LAMINAÇÃO - 2011
48º SEMINÁRIO DE LAMINAÇÃO
PROCESSOS E PRODUTOS LAMINADOS E REVESTIDOS
24 a 27 de outubro de 2011 — Santos - SP
ISSN 1983-4764

THE DANIELI SOLUTION FOR TAILOR-MADE COLD PLANT TO SUIT YOUR NEED – OVERVIEW OF THE 3 LATEST BRAND-NEW COLD PLANTS AT MARCEGAGLIA, ARVEDI AND MMK[1]

David Moxley[2]
Claude Bonaud[3]
Michele Turchetto[4]
Luciano Vignolo[5]

Abstract
The last 12 months has been an extremely busy time for the Danieli Wean United team as they have successfully commissioned four major cold rolling expansion projects in Europe. These have been for Arvedi and Marcegaglia in Italy and two for MMK Atakas production facilities in Turkey. The projects have included the latest technology covering every aspect of cold rolling and processing including both push/pull and continuous pickling, six new continuous galvanizing lines, a linked tandem mill, two 2-stand cold reversing mills and colour coating lines. The combined capacity of these lines is in excess of 3 million tonnes per year. This paper will highlight the reasoning behind the differing technologies adopted for each facility and how Danieli have developed a portfolio of products that recognise the individual needs of the steel producer.
Key words: Rolling; Galvanizing; Pickling; Coating.

SOLUÇÕES DANIELI PARA ATENDER NECESSIDADES ESPECÍFICAS EM LAMINAÇÃO A FRIO – INSTALAÇÕES DA MARCEGAGLIA,ARVEDI E MMK

Resumo
Os últimos 12 meses foram de intensa carga de trabalho para a equipe da Danieli Wean United, havendo comissionado com sucesso quarto importantes novos projetos de laminação a frio na Europa. Estas plantas foram instaladas na Arvedi e Marcegaglia na Itália e duas na MMK Atakas na Turquia. Os projetos contemplam as mais recentes tecnologias em laminação a frio e linhas de processamento, incluindo linhas de decapagem contínua e intermitente, seis novas linhas de galvanização contínua interligadas com laminadores Tandem mill, 2-cadeiras reversíveis de laminação a frio e linhas de revestimento e pintura. A capacidade combinada destas linhas novas é superior a 3 milhões de tonelada/ano. Este trabalho visa destacar as principais características e cada uma das diferentes tecnologias adotadas nestas instalações e mostrar como a Danieli desenvolveu sua linha de produtos para atender as demandas individuais de cada produtor de aço.
Palavras-chave: Laminação; Galvanização; Decapagem; Revestimento.

[1] *Technical contribution to the 48th Rolling Seminar – Processes, Rolled and Coated Products, October, 24th-27th, 2011, Santos, SP, Brazil.*
[2] *Technical Sales Manager, F.IMech.E, Danieli Davy Distington, UK.*
[3] *Executive Vice President, Danieli & C Officine Meccaniche S.p.A, Italy.*
[4] *Vice President Sales, Danieli & C Officine Meccaniche S.p.A., Italy.*
[5] *Vice President Technology, Danieli & C Officine Meccaniche S.p.A., Italy.*

ISSN 1983-4764

1 INTRODUCTION

1.1 The Cyclic Nature of the Steel Business

In economics, the term “pork cycle”,[1] is a model that describes cyclical supply and demand in a market where the amount produced must be chosen before prices are observed and is associated with long lead times between investment and return. It was first observed in livestock markets (hence the name) in the US by Mordecai Ezekiel and in Europe by the German scholar Arthur Hanau.[2] Producers' expectations about prices are assumed to be based on observations of previous prices and it explains why prices might be subject to periodic fluctuations in certain types of markets. The cyclical outcome in supply and demand predicted by this model is shown in Figure 1.

