PERFORMANCE EVALUATION OF A007 FLEXIBLE MANUFACTURING SYSTEM WITH COLORED PETRI NETS

POP Alin [1], BLAGA Florin [1], STĂNĂŞEL Iulian [1]
[1] University of Oradea
afpop@uoradea.ro

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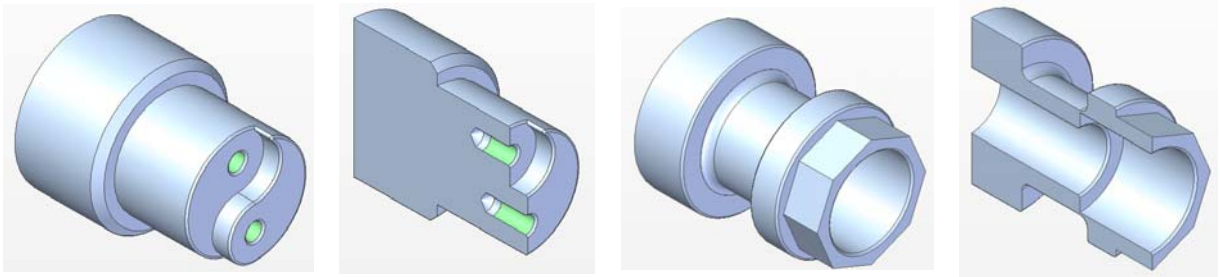
Abstract: The paper presents possibilities of modeling and simulation of flexible manufacturing systems with Colored Petri Nets. It's developed the case of A007 flexible manufacturing system of TCM Department of Oradea University. It's described the system: components, the processed parts and the operation mode. It's presented the model with Colored Petri Nets: structure and function.

1. Introduction

Flexible manufacturing system of TCM Laboratory (SFF A007) is intended for processing cylindrical parts witch have surfaces that are obtained by milling operations (Figure 1).



a) **b)**

Figure 1. Piece proccesed in MFS A007

The layout system is shown in Figure 2. The system is composed of:

- Power station (1);
- Evacuation station (2);
- lathe CNC CONCEPT TURN 55 (3);
- Control equipment (FANUC or SIMESS) of milling machine (4);
- milling machine CNC CONCEPT MILL 55 (May);
- Control equipment (or FANUC SIMESS) the lathe (6);
- Mitsubishi RV-2AJ robot (7);
- Handle the moving robot (8).

Besides the main components, the functioning, the command and the system control are provided through a pneumatic networks, sensors, electrical components Natural.All components are integrated in terms of information, enabling automatic operation in the entire system. It's possible to storage and use a very large range of "pisa programs".
A007 flexible manufacturing system can be completed with a quality station. There is no PLC (Programmable Logic Controller), all necessary checks for the proper functioning are made by the robot drive unit.

