanced analysis algorithms. *Figure 6* shows examples of the 3D

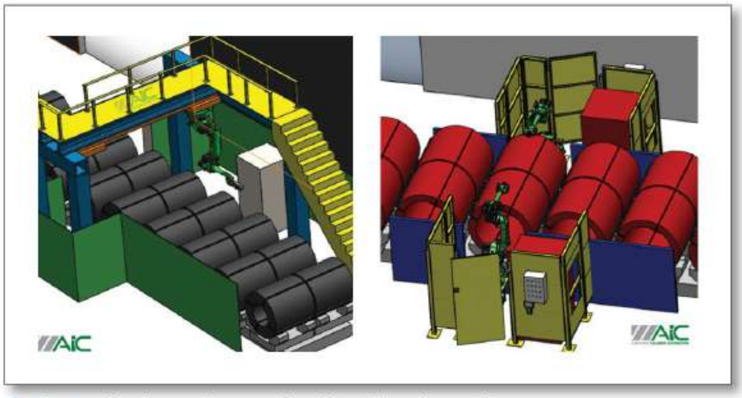


Fig 4 **Robotic tagging applications for wire rods**

Fig 5 **3D vision system during acquisition**

vision system output, with the color coding explained in *Table 1*.

The images shown in *Figure 6* appear on the operators' control panel and are also saved on a network data storage device, together with all other images used during the image processing procedure. These data are used for algorithm remote assistance, for quality control, and are accessible for remote control and operations.

To tag the wire rods, the robot is programmed to recognize several suitable places to apply the tag. After the scanning phase, if an obstacle or an unknown object is detected, the robot scans the coil on the other side to identify a new tagging position. Both QR code and RFID tag reader options are present, to double check the printed data with material data coming from plant tracking (*Figures 7 and 8*). After printing, the tag is read by an identification vision system and the data are verified. If the data are consistent, the cycle continues, if the data are not and there is enough time to print a new tag, this will be printed and the cycle will start from the beginning until the final application of the tag on to bundle. If there is insufficient time to reprint a tag, the bundle is flagged as a 'no-marked' bundle and is identified by the tracking system. Enhanced traceability is provided by a fully integrated tracking system with GPS options for geo-localization (*Figure 9*), data collection and database software that is connected to the main system of the plant and to remote controls.

The robotic cell can be equipped with printers in a backup configuration to avoid stopping the plant when the roll tag ends. In most cases, the printers, which are integrated into the robotic tagging island, are thermal transfer printers with an external tag charger to handle more than 10,000 tags. This is sufficient for one full production week, without the need to replace tags and ribbons. It is also possible to use metal tags with a ceramic surface (*Figure 8*) that are

Color Code	Explanation
White with a black cross	Chose item to tag
Green / Yellow	Alternative sites
Orange	Suitable but with limitations
Red	Unsuitable
Square blue lines	Region of obstruction
Blue circle	Region of interest

Table 1 **Key to color coding**

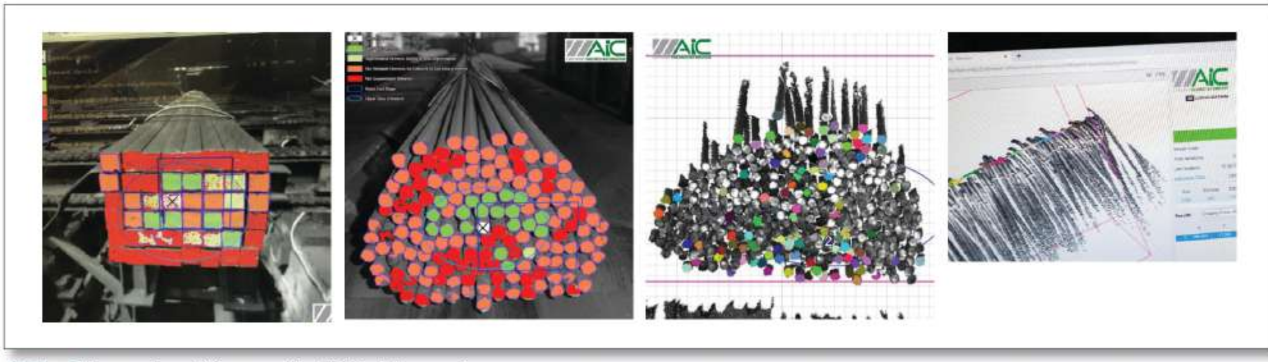


Fig 6 **Examples of the result of 3D vision system**

Fig 7 **RFID tag**

Fig 8 **QR code metal tag**

Fig 9 **GPS for geo-localization**

Fig 10 **Metal support machine**

applied at high temperatures of up to 1,000 °C. To print the relevant data, thermal transfer printers are substituted for high precision and durable laser markers for metal tags, that can last more than 10 years.