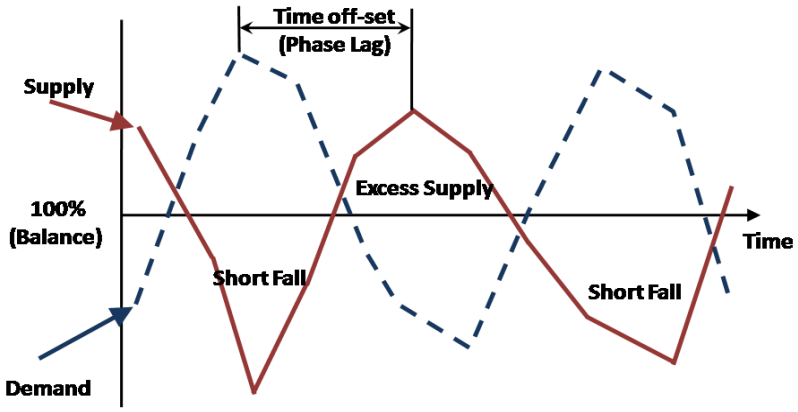

Figure 1. Cyclical economic model where an inherent delays occur in supply chain.

The model describes the inherent situation within the steel industry, where relatively long lead times for capital investment mean that producers need to predict market trends and prices years in advance of realizing returns. The resultant cyclical outcome can clearly be seen in the figure below which shows global steel price variation over a three year period.

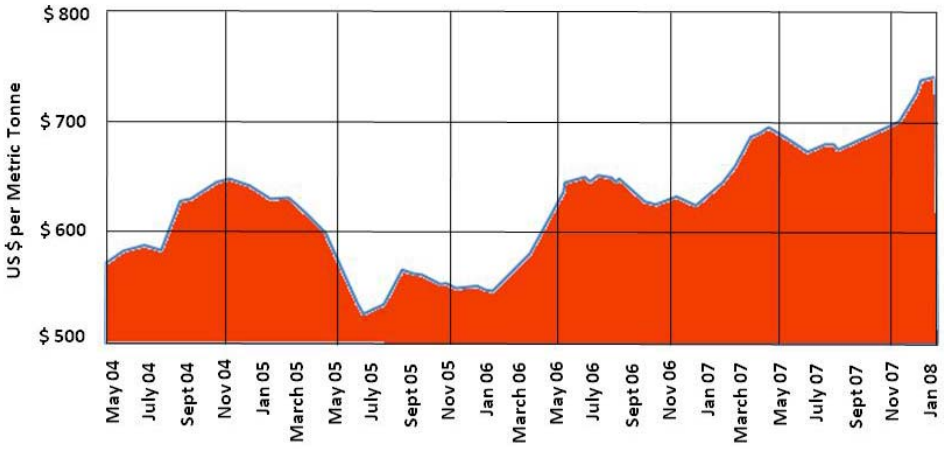

Figure 2. Steel price – source MEPS (International) Ltd.

ISSN 1983-4764

Clearly these Steel price fluctuations have a significant influence on producer profitability and the economic stability of the industry as a whole. The cyclical nature of the industry can be seen perfectly reflected in the stock index price of US Steel for the same period as shown in Figure 3.

