VALE PORT CAPACITY PLANNING SYSTEM OF THE IRON ORE TERMINAL IN SÃO LUÍS / MA[1]

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Abstract
The present article has the objective of presenting the SIMCAP system. It was developed by Belge at VALE to simulate the Ponta da Madeira port capacity in São Luís – MA. This port simulation model is used to measure the port capacity, sizing the number of resources necessary (railroads, stackers, reclaimers, wagon turners, stocking areas, pier, ship loaders, etc.) for increasing demands. Through a computer model, it was modeled all the processes since the iron arrival in the terminal with trains, until the ship loading. VALE has tested different productivity levels, maintenance, equipment capacities and quantities, which configures different scenarios. The model developed and the manager report will be showed in this paper. After running the simulation, using different parameters (sales forecasting, quantity and productivity equipments, increasing the resources availability, etc.), VALE could get the receiving, stocking and shipping capacity in this terminal for different demands: 70 Mt/year (actual situation), 90 Mt/year and 130 Mt/year.
Key words: Simulation; Capacity planning.

SISTEMA DE SIMULAÇÃO DA CAPACIDADE DO PORTO DE MINÉRIO DE FERRO DA VALE EM SÃO LUÍS / MA

Resumo
O presente trabalho tem como objetivo apresentar o sistema SIMCAP desenvolvido pela Belge na VALE para a simulação da capacidade do Porto de Ponta da Madeira em São Luís – MA. O modelo de simulação desse porto é utilizado para dimensionar a capacidade de movimentação de minério de ferro, planejar os recursos necessários (ferrovia, empilhadeiras, recuperadoras, viradores de vagões, pátios de estocagem, píeres, carregadores de navio, etc.) para um aumento de demanda. Através de um modelo computacional, foram modelados todos os processos envolvidos desde o recebimento do minério, através de vagões, até o seu embarque em navios. São testadas diferentes taxas de produtividade, manutenções, capacidade e quantidade de equipamentos, dentre outros, facilitando a criação de cenários de aumento de demanda. Será apresentado o modelo desenvolvido, a sua operação (simulação) e a obtenção de resultados. Simulando-se o sistema, a partir de uma combinação de parâmetros (previsão de vendas, quantidade e produtividade dos equipamentos, aumentando a disponibilidade dos recursos, etc.) obtemos qual a capacidade de recebimento, estocagem e expedição de minério no terminal para diferentes demandas: 70 Mt/ano (situação atual), 90 Mt/ano e 130 Mt/ano.
Palavras-chave: Simulação; Planejamento da capacidade.

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1 INTRODUCTION

VALE is a Brazilian company, founded in 1942 and one of the main private groups of Brazil. The company is the world leader in the market of iron ore and pellets, second major global producer of Mn and iron leagues and the largest Brazilian logistic services (railroads, ports and terminals). VALE is present in 13 Brazilian states and in 4 continents.
This papers will show how simulation technology helped and it is still helping VALE to plan the Ponta da Madeira terminal (TMPM) capacity located in São Luís – Maranhão.
Due the demand increasing of iron ore in the world, the company is working to increase its capacity (2004 – 66 Mt/year; 2006 – 78 Mt/year; future – 130 Mt/year). As a consequence of this increase, since 2004, VALE has developed with Belge SIMCAP - Capacity Planning System of Ponta da Madeira terminal, using simulation technology with ProModel to realize several studies of the logistics system in this port to allow them to identify the bottlenecks and which are the investments required.
Through the modeling of all the system's relevant operations and in response to the proposed scenarios, SIMCAP's objective is to obtain a simulation tool to study the TMPM, identifying the possible production bottlenecks, capacity restrictions, possibilities of enlargement and perspectives of future investments, in these scenarios.

