

## IMPROVING THE CAR REAR AXLE PRODUCTION PROCESS WITHIN A GENERAL ASSEMBLY LINE

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**Rezumat.** Această lucrare analizează procesul de fabricație al unui subansamblu din industria auto, precum și integrarea acestuia pe linia de asamblare. Sunt examinate etapele de dezvoltare, proiectare și testare ale subansamblului, având în vedere cerințele de calitate și eficiență. Obiectivul principal îl constituie optimizarea proceselor în vederea reducerii costurilor și îmbunătățirii performanței. Studiul utilizează metode avansate de producție și tehnici de asigurare a calității pentru atingerea obiectivelor propuse. Concluziile evidențiază eficiența abordării inovatoare implementate [2,4].

**Abstract.** This paper explores the manufacturing process of an automotive subassembly and its integration on the assembly production line. The development, design and testing stages of the subassembly are analyzed, taking into account the quality and efficiency requirements. The main goal is to optimize processes to reduce costs and performance improvement. The study uses advanced manufacturing methods and quality assurance techniques to achieve the proposed objectives. The conclusions demonstrate the effectiveness of the innovative approach implemented [2,4].

**Keywords:** car manufacturing, car subassembly, assembly production line, process optimization, quality assurance.

### 1. Introduction

The assembly of the rear axle subassembly on the production line is a complex technological process, which involves the coordination of several manufacturing steps, including mechanical machining, heat treatments, assembly and quality control [3]. The aim of this work is to analyze the manufacturing process of the rear axle subassembly, with a focus on the efficient integration of this subassembly on the assembly line, and to identify innovative solutions to improve its performance [5].

By using advanced manufacturing methods and providing automated quality control, the work aims to contribute to the optimization of production processes, cost reduction, and improvement of safety and reliability of the final product. The research will also focus on analyzing the impact of the implementation of modern technologies on the production flow and competitiveness of the automotive industry in the current context [1, 4, 8].

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## 2. Current Status

Currently, the manufacturing process of the rear axle subassembly is carried out within a well-established framework in a dedicated industrial unit located within the Mechanical plant. This facility includes a 550 m<sup>2</sup> specialized assembly line, which operates on a continuous flow to ensure a constant and fast production of components. The production line is designed to allow the efficient transfer of sub-assemblies from one workstation to another in order to produce the final product according to the technical specifications [3].

The rear axle sub-assembly is an essential part of the vehicle's drivetrain, with key roles in ensuring vehicle stability and safety, as well as transmitting forces from the engine to the wheels. The main components of the subassembly include the cast iron or cast steel housings, pinions, gears, bearings, seals, mountings and flanges, which ensure its integration into the chassis [7]. The rear axle is also manufactured in several variants, depending on the type of vehicle (H, L, B, R, F) and the presence or absence of ABS.

The production of the rear axle subassembly is organized in two main sections of the plant:

- Mechanical and Heat Treatment Section: in this section, the mechanical processing of the components (turning, drilling, sanding) is carried out, as well as the heat treatments necessary to ensure the strength of the materials (hardening, hardness improvement and behavior against mechanical stress) [4].
- Assembly and Finishing Section: In this section, the final assembly of the rear axle subassembly is performed, including welding, painting, and packaging of the final product. In this stage, functional checks are also performed to ensure the quality of each manufactured unit [3].

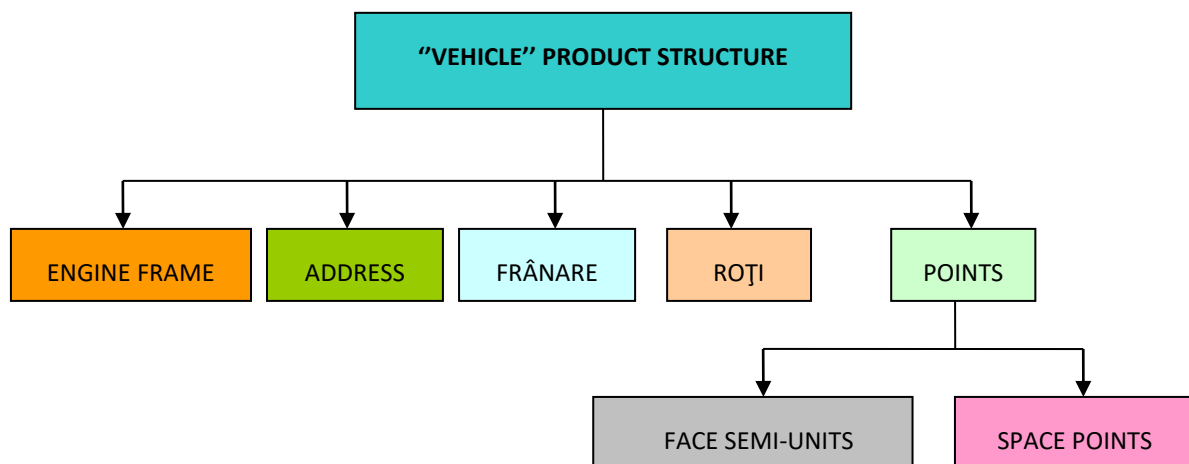
Production flow and key steps:

- Raw Material Receipt: Delivery of the required materials (cast iron, steel, spare parts, etc.) is ensured.
  - Mechanical machining: Material machining operations are performed to obtain the required shapes of the subassembly.
  - Heat treatments: Hardening processes and other treatments are carried out to improve the mechanical characteristics.
  - Assembly and functional checks: Components are assembled and subjected to functional tests to verify their integrity and performance.
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- Welding and painting: The subassembly is welded, and the elements are painted for protection and aesthetics.
- Final inspection and packaging: Quality control is performed to verify compliance with technical standards and specifications, and the final product is packaged for delivery.

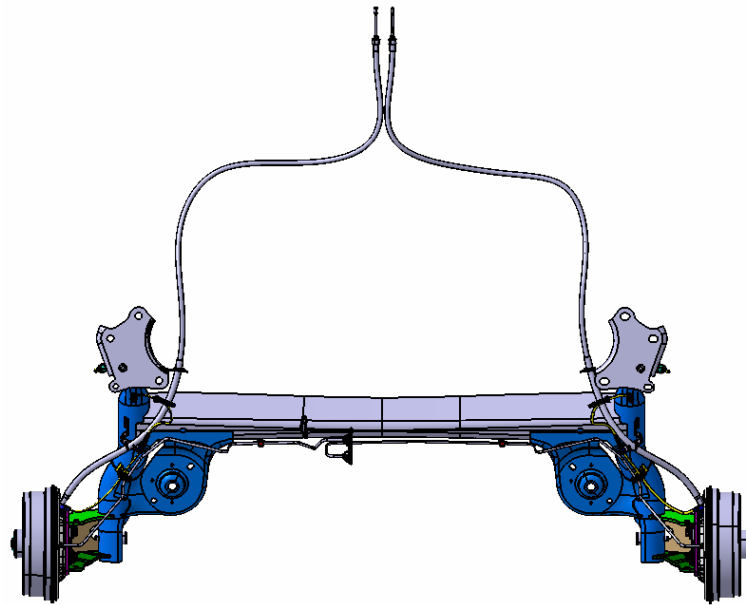
Logistics flow:

- Production of rear axle subassemblies is carried out in batches, with temporary storage of components in a buffer zone between production steps. Upon completion of the assembly process, the finished products are loaded on rolling bases (9 units/base) and transported to the General Assembly line. The transportation between the Mechanical plant and the General Assembly line is done with special vehicles, which ensure the synchronization of the delivery of the components so that the production flow is not interrupted.
- This efficient organization of the production flow, together with the well-defined structure of the manufacturing process, ensures the constant delivery of rear axle sub-assemblies to the General Assembly line, with quality and efficiency requirements [3,7].
- The rear axle product is a component part of the vehicles and its assembly on the vehicle is done in the General Assembly line.



**Fig.1.** Disaggregation structure of the 'vehicle' product before transfer

The resulting product from this line is the assembled rear axle, ready for integration on the vehicle.



**Fig. 2.** Product rear axle assembled result from supplier Mechanics

### **3. Case Study**

Implementation of a real-time quality monitoring system - by using sensors and IoT (Internet of Things) solutions, more rigorous quality control and quick reaction to possible deviations from the required standards will be ensured [6].

Diversification and improvement of the supply chain - to reduce dependence on external suppliers, investment will be made in developing in-house production capabilities for critical components such as drums [5].

#### **Impact on Productivity Initial Situation**

In the initial stage of the manufacturing process, rear axles were produced in the Mechanical plant on a 550 m<sup>2</sup> assembly line using a continuous flow. The production process was mainly manual, involving steps such as welding, component assembly and quality control, carried out by human operators [7]. Products were manufactured in batches, and their synchronization with the general assembly line was carried out at set intervals [2]. Although product quality was guaranteed, the process had certain limitations, including long production times and high labor costs.

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**Problem Identified**

Within the initial manufacturing process, several key challenges were identified that affected overall performance:

Long production and handling times - due to the predominance of manual activities, the times to make parts and handle them between stages were significant, resulting in low manufacturing efficiency.

High labor costs - the use of a large number of operators to carry out each step of the process involved constant expenditure on wages and training.

Variation in product quality - despite quality controls, the manual process generates differences in the execution of the parts, affecting their uniformity and reliability.

Limitations in production flexibility - adapting quickly to changing market requirements or product diversification (e.g. rear axles with/without ABS) was difficult and required significant process changes.