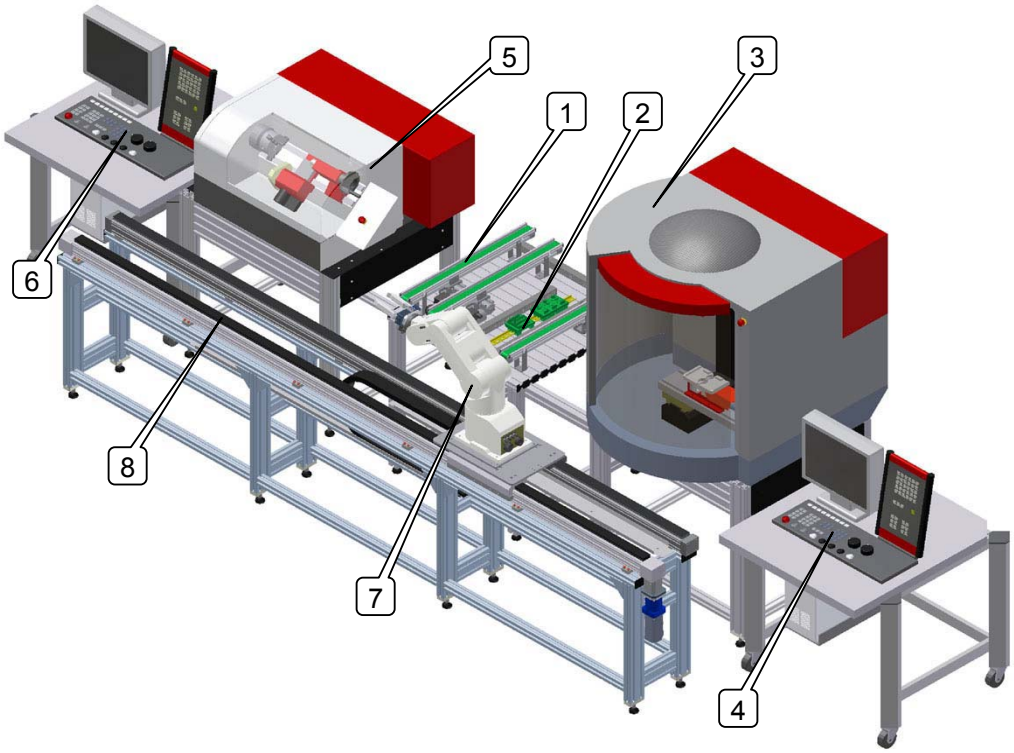


Figure2 A007 Flexible manufacturing system

Communication between stations is done through an interface I / O standard. Communication to / from stations with control cell occurs through the Ethernet network and DNC (Direct Numerical Control).

2. The Flexible Manufacturing System A007 model coloured Petri Nets

A version of route that the piece can traverse the system is: the piece is positioned by the installation whip in place where it will be processed by the robot, this brings the piece in input position if the CNC program is load.
The piece is clamped in the lathe to be processed by the program. After processing, the robot take the piece from the lathe and brings it to the milling machine, with the condition that the milling machine is not 0. The piece is attached to the device and processed by the program. After processing, the robot take a piece moved it to EI (exhaust installation finished parts). The Conveyor transfer finished parts in the storage.

Tabel 1. Positions significance

Token	Significance
A	- the piece is on the whip installation
B	- the piece is on the lathe
C	- the piece is on the milling machine
D	- the state of machine 1
E	- the state of machine 2
R	- the robot
F	- the piece is on the evacuation installation
H	- the lot of 12 pieces is evacuated
G	- the number of lots evacuated

The robot is the element the makes the relationship between the manufacturing system components and the piece. So it is necessary to know the previous stat of the piece so that we know where the piece has to be taking by the robot. The system stats are showed in the next table:

Tabel 2. The system stats

Position	Significance
0	- the piece is in storage
1	- the piece has been taken from the input installation
2	- the piece has been taken from the lathe
3	- the piece has been taken from the milling machine.
4	- the piece is in the lot of 12 piece that has to be evacuated

Tabelul 3. Transition significance

Transition	Significance
T1	- the piece is taken by the robot from the evacution instalation
T2	- the piece is put in the lathe
T3	- the piece is taken from the lathe
T4	- the piece is put in the milling machine
T5	- the piece is taken from the milling machine
T6	- the piece is put on the evacuation instalation
T7	- the robot is moving on the input installation
T8	- the lot 12 pieces is full
T9	- the evacuation of the 12 pieces lot
T10	- the piece in stoc

The position D shapes that the machine 1 is free.[1] When we load the piece on the machine on token is withdraw from the position [2]. We consider the fact that every piece that enters in machine 1 has different position in the evacuation group, so the position increment is made on the arrow that goes in the position D with the next syntax:

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if z=12  then 1`(P1,i,0) else 1`(P1,i,z+1)
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(1)

