Proceedings of the 2014 Winter Simulation Conference
A. Tolk, S. Y. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

ANALYSIS OF THE APPLICABILITY OF THE IDEF-SIM MODELING TECHNIQUE TO THE STAGES OF A DISCRETE EVENT SIMULATION PROJECT

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ABSTRACT

The IDEF-SIM technique was developed in order to facilitate the translation of conceptual models to computational models. Papers using this technique can be found in the existing literature, however, none present an analysis of how the technique behaves throughout all of the stages of a discrete event simulation project. Therefore, a research-action was developed with the practical objective of constructing a computational model as a help to future decision making. The knowledge objective is to analyze the applicability of this technique in all of the stages of the discrete event simulation project. It was concluded that the IDEF-SIM demonstrates as applicable: during the conception stage in which information of the process was documented in detail; during the implementation stage in which the conceptual model was converted into a computational model; and during the analysis phase, promoting the communication between modulators and managers in the presentation of proposed changes.

1. INTRODUCTION

Reasons such as growing globalization, accelerated evolution of communication, universal information and the decrease of the lifecycle of products have lead companies to focus their resources on strategies that allow survival in an increasingly competitive market.

Various strategies have been tracked by organizations wanting them to maintain their competitiveness in this turbulent market. One of these strategies is related to a better understanding of how the organization’s own processes function. Knowing its own processes, the company has a more solid foundation for future decision-making, and is able to visualize how their system would react to changes, for example, oscillations in demand, decrease or increase in labor, the automation of a process, among many other possibilities.

In order to understand and manage in the best possible way, many organizations have been motivated to make substantial investments in initiatives to model their processes. This situation in turn has triggered significant academic and commercial papers with the objective of finding solutions for modeling the processes (Rosemann et al. 2010).

Barber et al. (2003) believe that both process modeling (Business Process Modeling) and simulation (Business Process Simulation) has helped companies better understand their processes. Yet according to the authors, although process modeling directly provides a structured and static approach for the management of the improvement of processes, offering a holistic perspective of how the company works and a way of documenting the processes, it is simulation that permits one to study the dynamics of a process and still consider the effects of changes without risk, always supplying richer information.Several authors, for example, Banks (1998), Law (2006) and Montevechi et al. (2007) present methodologies to be followed for the structured development of discrete event simulation projects. The main steps of this methodology can be synthesized into three principal steps: conception, which has data collection, development and validation of the conceptual model; implementation which has construction, verification and validation of the computational model; and finally the analysis stage where it is possible to perform experiments and evaluate the results.

In the initial stage of a simulation project, the system to be simulated must be understood and the collected information must be translated into a conceptual model by means of an appropriate modeling technique. Meanwhile, Ryan and Heavey (2006) claim that few process modeling techniques used in BPM provide the support necessary for a simulation project. In order to tackle this need, the authors Montevechi et al (2010) developed a conceptual modeling technique called IDEF-SIM. This technique is a combination of modeling techniques already known: IDEF0, IDEF3, and flowchart, however it features a logic focused on the construction of discrete event simulation models.

There are examples of the application and analysis of the use of this technique in the existing literature (Silva et al. 2014; Sena et al. 2013; Rangel et al. 2013; Cardoso et al. 2012; Lima et al. 2012; Rangel and Nunes 2011;). However, the analysis of the applicability of the technique in these papers was restricted only to one stage of a simulation project, called implementation. Yet, the question arises: does the IDEF-SIM technique show itself applicable in all of the stages of a discrete event simulation project, that is, in the conception, implementation, and analysis stages? The authors of this paper intend to remedy this doubt and generate more knowledge about this conceptual modeling technique. It is noteworthy that, being a relatively recent technique in the existing literature, all of the analysis becomes important in the sense of contributing to the decision of a modeler in their choice of which conceptual modeling technique could be conducive to their objective.

The research method selected for the development of this paper is the Research-action method, since it seeks to resolve a problem and also generate knowledge about the solution encountered, the objective totally conducive to what is intended to be accomplished in this paper.

The objective of a research-action project can be divided in a practical objective and the knowledge objective. In this context, the objective of this paper follows this exact division, as seen in the following:

a. Practical Objective: Develop a discrete event simulation project so that the company managers being studied have a larger understanding about their process, as well as get to know their reactions facing possible changes.
b. Knowledge objective: Analyze the applicability of the modeling technique called IDEF-SIM, in all of the stages of a discrete event computational simulation project.

