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THE PETRI NETS MODEL FOR 2 R FMS FLEXIBLE MANUFACTURING CELL

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ABSTRACT
At the University of Oradea, Managerial and Technological Engineering Faculty a flexible manufacturing system (FMS) was designed and prepared to be realized. Part of the FMS system exists, such as a CNC milling machine, two industrial robots. The design of FMS and FMS itself will be done through the research activity of teaching staff that works in the fields of Robotics and Flexible Manufacturing Systems. To simulate its function, Petri Net models were used, together with Visual Object Net software.
Keywords: Flexible Manufacturing System, Petri Nets, Visual Object Net.

1. THE 2R 2002 FMS LAYOUT AND ITS COMPONENTS
The block scheme of the FMS was design to achieve the following functions:
- manufacturing function;
- quality assurance function;
- logistic function;
- automated storage and retrieval function;
- programming and control function.

In order to achieve these functions the FMS system needs to contain the following subsystems (Figure.1):
I – pallet and raw material input and storage subsystem; II – the manufacturing subsystem; III – quality assurance subsystem; IV – the transfer subsystem; V – the automated storage and retrieval subsystem; VI – the main programming and control subsystem; VII – the pieces output subsystem.
To work properly as a FMS system all these subsystems have to be integrated into materials, information and energy fluxes.
The raw materials enter in the FMS system through subsystem I (pallet and raw material input and storage subsystem, being positioned on pallets. The pallets are transferred to the next station by a conveyor (the transfer subsystem).
After manufacturing, the pieces are controlled using a vision station (CCD camera) – subsystem III.
After quality control, the pallets with the pieces can be stored in the automated storage and retrieval subsystem. Evacuation of the pieces, both of that which passes quality tests or not is made through subsystem VII.
The VI subsystem's main role is to coordinate from the informational point of view all other subsystems.

