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MODERN TYPES OF CONTROLLING THE ASSEMBLY SYSTEMS

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ABSTRACT
Among the most modern methods for controlling of the manufacture systems are the KANBAN method, the CONWIP method and the HYBRID method. Application of these methods in practice makes easier identification and remove of the bottlenecks of these systems. Having in consideration this important fact, in this paper the application of these methods in the electromotor assembling line is presented. The special interest in this paper is paid to the limits and priorities of these methods in the practice.
Key words: KANBAN, CONWIP, HYBRID

1. INTRODUCTION
An electromotor assembling and flexible palletizing system create a very sophisticated system. The core system consists of industrial ABB robots, palletizing stations, and transport system which connect these subsystems with another part of manufacturing system. Having in mind that system control is very important phase, in this paper three modern control methods KANBAN, CONWIP and HYBRID are elaborated and also compared.
Therefore, application of these methods in the electromotor assembling line is analysed. Results are graphically presented.

2. KANABAN CONTROL
Kanban is a Japanese word that means "card" or "signal". This is a type of the system control, which was initially applied in Toyota factory. By this type of production control, a high efficiency can be achieved in the system outcome, with an undersized inventory between working and particularly assembling stages. In the *Figure 1.* this type was shown, in a blue is shown a movement of parts, in red a circulation of kanban. Kanban, therefore, is nothing else but returned information, which is followed by the output buffer of the working stage, informing for new free places. By this we can understand that a buffer is ready to except another part. It could be understood this way: supposing that each part or unit is attached to a card. Before entering into the working stage, the unit should have its own card. The buffer's size is defined by numbers of the cards. At the entering moment at the working stage the entity is decoupled from the card, the card gets back to previous stage. Production stations are shown by M and triangles show the buffer. The control method of production systems avoids the working station blocking by the cards. The cards number in the system is variable and it depends from buffer's size of each working station.

The pallets number necessary in the assembling system of electrical motors is defined according to this:

N=DT/C

Where: n- is total number of pallets; D- is size of demand from the assembling system; C-is pallets' size expressed in number of pieces, especially less than 10% of daily requests; T-is time needed for the pallet to perform the entire working cycle (time of process duration).

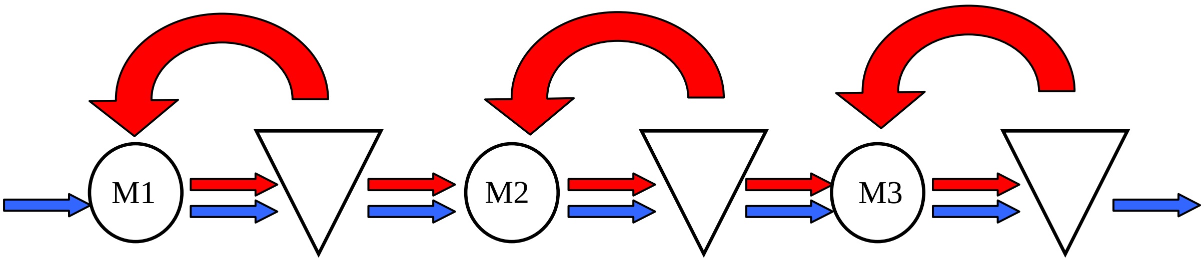

Figure 1. Control by Kanban method (red color)

3. CONWIP CONTROL

CONWIP (Constant Work-In -Process) is the other method of the production control system. This method is very popular in the production systems of developed countries. It came into practice after the Kanban 's appearance, as a result of many unsuccessful years of its experience, during the failure of the production working stations, and storage of large number of the buffers in the entry and the closing stages of production stations. In contrary to the Kanban control method, this method confines the cards number in the system. As by the Kanban control we it deals with variable number of cards, by CONWIP it is contrary to that, there are a set number of cards. As KANBAN control, this control method belongs to the so called "pull system". Subsequently, the system is pulling the entities towards the system outcome. The difference to the Kanban is also on buffers, which constantly stay empty at the CONWIP, except to the system outcome which is always full, (*Figure 2.*). The control mechanism of this system is shown below.