2. BACKGROUND

2.1 Conceptual Modeling

Mapping processes has turned into an important strategy adopted by companies, so that they can develop a greater understanding of their systems and thus have a larger base for analysis of decision making. In accordance with Madison (2005) process mapping is an effective technique that permits organizations to see their business systems graphically in any level of detail and complexity.

For Muehlen, Zur and Indulska (2009) the organizations are increasingly interested in understanding, managing, and improving their portfolio of processes. Glassey (2008) affirms that the methods and tools of the modeling process helps in capturing, representing, organization, and storage of knowledge of the state of an organization.

Despite all of the advantages offered by the process mapping activity, in some cases, the same can be unsatisfactory. According to Aguilar-Savén (2004), when an analysis of a process demands mechanisms more sophisticated than qualitative analyses or models of statistical diagramming, there is a necessity to use dynamic and functional aspects. In this case, the users need a model that permits more interaction for analyses such as "what would happen if", like computational simulation models.

Sandanayake, Oduoza and Proverbs (2008) believe that the modeling and simulation tools help in visualizing, analyzing, and optimizing complex processes of production, within a reasonable quantity of time and investment. Furthermore, according to the authors, the simulation of manufacturing systems has increasingly turned into an important search for an improved performance of processes.

Conceptual modeling has been recognized as a critical step that directly affects the quality and efficiency of simulation projects. A well-done conceptual model significantly reduces the communication barriers, diminishes the time of the project, and even improves the quality of the simulation (Zhou, Zhang and Chen, 2006).

The construction of a conceptual model impacts in all aspects of a simulation study, principally in the data collection, velocity with which the model will be developed, validation of the model, speed of the experimentation, and confidence in the results (Robinson, 2008). In accordance with Brooks and Robinson (2001), a conceptual model can orient the data collection stage, by defining the collection points, as well as streamline the elaboration process of the computational model.

For Kotiadis and Robinson (2008), in recent years many analysts and simulation modelers increased the interest for the conceptual modeling techniques, where, beyond just the efficiency in the abstraction of the model, it is searched to mature the knowledge referring to the system studied. Ryan and Heavey (2006) describe that by offering a detailed architecture of various levels of the system, the conceptual modeling process eases the collection, registration, and transmission of information and thus helps in the communication between the agents involved with the development of the simulation project.

Despite the large importance of conceptual modeling highlighted by the cited authors, this stage does not always receive the attention which it is due in computational simulation projects. Wang and Brooks (2007) affirm that of all tasks involved in a simulation project, the conceptual modeling is probably the one that receives the least attention and consequently is least understood.

Although the conceptual modeling is vital, it is the most difficult and least understood step in the modeling process (Robinson 2008). For the authors Zhou, Zhang, and Chan (2006), the construction of the conceptual model is the least understood and poorly formalized step and has been given little attention in this step in practice.

In accordance with Aigner et al (2007), the existing difficulties in the conceptual representation of a dynamic system are many, to start with the description of the large volume of existing data in complex problems such as varieties in the established times and rules. Montevechi et al. (2010) believe that a probable cause of this lack of attention offered to conceptual modeling is the use of conceptual modeling techniques that do not offer sufficient advantages for computational modeling, thus de-motivating special cares with conceptual modeling.

For Robinson (2008) this lack of attention is related to the fact that the conceptual modeling is more an art than a science, and thus is difficult to define methods and procedures. In order to work around this problem, diverse authors have searched to structure a methodology for simulation projects, consequently including a methodology to be followed for the conceptual modeling stage. However, the methodology used in the development of this project was the methodology proposed by Montevechi et al. (2010).

According to Harrel et al. (2002), in spite of each simulation project projecting particularities that it characterizes as exclusive, the adoption of a methodology that leads the analyst in the development of the computational model, could reduce the risks with the generation of unsatisfactory results.

The efficiency of one stage of modeling also is related to the correct choice of the modeling technique to be used According to Perera and Liyanage (2000) the correct use of modeling techniques in the conceptual phase increases the quality of simulation models and decreases the construction timedemandedfor the construction of these models.

