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# Structured Cross System Planning and Control in Modular Production Systems by Using Agent-Based Control Loops

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**Abstract :** In times of volatile markets with fluctuating demand and the uncertainty of global supply chains, flexible production systems are the key to an efficient implementation of a desired production program. In this publication, the authors present a holistic information concept taking into account various influencing factors for operating towards the global optimum. Therefore, a strategy for the implementation of multi-level planning for a flexible, reconfigurable production system with an alternative production concept in the automotive industry is developed. The main contribution of this work is a system structure mixing central and decentral planning and control evaluated in a simulation framework. The information system structure in current production systems in the automotive industry is rigidly hierarchically organized in monolithic systems. The production program is created rule-based with the premise of achieving uniform cycle time. This program then provides the information basis for execution in subsystems at the station and process execution level. In today's era of mixed-(car-)model factories, complex conditions and conflicts arise in achieving logistics, quality, and production goals. There is no provision for feedback loops of results from the process execution level (resources) and process supporting (quality and logistics) systems and reconsideration in the planning systems. To enable a robust production flow, the complexity of production system control is artificially reduced by the line structure and results, for example in material-intensive processes (buffers and safety stocks - two container principle also for different variants). The limited degrees of freedom of line production have produced the principle of progress figure control, which results in one-time sequencing, sequential order release, and relatively inflexible capacity control. As a result, modularly structured production systems such as modular production according to known approaches with more degrees of freedom are currently difficult to represent in terms of information technology. The remedy is an information concept that supports cross-system and cross-level information processing for centralized and decentralized decision-making. Through an architecture of hierarchically organized but decoupled subsystems, the paradigm of hybrid control is used, and a holonic manufacturing system is offered, which enables flexible information provisioning and processing support. In this way, the influences from quality, logistics, and production processes can be linked holistically with the advantages of mixed centralized and decentralized planning and control. Modular production systems also require modularly networked information systems with semi-autonomous optimization for a robust production flow. Dynamic prioritization of different key figures between subsystems should lead the production system to an overall optimum. The tasks and goals of quality, logistics, process, resource, and product areas in a cyber-physical production system are designed as an interconnected multi-agent-system. The result is an alternative system structure that executes centralized process planning and decentralized processing. An agent-based manufacturing control is used to enable different flexibility and reconfigurability states and manufacturing strategies in order to find optimal partial solutions of subsystems, that lead to a near global optimum for hybrid planning. This allows a robust near to plan execution with integrated quality control and intralogistics.

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