Best practices to implement complete revamping of obsolete plants

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INTRODUCTION

A common problem for several steel producers is the way to modernize and improve the production plants and schedules without a deep impact on the mechanical layout avoiding a too heavy financial charge.
In the project we detail below we'll describe AIC's strategy that allows to perform a complete electric Revamping of ORI Martin – Ceprano Rolling Mill (Frosinone, Italy), carried out in two phases planned during capital plant stops (August and Christmas period).
In the first step all activities concerning auxiliary services were implemented, while during the second step all tasks about rolling mill area and safety system were performed, preserving the existing mechanical equipments.
ORI Martin is a primary group, specialized in high quality long products steel production and its core business is the long products special steels (SQB) for use in the automotive indutry.
Ori Martin headquarters are situated in Brescia and houses a melting and rolling plant for the hot production of long product steels for mechanical applications, while the factory in Ceprano is focused on construction steels (SQB).
Founded in 1974, the revamped plant is specialized in the hot rolling of billets (mainly produced in the meltshop of Brescia) for the production of straight bars (from Ø 8mm up to Ø 32mm), wire rods (from Ø 8mm up to Ø 17mm) and coiler bars (from Ø 18mm up to Ø 32mm).
AIC is a global system integrator and supplier of Electrical and Automation systems for the whole Metals industry.
In the next figure we present the rolling mill layout of ORI Martin – Ceprano plant

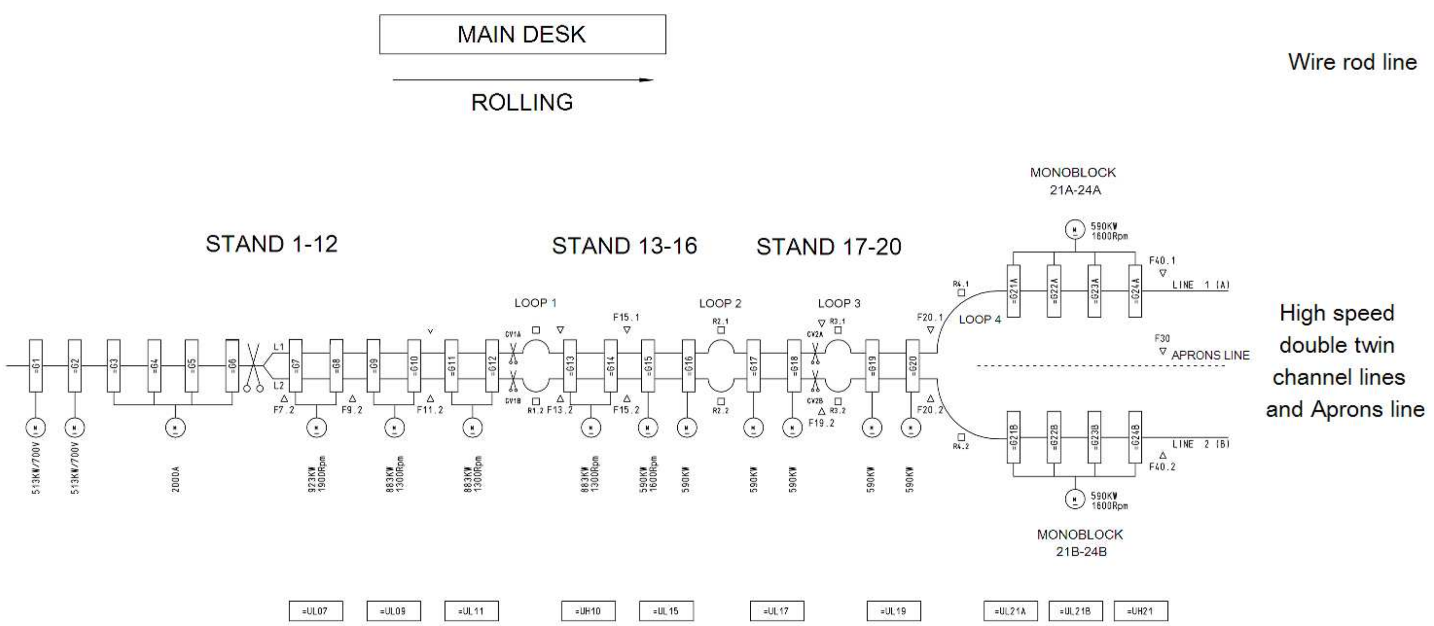

Fig. 1. Continuous Rolling Mill Layout and related productive options

The image shows the main characteristics of the layout configuration (rolling mill area): **two alternate strands** productive process, with 20 rolling stands, 4 intermediate shears (2 shears for both lines), 2 finishing blocks (4 steps).
After the first shared line different finishing ways can be scheduled, as per following list:

- Aprons line single strand, with optimizing shear and cut lenght shear and 50 mt start/stop cooling bed
- High speed lines two strands, with two dividing shears and optimizing shear, two double twin channel start/stop, 50 mt start/stop cooling bed and cold shear
- Wire rod line, with two head/tail shears, two laying forming head and related cooling conveyor.

