RFID TECHNOLOGY IN PRODUCTION AND POST PRODUCTION FOR THE AUTOMOTIVE INDUSTRY

Lavinia Ioana Culda*, Elena Stela Muncut (Wisznovszky)

University Aurel Vlaicu Arad, B-dul Revoluției nr.77, Arad, Romania
* Corresponding author. E-mail: lavyy_99@yahoo.com

Abstract: The continuous development of techniques and technologies that bring increased efficiency and a clear record of what happen on the flow and warehouses have made RFID (Radio-Frequency Identification) tagging sought after. The Internet of Things is becoming the technology of the auto parts management system. After the RFID identification, the auto parts go directly into the system and can be used on the flow exactly where they are needed and on the right car. The labelling can also be used post-production in service and other car monitoring applications.

Keywords: RFID, automotive industry, automation, storage.

1. Introduction

One of the most dynamic industries, the automotive industry, must cope with social and economic pressures through continuous adaptation).

Designing cars that leave the classic zone can be complex. That's why the big manufacturers are looking to innovate the car production process to produce something as cheap as possible in the shortest possible time and without compromising on quality, all intelligently combined.

The pioneer of production lines, Henry Ford, challenged the world to find ingenious solutions for efficient production. Robots and automation have steadily replaced humans in the manufacturing process. The acceleration of the manufacturing process causes specialists to find a solution to coordinate the entire process, avoiding the occurrence of blockages.

For this, it needs extreme flexibility both on the production side and in the post-production area.

Globally, the increase in competition makes it necessary to equip factories with modern, intelligent production equipment combined with flexible logistics systems. Manufacturers need systems that can adapt quickly and offer solutions for a variety of models.

2. RFID Tagging

Automation of information on the manufacturing flow but also in the warehouse provides for the association of products with RFID tags, to be able to follow the traceability of the goods and the automatic highlighting and confirmation of the necessary materials and tools.

Over time, R.F.I.D. proved to be a powerful method of object identification. It can be used for contactless transmission of large amounts of information. The operating distance can vary, taking effect even over long distances, and connection to higher-level PLC-type systems can be easily done.

The communication of the R.F.I.D. transmitters is done respecting the production logic and informational hierarchies.

Both RFID readers and transmitters equipped with the Ethernet interface are capable of establishing higher level communication.

With the help of these systems, the goods are visible in real time and are detected according to manufacturing requirements.

For a long time, there has been talk about warehousing automation, but there are still many areas where warehousing is done classically or semi-automated. One of these areas is the sale of spare parts for cars. However, in the area of car production there is a significant concern on the implementation of automatic and robotic technologies to increase quality and make production more efficient.

The automotive industry has increasingly introduced the notion of personalized cars. To customize something, you also need to have the components ready, with the desired characteristics, to be able to build something unique.

R.F.I.D. labelling refers to the automatic identification method consisting of transmitter and reader. The transmitting tag has the role of storing the information and the reader has the role of recovering the data without contact. Radio waves are used for remote reading.

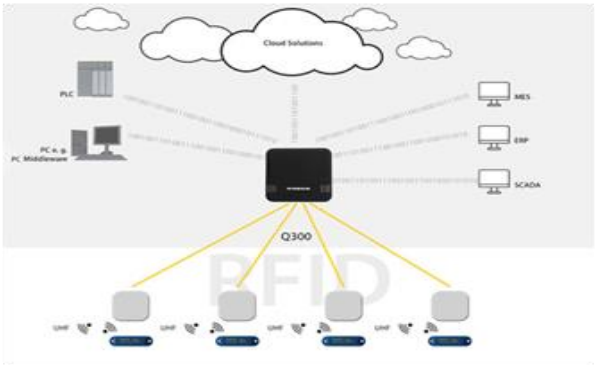

Fig.1. Direct communication with higher-level systems [8]

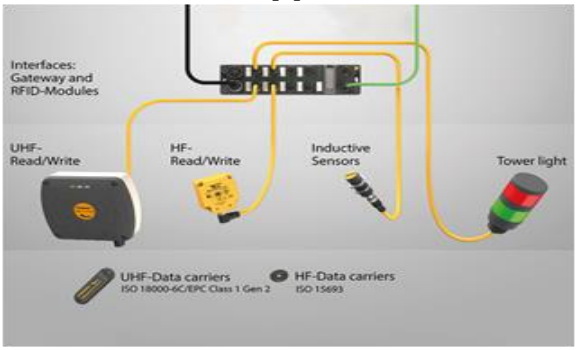

Fig. 2. RFID and higher-level systems from PLC to ERP [8]

The RFID tag has become synonymous with most tracking systems used in manufacturing today. The multitude of applications makes the RFID technology to leads to:

- Increase in production efficiency: Many steps are eliminated because RFID tag cable ties combine multiple functions: fastening, binding, marking, identification, product safety, the RFID product tracking and more.
- Safe marking and identification of products, even in harsh environments: The information stored on the RFID tag remains readable at all times even in extreme production and operating environments.
- Marking and identification of inaccessible components: the RFID cable ties are safe alternative, where conventional markings, for example barcode labels cannot be read or are difficult to read due to limited space or marking is not possible due to the material.
- Support for Industry 4.0 applications: A smart factory achieves almost unlimited purposes. The cable ties are used in almost every field today.

