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Fidan Smaili
University for Business and Technology

Hajredin Ibishi
˝ELSAM˝ Heat Exchanger and Steel Construction Company

Xhemajl Mehmeti
University for Business and Technology, xhemajl.mehmeti@ubt-uni.net

Afrim Gjelaj
University of Prishtina

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Fidan Smaili[1*], Hajredin Ibishi[1/2], Xhemajl Mehmeti[1], Afrim Gjelaj[2]

[1]UBT – Higher Education Institution, Lagjja Kalabria, 10000 p.n., Prishtinë, Kosovë

[1/2] ″ELSAM″ Heat Exchanger and Steel Construction Company

[2]University of Prishtina, Faculty of Mechanical Engineering

e-mail: fidan.smaili@ubt-uni.net

Abstract

The possibility of increasing production capacity by re-designing the actual layout and material flow at Elsam factory is explained in this article. Planning of the actual layout needs some improvements because it does not meet customer demand. The actual layout is found to be disorganized on material flow which leads to a decrease in production capacity. Three different layouts are prepared and be analyzed.A comparison between proposed and actual layout is shown to find out the influence on production capacity. According to the data taken from simulation software FlexSim, significant improvement is foreseen. This study reveals that redesigning of the layout ensure increase of production capacity from 11 unit per day to 17 unit per day, so while the throughput capacity is increased by 64.7%.

Keywords - Manufacturing process, The Systematic Layout Planning SLP, FlexSim program

Introduction

The actual management of the factory is preparing to be facing rapid change on the marked. Based on the client's demand, market concurrence, and increasing the price of the base material which must be taken into account, induce management to think about a new form of the organization. If layout is not in system, that influence negatively in different manufacturing phases [1]. There are different principles for improvement of manufacturing layouts, in our case we used Muthers principle [2] which is known as systematic layout planning SLP. It is necessary to take into account also zones which are particularly related to the factory planning [3],[4]. Simulation will help to analyze actual planning status and find out alternative solution to increase productivity [5] and also will help us to save time and money [6], [7]. The FlexSim [8] software is used in the research. Redesigning of layout, starting by the placement of equipment and processors (machines) in the new layouts factory will reduce the transport distance within consecutive processes, minimize production time and find ways to improve throughput capacity. Redesigning of the layout has several purposes:

1. Maximum Throughput Capacity

2. Flexibility of process flow

3. Maximum Efficiency Flow

4. Safe work.

This research method reduces the waste time during the flow of material and consequently resulting in the reduction of the factors which cause decreased throughput capacity. This simulation is very popular and has been constantly developed. As a result, simulation can be applied to a range of industries such as industrial production, transportation, distribution, or even to provide business services such as banks, hospitals, and so on. There are many cases of studying the application of FlexSim software in many industries. Applying the model to assess the layout planning efficiency, to improve production techniques, the appearance of the factory offers a way to evaluate layout.

Distance-Based Procedures were able to demonstrate an increase or decrease in the productivity of the factory. By taking into account the traveling distance, process time, and set up time between consecutive processes, the improvement of the layout after simulation could be considered, so the FlexSim is the right choice [8].

Methodology of the investigation

1) **Layout Planning:** the Precedence diagram method (PDM) and Muther's principle, called "Systematic Flow Planning: SLP" which are methods to plan production, consisting of different stages of the planned workshop (Model Patterns) model of individual components, as well as areas that partly relate to factory planning.

2) **Simulation**: The research was done using the FlexSim software, which helps in the simulation that serves us to find a solution as well as to improve systems in planning, such as restoring equipment in the factory production process at a distance short and find minimal production time and increase throughput capacity.

3) **Data Collection**: The information used to reflect the enterprise and research of the flow chart of work processes.

3.1) **Overview of Elsam factory**. Production Line has 20 people engaged. The number of machines used in the production of the oil tank is 7, which have the following functions: 1 Material cutting machine, 1 Sheet bending machines, 1 Drilling machine, 2 Welding machine and 1 Inspection machine and 1 Anticorrozive protection machine.

