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WINLINK® TECHNOLOGY FOR MODERN BAR ROLLING[1]

Ezio Colombo [2]
Ugo Zanelli [3]
Luigi Giacomini [4]

Abstract
The WinLink® technology for the endless production of long products from liquid steel, links a high productivity caster with a very compact rolling line. The endless production of bars offers a significant increase of yield, bringing a large advantage to the cost-effective operation. In order to fully benefit from it, a modern rolling approach is required. Both the process equipment and rolling practices need to focus on the maximization of the mill availability. For example, quick change solutions (stands, knives, guides, rolls/rings) and usage of rolling carbide rings are to be considered, while the duration of the rolling campaigns must be optimized. Due to the continuity of the rolling operation with the casting, the automation philosophy is reversed, and it must include the feature of under-load automatic gap control. WinLink® by Siemens benefits from the experience acquired in the industrial operation of the Arvedi ESP (endless strip production).
Key words: Direct rolling; Energy saving; Yield; Compact rolling; Cost-effectiveness.

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[2] *Head of Special Projects,Siemens VAI VAI - Long Rolling*
[3] *Technology,Siemens VAI VAI - Long Rolling*
[4] *Market Communication, Siemens VAI VAI - Long Rolling*

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1 FROM ENDLESS STRIP PRODUCTION TO DIRECT ROLLING OF BARS

For over 3 years, the first Endless Strip Production (ESP) has been in successful operation at ARVEDI works in Cremona, Italy. Building on this experience, WinLink has been developed, as the innovative techology for convenient direct rolling of bars, where the conventional billet re-heating furnace is eliminated.

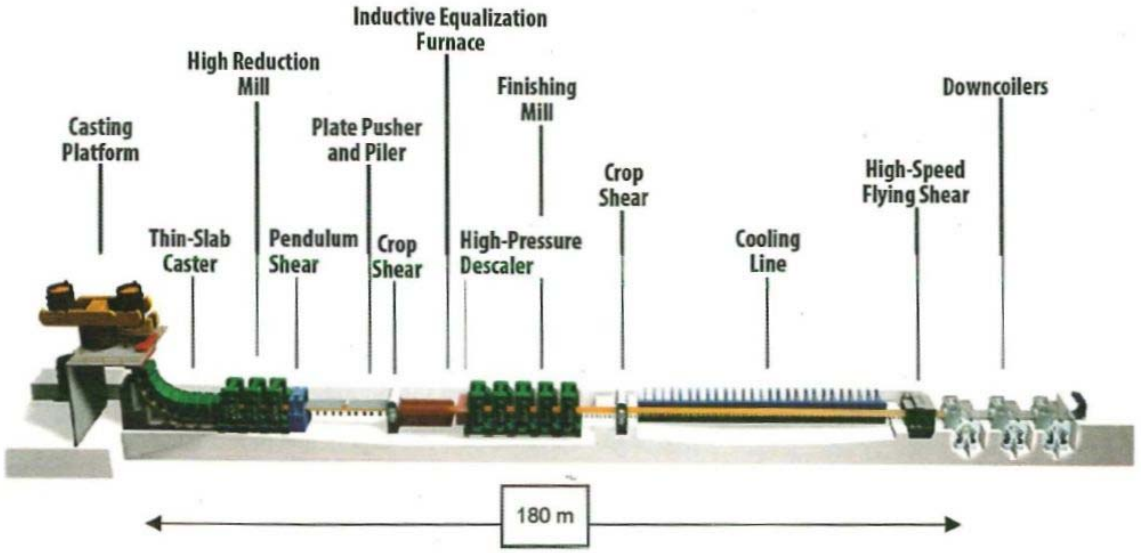

Figure 1. ESP-The Arvedi ESP Line in Cremona (Italy).

2 INVESTMENT FOR LONG PRODUCTS MADE AFFORDABLE

The benefits stemming from the application of WinLink* are numerous, and regard the capital (Capex) and operation costs (Opex), and the environmental issues.
Investment is made more affordable for small steel producing units with 300,000-400,000 tpy of rolled products for construction applications, as payback times are significantly reduced. Profit margins may be increased, and the economy of scale is improved moving operating costs to those of larger installations.

