Automatic tagging, tying and tracking of long products

AIC provides automation solutions to automatically tie and tag bundles of profiles, sections, rebars and wire rod coils. The main benefits are increased operator safety, better plant productivity, cost reduction and reduced errors in product identification and tracking.

Authors: Antonio Ambra and Andrei Molchan
AIC North America Corp. and Automazioni Industriali Capitanio srl.

Tagging of semi-finished or finished products is a requirement at steel plants and requested by customers for material tracking, and to aid product quality control. Manual tagging of bundles of bars in mill stocking areas with pre-printed labels as illustrated in *Figure 1* is the traditional method but it has a high error rate. Typically 5% of bundles are not tagged or tagged with the wrong tag, which equates to an average of 30 bundles per shift at the average plant. Such an operation tends to occur in the stocking areas of mills, so there are hazards associated with heavy equipment, roller tables and overhead cranes.

AUTOMATIC TAGGING

An automatic tagging system is one which is part of the plant tracking system, is situated within the process line (ie, before the stocking area) and which minimises or eliminates human activities in hazardous or hot areas and contributes to an overall upskilling of personnel at the plant. Our data indicates that automatic tagging reduces the number of bundles not tagged to 0.2%, a significant reduction. ▷
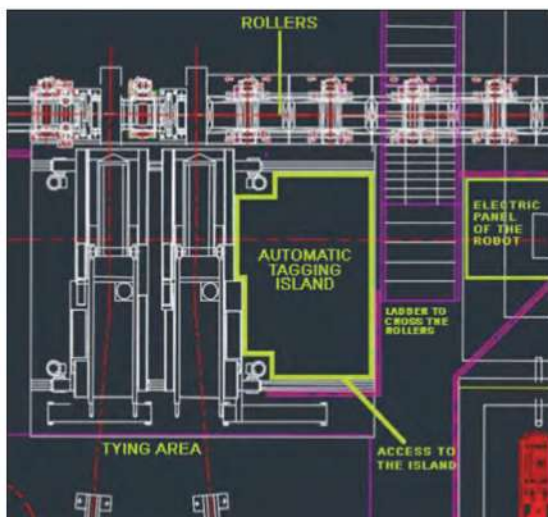

⊕ **Fig 1 Manual tagging of pre-printed labels**

⊕ **Fig 2 Typical automatic tagging island layout**

Colour code	Explanation
White with black cross	Chosen 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

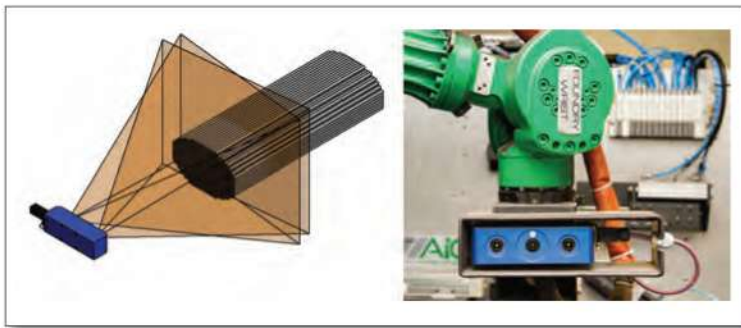⊕ Table 1 **Key to colour coding**

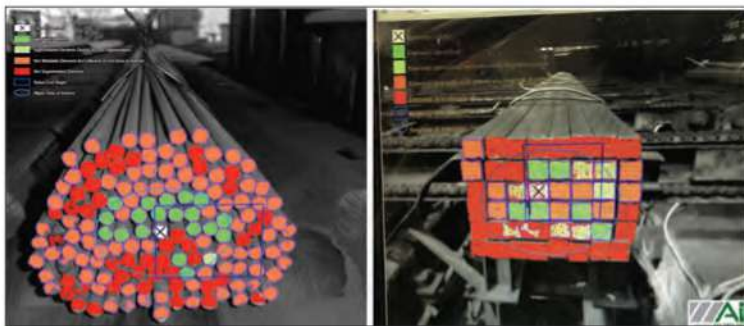⊕ Fig 4 **3D vision system during acquisition**

