NEW PLATE MILL STAND WITH QUALITY PACKAGE AT CSC TAIWAN[1]

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Abstract

The 4,065mm Plate Mill in China Steel Corporation, Taiwan (CSC) underwent a major upgrade in 2003, when the existing finishing mill was replaced by a brand new one with attached vertical stand and heavy work roll bending. VAI CLECIM was awarded the supply of a Quality Package, including 1300 mm diameter hydraulic cylinders, technological control system and upgrade of the process model. The project was conducted in an extremely cooperative way and proved to be very successful, in terms of execution as well as attained performances. The added value of the project was measured from day one of commissioning, with improvements on several fronts: productivity (increased by 8%), yield (increased by 0.5%), quality (thickness deviation down to 20 microns), and rejection rate (decreased by 30%). Such gains were obtained thanks to innovative equipment and control systems supplied, as well a dedicated team, focused on customer value chain improvement.

Key words: Plate mill; Yield; Productivity; Process model.

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1 INTRODUCTION

The 4,065mm Plate Mill in China Steel Corporation, Taiwan (CSC) was equipped with a single stand finishing mill and started the production in February 1977. A renewal project was decided to replace the existing finishing mill by a brand-new one in 2002 due to a problem of cracks on drive-side mill housing.
In order to enhance the rolling capabilities and plate qualities, a 3-in-1 renewal project was organized to replace the stand, the main-drive motor and to add an attached edger.
After presenting the main features of the equipment installed, this paper will focus on the project implementation methodology and key benefits provided.

2 EQUIPMENT FEATURES

The table in Figure 1 summarizes the new horizontal mill and attached edger characteristics

	New Finishing Mill	New Edger
Max. rolling load	66 000 kN	4 500 kN
Max. rolling speed	5.2 m/s	
Housing weight	275 tons / piece	
Roll opening	500 mm	1100 ~ 4140 mm
Work roll diameter	1100 / 1020 mm	850 / 750 mm
Back-up roll diameter	1830 / 1680 mm	
Main-drive motor	2×AC 6000 KW at 40/100 rpm	2×AC 1000 KW at 290/725 rpm
Hydraulic cylinder diameter	2 x 1300 mm	4 x 420 mm
Hydraulic cylinder max speed	34 mm/s	100 mm/s
Work roll bender (WRB) force	3000 kN/chock	

Figure 1. New equipment characteristics.

Below are some additional features of the equipment:

- Each housing post area is larger than 10 000 cm².
- Some crucial parts of the housing are coated with stainless steel overlay to prevent corrosion.
- The maximum stress of screw nut corner under maximum load should be less than 10 kg/mm², and less than 8 kg/mm² for the other housing corners.
- Total necking of the housing at maximum load is less than 1.5 mm.
- The HGC cylinders have a diameter of 1 300 mm for a maximum total force of 72 000 kN.
- The design of twin servo valve for each cylinder was adapted to the Hydraulic Gap Control (HGC) system.
- The distance between the edger and stand was kept to a minimum of 3 775 mm.
- A motor base frame was mounted on the top of edger housings, two main-drive motors and two gear boxes were fixed horizontally on the motor base frame.
- The AC type of main-drive motors is used for both the horizontal stand and attached edger.

3 AUTOMATION SYSTEM

The Automatic Gauge Control (AGC) system of the former finishing mill, which includes the Level 2 set-up model (P.L.A.T.E.[7]) and Technological Control System (TCS), was supplied in 1983 by VAI CLECIM and operated with the plate thickness control package.
In 1986, it was supplemented with the plan view rolling function (hereafter called TruShape), which optimizes the plate rectangularity.
Within the framework of the 2002 plate mill revamping project, VAI CLECIM was awarded the key components for performance achievement in the form of a 'Quality Package', described here below:

4 QUALITY PACKAGE

Hydraulic cylinder

The horizontal mill cylinder, shown in figure 2, has a diameter of 1300mm and can develop 3600 tons. It is a VAI CLECIM design with centre mounted Sony Magnascale transducer, spherical thrust bearing. This high speed cylinder is driven by two 1000 litre servo-valves, providing the required flow for the TruShape corrections.

