PARIPEX - INDIAN JOURNAL OF RESEARCH | Volume - 9 | Issue - 12 | December - 2020 | PRINT ISSN No. 2250 - 1991 | DOI : 10.36106/paripex

ORIGINAL RESEARCH PAPER

Management

USE OF SIMULATION TOOLS TO IMPROVE PRODUCTION PARAMETERS IN A FOOD COMPANY

KEY WORDS: Logistic, Creation, Simulation, Plant Simulation.

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ABSTRACT

The article deals with the activity of a production company for fish processing and production of various products from them. It describes the production process of some types of products, its needs and possible shortcomings. The aim of the project is to eliminate some shortcomings in this production process, or to innovate and improve them. We used a simulation tool to demonstrate the improvement of the parameters of the production process. As a simulation tool, we used Tecnomatix Plant Simulation software and some of its tools.

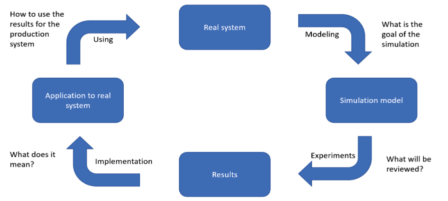
INTRODUCTION

Simulation can be defined as an imitation of a real process or system over time. In order to be able to create a simulation, it is necessary to first create a model. The model must contain the main characteristic or function of the physical or abstract process or object. The simulation represents the activity of a set of processes over time, while the model represents a separate system. It can be applied in various circumstances, in order to optimize the production process as a whole, in order to optimize the performance of any part of the system, to verify the overall efficiency of this system. Furthermore, it can be used to demonstrate the possible real effects of alternative conditions and procedures. The simulation is also used when the actual system cannot be plugged in because it may not be accessible, or it may be dangerous or unacceptable to plug in, or it is designed but not yet built.

The aim of the simulation is to achieve results that can be transferred to the installation in the real world. In addition, the simulation defines the preparation, execution, and evaluation of carefully controlled experiments within a simulation model. Generally, you run the simulation study using the following steps, which are shown in FIG. 1:

- First, look at the real-world installation you want to model and gather the data you needed to create a simulation model.
- You will then create this abstract installation in the abstract and create your simulation model according to the goals of the simulation studies
- Then you run the experiments, i. you perform simulation processes with your simulation model. This will bring a lot of results, such as how often the machines fail, how often they are blocked
- The next step will be the interpretation of the data produced by the simulation processes.
- Finally, management will use the results as a basis for their optimization decisions

Simulation modeling safely and efficiently provides solutions to real-world problems. It provides an important method of analysis that is easy to verify, communicate and understand. Simulation modeling in various industries and disciplines provides valuable



solutions by providing a clear overview of complex systems. The big advantages are:

- Risk-free environment,
- Save time and money
- Visualization,
- Insight into dynamics,
- Increased accuracy,
- Coping with uncertainty.

CREATING A SIMULATION MODEL IN THE TECNOMATIX PLANT SIMULATION ENVIRONMENT.

The production process, the problem of which will be addressed, was mapped and subsequently simulated in the environment of the simulation software Tecnomatix Platn Simulation version 15.0 (Fig. 2). The main advantages of this software are:

- clear and user-friendly interface,
- clear hierarchical structure of the model,
- simple object modeling on the principle of drag and drop,
- possibility to import data from / to MS EXCEL,
- possibility to import data from Process Designer,
- clear and unambiguous report of results,
- possibility to import 3D objects in ISO JT format,
- possibility to predefine initial tools (process? buffer, source, ...),
- optimization functions: material flow optimization, bottleneck analysis.

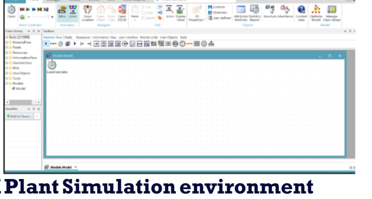


Figure 2 TX Plant Simulation environment

PRODUCTION PROCESS IN THE COMPANY

The company, which deals with the issue of this contribution, has been operating on the domestic as well as international market for several decades and offers a large number of products of various kinds in its assortment. These are various types of salads, rollmops, frozen and smoked fish products and the like. It would be very difficult in one simulation project to capture the production of all types of products at once, so several important product representatives were chosen and in these cases the given production problems were solved. These production representatives will be Cod and Paris Salad. These products are among the best-selling products of this manufacturer at home and abroad.