THE REVAMPING PROJECT

This electrical revamping project, started in the summer of 2009, was succesfully accomplished in the first months of 2010 and concerns a complete on-site upgrade of all stand drives through new drive control cards as well as new electrical equipments for auxiliary services, main and local desks, new PLC's platform for a complete process automation and optimization of the steel plant.
The electrical and automation scope of supply included :

- Electrical Engineering
- Upgrade of all Drives
- 12 automation PLCs with more than 7000 I/O
- Safety system based on safety PLCs, totally integrated in the main automation architecture
- SCADA control system in client-server configuration
- Main desks
- Local desks and control stations
- Hydraulic control
- CCVE system
- Spare part management

The target of the project was to increase the productive performances with a reduction of direct costs and allow the customer to calibrate the production rate for every range according to the reheating furnace capacity; optimize the productivity together with a great improvement of efficacy, efficiency and rolling performances, without any investment in new mechanical equipment.

BASIC STEPS TO UPGRADE AN OBSOLETE PLANT TO STATE OF THE ART

Best practices to fix the steps of the upgrade.

The prerequisite to define a succesful strategy for the modernization of the equipments was a deep understanding of the process and its peculiarity: starting from the structure of the plant the HW engineering team analyzed all different areas, each relating to a homogeneous phase of the production line, aiming to identify possible bottlenecks and critical configurations/situations.

- First step was a meticulous survey of all machines installed after more than 35 years of working history and several extension programs. Different suppliers and various criteria for the items of identifications had caused year by year a total lack of univocity; so the revamping project need to beginning from a new assignement of the items for every machinery ("=" referring to the international rules EN 61346, for example), in order to ensure homogeneity and to identify clearly the items to manage (giving, at the same time, a precious service to the customer).

Fig. 2. Collecting of technical data of the plant

- The next step was to replicate the same job described above also for motors and sensors. A detailed motor and sensor list, together with techical data, is a great resources to organize the technical documentation and to establish a right relationship between motors and machines

REVAMPING TRENO LAMINAZIONE

TITOLO - *TITLE* Motor list +Y05 COMP. DA - *BY*

Item	Denominazione	N° Motori	Potenza Kw	Tensione V	Corrente A	Giri Rpm	Cosfi	Rendimento %		Ptot Kw	Corrente A	
=G7/8	Ventilatore motore gabbia 7-8	1	15	400	27,67	2940	0,86	91,00		15,00	27,67	KA
=G9/10	Ventilatore motore gabbia 9-10	1	15	400	27,67	2890	0,86	91,00		15,00	27,67	KA
=G11/12	Ventilatore motore gabbia 11-12	1	15	400	27,67	2940	0,86	91,00		15,00	27,67	KA
=G13/14	Ventilatore motore gabbia 13-14	1	15	400	27,67	2890	0,86	91,00		15,00	27,67	KA
=G15	Ventilatore motore gabbia 15	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G16	Ventilatore motore gabbia 16	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G17	Ventilatore motore gabbia 17	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G18	Ventilatore motore gabbia 18	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G19	Ventilatore motore gabbia 19	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G20	Ventilatore motore gabbia 20	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G21/24A	Ventilatore motore Monoblocco Linea 1	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G21/24B	Ventilatore motore Monoblocco Linea 2	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KA
=G7	Regolazione cilindri G7	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KR
=G8	Regolazione cilindri G8	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KR
=G9	Regolazione cilindri G9	1	7,5	400	14,72	2890	0,85	86,50		7,50	14,72	KR

Fig. 3. Extract of motor list of the project

- The next practice required to detail the bottlenecks and to establish the priorities of action; in the project we are describing the most critical zone was the delivery area (cooling bed entry system as well as compactors, stackers, tying machines and bundlers), unable to support any possible increase of productivity and managed without automation systems, but only through manual control of operators by pulpit or in field (source of inefficiency and danger for the workers).
  In the next paragraph we'll explain how we organized the revamping phases according to more relevant bottlenecks.

- The last preliminary step was the HW design of new electrical equipment and the revamping of existing ones, in order to implement the re-allocation of all machines, motors and sensor to command & control. Through the redesign of the electrical functions and equipmets with related new identification item, AIC's staff rationalized criteria and logics of control for the steel plant, as done for mechanical side

Bottom up strategy for improving the production performances.

Following the analysis of baseline, the key for a successful project is a strategy for the resolution of most critical productive limits of the plant. The brilliant idea that characterizes this job was a bottom up approach: the revamping needed to start from the last phases of the line, aiming to allows the plant to manage and handle final products with a rate appropriate to superior rolling and productive performances.

