APPLYING NEW TECHNOLOGIES TO AUTOMATE AND SUPPORT COMPLEX SIMULATION MODELS FOR OIL DISTRIBUTION IN BRAZIL

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Abstract: Distribution centers managed by BR, one of the Petrobras group companies, are the starting point from Gas stations and big fuel customers supply. These centers, intermediate links of the fuel supply chain, provide oil products to a very competitive market. To be efficient, the centers must have regulating stocks that use service level parameters for management purposes. Determining these parameters according to the number of centers and their localization around Brazil require plenty of simulation models, which have to be managed by an information system, so that they can be used in a friendly way. The focus of this paper is to describe the new technologies involved in supporting and automating the models created, the steps being taken for their implementation and the role of each software used.

keywords: rule-based systems, system integration with high performance.

1. INTRODUCTION

Petrobras is a large petroleum company, leader in Latin America, present in several countries and is considered one of the top energy companies in the world.

The Operations Research Team has a lot of experience in building decision support systems, mathematical programming, simulations and statistics. Our main applications are in oil selection and purchasing, investments, distribution, sales forecasting and resource allocation.

The Operations Research team has always developed projects using simulation. The team used FORTRAN, then moved to GPSS. Today, **PROMODEL** languages are used.

The most relevant simulation applications in Petrobras can be classified in two groups:

- Critical resources, drilling or maintenance rigs, the rental of specialized vessels (about US$20,000 per day), port extensions, fleets and others.
- Determination of stock levels, LPG infrastructure (pipes and tanks) investments.

In the present case, a system was planned to manage all the process of simulation, starting from the choice of the distribution center, the selection of a product handled at this center, organizing the creation of scenarios, initiating and monitoring the simulation process of the equivalent model chosen. Finally, it has also been projected to generate customized reports, some of them presenting graphical features.

The system has been developed in VISUAL BASIC, and it integrates PROMODEL, MS EXCEL and MS ACCESS to support all that functionality. Some difficulties appeared when starting to integrate all the software and making it work together. After that, other relevant aspects came round, like the time spent by the simulation models processing and the consumption of computer resources (memory), beside others.

Recently, the CITRIX solution has been tried out in order to solve some of these problems and then, after being approved, would be implemented.

2. THE PROBLEM (SIMULATION MODEL OBJECTIVE)

The project's objective was to define the amount of fuel that is stocked in the distribution centers, to set up service level goals and company management strategies, keeping costs at competitive levels.

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The concept of safety stock inventory is widely used in petroleum companies, because mistaken sales forecasting and irregular supplies may cause loss of sales (stock-out) or increase stocking costs (surplus stock).

Sales variability and Irregular supplies (supply uncertainty) from distant centers might cause **stock-out** if there is a lack of product, possibly caused by a delay of the deliver, or **surplus stocks**, which involves higher costs, using ships or trains for storage if there is no room in the tanks at the centers.

Our first main difficulties were:

- Number of sites;
- Extensive supply lines all over Brazil;
- Almost all clients are demanding experts in logistics;
- Need to adapt results to each situation; in other words, we had to customize models for each center;
- Need for huge amounts of information;
- Need for a friendly IT solution, mainly because this solution is intended to be used intensively.

3. THE SOLUTION (SYSTEM STRUCTURE)

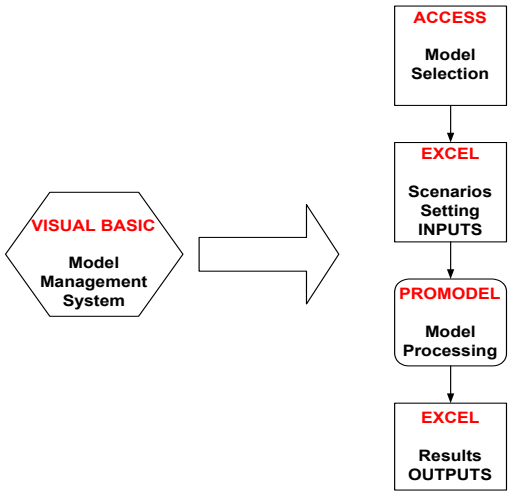
The solution was to develop a Decision Support System involving a large number of simulation models to inform the distribution sites stock management. It was developed in VISUAL BASIC and integrates PROMODEL, EXCEL and ACCESS to support all the following functionality:

- Determine, monitor and review target stocks, tank capacities and other parameters for each site;
- Support models for the calibration and maintenance of databases;
- Creating scenarios for studies;
- Manage all the process of simulation (initiating and monitoring the simulation process of the equivalent model chosen);
- Generate customized reports.

As we were working with about 50 models, each one containing diferent characteristics in terms of inputs and output format files, we need to develop a System to support and manage the process related to the simulation of the models, covering the distribution and the fuel security stocks from all the BR refineries and distribution centers (subsidiary), which are geografically spread all over Brazil.

The focus of this paper is to describe the appliance of new technology to manage and support the amount of models created and turning them easy to use (friendly)

Decision Support System Architecture:



Picture 1

The models has been developed in PROMODEL, which has got some built-in tank routines developed to make it easier to construct models with tank representations and its product operations. Besides that, it gaves us much more flexibility to programme our fuel distributions process as close as possible to its real performance.

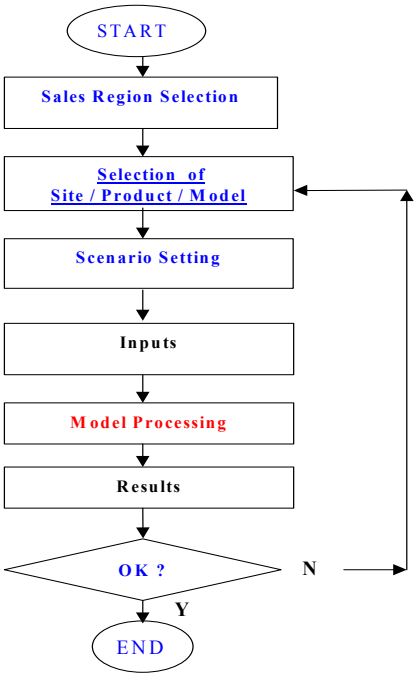
The model's structure is based on tridimensional arrays, importation and exportation files, intern tables and others. Some generalized subroutines were created, saving a lot of time in developing models for all the company's distribution centers, because they could be easily adapted for developing all the models, due to their similarities. The files used by the system throughout the process also use generalized codes which can be customized very fastly, thanks to their structure.

Because of the limited resources of the Simulation Softwares available, we've had to decentralize the model using EXCEL and ACCESS capabilities so that we could generate scenarios and turn it's usage much more easier for those who doesn't know how to operate simulation sofwares.

Then, the next step was to develop the automation of the simulation software, and the VISUAL BASIC was chosen for that.

Structurally, the process can be presented as the following flowchart

Colors: ProModel - red; VisualBasic – blue;
*Excel – **black**; Access - ___ (underlined).*



Picture 2

The step of **Selection of Site/Product/Model** is supported by ACCESS. The database makes the relation among the Sales Region, the sites and the products available at that site and also combine the selection with the appropriate equivalent model developed for that choice.

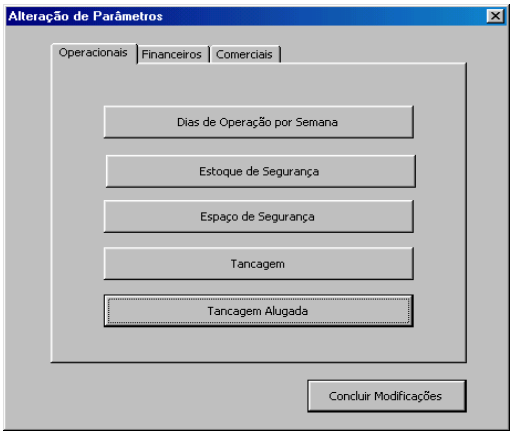
Due to the large amount of data, an ACCESS database was also needed to support the distribution defining process and their calibrations.