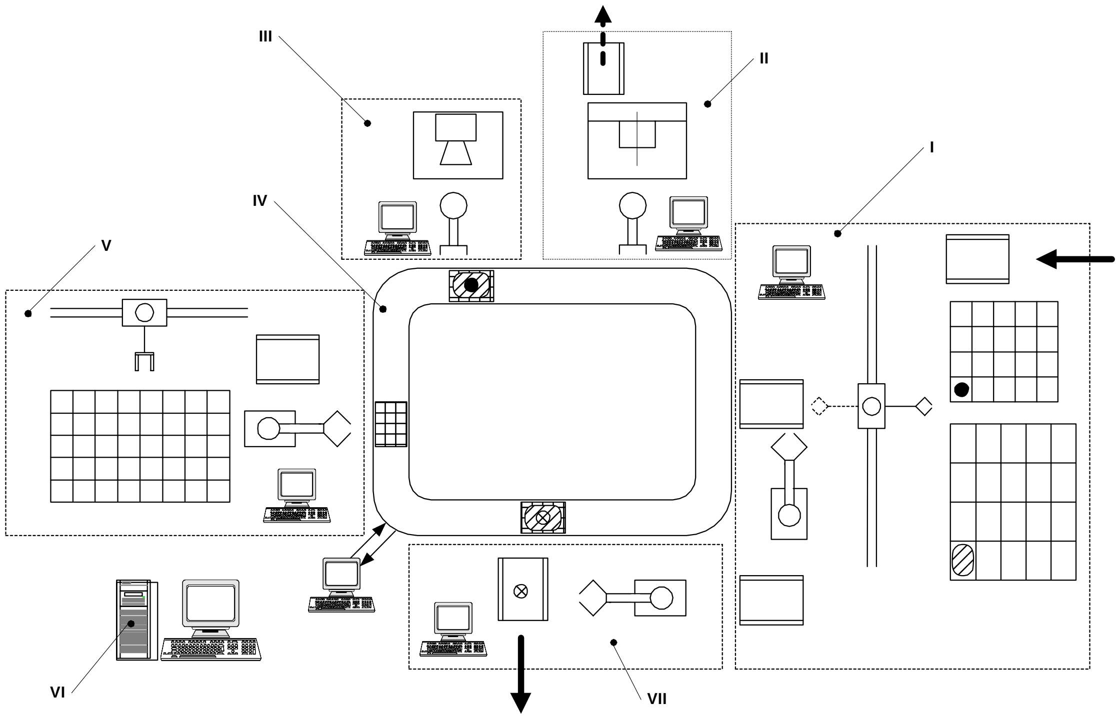

Figure 1. 2R 2002 FMS – layout

2. THE 2R 2002 FMS PETRI NET MODEL

The Petri net model of the 2R 2002 flexible manufacturing system is presented in figure 2
Manufacturing cycle begins with the pallet selection from the pallet warehouse, modeled with the P2 position, by the R2 linear manipulator modeled by P1.
T1 is the transition that corresponds to the robot loading. Pallet loading condition onto the robot is modeled by P3. Storage point presents in the initial phase a marker that specifies its availability.
T2 transition models the storage point whilst P5 position identifies if the storage point is available or not. Simultaneously with the storage point loading R2 represented through P6 is released. Together with P7 which models the cylindrical raw materials warehouse, through T3 transition it models the R2 loading with raw materials.
P8 marks that R2 is loaded with raw material. P5 and P8 determine, through T4, the storage point loading with pallet and raw material. As the loading moment occurs, R1 is released may pick the raw material its state being modeled through P10 and P11.
The number of the free carriages on the conveyer is modeled through P12 and their load with raw material through T6 transition. This is the final condition in the storage system. It's entrance position is P13 which models the carriage loaded with raw material waiting near milling machine until it is available (P14) when the manipulator loads the raw material that is to be manufactured (T3); at the end of the manufacturing process the manipulator loads the machined piece onto the carriage that waits in front of the machining point P23.
After machining the manufactured piece is controlled. This operation is very similar to the precedent one, its output being a decision: The manufactured piece is rejected or useful.
After the decision the piece is loaded on the waiting carriage in front of the control point P33. If the storage room of the evacuation subsystem is free and if R5 is free (P34) the latter is loaded with raw material and the storage at the storage point after which the good piece or the rejected one is exhausted to the final pieces or to the rejected pieces store. The voided palette is undertook by R5 and transferred to the raw material storage system. R2 manipulator loads it and puts it onto the palette storage room. If the exhaust subsystem is busy the manufactured piece is delivered from the control subsystem to the storage buffer.
R3 robot's availability is modeled by P43, the robot having to load the pallet with the final piece or the rejected piece and live it at the storage point where from it shall be picked up by the linear manipulator modeled by P48 and delivered to the storage buffer until the exhaust system is available.