Dependency on external suppliers - for some critical components, such as drums, it was necessary to involve external suppliers, which created additional supply chain risks.

**Proposed Solution**

In order to solve the identified problems and optimize the rear axle production process, it is proposed to implement a series of technologically advanced measures and reorganize the manufacturing flow. The proposed solution aims at integrating innovative technologies, automation of key steps and optimization of materials, with the aim to improve efficiency, reduce costs and increase product quality. Details of the solution include:

**Production Process Automation**

The implementation of robotized production lines will help eliminate many manual steps, thus reducing manufacturing times and human errors. Robots will take over tasks such as welding, component assembly and quality inspections, ensuring greater accuracy and reducing variation between manufactured products. Automation will speed up the entire process, enabling faster production and a considerable reduction in labor costs.

**Use of Innovative and Lightweight Materials**

Another aspect of the proposed solution is the adoption of lighter but stronger materials, such as aluminum or composites, for the rear axles. These will help reduce the weight of the final products, improving vehicle performance, reducing fuel consumption and increasing the durability of parts. The use of innovative

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materials can also reduce production costs in the long term through material savings and increased manufacturing efficiency.

### **Advanced Welding Technologies**

Replacing manual welding with precision robotic welding and laser welding will improve the quality of joints, increasing their consistency and strength. The use of modern technologies will reduce human error and minimize the cost of defective parts, while ensuring better adaptability to the technical requirements of new bridge designs.

### **Integration of Quality Monitoring Systems**

The introduction of an automated quality monitoring system, based on advanced sensors and IoT (Internet of Things) technologies, will allow real-time verification of each production step. This system will detect any deviations from pre-set parameters and allow for quick intervention, reducing the risk of defective products. This will ensure consistent, high quality and make the control process more efficient and less costly.

### **Supply Chain Diversification**

In order to reduce the risks associated with dependence on external suppliers, the proposed solution includes the development of in-house capabilities for the production of critical components such as drums. This step will improve control over component quality and reduce lead times, thus contributing to improved production flow and lower logistics costs.

### **Reorganization of Production Flow**

In parallel with automation, a reorganization of the production flow is proposed to maximize efficiency. New assembly line configurations will be implemented, based on Lean production principles, which will eliminate wasted time and optimize the use of resources. This reorganization will reduce waiting times between steps and support faster and more efficient production.

To address the identified challenges, several technological and organizational solutions have been proposed to improve the production process and reduce operational costs:

Automating the manufacturing process - the implementation of industrial robots and automatically controlled production lines will significantly reduce parts processing time and eliminate many manual activities, improving efficiency and accuracy.

Use of lightweight and innovative materials - by choosing lighter weight materials such as aluminum or composites, the aim is to reduce the weight of parts, which

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will contribute to increased vehicle performance, reduced fuel consumption and improved product durability.

Optimization of welding technologies - the introduction of laser welding technologies and the use of robotic welding will increase the accuracy and uniformity of welds, reducing human error and variability in the final products.

The implementation of these solutions will have a significant impact on the overall productivity and performance of the production process:

- Reduced production times - process automation will lead to a reduction in the total time required to manufacture each unit of product by approximately 20-30%, due to the elimination of manual steps and improved production flow.
- Reduced operational costs - decreased reliance on manual labor and reduced risks associated with quality variability will significantly reduce production costs, especially payroll and scrap.
- Increased product quality and consistency - modern welding technologies and quality control systems will ensure superior uniformity of final products, reducing deviations from desired standards.
- High flexibility in production - automation and diversification of materials will allow rapid adaptation to new market requirements or changes in product specifications, reducing the time needed to implement changes in the manufacturing process.
- Improved safety and reduced risks - reducing human interaction in hazardous processes will contribute to greater worker safety and minimize human error.

#### **4. Conclusions**

The implementation of the proposed solutions to improve the rear axle production process has a significant impact on the entire manufacturing activity by streamlining operations and increasing market competitiveness. By automating key production steps, utilizing innovative materials and improving welding technologies, a considerable reduction in production costs and an increase in product quality is anticipated [8]. These measures will contribute to improving the accuracy and reliability of the final products, thus reducing the risks associated with manufacturing errors and the need for subsequent repairs.

Reorganization of the production flow and integration of advanced quality monitoring systems will optimize the use of resources and eliminate wasted time, leading to faster and more flexible production. Diversification of the supply chain,

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by developing in-house production capabilities for critical components, will support better cost control and ensure greater independence from external suppliers, which are essential to maintain stable and high-quality production.

Overall, these solutions are key to adapting the production process to today's industry requirements, supporting not only improved economic performance, but also ensuring a positive impact on environmental sustainability and product safety. Their successful implementation is expected not only to significantly increase productivity, but also to strengthen the company's position in the market by delivering higher quality products in shorter lead times.

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