The authors Ryan and Heavey (2006) affirm that no modeling technique exists that offers sufficient support to simulation projects. As a result of the limits of these techniques, different integrated modeling methods have been developed (Hernandez-Matias et al., 2008).

Jeong, Wu and Hong (2009) affirm that the practice of the construction of models without a methodological approach produce incorrect models, mainly because of the lack of communication and the improper abstraction of the model. The chosen technique for the conceptual model should be complete or sufficient to comply with its objectives, but at the same time should be easy to understand. The experience shows that complex mapping techniques allow for meeting its objectives, becoming impractical (Montevechi et al. 2010).

2.2 IDEF-SIM (Integrated Definition Methods - Simulation)

Montevechi et al. (2010) proposed a conceptual modeling technique, named IDEF-SIM, that uses and adapts logical elements of modeling techniques already consecrated in Business Process Modeling, thus permitting an elaboration of conceptual models with useful information for the computational model. Beyond this use, the technique permit's a documentation of computational models, easing the understanding of the project.

The main characteristic of IDEF-SIM is the identity of its application logic with the logic used in discrete event simulation.This characteristic has the objective of creating a conceptual model of the process to be simulated, that have elements required in the computational modeling phase.

The elements used to compose the IDEF-SIM technique were selected from the modeling techniques already consecrated: IDEF0, IDEFH3, and the flowchart. Although the techniques IDEF are apt for the modeling of systems, when used in simulation projects they allow for the registration of important aspects, for not having been structured for simulation projects. In this way, IDEF-SIM is used for symbols of IDEF0, IDEF3, and the flowchart but within a logic that contemplates discrete event simulation (Montevechi et al. 2010)

Furthermore according to Montevechi et al. (2010), in order to elaborate the logic of IDEF-SIM, logical elements which permit the specialist in computational modeling to construct an initial model with the main structure of the system to be simulated. These logical elements of IDEF-SIM induce the responsible person by the conceptual model being able to concentrate on the aspects that afterwards would be fundamental to the person responsible for the computational model.

3. RESEARCH METHOD: RESEARCH-ACTION

Coughlan and Brannick (2005) affirm that the research-action method is a research approach based on a collaborative relationship between the researcher and client that helps both to solve a problem and generate new understanding.

In accordance with Coughlan and Coghlan (2002), research-action method has two objectives:

- Practical objective: to contribute to the best equation possible of the problem, considering how the center of the research, with raising solutions and the proposal of corresponding actions for the solutions to help the agent in his transformative activity of the situation.
- Knowledge objective: Obtain information that would be difficult to access by following other procedures and thus increasing the knowledge about certain situations.

A planning application of the research-action method encountered in the existing literature is the proposal made by the same authors Coughlan and Coghlan (2002). According to them, the application of the research-action understands three main phases: the pre-step, related to the understanding of the context and the planning of the research, the six main steps that make a known cycle a main cycle of the research-action and the meta-step for monitoring, which has an investigative character.

The following has been the description of the six main steps, according to Coughlan and Coghlan (2002).

1. Data collection: The data is collected in different ways, depending on the context, by observation groups or researchers. There are those called primary data, for example, data collected by means of

financial briefs and marketing reports. There are yet the secondary data that are collected by means of observations, discussions, and interviews.

2. Feedback of the data: The researcher gathers the collected data and feeds them to the system client with a connotation that turns it available for analysis.
3. Data analysis: the critical aspect of the analysis of the data in the research-action is that it is collaborative, both the research and the client system members perform together. This collaborative approach is based on the assumption that the clients know their company best, since they will be the ones that implement and follow the proposed actions, therefore they know what would work.
4. Action planning: Questions such as which changes are necessary, where they should occur and what type of help will be necessary are raised in this stage.
5. Implementation: the implementation stage consists of completing the desired changes and following the plans in a collaborative way with relevant key members of the organization.
6. Evaluation: involves a reflection about the intentional and unintentional results of the action, a revision of the process so that the next planning cycle and action cycle can benefit from the cycle already completed.

For the application of the research method in this paper, each cycle of the research-action will correspond to a stage of a discrete event simulation project. It should be noted that different proposals of stages of the conduction of a simulation project exist; however, in this paper the structure proposed by Montevechi et al. (2007) will be implemented. In this methodology the twelve main steps can be grouped into three principal stages, the conception, implementation, and analysis stages. Therefore, three cycles of the research-action will be completed, one cycle for each stage of the simulation project (figure 1).

