A Digital Model to Analyze the Operational Behavior of Enclosure Meshes Manufacturing

Un Modelo Digital para Analizar el Comportamiento Operativo de la Fabricación de Mallas de Encerramiento

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ABSTRACT

Enclosure mesh manufacturing is growing and expanding around the world. Due to that is employed in a variety of environments. For example, in any urban sports center, the mesh prevents fans from usually fans are not allowed to interacting with athletes. Also are used to enclose domestic animals in rural regions. Furthermore, because of their high ability to offer security and delimit private areas, utilized in a high variety of settings. Therefore, this paper analyzes the operational behavior of the manufacture of enclosure meshes. These are rhombus-shaped and interwoven transversely. It is created by a weaver who takes a galvanized wire and weaves it a rhomboid shape as if he were trying to make a braid with the required dimensions. This research began with the gathering of data in a company in Barranquilla city. With this information, a digital model was created in Arena software, and it was discovered that just 1% of the materials were rejected over the simulation time. As a result, it was determined that the percentages of weaving machine, weaving operator, and winding operator use were 4%, 4%, and 3%, respectively. At the conclusion of this investigation, it was determined that the usage of this simulation tool is quite beneficial for process analysis. additionally, it is suggested to increase sales to improve resource efficiency and invest in marketing to position the brand in the market.

Keywords. Digital Model, Enclosure Meshes, Process Constraints, Process Simulation, System Simulation.

RESUMEN

La fabricación de mallas para cerramientos está creciendo a nivel mundial. Estas, se utilizan en una gran cantidad de lugares, por ejemplo, en polideportivos, donde previene que los espectadores tengan contacto con los deportistas. En las zonas rurales, se utilizan para encerrar animales domésticos. También se utilizan en muchos otros lugares, debido a su capacidad para brindar seguridad, así como también se utilizan para la delimitación de lugares privados. Por lo tanto, en este estudio se analiza un modelo digital para conocer el comportamiento operativo de la fabricación de mallas de encerramiento. Las mallas, tienen forma de rombo, entrelazados transversalmente. Están son fabricadas con alambre galvanizado por un tejedor, que toma el alambre y le da forma romboidal, como si quisiera hacer una trenza con las dimensiones requeridas. Este estudio inicia recolectando los datos pertinentes en una compañía de la ciudad de Barranquilla. Con esta información se diseñó un modelo digital en el software Arena, donde se observó que, durante el tiempo de simulación, solo el 1% de los materiales fueron rechazados. A su vez, también se observó que los porcentajes de uso de la máquina de tejer, el operador de tejido y el operador de bobinado fueron del 4%; 4%; y 3 % ; respectivamente. Cuando se finalizó el estudio, se llegó a la conclusión que, para analizar los procesos, esta herramienta es muy útil. Se recomienda a la empresa estudiada aumentar las ventas para mejorar la productividad de los recursos e invertir en la promoción o marketing del producto para posicionar su marca en el mercado.

Palabras clave. Modelo Digital, Mallas de Encerramiento, Restricciones en los Proceso, Simulación de procesos, Simulación de Sistemas.

1. INTRODUCTION.

The use of simulation tools, such as the Arena software, is of great help when it is necessary to know or identify restrictions or bottlenecks [1, 2, 3], or it is also useful for decision making in any company [4, 5, 6]. Simulation is a multidisciplinary, functional and intuitive tool that can be used by any company in any economic sector, as can be seen in the research of [7, 8, 9, 10, 11]. When simulation models are developed, a greater perspective is obtained on the behavior of the process, which makes the study easier, and this computerized model can be called as a digital twin [12].

Based on the above, it is proposed to analyze the manufacture of enclosure mesh, are a fabric whose characteristic shape is a rhombus, it is made generally made with galvanized wire, depending on the client's requirements it can be coated with polyvinyl chloride "PVC" [13, 14]. This is done by a weaver who takes the galvanized wire and shapes it into a rhombus, this wire is interlaced as if it were a braid, an operator is a charge of ensuring that the wire is correctly interlaced, and in the same way granting the dimensions that are requires.