3 CONCEPT AND APPLICATION

WinLink concept is based on the direct link between a multi-strand (i.e. at least two) billet caster and a highly-available rolling mill, without the conventional billet re-heating furnace. Liquid steel is processed to bars in a continuous, endless production line.
The typical application is for installations with local availability of scrap, which produce between 300,000 and 400,000 tpy of finished bars. The finished bars are typically rebars for the construction industry, but small flats and profiles (e.g. angles) may also be considered. Having more than one casting strand improves the economy of scale of the meltshop, and offers flexibility in view of unpredictably changing market scenario. While the primary casting strand is dedicated to the

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endless feeding of the rolling mill, the secondary strand(s) allow a limited production of flexible size billets, finished and saleable.
While the rolling mill must have a very high availability, in case of possible extended downtimes, the secondary strand(s) also serve as backup production line.

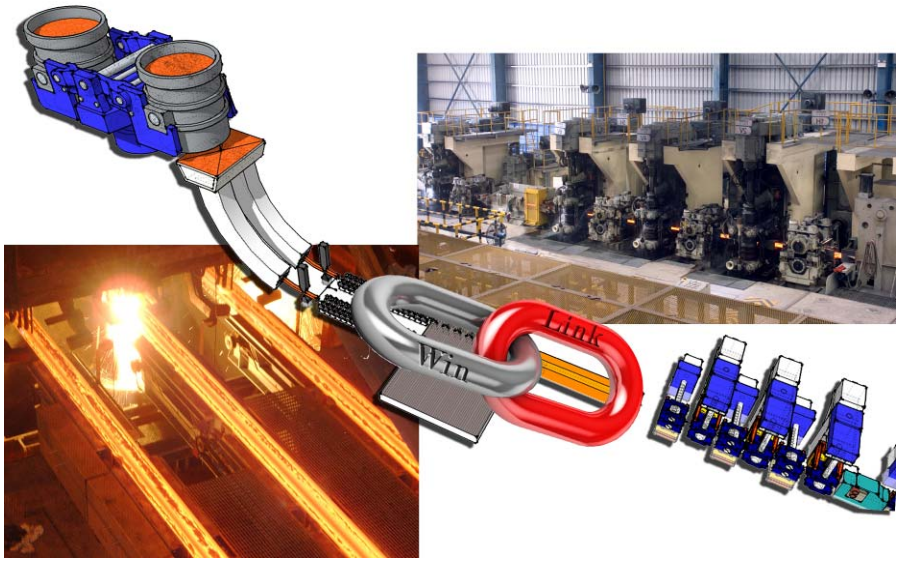

Figure 2. WinLink Concept.

4 INDUCTION FURNACE

One of the energy savings proposed by WinLink consists in avoiding the normal cooling of the billet down to room temperature, and the following re-heating to the 1000-1100°C required for initiate the rolling. The billet is cooled to the temperature required by the casting process to guarantee the solidification of the billet, and before entering the rolling mill it goes through an induction furnace with high efficiency. The induction furnace is the best technical solution to rapidly achieve the required rolling temperature. It is designed to provide about 200°C of temperature increase with a compact length, and to apply a uniform heating action on the billet. Its installed power is approximately 4,000 kilowatts.
Replacing the conventional gas or oil re-heating furnace with an induction furnace has also the benefit of reducing the CO_2 emissions.