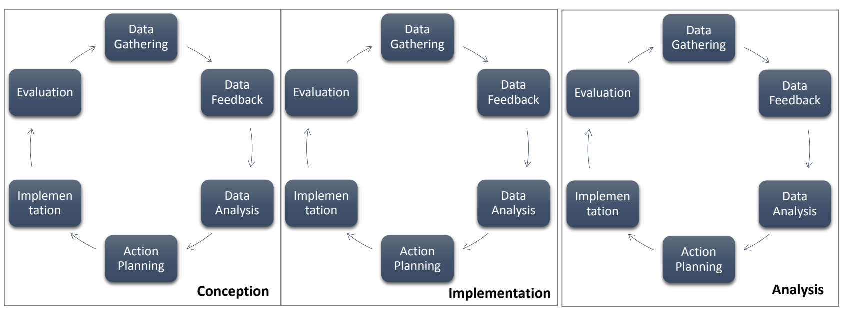

Figure 1 - Cycles of the research-action associated with the stages of a simulation project.

It is important to highlight that in order to reach a significant result of the knowledge objective, the meta-step of the research-action related to the monitoring of all steps of the cycle, will be used to analyze the use of the IDEF-SIM technique in all of the steps of the computational simulation project being developed.

4. APPLICATION OF THE RESEARCH-ACTION METHOD

According to Coughlan and Coghlan (2002), the pre-step is directed by two questions related to the rationality for action and for research. The rationality for action begins when a research-action unfolds in real time and starts with the key members of the organization developing an understanding of the context of the action project. The rationality for research involves questioning why this action is worthy of studying, as research-action can be considered a methodology suitable to be adopted and which has a contribution desired to develop knowledge.

In order to identify the question of the rationality of action, a meeting was held with the key members of the organization selected for study. In this meeting the industrial director, the quality coordinator, the production manager, and a production engineer were present. All were interested in the project to be developed in the company.

Those involved in the project on behalf of the organization demonstrated exceptional concern for the quality control cell. This is responsible for testing close to 80% of products produced in the production cells of the company. The managers believe that this cell could be overloaded and they don't know how it would react facing some changes such as a possible increase in demand, a change in the types of products tested by the cell, or if automation were to be introduced in one of the existing test steps.

Facing the company's concern to better understand the process of its quality control cell, as well as prevent reactions of the cell to certain changes, it was proposed to develop a simulation project in the cell in question. This simulation project is related to the action of the research-action method. Since the rationality question for research corresponds to the analysis of applicability of a new conceptual modeling technique called IDEF-SIM, to be used in this computational simulation project.

4.1 Cycle 1: Conception Stage

The main result of this stage is a simulation project and a valid conceptual model, that together with the modeled input data, it would enable the construction of a computational model of the system.The first stage of conception of a simulation project developed in the quality control cell of the company in question corresponds to the first cycle of the chosen research method, research-action. A summary of all of the stages of each step of this method related to the development of the conception stage of a simulation project can be found in table 1.

Table 1- Steps developed in Cycle 1 of Action Research

Data gathering:	Direct observation of the cell, process mapping through the SIPOC and flowchart techniques
Data feedback:	Presentation of data gathered to the sponsors of the company
Data Analysis	Important information for the understanding of the functioning of the cell and for the construction of the computational model that were not detailed.
Action Planning	Selection of the IDEF-SIM technique for the modeling of the process.
Implementation	Construction of the conceptual model of the cell in IDEF-SIM
Evaluation	Face to face validation of the conceptual model on behalf of the system experts.

4.2 Monitoring the IDEF-SIM technique in Cycle 1

Within the first cycle, the use of the IDEF-SIM technique it was seen as necessary in the step where the collected data was analyzed. It was perceived that the information mapped out by SIPOC and the flowchart would not be sufficient to construct a computational model nor for a detailed documentation of the cell's functionality. In the later steps, the construction of a new conceptual model was planned, using the IDEF-SIM technique in question, and then in the implementation step, the construction of this conceptual model was completed. In the evaluation step, during a meeting with the managers, the degree of understanding of the technique and its validity can be evaluated. Additionally, in this step the discussion of information carried by the conceptual model can be carried out. In figure 2, there is a section of the conceptual model of the quality control in question, where it is possible to perceive the high level of detail of the information made possible by the IDEF-SIM technique.

