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COLOURED PETRI NETS MODELING USING CPN TOOLS

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Abstract: The paper presents the possibilities of modeling of the SFF using color Petri net. The evaluation of the flexible manufacturing system performance is make by using the modeling and simulation color Petri net software CPN Tools.

1. INTRODUCTION

The coloured Petri nets is using for system modeling which have problem with resurse allocation and synchronization. These problems characterize the flexible manufacturing system.

A coloured Petri net (RPC) is a subset that look like the following [2]:

$$RPC=<P,T,Pre,Post,Mo,C> \quad (1)$$

Where: P is the multitude of positions;T is the multitude of transtions; Pre Post are functions that establish the relationship betwen every transitions color and postions color (are charged the arcs that in/out on a transition; M is the initial marking.C={C_1,C_2 …} is the multitude of colors.

2. THE MODELING WITH COLOURED PETRI NETS

It's given a flexible manufacturing system with two working machine, machine 1 and machine 2 [2]. The pieces are transported through palettes: n_1 pieces for p_1 and n_2 pieces for p_2. The palettes may be reintroduced into the processing system at the end of a piece made.

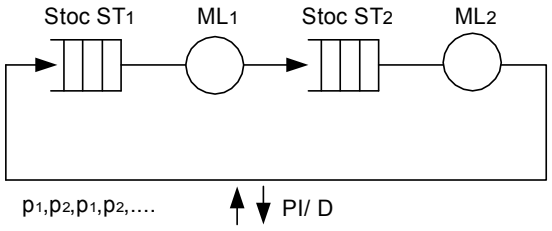

Fig.1. Flexible manufacturing system

The ordering within the system lies in the processing of alternative types of parts in succession: p_1, p_2, p_1, p_2, p_1. It is assumed that the loading / unloading palettes is instantly (it has a negligible period of time).

The coloured Petri net which model the system is shown in Figure 2.

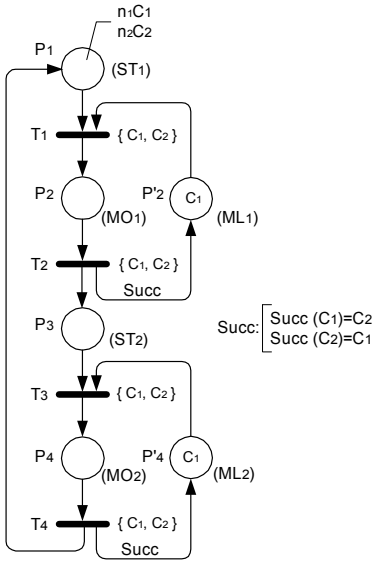

Fig.2. The model with Coloured Petri Nets

C_1 and C_2 colors are associated with palettes where are put the pieces. C_1 for the type1 palette – corresponding to the p_1 piece and C_2 for the type 2 palette which corresponds to the p_2 piece. The multitude of colors C_1, C_2 is associated with all positions and all transitions.

Notations used:

- ST_i positions which modeling the stock before car i;
- ML_i positions which modeling that the car i is free;
- MO_i positions which modeling that the car that is occupied;
- T_i transitions that modeling the loading machine;
- T_i` transitions that modeling the unloading machine.

In all the case i={1,2}.

The ST_1, MO_1,ST_2 şi MO_2 position modeling the physical stages of the system.

ML_1 ML_2 positions describe that machine 1 and machine 2 resources are unique in each one part in relation with the piece1 and piece 2, its will be shared between several pieces.

In the model presented appears sequence and function defined as follows:

$$Succ(C_1)= C_2 \quad (3)$$

$$Succ(C_2)= C_1 \quad (4)$$

This ordering is causing the two types of parts in the system in succession: p_1, p_2, p_1, p_2, p_1.

The mark initially has two components:

$$Mo(ST_i)= n_1\ C_1+ n_2\ C_2 \quad (5)$$

- in the entry stock al the ML machine are n1 piece of type p1 and n2 pieces of type p_2.

$$Mo(ML_1)=Mo(ML_2)= C_1 \quad (6)$$

The meaning of this relation is that each of the two machine are waiting a piece of type p_1.

