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iWePro

IWEPRO –
INTELLIGENT SELF-ORGANIZING JOB SHOP PRODUCTION

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Typical production lines for today's mass production are currently primarily designed for specific components and often operate with rigidly interlinked machining processes. Yet with increasing product variety such line-oriented production systems are straining at their limits – particularly in terms of their ability to respond quickly, their workloads and their ability to meet delivery deadlines. In the »iWePro – Intelligent Self-Organizing Job Shop Production« project partners from science and industry are designing innovative production concepts to enable smart job shop manufacturing with decentralized production control.

Application case

Gear manufacturing is an example: So far, gears are manufactured in lines where, for example, milling and turning machines are rigidly interlinked. The entire line will come to a standstill if a single machine fails. In addition, it is complicated if not impossible to adapt lines to small or smallest orders with special requirements or product features. Greater flexibility in this regard requires that such interlinked structures be broken up.

Alternatives to line structures do exist. One of these is job shop production. The philosophy applied in this type of production permits orders to be guided flexibly through the manufacturing process. It allows, for instance, an order to be turned on all the turning machines available in a company, which massively widens the scope for optimization. But such production structures also require methods to ensure that the orders make their way through production reliably, on time and at optimized costs.

In the iWePro project, IPK developers are working with partners from industry to test how the production of gears may be reliably controlled

at production level without the use of inter-linked structures. So far, industrial production requires that a plan be drawn up in advance that will govern the entire production from the blanks to the ready-to-use gear and that then the plan only needs to be followed. iWePro in contrast is aiming at »smart« job shop production using decentralized structures with small control loops and efficient, results-oriented communications between all employees and resources involved in the process. This principle assumes that still, production be planned in advance by the management – because only centrally optimized processes are able to focus on overarching optimization requirements – but it should also be possible for shop floor workers to actively intervene in the planned sequences, e.g. to ensure that deadlines are met.

Technology

To be precise, iWePro is researching whether and how central scheduling software may be combined with an agent system that supports the situation-oriented and dynamic adaptation of a previously prepared plan while production is ongoing.

It is based on the »Job Shop Scheduler« fine-planning tool by flexis AG that was developed within iWePro. The software generates detailed production plans for pending production jobs and presents them in Gantt charts. These charts illustrate what machining step of an order needs to be carried out on which machine and when. The system additionally permits different scenarios to be planned by, for example, dividing production into a fast lane for parts that are in high demand and a flexible section for more exotic components. The agent system then derives precise action recommendations for the shop floor staff from the detailed planning. This method means that production plans may be shared more directly with staff than was previously the case. Networked technologies allow the parts of the plan that are relevant to specific employees to be made available to them directly at their workplace. The time spent on briefings may be significantly reduced.

At the same time, the agents support situation-oriented adjustments to the planned production sequence. This works as follows: Each production job and every resource – machines, employees, tools, etc. – are represented by an agent. These agents communicate and negotiate with each other. If, for instance, a phase of work is almost complete, the agent representing the work pieces will ask the agent representing the machines at the next processing station who is available to perform the corresponding tasks. The machine agents will reply with, among other things, dates and costs. On this basis, the employee in charge of processing will be offered a range of possibilities for the next stage of processing indicating which machine will be available when and under which conditions. This information will make it easier to make quick and efficient decisions.

Simulation

In order to protect investment-intensive decisions regarding the implementation of job shop production, it is necessary to assess whether this type of organization will actually be able to deliver better results than classical line systems, which are technically highly sophisticated. To this end, a complex simulation is being created in iWePro using the Demo3D software by SimPlan AG. It will make it possible to analyze what combination of central planning and decentralized replanning is suitable for which application case. A demonstrator is being developed in parallel that will allow to evaluate which information should be indicated to shop floor staff, e.g. on smart devices.

Projektpartner

- Adam Opel AG, Rüsselsheim
- DMG Electronics GmbH, Pfronten
- flexis AG, Stuttgart
- SAFELOG GmbH, Kirchheim
- SimPlan AG, Maintal
- Sociological Research Institute (SOFI) at University of Goettingen
- TAGnology RFID GmbH, Voitsberg (A)

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