Like all random simulation models, these models are prepared to receive regular calibrations. However, any emergency calibration can be made when the need arises. This can be easily done because of the database.

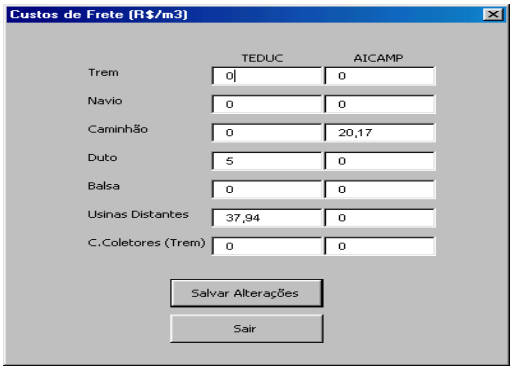
The next picture shows the first screen displayed when the system is initialized

Picture 3

There is a large amount of EXCEL files manipulation, managed by the system, each one having a different MACRO developed to support the process and make it easier for the user to modify the **Inputs** when creating scenarios.
Examples of input parameters screen (**Pictures 4 and 5**)

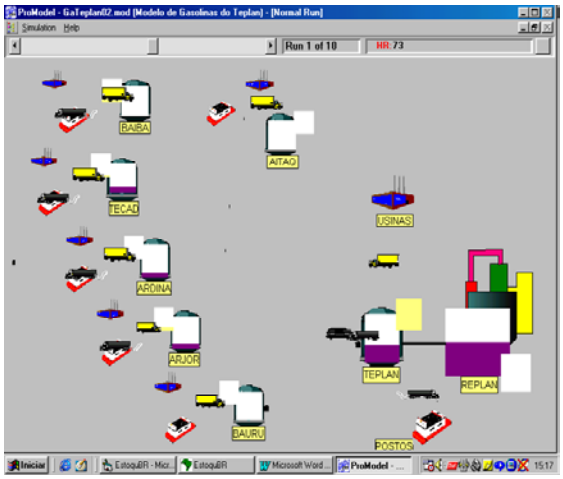


Picture 4



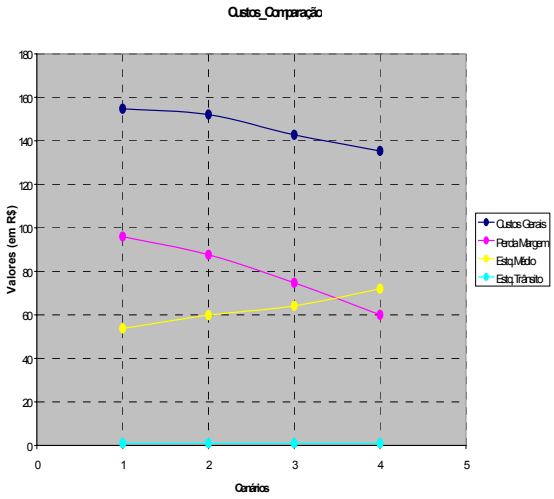
Picture 5

The following picture shows an example of a model being processed by PROMODEL



Picture 6

Some macros were also developed in EXCEL to present the **Results** and to calculate the average values obtained from the replications processing for each scenario. In addition, reports are generated at the end of each scenario simulation and there is also a customized report which compares graphically the results of the different scenarios created as it can be seen in the next picture.



Picture 7

There are two types of graphics generated by the system. One of them shows the evolution of the service level of the distribution centers when modifying security stock levels for each product handled in the model chosen. The other one is the evolution of the stock costs within the distribution system for each scenario created.

The reports generated at the end of each scenario simulation contains only customized information about it, which was developed in EXCEL in order to give the user much more flexibility to analyse and use the results.