2.2 Presenting the software *CPN Tools*

CPN Tools is a tool for editing, simulating and analysing Coloured Petri Nets. The GUI is based on advanced interaction techniques, such as toolglasses, marking menus, and bi-manual interaction. Feedback facilities provide contextual error messages and indicate dependency relationships between net elements. The standard state space report contains information such as boundedness properties and liveness properties.

Design/CPN was first released in 1989 with support for editing and simulating CP nets.

Since then a significant amount of time has been invested in developing efficient and advanced support both for simulation and for generating and analyzing full, partial, and

reduced state spaces. While the analysis components of Design/CPN have steadily improved since 1989, the graphical user interface has remained virtually unchanged.

CPN Tools is the result of a research project, the CPN2000 project [7], at the Universityof Aarhus, sponsored by the Danish National Centre for IT Research (CIT), George Mason University, Hewlett-Packard, Nokia, and Microsoft. The goal of the CPN2000 project was to take advantage of the developments in human-computer interaction, and to experiment with these techniques in connection with a complete redesign of the GUI for Design/CPN.The resulting CPN Tools combines powerful functionalities with a flexible user interface,containing improved interaction techniques, as well as different types of graphical feedback which keep the user informed of the status of syntax checks, simulations, etc. All modelsthat are created in Design/CPN can be converted and then used in CPN Tools; the reverse,however, is not true.

2.3. Modeling with *CPN Tools*

The same application presented in paragraph 2.1. was implemented using software CPN Tools.

Initially were declared two colors:

$$colset\ culoare=with\ C1|C2 \tag{7}$$

colset-is the keyword in Modeling Language with what the colors are declared. In the previous line is declared a set of colors consist of two elements C_1 and C_2.

The arcs are elements that make the link between a transition and a position. The arcs value is defined as the type of color that carries.

$$Var\ i:culoare; \tag{8}$$

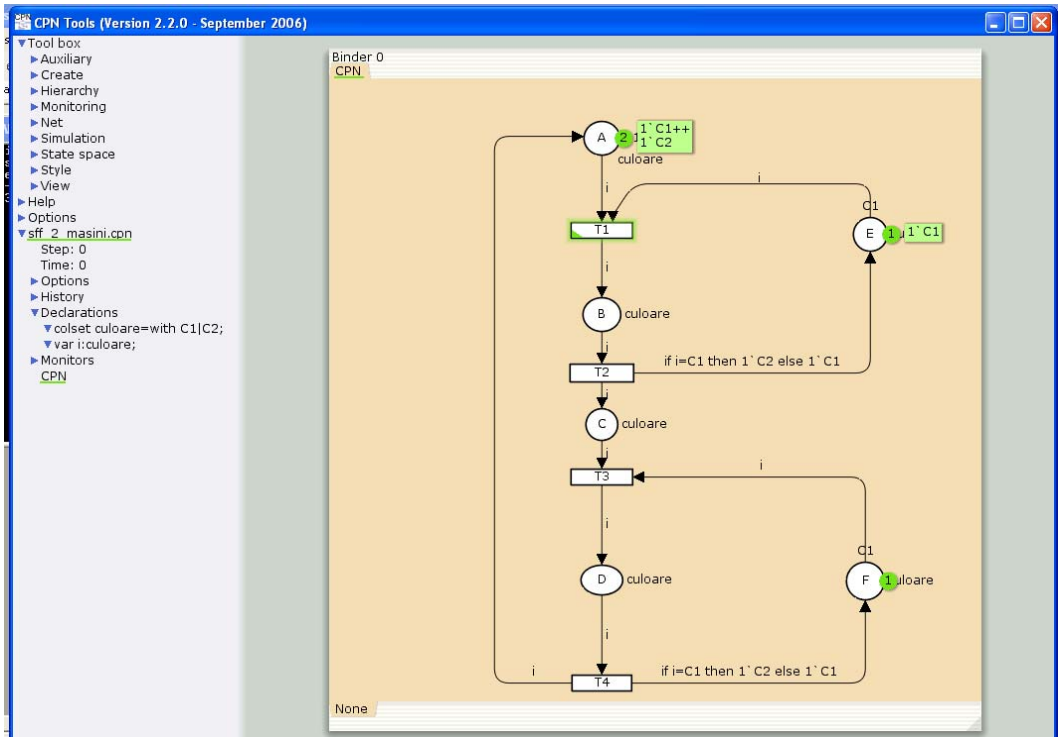

Fig. 3. The flexible manufacturing systems model made in CPN Tools – T2 transition

In carrying out the model are used 6 positions (A… F) and 4 transitions (T1… Q4). The initial position will contain two colors:

$$1'C1++1`C2 \tag{9}$$

-"+ +" is used like a concatenate operator between the two colors and operator "` "is used to specify the number of color markings.

