SIMULATION AND OPTIMIZATION OF PROCESSES TECHNOLOGY FOR BRAZILIAN STEELMAKING: COMPANIES THAT ARE ALREADY USING IT & PANEL OF THE POTENTIAL BENEFITS[1]

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Abstract

Conception on the simulation and optimization technologies for industrial processes applied in the steelmaking environment: tools and methodologies. Clarifications provided about the differences of these techniques when compared to other analysis options (intuition, use of static spreadsheets, etc.). Presentation of practical cases: Simara, Vallourec&Mannesmann, etc. These projects have been individually presented in technical congresses at ABM and Belge, known as Innovation Congress (international congress specialized in simulation and forecasting technologies). Here they will be shown in a board of diversified applications of this technology in Brasilian companies. They will be well illustrated through models of dynamic simulation of these steelmaking, each one with its set of objectives, scopes and gotten results (for example: production increase; identification of bottlenecks; economy to avoid the purchase of badly dimensioned or unnecessary equipments; consolidation of projects and approval of investments in expansions; improvements in production programming, etc.).

Key words: Steelmaking; Processes; Simulation; Optimization.

TECNOLOGIA DE SIMULAÇÃO E OTIMIZAÇÃO DE PROCESSOS EM ACIARIAS BRASILEIRAS: EMPRESAS QUE JÁ ESTÃO UTILIZANDO E PAINEL DOS BENEFÍCIOS POTENCIAIS

Resumo

Conceituação sobre as tecnologias de simulação e otimização de processos industriais aplicada no ambiente de aciarias: ferramentas e metodologias envolvidas. Esclarecimentos acerca do diferencial destas técnicas quando confrontadas com abordagens menos quantitativas (intuição, uso de planilhas eletrônicas estáticas, etc.). Apresentação de casos práticos: Simara, Vallourec&Mannesmann, entre outros. Estes projetos foram apresentados individualmente em congressos técnicos da ABM e da Belge, chamado Innovation (congresso internacional especializado em tecnologias de simulação e forecasting), realizados no Brasil e aqui serão mostrados na forma de um painel de aplicações diversificadas desta tecnologia em siderúrgicas nacionais. Serão bem ilustrados através de modelos de simulação dinâmica destas aciarias, cada um com seu conjunto de objetivos; escopo e resultados obtidos (por exemplo: aumento de produção; identificação de gargalos; economia ao se evitar compra de equipamentos mal dimensionados ou desnecessários; consolidação de projetos e aprovação de investimentos em expansões; melhorias na programação de produção etc.).

Palavras-chave: Aciaria; Processos; Simulação; Otimização.

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1 INTRODUCTION

Several steel industries in Brazil have used simulation technology in their production and / or logistic processes focusing cost reduction in its production chain, especially in the steelmaking area. Until very recent days, methods used to estimate the possible reductions were intuition, spreadsheets and others, often with crude approximations and without good results. The processes in the steelmaking are complex. They depend on each other for their progress and must also be very well synchronized to minimize production interruptions. The simulation technology is the best tool to play in computers and analyze them in various scenarios, as we shall see below.

The works that will be exposed here were developed by engineers of Belge Engenharia e Simulação with steel companies. They were individually presented in technical conferences at ABM and at Belge, known as Innovation Congress (international congress specialized in simulation and forecasting technologies). Here they will be shown in a board of diversified applications of this technology in Brazilian companies.

2 MATERIALS AND METHODS

Simulation is a technology that allows you to run your company (entirely or partially) in a computer model. There are configured and tested alternative scenarios with different demands, quantities of resources, layouts and systematic targeting aiming on obtaining maximum productivity.

Today there are good tools to create a model and simulate various scenarios. Let's stick to the software of simulation ProModel, from an American company, leader in this field. ProModel is the most appropriate tool for this type of application because its use is very friendly (which requires less programming complex) and has a specific module for modeling of cranes, which is a vital application in steelmaking.

As the operation of a steelmaking plant involves great complexity and interdependence between the events, it is very difficult to analyze all possibilities in a static spreadsheet. Also, in a spreadsheet we use medium values for studies of planning, and discard the effect of variability over time. This approach can lead to disastrous conclusions.