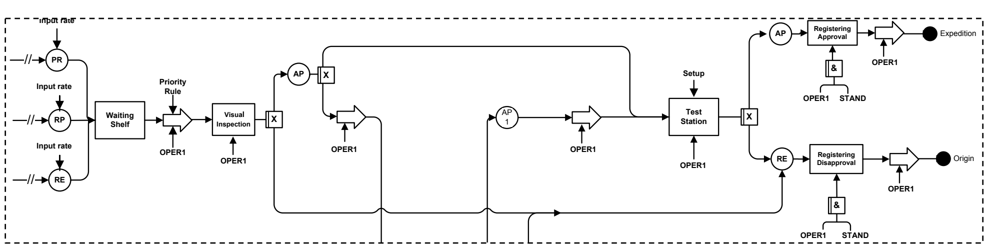

Figure 2: Section of the conceptual model in IDEF-SIM of the quality control cell

To generally monitor the use of the IDEF-SIM technique in the first cycle, in order to partially reach the second objective of this paper-- to analyze the applicability of the technique in the three stages of the simulationproject--some benefits of the use of this technique can be highlighted, such as the following:

- It is an easily understandable technique, since the managers of the company being studied could quickly assimilate its logic, even though they were not users of simulation. The technique facilitates the face to face validation of the conceptual model with process experts.
- Makes it possible to collect important data for the computational model in a later phase.
- Supplies a detailed vision of the process, making it possible to identify who is responsible for the activities and even indicate the transports performed.
- Awoke interest in the managers to put the IDEF-SIM model printed in the quality control cell, so that the employees and visitors could understand the process that is being completed in the cell in question.
- The mapping in IDEF-SIM supplied important information so that the managers of different areas could discuss the activities performed in each cell, such as, for example, the lack of standardization of the time of a product in the oven and the priority of the testing of products that enter the cell.

4.3 Cycle 2: Implementation Stage

The implementation phase in a simulation project is related to the construction, verification and validation of the computational model. In this phase, the programmer uses the gathered data of the system and of the validated conceptual model to elaborate the computational model. The use of a conceptual modeling technique which is easily understood and highly detailed, is very important in this moment of conversion, since it helps in the construction of a computational model more true to reality, apart from reducing the time spent in the construction of the same. The second cycle of the action research is related to the implementation stage of a discrete event simulation project.

Table 2- Steps developed during Cycle 2 of the Action Research

Data gathering:	Necessary data for the construction of the computational model: the conceptual model in IDEF-SIM, system data and timed data of the company.
Data feedback:	Data presented to the managers in graphical and table form.
Data Analysis	Despite illustrating important points of the functionality of the cell, not all of the questions could be responded to with the data collected.
Action Planning	Construct the computational model of the cell in order to visualize the functionality through the animation and measurement of the principal variables, verifying the interdependence between them and analyzing the utilization of the operators.
Implementation	Construction of the computational model of the cell with the support of the conceptual model in IDEF-SIM
Evaluation	Validation of the computational model: face to face with the experts (through graphical animation and presentation of the conceptual model of the cell so that the managers understand the logic used in the construction of the computational model) and statistical validation.

4.4 Monitoring the IDEF-SIM technique in cycle 2

In the first step of the cycle where the data was collected, the conceptual model in IDEF-SIM helped with the identification of the principal points to be completed as part of the timing activity. In the implementation step, its easily understood symbols, its highly detailed representation of reality, and its logic similar to that of computer programming, helped in the construction process ofa computational model reducing the time and effort spent on this process.

The fact that this conceptual model in IDEF-SIM represents the main points of the modeled system in great detail, was very valuable. This is due to the fact that with all of the necessary information registered in the construction of the computational model, it was not necessary that many visits to the cell were made to search for this information.

In figure 3, there is an example of the registered information in the conceptual model converted into information used in the computational model of the cell being studied. In the highlighted section of the conceptual model in IDEF-SIM in figure 3, one can perceive that the test station, being a place of testing, can result in approved or disapproved products. This alternative flow is represented by the junction “X” in the conceptual model, as well as representing a percentage related to each possibility of exit, in other words, 97.51% of the pieces tested in the test station are approved, while 2.49% are failed. This information of percentages and of possibilities of two exit flows are represented in the programming section of the computational model in the same figure.

