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IMPLEMENTATION OF AUTOMATIC GUIDED VEHICLES IN THE OPERATIONAL PRODUCTION FLOW

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Rezumat. *Lucrarea de față este bazată pe implementarea, realizarea și testarea unor vehicule cu ghidare automată (AGVs) în cadrul Uzinei Vehicule DACIA. Un AGV cu sistem de transfer este un vehicul ghidat automat care are un rol de a efectua mișcări de alimentare, transport și transfer în cadrul unui flux logistic, într-o întreprindere cu activități de producție. Acestea sunt întâlnite în industrie atât la începutul cât și la sfârșitul unui flux logistic automatizat. AGV-urile sunt necesare pentru a micșora atât timpul cât și costul de producție determinând fluxuri inteligente și eficiente de materiale pentru o intralogistica orientată către client.*

Abstract. *The present work is based on the implementation, realization and testing of the vehicle with automatic guidance (AGV) within the DACIA Vehicle Plant. An AGV with transfer system is an automatically guided vehicle that has a role of performing power, transport and transfer movements within a logistics flow, in an enterprise with production activities. They are found in the industry both at the beginning and at the end of an automated logistics flow. AGV's are needed to decrease both the time and cost of production by causing intelligent and efficient material flows for a client-oriented intralogistics.*

Keywords: AGVs implementation, material flow

1. Introduction

Industrial robots are the most used type of robots, these being also the first to appear, in response to the need to perform faster and more accurate repetitive operations, often found in production processes.

In recent decades, in the industrial, agricultural, forestry fields, in order to solve problems related to local transport, mobile robots are represented by AGVs (Automated-Guide Vehicles), vehicles with automatic guidance, which were originally introduced in the automotive industry around the 1950s. Nowadays,

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their applications have been expanded and are no longer limited to the industrial sector, being also used in hospitals, museums, airports, etc. [1], [2].

The first AGV was brought to market in the 1950s by Barrett Electronics of Northbrook, Illinois, and at the time it was simply a tow truck that followed a wire in the floor instead of a rail. From this technology a new type of AGV has emerged, which tracks invisible UV markers on the floor instead of being towed by a chain. The first such system was installed at Willis Tower (formerly Sears Tower) in Chicago, Illinois, to deliver mail to all its offices.

They follow a predetermined path, stopping at each machining or assembly line to be loaded with parts or unloaded, manually. Unlike traditional robots, AGV's are not manipulators, they are vehicle handlers programmed to follow a route.

Studying and implementing the latest technologies on the market is a priority for many companies, given the benefits that new technologies offer. The current trend to flexibly automate the production process comes as a direct response to the demand on the market to be able to offer a wide range of products, manufactured in different time regimes, in different batches, with different peculiarities.

With the opening of the subject of automation, there are also ethical problems that tend to put people in competition with the car. There are many aspects that must be taken into account when wanting an evolution from a technological point of view, because until now the global trend has been to ease the work that man performs. Recently, it has come to the point where numerous processes that up to a certain point were carried out either by operator or by operator with the help of a machine, have been developed in such a way that there is no longer a need for a direct involvement of operators for a favorable result [3],[4].

The current problem is not to completely replace people but to identify and separate into two groups the duties that people can perform and the duties that machines can perform in a technologically, economically and socially efficient manner. Thus, a human-machine collaboration is still needed, which would imply an efficient development of the activities in order to achieve the desired results and as paradoxically as it seems a collaboration between man and machine following the trend of separating their duties, as difficult as it is to avoid or neglect this aspect.

AGV's are controlled by a software in which the individual route of each one is programmed, and a single operator can track through the interface the functioning of all the machines within the company. For navigation it must be guided with the help of wires, magnetic tapes or sensors, which usually requires work in the units where they are to be implemented.

By using them, the manual work in taking over and transporting the products will be completely canceled, the supply and production flow as well as the safety in handling will be increased. The AGV is also limited to fixed routes, which translates into additional costs and new disruptions to activities, if in the future the routes will have to be modified.

They can detect obstacles in front of them, but they cannot bypass them, so they simply stop until the obstacle is removed. The implementation of these automated machines allows the making of safe forecasts regarding the stocks and distribution of goods and to optimize all the logistics processes within a company by eliminating time losses, human errors, accidents and other unforeseen elements.

AGV’s can be customized according to customer needs, to be used for load transfer (with conveyor belt), or used, for example, as forklifts or mobile mailboxes for the distribution of mail and parcels.