Figure 2. Hydraulic Cylinder

With its compact design, the cylinder is mounted at the bottom of the stand, between the housing and the backup roll chuck.

The spherical thrust bearing, shown on Figure 3, supports the axial forces applied to the cylinder while allowing the piston to follow the back-up roll chuck movements.

A second position transducer (LVDT[8] type) is mounted within the cylinder. This sensor provides a redundant position feedback, and is used for safety reasons.

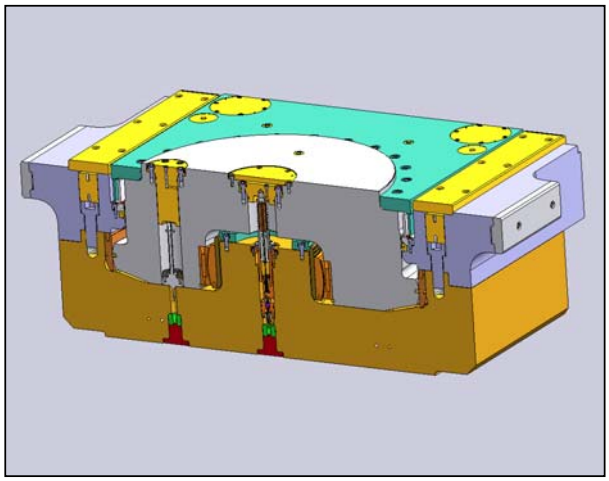

Figure 3. Hydraulic Cylinder.

[7] P.L.A.T.E. is a trademark of ARCELOR
[8] LVDT stands for Linear Variable Displacement Transducer

Technological Control System (TCS)

The TCS was upgraded with a new stretch model, the addition of a Work Roll Bending Control (WRBC) and an Automatic Width Control (AWC) for the Edger.

The AGC trims include gaugemeter loop, oil film compensation, oil compression correction and dynamic eccentricity control as shown in Figure 4.

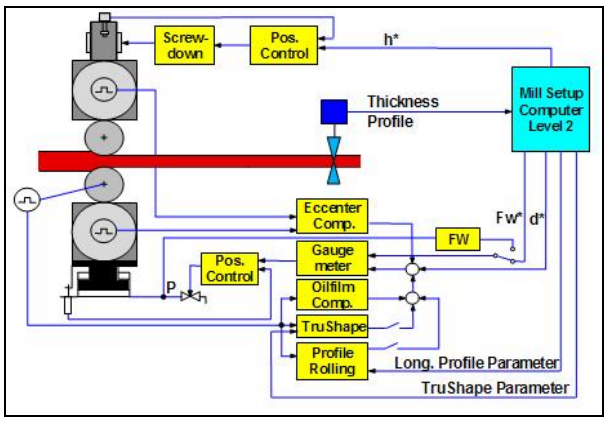

Figure 4. AGC Principle Diagram

Automatic Width Control (AWC)

AWC corrections include absolute width control and short stroke control (SSC) on head and tail of the product, with special non linear corrections.

Plate Mill Process Model

The process model underwent some significant changes in order to optimize the new equipment utilization ; main architecture is shown in Figure 5.

- Addition of an auto adaptive Edger model with corresponding rolling strategies
- Addition of a heavy bending pre-set strategy
- Replacement of the stretch and shape models.
- Upgrade of the roll thermal model

