IPMM 2011

7th International Conference on Intelligent Processing and
Manufacturing of Materials
September, 02-03, 2012, Foz do Iguaçu, Brazil

Simulation Tools: a study of application at the Nouadhibou Port

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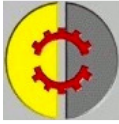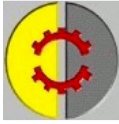2. Hatch, Iron Ore Business Unit, São Paulo, Brazil, plivoratti@hatch.com.br

ABSTRACT

Faster and cheaper, are two words highly prized in a project and how the companies can combine these words is the key for the best result. Besides, being an operational simulation software, it has been used as a tool in decision making, knowing that, simulation is a powerful tool to assist any project, decisions making, which can influence the progress of the project. More than that, this tool can optimize the equipments, evaluate the impact of various operations parameters and find the bottleneck in the operation.

This paper describes those cases by using two different software to create a model to simulation, it`s possible to use the cheaper or the faster software, but when use each one? The right choice can help getting the best result. Theses software are Visual Basic and Arena. They were used to model the Nouadhibou Port, located in Mauritania, West Africa. In both cases, using Visual Basic and Arena, a description of content of the model, key results and conclusion of the advantages and disadvantages are presents in this paper.

INTRODUCTION

The model of the Nouadhibou Port, situated at the peninsula in the north western corner of Mauritania, belong to SNIM, Société Nationale Industrielle et Minière, Figure 1, was to review the current capacity and the prospect ones with the implementation of new equipments, as show in the Table 1.

This work shows that a reliable model can be developed based on known parameters. In this case, the first stage was built and the port will be optimized by operation simulation, for the subsequent stage, the combination with the proper integration of the process knowledge to develop a dynamic model and help in the equipment definition.

Figure 1 – Nouadhibou Port Satellite Picture

Table 1 – Port Phases

Port Phase	Number of product in the stockpiles	Description
1	4	Current Port
2	4	Implementation of a new shiploader and berth
3	6	Upgrade the single Rail Car Tippler to double
4	7	Implementation of a new double Rail Car Tippler, two stockpiles, two reclaimers and one stacker, as shown in the up of the Figure 2.

The port is strategically important for Mauritania, because it will receive most of the iron ore produced in the country, so the simulation have to include this product mix. In the last phase (4), the layout can be seen in the Figure 2, the port will handle seven iron ore products.