2 MATERIAL AND METHODS

According to Shannon,[1] simulation can be understood as a process representation or reproduction used for observation, analysis and prediction. Another simulation definition is an experience realized using computer models of processes impossible to be done in the real world. Bateman[3] define simulation as "simulation is make real what is not real, that is, reproduce something closer the reality, certain aspects of a situation or processes".
Simulation is a large processes. It is not just building the model, but this concept involves all the experimental methods, such Gordon[2] say:
a) Describe the system behavior;
b) Build theories and hypothesis considering the observations done;
c) Use the model done to predict the future behavior of the system, that is, analyze the effects produced due to changes in the system or in the methods used in the operations.
The simulation concept in this case, uses the simulation technology of the ProModel software integrated with spreadsheets and VBA (Visual Basic for application) to configure the hole system.

3 SIMCAP SYSTEM

SIMCAP is a capacity planning simulator of Ponta da Madeira Port used by VALE. This system uses the simulation technology and allows VALE to realize their studies and the port capacity planning.
Some years ago, VALE used spreadsheets to realize these studies. In the beginning, they could analyze some aspects of the terminal but it was not enough to generate conclusions about the bottlenecks and which investments would be necessary for a new demand, etc. Besides, this kind of study has high complexity due the variability

and interdependences of several variables in the port. So, VALE decided to develop a system with the simulation technology, to help them to take better decisions.

3.1 Models

The system is composed by 3 main modules:

Ship's line generator

- From the spreadsheet of forecasted sales, it generates the probabilistic line of ships for the period (based in the historical behavior and in the types of products and clients)
- it chooses the pier where the ship is going to dock

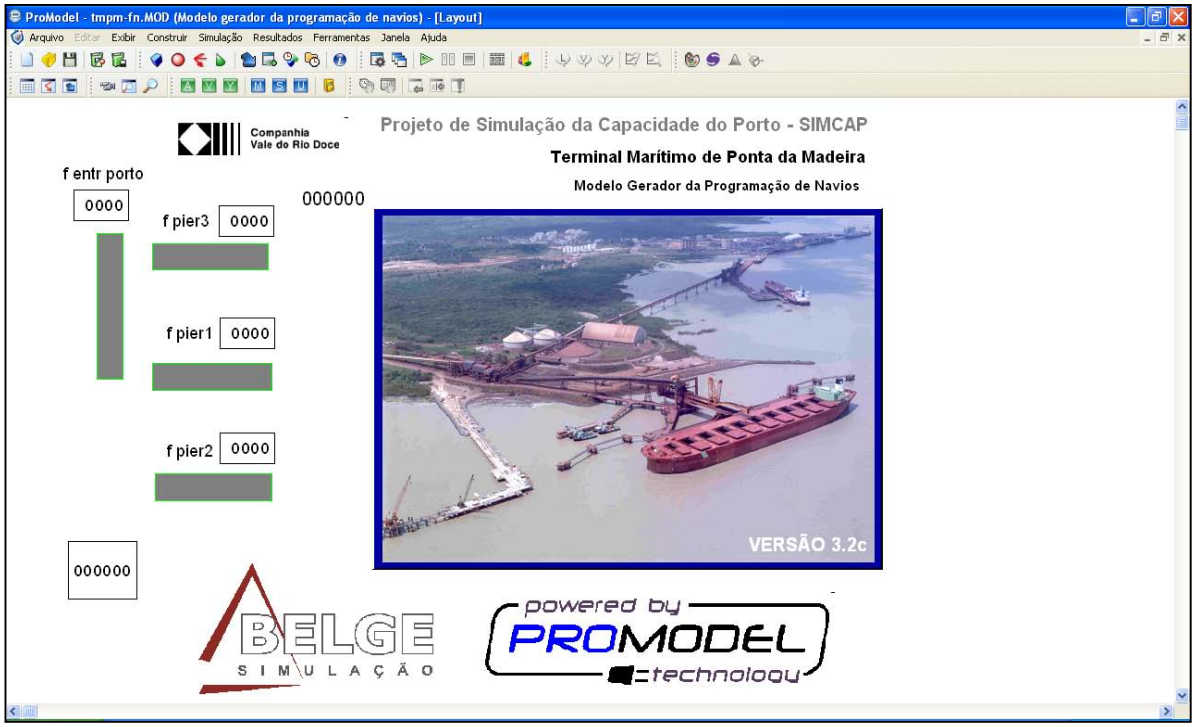

Figure 1. Ship´s Line Model

Train's line generator

- With the ship's line, it creates the railroad lots that arrive in the terminal – probabilistic generation based on the history of supply and transportation restrictions to each product.

