

USE OF IDEF-SIM TO DOCUMENT SIMULATION MODELS

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ABSTRACT

The technique of conceptual modeling IDEF-SIM uses the syntax of IDEFØ and IDEF3 adapted to the peculiarities of the simulation models. It allows the state variables and the logical elements of a discrete system to be abstracted and ordered with most representativeness. However, it is essential to establish additional measures that enhance the process of collecting and authenticating relevant data. This context has motivated this research, which suggests a model documentary that, when associated with the methodology IDEF-SIM, allows recording the details of a dynamic system in an objective and standardized way. We carried a study on a seaport, allowing verifying that the system was translated with greater speed and detail. In this sense, we concluded that the record out in detail increased efficiency in the generation of knowledge about the particularities of the system, regardless of the complexity of the problem and the computer language adopted.

1 INTRODUCTION

The system of discrete events can provide difficulties in comprehension due to the complexity of the data. As a result, we can verify the construction of models with reduced reliability and effectiveness. According to Ryan and Heavey (2006), in the development of a simulation project, the adoption of measures that enhance the recording of data abstracted by the analyst echoes in the detailed description of the system and enhances the process of creating of the computational model.

Thus, we should develop the conceptual modeling techniques in order to facilitate the capture, visualization and interpretation of the elements of the system. This measure allows for the orderly progression of the study. We will investigate and represent through schemes, pseudo codes and/or verbal descriptions (Maria 1997; Banks et al. 2009; Carson 2004; Pidd 2004; Sargent 2008; Zachman 1987) all functions and variables available in the real environment, as well as the interconnections and rules. We note that we can employ various methodologies, but the best techniques reduce the efforts with the development of the model by rationalizing and integrating all components of the system.

The technique of conceptual modeling IDEF-SIM, proposed by Montevechi et al. (2010), allows the representation of the system in a satisfactory way and with simplified reading. It also offers logical elements for specific projects in the simulation. However, in complex environments, just as with IDEFØ and IDEF3 techniques, only the labeling of the elements and the use of a descriptive framework will not ensure that the model conveys the desired communication. One who knows the technique IDEF-SIM deeply but has little knowledge about the modeled system may not understand the meanings of the information described in the diagram. In this sense, the IDEF-SIM will maximize its efficiency when combined with a documental technique that, in standardized form, may collect and record the specifications of the system. We can list these specifications as the context of the problem and goals that must be met with the design of simulation, the detailed description of the facts and restrictions that constitute each element, and details of the input data.

Through the above context, this paper aims to present a proposal for standardized documentation that supports the conceptual modeling technique IDEF-SIM, increasing the systematic recording of information and data abstracted by the modeler during the development of simulation project.

2 IDEF-SIM MODELING

According to Whitman, Huff, and Presley (1997), the use of IDEFØ and IDEF3 techniques allows improvement in the capture and description of information concerning the system, in order to develop the conceptual model in simulation projects. However, the representations of the state variables and of the logic elements available in these techniques, when used separately, may not be sufficient to meet the needs of a simulation project. Simulation projects need grouping and adjusting of the conventional symbols. In this sense, Montevechi et al. (2010) propose a methodology for conceptual modeling called IDEF-SIM that by using the syntax and semantics of IDEFØ and IDEF3 adapted to the peculiarities of the simulation shows to be efficient in the representation of the simulated systems.

3 METHODOLOGY FOR DOCUMENTATION OF THE CONCEPTUAL MODEL

In the documentation of models, we must first determine the purpose of the project. We must emphasize the goals to achieve by declaring needs and defining the issues to be answered (Mayer et al. 1995). The question and the response of the real reasons for the problem analysis and the identification of the outcome favor the selection of performance measures and assist in developing the action plan (Carson 2004, Freitas Filho 2008, Ramirez 1998).