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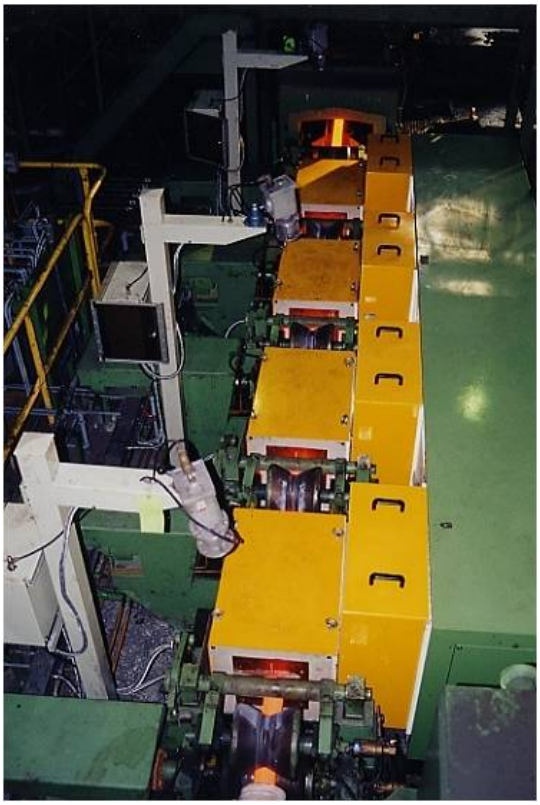

Figure 3. Induction Furnace.

5 ROLLING MILL STANDS

The rolling mill must be equipped with state-of-the-art components, in order to guarantee the availability required for the endless rolling process to offer its maximum advantages.
When the typical product mix for rebars from 8 to 40mm diameter is considered, the mill includes 18 stands with roll diameters ranging from 600 mm in the roughing area to 360 mm in the finishing area. The smaller dimensions are slitted to increase its productivity, while the maximum finishing speed is 15m/s.
The best choice for the rolling stands is represented by the RedRing, which are reknown for their high-rigidity, durability and ease of maintenance. The housingless and double support design with a reduced stress-path has been implemented in several generations of RedRing, with more than 6,000 units installed.

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Figure 4. RedRing stands.

In order to obtain long rolling campaigns, the mill stands may be equipped with carbide rolling rings mounted on shafts instead of cast iron rolls.
Groove change is realized by a dedicated fast guide changing system.
Quick-change systems must be provided, so to reduce to a minimum the change times.
While in a conventional mill the stand quick-changes are provided in the finishing train, WinLink foresees its application in the last 9 stands.
With the automatic connection of the spindles and fluid utilities, the stands can be interchanged very quickly.

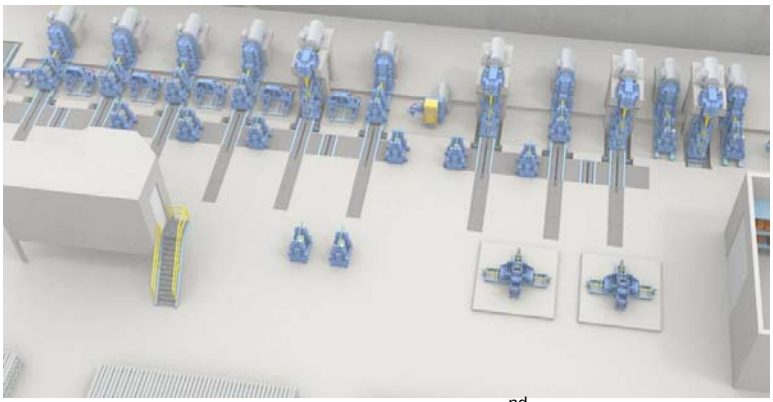

Figure 5. Stand quick-change system applied from the 2nd intermediate train (final 9 stands).

Stands and guides are completely preset and adjusted offline, and made ready along the rolling line, where the fast changing devices put them inline.
The stands feature the possibility of adjusting the gap under load conditions.
Bearings of both stands and drive components must be selected so to have an extended life-time.

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6 POWER SLITTING

In order to increase the productivity of smaller sizes, 8 and 10mm bars are slitted. Siemens VAI's powered slitters provide highly accurate and consistent dividing. They allow rebars to be rolled in multiple strands, significantly improving the productivity of small size rebars, without increasing their finishing speeds. Slitting rolls have ten times the life of slitting guides, while offering higher speeds and better accuracy.

Figure 6. Powered Slitting Unit.