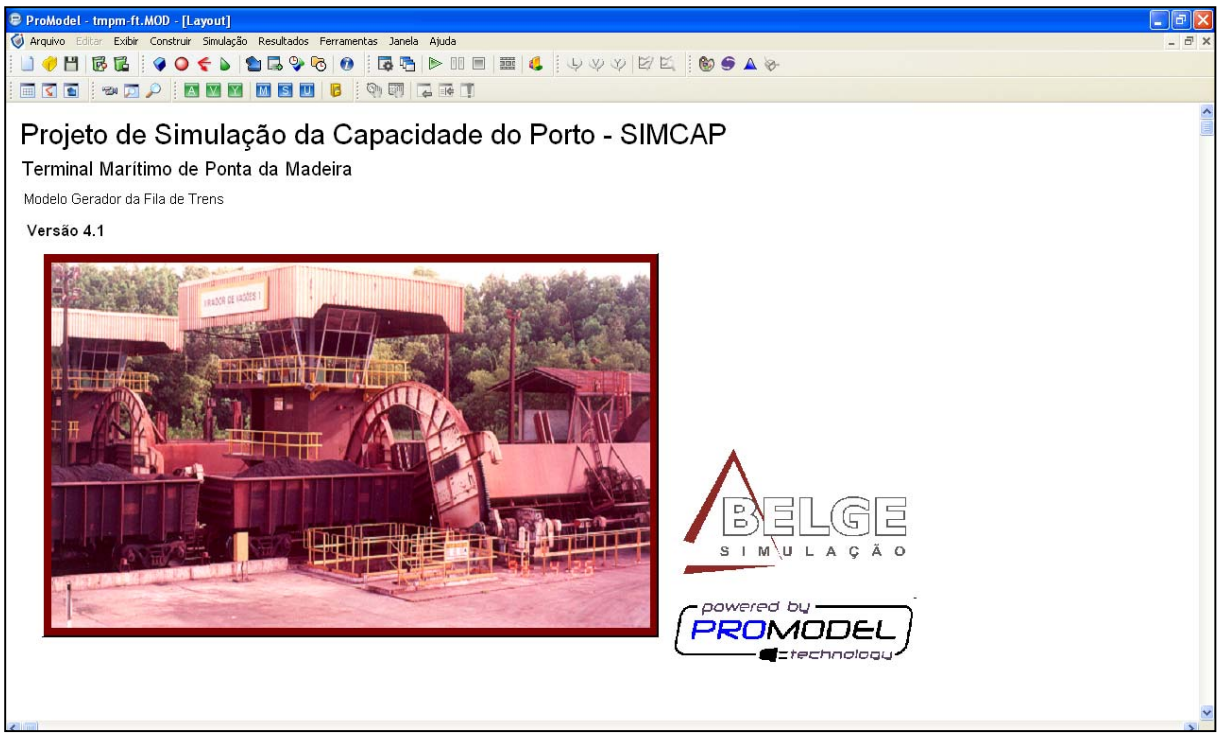

Figure 2. Train´s Line Model

Complete Model

- Trade-offs: demand (ships) X supplement (trains)
- Pile up based several rules
- Recuperation for the ships boarding