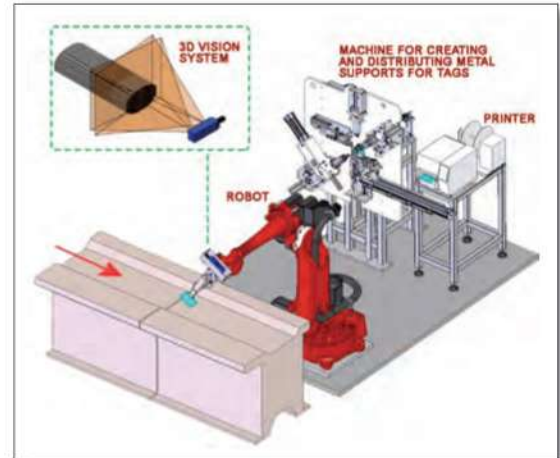⊕ Fig 5 **Examples of result of 3D vision system**

⊕ Fig 3 **Schematic of component parts**

The Automatic Tagging island has been designed by AIC as a solution. A typical layout adjacent to a process line is illustrated in *Figure 2*, and *Figure 3* illustrates its component parts, namely:

○ Anthropomorphic 6-axis robot
○ 3D vision system installed on the robot wrist
○ Set of printers for the identifying tags
○ Machine to create and distribute the tag supports
○ Welding machine
○ Electrical panel that commands the complete island and includes the relevant HMI's for diagnostics and alarms

The island has a small footprint and is completely contained in an industrial container properly designed and engineered to include all the machinery in an air conditioned and protected area.

Anthropomorphic robots are nowadays well proven devices and are used in several different applications in the steel industry. There are 'foundry' models available that are specifically designed to work in harsh environments and that are versatile in use.

The 3D vision system adopted by AIC is a double camera system specifically engineered for harsh environments and which does not require a laser beam (*see Figure 4*). With this system, there is no need to scan the product in order to create the cloud of 3D points but a simple acquisition, like a picture is enough in order to recreate the 3D profile of the product. The sensor used is a matrix sensor and not used for profilometry. In this way, no special movements of the robot are needed to finalise the material scan, and only positioning the bundle on the conveyor is required.

Measurements have been taken on a rebar rolling mill where the robotic tagging application is running at 180tph with a cycle time of 8 seconds where the bundle ▷
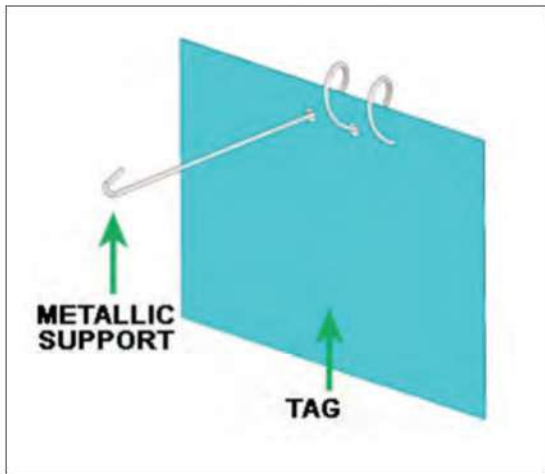
Fig 6 **Tag and metallic support**
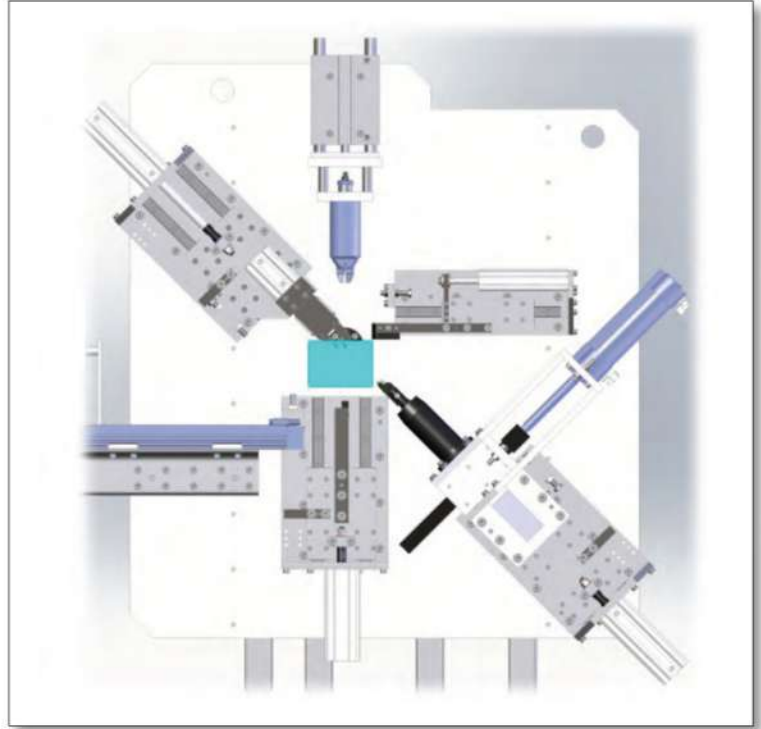
Fig 7 **Metallic support machine**