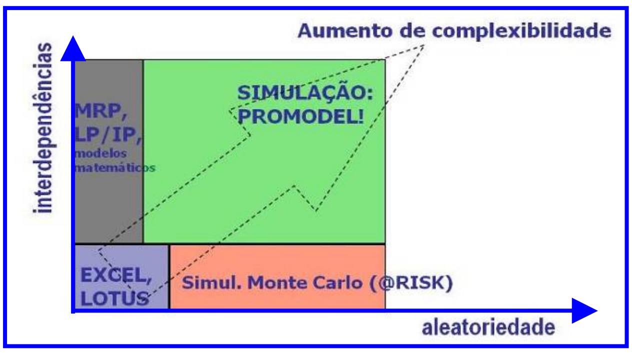

Figure 1. When simulate?

In the analysis with dynamic simulation, it is possible to examine the effects of various interactions between positions and resources over the time, also considering the probabilistic effects on the occurrence of events, its frequency and its duration.

So, you can see the effect of broken equipment, as a crane, a delay of operation, changing the sequencing of production, etc.

3 PRESENTATION OF PRACTICAL CASES

We will introduce below some practical cases of simulation in steelmaking developed for the enterprises: Simara, Vallourec and Mannesmann and other 2 national companies. There have been created dynamic simulation models of these steelmakings, each one with a set of objectives, scope and results.
Normally in a simulation project we have several parameters in an data entry spreadsheet and its values are defined for a simulation scenario. The model then simulates that scenario and provides the results in charts or tables, as outline in Figure 2.

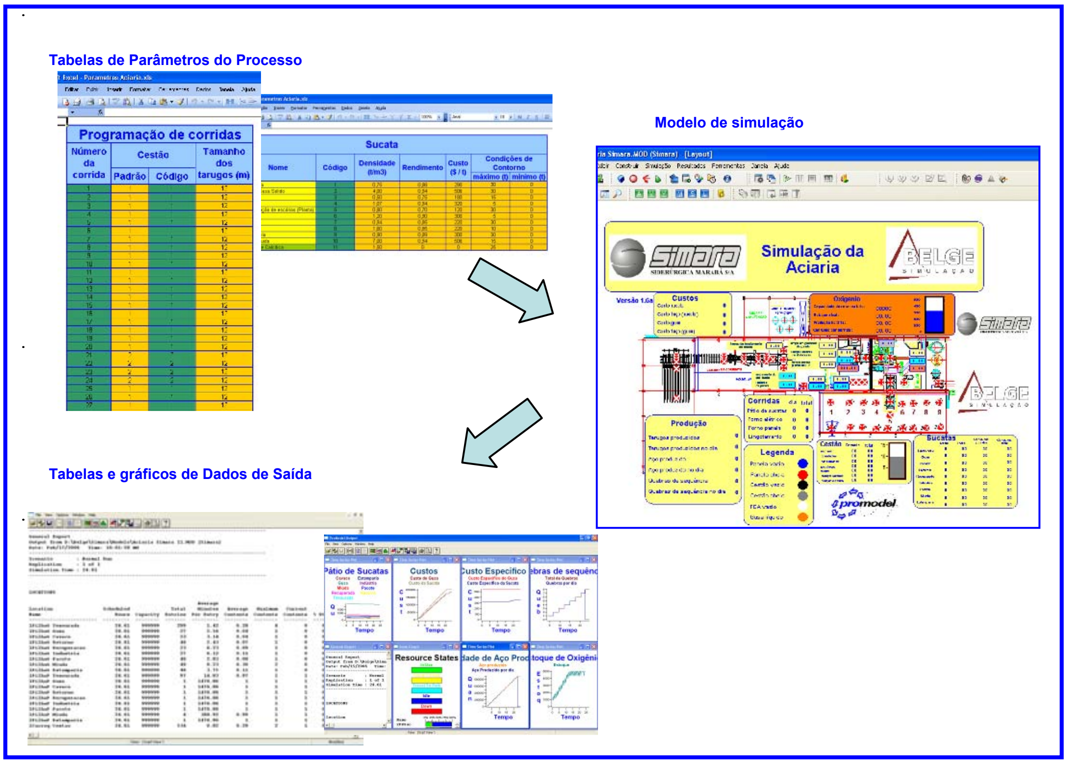

Figure 2. Components of a simulation project

3.1 Siderúrgica Marabá – SIMARA

3.1.1 Objectives
Development of a simulation model for a new steelmaking aiming at identifying possible bottlenecks, idleness and indicate the production result to be expected, by changing the parameters and equipment of the production process. Assisting in the analysis of the main interference in the steelmaking area, creating conditions for making a decision based on alternatives that make the system viable, if detected a bottleneck.