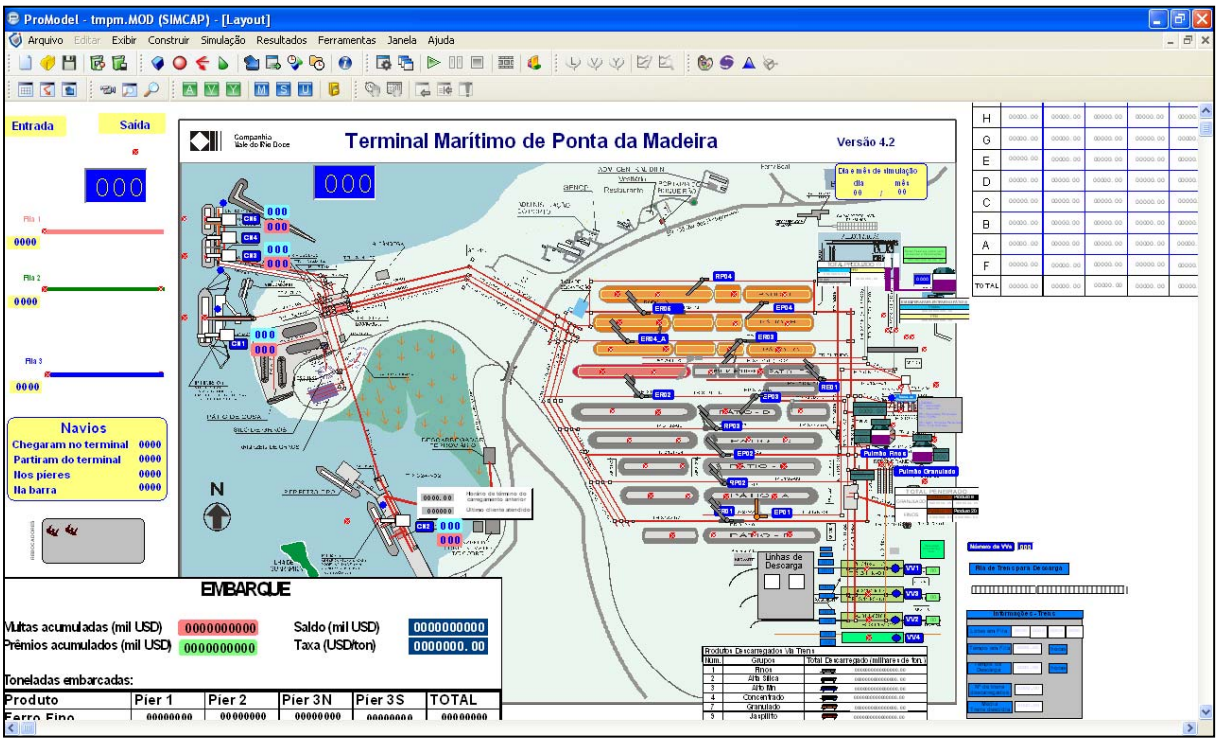

Figure 3. Complete Model

These 3 models are integrated according to the following architecture:

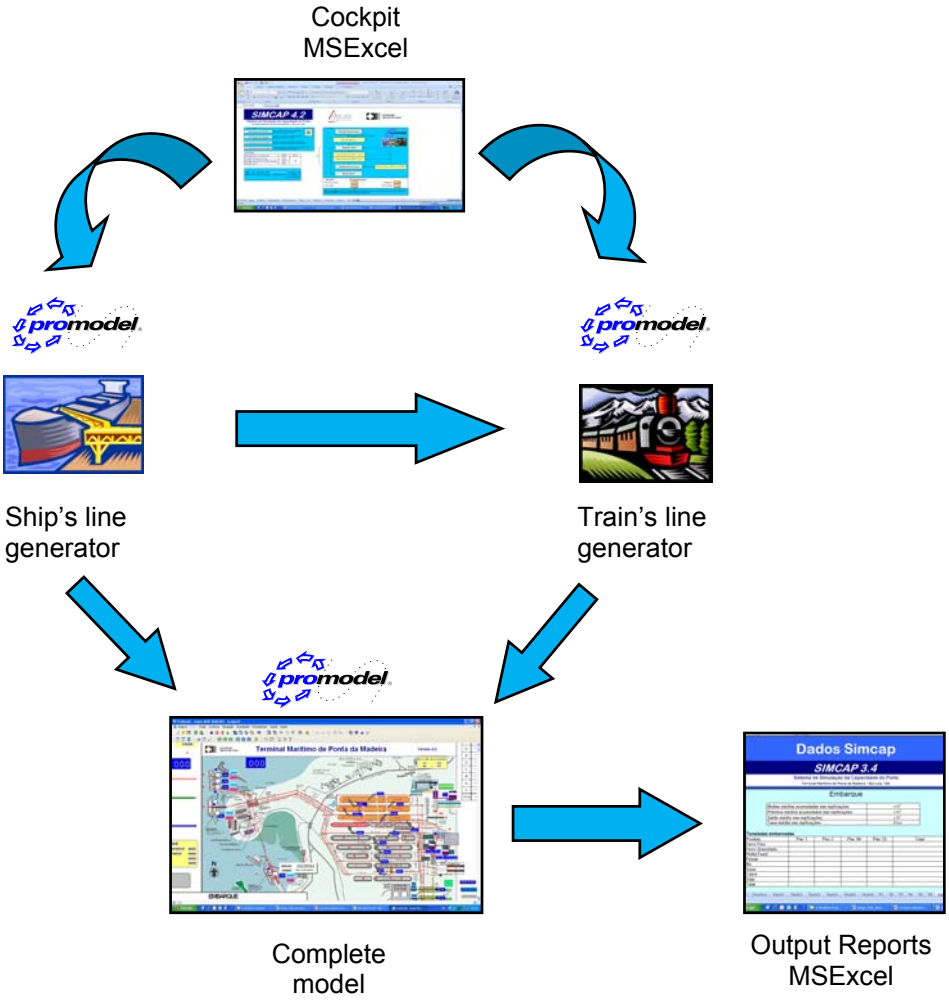

Figure 4. Simcap architecture.

The system is composed by several files, such as:

- Cockpit: it is the file where VALE changes the parameters to configure new scenarios. Example: sales forecasting, clients, products, equipment capacity (ship loader, train discharge, reclaimers, stackers), railroad restrictions, storage area capacity, activation new equipments (stackers, reclaimers, towboat, ship loaders etc.).

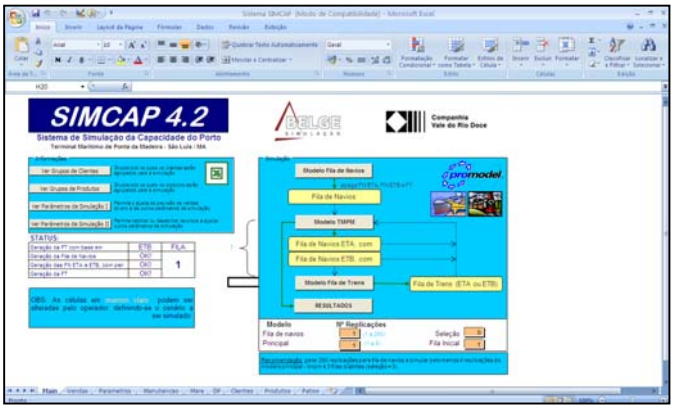

Figure 5. Cockpit

- Ship´s line generator: based in a forecasting sale, this model generates the ship lines using probabilistic curves to the time between arrivals, ship size, ship product to each client, etc.