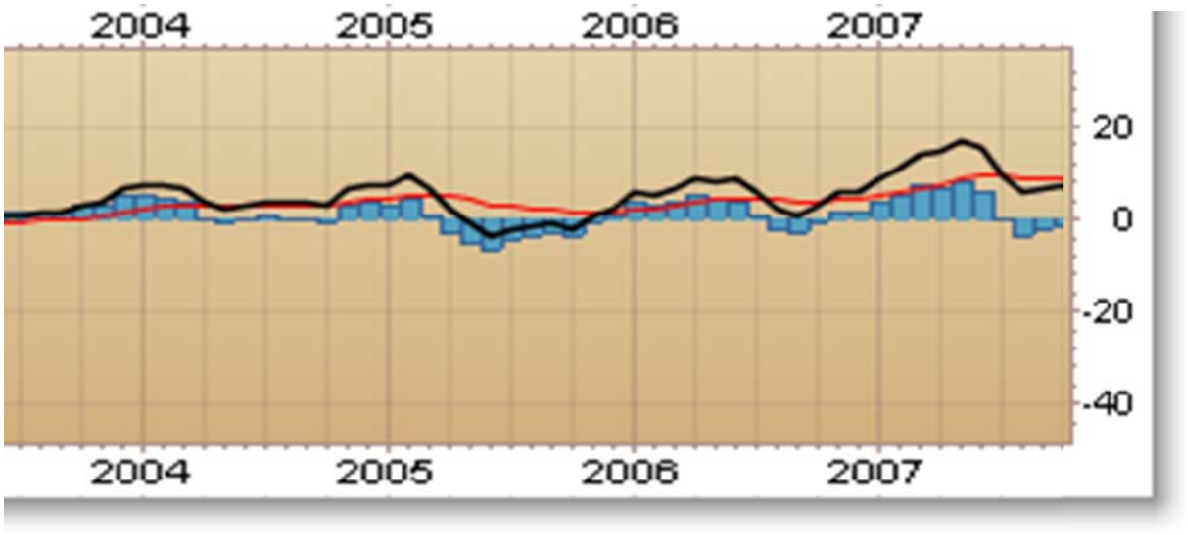

Figure 3. USX US Steel Group Inc Stock Prices NYSE@Stockcharts.com.

This inherent problem is further complicated by speculative investment in steel stocks making the correct choice of capital plant within the metallurgical sector a complex process. Added to which there is the choice of which technology to adopt and the return on investment calculations necessary to ensure a positive and profitable project.
Steel producers therefore face a great deal of uncertainty when trying to make the right choice in capital plant selection.

2 WHAT CAN EQUIPMENT OEM'S DO TO HELP REDUCE INVESTMENT RISK?

In recognizing these uncertainties in the metals market and the difficulty faced by steel producers when considering production expansion, Danieli have responded with a number of initiatives as summarized below;

2.1 In-House Manufacturing

Danieli have invested in a number of wholly owned manufacturing workshops around the world. Started in 2005, Danieli Far East is a fully-owned and directly managed company located in Rayong province (Thailand) with an area of over 200,000 m^2 for manufacture & assembly, employing over 2,000 people. Other major manufacturing centres are located at the head-quarters in Buttrio, Italy, and in both Shanghai & Beijing in China. These investments ensure total control over equipment build quality (often including significant pre-assembly) thereby minimizing site delays, and ensuring timely delivery to the end user.

ISSN 1983-4764

2.2 Full Portfolio of Engineering Solutions

Building on the significant library of references from the historical family of Danieli companies – including Wean and United – and order success in the last decade including 11 new pickle lines, 31 Cold Mill Stands and 25 Galvanizing lines, there is now an extensive catalogue of engineering solutions available. Using the very latest computer based engineering, employing both 2D and 3D design tools, enables flexible and rapid solutions meeting the individual client needs whilst retaining the shortest delivery times.

2.3 Research and Development

In parallel to the projects group, Danieli has maintained a high investment in R & D (€150 million in 2010) employing over 60 people, with a dedicated test facility, including both computer simulation and physical prototyping, at its headquarters in Italy. Recent work here includes, hydrodynamic modelling in metallic coating of strip, electro-magnetic systems, processing of high strength steels and flatness control in tension levelling.

2.4 Total Supply Capability

Danieli also offer a complete integrated package of products and services or “one-stop-shop” to ensure a seamless, fast and contractually simple project execution. This includes mechanical design, manufacture, electrics and automation and “full turnkey” installation services. This is further enhanced by a global network of local offices ensuring that production build up is as short as possible and after sales support is available in the same time zone and language.
The outcome of these initiatives is to be able to offer the steel producers tailor made solutions to enable them to bring product to the market in the shortest time. This should enable producers to respond faster to change and help break the cyclic behaviour of the market.