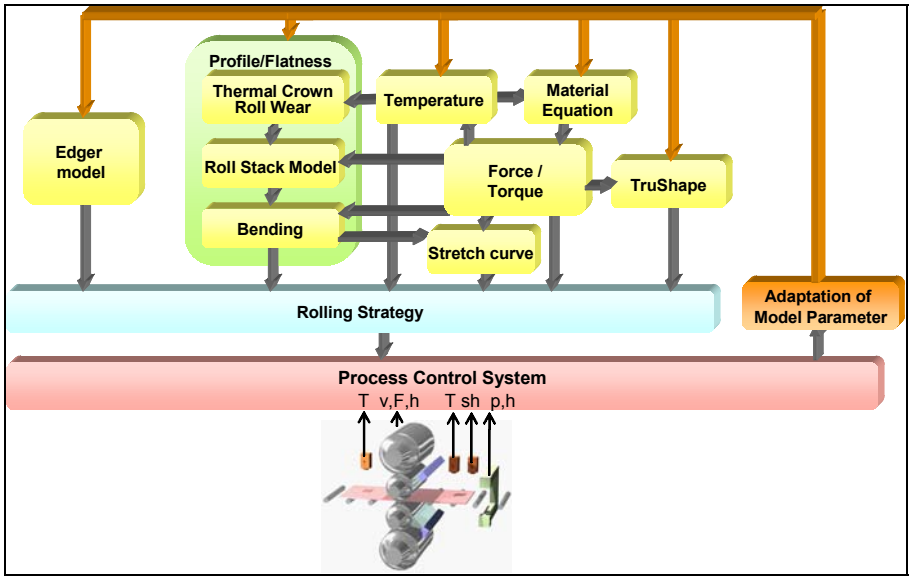

Figure 5. Process Model Architecture

The modernized Level 1 and Level 2 systems feature the following:

- The physical and metallurgical non-linear formulas together with the numerical analysis methods give the optimum pass schedule for horizontal rolling and vertical rolling which can reach the target of plate dimension in a minimum rolling time and without exceeding equipment constraints.
- The combination of horizontal stand Plan View Rolling (TruShape) and Edger AWC provide with excellent rectangularity control
- High Speed AGC with non linear mill stretch model ensures the optimum gauge performance and camber control.
- A full size Process Data Acquisition (PDA) stores all process parameters at high speed and provides very valuable information in a graphical format, for troubleshooting and further improvements on process control.

5 PROJECT METHODOLOGY

This section focuses on the project key success factors, in terms of project organization.

Team Work

This project was handled as a real team work from the first day. For instance, the Level 2 and Process Model part was designed in France with the participation of two CSC engineers, and then implemented on site, jointly with VAI CLECIM & CSC staff.

Commissioning preparation

To minimize the impact of reduced plate supply caused by the mill downtime, the construction work was split in two phases: the pre-shutdown and the main shutdown activities. The first phase, from November 2002 to September 2003, was carried out during mill production time or regular maintenance day, while the second phase took actually 48 days from October 7 to November 24 in 2003, as shown in figure 6 project schedule.

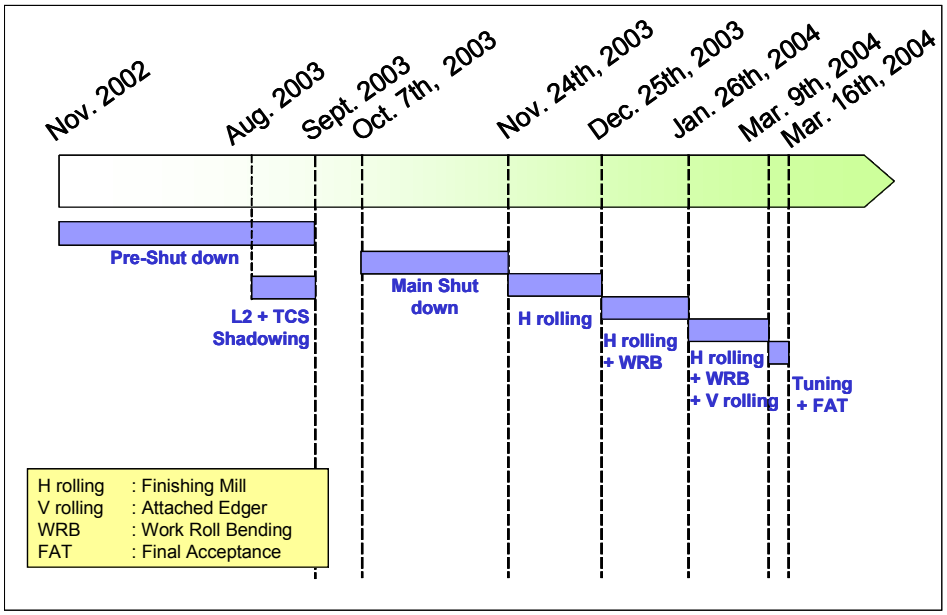

Figure 6. Project Schedule

In order to ease the hot commissioning, a pre-commissioning panel was introduced to provide the environment for off-line testing of the HGC, WRB, AGC, while the upgraded setup model was implemented on the Level 2 backup computer. All available active signals were wired in parallel to the TCS cabinets.
Then, during the weeks preceding the outage, both Level 1 and Level 2 systems were fully tested and validated in shadowing mode.