3.1.2 Scope
The model covers from the withdrawal area of scrap up to the exit of the products from the continuous casting process. All stages of the process have parameters (capacity, procedure times, interval between events and others), which can be

changed through specific spreadsheets, according to the needs of the user. General parameters can be changed by the user, such as the pattern of each big basket in each race. We considered all transport (cranes and car carriers) that moves big basket and pans through each step of the process, and its speed and capabilities.

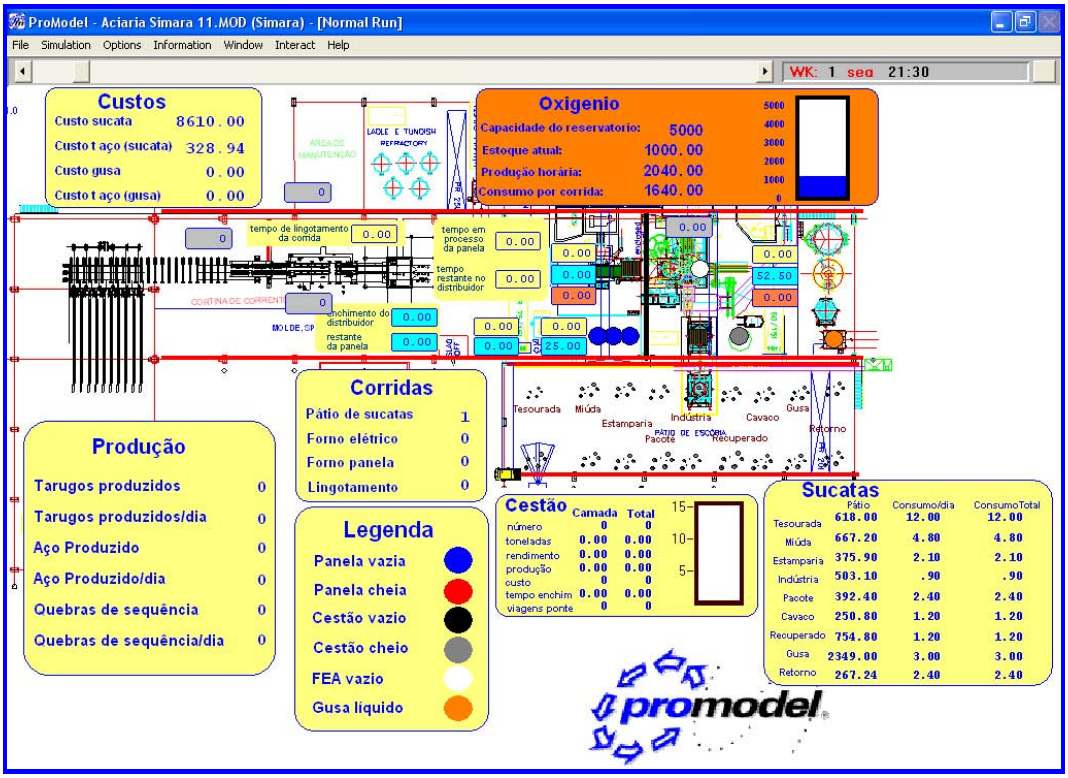

Figure 3. Simulation model of Simara steelmaking

3.1.3 Results

After the simulation, the model presents an output of results for analysis. Here we have information on cost, productivity, the timing of the steelmaking and other data that are relevant for optimization of the process. Each set of parameters, which define a scenario, provides a result that allows Simara to assess whether all that set is appropriate for achieving certain production and the costs involved.

3.2 Enterprise X

3.2.1 Objectives

Development of a simulation model for the steelmaking area to identify any bottlenecks for various scenarios. Change up the parameters and / or equipment of the process to enable the production to a level pre-seted.

3.2.2 Scope

The model to simulate the steelmaking area includes the production of billets from the shipment of scrap in big baskets, with the necessary trimming, up to the removal of billets by continuous casting through the bed of cooling and their transport to a deposit area.