3 THREE RECENT SUCCESS STORIES

To validate the outcome of these initiatives we will now review three recent major expansion projects where Danieli Wean United was selected as the major process equipment contractor. Each has been successfully completed within the last 12 months and saw Danieli as the supplier for all the major process equipment including electrics and automation, annealing furnaces etc.

3.1 Marcegaglia

Marcegaglia, which is one of the most important galvanized coil producers in Europe, placed orders with Danieli for the following equipment at its plant located in Ravenna on the East Coast of Italy:

- one 2-stand reversing cold mill;
- two new galvanizing lines no. 3 & no. 4 (one for heavy gauge and the other for white goods with integrated colour coating section);

ISSN 1983-4764

- revamping of Danieli's CGL no. 2 with X-Jet Air Knives.

3.2 MMK- Atakas

This is a joint venture between MMK and the Turkish steel company Atakaş. The investment involved new equipment at two sites in Turkey.
One production facility is in Istanbul where the following equipment was supplied:

- one new galvanizing line;
- one colour coating line.

The other facility is a brand new steelmaking complex in the South of Turkey at Iskenderun, producing hot and cold-rolled steel, including galvanized and colour-coated steel. Danieli was responsible for all the major technological processing equipment including:

- melt shop (EAF, twin ladle furnace and vacuum de-gassing);
- thin slab caster;
- hot strip mill;
- continuous pickle line;
- double stand reversing cold mill;
- hot dip galvanizing line;
- colour coating line.

The Iskenderun plant, is built on an area of 500 acres, employs 2,500 people and produces 2.5 million tonnes of hot product, 1.2 million tonnes of pickled product, 1 million tonnes of cold rolled product, 900,000 tonnes of galvanized products, and 400,000 tonnes of colour coated products per year. The plant was officially opened on 9 March, 2011. On 26 May 2011 the cold mill ran at full speed (1,300 mpm) with an average shape error of 3.4 I-units.

3.3 ARVEDI

This project involved a major expansion to the rolling facilities of Arvedi at its Cremona facility in Northern Italy including:

- one push pull pickle line;
- one continuous pickle line;
- one three stand tandem cold mill;
- two galvanizing lines (no. 2 and no. 3).

The first coil through the PLTCM was rolled on 17 November 2011 and was of saleable quality.

4 CHOICE OF TECHNOLOGIES

4.1 Overview

Marcegaglia had sufficient pickling capacity for its planned expansion from two existing continuous pickle lines with a combined capacity of 2.5 million TPY. However MMK Atakas and Arvedi need to pickle the entire product destined for the new cold mills and also required additional pickled and oiled hot band for direct sale. The total pickle

ISSN 1983-4764

capacity for MMK was about 1.2 million TPY. This demanded the selection of a continuous pickle line with entry and exit horizontal loopers, incorporating 100 metres of Danieli's' ultra efficient Turboflow® pickle technology combined with a scale breaker and in-line turret head side trimmer operating at a maximum process section speed of 300 m/min. Arvedi had even higher demand for additional pickling capacity with 1 million TPY for cold rolled and an additional 1.25 million TPY for supply direct to the market. Two lines were therefore selected – one continuous line for high production volumes and one push-pull for smaller batch processing.

Now considering cold reduction requirements; Marcegaglia required 600,000 TPY and MMK Atakas 750,000 TPY. These capacities are ideally suited for two-stand reversing cold mills which were chosen for each of the projects. In addition to the excellent capacity match, the reversing mill benefits from high flexibility in production scheduling and faster reaction to order changes. Yield losses inherent with a stop-start batch type reversing mill process have been minimized through careful engineering of the mill layout reducing as much as possible the geometric length between reels (which is the parameter that mainly defines the out of gauge unrolled material). In contrast Arvedi required 1 million TPY cold rolling capacity and a three stand Tandem Mill was selected. Space has been included for the addition of future pickling and rolling capability providing expansion flexibility in the future.