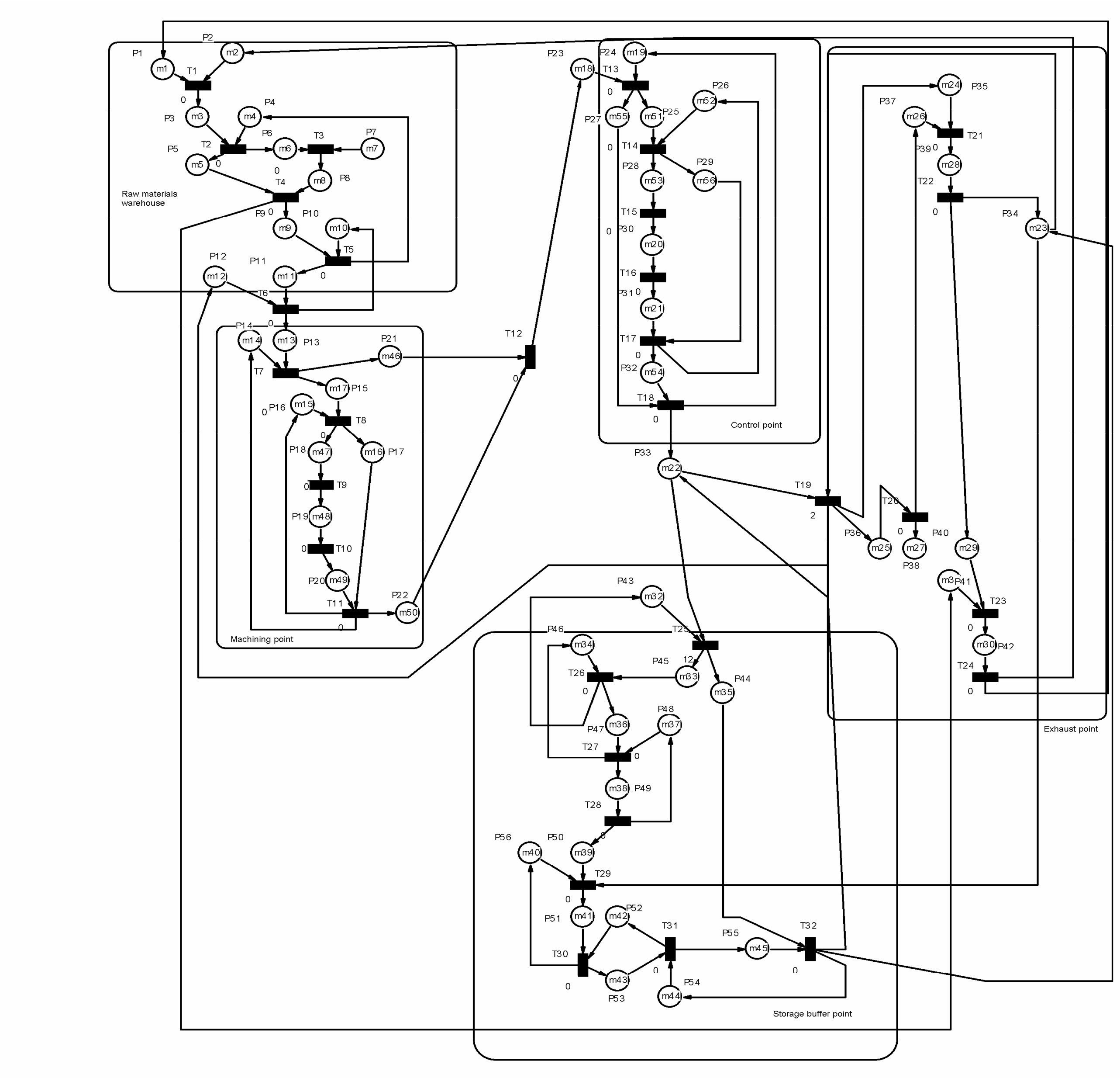

Figure 2. 2R 2002 FMS Petri net model

3. THE SIMULATION OF 2R 2002 FMS PETRI NET MODEL

If Petri Nets model is used to simulate the function of the cell, the marker evolution graph associated to P2, P7 P12 and P38 positions, modeling correspondingly the palettes warehouse, the material raw warehouse, the number of the available carriages on the conveyer and the final piece and rejected piece warehouse can be viewed in fig.3.

Functioning times associated to the flexible cell elements are presented in the graphs dependent upon time and on the number of pieces considered.

Having an initial stock of 20 palettes and considering P2 loaded with the afferent marks which models the palettes number inside the warehouse it can be observed that during the four manufacturing cycles this number remains constant a single palette at the time being on the conveyer.

Raw material variation inside the stock, modeled by the P7 position, can also be seen. The number of raw material continuously decreases.