According to Mayer et al. (1995), five inquiries must be met for efficient collection and organization of data, namely:

a) Collect the data: This is the detailed log of the observations made in the sequencing of a production process. In this respect, the modeler must agree with the system experts and can capture an initial set of data from the explanation of the process. An efficient way to perform this topic is the previous preparation of the interview, namely: Establish goals and the types of information required; request authorization and scheduling of the interview; and submit, in advance, questions that can stimulate discussion and capture information with higher quality. In order to generate additional information, these interviews may happen throughout the project.

b) classify the data: it lists the productive phases with other elements available on the techniques of process modeling, such as the roles and relationships, the units of behavior, the segments or links, joints, objects, states of the objects and others;

c) organize the information: in this step, the data collected and classified will be sketched in accordance with the syntax of the diagram.

d) approve the scheme: a conceptual model validation is accomplished through following approaches: syntactic analysis and semantic analysis. Still in the semantic analysis, it is verified that the diagram represents the system under study based on information provided by customers and experts involved with the project.

e) refine the layout: the models can be constantly reviewed, so that possible adjustments are made. These refinements will occur by reason of adjustment of information, simplification of the scheme or assignment to elements.

Based on the context above, this paper presents a set of documents intended to assist the registration and interpretation of information available in systems formed by discrete events. Therefore, we pooled and adjusted the *IDEF3 Description Summary Form*, *Standard Diagram Form*, *IDEF Kit Contents Form*, *Units of Behavior (UOB) Elaboration Form*, *Junction Elaboration Form* and *Object Elaboration Form*,

constituents of the IDEF0 and IDEF3 techniques, to the principles and requirements of the modeling technique IDEF-SIM.

Due to the interactivities and characteristics in the generation of knowledge, the documental model suggested for the capture and transcription of the system parameters is not intended to set up a single and sequential approach to record the data. However, we propose the adoption of four forms, adapted to assist the process of examining, collecting, recording and reporting of data, namely: *Descriptive Summary IDEF-SIM*, *Standard Diagram IDEF-SIM*, *Registration of Legends and Contents IDEF-SIM* and *Preparation of the Elements in IDEF-SIM*. We develop the details of this documental model in Section 4, where we verify its applicability in describing the process of unloading coal at the Ferry Terminal Ponta Ubu - Samarco, located in Espírito Santo, Brazil.

4 IMPLEMENTING THE PROPOSAL DOCUMENT

In developing this section, we evaluated the efficiency of the documental model when used as an auxiliary tool in the acquisition of relevant data from the system and especially in supporting the process of computational modeling. To this end, we developed a case study for the system of unloading coal at the Ferry Terminal Ponta Ubu - Samarco - ES, Brazil, which in turn allowed to collect data, record them in the forms proposed, model conceptually the system through the IDEF-SIM and then interpret it in the simulation software Arena[®] 12 (Kelton et al. 2007).

Note that this research does not aim to hold trials for decision making and proposals for improving the ferry terminal, but to submit the documental model to a real environment. We did not consider all the variables present in the unloading of coal but only those that represent the essence of the system. That is in order not to expose the business, and to consider that simplifying the process would not affect the purpose of the study. As for methodology, we collected data through interviews with the technicians responsible for the operations of the port and by direct observation of the system under study.

4.1 Case Study

Samarco Mining, founded in 1977, now owned by companies Vale (50%) and BHP Billiton (50%), is a producer of iron ore, with a characteristic single production process. This process begins with the extraction of minerals in mining of open pit, followed by improvement in the Concentration Plant. The ore, once concentrated, is carried 396 km via pipeline to the Pellet Plants at Ponta Ubu, municipality of Anchieta (ES - Brazil), where it is thickened, processed (pellet-feed, sinter feed - or pellets), stored and shipped via a marine terminal (Samarco Mineração SA, 2009).

The Ferry Terminal Ponta Ubu, apart from exporting the production of ore and pellets, is also used in the reception of various charges for their own company and third parties. Among the main raw materials received, we highlight coal due to the volume moved and the relevance to the impact on the operations of the port.

4.2 Summary of Unloading Cycle

The process of unloading, where the coal is removed from the port and transported to the storage area of the company, begins with the early recruitment of dump trucks, which should be available in the ferry terminal before the arrival of the ship. These trucks wait in the waiting area until called to take up their positions in the loading area. In general, the unloading cycle is performed in a sequence (Figure 1). Firstly, the trucks occupy the loading area. Secondly, the load is removed from the ship and placed in trucks with the use of cranes on board and of the grabs. The loaded trucks will only be dispatched to the area of stock when the outflow is available. Once allowed to leave, the coal will be transported to the storage area, and the empty trucks return to the waiting area at the Ferry Terminal, repeating this cycle until the ship is fully unloaded.