Thus a new command logic of delivery area was designed, including electrical panels, main & local desks, PLCs and SCADA Software designed to implement a new tasks as per following list:

- Increase of packing performances through automatic cycles
- Increase of quality and uniformity of bundles
- New binding cycles control
- Complete automation and securing of delivery area (safety operating activities)
- Data and alarms interchange with rolling mill & cut lines software.


Fig. 4&5. Bundles and Binding cycle

A single brand for power control upgrade (Drives).

To perform and complete this major plant modernization was designed and commissionned also a deep revamping of all rolling mill drives upgrated with new digital drives control cards, preserving the existing power section.

The choice of Ansaldo as single brand for all power control components grants to the customer an easier and effective integration and maintenance programs.

Furthemore the integration and connection of updated drives in the Profibus network allows to interface all power parameters (tension, current, alarms control...) with automation system as well as to manage and set proper configurations. The operators on command pulpit can thus monitor continuously the state of all DC Drives thanks to a manageable and user-friendly HMI system.

Fig. 6. Sample of DC Drives before revamping

Fig. 7. Sample of DC Drives after revamping

This step also included new auxiliary services control logic (stands handling, lubrication and cooling), as well as high speed and aprons cut lines automation with cut length optimization and rolling mill area complete automation: intermediate shears, loopers and cropping shear.

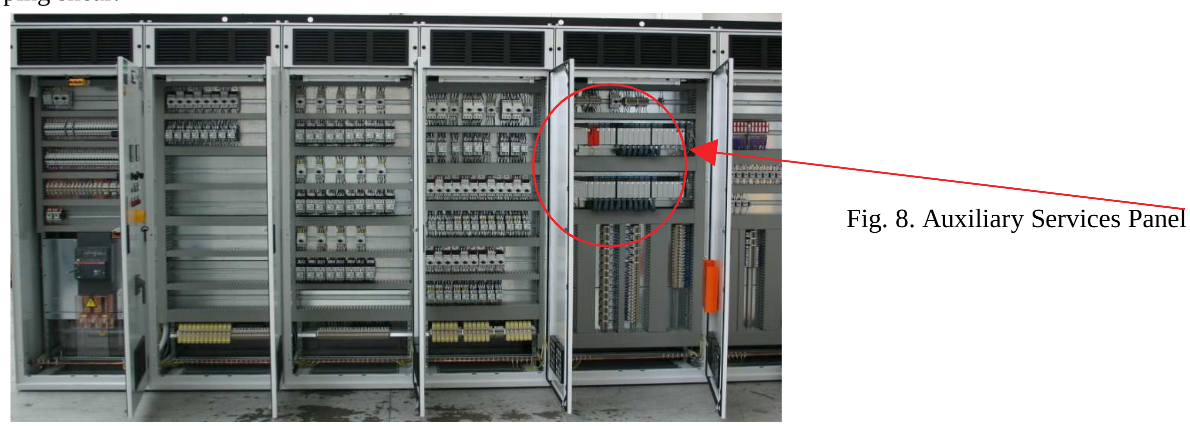

Fig. 8. Auxiliary Services Panel with Safety CPU

A single brand for automation control (PLCs Platform, SCADA & Safety System).

The complete electrical equipment revamping was followed by a new **RACS system**: a completely integrated Rolling Mill Automation Control System implemented by AIC through PLCs and SCADA platforms.

The previous logic system for the control of the plant was based on components out of business with no spare parts; the job thus included supply of 12 new state of the art Allen Bradley ControlLogix5000 PLCs (including one safety CPU), suited to command and control all tasks of different production lines, starting from reheating furnace automation up to finishing and delivery area, including PLCs safety system.

A new HMI system in client-server configuration has been also implemented.

The PLCs software designed by the AIC's engineering team allows to achieve several improvement and result, as for example:

- Reheating furnace movement and combustion automation, with consumpion analysis and optimization and production statistics;
- Cascade speed control used to change the speed of the selected machine and of all the upstream stands in the production line;
- Tension and loop control, designed to adjust the speed references of the stands in order to form the loop between them or to carry out a fine regulation of the speed reference of the stands in order to maintain a constant tension or push on the material between two stands;
- Continuity rolling control, in order to automatically detect possible cobbles;
- Ghost billet: the system can simulate the rolling process with no material at a given line speed (parameter in the HMI system), including also the shear cutting; this function is used to save material at the beginning of the hot test and can also be used to continue the rolling process even in case of failure of the encoder used for the cut-to-length calculation;
- High cutting accuracy and repeatability as well as cutting optimization strategy: the system automatically calculates an optimal cutting strategy to minimize material scrapping; this system can also take advantage of a pre-optimization shear to scrap the material in the middle of the rolling process
- Cut cycle simulation: RACS system allows to simulate the presence of a billet, with a prearranged length, in transit in the rolling mill at the selected speed line. Through the simulation it is possible to verify the correct operation of every machine involved in the cutting cycle and in the unload
- Motors load control: the stands motor load is constantly controlled to detect anomalous variations due for example to the stand bearing breakup or to excessive stand cylinder deterioration;
- Complete process optimization, including shears control, cooling bed, finishing and delivery area optimization both for aprons, high speed twin channel and wire rod line;
- Head forming layer control system for wire rod line with head positioning on coil conveyor;
- Series of functions to save in a database the rolling parameters and the machine parameters. They are collected in a recipe containing the values of the parameters related to a specific rolling mill configuration. The recipes are then collected in various recipe books, one for each mill area or automation function;
- Production control and instant productivity: on request of the customer's operator it’s possible to build graphic pages that show indication on the instant productivity of the plant;
- System deeply integrated with CCVE (Closed circuit video equipments).