Some time ago, the philosopher Plato said: "The world needs a mesh", this phrase has carried importance because, nowadays the mesh plays an important role in the residential enclosure, schools, hospitals, etc.; because they have excellent quality, resistance and durability. These meshes are inexpensive, affordable and durable products, they can last up to 15 years, as long as they are properly maintained. Among its uses are urban, rural and industrial enclosures, the manufacture of doors, in addition, they can be used in windows when you do not want to use glass, and in some cases, they are more viable because they offer greater ventilation. In the field of security, the best example are sports venues where it is used to avoid excesses. For this reason, the meshes are a desired element both in urban areas and in rural areas where it is attributed a vital importance. [15, 16, 17, 18]. The identification of the restrictions is essential for the improvement of the processes, but what are the bottlenecks within a process: "Are the operation that has the lowest effective capacity among all those of the installation and which, therefore, limits the output of product from the system" [19], is to say they, in short, are the elements that interfere with the flow of the production process, increasing waiting times and consequently it reduces the productivity of the company. This can be due to many factors among, which it may have: Poorly trained workers, poor administrative management, or also a lack of interest, or resources scarce, therefore according to [20, 21], this is very important and should be correctly identified in order to increase productivity, thus avoiding setbacks and economic losses.

2. BACKGROUND

Throughout the years the process of manufacturing linked meshes has had variations, it is worth knowing a little more about the history of the Triple Twist Mesh, the story begins where Charles Barnard, a young entrepreneur who was around the year 1826, when Charles Barnard, decided to take the step of creating his own company in Norwich (Great Britain), at that time it was a brave and risky decision to create your own company or organization, but that did not stop him, he took a risk and managed to create his company called Bishop & Barnard, a company in which product various were manufactured. From the idea of clothing looms arose the idea to create a loom to make wire mesh. Initially they invented the first mechanical loom with which they produced a hexagonal mesh, which now is know them as chicken coop mesh, thus they began to cover the agricultural need of the area.

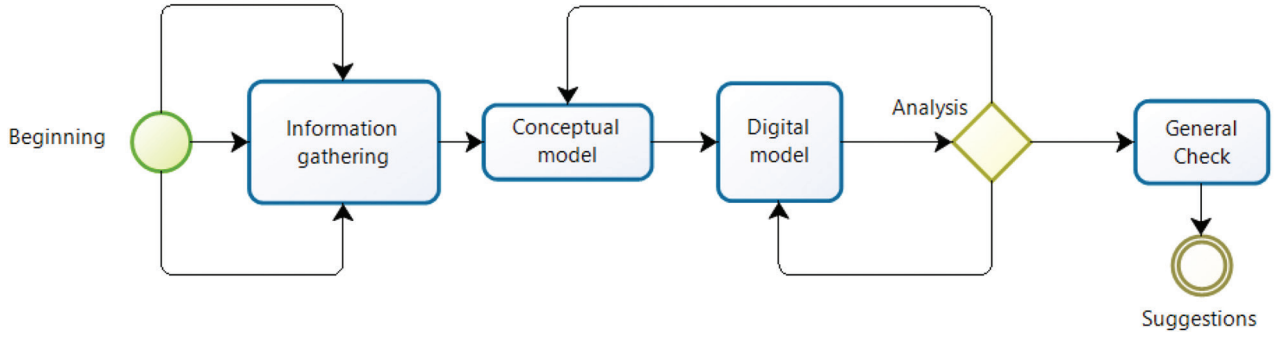
Over the years the company Bishop & Barnard became a one of the most important in the area which growing continued despite the death of Carlos. His successors knew how to adapt to the times, as soon as James Bower, the new owner, made the decision to redesign and rebuild the mesh loom and authorized a new machine capable of manufacturing, in this case, the simple twist mesh, which has lasted until today, becoming a leader in all the meshes. Simple twist mesh would initially be made with a single rod wire, but over the years this method has been transformed, to currently manufactured with wire in two rods, this company of Charles Barnard would achieve great success, first due to the sales of the triple twist mesh, using for places where you work with animals and later with its simple twist mesh. After a few years of success, they realized that it was time to sell the machine to other areas. One of its first buyers were the Australians, who had the need to use a strong mesh so that the kangaroos did not trespassing his places.