Figure 3: Conversion of the information of the conceptual model in programming

It is noted that if any alteration were needed in the computational model already constructed, the person responsible for the programming should revise the computational model. Many times this revision causes the person responsible for the programming to spend time remembering the logic applied to the model. One alternative to streamline this revision is the documentation of the logic used in the computational model. In this sense, the IDEF-SIM can be used after programming as a way to register all of the elements programmed and the logical relationships used. In this moment, the IDEF-SIM is no longer considered only a conceptual modeling technique, it becomes a technique to register the programming logic, independent of the software used.

The IDEF-SIM technique showed itself applicable not only in the construction of the computational model by bringing detailed information to the real system, but also showed itself applicable in the verification and validation process of this model.

In the verification process, the conceptual model in IDEF-SIM was used to confirm if an element was forgotten or if there had been any error in the logic of the computational model. This assistance in the verification can be an advantage of the conceptual model, independent of the mapping technique used, honeyeater, it is important to note here that without the high level of detail offered by the IDEF-SIM technique, the verification process could not be so simple.To exemplify, if the chosen technique to help in the verification process were a flowchart, doubts could arise, such as the following: how many employees work in this cell? Or, who is the employee responsible for this transport?

In the final step of the cycle, the validation process, the technique proved itself important since it favored the managers’ understanding of how the computational model’s logic was constructed. A meeting with the managers and the main people responsible for the cell was held where the computational and conceptual models were presented in order to clarify the programming used. The conceptual model IDEF-SIM, together with the graphical animation offered by the ProModel® software, made the face to face validation process with the system experts much easier.

4.5 Cycle 3: Analysis Stage

The third cycle of research action to be completed is related to the analysis stage of a simulation project. In this stage, the computational model which has been already validated is apt to receive diverse experiments, so that a better analysis of the modeled system can be made.

Table 3- Steps developed in Cycle 3 of Research action

Data gathering:	Data related to the results generated by the computational model of the years in analysis.
Data feedback	Results presented in graphic form to the managers.
Data Analysis	The functionality of the cell was understood, however, questions were raised about how the cell would react to some changes.
Action Planning	Construct scenarios to analyze possible changes. The proposals of the scenarios were presented to the managers using the IDEF-SIM conceptual model as well as the Kaizen symbol to highlight where the changes were completed.
Implementation	Construction of the computational models of eleven different scenarios, the stage supported by the conceptual models in IDEF-SIM of the same.
Evaluation	Results generated of the models were presented to the sponsors of the organization, so that they could choose which is the best option to be implemented.

4.6 Monitoring the IDEF-SIM technique in Cycle 3

In this step how the IDEF-SIM technique was applied during the third and last cycle of this research action, the analysis cycle, will be evaluated. It is worth noting that there was no paper found in the existing literature that did an analysis of how the IDEF-SIM technique behaves in the analysis step of a simulation project. This is because in many of these projects the use of the conceptual model is limited to the implementation stage, more specifically, in the construction of the computational model.

The use of the IDEF-SIM technique proved itself valid even in the action planning step. In this step it was necessary to present to the managers, in a clear manner, which of the scenario proposals could be built. Therefore taking advantage of those involved in the project's familiarity with the modeling technique in question, each proposal was presented in the IDEF-SIM conceptual model form. Further taking advantage, the Kaizen symbol, already consecrated in the Lean philosophy, and was used to highlight which resource, entity, or activity would suffer an alteration and what the change would be. In figure 4, there is an example of the proposal of one of the scenarios presented to the managers highlighted in the conceptual model.