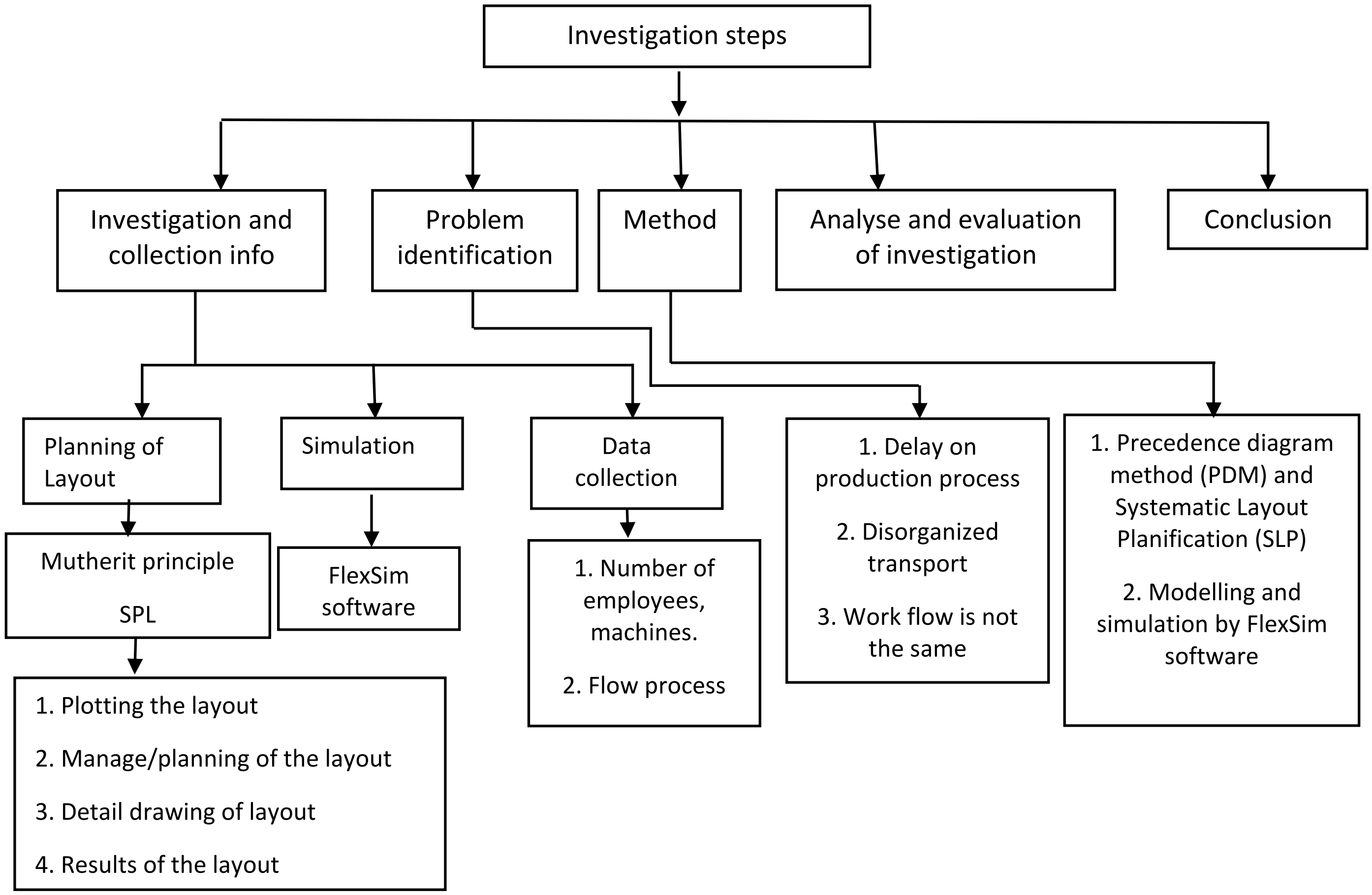
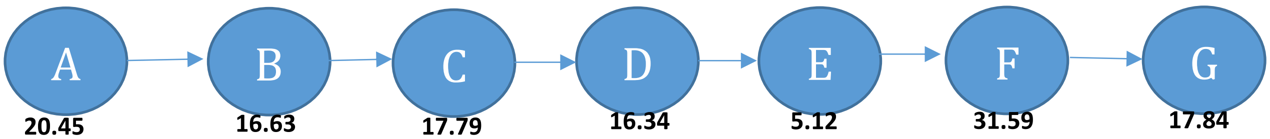


Figure 1. *Investigation steps*

Experimental work

Precedence diagram method (PDM) with respectively time duration of process time is shown below starting from first workstation A to the last workstation G of the layout, where: Cutting (A), Drilling (B), Bending (C), Assemble-Welding (D), Inspection (E), Anticorrosive protection (F), Packing (G).