Fig. 9. Main control room (Rooling mill area) before revamping

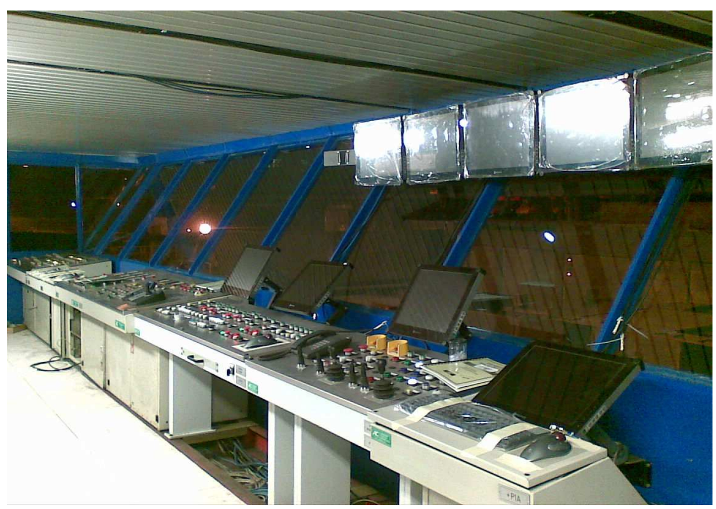

Fig. 10. Main control room (Rooling mill area) after revamping

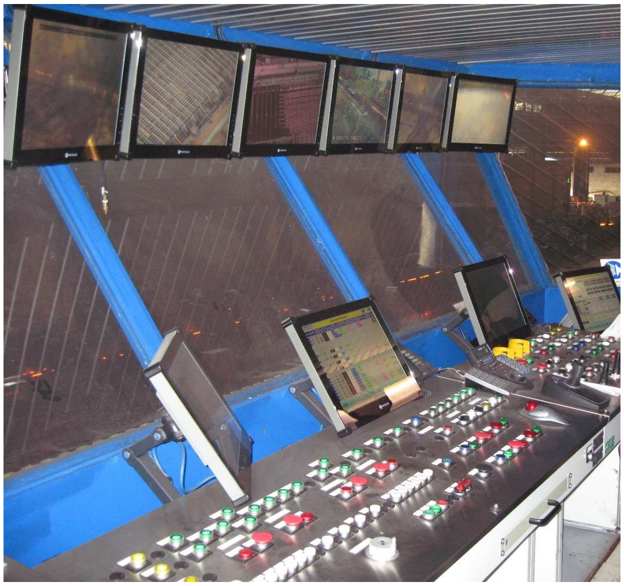

Fig. 11. Main desk and HMI system

Fig. 12. Reheating furnace automation

Fig. 13. Rolling mill automation

Fig. 14. Delivery area automation

REVAMPING OF NETWORK CONFIGURATION: ETHERNET, CONTROLNET AND PROFIBUS

In the previous paragraphs we have described the panels and desks designed and installed to upgrade performances and productivity of the plant, but the supply of new power & control solutions is not enough. A complete automation system needs a state of the art network configuration, in order to properly interlace the HW & SW solutions and exploit their potential.