Those products came from 3 companies, SNIM, Sphere and MinMetals. Four of them (SNIN-concentrate, Minmetals-concentrate, Sphere-El Aouj mine and Sphere-Askaf mine) arrive by train and after stored are loaded in the ships. One of the products (SNIM-ROM) after storage, needs to be processed in the Process Iron Ore Plant and will generate the two other products (SNIM-fine and SNIM-lump).
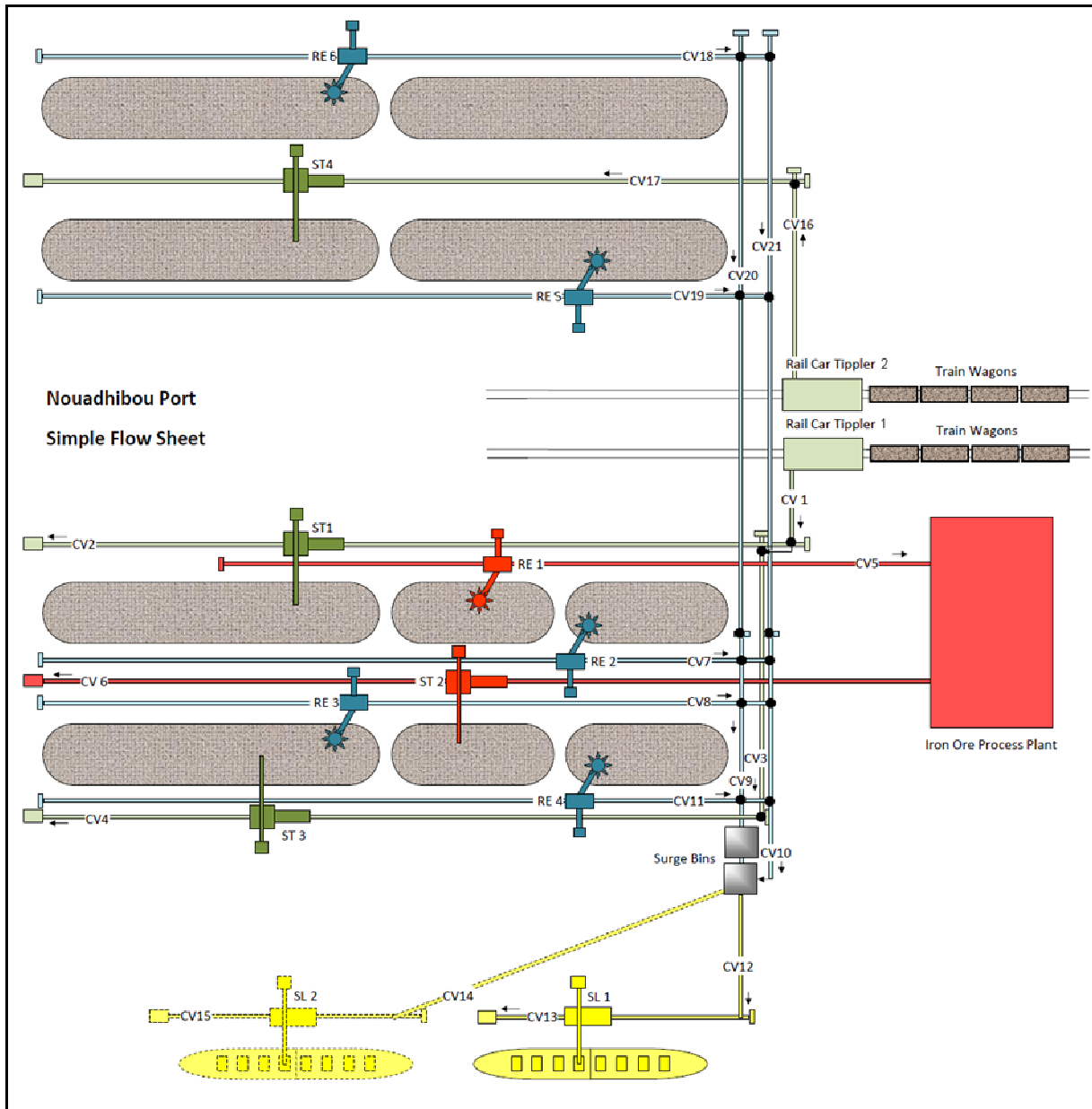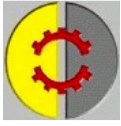
Figure 2 - Phase 4 Plot Plan

OBJECTIVES

The main objective of the study was to compeer the two software (Arena and Visual Basic), to show the advantages and disadvantages of each software and the best time situation to use each one, more than that, this article will suggest the appropriate tools to build a dynamic simulation model.

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DEVELOPMENT

According to Dowell (2006), the Port was divided in four systems to be modeled, showed on Figure 3.