7 QUENCHING AND TEMPERING

Rebar quenching and tempering represents an effective way of obtaining the desired metallurgical and mechanical features, avoiding the usage of expensive micro-alloys during melting without requiring post-rolling treatments such as cold drawing. The final structure of martensitic self-tempered outer surface, with ferrite-pearlite core, allows to control the values of tensile strength/ yield strength ratio and elongation, so to meet any specification. The weldability remains excellent due to low carbon content.
Water boxes and nozzle design used by WinLink have a high cooling efficiency, which result in compact installation, increased lifespan of pumps, valves and other critical components and lower water consumption costs.
Wear parts of nozzles are easily replaceable, for minimizing downtimes.
Having less water in contact with the product reduces the tendency for cobbles, which improves the reliability and availability of operation.
Water boxes are traversable (instead of lift-out) for minimizing change times.

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Figure 7. Quenching and Tempering with Quick-change.

8 FINISHING EQUIPMENT

Hot dividing of bar is optimized so that only multiples of commercial length are sent to the cooling bed, while shorts are removed by a dedicated scrapping unit.
WinLink is equipped with a compact cooling bed, while cold cutting is done by a static shear. This solution allows to maintain the flexibility of producing not just round bars but also small flats and profiles (e.g. angles). As alternative, the possibility of commercial cutting done in hot condition may be considered. In this case, a special high-speed hot cutting station is required at the entry of the cooling bed, which becomes shorter (but wider), while the cold cutting equipment is eliminated.

8.1 Bar Counting

Fully-automated counting of bars is provided on transfer unit between the cooling bed and the bundling station. The system is capable of high production rates for al sizes of bars and has a consistent accuracy exceeding 99.9%. The operation is completely automated, and both current count and end-of-batch signals are output to downstream equipment and to the mill tracking system for full control and information on the process.

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Figure 8. Automated Bar Counter.

Bundling and wire-binding (or strapping) operations are completely automated, as are the following weighing and labeling steps.

9 AUTOMATION

There is no parallel in the metallurgical plant-building industry to the worldwide experience of Siemens in electrical and automation systems. This can only benefit WinLink, where reliable process controls and exact temperature regulation along the whole production chain are critical to reaching the desired high availibility of operation. State-of-the-art hardwares and softwares are fully integrated in the required levels of automation, for both power and process control.
High-level automation systems are also applied to monitor and perform the entire production process, to ensure that the required quality demands are met, and to reduce the human presence requirements. Steel grades and products are carefully tracked throughout the process up to final product dispatch. The availability of mill is also enhanced by a mill management system (such as Siemens' XpertManager) which provides accurate product tracking and tagging, up to final shipment.

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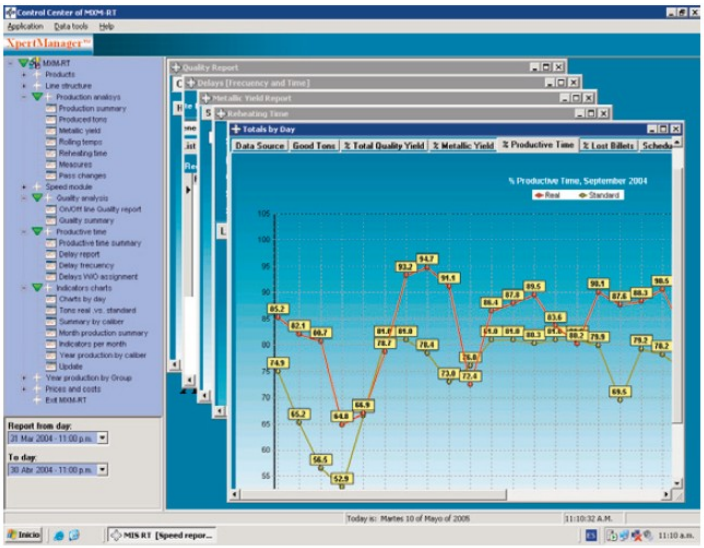

Figure 9. Interface of XpertManager Mill Management System.