In automotive manufacturing, the RFID began to be used mainly to detect tags on large parts such as car bodies.

But what do we do with the other components that go into car production? In order to follow to the end what is included in the composition of the car all the medium and large dimensions have been labelled. Thus, there were labelled: the seats, the body components, the bags, the rear-view and side mirrors, the tires (tire management), etc.

Fig. 3. The worker places the bumper in the transport box indicated by the system [9]

Fig. 4. Bumpers identified with RFID tags throughout the production and logistics process. [4]

Fig. 5. Examples of RFID labelled components [3]


[10]


[5]

Fig. 6. Examples of RFID labelled components

In the study carried out on the production line of the group, the biggest concern with the introduction of RFID tags was the use of metal tags for all their models.
The application of the label on the body takes place at the first point of vehicle assembly, on the rear of the car, because it is desired:

- That the vehicle is identifiable starting from the first component,
- Identification through all stages of production until delivery to customers
- It is important to store information from readers: body shape, paint, engine and vehicle characteristics

Fig. 7. Tracking with RFID tags [8]

The content of the data carrier is deleted before it leaves the factory premises, as data strictly related to the manufacturing process is stored in the factory, so that at any time it is known exactly which parts and how the vehicle was worked on.

The tag used is a metal RFID tag with dimensions of 50 x 30 x 3 millimetres and an EPC memory of up to 496 bits that withstands temperatures from -40 to +250 degrees with a quality of 99.8% accuracy of reading.

The RFID tag used on the car body in Neckarsulm will become the standard for all and Volkswagen plant products in the coming years. The RFID tag used is a spaceless tag that uses the car body as an extended antenna, thus benefiting from an increased transmission quality.

The purpose of introducing these labels is not only to customize but also to achieve a more efficient production by making the assembly lines more flexible, resulting in the efficiency of the car manufacturing process.

The plant in Neckarsulm is the first location in the Volkswagen Group to implement full vehicle identification in all production processes. Vehicles are identified by a RFID tag on the body. The body shape, paint, engine and features are digitized and can be viewed in real time. This means that it can be guaranteed that the vehicle ordered is manufactured and subsequently delivered exactly according to the customer's wishes.

3. The RFID Technology, the Foundation of a Fully Networked Factory

Systems thinking in production and logistics automation lead to increased production efficiency.

Within the auto body department, the production line is divided into:

- Main subassembly line
- Lower body reference subassembly line
- Side body reference subassembly line
- Body adjustment line

These lines differ depending on the production process.

To unite all these components in an assembly point, we need an intelligent interphase transport system that is able to bring to one point all the landmarks necessary for assembly.

The normal operation of the mechanical transport system is a requirement for the production of the entire body section.

That's why an automated conveyor system is needed to unite all processes efficiently and without interruption.

In addition to an automated interphase transport system, the passenger car production line also needs.

- **Optimization of body welding**. Welding is an important part in the process of obtaining a car and therefore it is an area that requires modern and complex equipment for fast production.

In a customization-oriented industry, but also in the case of the mass production line, it is important to know at every moment where the landmarks necessary for assembly are located.

By mounting the RFID tags on the components, they will remain even after obtaining the car body. Thus, we will have access throughout production to information about the car model, the production line on

which it must be assembled, and we will know in real time where each car model is.

The RFID tag is not only useful for production, but also to be able to automatically and efficiently sort the machines according to the model, so that we know what and where we have to weld according to the technological specifications.

Tagging helps reduce waiting times in the welding area and increases efficiency by continuously monitoring the time needed to weld the body.

- **A custom component detection systems**. With the help of RFID, the device will benefit from exactly the components chosen by the customer.

Therefore, these labels are useful not only in the production process but also in warehouses. For increased profitability and efficiency, we need automated warehouses equipped with RFID tags. With the help of the warehouse map and the labels on the landmarks, we can evaluate several basic indicators in real time, such as: the degree of filling of the warehouse, the management of each landmark in the warehouse, the easier identification of the requested landmarks, the degree of use of space in the warehouse , etc.

The Skoda Company offers us an example of an automated warehouse implemented in its factory, in accordance with the needs of RFID automation and the principles of Industry 4.0. A high level of automation makes it possible to increase the efficiency of work processes in the logistics of small factory parts.