The hardest part of the simulation is to model the large amount of different material, and its effect on equipments to be used while loading ships. The reclaimers that can be used are dependent not only to the material that will be loaded in the berth, but also, the material that is being loaded into the second berth (Brinati, 1985). The optimization of this interaction, was done by comparing different scenarios, where the results were displayed in a graphic to identify the most efficient project configuration in terms of increase of port capacity.
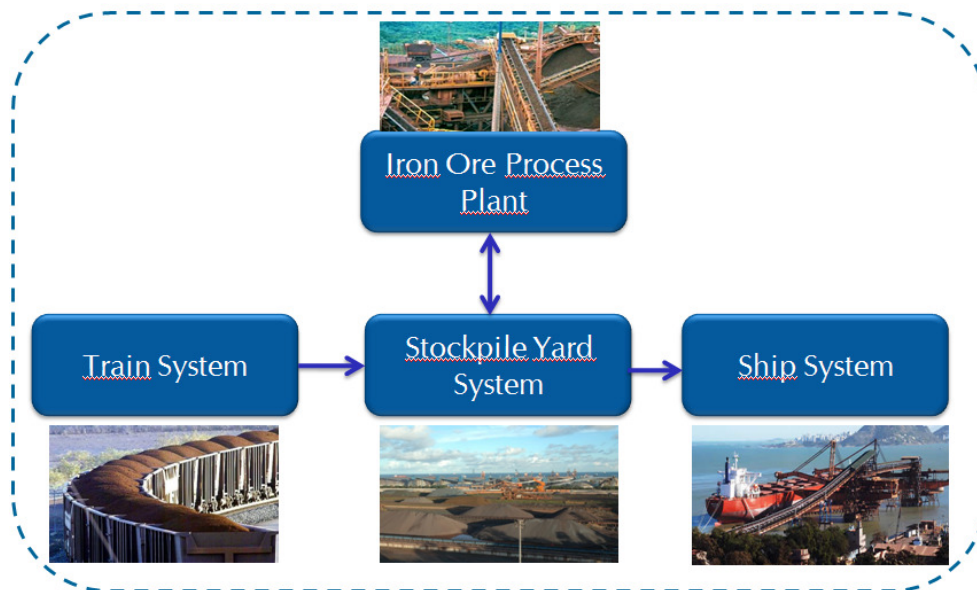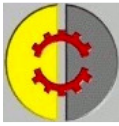

Figure 3 - Flowchart model adopted

The first model, simulates the port Phases 1 to 3. The software selected to model was Visual Basic, because the greater experience by using this tool. The logic of this system, was done in a script, that has more than 3,500 lines. The script and some page results can be seen on Figure 4.

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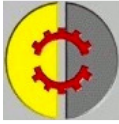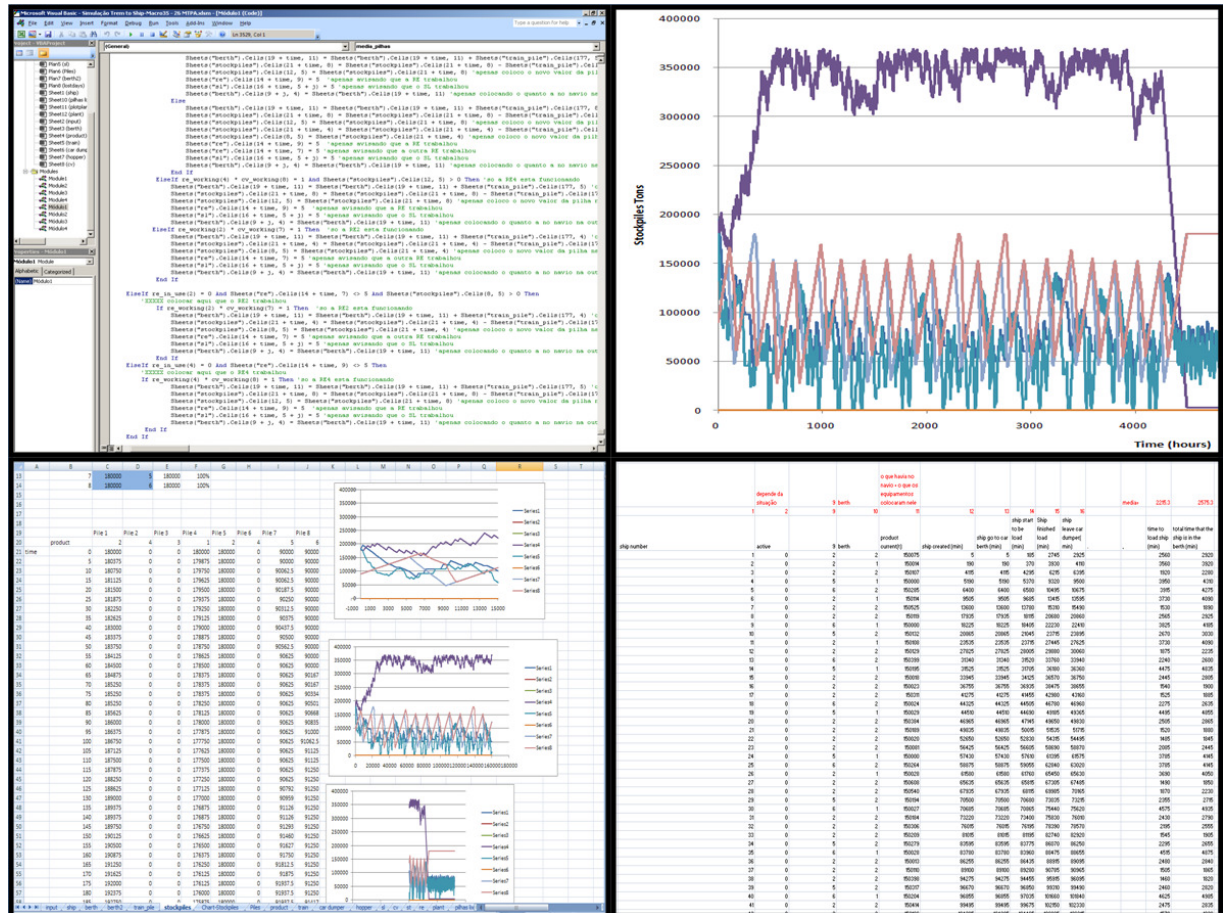September, 02-03, 2012, Foz do Iguaçu, Brazil