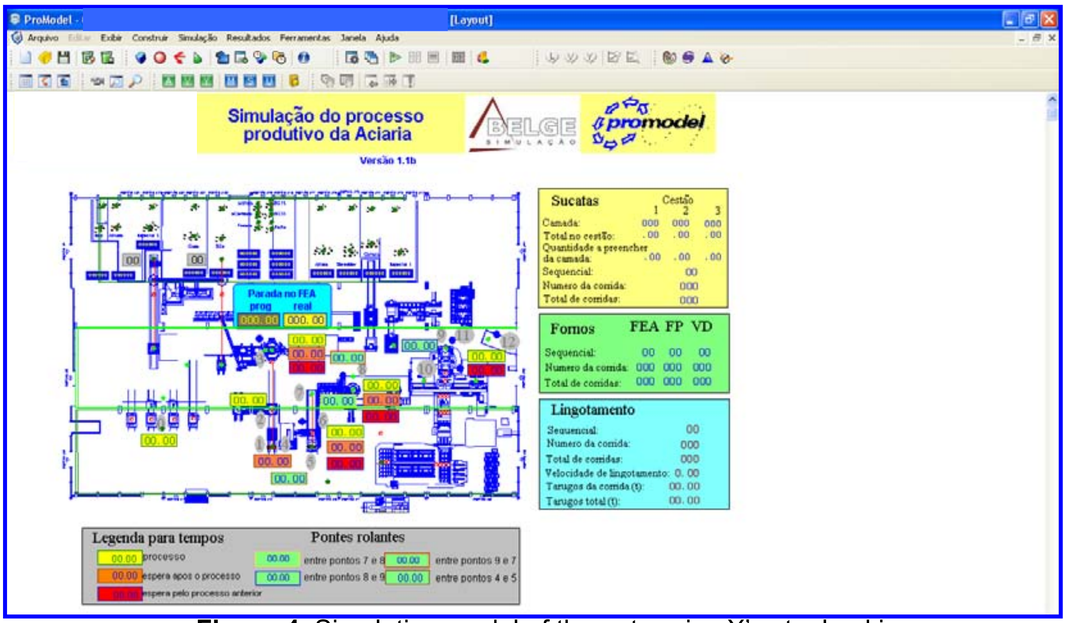

Figure 4. Simulation model of the enterprise X's steelmaking

3.2.3 Results

With the model developed, the company X can simulate different situations of the steelmaking's furnace programming and see any bottlenecks, identifying which is the most used equipment, which are waiting the processing of the previous phase and so on. All operating conditions were placed on the model so that it truly represents the steelmaking reality.

3.3 Enterprise Z

3.3.1 Objectives

Develop a simulation model with different options of layout, for a new steelmaking area at enterprise "Z", to point which option presents the best result, by changing the parameters and / or equipment of the production process.

3.3.2 Scope

We made two models with two alternative layouts:

i) The first model is shown in Figure 6 below and has the main features of a Ladle Transfer from the FEA to the Tower of FP and the Tower of FP itself similar to the Tower of LC. These features are new in comparison with the basic model. Both the FEA as the FP, the VD and the Tower of LC are on the same area which contains two cranes.

ii) The second layout (Figure 7) is composed of two Ladle Transfer of the FEA to the FP. These are in V with vertex in FEA. The electrodes of the FP thus ending the process in a ladle at the end of one of the Transfer move to another ladle that is already positioned at the end of another Transfer. The first ladle is brought, by crane, for the VD. The FEA is on a ship that contains a crane. The FP, the VD and the Tower of LC are in another ship that also contains a crane.