Commissioning

After the pre-commissioning, the hot commissioning of the new equipments was arranged as a three-stage hot run test.

- Stage 1: Simple horizontal rolling by 4-high finishing mill
- Stage 2: Horizontal rolling with WRB by 4-high finishing mill
- Stage 3: Horizontal rolling connected with vertical rolling by edger

Thanks to the above mentioned preparation work, the mill production was back to nominal production on **the fifth day** after the mill start.
The complete commissioning of the new plate mill took approximately three and a half months, and the final acceptance tests were completed in one week.

6 KEY BENEFITS

The main benefits for China Steel Corporation are described hereafter:

Productivity

The mill productivity was increased to 1,174,000 tpy after the quick ramp up shown in Figure 7.

This gain of **8%** comes not only from the mill power increase, but also from a fully automatic operation, together with an optimum presetting of the finishing mill.

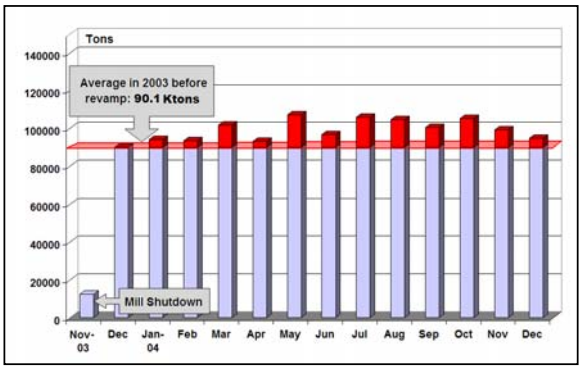

Figure 7. Productivity Ramp-up after shutdown

Yield

After the new system implementation, the yield went up to **92.7%**, as shown in Figure 8, i.e. an increase of **0,5%**. This increase comes from and enhanced rectangularity and accurate gauge control, achieved thanks to:

- TruShape on the horizontal mill, acting during the sizing and broad siding phases
- The Edger automatic width control during the thickness phase.
- Optimum gauge and crown control, with AGC & WRB, to minimize the difference between sold and achieved gauge.

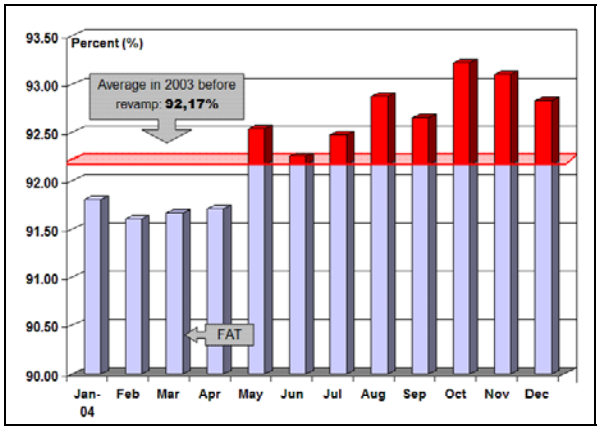

Figure 8. Yield (%) - 2004

Thickness and Flatness Quality

The combination of AGC and process model with accurate force and mill stretch prediction result in a reproducible accuracy in-bar and plate to plate as shown in Figure 9.

The heavy bending system, driven by the new shape model, and the optimum reduction schedule lead to excellent flatness results: **99.8% of the total production meets half tolerance of ASTM standard.**

Width (mm)	1500 to 1800	2100 to 2500	2700 to 3000	3200 to 4000
Thickness accuracy (µm)	39	36	63	91
Thickness uniformity (µm)	20	20	30	30

Figure 9. Thickness FAT performances (9 to 12 mm range)

Overall Rejection Rate

The combination of the excellent above mentioned performances reduced the rejection rate by **30%**, to an average of 0.21% as shown in Figure 10.