Figure 4 – The script lines and some page results for each simulation (stockpiles per time and ship description)

More than the outputs, it was created a graphic animation of the model. This animation is illustrated in Figure 5, and shows in the real time what is happing in the model, when the model is running. This enable the view of the process and the points that could be optimized, moreover this tool could help indentify errors in the logic.

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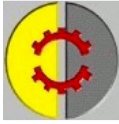September, 02-03, 2012, Foz do Iguaçu, Brazil
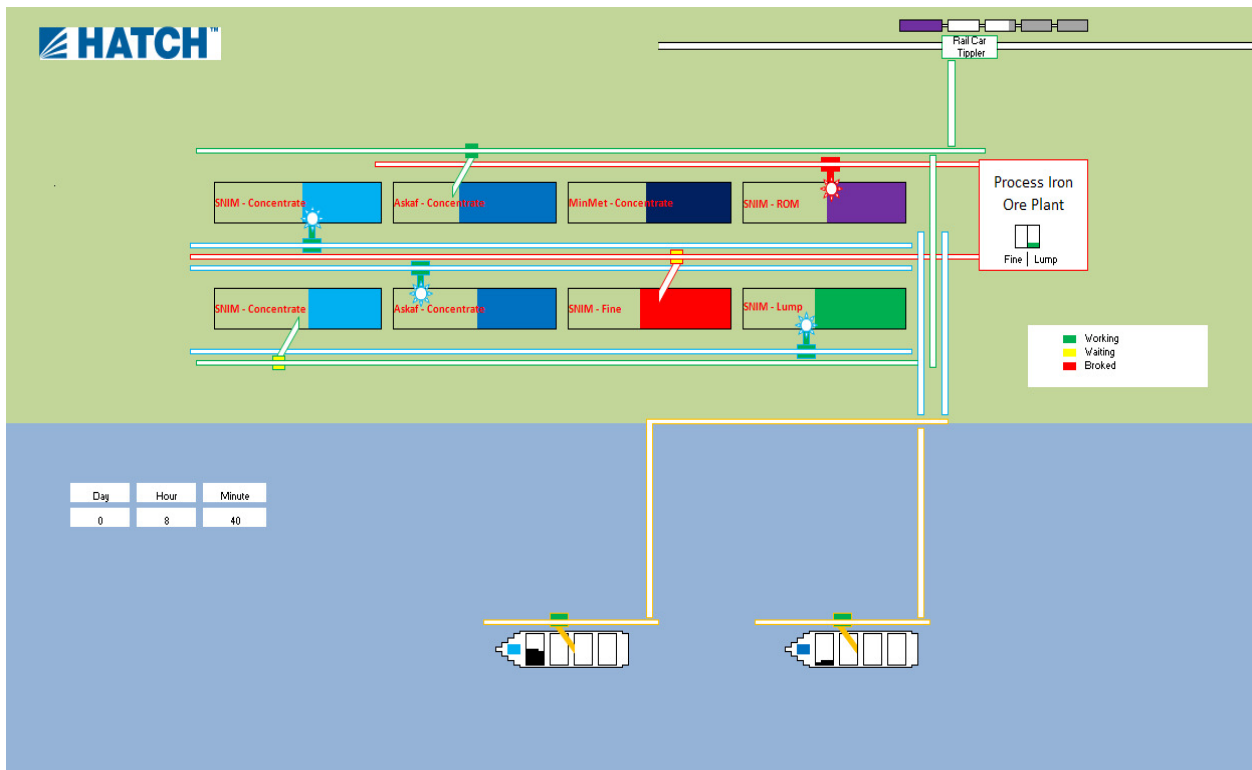
Figure 5 - Graphic Animation Model in Visual Basic