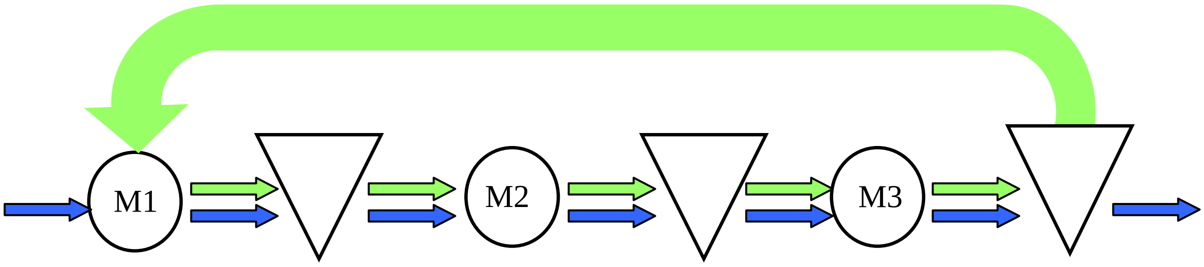

Figure 2. Control of production systems by CONWIP method

The entities which flow are shown in blue, while the cards are in green. Different to the Kanban control, undersized line we have only from the final station to the first one. Therefore, if a working station is anticipated with two buffers: an ingoing buffer and outgoing one, then according to CONWIP control, at the outgoing buffers the entities are stacked. The ingoing buffer always remains empty. Such mechanism makes understand that when the system fails, from the outgoing buffer there are a lot of entities, which supply the incoming machine with material. So until the repair is undertaken, there are parts, by which is prevented the failure of other working station from the production system, an issue that doesn't happen with Kanban contol. It has full outgoing buffer and if this station fails from production, its restarting needs a lot of effort to reach the steady level and avoid overcrowd at the input buffer. Conwip control shows the stability towards the flow of the material, while kanban acts contrary to it. In that way it is reached a same outcome of the system for less storage of the buffers in the working stations. In case, when the final machine fails from the

production, then the consumers will be supplied with standing by parts, until the restart of the machine is done.
By the practical Kaban, and CONWIP application, we could say that based also on long time experience, it is very easy, for the last method to be applied because of its cards number set circulating in the system.

4. HYBRID CONTROL

Sometimes if the system is very heavily utilized or there is a bottleneck in the line, the buffers towards the upstream end of a Conwip line will be quite high levels. On the other hand, Kanban control was designed to prevent individual buffer levels from exceeding designated limits. Therefore, it came to the idea on

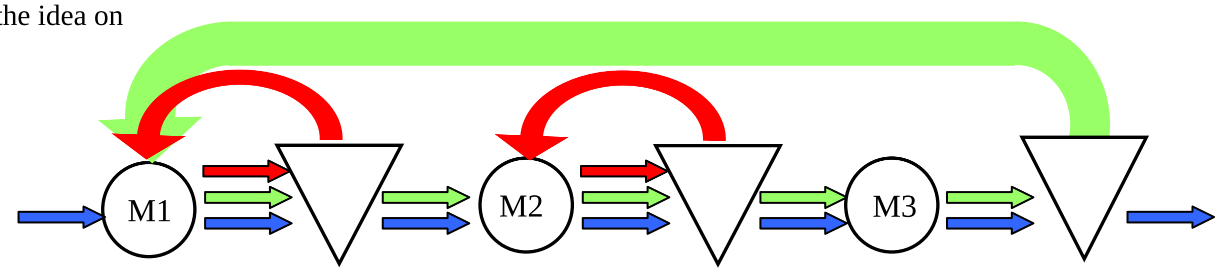

Figure 3. Control of production systems by HYBRID method

implementing the Hybrid control. This method utilizes both advantages from previous presented methods.
In this way Hybrid method functions, by putting bottlenecks in the working stations, *Figure 3.* puts Kanban method under control.