The tags can be applied using a metal support that can be supplied by a specifically engineered machine (*Figure 10*), a vibrating stud dispenser (*Figure 11*), or directly through the head of the robot.

There are various types of metal support for the tag, depending on the product to which it will be attached:

1. Ring-shaped supports made of a metal wire supplied through the head of the robot for tagging the coils of wire rod (*Figure 12*).

2. Studs supplied by the vibrating stud dispenser for tagging bars and bundles (*Figure 13*).

3. Metal supports created by a specially engineered machine for tagging billets, blooms, slabs, etc. (*Figure 14*).

4. Clip-shaped metal supports for tagging tubes (*Figure 15*).

ADVANCED
AUTOMATION & MECHATRONIC
SOLUTIONS

CAPITANIO TAILORED AUTOMATION

AIC has more than 40 years of experience in steel industry which allows to listen and solve every customer's needs.

We offer state-of-the-art systems (specially designed for **long-product rolling mills, meltshops & casters**) and supply technological solutions.

We take care of every detailed step from Power control, PLC & HMI software up to innovative solutions, Level 2, robotic applications, automatic tying machines for bundles and stacks, commissioning and after sales services.

The results lead to a **better performing, safer and more efficient production process.**

OUR RESULTS ARE CONSTANTLY CONFIRMED BY THE LOYALTY OF OUR BEST CLIENTS

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Fig 11 **Stud dispenser**

Fig 12 **Ring-shaped support**

Fig 13 **Stud**

Fig 14 **Metal support**

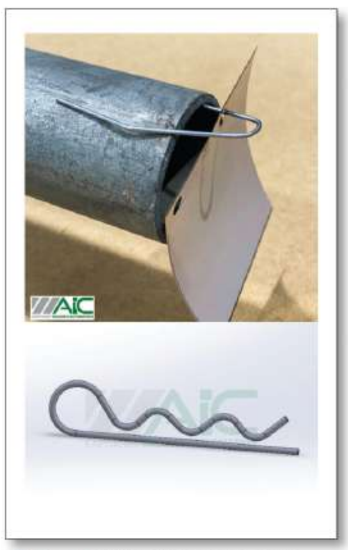

Fig 15 **Clip-shaped support**

Fig 16 **Welding machine**

The metal support keeps the printed tag away from the semi-finished or finished products where the material temperature is still high. For instance, studs are used when the application is done on relatively cold material where it is not a problem to keep the printed tag at a close distance between the head of the bundle and the tag itself. For these purposes, a welding machine is installed (*Figure 16*). There is no need for a welding machine to be used for tagging wire rod, coils and tubes. The robotic tagging application has many additional options that increase the flexibility and safety of the system to meet customers' needs:

- An interface for the system can be developed to integrate it with existing tracking systems already present in plant. The system can receive relevant data to be printed on the tags, such as: product ID, billet number, date and time of the tag and logo.
- The Human Machine Interface (HMI) may also show the tags in chronological order to the operator, so that they can be attached manually if there is an error on the printed tags. The graphical interface allows the operator to remove the tags once they are applied.
- Images are scanned and archived in a separate database for all the products.

Both the PLC programme software and the control unit of the robotic application, can be based on and developed using components from either Siemens, or Rockwell Automation. This flexibility allows the user to implement a stand-alone station with a compact CPU, or to integrate the system into a plant CPU. AIC has also developed a unique solution that allows a drive to be installed inside the PLC panel (*Figure 17*). Full integration no longer

Fig 20 **Example of the product**

Fig 21 **Tying machines for bundles, sub bundles and stacks**

Fig 22 **'Open' external barriers**

Fig 23 **Closed container**

machine and allows the operator to manage the tying machine manually.