2. Evolution of the logistics concept

The development and modern application of the term logistics was achieved in a rather long evolutionary period.

The first definition of logistics was enunciated in 1948 by the American Marketing Association in the form: *"The movement and handling of products from the point of production to the point of consumption or use".*

A broader definition of the term logistics was coined in 1963 by the newly established National Council of Physical Distribution Management (NCPDM), which defined the management of physical distribution as follows: *“The term used in industry and commerce for describe the wide range of activities required to achieve an efficient movement of finished products from the exit of the manufacturing process to the consumer and which, in some cases, includes the movement of raw materials from the supplier to the entry into the manufacturing process. These activities include transporting products, warehousing, handling, protective packaging, stock control, choosing the location of factories and warehouses, fulfilling orders, market forecasts and customer service”.*

The transport of raw materials or materials that are necessary for the technological processes related to the production unit is one of the most important processes, with both operational and functional role, which is found in every enterprise where a series production is carried out.

This process has a direct impact on the productivity and operational efficiency of the enterprise. This requires good management of the logistics flow related to the transport of materials, their handling and the supply of workstations. All this has an impact on the volume of a batch, the time in which a batch is produced and even the quality of the technological operations that are found within a company [5], [6], [7].

The problem arises mainly in choosing the optimal way in which the transport is performed. Failure to choose the right route can lead to significantly higher costs than necessary. The automation of the materials transport process has the potential effect of streamlining the process and involves:

- Reducing the costs required for the process;
- Improving the transport process;
- Improving the time required for production;
- Identify the degree of applicability of the automation in question.

3. Automatic guided vehicle – OSMOZE 3

This paper is about the OSMOZE 3 AGV which was manufactured in France at Cleon and implemented within SC AUTOMOBILE DACIA SA, chassis section.

At Cleon, Renault has launched 90 million mechanical parts since 1958. Today, Cleon is a key platform for Renault's industrial system in Europe. Therefore, it is not surprising that the carmaker has chosen to make one of the pilot sites for its "Factory of the Future" plan, which is currently underway. The Cleon plant will be responsible for large-scale testing of major industrial innovations, which will then be launched in the 36 Renault factories around the world. These innovations seek to improve the quality of the output line and reduce by 50% the time between order picking and delivery.

Figure 1 shows the OSMOZE 3 AGV, which is an autonomous robot with dynamic navigation mode, using an anti-collision laser scanner that allows it to stop in front of an obstacle.

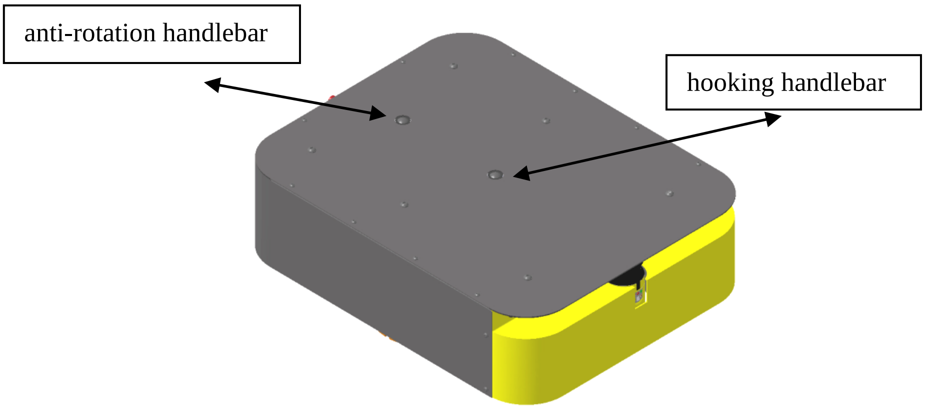

Fig. 1. AGV – OSMOZE3

The guidance mode is optical. He has the ability to travel a route with the help of a map. To make a circuit you need a ground track, as well as information to manage the running, stopping, speed, direction of the AGV. This information comes from the TAGs on the track, which contain a number between 1 and 1000. The action associated with each TAG number is programmed in a routing table. The minimum space between the two TAGs is 40cm. The AGV is equipped with an RFID antenna that reads the TAG number and then performs the associated task in relation to the user's program. RFID tags are pasted on the floor at key points along lines that allow the AGV to execute various commands (turn right or left, stop, change gears, etc.). Return point tags tell the AGV whether to continue or stop.