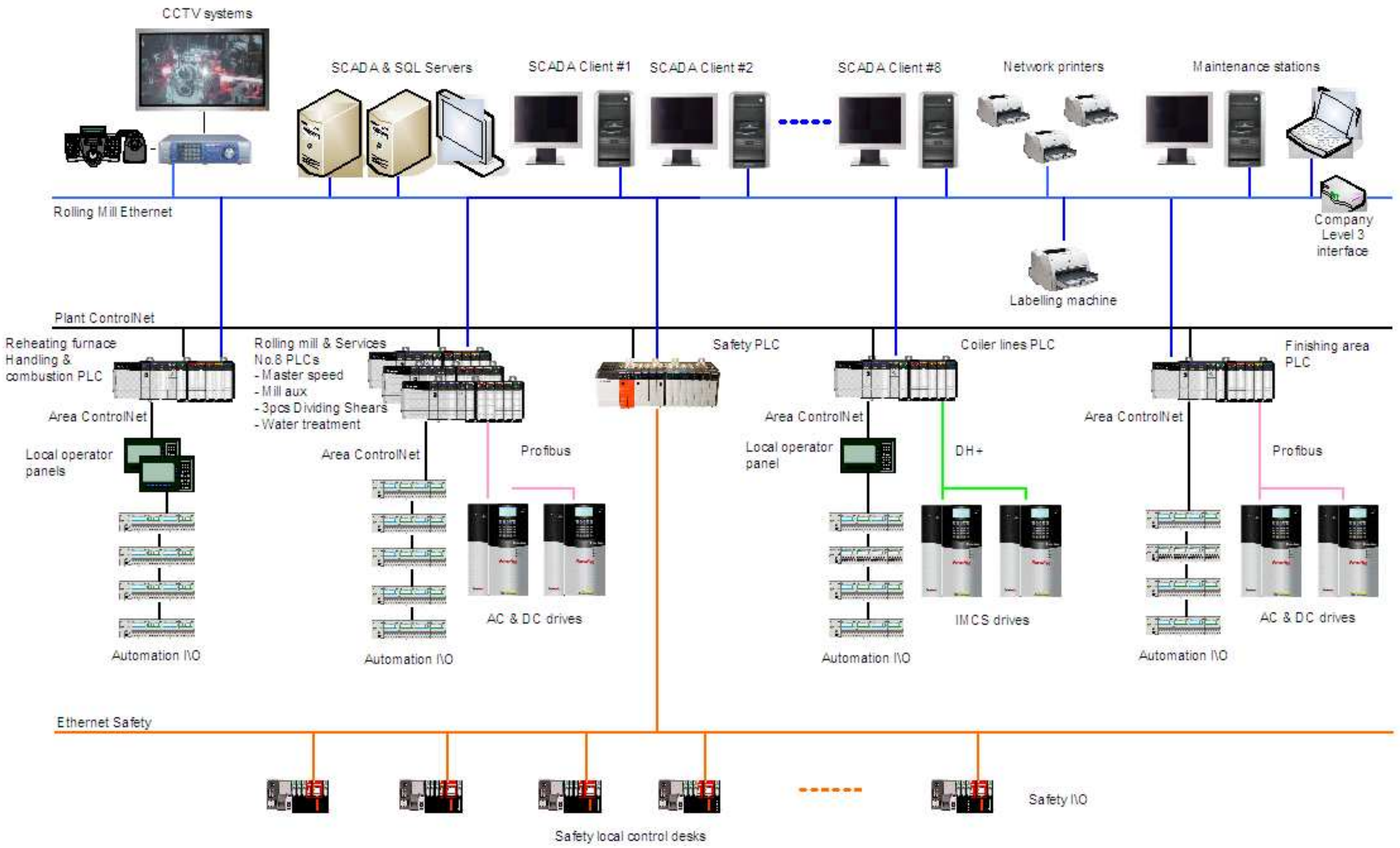

Fig. 15. General automation layout with network communications.

The above image shows the final layout configuration:

- Automation CPUs (Reheating furnace, Rolling Mill & Services, Coiler lines and Finishing Area) are interconnected through a dedicated ControlNet network.
- Automation & Safety CPUs are connected to the SCADA system through Ethernet network
- Safety CPU and safety remote I/O are interconnected through a dedicated Ethernet network.
- AC&DC Drives are connected to PLCs through Profibus networks.
- CCVE is integrated on plant Ethernet networks as well as printers and labelling machines.

All communication networks are together interconnected and can be easily reached and managed through remote control not only by the maintenance operators, but also by AIC engineers, thanks to a Secure Remote Device Management.
This efficient tools allows supplier of the automation system to help and assist the customer in start-up activities and production management, thanks to remote data analyzers and troubleshooting tools.
The safety system is also exclusively based on Allen Bradley PLC ControlLogix system and it does not require traditional cable pulling.
Previous traditional safety systems were based on standard hardware/electromechanical modules that needed to be wired; thus the main problem was the difficult integration with the command system. The integration in the main automation system was frequently well-nigh impossible, except against additional wirings that always complicate the hardware structure.
At the opposite the designed PLC's safety system is totally integrated in the main automation system and can be very easily modified, expanded or reduced both in erection phase and in commissioning or after-starting phase.

To implement the automation&safety system the engineering team handled 37 remote I/O units (automation) and 6 safety remote I/O units, with about 7000 I/O signals.

Rolling mill Auxiliary services: hydraulic and oil control units.

Among and to complete the revamping works on power and logic control system of main production lines, auxiliary services management and control has been integrated in the general automation system, mantaining existing oil and hydraulic unit as well as local sensors.

By adding a remote I/O unit for each fluid unit, a complete integration of services has been reached.

Thus the operator can take several advantages, such as:

- Easy and user-friendly interface for services management integrated in the main HMI system;
- Management and control of reports and alarms;
- SCADA screens dedicated to oil and hydraulic units.