The dynamic simulation takes 15 days to be created and validated, and to run each state of this simulation takes 40 minutes without animation. According to the project and the inputs, it was necessary to created 5 scenarios for each phase, where were tested the different inputs and the output that they generated. Moreover, to optimized and find the bottleneck for each phase, for this takes around 7 simulation states, those result generated a graphic that describe the situation of the system to increase the port exportation.
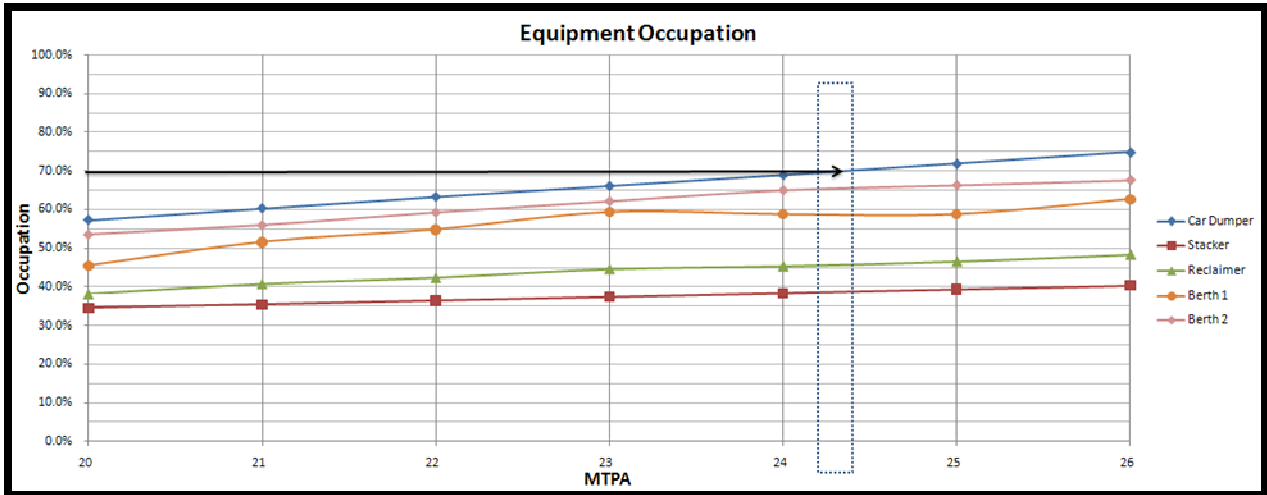
Graphic 1 shows the results of the third phase, which takes 7 simulation states, between 20 to 26 Mtpa, evidencing the maximum occupation of the equipments defining the limit of the port capacity. This information was obtained on the *Port designer's handbook* (Carl, 2006).

In summary, the approximate linear time to run all the states in the model was 3 x 5 x 7 x 40 min = 70 h.