From the point of view of optimal functionality and motor skills, the AGV comprises the following components which are presented in Figure 2:

1. optical guidance camera (route)
2. ground RFID tag reading antenna (reader)
3. induction detector (precise stop)
4. anti-collision laser scanner
5. 4 freewheels
6. two traction and steering wheels

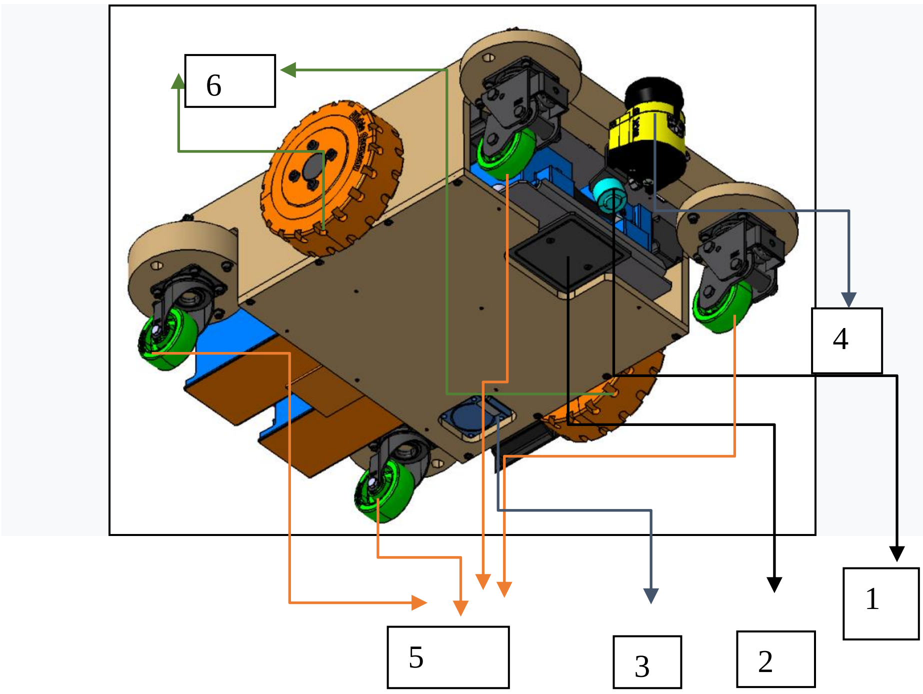

Fig. 2. Components of Automatic Guided Vehicle.

Its main functional characteristics are shown in Table 1.

Table 1. Functional characteristics of the AGV

Maximum allowed ground slope	3%
Soil properties	Dry soil and not oily
Maximum running speed	40m/min
Routing	RFID tags
Maximum load that can be transported	1000kg
Maximum load that can be towed	1600kg
Laser for route scanning	yes
Autonomy	About 8 hours of continuous use
Turn radius (AGV only)	1000 mm up to 40 m/min
Optical guidance	Dark path on a light background or a light path on a dark background
Dimensions in mm	950 x 750 x 279/343.3 Length x Width x Height

If an AGV fails, it will be taken off-road to be repaired, and the transport will be replaced by the operator using a car. This is done before this auto-guided transport is implemented.

4. Kiting area circuit

The process that is to be automated can be found in the Mechanical and Schassiuri Plant, Chassis-Welding department, X07 frame welding workshop. To eliminate two shift operators, two logistics flow automations are needed to implement and develop the AGV system. These AGVs will work simultaneously on two welding fluxes, respectively AGV no. 1 will work on line 1 and 3 feeding 8 automatic welding stations, and AGV no. 2 will supply line 2 and 4, supplying 7 automatic welding stations, specifying that line 4 comprises two diversities.

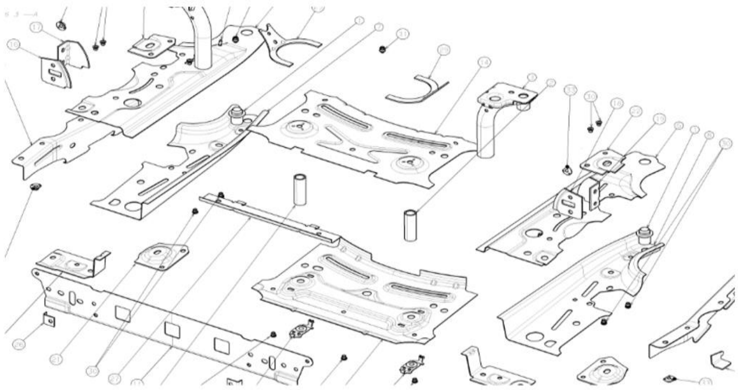

Fig. 3. Parts transported by AGV.