Fig 8 **Stud dispenser**

Fig 9 **Stud application machine**

Fig 10 **Tags metallic supports on bundles**

Fig 11 **Tags with studs on bundles**

is stopped on a conveyor for tagging. 1.2 seconds is the timing dedicated to a 3D scan of the bundle.

The 3D vision system can automatically detect the type of product without any specific setting thanks to advanced analysis algorithms. *Figure 5* shows two examples the of 3D vision system output. The colour codes are shown in *Table 1*.

This 'photo' appears on operators control panel and it is also saved on a network data storage device, together with all other images used during the image processing procedure. This data is used for algorithm remote assistance, for quality control, and are accessible for remote control/operations.

Printers and tagging The printers installed in the tagging island are of the thermal transfer type. There is an external tag charger to handle up to 10,000 tags, able to cover one full production week at site without the need of replacing the tags and ribbon. The tags can be applied using a metallic support (*see Figures 6 and 7*) using a specifically engineered machine or they can be applied with a stud as illustrated in *Figures 8 and 9*.

The metallic support is used to keep the printed tag away from the head of the bundle when material temperatures are still high. Studs are used when the application is done on relatively cold material where it is not a problem to keep the printed tag to the minimum distance between the head of the bundle and the tag itself. For both these purposes, there is a welding machine installed. *Figures 10 and 11* show examples on steel bundles.

The robotic tagging application has many additional options that increase the flexibility of the system to meet customers' needs:

○ The robot can be used for counting the pieces inside a bundle.

○ Other locations where it is possible to install the tagging robot are:
   o At billet caster exit
   o The finishing area of a wire rod mill. Here, thanks to the 3D vision system and advanced image recognition algorithms, the robot chooses the most suitable position for the tag and applies it to the wire rod coil by using a metallic support created directly in the robotic island, without the use of a welding system. The clip is applied to the selected rod with a dedicated movement of the robotic wrist. *Figure 12* shows 3D schematics of coil position identification, while *Figure 13* shows a tagged coil.

○ Trolleys and guides can be used in order to tag coils coming from several production lines.
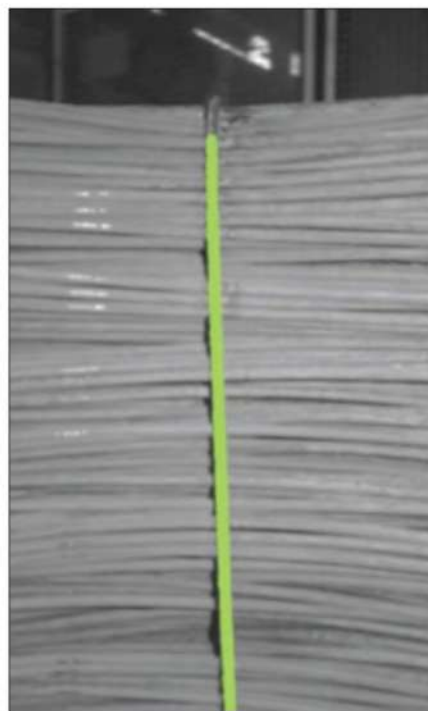
TYING MACHINES