Graphic 1 – Third phase (with six product) results

After the results, the client requested some modifications, and other points to be analysed. This modification generated another simulation, call Phase 4. The modifications were like new products in the stockpiles and the new equipment configuration. The time to adapt the existing model was estimated in 10 days. To reduce this time, the Visual Basic software was replaced by Arena, because of the spent time to create and run the model. The graphic animation of the model can be seen on Figure 6.
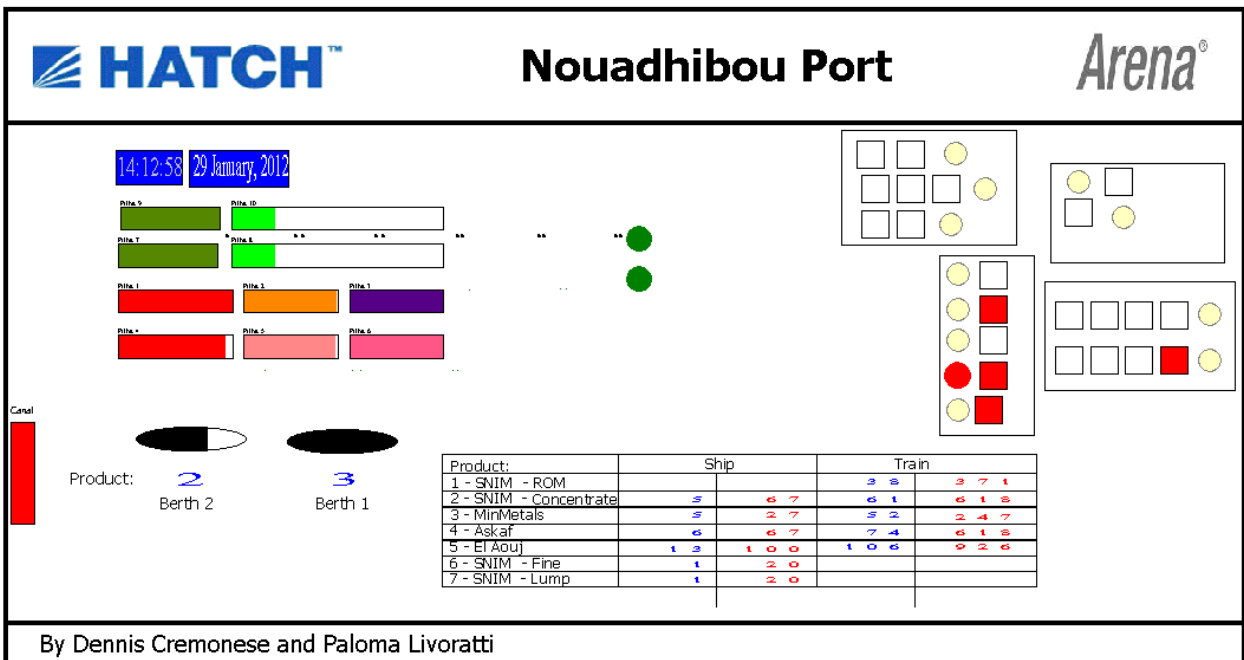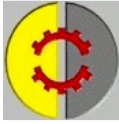

Figure 6 - Graphic Animation Model in Arena

IPMM 2011

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In the simulation using the ARENA software, the time to create and validate the model was 5 days, half of the time that was estimated to adapt the existing model in Visual Basic. Moreover, each simulation state takes around 2 minutes to run.

The ARENA software is faster than the Visual Basic, but the price of a license is around U$ 40,000.00 (Rockweell, 2011), and an engineer hour can be estimated in U$ 100.00. The office package to use Visual Basic cost U$ 419.00 (Microsoft, 2011). The costs and time to run and create the model can be summarized on Table 2.

