WEEKLY PLANNING - HOT STRIP MILL AM TUBARÃO *

Nayara Neves Coutinho[1]
Jovanir Francisqueto[2]
Marco Túlio Costa[3]
José Fagundes[4]

Abstract
The purpose of this project is to increase the visibility of which will be daily produced on the hot strip mill (HSM). The forecast was performed through the implementation of an automated tool for weekly HSM production planning. The project was started with the definition of the weekly planning process, through the determination of the main business objectives, like as: priorities of service (customers and delivery date), definition of HSM's rules and restrictions of operating resources. Using a sophisticated mathematical model, through the computational simulation is possible the experimentation of various production scenarios, allowing the visualization of volumes by type of sequence, clients / priorities, mix to be produced, cylinder change quantity forecast, better forecasting of the productivity of the HSM, consumption of utilities, within others. Main benefits: sequencing which production orders should be produced, reducing unforeseen stops due lack of material, improving the quality of the stock which allows the reduction of the aging of slabs in the slabyard and the vision of customer services. Computational simulation as a weekly planning tool achieve, with other benefits, to present alternatives for better decision making.
Keywords: Planning, HSM, Simulation.

[1] *Engenheira Produção, Especialista em Desenho Integrado de Processos, Gerência de Desenho Integrado de Processos, ArcelorMittal Tubarão, Vitória, ES, Brasil.*
[2] *Engenheiro Metalúrgico, Mestre Eng. de Produção, Especialista em Desenho Integrado de Processos, Gerência de Desenho Integrado de Processos, ArcelorMittal Tubarão, Vitória, ES, Brasil.*
[3] *Sistemas de informação, Especialista de programação de produção, Gerência de Área programação da produção, ArcelorMittal Tubarão, Vitória, ES, Brasil.*
[4] *Engenheiro Metalúrgico, M.Sc., Especialista de Desenvolvimento de Processo e Modelamento, Gerência de Área de Confiabilidade de Produção de Bobinas, ArcelorMittal Tubarão, Vitória, ES, Brasil.*

** Technical contribution to the 56º Seminário de Laminação e Conformação de Metais, part of the ABM Week 2019, October 1st-3rd, 2019, São Paulo, SP, Brazil.*

1 INTRODUCTION

The demand for improving the efficiency and effectiveness of services and products has become a priority for organizations, the need for innovation in processes and the search for a competitive differential has been a great challenge for companies. It is in this business context that ArcelorMittal Tubarão started the process implementation project and computerized tool to perform HSM weekly sequencing integrated with the Steel Shop. The main objective is to raise the visibility of programming (from 1 shift to 7 days) and consequently anticipate decision making.

Chiavenato (2008) explains that for companies to achieve their objectives and properly apply their resources, they need to plan and efficiently control their production. According to Tubino (2017), the system to be used for planning, scheduling and production control should allow a view of the planning horizon, answer the questions such as: what, when and where, allow the processing of manufacturing environments (Make To Order, Make To stock and others) and to present elements necessary for the operation.

For Slack (1999), planning is the formalization of what must happen in some future time, a plan based on expectations that do not always occur as expected - for example, a machine may break down, suppliers may not deliver on time, or customers may change of ideas, which may mean that plans must be redone. This process of dealing with this change is known as control.

ArcelorMittal Tubarão is a flat steel production unit with an annual production capacity of 7.5 million tons of sheet steel and hot rolled coils. It is the 3rd largest Brazilian producer of rolled steel and is part of the ArcelorMittal Group, the world's largest steel producer. In order to maximize the return to the business and optimize the weekly sequencing process of the Hot Strip Mill integrated with the Steel Shop, the project was phased in two stages: the first phase basically consists of implementing the process and the computerized tool for HSM's weekly planning. However, step 2 of the study consists of:

- Define modus operandi of the new integrated weekly planning process HSM and steel shop;
- Raise new needs and redefine information needed for integrated planning (inputs and outputs - until steel shop scheduling);
- Redefine criteria and parameters for weekly planning;
- Calibrate the optimizer of the tool to improve results (Tuning);
- Create reports (with HSM's and Steel Shop's vision) to support the weekly planning process.

Currently, the project is in the phase 1 commissioning stage. The area responsible for production planning uses the tool to weekly production planning of the HSM. In parallel, small system improvements and fine-tuning adjustments are being made.

1.2 General concepts

According to Laugeni (2015), production planning, scheduling and control is an information system, which must always be available, up to date (for the customer and for the factory floor) and directly linked to the company's stategy.