Dedicated mechatronical packages provide complete and effective control of the equipment, to assure functionality, flexibility and ease of use. They also significantly shorten start-up times of commissioning, allow a steeper ramp-up of productivity and help achieving the rated performance values fast, steadily and reliably. Available packages range from stand speed referencing (starting from caster speed), to under-load gap adjustment, stand speed control, tension control, enhanced cut optimization, bar counter, cold shear, bundling & tying, cooling and quenching systems.

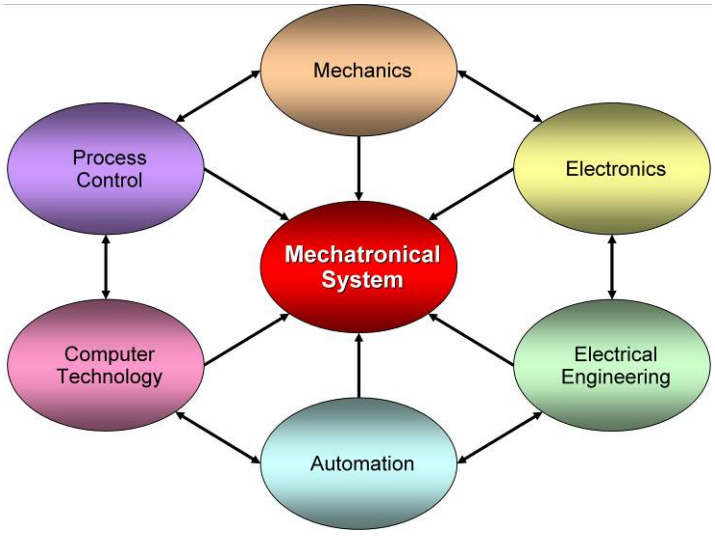

Figure 10. Mechatronical Concept.

WinLink makes use of the most advanced methods of Condition Monitoring (CM), which allow an efficient and continuous in-line monitoring of the equipment parameters, so to early tell the symptoms of developing failures. Anomalous conditions which jeopardize the integrity of the equipment or shorten its lifetime are immediately spotted by CM, so that corrective actions may be taken before failures occur. Mill operator are assisted with predictive maintenance techniques, in order never to let the equipment give out. The benefits of CM are greatly advantageous to the cost-efficient operation, in that downtimes are minimized while normal part wear and utilities consumptions are optimized.

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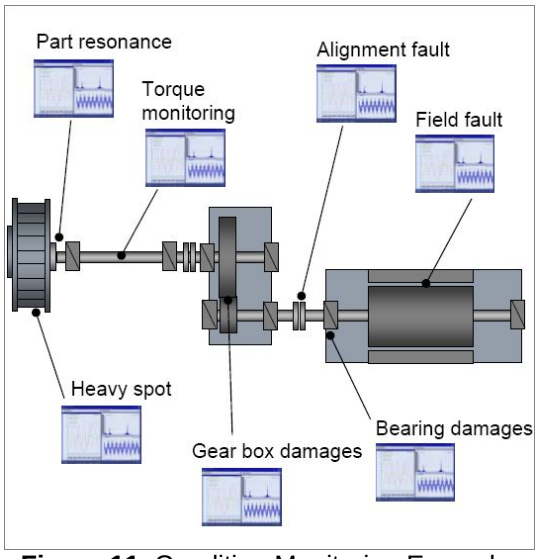

Figure 11. Condition Monitoring Example.

10 MAIN BENEFITS AT A GLANCE

In comparison with conventional minimill plant configurations, WinLink offers a number of advantages over conventional minimill configuration:

- Capex for main equipment are smaller
- Opex are reduced, up to $40/t of rolled steel depending on unit costs
- Low inventory and working-capital requirements
- Reduced requirements of personnel
- Reduced civil works and infrastructure costs
- Reduced energy consumption
- 24-hour continuous and smooth mill operation
- Higher product yield due to long uninterrupted casting and rolling sequences
- Low CO_2 emissions and fluid consumption
- Required space (footprint) is smaller
- Production of finished rolled products from scrap in less than 2 hours

The WinLink-based minimill also builds on the experience acquired from the Arvedi ESP process for the endless production of flat products. Furthermore future connections with high efficiency production systems in EAF field, such as SiemensVAI's Quantum® is also under development.