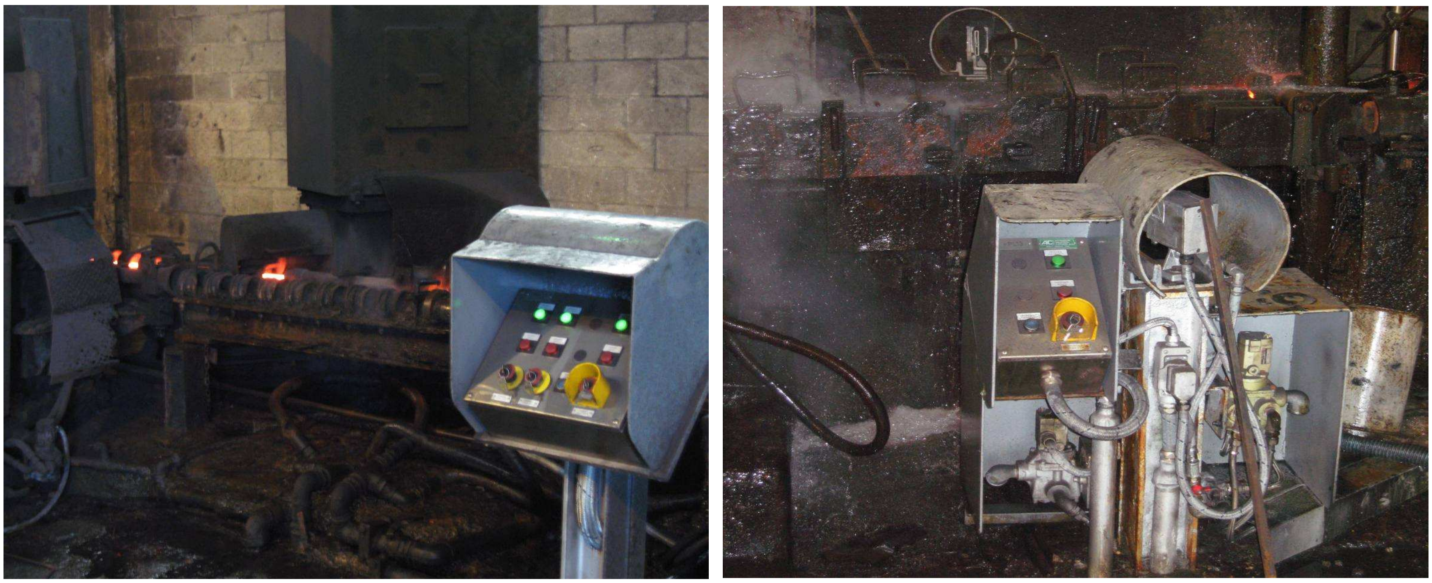

Fig. 16. New Local boxes for auxiliary services control

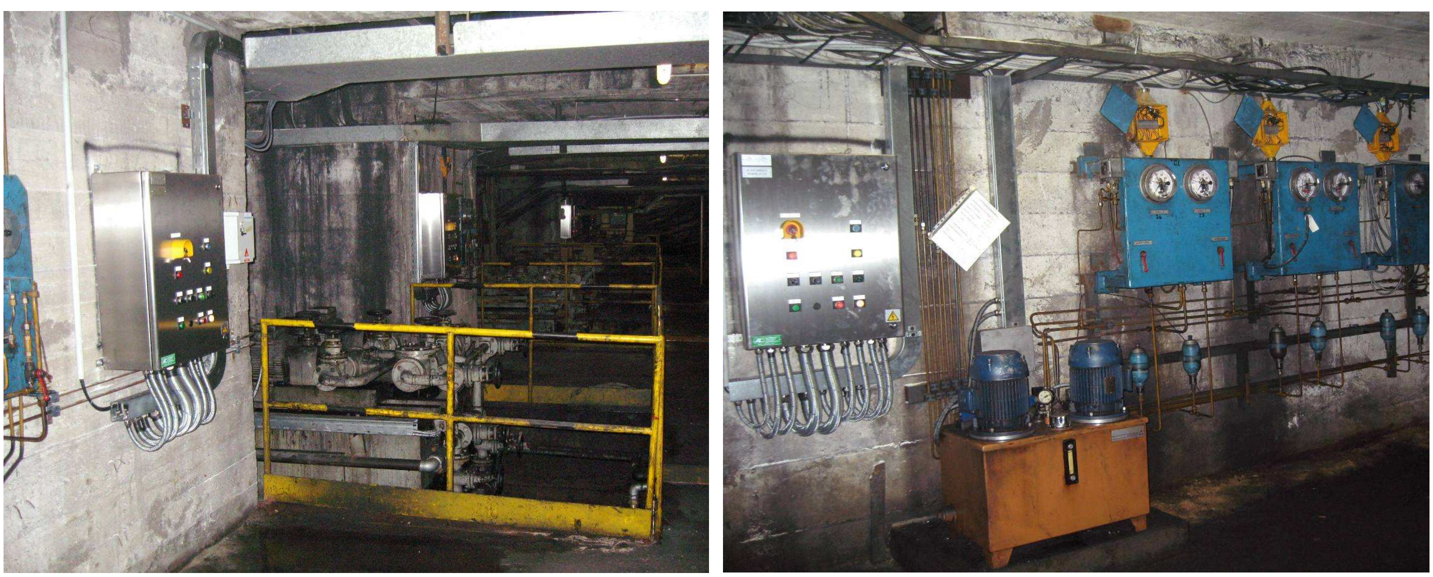

Fig. 17. New local stations suited to control oil circuit

Realtime diagnostic and SCADA system.

The implemented Client-Server HMI system is based on certified package (Allen Bradley Factory Talk View) and enables real time control of plant conditions as well as their quick and easy visualization through SCADA screens showing:

- Reheating furnace movement and combustion parameters;
- Plant synoptic and state of the machines;
- Selected stand of rolling mill with bar graph of the speed and current;
- Tension and loop regulator gauge;
- Management of rolling recipes and related parameters as well as management of alarms and auxiliary devices parameters (without stopping the mill);

The SCADA Screenshots allow to continuously monitor the state of the production line and the state of the machines controlled too. The supervision station allows also a sophisticated