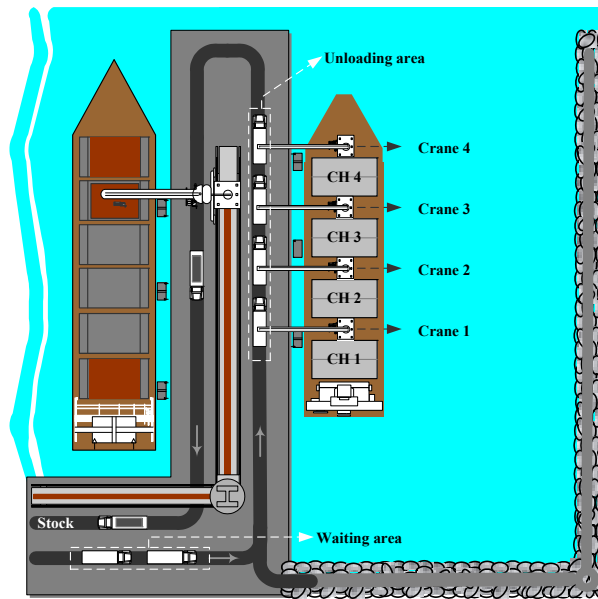


Figure 1: Unloading flow of coal

The lack of physical space for independent maneuvers generates the arrival of trucks in the series, i.e., as the mobile carrier ship (*ship loader*) occupies the central pier, the only entrance and exit restricts the movement of trucks. It stands out, too, that the combination of the characteristics and peculiarities of the ship employed may be increasing the problems of unloading. In this sense, taking into account the normal operation of the Ferry Terminal Ponta Ubu, the model considered a ship with four cranes and four bays, which, in turn, will order four dump trucks.

4.3 Formulation of the Documental Model: Collection of Macro Information and Conceptual Modeling

We relate the development of this step to the use of the forms *Descriptive Summary* and *Standard Diagram*. The *Descriptive Summary*, as shown in Figure 2, is used not only to contextualize the problem and record the goals that must be met with the project, but also to describe the appropriate scenarios to be modeled.

Mayer et al. (1995) describe that, commonly, an initial program of research may vary due to different needs that arise during the project. Therefore, in the *Descriptive Summary* form, we see recorded information related to the purpose and context of the study, serving as guidelines for analysts not to deviate from the preset goals. The contextualization of the problem should be concise, however, without losing efficiency in the generation of knowledge. In other words, the description should allow a person, unconnected with the case, to understand the process or at least to understand its nature. In the latter case, it will be easier to get the achievement of pending information. Note, also, that the field goal was hypothetically filled by considering that in this work there is not a problem to be solved.

Once collected, the macro information on the system should be outlined in the *Standard Diagram* form. In this sense, Figure 3 shows the conceptual framework based on IDEF-SIM technique. It refers to the current study (001/09), where the contextual elements were chronologically specified.

Rangel and Nunes

Analyst: <i>AFN</i> Company: <i>Samarco</i>	Date: <i>08/10/2009</i> Project n°.: <i>001/09</i>	<input checked="" type="checkbox"/> Working <input type="checkbox"/> Draft <input type="checkbox"/> Recommended <input type="checkbox"/> Released	Reviewers:	Date:
<p>Background: <i>The cycle of unloading of the coal consists of the following steps: (i) The trucks wait in the waiting area until they are allowed to enter the pier. (ii) Condition 1: the entry clearance of trucks depends on the existence of vacancies in the unloading area (note: the number of vacancies is related to the number of cranes in operation). (iii) Each truck holds a loading area (bay), positioning the trailer in the hopper. (iv) That done, each crane on board, through the grab, pull the coal from the ship's hold and move it up to the hopper, where the load is dumped into the bucket with effective capacity of 40 tons (note: this operation is repeated until the truck reaches the maximum load). (v) Condition 2: If the subsequent unloading area is released and the truck has not completed its loading capacity, it will move to the next area to continue the transfer and release set for the input of another truck. (vi) Condition 3: If the truck loading is complete and in front there is another truck in operation, it must wait for the release of the outflow (note: the conditions 2 and 3 were due to the impossibility of maneuvering of trucks on the pier, where they will come and go in series). (vii) With the withdrawal of the pier, the trucks will pass slowly by a scattering of water (shower), reducing the suspension of dust. (viii) Finally, the truck will transport the coal to the storage area and then will return to the waiting area at the Ferry Terminal, restarting the cycle of unloading.</i></p> <p>Objective: <i>(i) reduce the number of vehicles hired and; (ii) minimize the mismatches in the area of loading, caused by the batch process and the different capacities.</i></p>				
List of Scenarios		Modeler	Priority	
<ol style="list-style-type: none"> 1. <i>Macro process of unloading of coal (input flow, loading of the truck, stock of coal and return of the truck to the waiting area);</i> 2. <i>Process of unloading of coal;</i> 3. <i>Process of storage of coal.</i> 		-	-	
Project Name: <i>Description of unloading of coal at the Ferry Terminal Ponta Ubu</i>			Type Form: <i>Summary</i>	<i>SD 001</i>