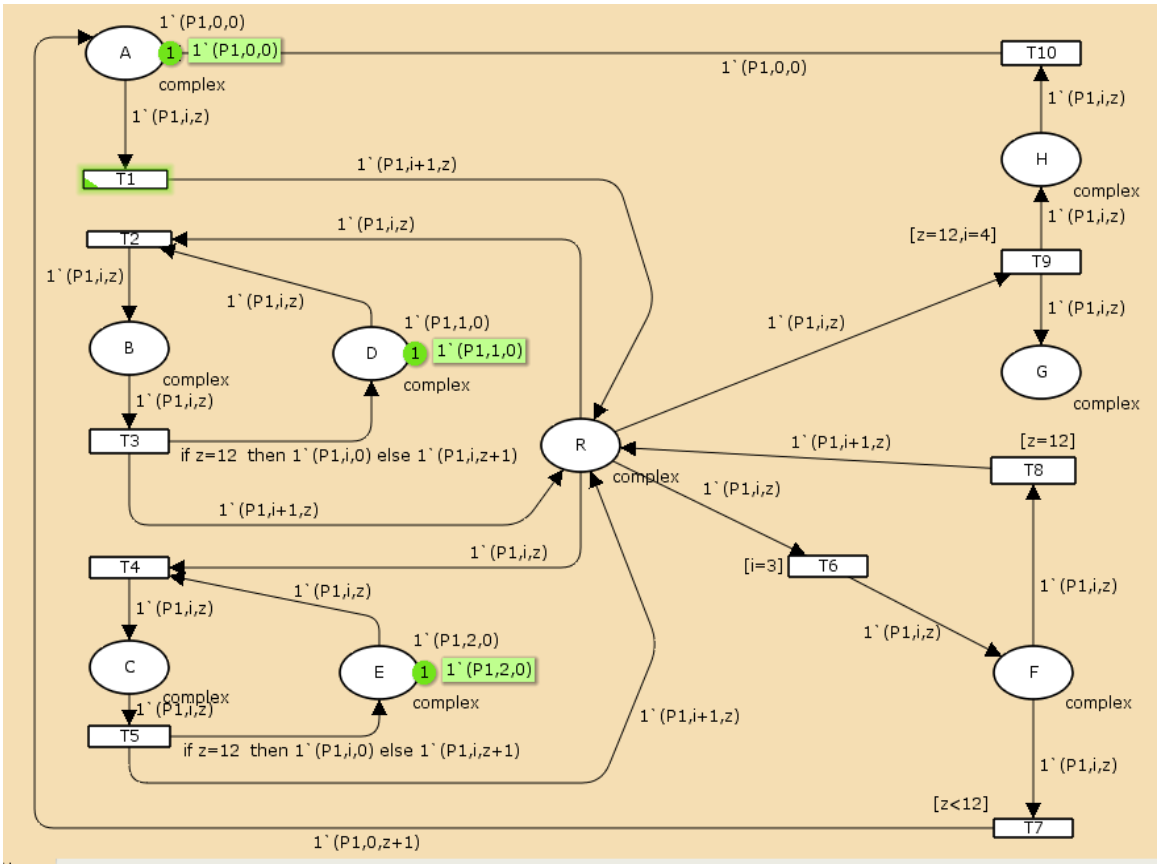

Figure3. CPN Tools model of A007 flexible manufacturing system

There is transition with are conditioning by the piece stats at one moment. So the position T6 is executed only if the piece has been taken by the milling machine. This can be verified by putting on the transition T6 that [i=3].
Transition T7 is executed if the position in the manufacturing group is smaller then 12, condition put to transition T7 [z<12] and transition T9 is executed only if the number of pieces in the evacuation group is equal with 12.
The manufacturing system simulation in CPN Tools [5] involves the definition of variables that are associated with complex color. All positions [4] of the simulation framework scheme are complex type, type witch is defined as a Cartesian product between three simple colors: piece, history and position.

colset complex=product piece*history*position (2)

Variable p witch has the “piece” type it will indicate the type of piece . In this case the type of piece is P1 all the time.
Variable has the type “history”, and it will indicates the stats in witch the piece is at moment of time.
Variable Z it will indicate as the position of the piece in manufacturing group.