The E, F is the initialized, with color C1.

The positions E, F will be charged alternative with the colors C1, C2 due to conditions specified by the directed arcs that fall into them.

$$if\ i=C1\ then\ 1`C2\ else\ 1`C1 \tag{10}$$

The significance of this condition is as follows: If the value "i" of the arc is C1 then the position in which the arc entry, is loading with C2 marking, otherwise C1 is the value by which is loading the position.

The first step in simulation is the running of the T1 transition, this being validate because the position A and E are loaded with C1 mark. On the execution of the transition T1 are withdraw the marking of color C1 from the position A and E and lodged the marking C1 in position B (Fig 3).

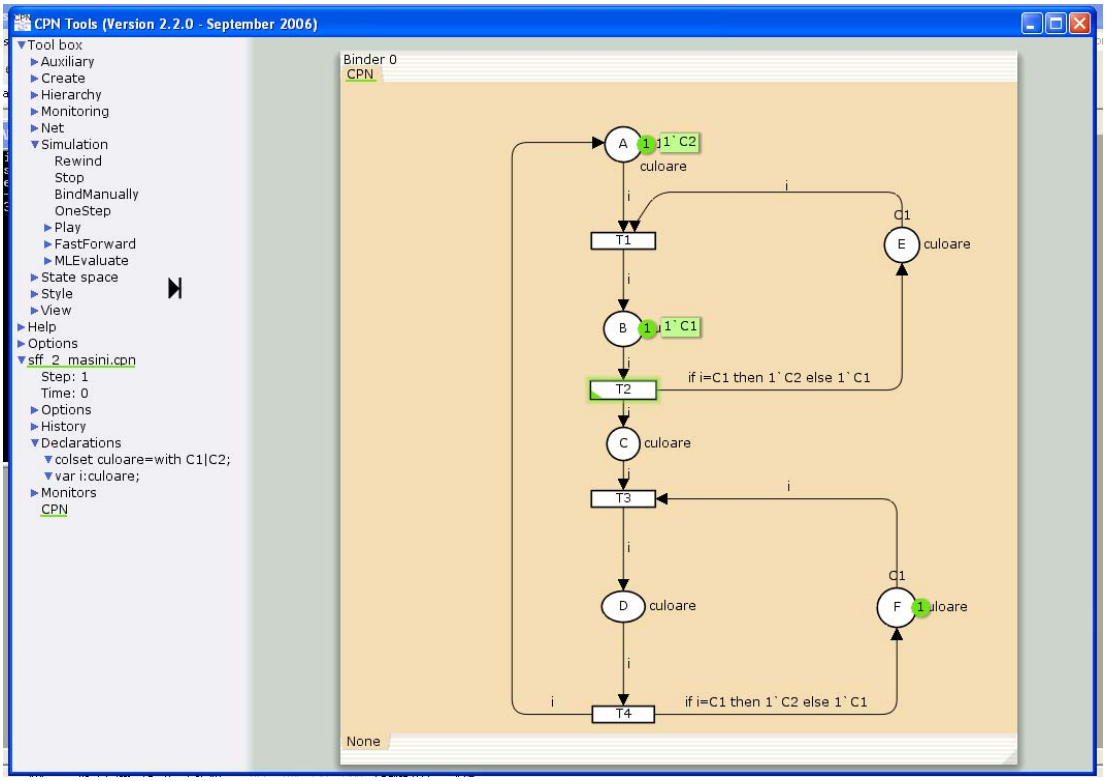

Fig.4 The flexible manufacturing systems model made in CPN Tools –The execution of the T2 transition

On the T2 transition execution (Fig 4), from the position B is withdraw the marking C1 and lodged into the position C and in the position E it will be lodged the marking C2, because of the condition specificate on the arc (Fig 5).