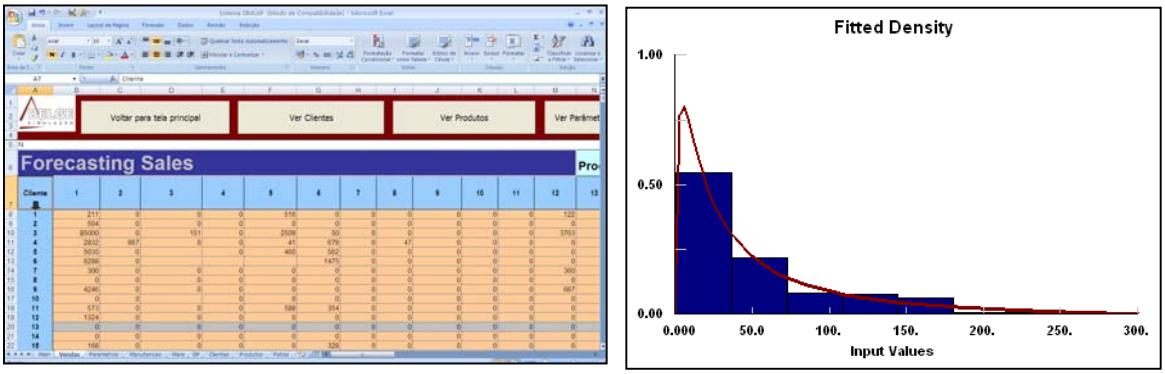

Figure 6. Forecasting Sales e Statistical distribution for ship´s arrivals

- Train´s line generator: using the ship´s lines, this model generates the train's lots that will arrive at the terminal with the iron ore necessary. VALE can test the number of wagon to each train, railroad capacity, mine restrictions etc.