Figure 2: Descriptive Summary of the process of unloading of the coal

The data that composes the documents above is interpreted in different ways. So, for the *Descriptive Summary Form*, it is respectively reported the name of the analyst responsible for simulation project, the date on which the document was created, the name of the company studied, the number of the project, the project name and the form code. For purposes of planning, there is a list of possible scenarios for the project, as well as it includes the name of those responsible for analyzing and describing the scenarios and the order of priority of this study. The *Standard Diagram Form* includes the name of the author responsible for developing the conceptual model, the creation date of the document, the name of the project in accordance with the above in the Descriptive Summary. It also includes the reference node for the appointment of the level of decomposition of the scheme and identification of which element, of the parent diagram, is being detailed. The title and the code / page of the document close this Form. Finally, for *both forms*, the conditions of the model, the names of the reviewers and the date of occurrence of reviews are described. Under the conditions of the model, it is specified the situation where the document is. Thus, in the *Working* item there is an indication that the scheme analyzed is under construction or that there is a significant change being developed, regardless of previous *status*. The *Draft* states that one needs to make minor corrections to the previous scheme before accepting it. That is based on the opinions

of a number of analysts. When the *Recommended* field is registered, it is understood that the document is providing information regarding the review and approval of the project, not being used for future changes. In the *Released* field, it is informed that the document is in the final version and may be published.