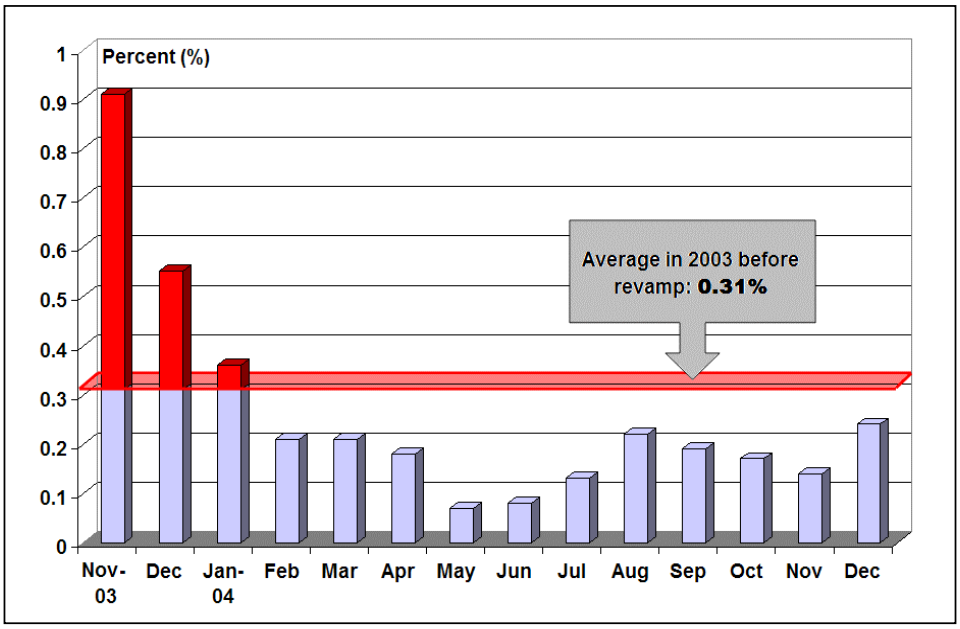

Figure 10. Rejection Rate (Mill Area)

7 CONCLUSION

The 2004 China Steel Corp. project illustrates very well the continuity of service provided by VAI Clecim, and the constant focus on quality and productivity improvement.
The success of this project also reminded us that miracles do not exist in our business! A successful project is the combination of several key factors:

- Innovative, while proven technical solutions, i.e. Quality Package
- Team spirit & mutual trust between customer and supplier
- Experienced & dedicated personnel
- Careful preparation of testing and commissioning phases

NOVO LAMINADOR DE CHAPAS GROSSAS COM PACOTE DE QUALIDADE NA CSC, TAIWAN[9]

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Resumo

O Laminador de Chapas Grossas de 4.065 mm da China Steel Corporation, Taiwan (CSC), passou por uma grande modernização em 2003, quando o laminador de acabamento existente foi substituído por um laminador inteiramente novo com cadeiras de laminação verticais e cilindros para trabalho pesado. A VAI CLECIM foi contratada para o fornecimento de um Pacote de Qualidade, incluindo cilindros hidráulicos com diâmetro de 1300 mm, sistema de controle tecnológico e modernização do modelo de processo. O Projeto foi implementado com uma abordagem extremamente cooperativa, tendo se mostrado muito bem sucedido em termos não só de execução, mas também de desempenho. O valor agregado do projeto foi medido desde o primeiro dia de comissionamento, com aperfeiçoamentos em várias áreas: produtividade (aumento de 8%), rendimento (aumento de 0,5%), qualidade (desvio de espessura reduzido para 20 microns) e taxa de rejeição (redução de 30%). Tais ganhos foram obtidos graças aos inovadores sistemas de controle e equipamentos fornecidos, bem como em função da equipe dedicada com um foco concentrado sobre a melhoria da cadeia de valor do cliente.

Palavras-chave: Laminador de chapas grossas; Rendimento; Produtividade; Modelo de processo

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[9] *42ª SEMINÁRIO SOBRE LAMINAÇÃO - Processos, Produtos Laminados e Produtos Revestidos – 25 a 28 de outubro de 2005, Santos– SP - Brasil*
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