The AGVs have the role of transporting a number of 33 elements, which are divided into 4 operations (kits). These pieces can be seen in the Figure 3.

The monitoring system works with the help of the manufacturing operator desk (POF) and the kiting operating desk (POK). In the manufacturing desk, the operator needs parts and requests parts for kiting.

When the operator in the production lines needs parts, he requests parts to the kiting area. The parts request is made when the empty base is in the takeover position by AGV in POF and the operator has pressed the validation button on the station (black mushroom button), see Figure 4.

Fig. 4. AGV call button.

Confirmation of the application submission conditions can be viewed by turning on the green and orange light, as shown in the Figure 5.

When the request is sent correctly, the green light is on permanently and the orange light is blinking.

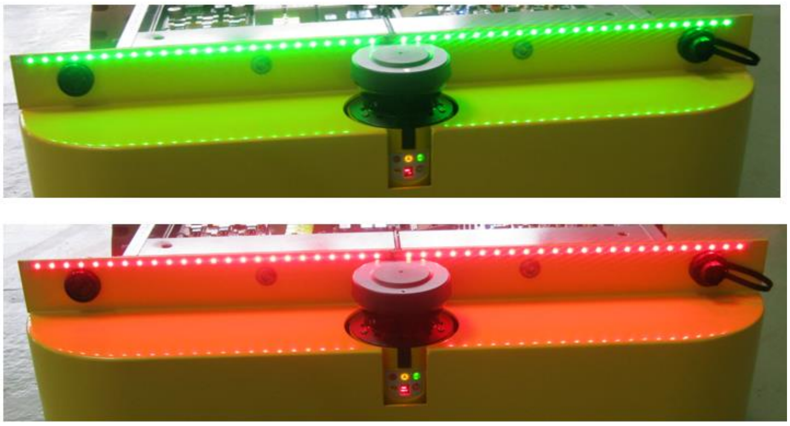

Fig. 5. Led band code

The kiting area circuit is divided in two parts, because we have two AGV's that individually transport parts on two welding lines each. Circuit no. 1 transports parts on lines 1 and 3 (Fig. 6) and circuit no. 2 carries parts for lines 2 and 4. The AGV is always located on tag no. 1 where waiting for the order for the welding line.

All these kiting zones are validated on the kiting operator panels with the zone specification (of line 1, 2, 3 or 4) and with the detection, with the help of inductive sensors on the rolling base area. In figure no. 6 shows the control panel in the kit area which includes the validation button and the inductive line detection sensors.

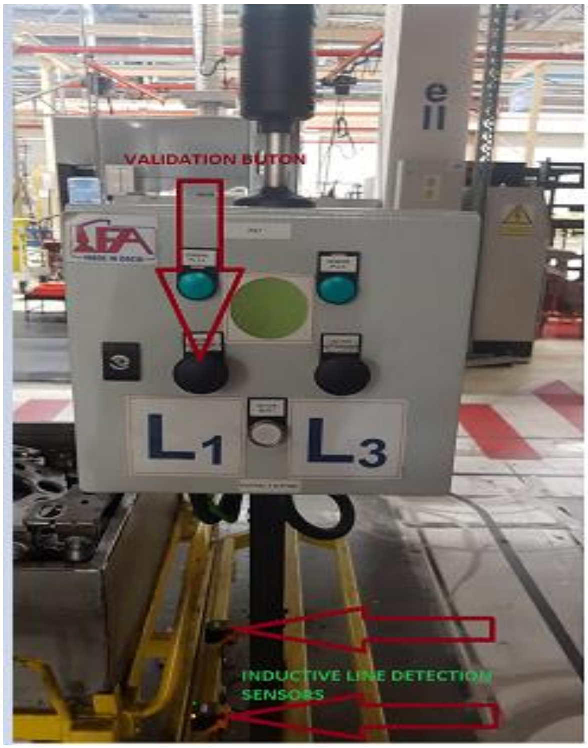

Fig. 6. Panel controls on the kiting area.

The tags of each putty were written according to the operation number, i.e, receiving the command from operation 230 from line 1 or 3 means that the AGV reaching TAG 531 must have a fixed and precise stop, to make a rotation turn 90 degrees to the right and continue on to the 533 mark.

Tag 533 means that the AGV is in the full wheelbase pick-up position for operation 230 for line 1 or 230 for line 3. After the wheelbase is picked up, the AGV will continue its circuit with a right turn.