Tying machines are designed to automatically tie bundles, sub-bundles and packs with steel wire. They are positioned downstream of the product formation area and have the shortest tying cycle available on the market (6.8 seconds for complete double turn tying); *Figure 14* illustrates different designs. The main parts of the machines are:

- **Main body with guides** A welded steel structure is mounted on combination bearings that run on horizontal guides. For cleaning and maintenance the machine can be retracted to keep the rolling table clear, inductive sensors and a gear driven motor provide online or offline positioning. Moreover, two vertical guides are also installed in the part where the tying head moves driven by a hydraulic cylinder, another inductive sensor is provided for device positioning in stand-by and a photocell for tying.

- **Tying head** This is positioned in a solid, welded, annealed and machined steel structure where all the cables and pipes run through ducts. It comprises a wire feeding device, a knot forming device and the guide clamps. The wire feeding device is made of two steel plates with a characteristic profile shape assembled in order to set up a conical channel between them where the wire will be loaded and trailed. The knot forming device is a revolving tool steel head driven by a hydraulic motor with jaws and wire cutting knives built inside. The guide clamps are arc shaped plates of wear resistant steel that supports a set of rolls that drive the wire around the bundle. An appropriate number of movable rolls is provided for the feeding of the tie wire and his recover during the tying process.

- **Bundle retaining jaws** The jaws are installed in the welded steel structure pivoted on a common base. They are driven by two hydraulic cylinders that allow them to close in order to keep and hold the bundle in the correct shape during the tying process.

- **Valve bench** The valve bench drives the hydraulic devices of the machine and is installed at the back of the machine.

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 control panel) and twisted. The roller table will move the product to the next position, and the cycle will be repeated when all the required ties are made. At the end of the tying the process bundle is transferred to the discharging area for its tagging and final storage. An example is shown in *Figure 15*.
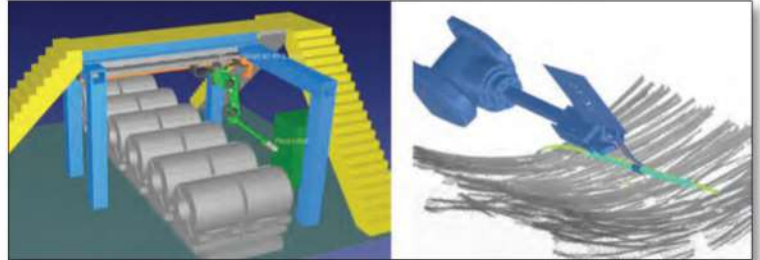
⊕ **Fig 12 Position, place identification and tagging process on wire rod coils**

⊕ **Fig 13 Tag on wire rod coil**

⊕ Fig 14 **Tying machines for bundles, sub bundles and packs**

⊕ Fig 15 **Example of the product**

CONCLUSIONS

Automatic tagging reduces the number of bundles not tagged to 0.2% compared to 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 where the bundle is stopped on conveyor for tagging. 1.2 seconds is the timing dedicated to 3D scan of the bundle.

The tying machines described above have been designed in order to have the following advantages: the shortest tying cycle available on the market (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; heavy and sturdy machines minimise maintenance cost and reduce downtimes and production loss. All the above allows simplified routine operations and increases efficiency of the plant.

The material tracking system directly connected with automatic tagging systems assures the tagging of each single product with the right identification data and improving traceability of finished products. Data connection to database makes the traceability complete following the product in all the production operations until the end user. **MS**

Antonio Ambra is with AIC North America Corp. New York, NY, USA. Andrei Molchan is with Automazioni Industriali Capitanio Srl., Odolo, Brescia, Italy.

CONTACTS: andrei.molchan@aicnet.it