Strip flatness and thickness tolerances of all three mills meet the latest European standards. The main benefit of the 2 stand reversing mill is good productivity, operational flexibility, fast commissioning learning curve and reduced operators compared with improved transformation efficiency at a capital and operating cost premium for the Tandem Mill.

For galvanizing, Marcegaglia has a broad market. It was therefore decided to supply two lines – one high capacity heavy gauge line (0.6 mm to 4 mm) with horizontal furnace producing 600,000 TPY of galvanized coils and one high speed thin gauge vertical line (0.25 mm to 1.5 mm) combining galvanizing and colour coating, producing 350,000 TPY. In contrast MMK Atakas had a market demand for 450,000 TPY of galvanized coil from both their Istanbul and Iskenderun plants so separate stand alone CGL's were selected for each site. For Arvedi the 700,000 TPY galvanizing product was split between two new 350,000 TPY lines – one with horizontal furnace more suited to heavy gauge and one with vertical furnace.

4.2 Combined or Stand Alone Colour Coat Line

Arvedi supply their entire galvanized product, uncoated, direct to the market whereas both MMK and Marcegaglia supply colour coated zinc plated sheet. However, even for these two plants, quite different technical solutions were chosen at the finishing end of the production route for colour coating.

Let us analyze the main differences between the two: MMK, being a start-up plant, needed to maintain short order flexibility and a separate colour coat facility was chosen as the optimum solution.

The Marcegaglia Ravenna site already has a standalone colour coat facility able to process small batches and special products therefore an integrated CGL/CCL was chosen to expand production capacity. In-line painting within the CGL is ideal for long production batches of standard products and offers the possibility to reduce production

ISSN 1983-4764

costs by minimising the number of operators, reducing coil handling time associated with transferring coils between processes and reducing inventory and coil storage requirements.
However combining metal and colour coating in the same line, as chosen for Marcegaglia, requires careful design considerations as listed below;
It is important to minimise process speed variations in a multi process CGL/CCL therefore a large entry accumulator (close to 3 minutes) is necessary in order to allow re-welding without slowdown.
Maximization of fibre usage in the DFF annealing furnace reduces the thermal inertia in order to enable flexibility in thermal cycles.
Efficient cleaning of the Skin Pass Mill is essential before passivation and painting. The painting section speed was designed to be able to run at the maximum metallic coating speed of 180 mpm. and this was combined with a high efficiency solvent removal and burning system and in-line paint thickness measurement system.
The drying oven must react as quickly as possible to strip speed changes and NIR was selected as the preferred technology for Paint Curing.
An automatic spool loading system was included on the Tension Reel to help minimize exit coil change over time.
Finally to enable total production flexibility the line has the possibility to quickly by-pass the painting section for galvanized only production.

5 PRODUCT DEVELOPMENTS APPLIED AT ARVEDI, MARCEGAGLIA & MMK PLANTS

As mentioned earlier Danieli have invested heavily in R&D and a number of new products were introduced on these new projects to improve productivity and product quality.

5.1 Danieli X-Jet Air Knife

All six new Galvanizing lines and the one revamp CGL associated with the reference projects use the Danieli Kohler Air Knife. This has undergone significant R&D aimed to initiate a completely new design of equipment. The project started in 2003 with the development of a fluid-dynamic model of the air flow inside the existing air knives plus a final zinc thickness prediction model. As a result the nozzles, lips and air knife beams were re-designed. The X-Jet Danieli Air Knife was further improved by the addition of closed loop control with the on line coating weight gauge.
The diagram below shows the average coating weight vs. line speed measured on a number of European HDGL lines represented by the blue dots. The production data from Marcegaglia line 2 before and after revamping is represented by red triangles, and the improvement can clearly be seen.
Variation is less than what can be achieved manually, and the figure also allows a target coating value that is closer to the production quality to be guaranteed in terms of grams of zinc – generating significant Zinc savings