From the precedence diagram method is clearly visible that only the Cutting process (A) does not have any predecessor processes, but the others processes does have, data are shown in Table 1.

Table 1 The work flow sequence of oil tank production

Task/Workstation	**Description**	**Immediate predecessor**	**Task time (minutes)**
A	Cutting	-	20.45
B	Drilling	A	16.63
C	Bending	B	17.79
D	Assemble-Welding	C	16.34
E	Inspection	D	5.12
F	Anticorrosive protection	E	31.59
G	Packing	F	17.84
Total time			=125.76

Measurement of traveling distance between consecutive processes of workflow during the manufacturing of oil tank for actual layout and three different improved layouts are presented in Table 2.

Table 2 Traveling distance

Material flow process				
Number of employer	**Layout**			**Description**
	Actual	**Type 1**	**Type 2**	
	Distance (meters)	Distance (meters)	Distance (meters)	
2	32.00	10.54	10.54	Movement from workstation A to B
1	23.35	15.51	15.44	Movement from workstation B to C
1	19.38	15.50	15.50	Movement from workstation C to D
1	21.64	17.20	17.20	Movement from workstation D to E.
1	15.48	14.15	14.15	Movement from workstation E to F
1	13.49	13.50	13.50	Movement from workstation F to G
Total distance	125.34	86.40	86.33	

From the data collected to study the function table in Table 1 and Table 2, information about the number of employees, the travel distance between each production process and the process time are presented. According to data it is clear that the actual layout can produce approximately 1 piece every 140 minutes. Improvement of layout type 1 can produce 1 piece every 136.62 minutes, layout type 2 can produce 1 piece every 136.62minutes.

Design layout relationships of three types of layouts are shown on Figure 1 to Figure 3. It shows the comparison between actual layout and improved layouts:

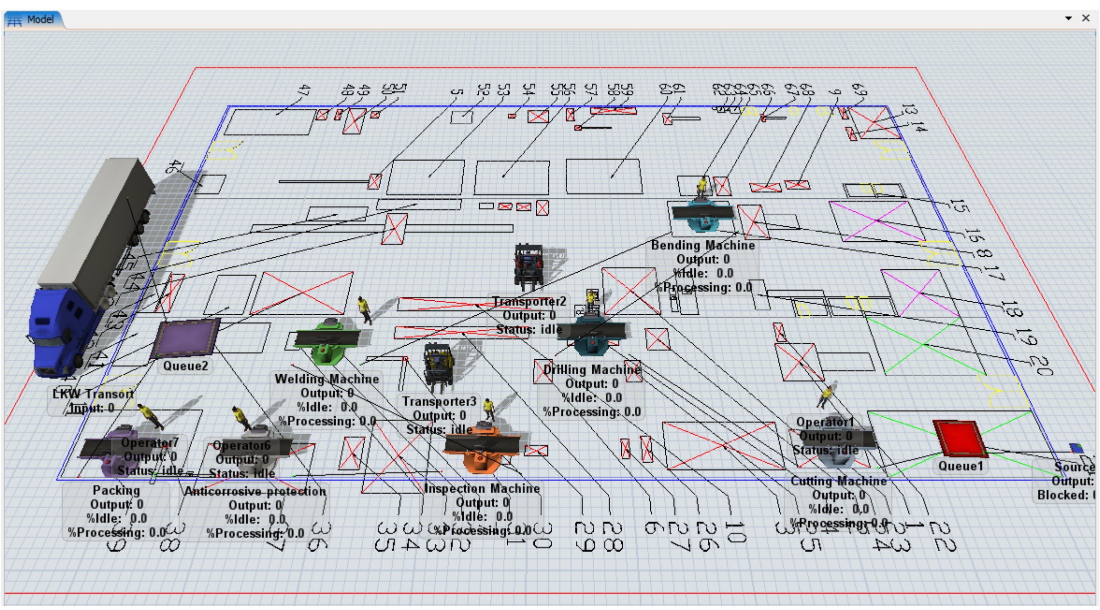


Figure 1 Actual layout of the production line

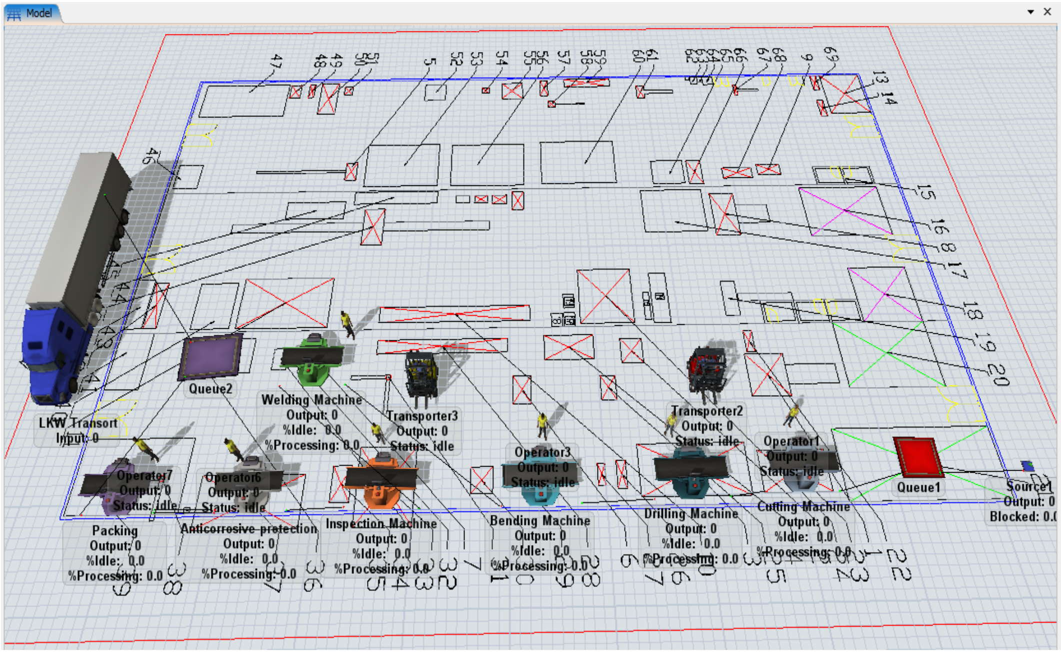


Figure 2 Type 1 of layout of the production line

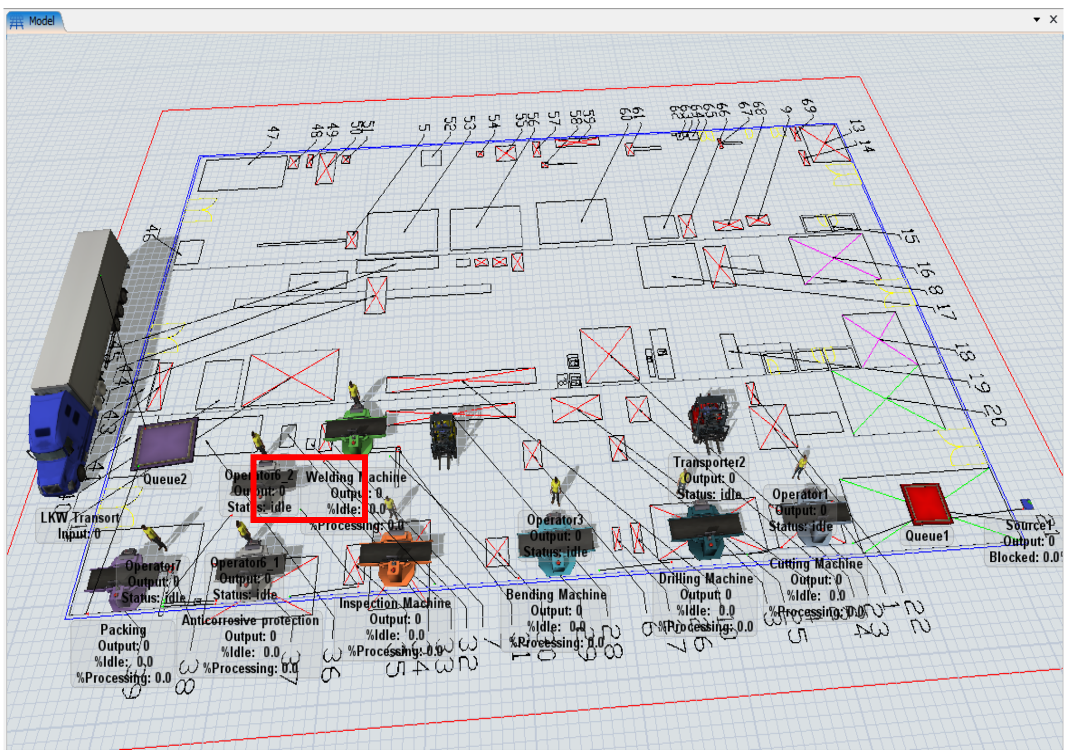
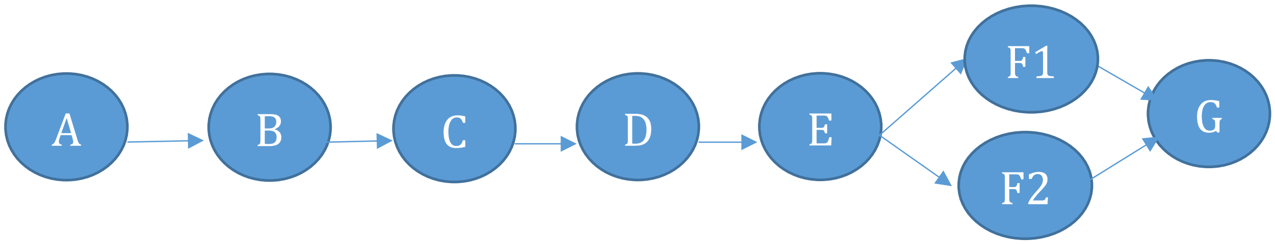