An example of this is the use of robots (manipulators) that take parts from warehouses and transport them directly from the warehouse to the assembly line. Skoda Auto operates such a warehouse in Kvasiny. Michael Oeljeklaus officially opened the automatic ASPW small parts warehouse in 2018, a warehouse that rigorously applies the principles of Industry 4.0. Small parts are now stored and removed from the shelves fully automatically from there they are delivered to the assembly line immediately as needed. Automation makes it possible to further increase work precision, speed up logistics processes and minimize the error rate.

[6]

[7]

Fig. 8. Automatic storage of small parts within the Skoda Company

When we want to implement such a system, it is good to know that automatic warehouses can be equipped with:

- **Warehouse robots**: Warehouse robots have developed a lot over the years and now have increased mobility and efficiency. Known as Autonomous Mobile Robots (AMRs), these robots can be loaded with warehouse maps and the exact locations of each stored landmark, but also have the ability to identify if a landmark is out of place. For collision avoidance, these robots are equipped with sensors all around, 3D cameras and scanners. These features allow warehouse robots to navigate without any problem.

Fig. 9. Examples of Autonomous Mobile Robots (AMR) [11]

-**Collaborative cobots or robots**. Warehouse robots are also present as collaborative robots. They have the ability to work in warehouses, side by side with the

human operator if necessary or together with other warehouse robots, collaborating and performing various tasks.The use of cobots in warehouses brings efficiency to the handling operation, reducing the effort of the operators. If also equipped with RFID readers, they can perform multiple tasks in tandem with other warehouse robots, increasing the degree of warehouse automation and significantly reducing human error.

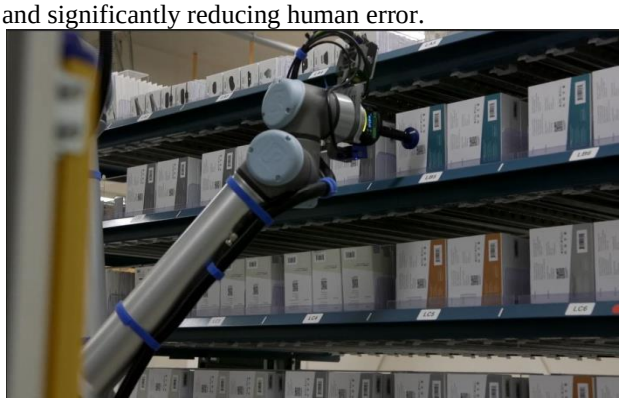

Fig. 10. Cobots for warehouses [12]

-**Automatic storage and retrieval systems**. There are warehouses where it is more efficient to have automated storage systems than robots. Such a system lends itself very well to the storage of small items. Automated storage and retrieval systems (AS/RS) being systems directed by the warehouse management system. Thus, the AS/RS can quickly process the commands received in the system. These systems allow the storage of a large volume of goods on a smaller surface, handling in and out of the warehouse being performed automatically.

Fig.11. AS/RS systems [13]

- **Aerial drones**. Drones, even though they are new to the warehousing area, are already being used in external warehouses to locate and track inventory. Being easily integrated into the warehouse management system, they can easily transmit the information captured on the camera. Equipped with RFID readers, they can remotely read the tags and will easily and quickly identify the batch of cars ready for delivery. For this purpose, a specially developed Hexacopter (a drone with six propellers) to track the inventory of the fleet of cars to be delivered. The drone reads the body tag using an RFID reader while flying and records the obtained GPS position. Once the drone has landed, the data is automatically transferred to a database via WLAN. The result is displayed on a digital map after the flight and optimizes operational planning. It sees the use of drones as an additional building block on the road to digital manufacturing.

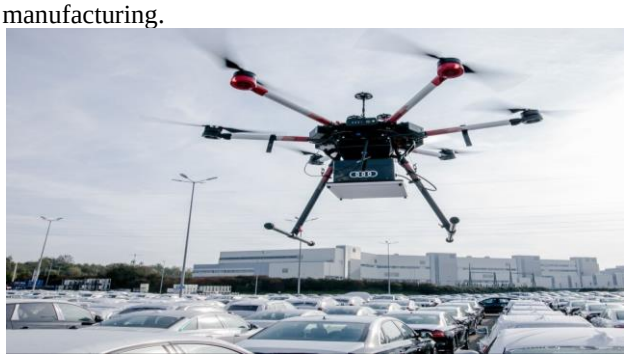

Fig.12. Inspection of the car park with the help of the Hexacopter drone [14]

These are some of the applications of RFID in modern factories, which are moving towards a massive implementation of automation components in all branches of the production process, so that the human presence is limited and the possibility of offering a customized product to the customer increases.