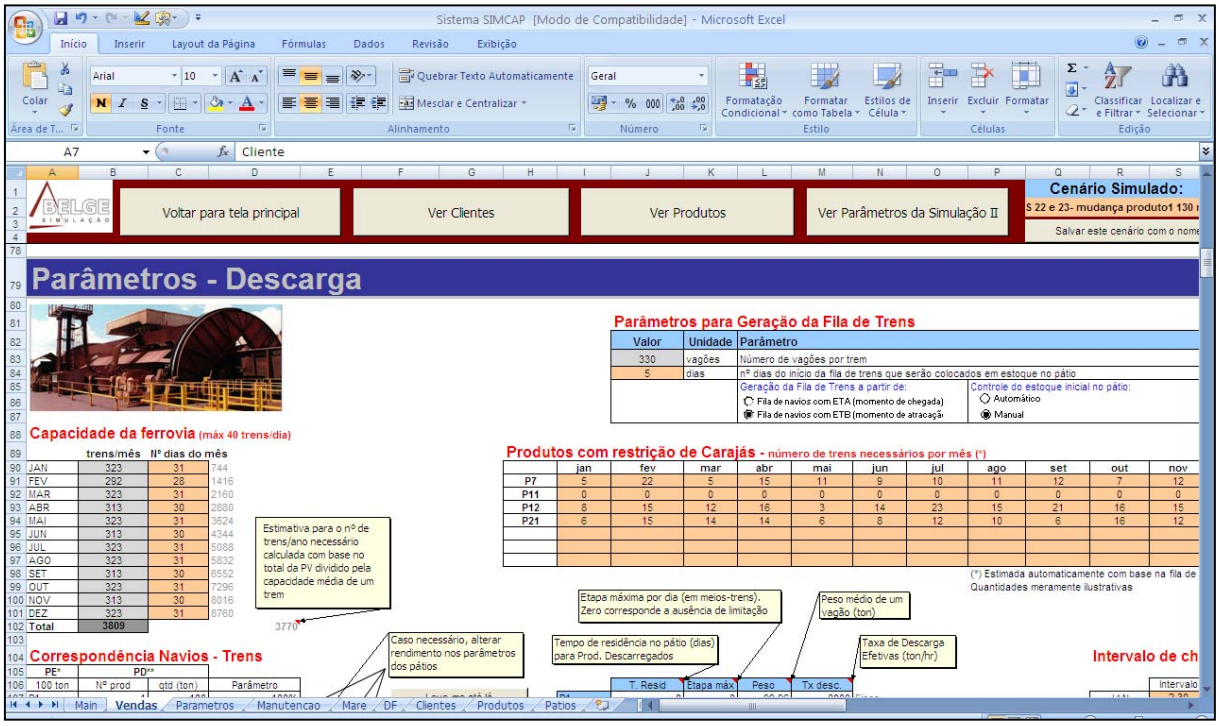

Figure 7. Trains & railroad parameters

- Complete model: it´s the Ponta da Madeira Terminal Model. This model consider the trains arriving at the terminal to unload iron ore and the storage areas, where different kind of products are kept to be moved to the pier when the ships arrives in the terminal to load iron ore.

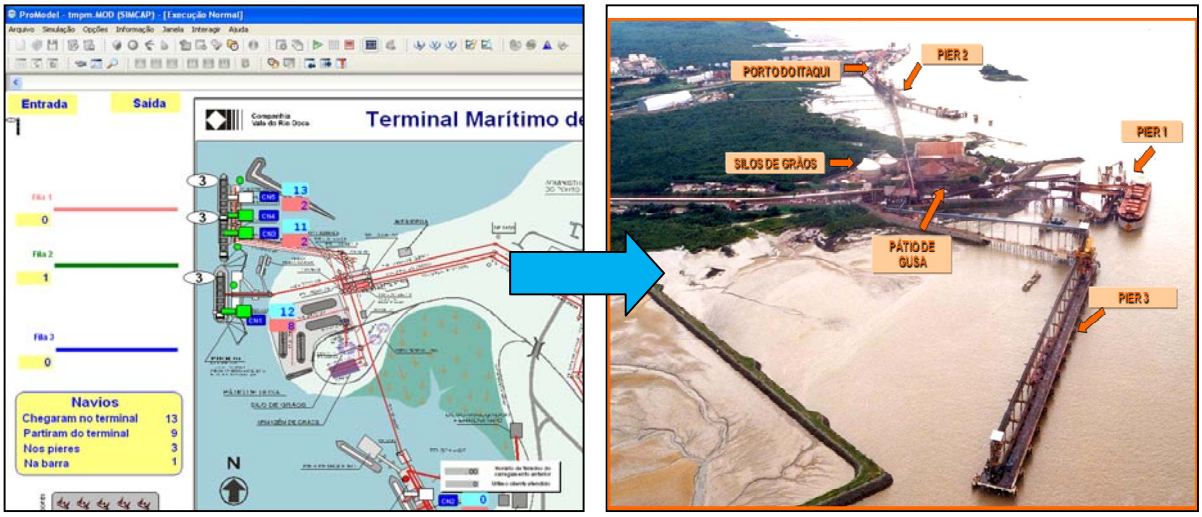

Figure 8. Pier

There are 3 piers in the terminal:

- ✓ Pier 1: Iron Ore – 1 ship loader
- ✓ Pier 2: Soy, Pig iron – 1 ship loader
- ✓ Pier 3: Iron Ore – 3 ship loaders

The iron received by train is moved in conveyors to the storage areas.