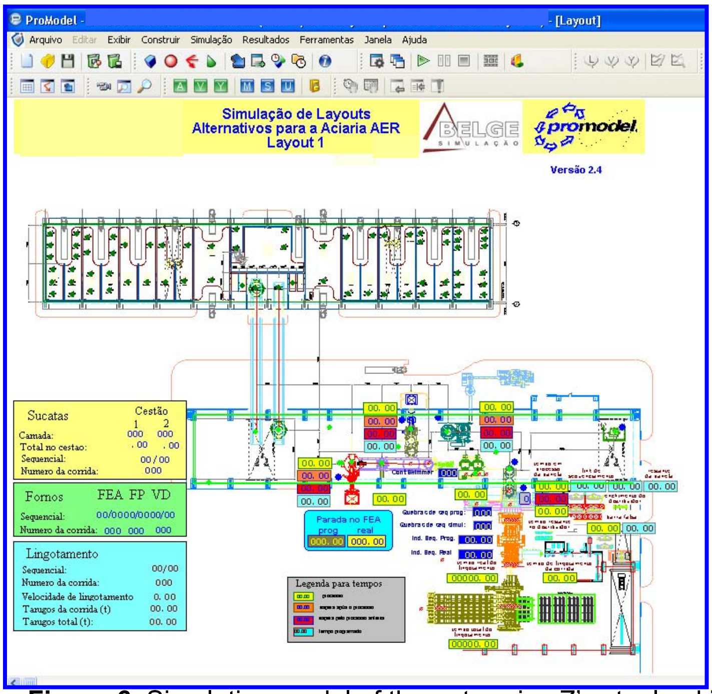

Figure 6. Simulation model of the enterprise Z’s steelmaking - Layout 1

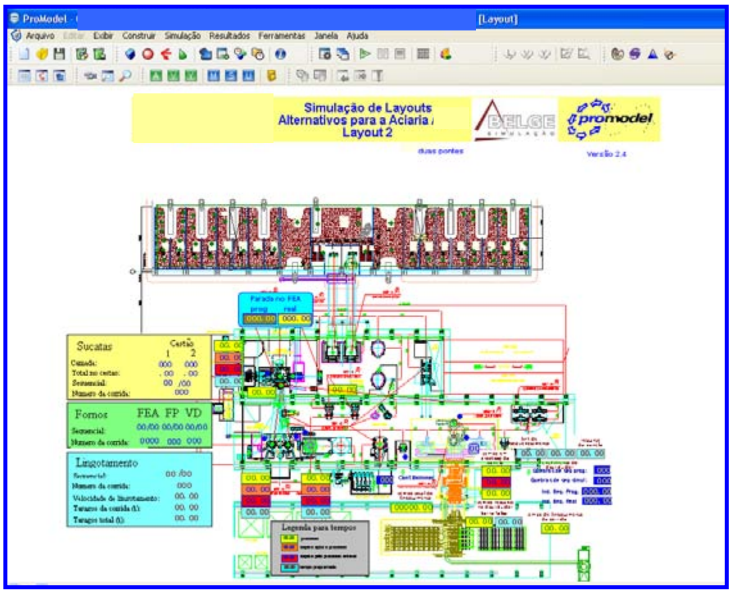

Figure 7. Simulation model of the enterprise Z’s steelmaking - Layout 2

3.3.3 Results

Based on results obtained from a specific production programming it can be stated that:

a) The layout (1) presented a lower productivity (about 15%) than layout (2) because of a greater number of broken sequences;

b) Losses of sequence of layout (1) may perhaps be eliminated, as were relatively low value;

c) The use of cranes EF1 and EF2 in the layout (2) were almost the same as in cranes CD2 (about 65%) and you can see visually that the latter did not cause delay in the delivery of ladle. In this aspect, layout (2) is not advantageous because it will require more investments than layout (1).

3.4 Vallourec&Mannesmann (V&M)

3.4.1 Objectives

Review and improve the logistical aspects of the new production line of heat treatment pipes, areas of: quenching, tempering and inspection. Through various scenarios of the production process and availability of tubes to temper, offered by rolling, sought to ascertain what would be the bottlenecks, the intermediate stock, aspects of assigning shifts and maintenance of equipment, new productive capacity and the extent of use of resources allocated.

3.4.2 Scope

Were included in the model:

- Quench and the Tempering, composed of:

3.1. Storage of tubes from the lamination;
3.2. Cranes;
3.3. Austenitization furnace;
3.4. Tempering;
3.5. Quench;
3.6. Cooling bed;
3.7. Table and bed of rollers between each party above;
3.8. Storage of pipes for inspection.

- Inspection, composed of:

3.9. Cutting tubes for sampling
3.10. Table of visual and dimensional inspections
3.11. Storage of tubes to be un-carved;
3.12. Cabin inspection of the left edge;
3.13. Cabin inspection of the right edge;
3.14. Inspection Station with ultrasound;
3.15. Table of scrap;
3.16. Table and bed of rollers between each party above;
3.18. Storage of pipes inspected.