COD PRODUCTION PROCESS

The cod production process begins with the receipt of frozen fish from storage. Prior to processing, the frozen fish raw material is unpacked from the transport packaging and stored in a thawing box, where the thawing process itself takes place. Thawing takes place in the afternoon and at night. Thawing time is 15 to 24 hours. At the end of the thawing process, the raw material is unwrapped from the foils and at the same time the quality of the thawed raw material is checked. Another process is cooking in cooking chambers, which lasts approximately 90 minutes. After cooking, the raw material is cooled by air in a cooling chamber for about 30 to 45 minutes. The cooked fish is then cooled with water for about 30 to 45 minutes. The cooled cooked fish raw material is moved to a marinating process, which takes 12 to 15 hours. At the end of the marinating period, the varnish is drained and then the raw material is cut on a grinder. The semi-finished product processed in this way is ready for the production of Cod. Another process is the preparation of sterilized vegetables, which must be rinsed and then drained for at least 5 minutes after being poured into sieve containers. Other necessary semi-finished products such as mayonnaise are prepared in advance and stored in their place, from where the expected volume is transferred for the given day for weighing. Other additives are weighed according to the material standard and are added when weighing the mixture into Cod. After weighing the individual semi-finished products and additives, the container is moved to the production room, where the penultimate phase of production takes place. The weighed mixture is poured into a mixing machine and the mixed cod mixture is then transferred to a hopper. The mixture from the hopper is gradually transferred to the machine and the Cod itself is filled into pre-marked crucibles. The machine will mark the correct expiration date. The products are then moved along the conveyor to the packaging process. There is a sensor on this conveyor that scans the entire product. This sensor checks whether the date of minimum consumption is correctly printed on the crucible (Fig. 3 a).

a) b)

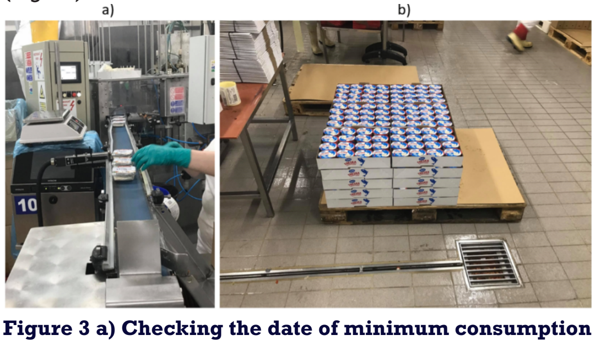


Figure 3 a) Checking the date of minimum consumption b) Packing the products in cartons

If the date is not printed on the packaging, the sensor automatically discards this product using a flap in the hopper by the conveyor. The operator then returns these products to the marking device to indicate the date of minimum consumption. The worker packs the required number of 16 pieces of products in a paper carton and places them on a pallet (Fig. 3 b)).

As for the products for the above-mentioned customer, who additionally requires control for the presence of unwanted bodies, the entire product range is moved to a free-standing detector. All products packed in a cardboard box are gradually inspected on this detector. This check is performed by a worker who gradually takes cartons of products from the pallet and inserts them into the detector. If the detector detects unwanted particles, the entire carton is automatically discarded. Cartons, which are in order, are placed back on the pallet by the worker, and the worker proceeds to wrap the pallet with foil for safe transport of products to the dispatch warehouse, from where they are gradually delivered according to orders to branches and customers.