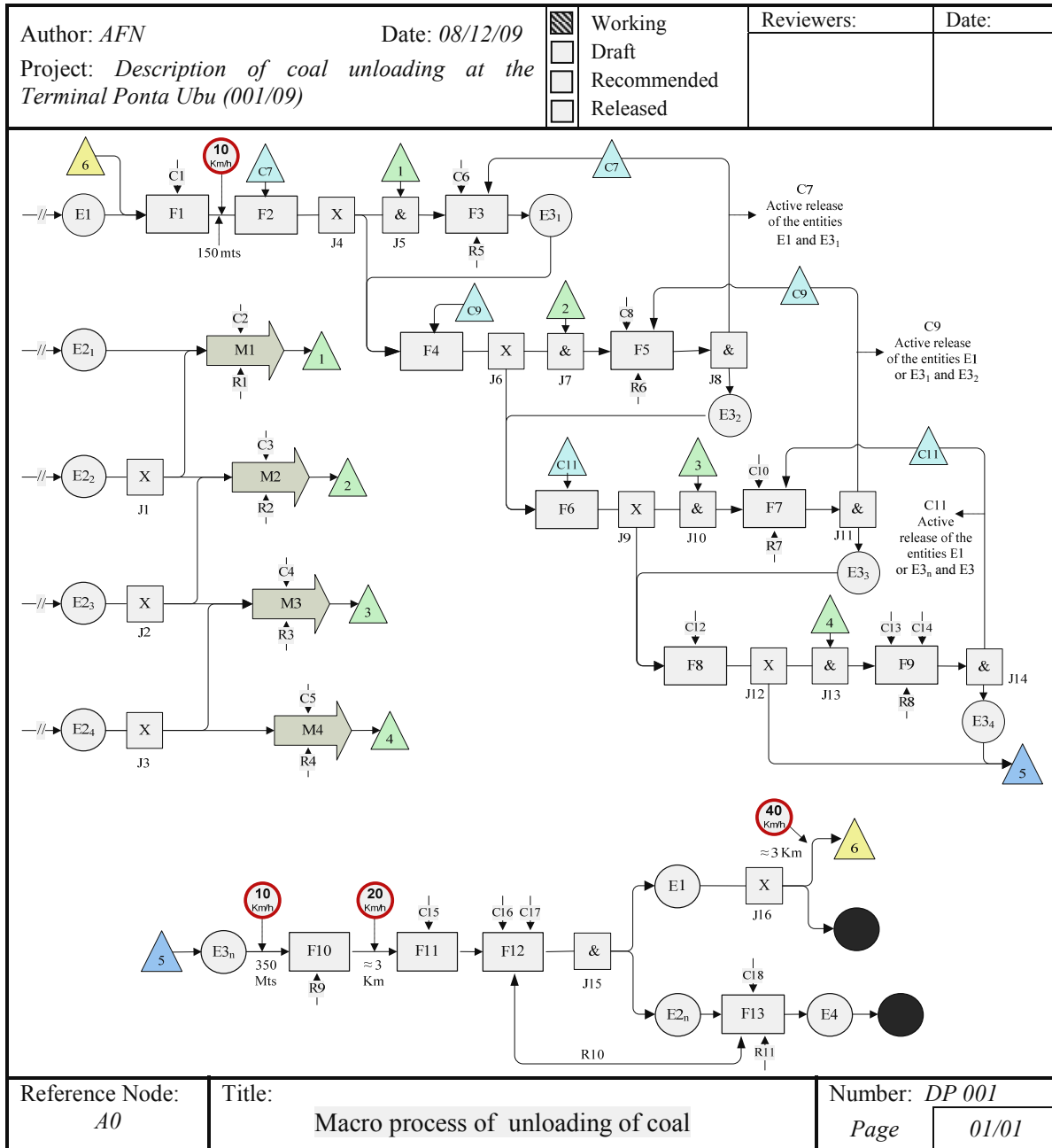


Figure 3: Standard Diagram of the macro process of unloading of coal

4.4 Formulation of Documental Model: Collection, Treatment and Data Registration

The main elements of IDEF-SIM technique used to lay out the system (Standard Diagram) should be labeled, in a concise way, in the *Contents and Legends Registration* form. The description of the elements in this form (type, code and title / description) could be developed in a sequential manner, respecting the

order of their occurrence in the diagram and / or group of elements. In order to facilitate understanding, the use of this tool is explained in Figure 4.

Author: <i>AFN</i>		Date: <i>08/12/09</i>	<input checked="" type="checkbox"/> Working	<input type="checkbox"/> Standard
Project: <i>Description of unloading of coal at Ferry Terminal Ponta Ubu (001/09)</i>			<input type="checkbox"/> Draft	<input type="checkbox"/> Update
			<input type="checkbox"/> Recommended	
			<input type="checkbox"/> Released	
Type	Code	Title / Description	Page	
<i>1</i>	<i>E1</i>	<i>Empty truck</i>	<i>01</i>	
<i>1</i>	<i>E2₁</i>	<i>Coal available in the hold 1 of the ship</i>	<i>01</i>	
<i>1</i>	<i>E2₂</i>	<i>Coal available in the hold 2 of the ship</i>	<i>01</i>	
<i>1</i>	<i>E2₃</i>	<i>Coal available in the hold 3 of the ship</i>	<i>01</i>	
<i>1</i>	<i>E2₄</i>	<i>Coal available in the hold 4 of the ship</i>	<i>01</i>	
<i>1</i>	<i>E3₁</i>	<i>Truck loaded in bay 1</i>	<i>01</i>	
<i>1</i>	<i>E3₂</i>	<i>Truck loaded in bay 2</i>	<i>01</i>	
<i>1</i>	<i>E3₃</i>	<i>Truck loaded in bay 3</i>	<i>01</i>	
<i>1</i>	<i>E3₄</i>	<i>Truck loaded in bay 4</i>	<i>01</i>	
<i>1</i>	<i>E4</i>	<i>Coal stacked in the storage area</i>	<i>01</i>	
<i>3</i>	<i>M1</i>	<i>Getting the coal from the hold of the ship into bay 1</i>	<i>01</i>	
<i>5</i>	<i>C2</i>	<i>Check if the truck is positioned in the bay or is already loaded</i>	<i>01</i>	
<i>6</i>	<i>R1</i>	<i>Crane board 1, grab 1 and crane operator 1 (docker)</i>	<i>01</i>	
<i>3</i>	<i>M2</i>	<i>Getting the coal from the hold of the ship into bay 2</i>	<i>01</i>	
<i>5</i>	<i>C3</i>	<i>Check if the truck is positioned in the bay or is already loaded</i>	<i>01</i>	
<i>6</i>	<i>R2</i>	<i>Crane board 2, grab 2 and crane operator 2 (docker)</i>	<i>01</i>	
Title: <i>Macro process of unloading of coal</i>			Ref. Node: <i>A0</i>	
Element Type: <i>1 – Entities; 2 – Functions; 3 – Drive; 4 – Rules; 5 – Control; 6 – Means; 7 – Others</i>			Page	<i>01</i>