ISSN 1983-4764

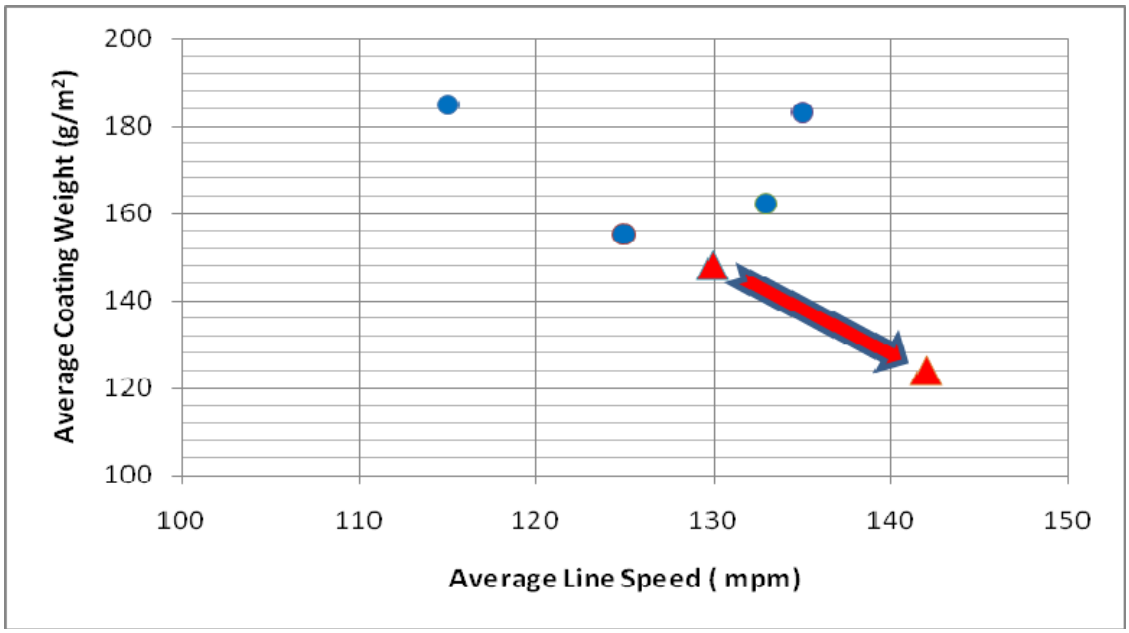

Figure 4. X- Jet Air Knife performance improvement – average yearly production data before and after revamping.

The new design strengthens the supporting beams of the knives, includes no-touch edge baffles with an optical sensor and allows easy adjustment of the knife width, whose high level of reliability has been proven during production.
The resultant line speed increase is 9%, and reduction in zinc coating weight of 15%. The overall benefit resulting in 8 to 14 months investment payback.

5.2 Danieli Robotic Pot Skimming

This new development has been installed at the Marcegaglia no. 2 line and, as a result of its success, is planned to be installed on all three other lines at the Ravenna plant in Italy.
The robot is designed to continuously remove the dross formed on the surface of the CGL zinc pot. It is a 6 axis machine with integrated control system and the main advantages are as follows;
A reduction in operator repetitive effort resulting in less strain injuries.
Better pot surface condition therefore improving zinc adherence on the strip.
A safer working environment with less risk of accidents associated with zinc splashing and operators in the pot area.
Significant reduction in zinc content in the dross which was between 90% to 95% using manual skimming.
Capability to move the skimming tool around obstacles, such as the zinc ingot loading system and furnace snout.
The robot has been working continuously three shifts per day since start up in February 2011 and Danieli is working on a future R & D program to include a vision based intelligent dross detection capability.