One of the best-selling times was during the first world war, where a large quantity of Simple Twist Meshes was sold, its main function was its use on roads or in high-traffic areas. Therefore, other companies began to be interested in this type of Mesh, from companies in Great Britain, from the same area of Norwich, to companies in the United States, such as Anchor Post Fence Company, which bought the license of the machine to be able to sell these meshes in America, which with the arrival of the Second World War it began to be sold all over the world, and many other factories were created that used this machine to create this type of mesh to this day, which due to its versatility, easy of assembly and its economical price, make are today a large part of the plots of our country are fenced with Simple Twist Meshes and Zinced Posts [22, 23, 24, 25, 26, 27, 28, 29, 30].

3. METHODOLOGY

The following methodology is proposed for the development of this study. Foremost, the company will be asked for all the information related to the process to be analyzed, such as its variables (raw materials, resources, times, etc.). After obtaining this information, a conceptual model of the manufacturing process will be made. Next, a digital model will be designed in Arena software, in which it will be possible to analyze in greater detail the process, evidencing the use of the resources, incoming raw material, outgoing material, process time, and operator occupation. Finally, the respective suggestions or recommendations for improvement will be made. Figure 1 shows the methodological sequence.

Figure 1 Methodological sequence
Figura 1. Secuencia metodológica



4. DEVELOPING THE METHODOLOGY

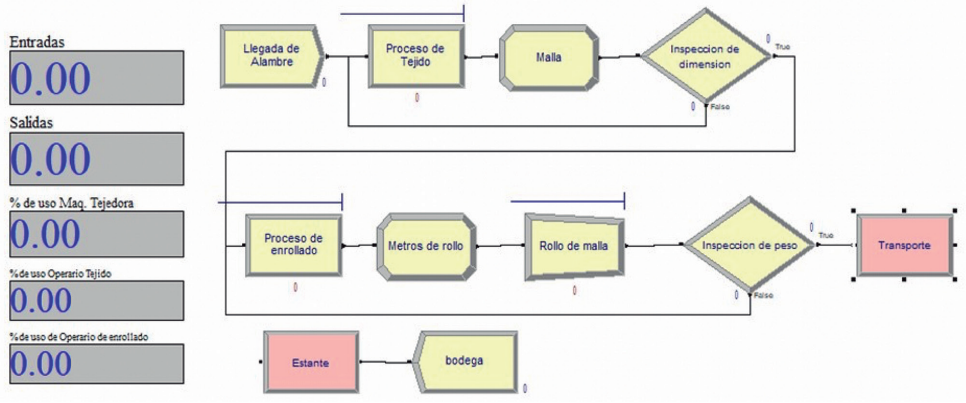
In accordance with the proposed methodology, information is collected on the enclosure meshes, the image of which can be seen in figure 2. All the information concerning the manufacture was taken from the Construmallas company in the city of Barranquilla Colombia, where it could be observed the manufacturing process.

Figure 2. Kind of Enclosure meshes
Figura 2. Tipos de mallas de cerramiento

After having obtained enough information, the conceptual model was drafted, which consisted of describing the process of manufacturing enclosure meshes. as detailed below.

To start the manufacturing process, the wire first enters the galvanized process or, failing that, polyvinyl chloride coated wire, which is purchased in meters, of this wire 100 meters are purchased. Then it goes to the weaving machine, which performs the weaving process, requires an operator. In the weaving machine, 100 square meters of mesh are manufactured in an 8-hour work shift, simultaneously there is another operator who is in charge of winding the mesh and must make rolls of 10 meters each. With the above information, it will proceed to build a digital model Using the Arena Software, the logical sequence of the model can be seen in Figure 4

Figure 3 Digital model of enclosure mesh manufacturing
Figura 3 Modelo Digital de la fabricación de mallas de encerramiento