Figure 4: Registration of Legends and Contents of the macro process of unloading of coal

Considering that the objective of this research is to present the applicability of the documental draft and that the conceptual model IDEF-SIM, which refers to the Macro process of Unloading of Coal, is composed of 76 elements highlighted, only 16 of these elements were labeled in the form above, being sufficient to demonstrate the form and the simple process to fill the form.

The *Contents and Legends Registration* form aims to facilitate the reading and interpretation of the Standard Diagram. However, as this is a brief description, some information of the system such as the *objects involved (entities)*, the *summary of the facts*, the *case constraints (restrictions)* and the *design of the input data* may be omitted or constructed without clarity, especially in environments with higher levels of complexity. In this sense, to increase efficiency in detailing the features and characteristics of the elements of a system, its characteristics should be recorded in the form *Preparation of the Elements*. This measure allows the transcription of pertinent information that would hardly be expressed in the schematic model and simplifies the process of review and validation of the conceptual model IDEF-SIM.

In this section, to demonstrate the functionality of the form *Preparation of the Elements* (Figures 5 and 6), only the elements E1 (empty truck) and M1 (Getting the coal from the hold of the ship to the truck located in bay 1) have been elucidated.



Author: <i>AFN</i>		Date: <i>08/12/09</i>		<input checked="" type="checkbox"/> Working	Reviewers:	Date:
Project: <i>Description of the unloading of coal at the Terminal Ponta Ubu (001/09)</i>		<input type="checkbox"/> Draft	<input type="checkbox"/> Recommended	<input type="checkbox"/> Released		
Element Symbol   Code <i>E1</i>	Element Name: <i>Empty truck (Type: Flow into the modeled system and Entity)</i> Objects: <i>Empty truck (Created, Agent and Participant).</i> Facts: <i>(i) In the input flow, the truck (E1) should arrive one hour before the start of the loading process. (ii) Its entry on the pier is related to the order of arrival in the waiting area. (iii) After the filling of the charge in the storage area, the empty truck returns to the waiting area. Note: This cycle is repeated until the unloading of the ship is complete.</i> Constraint: <i>(i) The reduction in the availability of trucks due to the non-attendance of the vehicle hired and possible breaks in the proceedings. (ii) The maximum rate of displacement at the pier and return to storage area, which are respectively 10 km/h and 40 km/h.</i> Description: <i>They are hired, on average, 30 trucks, which should be available before the process of unloading coal from starting. Therefore, the input flow of this entity will not affect the model. These trucks are the rocker with effective capacity of 40 tones. Note: The amount of contracted trucks is estimated considering the risk of breakage of the truck (reliability), the number of cranes on the ship and the constant stops in the process of unloading coal.</i>					
	Description of Input Data					
	Dimension (n) / Composition:					
	Statistics Distribution:					
Statistics Summary:						
Reference: <i>Project 001 – SD 001</i>		Element Described: <i>Entities Empty truck (E1) and Coal in the hold 1 (E2₁).</i>			Form: <i>EE 001</i>	
					Page	<i>01</i>