Figure 3 Type 2 of layout of the production line

In the type 2 layout is added an additional workstation named F2 (see red rectangle Figure 3) in order to eliminate the bottleneck, which is identified and which has a significantly negative effect on the production capacity. PDM diagram after adding a new workstation took the form:



The research results show that from the collected data of FlexSim simulation software production volume in the actual layout can produce only 11 units per day. The reconstructed layout system type 1, type 2 shows improvements as follows:

- In type 1 ensure production of 11 units per day,

- In type 2 ensure production of 17 per day.

Respectively as shown in Table 3. It has been shown that the layout type 2 is the most appropriate and best because of its higher production rate, but it require investment for one additional workstation.

Table 3 Data collection from software FlexSim

List of layouts	Distance (m)	Time (min/piece)	Production rate (piece/day)
Actual Layout	125.34	140	11
Type 1	86.40	136.62	11
Type 2	86.33	137.12	17

From the production window created according to Precedence Diagram Method (PDM) and the principles of Systematic Flow Planning (SLP), type 2 planning has become more appropriate. According to Table 2. the actual layout distance is 125.34 meters, but after redesign of layout type 2 is chosen where the 86.33m movement distance during a cycle work is reduced by 39.01 meters. Since the movement distance between consecutive processes is decreased, it also reduced the idle time during transportation (movement of material between workstations) and this contribute on increasing of safety work in factory. It also solved the problem with bottleneck in workstation F (Anticorrosive protection) by adding a workstation F1 which has significantly increase production capacity by 64.7%.

3D view and dashboard of the analysis using the FlexSim software of three layouts types are shown in Figures (4-5-6).