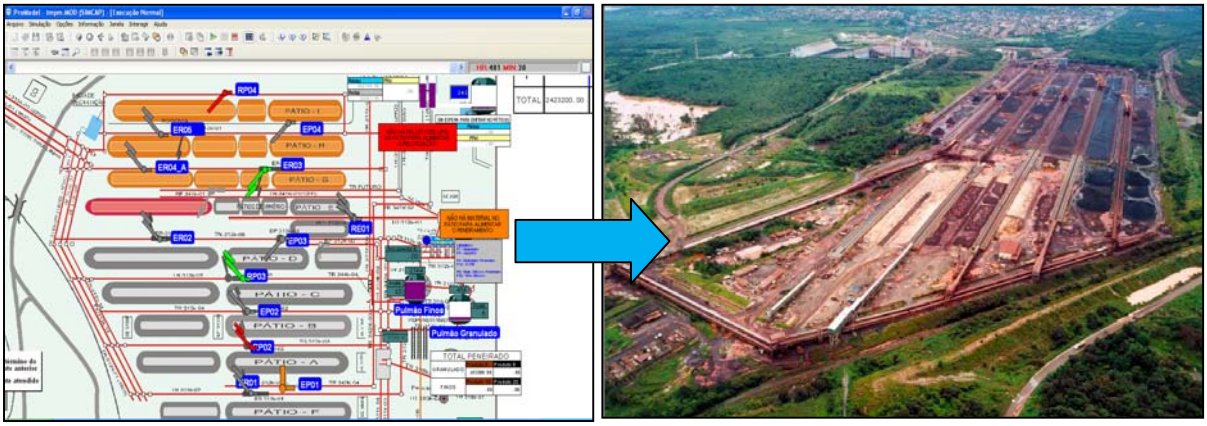

Figure 9. Storage areas

There are 9 storage yards in the terminal: A, B, C, D, E, F, G, H e I.

- Statistical reports: after running the simulation, the system shows the results in a manager report. This file show several statistics as: demurrage, iron ore loaded in ships, commercial rates, ship line, total discharged by trains, resources level occupation (stackers, reclaimers, wagon turner, ship loaders, towboat, etc) and pier states (in use, downtime, idle, waiting).

4 RESULTS

After running a scenario, SIMCAP show the results of each simulation in a manager report.

Some results:

- ✓ Demurrage
- ✓ Ship lines
- ✓ Comercial rates
- ✓ Train lines
- ✓ Resources utilization
- ✓ Location states
- ✓ Boarding quantities
- ✓ Yard occupation
- ✓ Etc.

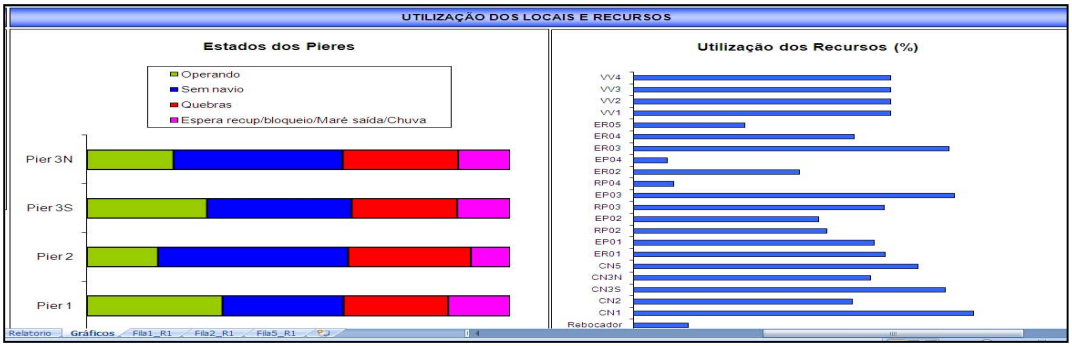

Figure 10. Manager report

Since 2003, when the system was built, VALE has used the system to:

- ☐ Adaptation of the plant to the demand increase forecasts for future years
- ☐ Identification and measurement of the potential operational restriction points in the system
- ☐ Supply technical basis to the Strategic Planning

5 CONCLUSION

VALE has an import tool to realize the port capacity planning based on the simulation technology, typically used to analyze complex situations.
Some facts:

- ☐ The demand is continuous increasing;
- ☐ It´s necessary new investments to increase the port capacity;

In this way, it is more and more important to realize the best capacity planning and the simulation system, is ready to help VALE to answer the questions:

- ☐ What is necessary to achieve the demand targets?
- ☐ How minimize costs and maximize productivity?
- ☐ What investments are necessary?
- ☐ What are the bottlenecks?
- ☐ How will be the port behavior for new scenarios?

Now VALE can get this answers using simulation.

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