management of a temporal graph dedicated to simplify the operation of fine configuration of the plant and of search of breakdowns. The temporal graphs, besides allowing the real-time visualization (armature currents and voltage, speed and signals feedback, for example), allow the visualization of data previously stored on database. This function is very useful for an analysis of anomalies that happen desultorily and of difficult individualization. If necessary, the recorded data could be extracted and sent to after-sales service for further investigations.

A fast data recording and acquisition IBA system for maintenance, production optimization and historical analysis has been also installed; stand-alone IBA system is designed to easily interface with PLCs for high performance data acquisition, trend registration and database organization.

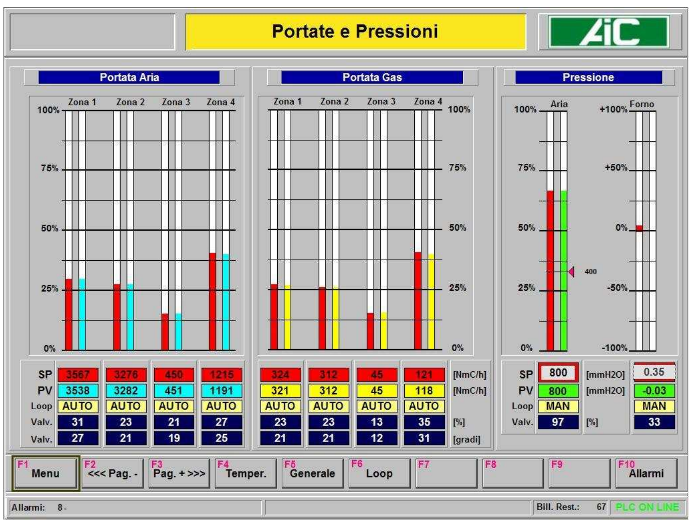

Fig. 18. Screenshot showing management and control of air/gas flow and pressure in the reheating furnace