THE PROCESS OF MAKING PARISIAN SALAD

The production process of Paris salad is very similar to that of cod production. The process differs at the beginning of the production process, where salami is processed instead of cod processing. The salami is cut on an automatic slicer. After slicing, the salami is varnished for about 2 hours. After the varnishing time has elapsed, the varnish is drained, the marinated salami is allowed to drain and is subsequently used in the production of salad. Another process is the preparation of sterilized vegetables, which must be rinsed and then drained for at least 5 minutes after being poured into sieve containers. Mayonnaise as a semi-finished product is prepared in advance and stored in its place, from where the expected volume is transferred for a given day using the FIFO system for weighing. From this step, the production process is identical with cod, it differs only in the recipe, which is governed by the material standard of the given product during the individual steps and weighing in the raw material.

Some customers of the manufacturer in question require, in addition to the routine inspections carried out by the manufacturer in his own laboratories and veterinary inspections carried out externally, in addition to the presence of foreign hazardous particles such as metals, glass, plastics, wood and the like. These checks for these customers are performed by the manufacturer under his direction on a separate detector, which is located in the production process. The inspection on this detector takes place in such a way that the employee brings all the products packed in cardboard packaging to this detector. He takes the products from the pallet on the cartons and inserts them into the X-Ray detector. If the packaging is in order, the employee will return it to the pallet, which he will then move to the finished products warehouse after securing it for transport. Such an inspection takes a relatively large amount of time and requires the presence of a separate operator who operates this device. The company plans to solve the problem of inspecting its products by applying such a sensor directly to the production line, where such an inspection would take place on all products and thus could declare the safety and increase the quality of all products. The company also plans to automate the packaging process by attaching a handling robot to the line. This robot would ensure the packaging of products in cardboard boxes and thus facilitate the work of the operator, who performs this activity manually during the entire work shift.

SIMULATION OF THE PRODUCTION PROCESS

After mapping and thorough analysis of the entire production process of the products in question, it was possible to proceed to the processing of the simulation model. The production process of both products takes place gradually on two floors of the manufacturer's production hall.

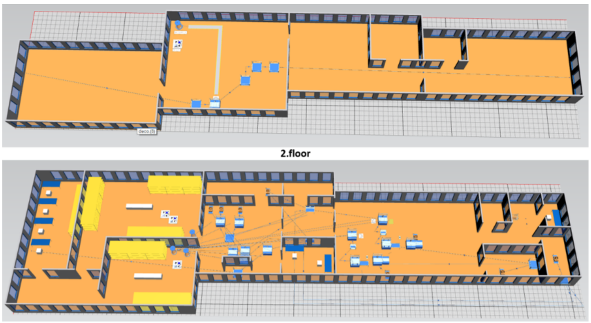


Figure 4 Digital form of the production process in the simulation module Tecnomatix Plant Simulation

In the production premises on both floors, the production of other products from the company's range takes place. Simulation model, however, we created only for our selected representative products. The control on the X-ray detector is not included in this simulation model and the packaging is performed in the current way. The worker manually transports the products and places them in cartons (Fig. 5).

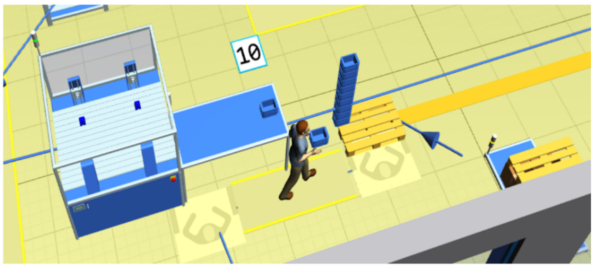


Figure 5 Current state at the workplace of product packaging

In FIG. 6 we can see a statistical evaluation of such a production process in the normal and previous state. We downloaded statistics on basic indicators from the software, such as: Productivity of the production process, which is at the level of 46.15% in this process. we can also track how many individual devices were in working mode, how long they were blocked by other related operations, or how long they waited for the operation before them to complete.