On the ordinate line the moment at which a raw material is delivered is visualized. On the abscissa the remaining raw material number is presented. From the graph which presents the using time of the carriages (P12) one can observe that a single carriage is used during one functioning cycle, being

successively used. As in the case of the palettes their total number remains unchanged during one cycle, only stationing times being variable.
P38 models the manufactured pieces stock. This stock is in inverse ratio to the initial raw material stock. The manufacturing cycle duration can be measured directly on the graph as a difference between the moment of the palette pick up and the delivery moment of the final piece.

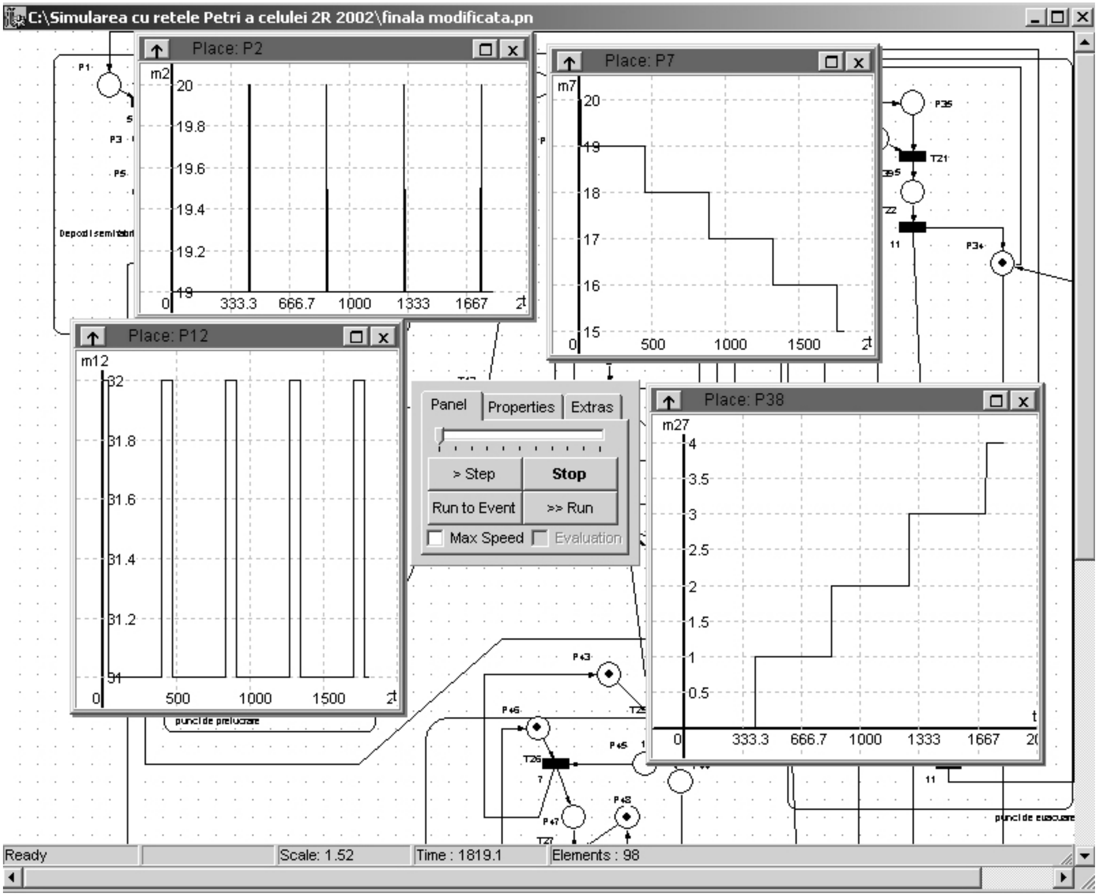

Figure 3. Visual Object Net ++ windows during simulation

4. CONCLUSIONS

The temporized Petri Nets gives special facilities in FMS performances evaluation. This is possible using “time” factor as a determined element associated to sequences executed by system components. The modeling and simulation Petri Nets program through the decision indicators they are giving became a useful instrument in order to improve management activity.

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