MODELING AND SIMULATION OF THE PRODUCTION PROCESS OF A STATOR

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KEY WORDS

Petri nets, CPN TOOLS, stator, manufacturing

1. Presentation of the production process of the stator

The operator picks up the stator elements and loads them onto a chuck, which is counted automatically according to height. There are two chucks at the welding station: one for charging and one for welding. After welding, the stator is cooled and checked,then a QR code is applied to it. Next is isolation, deposition on a conveyor and preparing the coils in the winding machine. The stator is then inserted, preformed,tied with thread and final format.

Fig 1 Stator elements

Fig 2 Stator

2. Modeling and simulation of the production system using colored Petri nets

The following positions and transitions were defined:

Table 1. The postions and transtions of the model

Position	Definition
P1	Stator element in the warehouse
P2	Stator element on the chuck
P3	Checked Stator element
P4	Welding support chuck 1
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.	
P19	Stator welded and connected to connections
P20	Stator on the binding machine
P21	Pressed stator
P22	Stator checked

Symbol	Definition	Time
T1	Load stator element	10 sec
T2	Check stator element	6 sec
T3	Load signs at the welding station	8 sec
T4	Sheet metal welding operation	56 sec
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.		
T15	Insert stator	6 sec
T16	Stator welding and bonding connections	46 sec
T17	Stator pressing	20 sec
T18	Verification	21 sec

3. CPN TOOLS model

CPN Tools is a column processing network (CPN) modeling and analysis program. It provides a graphical and interactive environment to create and manipulate CPN models, as well as to perform advanced modeling and analysis.

In order for the model to be functional, the following sets of colors will be defined:coil, piece, robot, respectively variables b, i, r associated with arcs as being of the color typepreviously defined.

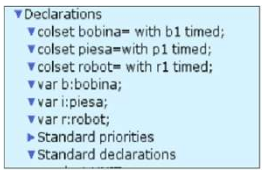

Fig 2 Definition of variables in the model made with the CPN TOOLS program

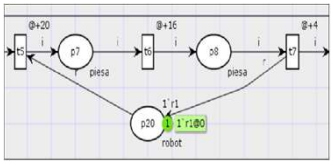

Fig 3 Modeling of robot 1 by defining the P20 position

It should be mentioned that the assembly process of the stator also involves an intermediate process of assembling the coil. This is highlighted by the positions and transitions in the figure.

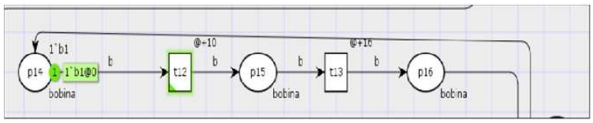

Fig 4 Modelling the coil assembly

4. Results

21 positions and 18 transitions were used to model the system. Each transition has an associated time, this network being a timed Petri T network. Initial markings p1,b1,r1 are defined for the stator, the coil and the robot. The simulation of the production process assumes the definition of the total operating time as 28800 seconds.

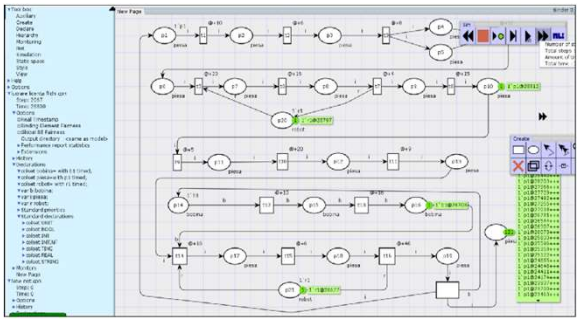

Fig 5 Model with Petri nets made with the CPN Tools program

The figure shows the simulation of the assembly process of the Stator landmark for a period of 8 hours. Thus, 121 pieces were obtained in this period of time. The times at which each assembly is made can also be identified.

5. Conclusions

Modeling and simulation with timed Petri nets provide important data on the dynamic behavior and performance of the system to be modelled. The results of the simulation constitute information that can be the basis of decisions regarding the management of real manufacturing systems.

6. BIBLIOGRAPHY

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