Once on tag 31, the AGV will continue to travel to operations 230 line 1 or 3 with a maximum speed of 40 m/min. When the AGV reaches tag 32, he knows that he has to reduce his speed from 40 meters / min to 20 m/min. When it reaches the 532 tag, it means that the AGV must make a precise stop, turn 90 degrees to the left and continue on its way.

If the AGV is on tag 534 this means that it must leave the empty base that came with it from Operation 230 line 1 or 3, rotate 180 degrees and continue its turn to the left to the position home to receive a new order.

For this line the tags *31, 34, 37 and 40* are “grande vitesse” ie 40 meters / min with a full base to the operator station, and the tags *41, 38, 35, 32* are “petite vitesse”, ie 20 m/min because the AGV has to make a precise stop at the tags where it has to turn left to leave the bases empty coming from the welding stations.

The process is the same for lines 2 and 4 where tags *51, 54, 57 and 60* are for “grande vitesse” and tags *61, 58, 55 and 52* are for “petite vitesse”.

Tags 633, 623, 613, 643 are for taking full bases for operations 210, 220, 230, 240 and *tags 634, 624, 614, 644* are the empty bases that AGV has brought from the welding lines.

Figure 7 shows the kit area for lines 1-3, 2-4 which includes the tags, as well as the operations performed by the AGV while transporting the parts to the welding stations.

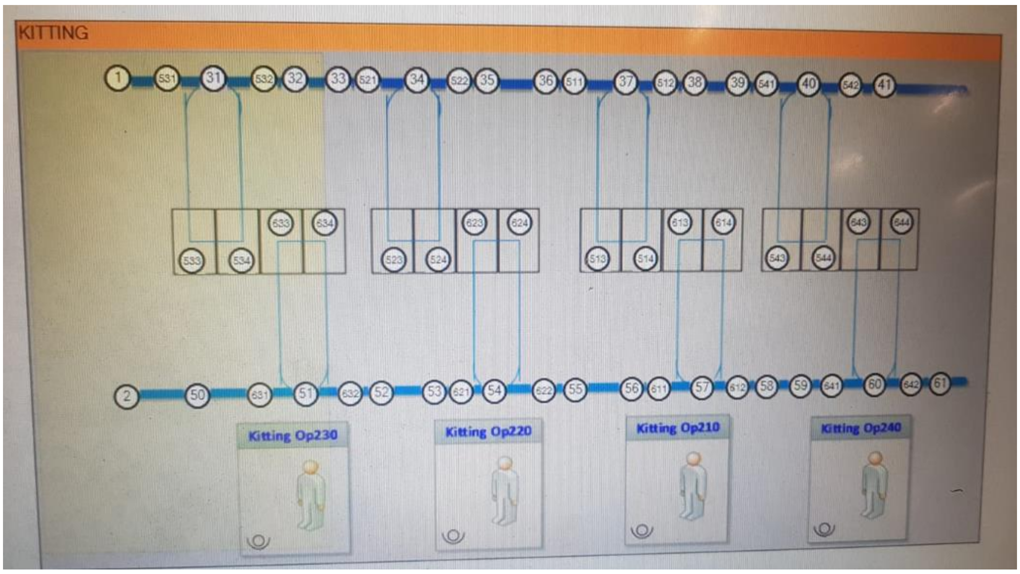

Fig. 7. Kiting area lines 1-3, 2-4.

5. Conclusions

It was a unique experience for the entire team on the Dacia Platform, because it helped them combine the economic part with the technical part (studies, design, design, engineering, maintenance and purchasing), identifying the axes of progress on the main lines, by eliminating NVA (without added value), capitalizing on and sharing good practices with the IFA (Integrated Factory Automation) service.

In addition to the fact that it was a unique experience, it was also a challenge because this project had a short implementation period, the whole team having to first realize how it works and what it can do, and then find solutions. to be able to be implanted in lines.

The complexity also consisted in the fact that there were 2 AGVs available that had to supply 4 lines, of which one line produced 2 different parts.

The aim for the implementation of this AGV was to reduce staff, eliminating two operators after each shift, making a total restructuring of six operators.

Another aspect that was pursued in this project was to avoid a possible risk of injury between the forklift that takes over the finished part and takes it to cataphoresis and the operators who carried parts to the welding stations.

Abbreviations

AGVs = Automatic Guided Vehicles
NVA = No value added
IFA = Integrated Factory Automation
POF = Manufacturing desk
POK = Desktop operator kiting

R E F E R E N C E S

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