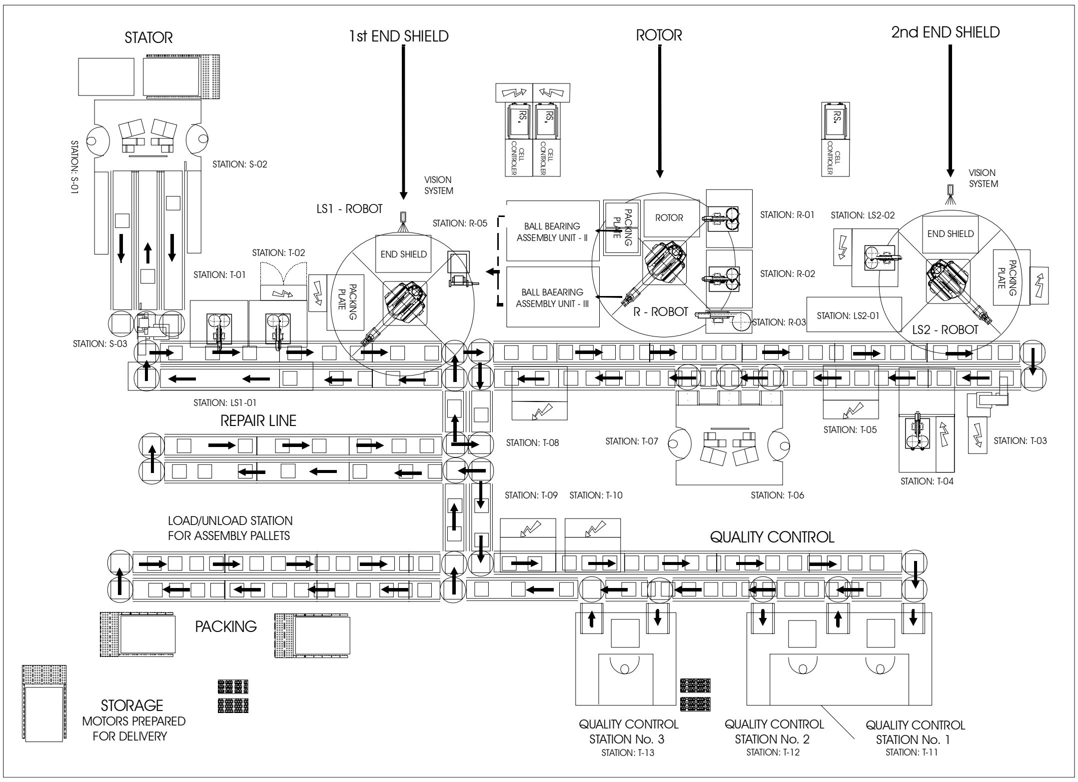

Figure 4. Flexible electromotor assembling system

This system reacts in CONWIP way but with small number of stocking in buffers when system failure is real. The sizes of buffers are determining by the number of cards in the circulation.
The elaborated theory is used for simulation of control methods at flexible electromotor assembling system shown in *Figure 4*.

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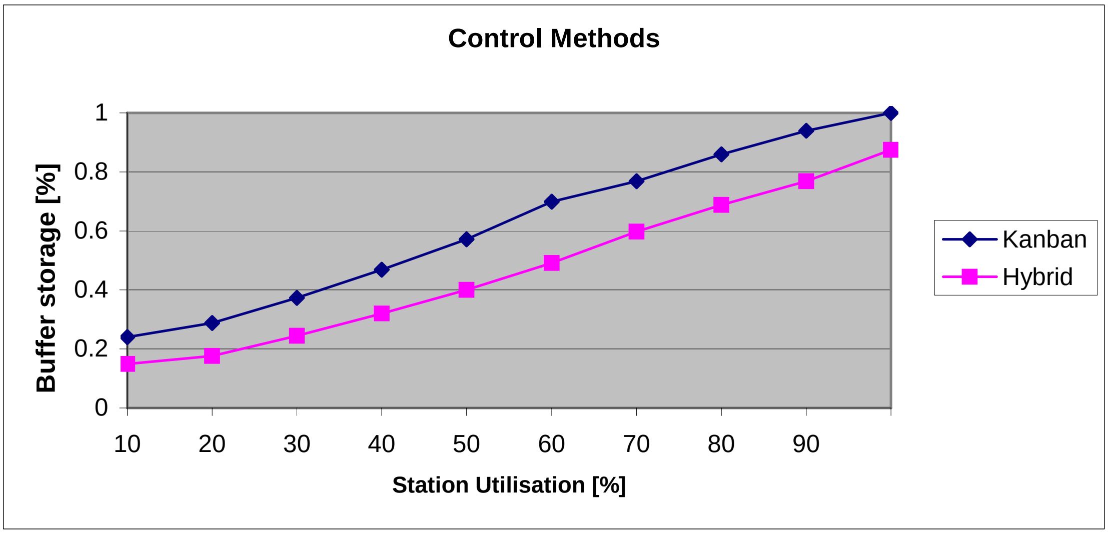

Figure 5. Graphically presented results

5. CONCLUSIONS

Kanban control fills up a lot of the buffers of working stages, but in other way it increases the utilization levels.
The hybrid method reaches, almost the same utilization level and it less uses the buffers.
Nevertheless, the flexible assembling system can be controlled by the Kanban method, and in some working stations by Hybrid, because it Is designed in such hardware way.

6. REFERENCES

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