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A Hybrid Transport Concept for the Material Supply of a Modular Manufacturing Environment

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Abstract

Today's research projects propose a modular manufacturing environment for automotive production sites, which adapt itself autonomously and makes manufacturing decisions without the need of human interaction. Tugger trains are an energy-efficient possibility to handle intralogistics material supply due to the bundling of transport volumes but reaches its limits in the proposed automotive manufacturing environments. The spatial nearness of the production units and the necessity of a high-frequented and small-scaled supply lead to the application of small-scaled autonomous transport entities. The main disadvantage of this technology in turn is a higher intralogistics traffic. Therefore, the concluded concept of this paper connects the advantages of both technologies.

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1. Introduction

Tugger trains are an energy-efficient possibility to handle intralogistics material supply due to the bundling of transport volumes. The technologies of Industry 4.0 allow the horizontal integration of these systems to manufacturing machines in the up- and downstream, which leads to a data processing in real time. Related to the

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material supply, this method means that the supply system detects immediately on which position material is required. Due to its decentralized pathing algorithms, an energy-efficient tour of the autonomous tigger train is planned and executed. However, against the background of current developments in the field of manufacturing organization, the tigger train principle reaches its limits. Today's research projects, like ARENA 2036 or Smart Face, propose a modular manufacturing environment, which could adapt itself to current customer demand and make autonomous manufacturing decisions.

The spatial nearness of these units and the necessity of a high-frequented and small-scaled supply lead to the application of small-scaled autonomous transport entities for the material supply of such a manufacturing surrounding.

AGVs have advantages over tigger trains in these manufacturing environments because of their size, flexibility and the energy efficient transportation of small transport volumes. The main disadvantage is the increase of intralogistics traffic within the operation of small-scaled vehicles in a swarm. The remedy could be a high-level instance, which executes the route design of the small-scaled transportation units.

Nomenclature

AGV	Automated Guided Vehicle
ARENA 2036	Active Research Environment for the Next Generation of Automobiles
CPS	Cyber-Physical System
ERP	Enterprise Resource Planning
MES	Manufacturing Execution System
VAV	Versatile Autonomous Vehicle
SLC	Small Load Carrier
SBC	Single Board Computers
LiDAR	Light Detection And Ranging

2. Advantages of modular manufacturing environments

The aim of a flexible, versatile and resource-efficient production of automobiles can only be reached by an optimized chronological coordination of the produced products, the material-flow and the production equipment. Besides, the strategies for modularization, scalability and mobility also become crucial for change[1]. Therefore, the rigid line production is dissolved and hence a fixed-installed conveyor technology between the operation stations, fixed manufacturing cycles and fixed workplaces are renounced. Instead, a modular manufacturing system is introduced, basing on separate autonomous and decentralized manufacturing stations. By combination with innovative technologies in the context of Industry 4.0 the whole production system becomes a CPS. [2, 3]

Because the vehicle variants have different manufacturing demands, the workstations can be integrated to the workflow according to these specific demands. In addition, the vehicle itself becomes a CPS, which means that it can determine its production process and the moment of its treatment independently and flexibly. Therefore, the assignment of the assembly activities is determined for the separate assembly stations of the vehicle and not by a fixed-installed transport system. [2, 3]

The organization of modular manufacturing stations is examined in several research projects at present. The research project ARENA 2036 develops a future layout of a factory for the automobile production. Within the framework of the examination the following four adjusting levers are identified to form a flexible production system:

- Modular and lean logistics and equipment
- Intelligent robots as equipment

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