ISSN 1983-4764

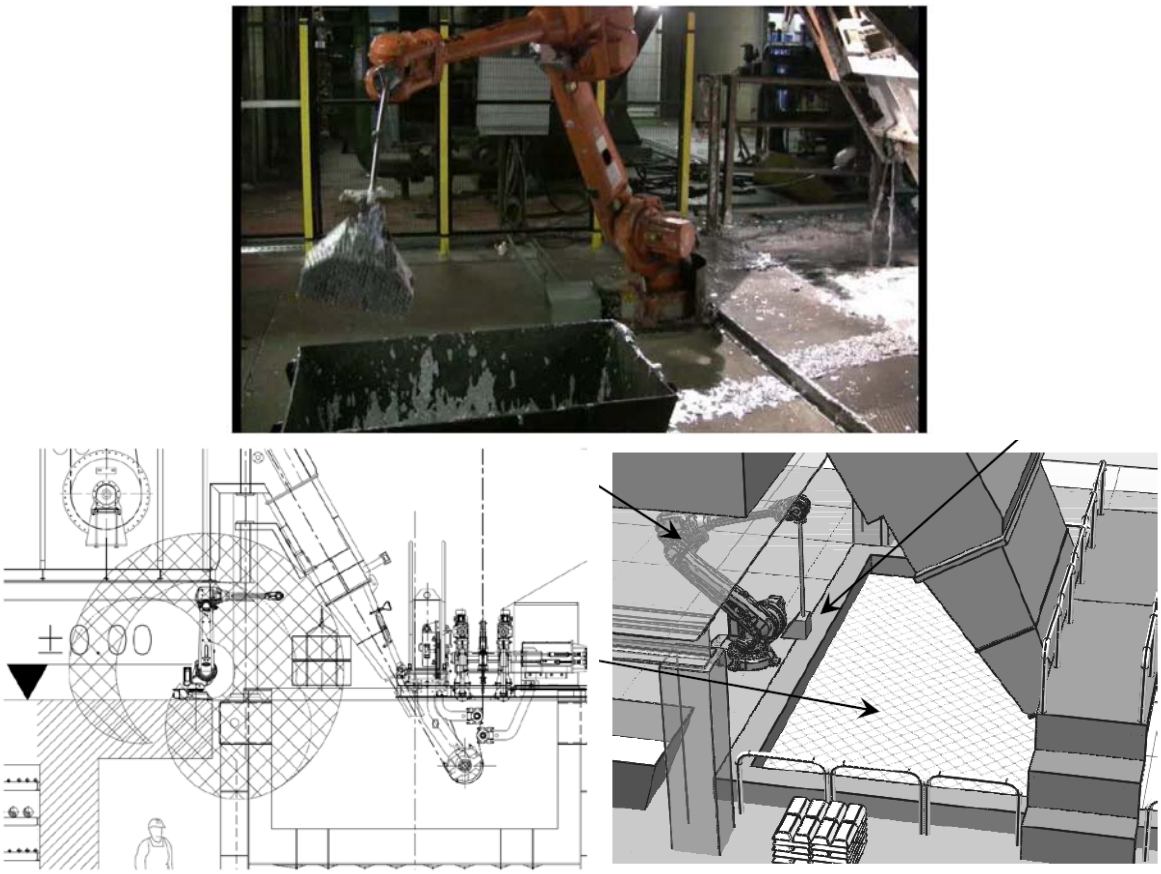

Figure 5. Danieli Dross Removal Robot.

5.3 Confined Strip Dryer

A common problem in cold rolling is the removal of water based emulsion after the last rolling stand. If not properly removed strip staining can then occur as a result of the reaction of water and oxygen particularly during the annealing process (Figure 6).
Coolant solution can reach the strip surface at the exit of the rolling stand through the following mechanisms:
Carryover on the strip edges, transfer from the work roll to the back-up roll surface and then sprayed as droplets due to roll rotation, droplets coming from the exit cobble guard, and droplets produced by condensation on above pass line equipment surfaces.
Danieli Wean United started with an R&D activity based on computational fluid dynamic analysis of the exit of the roll bite (Figure 7).