For Corrêa, Gianesi and Caon (2019), the planning process must be continuous, always one must have the vision of the present and the future, as well as have the notion of the elements that affect the decisions that must be made in the present. It summarizes the planning dynamics in the following five topics:

- Raise the current situation that are the activities and resources, ie, photograph the vision of the present;
- Develop and consider the vision of the future so that it can influence the decision process;
- To deal together with the vision of the present and the future, for better decision-making;
- Managerial decision-making, in this stage the questions will be answered: what, how much and when to produce;
- Execute the plan. At this stage some things may not occur as planned, so it is a good practice to revisit the vision of the present and begin the process by going back to step 1.

According to Tubino (2019), the planning horizon is usually classified into three levels: long, medium and short term, the process that addresses the latter is called plant floor scheduling. According to Slack (1999), sequencing is the activity where one must make the decision on the order that the tasks will be executed, given the priorities established by a set of rules.

2 MATERIAL AND METHODS

The first stage of the project is the implementation of the computerized tool for HSM's weekly planning. For this, the premises and restrictions of the process were raised, the need to revise the sequencing pattern and to define the necessary data (inputs and outputs) to accomplish the weekly plan was also identified. In addition, the management and operational reporting requirements / KPIs required to monitor the weekly plan were mapped.

2.1 Weekly planning and optimization system

Currently the preparation of the HSM's daily sequence is done by a specialized system of production sequencing. The first step was to define the planning horizon and rules to be followed in each planning period (daily and weekly).

In the weekly planning process, the system uses more flexible slab-to-slab sequencing rules, more detailed scheduling must be performed by daily planning. Weekly scheduling defines the types of rolling instruction (for example: wide material instruction) and allocates orders / slabs to instructions, noting:

- Flow restrictions - external and internal market material etc.;
- Basic instruction constraints - maximum and minimum sequence size etc.;
- Calendar constraints - stops, start and end times.

The main premises and restrictions were also raised to carry out the weekly planning:

- The planning can be done at least once a week, and for each need identified by the areas, it should be revised (new round) - This definition is in the area of production planning and scheduling;
- Revision of the database, adjustments to the expected date of slab availability to allow for the projection of inventories and projection of hot charge;
- The date and time of slab availability for the HSM is a basic requirement for sequencing;
- Definition by group about the rules to be adopted in the tool (optimizer). Example: Use the same rules of daily sequencing;

- Reports with programming and operations view, to verify compliance with the requirements.

After defining the planning horizon, sequencing rules, premises and constraints, the system receives as input:

- Real slabs, those that are physically in the HSM or conditioning yard;
- Forecast slabs, those that have been programmed in the steel shop;
- Virtual Slabs, those that were created from the order book.

The sequencer must configure the system with the weekly requirements, such as programmed stops, material production flow, constraints, daily production rhythms for internal / external market and priorities.

As output the system provides the weekly plan and several reports for management and operational monitoring. They are released weekly by the production planning area for the interface areas. The reports have the detailing of the plan for the week, as well as the completion of the previous week's planning. In short, the system is a simulator of what will happen to HSM the following week.

Weekly Planning Process

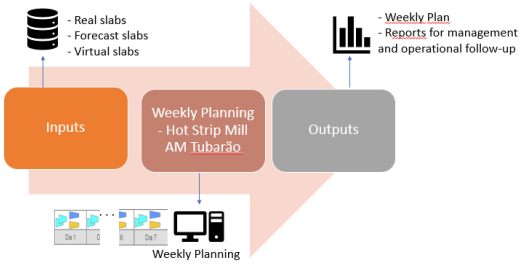

Figure 1. Weekly Planning Process.

According to Figure 1, after the inputs are loaded into the system, the programmer sets the tool with weekly guidelines and runs the optimizer to generate the best solution. Then it analyzes the result, being able to accept the system proposal, make punctual changes manually or go back to the configuration step to generate a new scenario simulation. After completing the analysis and obtaining the final scenario, the sequencer releases the HSM's weekly plan to the interface areas.

Another feature of the system is that it also allows to follow through a Gantt chart the distribution of the material by any selected characteristic (example: material with coil thickness <= 3,00 mm), also presents the type of rolling instruction, programmed stops, size and volume of each sequence.

An important report that is released weekly is an excel spreadsheet containing the characteristics of the order / material to be produced that week. You can also check in the charts available in the tool, the forecast of the volume of material to be produced in the week by any characteristic of the material or the order book, according to figures 2, 3 and 4:

Expected material for finishing lines (after HSM);

		Route_LA	Route_LT	Route_LA_LT	NO_Rota
	2721	311	262	0	2148
Between 2.50-3.50mm	811	136	62		613
Between 3.51-4.50mm	623	25	60		538
Between 4.51-5.50mm	357	17	16		324
Between 5.51-6.50mm	236	6	45		185
Between 6.51-7.50mm	24		1		23

Figure 2. Finishing Lines.