3. Post-Production - RFID Tagging

Growing consumerism seeks to offer as diverse and personalized products as possible to attract people willing to invest in unique or highly unique cars. The multitude and complexity of car models as well as the variety of types of equipment included in their construction are enormous.

This variety of cars and milestones comes with great challenges. In the assembly process, workers encounter almost identical landmarks, and thus the probability of putting a similar part in place of the one assigned to the car on the line increases.

Fig. 13. RFID application [15]

To avoid errors, an efficient milestone management system is needed. Most of the relevant components are provided with codes that must be scanned manually. If we equip these components with RFID tags, identification of the component elements can be done automatically by the system, and the operator receives exactly the landmarks assigned to that car.

If classic labelling only provides information about the type of product, the RFID tag provides more complex information. The basic information, important in the production process, is thus obtained in a few seconds. Quality control of the product on different interphase areas, can be easily done in case of labelling of important and safety components. You don't need to have a good reading angle, or enough space for classic e-reading. RFID tagging allows a remote reading, without visual contact, a function that is not lost if the tag is dirty, subjected to mechanical, thermal or chemical loads. The tag follows the vehicle even outside the factory, erasing only the manufacturing information related to the company's secret.

Fig. 14. Car landmarks [16]

In the post-production area, when, after driving, the car faces the need to change some landmarks, with the help of the RFID tags already installed in the production process, the identification of the landmark assigned to a vehicle is easily identified.

It is known that cars contain parts that, through running or exposure to various variations in temperature or climate, receive wear.

The cars contain countless moving parts that receive normal wear and tear every time we drive the car. Weather has an impact on auto parts, as most cars are exposed to each of the extremes of heat, cold, and humidity in the outside world.

Thus, we arrive at the parts store to buy the desired part. Finding the right part is a challenge, as the software that helps sellers search for and bring in the desired part often misses, and an increase in part customization makes it mandatory to associate a RFID code that allows the seller to order the exact part needed for that car. The serial markers can be obtained on lots of car models, but markers that are customized can only be brought to order, according to the data collected from the RFID tag of the damaged marker.

With the help of RFID, auto parts distributors and sellers will have access to auto parts that are in inventory. The use of RFID enables secure traceability in the automotive supply chain.

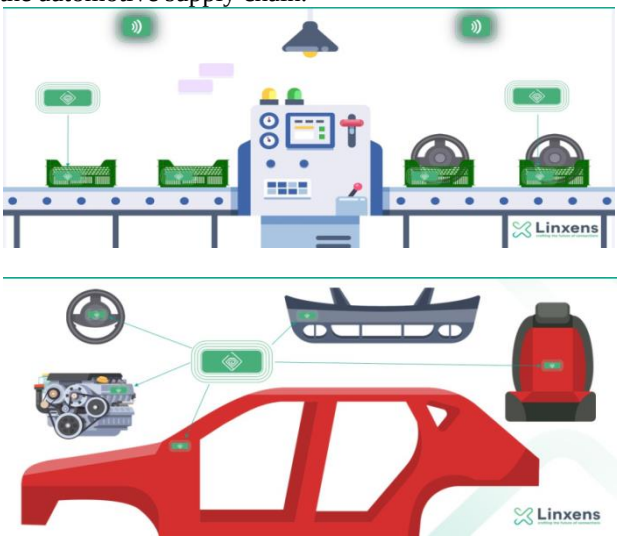

Fig. 15. Returnable Items [15]

As a bonus, the solution makes the products harder to counterfeit. Each assembly that is marked with an electronic tag has a unique, unchangeable number. This number is registered in the production database and is virtually impossible to falsify. So it is easy to identify if the parts are aftermarket or original as well as which parts have been returned as non-compliant in terms of quality.

4. Conclusions

The industrial production, due to socio-economic factors, becomes highly automated and flexible, offering the advantage of networking for identifying systems, tools, parts and products, thus increasing production efficiency. The RFID technology is mainly used in cases where the labels are mounted on the product, not on the work piece support, which makes it difficult to reach or even leave the production site. Bulk readings are another advantage of RFID technology. RFID technology is therefore used especially in logistics applications that require the simultaneous reading of several labels.

Due to its specific advantages, the RFID-based identification technology compares with alternative solutions such as optical identification and is therefore undoubtedly one of the key technologies for Industry 4.0. In many places today, the introduction of RFID manufacturing processes is still complicated and time-consuming.

Even if it is not a perfect solution, it opens new horizons in industrial production and beyond, providing a first step in the introduction of artificial intelligence in the manufacturing and service sectors.

The RFID applications do not stop here. Once installed on the car, the label can be used for many purposes: ITP registration, tire wear check, presence in traffic...etc.

But its use in the post production area of the car is more and more necessary.

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