ISSN 1983-4764

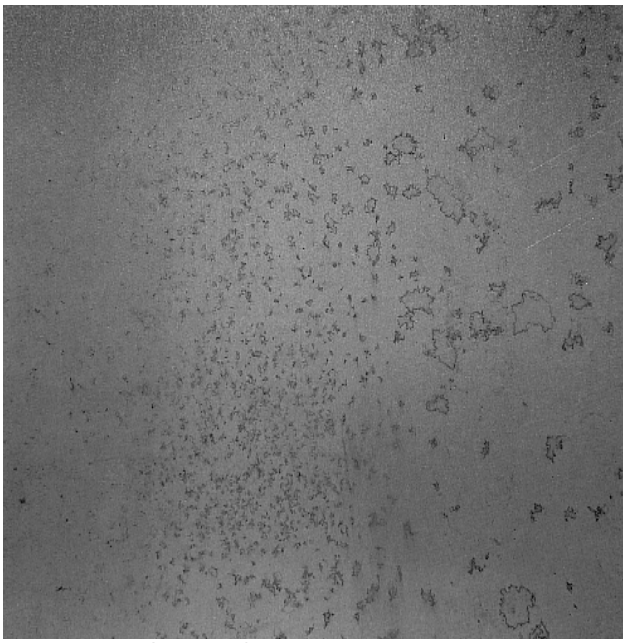

Figure 6.Stain defects on low carbon steel strip.

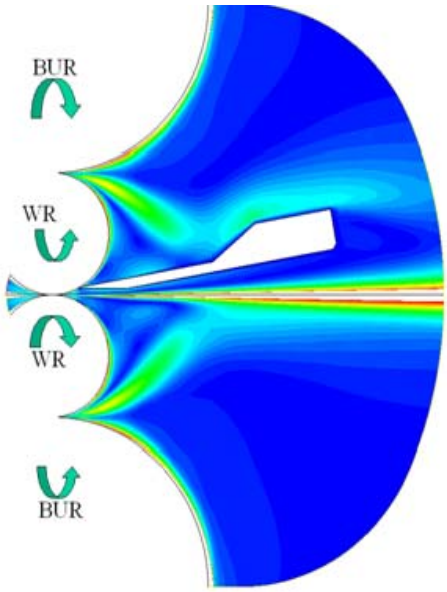

Figure 7. Computational analysis of the roll bite.

The outcome of the development was the Confined Strip Dryer which consists of a wiping system for both top and bottom strip surfaces that is able to apply high pressure and therefore a shear force 10 to 20 times greater in comparison to conventional nozzles, on the strip surface. The removed coolant is then exhausted. This system was included on both the 2 stand cold reversing mills at Marcegaglia and MMK Atakas and the Tandem Cold Mill for Arvedi.

The Arvedi Tandem Mill has operated since start-up in November 2010 without any strip staining and in some cases with the CSD being the only operating mechanism for coolant removal.

ISSN 1983-4764

6 CONCLUSIONS

The steel industry is subject to variations in product demand and price - some of which can be forecast, some associated with the inherent cyclical nature associated with long lead times in capital plant supply - and some purely driven by the vagaries of the global economy and stock market. Steel producers need to both try and anticipate these changes, and also accept an element of uncertainty, and build in flexibility to best respond to the sometimes unpredictable nature of the market.
Danieli, as a major global equipment supplier to the metals industry, has put in place a number of initiatives to help reduce this risk by providing a full portfolio of products with the most flexibility recognizing that “one size doesn’t fit all”. This has been achieved by investing in product development, engineering design, having a large portfolio of equipment design solutions, and offering a fully integrated in-house capability for mechanical, electrical, automation and manufacture. This paper demonstrates that applying this approach at three major quality steel producers in Europe, has resulted in flexible, low cost operations well matched to the future flat rolled carbon steel market.

REFERENCES

1 ROSEN, SHERWIN; MURPHY, KEVIN; SCHEINKMAN, JOSE (1994), "Cattle cycles", Journal of Political Economy 102 (3)
2 ARTHUR HANAU, “*The forecast price of pigs”*, 1928.