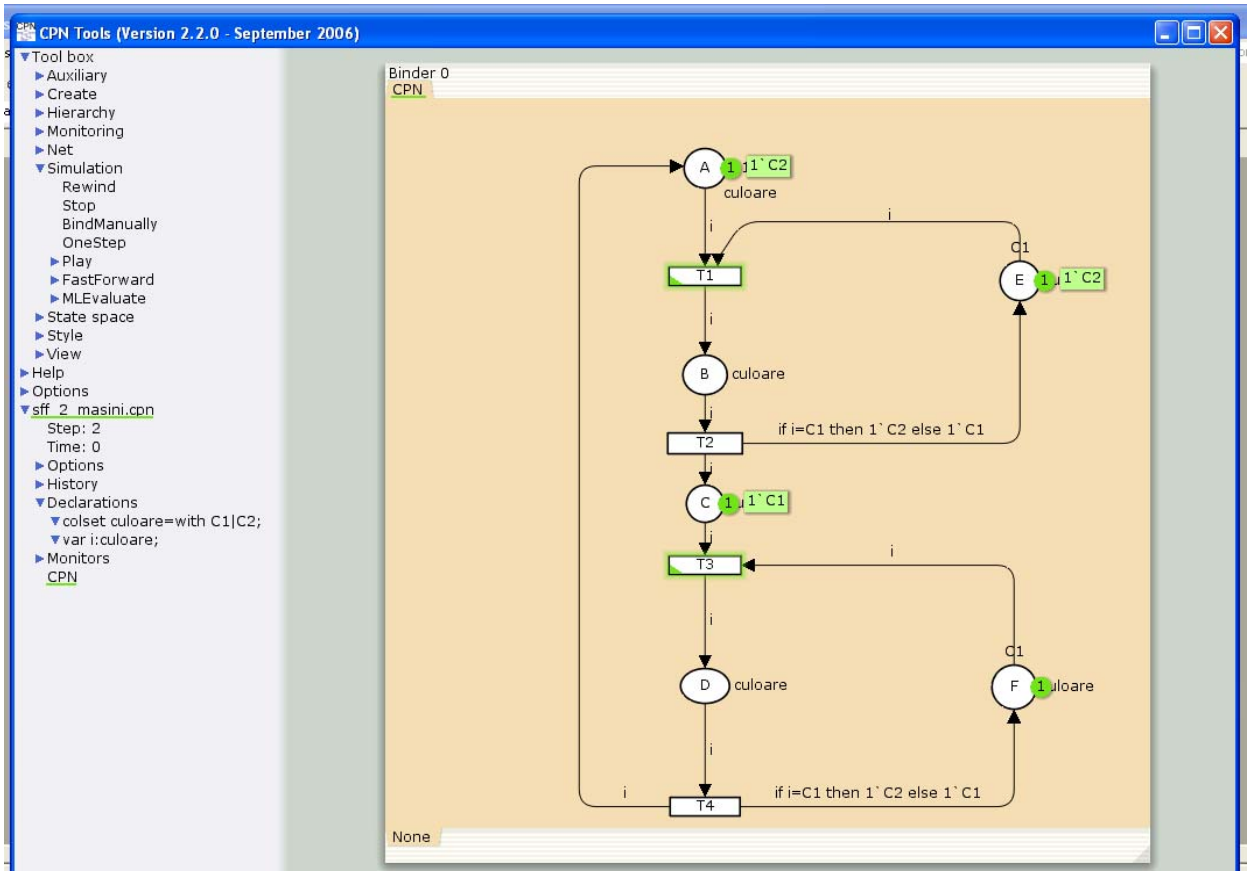

Fig.5 The flexible manufacturing systems model made in CPN Tools –The execution of the T3 transition

2.4. The modeling of flexible manufacturing systems with Coloured Petri Nets

It is considered manufacturing system presented above. The model system with Coloured Petri Net using color complex is the one shown below in Figure 6. In this model the notes have the following meanings:

- A- modeling stock in front of each machine;
- B modeling a car occupied;
- C modeling a car free;
- transition T1 is modeling the loading of a car;
- transition T2 is modeling the discharge of a machines.