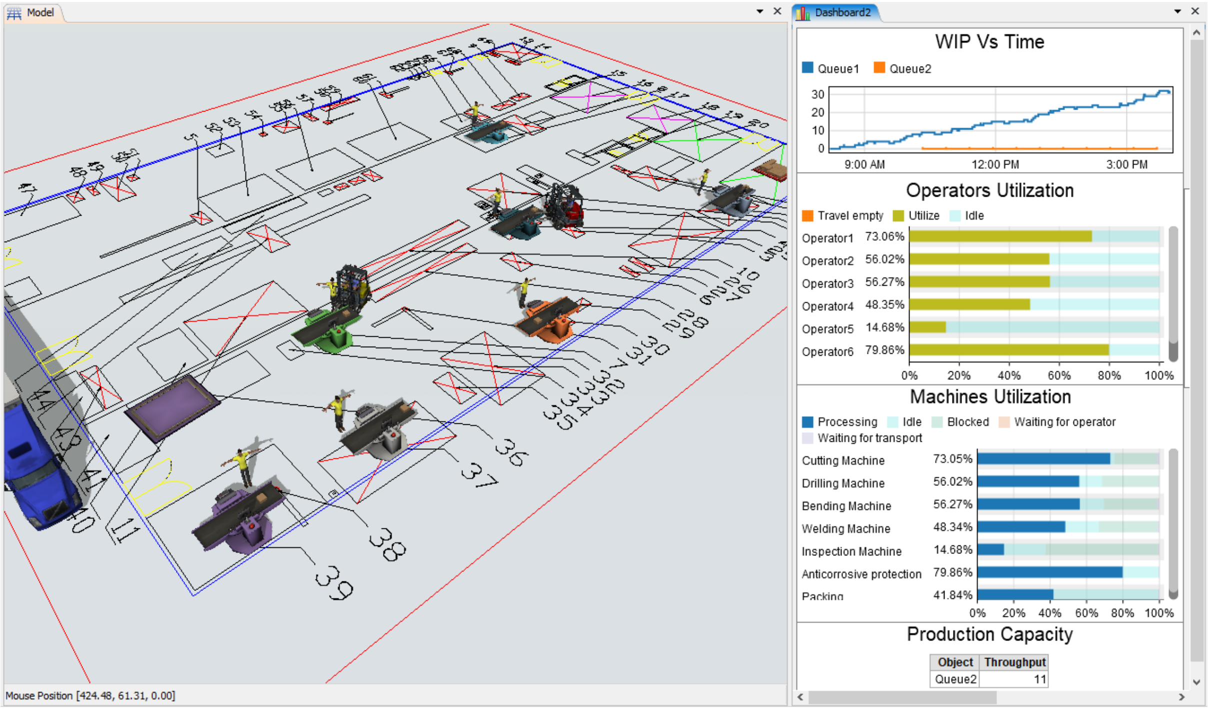


Figure 4 Analysis and 3D view of the production line of actual layout

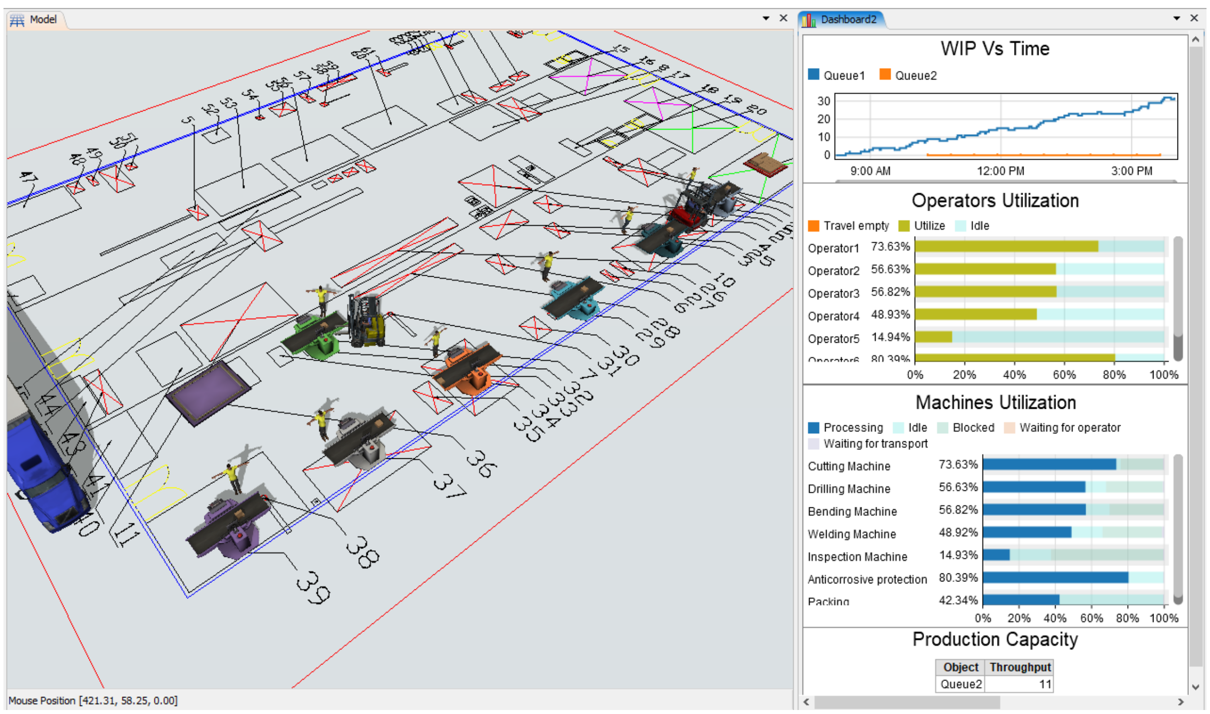


Figure 5 Analysis and 3D view of the production line of layout type 1

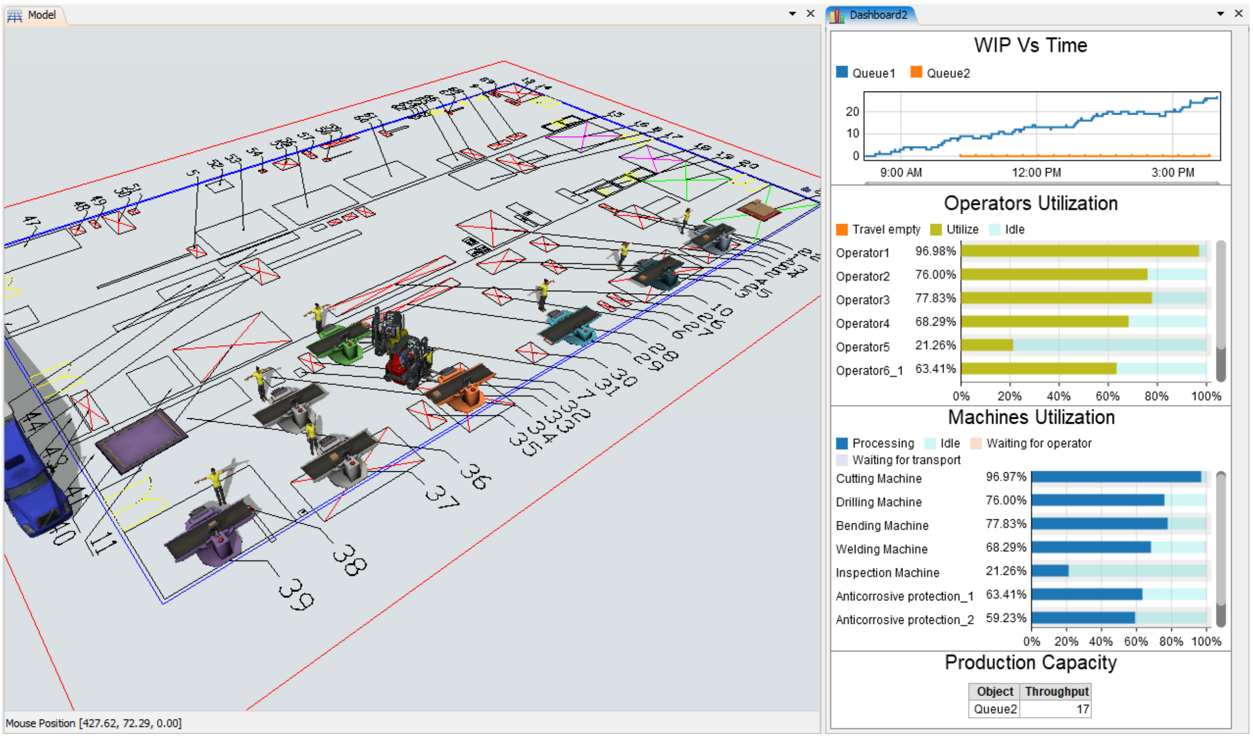


Figure 6 Analysis and 3D view of the production line of layout type 2

Conclusion

The research results of the experimental part of this paper have revealed that the planning problem in the current layout was a material leakage disorder and bottleneck. Consequently, the flow of material movement has been inefficient. During transport process between two consecutive manufacturing processes has been time delay identified. Based on the principle of systematic flow planning (SLP), as well as in the analysis of FlexSim software simulation improvement and the reconstructed layout was possible to recommend.

Results taken from simulation enabled us to choose the upgraded type 2 layout while it ensure the highest throughput capacity. Based on the experimental data, cycle time of 138.12 minutes and the maximum throughput rate equal to 17 pcs per day taken from the FlexSim software simulation shows that throughput rate has been increased for 64.7%. Reduce of transport distance and elimination of bottleneck in the production process, allowing employees to work faster, reduce idle time, increase production rates, and efficiency in the production process. Therefore reduced transport distance has also decreased rate of the injury risk of workers or any other damage.

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