Material distributed by width and thickness;

		Between 800-1000mm	Between 1001-1200mm	Between 1201-1400mm	Between 1401-1600mm	Between 1601-1800mm
	27210	5950	10580	7040	3070	360
Between 2.50-3.50mm	8110	2580	2690	1540	1140	150
Between 3.51-4.50mm	6230	870	2440	1970	690	150
Between 4.51-5.50mm	3570	500	1210	1450	300	30
Between 5.51-6.50mm	2360	410	1410	190	310	10
Between 6.51-7.50mm	240		230	10		

Figure 3. Width and thickness.

Mix of material

		Low_Carbon	Ultra_Low_Carbon	HSLA
	27210	10170	3710	13330
Between 2.50-3.50mm	8110	2500	2310	3300
Between 3.51-4.50mm	6230	2010	640	3580
Between 4.51-5.50mm	3570	1490	570	1510
Between 5.51-6.50mm	2360	590	170	1600
Between 6.51-7.50mm	240	120		120

Figure 4. Mix of material.

The entire weekly planning process in the system lasts around 1: 40h. The first step

of the process is to generate the inputs, this step lasts about 1h. Already the step of giving the weekly guidelines, lasts around 30 minutes. This is one of the most important activities of the process and should be done with the utmost attention. In this activity the sequencer tells the system which path to follow. After setting the guidelines, the tool takes about 3 minutes to generate the weekly schedule (run the optimizer).

3 RESULTS AND DISCUSSION

As soon as the weekly plan is implemented, the production planning area generates the KPIs responsible for monitoring the achievement of the plan, as follows:

- Individual Achievement: Produced Weight / Actual Planned Weight. The maximum value of achievement is 100%.
- Total achievement: average of individual achievement.

The main result was the elevation of the HSM's programming view from 30h to 4 days with the achievement of> 70% of the planned instructions, according to figure 5.

Achievement of Weekly Planning

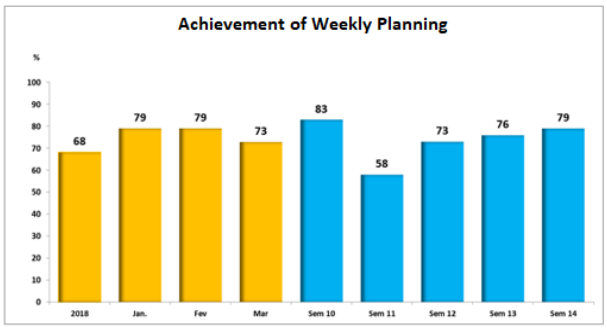

Figure 5. Achievement of Weekly Planning.

In addition, the area of production planning acts correctively over the main reasons for not achieving the plan. As for example, identify and evaluate the main causes that impacted the achievement.

Other non-quantified benefits were also mapped:

• Allows visibility at the HSM and generates information to prioritize the need to release sales orders;
• Generates the needs for steel shop in the week (per day);
• Support for prediction of hot charge and increase of instruction size in HSM;
• Visibility of stops not foreseen due to lack of material in the HSM;
• Estimation of the HSM's productivity and consumption of utilities in the week;
• Better distribution and visibility of critical material in the sequences;
• More assertive decision making.

4 CONCLUSION

The system presented satisfactory results in achieving the weekly planning, with an increase in the scheduling vision of the mill from 30h to 4 days, achieving> 70% of planned instructions. Weekly planning in the tool made it possible to use resources efficiently and clearly in obtaining the resources needed to achieve the objectives. Another advantage of the system is the ability to simulate different scenarios (different configurations) until the best result is achieved, with a high potential for increasing the size of the mill sequence, reducing the intermediate stock, increasing the percentage of hot charge and integration with the scheduling of the steel shop.

REFERENCES

1 CHIAVENATO, Idalberto. Planejamento e controle da produção. São Paulo, Manole Ltda, 2008.
2 TUBINO, Dalvio Ferrari. Planejamento e controle da produção: teoria e prática. São Paulo: Atlas, 2017.
3 Slack, N et al. Administração da Produção. São Paulo, Atlas; 1999.
4 LAUGENI, Fernando P.; MARTINS, Petrônio Garcia. Administração da Produção. São Paulo: Saraiva, 2015.

5 CORRÊA, Henrique Luiz ; GIANESI, Irineu Gustavo Nogueira; CAON, Mauro. Planejamento, Programação e Controle da Produção. São Paulo: Atlas, 2019. E-book.