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
End_of_production	Pallete_of_cod	1:59:01.0441	7	1	46.15%	53.85%	0.00%	0.00%	

Object	Working	Set-up	Waiting	Blocked	Portion
Cod_decantation	51.00%	0.00%	0.00%	49.00%	
Weighing_of_cod	6.25%	0.00%	62.06%	31.69%	
Mixing_of_cod	15.63%	0.00%	9.01%	75.36%	
Cod_tray	0.15%	0.00%	5.93%	93.92%	
DS_2500	33.41%	0.00%	5.94%	60.65%	
Packaging_of_cod	50.00%	0.00%	50.00%	0.00%	
Palletizing_of_cod	55.53%	0.00%	44.47%	0.00%	

Figure 6 Statistical evaluation of the current state of normal production using simulation software

PRODUCTION PROCESS DURING INSPECTION USING AN X-RAY DETECTOR

In the next figure, the detector for the presence of undesired bodies in products such as metals, plastics, glass and the like is also involved in the production.

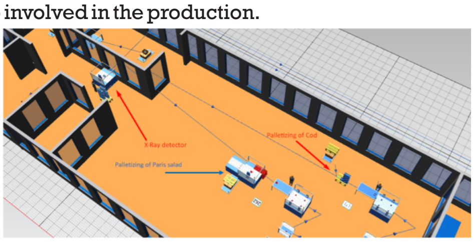


Figure 7 X-Ray detector in the production process

The statistical data from the software in such a production mode are shown in the following figure (Fig. 8). It is clear that the production process in such a regime is much less productive than in the previous case, where no such inspection was carried out. For this reason, the manufacturer wants to improve the process of this inspection and thus increase the efficiency and productivity of production of all products.

Cumulated Statistics of the Parts which the Drain Deleted

Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
End_of_production	Pallete_of_cod	4:39:41.8999	5	1	19.03%	80.97%	0.00%	0.00%	

Object	Working	Set-up	Waiting	Blocked	Portion
Cod_decantation	51.00%	0.00%	0.00%	49.00%	
Grinding_of_cod	69.88%	0.00%	0.05%	30.06%	
Weighing_of_cod	6.25%	0.00%	62.06%	31.69%	
Mixing_of_cod	15.63%	0.00%	9.01%	75.36%	
Cod_tray	0.15%	0.00%	5.93%	93.92%	
DS_2500	33.41%	0.00%	5.94%	60.65%	
Packaging_of_cod	50.00%	0.00%	50.00%	0.00%	
Palletizing_of_cod	55.53%	0.00%	44.47%	0.00%	
X_ray_detector	51.28%	0.00%	18.60%	30.11%	

Figure 8 Statistical evaluation of production during the operation of the X-Ray detector

SUGGESTIONS FOR IMPROVING THE PRODUCTION PROCESS

The company is primarily concerned with addressing the issue of eliminating time lost when using an X-Ray detector when ordering for customers who require this inspection. The innovation of the production process should take place by applying the Alien body detector directly to the production line. This detector would work in a similar way as the sensor currently operates on the date of minimum product consumption. The product moves along the conveyor belt, and if the sensor does not detect the marked expiration date, the switch on the conveyor disables the product outside the conveyor. At this point in production, the operator stands and returns such a product to production at the place where the date is marked. In this way, it is also planned to solve the application of the Alien body detector for the presence of undesired parts in the products. The product in which the non-conformity is recorded will be automatically decommissioned and subsequently decommissioned. In this way, on the one hand, the current time of this check on the external detector is shortened. The number of discarded products will also be reduced. In the current state of inspection, the inspection is carried out on products that are packed in a cardboard package, according to the prescribed number of pieces of crucibles with products per package. If the X-Ray detector detects a discrepancy, the entire package of several products is discarded from production. After the upgrade, all crucibles with products should be inspected separately and only the specific crucible in which the discrepancy is detected will be discarded. By applying this inspection, the company will be able to declare the performance of such inspection on all its products, not only on products for the specific customer who requests it. This will increase the quality of all products and improve the way in which the health safety of products is declared. This method of inspection directly in the production process would take about a second for each product. The total production cycle would be extended by this time. This increase in time would, however, be eliminated by applying an automated element to the process of packaging the products in cartons. This step would relieve the burden of a worker who performed such packaging manually and placed each product individually in cartons on a pallet. This worker could move from the packaging position to a more comfortable and less strenuous position towards the Alien body detector and remove products that the detector would identify as faulty. Figure 9 shows both proposals for improving the production process in a simulation model.