4. FURTHER PROBLEMS (APPLYING NEW TECHNOLOGY)

After that, we have faced some problems related to the instalation of the system, because it envolves different softwares and also because of the different versions of the required softwares found on the client's machine . Besides that, the system consumes memory because it access information through a data bank and manipulate lots of information from different files and writes a lot of information into another files.

In addition, our client used to have short period decisions on it's daily workday and their resources (computer) could not be interrupted to do a long processing, because it could interfere their operational decisions.

In order to solve this difficult matter, we decided to analyse the CITRIX solution.

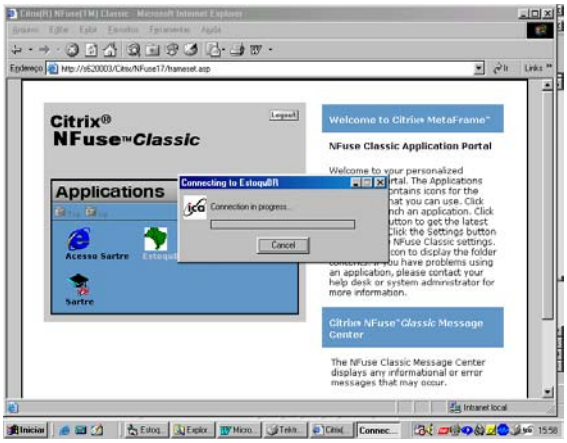
With this solution we could get some advantadges:

- This operation costed almost nothing for our department in terms of equipment, maitenance and support, because we have already had a server available to install all the necessary files and programs and a team trained with this technology (CITRIX) to do the necessary assistance;
- This solution doesn't demand upgrade from the client's Hardware (computer);
- The system can be used in different Operational Systems, because the application runs in the server (Metaframe), releasing the clients resources (concept of *Thin Client*);
- Makes easier the updatings and management of the system (through the server);
- Reduces the costs of development, maitenance and more (usage of client's computer);
- Visualization through a common Web Browser (Nfuse Technology);

Drawbacks:

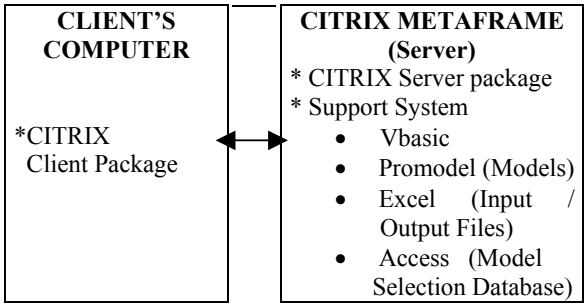
- Print the results through a local Printer (client);
- Availability of the Metaframe CITRIX (server) for a large usage and trustability (multiusers access).

Example of a connection through a common web browser



Picture 8

The structure of this functionality is shown bellow



Picture 9

5. CONCLUSIONS

The usage of new technologies is recommended to support and manage all the simulation process, but some important issues should be observed when many application are integrated to work all together.

Besides the simulation software, support software versions, PC hardware and Operational System should follow a common configuration set up by the developer. If it not possible to accomplish, because of the dependency of the applications used, the Citrix solution seems to be a good support decision.

We have also tried to use the system with more than one user at the same time, and everything seems to work well. The performance wasn't harmed by the multiple accesses.

Recently, we have been testing it exaustively. As soon as it has been approved, we are going to implement this solution for our users. It would save time in development, maitenance and, above all, costs.

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7. BIOGRAPHY

Guilherme Júlio Barbosa is 29 years-old, has graduated in Electrical Engineering at UFJF and has also a MSc Degree in Industrial Engineering at PUC-RJ. He has been working for 2 years as an Analyst of Operations Research for Petrobras, with simulation projects related to the determination of stock levels from BR Distribution Centers (one of Petrobras Subsidiaries), determination of the economical number of critical resources, drilling or maintenance rigs and rental of specialized vessels to assist the FPSO's offloading operations in Campos Basin (Brazil), besides others. Nowadays he is taking his Executive MBA in Petroleum at COPPE / UFRJ.

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