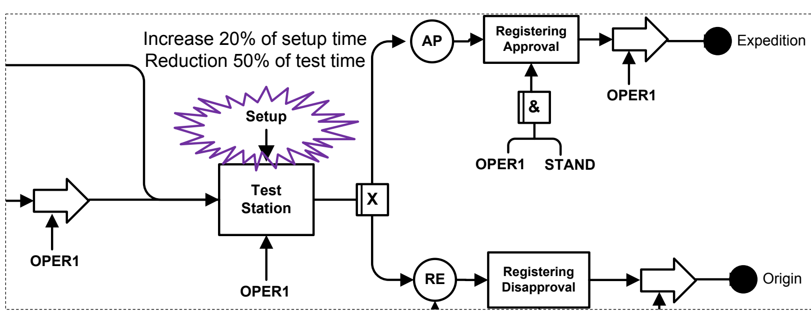

Figure 4: Section of the conceptual mode with the proposed scenario Setup

Execute the presentation of the proposals of the scenarios through the conceptual models in IDEF-SIM was of great value, thereby the managers could understand with greater ease which of the changes would be made in the cell, within each proposal. The Kaizen symbol used in the models highlighted where and which would be the alterations to be executed with each scenario. It can be said that the conceptual model in this step promoted a better communication between the researchers and key members of the company. However, it can be noted that this was only possible because of some advantages offered by the IDEF-SIM technique, like a large level of detailing with a consequential representation true to reality and its large flexibility, which permitted the use of new symbols to highlight changes.

For the implementation stage of this cycle, where the computational models of the scenarios were constructed, once again the IDEF-SIM technique proved itself applicable. Its logic is similar to that of computational programming, its vast level of details and the Kaizen symbol associated with it, ease the construction of the computational model of each proposed scenario, reducing the time and effort spent in this process.

5. CONCLUSION

A discrete event simulation project was developed in a quality control cell, in order to reach the two objectives of this paper, the practical and the knowledge objective. The practical objective through this project was to promote a better vision of the operation of the process by the managers and still supply a solid base for decision making. The knowledge objective was to generate a better understanding about a new modeling technique called IDEF-SIM, mainly regarding its pertinence in all of the stages of this same project, being that no project in the existing literature presents this analysis.

Using the research-action as a method to conduct this paper was a large value-add since this method brings two main objectives, one related to action, called the practical objective, and the other related to research that is the knowledge objective. This division of objectives strongly corresponds to the intentions of this paper. The well-grounded steps of the research method help in the conduction of the project and it can be noted that the monitoring was of extreme importance so that the conduct of the IDEF-SIM technique in each step of the project could be analyzed.

It can be said that the practical objective of this paper was reached, since the constructed computational model allowed for a larger understanding of the functioning of the cell being studied, on the part of the managers.Through the construction of diverse scenarios, it was still possible to simulate some alterations in the system in question and thus analyze how the same would react facing some changes, mainly in relation to the number of pieces tested, therefore providing the managers a base for future decision making.

In order to reach the second objective of this paper, titled the knowledge objective, the monitoring meta-step of the research-action method was used. Three cycles were completed throughout the paper, being that each cycle developed, corresponded to one stage of the simulation project, and in each step in which the modeling technique IDEF-SIM was used, its conduct was evaluated, mainly regarding the advantages and disadvantages brought to modelers and users of this technique.

It was concluded that the technique proves itself applicable in the following stages: conception stage, thoroughly collection and documenting important information of the process; implementation stage, easing the conversion of the conceptual model into a computational model and still being a strong support in the verification process of the model and the validation with the help of specialists; and finally, in the analysis stage, promoting the communication between modelers and managers in the presentation of proposed changes to the system in question, besides facilitating the construction of computational models of the scenarios, reducing time and effort dedicated to this process.

All of these conclusions obtained were the product of a documented conversation with the managers and principal agents responsible for the cell. In a meeting with the managers and main actors, in each presentation of the IDEF-SIM technique it was possible to collect their opinions about the use of this new modeling technique in the stages of the simulation project. It is noteworthy that even the opinion of the system modeler who converted the conceptual model into a computational model was collected.

As a future suggestion, in relation to the practical part of the paper, it is suggested that the interface of the computational model which was constructed, be developed in order to facilitate the use of the model by managers of the company. With this interface the managers could alter diverse parameters of the model, according to the reality of the cell which is constantly moving in the study. In relation to the generation of knowledge of this paper, it is suggested that it be applied using the research-action for developing a simulation project in the services and others areas so that it can be analyzed how the modeling technique IDEF-SIM behaves in a different environment of manufacturing.

ACKNOWLEDGMENT

The authors would like to thank the company Padtec and the financial support of the organs CNPq, Fapemig and Capes.

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