Table 2 – Cost and Time Summary

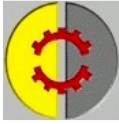|	Initial cost (U$)
Visual Basic	419.00
Arena	40,000.00

Engineer Hour Price (U$)	100.00

	time for each state (min)
Visual Basic	40
Arena	2

	time to create model (days)
Visual Basic	15
Arena	5

	spent total time in each model (hours)*
Visual Basic	142.2
Arena	43.3

*Considering 100 states per model, and that the Visual Basic run 3 states in parallel.
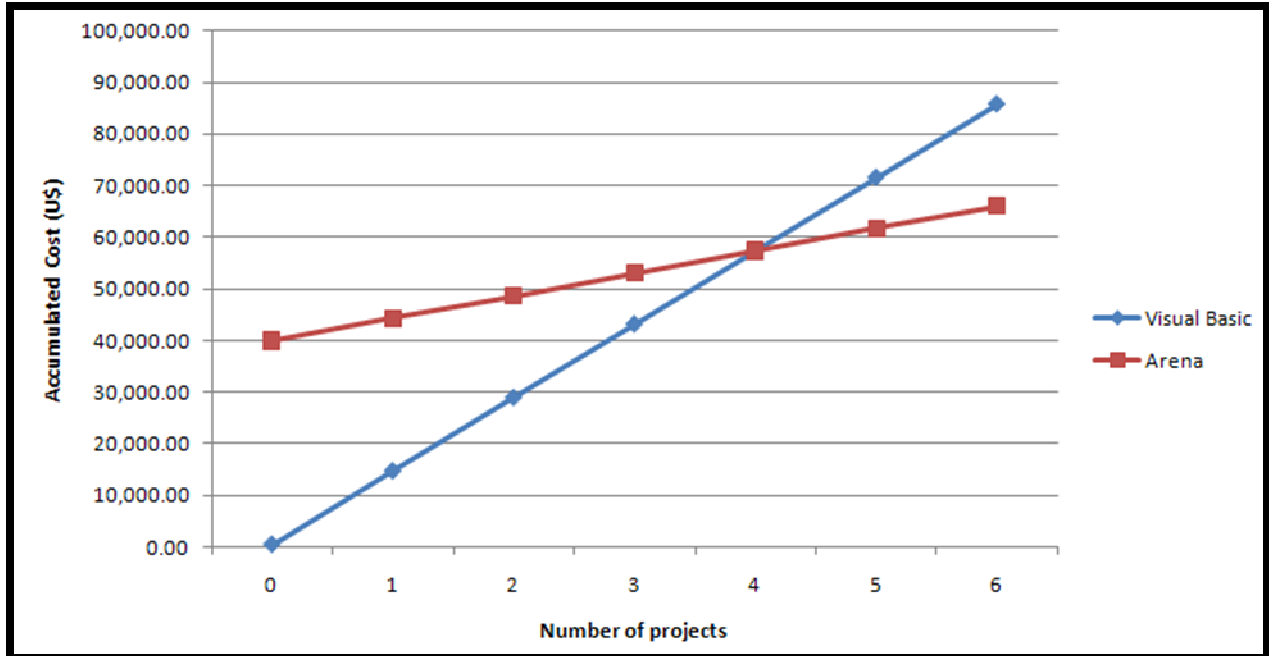
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CONCLUSION

Summarizing, the results from the Visual Basic and Arena software were very similar, the differential between them is the time to create and run the models.

The main objective of this study was to compare the software's investment cost. The values obtained in this project were placed in graphic, which can be seen in the Graphic 2, that shown the Accumulated cost (U$) per project made.
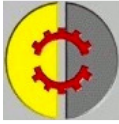
The graphic shows that if the Project Group wants to enter in the market of simulations, acquire the license is valid measure, but if the Group will do less than 3 projects, purchasing the license isn't a good deal.

Graphic 2 – Accumulated cost (U$) per project

According to this study, the Arena software is more indicated when the group uses the simulation to help him make decisions along the project design. In this phase it's possible to create a lot of scenarios, where the solution combinations can be tested, and the best result can be selected. In conclusion, this software is very flexible and more indicated for decision making.

However, the Visual Basic is more indicated when the client has a concluded project or will simulate less than 3 model, because is cheaper.

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ROCKWELL*, Rockwell Automation, Inc,* responsible for the software ARENA, Milwaukee, WI, United Stated of America, 2011.

AUTHORS

Paloma Livoratti is a Mechanical Engineer that works in the Mechanical discipline at Hatch São Paulo office in the Iron Ore Business Unit. She has experience in material handling, mainly stacker/reclaimers and port simulation.

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