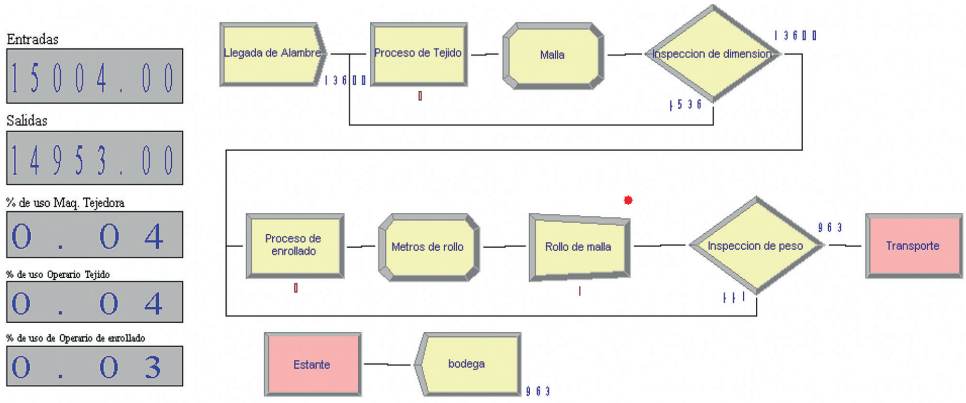


5. RESULTS

The process was simulated for 6 months, and the results produced by the software were analyzed, this part is evidenced in the Analysis of the results. The number of entries in the process was 15004 units, where the quantities that came out were 14953, as can be seen in figure 5, yielding a percentage of 99.6% of the finished product, based on the report of the digital model it could be observed that there was an average of outgoing quantities of 963, where there was a number of work in process of 45.3%

However, one of the main analyzes in the winding process, was 0.2% per hour, 0.26% per hour in the weaving process, and lastly 2.33% per hour in the mesh roll. It was also possible to analyze that there is a restriction in the winding process, in this analysis, was reached by seeing that the lead time is very highest in the batches of mesh.

Figure 4 Simulation results
Figura 4 Resultados de la simulación



As can be seen in figure 5. It was also possible to analyze that there is a bottleneck in the winding process, this analysis was reached by seeing that the percentage of waiting time for batches of mesh roll is high

Figure 5 Process restrictions or bottleneck
Figura 5 Restricciones o cuello de botella en el proceso

Waiting Time	Average	Half Width	Minimum Value	Maximum Value
Proceso de enrollado.Queue	0.00021283	0,000021498	0.00	0.00222222
Proceso de Tejido.Queue	0.02064602	0,000231898	0.00	0.04527778
Rollo de malla.Queue	0.06311841	0,006659901	0.00	1.9558

After having analyzed the results and defined the deficiencies of the process, it proceeded to devise proposals to solve them. The company was recommended to acquire an increase in orders in order to increase productivity in the resources established in the process of manufacturing linked meshes, for this, taking into account that it is a small company and with very good bases, it was recommended to invest in Product Advertising in order to position the name and the product itself so that in the near future the objective of increasing productivity.

6. CONCLUSION

From this case, the following conclusions could be obtained: First, that the use of Arena software is essential to avoid incurring unnecessary costs such as doing a simulation day in the production plant or in any process, which is why this simulation is so intuitive that the tool is used to carry out any process as many times as necessary for the optimization of one or several processes. The importance of the enclosure meshes was also understood, which in short provide privacy and security in the premises of urban residences, sports venues, among others. Secondly, with based on the results obtained in the digital model, regarding the percentage of use of the resources used in the manufacturing process of linked meshes in the company Construmallas S.A.S., are the 4% in the use of the weaving machine, the utilization percentage of the winding operator is equal 3%, which indicates that the process managed by the company needs a higher production rate.

All of this was done to propose how to enhance the process. It is suggested that sales be increased in order to improve resource productivity. For this, it is vital to invest in product promotion or marketing to position the brand, and the product itself. Such that the goal of boosting productivity may be realized in the near future.

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