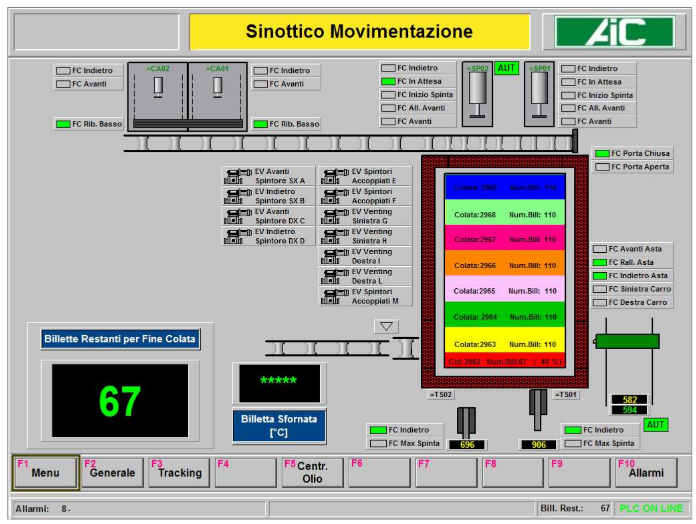

Fig. 19. Screenshot showing parameters of reheating furnace movement

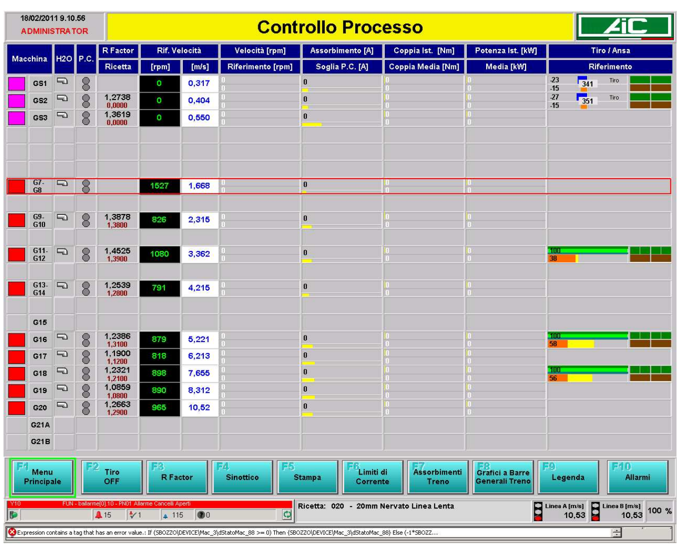

Fig. 20. Screenshot showing control process interface

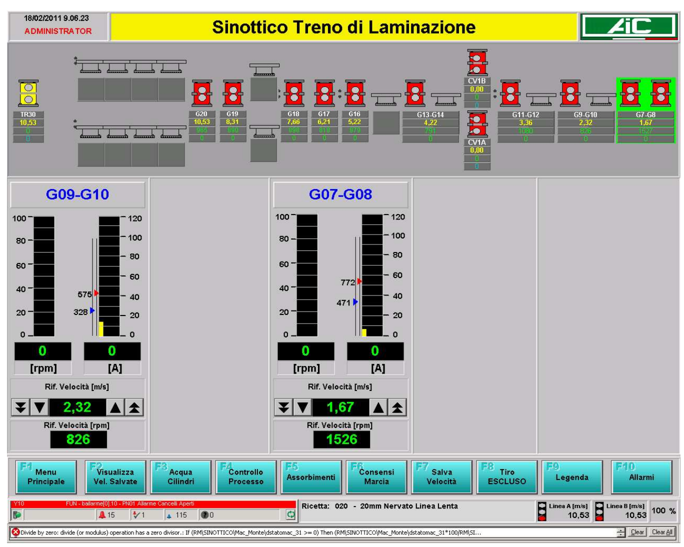

Fig. 21. Rolling mill synoptic and stands selected

Figure 22: PC Panel with client/server IT machines and CCVE digital recorder

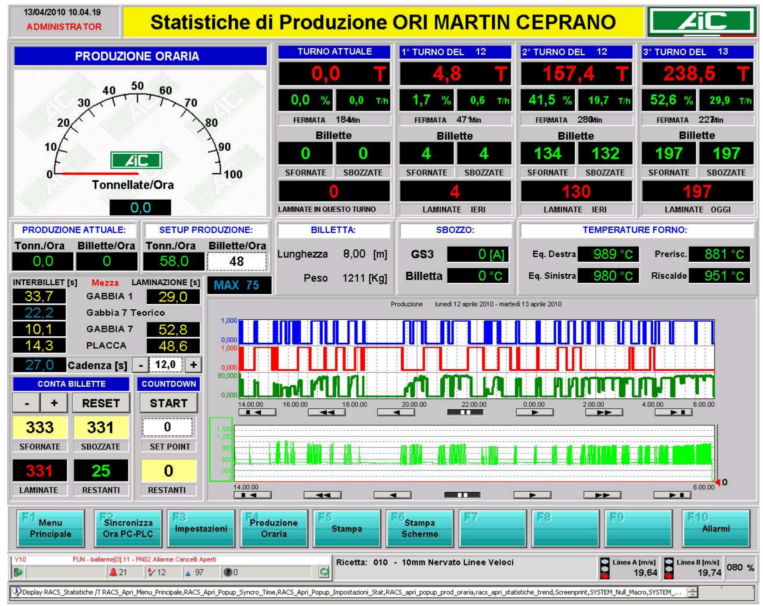

Figure 23: SCADA Screenshot showing production statistics in different shifts

CONCLUSIONS

ORI Martin – Ceprano reached the following results:

- Revamping tasks concluded in two phases planned during year maintenance shutdown, ensuring very minimal impact on production schedule;
- After only few months of speed line increase of 20% of rolling performances for Ø 8 – 12 (rolling speed from 18m/s up to 22 m/s);
- Increase of reliability and yield optimization;
- Standardized product range in quality and reduction of scrapped material due to the pre-optimization and optimization shear cutting strategy;
- Data Analyzer system helps the operators to work efficiently with quickly troubleshooting;
- Secure Remote Device Management allows the customer to be helped “on-demand” by the system integrator;
- CCVE and Safety system allows the operators to work safely.

The target of the project was achieved within the first year of production; this job confirms that a state of the art automation system, based on a long time experience and know how, can modernize an existing plant, ensuring reduction of productive costs increasing safety, efficiency and reliability.

ACKNOWLEDGMENTS

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