In building the model is using basic color (P_1, M_1) which defines the piece p_i (i = (1.2)) is processed on the machine m (j = (1.2)). A mark of color (P_i, M_j) in position A means the existence of the one piece of P_1 type in the entry stock of the car j. A mark of the same color in the position C means that the car j is available and is to process a piece of P_i type.

The marking of the initial position A:

$$3`(P1,M1)++3`(P2,M1) \qquad (11)$$

- marking the significance of this is that in the stock of entry before the machine 1 are pending 3 pieces P1 and 3 pieces P2

The marking of the initial position B:

$$1`(P1,M1)++1`(P1,M2) \qquad (12)$$

- machines 1 and 2 are available and are going to process a piece P1.

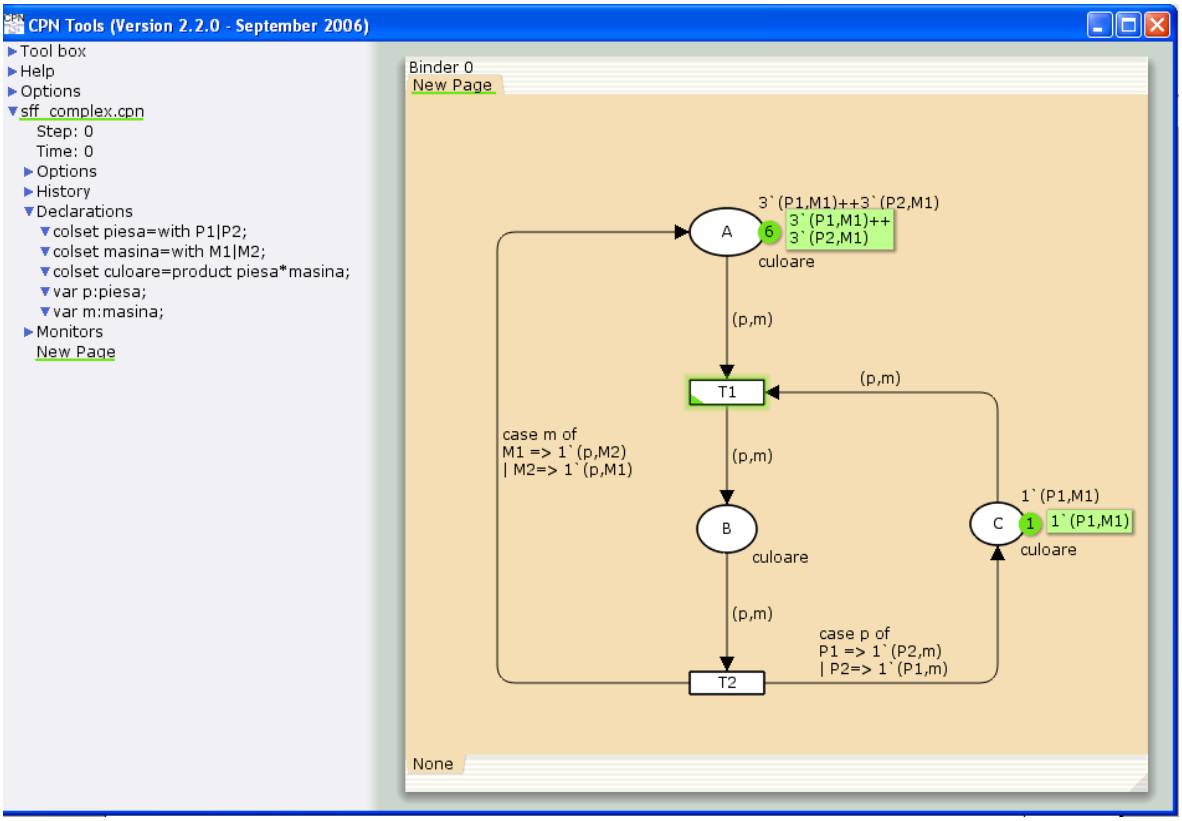

Fig. 6 The flexible manufacturing systems model made with complex colors

3. CONCLUSION

Coloured 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 finding. Using color complex significantly simplifies the construction of model

The modeling and simulation softwares with coloured Petri net through the information that provide to the decision-makers, become a useful tool for making management activity.

Among these programs, CPN Tools are distinguishing by the multitude of feature that offers the friendly and accessible to the user.

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