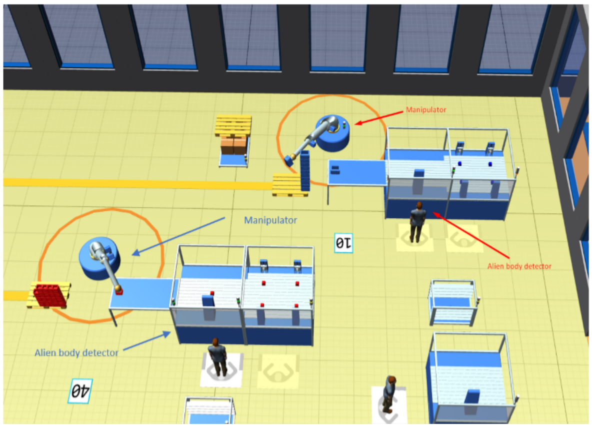


Figure 9 Proposal for the implementation of innovative solutions in the production process

The statistical evaluation of these proposals shows an improvement in the current parameters of production. The total productivity of the modeled production would increase to 47.16%. Compared to the original state of production, in which no inspection of unwanted parts in the products was performed and manipulation was performed manually by the worker, there was an increase of 1.1% of the total production.

Cumulated Statistics of the Parts which the Drain Deleted									
Object	Name	Mean Life Time	Throughput	TPH	Production	Transport	Storage	Value added	Portion
End_of_production	Pallete_of_cod	1:25:53.6496	10	1	47.16%	52.84%	0.00%	0.00%	

Object	Working	Set-up	Waiting	Blocked	Portion
Cod_decantation	58.20%	0.00%	0.00%	41.79%	
Grinding_of_cod	80.96%	0.00%	0.05%	18.98%	
Weighing_of_cod	7.50%	0.00%	71.62%	20.88%	
Mixinf_of_cod	18.62%	0.00%	10.83%	70.56%	
Cod_tray	0.18%	0.00%	5.93%	93.89%	
DS_2500	26.30%	0.00%	47.29%	26.42%	
Alien_body_detector	40.09%	0.00%	33.52%	26.39%	
Packaging_of_cod	33.40%	0.00%	53.62%	12.98%	
manipulator	32.63%	0.00%	50.69%	16.68%	
Palletizing_of_cod	33.37%	0.00%	66.63%	0.00%	

Figure 10 Statistical evaluation in the implementation of the proposed solutions

CONCLUSIONS

It is clear from the simulations and the statistical results from them that the application of such a tool is currently being used in various areas of production. It is obvious that the application of simulation is important not only in the automotive industry, but also in the food and other industries. Simulation tools can help not only in designing new planned productions, but also in improving existing productions. They help in the decision-making process what change in the production process to make without the need for physical intervention in this process. After a thorough analysis of all possibilities for improvement from various points of view, modules can be prepared in advance to be deployed or replaced in production, without the need to interrupt production for a lengthy line reconstruction that would require a long production downtime. Even in this case, an improvement of 1.1% over the original situation is visible. Such an increase may not seem very dizzying, and the question is what the return on such an investment would be for society. However, account must be taken of the fact that the above simulation study was carried out on only a small number of product representatives and it is stated in the introduction that the manufacturing company has several dozen product types in its portfolio. Most of these products are manufactured, or at least packaged in a similar manner to the products mentioned, which have been chosen as an example for the creation of such models. If a similar increase in productivity were confirmed for each product, the payback period of such investments would be significantly shortened.

Acknowledgement

This article was created by the implementation of the grant project APVV-17-0258 "Digital engineering elements application in innovation and optimization of production flows", APVV-19-0418 "Intelligent solutions to enhance business innovation capability in the process of transforming them into smart businesses", VEGA 1/0438/20 "Interaction of digital technologies to support software and hardware communication of the advanced production system platform" and KEGA 001TUKE-4/2020 "Modernizing Industrial Engineering education to Develop Existing Training Program Skills in a Specialized Laboratory."

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