- **Wire unwinding and loop recovery systems** These systems are positioned between the coil container and the tying machine body. They are composed of a structure with an arm, and feed the machine through a feeding wheel on the top. The arm can be manually lowered to feed the wire into the guide system. Inside the arm, a carriage moves when the machine retrieves the wire around the bundle, to avoid the formation of a loop.

The machine is installed after the material bundle forming station. Once the product stops in the tying position on the roller table, the automation system sends a signal of 'BUNDLE READY'. A pair of jaws holds the product while the wire is tightened with one or two turns, selectable via a control panel, and twisted. The roller table moves the product to the next position and the cycle is repeated when all the required ties are made. At the end of the tying process, the bundle is transferred to the discharging area for tagging and final storage. An example is shown in *Figure 20*. Depending on the characteristics of the plant, AIC Group also offer tying machines for sub bundles, stacks and big stacks (*Figure 21*).

SAFETY SYSTEMS, AREA PROTECTIVE FENCES AND CRANES

Safety is the most important aspect of the production process and AIC Group has developed solutions that meet the highest international safety standards and requirements, such as:

- To protect the robotic tagging application area, AIC is able to design, supply and install protection cells with 'open' external barriers (*Figure 22*) or as a closed container (*Figure 23*).
- Safety and access control to the operating area of the robot can be managed locally, by safety logic and be connected to interlocked systems with smart electric locks linked to the automation system, or the release of coded keys.
- Safety boxes with alarms (*Figure 24*).
- Laser barriers or laser scanners.
- 'KERN Schutzsysteme' area protective safety fences. 'KERN Schutzsysteme' is a brand of KERN Industrie Automation, which is a partner of AIC Group as a system integrator and manufacturer of special fences for the iron and steel industry and in process engineering in metallurgy (*Figure 25*).
- Cranes and other advanced logistics and material handling solutions (*Figure 26*).

CONCLUSIONS

The rapid development of technologies makes it possible to expand production capabilities and reduce the number of interventions in hazardous, or hot areas through automatic solutions that can be fully adapted to customers' needs.

Automatic robotic tagging applications reduce the number of bundles not tagged to 0.2% of the produced bundles compared with 5% for manual systems. Measurements have been taken on a rebar rolling mill where the robotic tagging application is running at 180t/h with a cycle time of 8 seconds and where the bundle is stopped on conveyor for tagging. The time dedicated to a 3D scan of the bundle is 1.2 seconds.

As a reference, robotic tagging applications have been installed at Ferriera Valsabbia in Italy. Currently, only one operator works on the cold shear pulpit, which functions 100% automatically, one operator is on field for any needs and another operator is available for truck loading. The rolling mill has 94% active rolling time per working hour, with the remaining 6% including production change, cobbles, mechanical, hydraulic and electrical configurations. The inter-billet time is less than 2 seconds. Total yield loss is 1.5%. By developing the robotic tagging application, AIC will further improve performance due to an upgraded billet welder. Moreover, AIC has developed a unique solution that allows for the installation of a drive and control unit inside the PLC panel (*Figure 17*). Full integration no longer requires a dedicated electrical panel and can be integrated into existing automation panels. All information can be remotely accessed from the HMI system or remote panels.

A material tracking system directly connected to automatic tagging systems, assures the tagging of each single product with the right identification data and improves traceability of finished products. RFID tags, GPS for geo-localization, remote supervision and data connection to a database make traceability complete, tracking the product through all operations to the end user.

The tying machines described above provide the following advantages: the shortest tying cycle available on the market (TMB 400 operates at 6.8 seconds for a complete double turn tying); smooth integration in rolling mill layouts due to optimised dimensions and complete supply of mechanical, media, electrical and automation systems; and heavy and sturdy machines minimising maintenance cost and reducing downtime and production loss. All the above allow simplified routine operations and increased efficiency of the plant.

Safety systems, protective fences, cranes and other material handling solutions can be designed and easily integrated into any layout based on customer needs. MS

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Fig 24 **Safety boxes with alarms**

Fig 25 **Example of the area protective fences (reference only)**

Fig 26 **Example of the crane (reference only)**