Figure 5: Form for the Preparation of Elements of the conceptual model, element E1

It is observed that the data of the headers that compose the Contents and Legends Registration and Preparation of Elements are identical to the Standard Diagram form, keeping the same meaning. However, other fields are interpreted as follows: For the Contents and Legends Registration form in Figure 4, the *kit Standard* reports that the model was developed in an orderly manner and the *kit Update* is adopted to record the final version and to indicate that updated information were added to an existing and validated model. In the body of the document, they are informed the type of element, the element tag in accordance with the conceptual model, a brief description of the element and Standard Diagram page in which the element has been described. Finally, at the bottom, it is described the title of the system under study, the reference number of the element type (coded 1 to 7), the reference node of the diagram documented and pagination of the form. In the *Preparation of the Elements* form in Figure 5, one can see that fields are suitable for all elements of the methodology IDEF-SIM, avoiding the use of various documents. In this sense, in the *Element Name* field, it is briefly described the functionality of the element in the modeled system. The *Objects* represent the physical or informational entities that interact directly with the element documented, and can be created, modified or destroyed in the process. Mayer et al. (1995) add that the objects of interest can be classified as *Agent* (when the object to be subjected to a processing unit plays an active role), *Affected* ((when the object receives the processing by a unit),

Participant (when the object does not suffer or cause changes when interacting with the processing unit) and *Created* or *Destroyed* (when the object, respectively, is created or destroyed by a processing unit). In the field *Facts*, the main actions and measures are in context, giving meaning to the events represented by the elements under study. The *Constraint* is a field created to list the restrictions or obligations on the system modeled. In the *Description*, one can detail the characteristics of each element, such as its function, interactions (links input and output), the resources used and the controls established. When the interaction between the static and dynamic elements of a system is time consuming, either to insertion or systematic processing of a temporary entity, the statistics of *Input Data* needs to be documented. Due to the learning curve and changes in the process, this information needs to be constantly reassessed.

In summary, the proposed forms for the documentation of discrete event intend to collect, sort and organize data, but also to facilitate the process of verifying and refining the schema. In this sense, it seeks, efficiently, to represent the way the system operation takes place and not the way it will be developed in simulation software. This move enables an analyst, experienced or not, to get the information needed to develop the computational model, regardless of language used.


Author: <i>AFN</i>		Date: <i>08/12/09</i>	<input checked="" type="checkbox"/> Working	Reviewers:	Date:
Project: <i>Description of the unloading of coal at Terminal Ponta Ubu (001/09)</i>			<input type="checkbox"/> Draft		
			<input type="checkbox"/> Recommended		
			<input type="checkbox"/> Released		
Element Symbol	Element Name: <i>Getting the coal from the ship's hold to the truck positioned in the bay 1 (Type: Drive).</i>				
	Objects: <i>Empty truck (Agent) and Coal (Agent).</i>				
Code	Facts: <i>Crane No. 1, through its Grab, removes the coal within the hold 1 or 2 and puts in the hopper to fill the back of a truck positioned in the bay 1.</i>				
<i>M1</i>	Constraint: <i>(i) The ability of the Grab is defined as the attributes of the cranes, i.e., the ship employed is responsible for providing this equipment, which in turn will be sized according to the effective capacity of the cranes on board. (ii) Operators of cranes (stevedoring) have different abilities, creating a high variability in the time of discharge. Note: the building of the operators team is made by the union and not by the company.</i>				
	Description: <i>The resources required for this operation are the ship's crane 1, Grab 1 and Crane Operator 1. As for the controls it is essential that the stevedore monitors the volume of charge in the back of the truck and inside the ship. It is also important to be taken into account the distance from the hold/ pier and conditions of tide and wind.</i>				
	Description of Input Data				
	Dimension (n) / Composition: <i>100 observations / Systematic sampling.</i>				
	Statistics Distribution: <i>Triangular (a, m, b).</i>				
	Statistics Summary: <i>Range of 1.20 minutes with minimum and maximum values of 2.45 and 3.65 minutes. The average time is 3.14 minutes, standard deviation of 0.289 minutes and the sum of squared errors of 0.025936.</i>				
Reference:	Element Described: <i>Movement of coal through the cranes M1.</i>		Form: <i>EE 001</i>		
<i>Project 001 – SD 001</i>			Page		<i>02</i>

Figure 6: Form for the Preparation of Elements of the conceptual model, element M1

5 TRANSLATION OF THE DOCUMENTAL MODEL IN ARENA® 12

The translation efficiency of the conceptual model requires that the main events of the system are reported clearly. In this sense, the development of a computational model (Figure 7) relied on information in the Descriptive Summary, Contents and Legends Registration and Preparation of the Elements forms.