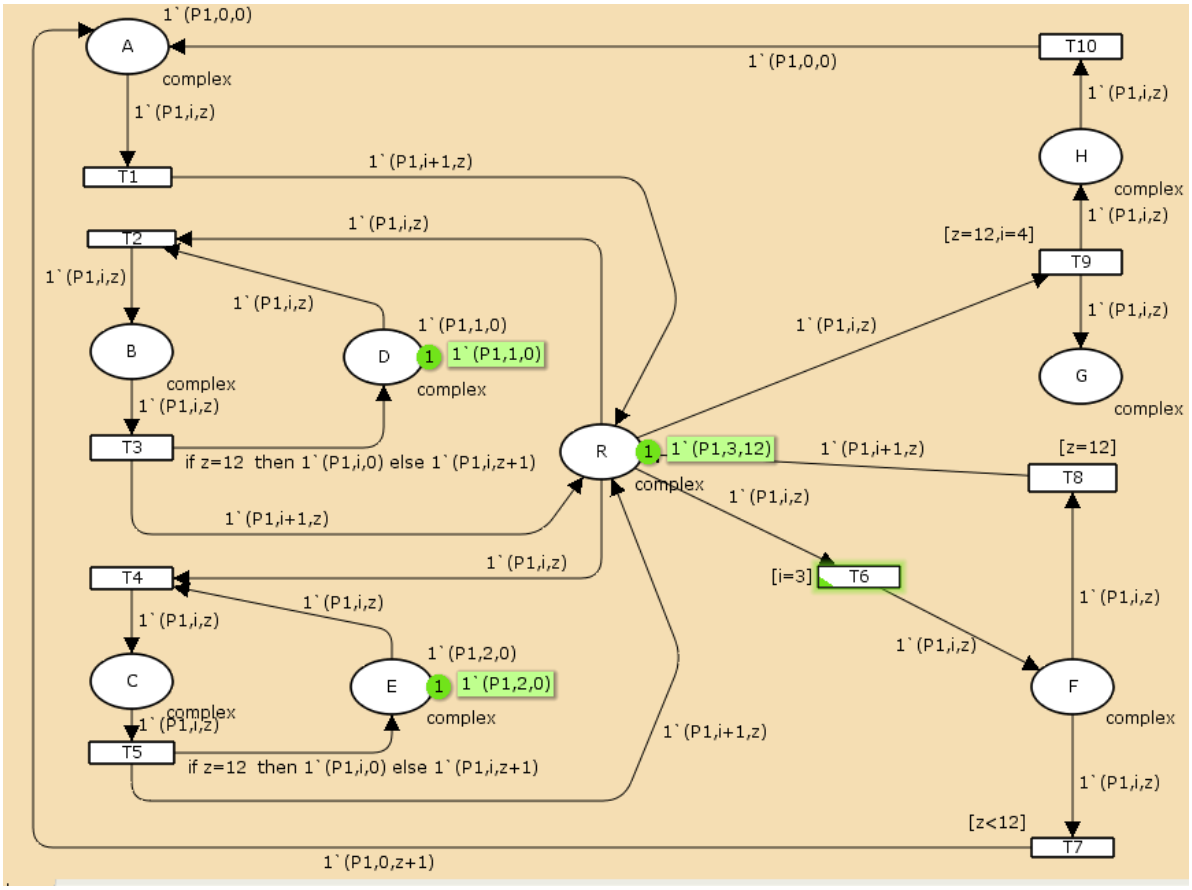

Figure4. The simulation model of A007 FMS after 12 piece is processed

3. Conclusion

Colored Petri Net offers special facilities for evaluating the performance of flexible manufacturing systems.

This is possible through the introduction of color marks type and the functions as loading on the arcs. These models describe more faithfully the real system and the various states in where can be found. Using color complex significantly simplifies the construction of model.The modeling and simulation software with colored Petri net through the information that provide to the decision-makers, become a useful tool for making management activity.

4. Bibliography

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