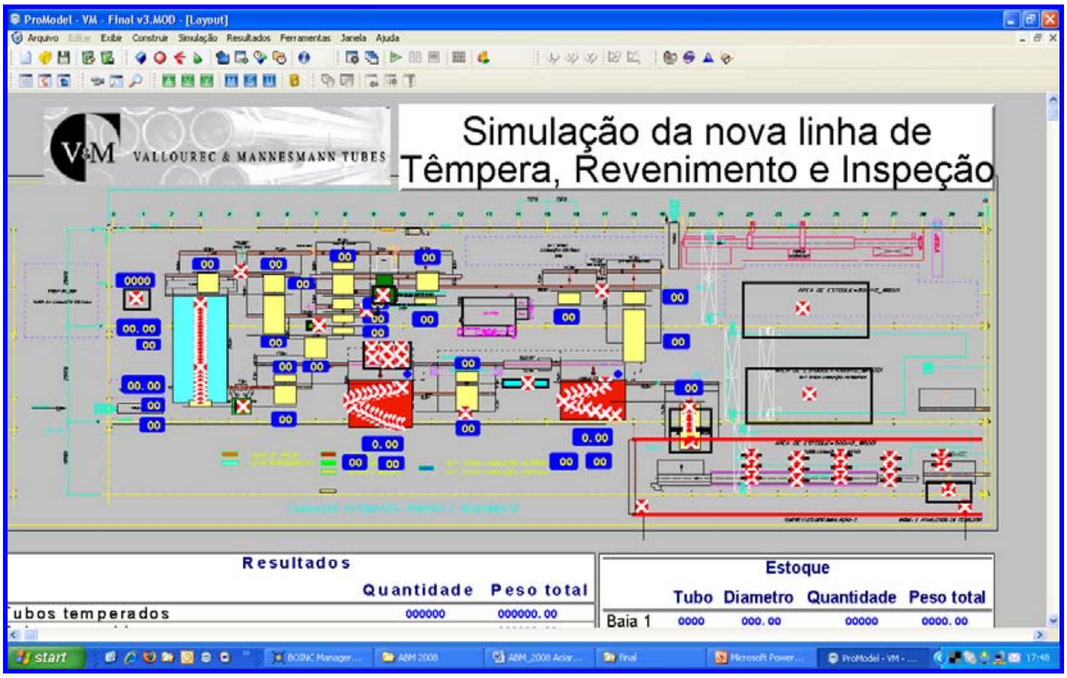

Figure 8. Simulation model of the Vallourec&Mannesman steelmaking

3.4.3 Results

The development of the simulating project of the new production line of heat treatment has brought many benefits to the company, which can be easily identified:

i) Scaling capabilities

The simulation allowed more accurate study of local capacities, as well as overall capacity of the new line.

ii) Choose the best strategy for production

The simulation of different strategies for sequencing of production - by sequencing the lamination, by increasing diameter, with minor setup - showed that the best strategy is that "with minor setup" of the line, when a new race enter into production. From this finding, the project signaled to the fact that the "setup" of the line, with significant influence in productivity, should merit a more detailed study in order to minimize their time and thus maximize the production.

iii) Reducing the unit cost of production

When using the simulation as a tool for planning the sequencing of production, this allows the rapid choose the best strategy for production giving new line for a gain of about 10% in unit cost of production.

iv) Absorption of simulation technology

The growing use of simulation technology in various sectors, for multiple users and the various decisions making of the V&M, provides a considerable competitive gain, thus enabling practices becoming less "intuitive" and more professional and productive.

In short, we can say that the implementation of the simulation project, coupled with the deployment of ProModel software, has provided V&M with an operational tool of effective and optimization programming, besides having consolidated several decisions of project, identified and quantified problems that were at most “guessed”, in time to be resolved before the effective installation of the line.

4 CONCLUSIONS

The models above allowed the examination of operation methods and its verification of the main interference in the environment studied (idleness or lack of equipment, etc.), creating conditions for decision making on investments needed for the steelmaking.
These models can make a comprehensive analysis of all the steelmaking processes, as they were developed using specific parameters for each activity of the big basket handling, preparation and loading procedures, applied in the areas of scrap preparation, Electric Arc Furnace Oven, Ladle Oven, handling the ladle preparation, for cranes and sequencing of continuous casting process.

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