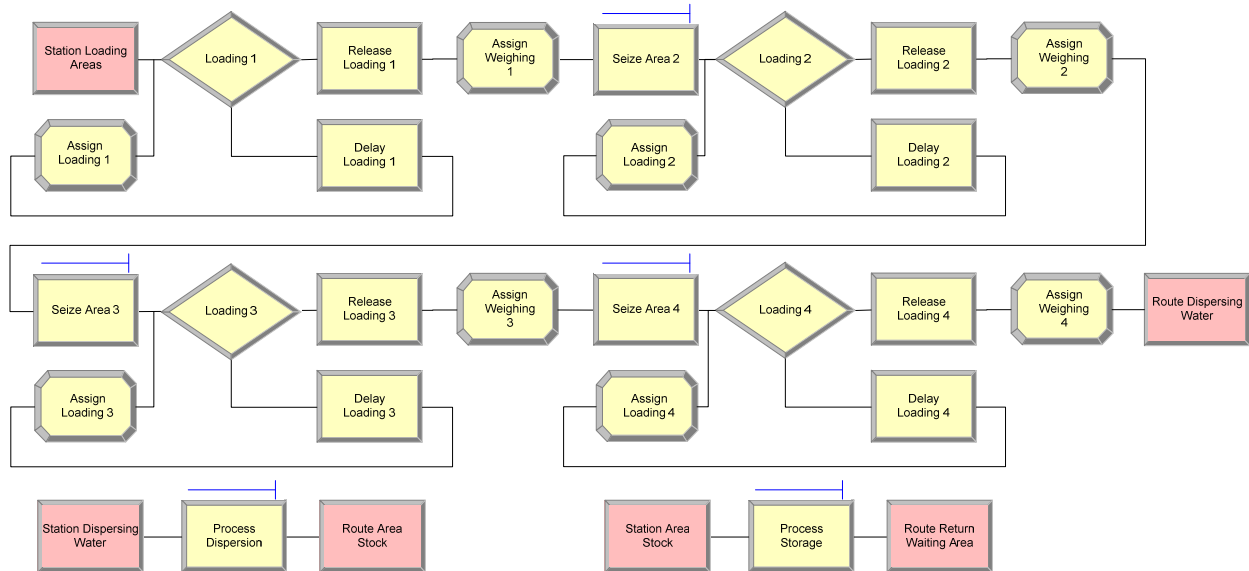


Figure 7: Computational modeling (Arena® 12) of the system of unloading of coal

The modules *Assign* and *Decide* establish the logical parameters responsible for monitoring the dynamics of the model. Initially, there is an *Assign* module that adds an attribute, named Charge, to each entity that enters the system modeled. This attribute, then, is used to control the amount of charge added to the truck and allows that the *Decide* modules, through its logic control, occupy the loading bays. The occupation is made in decreasing order, starting from the last (Bay 4) for the first (Bay 1). The release control of the bays is also run by the *Decide* module, where the truck will be released, when the subsequent bay is available and the Loading variable *n* reaches the preset value. The combination of the modules *Station* as a destination and *Route* as a source enables that the time consumed with the displacement is adequately represented in the model.

6 WHAT HAVE WE LEARNED?

In developing this model, it was evident that the adoption of the proposal document increased efficiency in the generation of knowledge and thus facilitated the construction and verification of the computational model. In complex environments, just as with IDEF0 and IDEF3 techniques, only the labeling of the elements and the use of a descriptive framework will not ensure that the model conveys the required communication. A person, who deeply knows the technique IDEF-SIM, but has little knowledge about the modeled system, may not understand the meanings of the information described in the diagram. In this sense, the IDEF-SIM will have maximized its efficiency when combined with a documental technique that, in standardized form, may collect and record the specifics of the system.

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