Dissertation title:

Method for proactive manufacturing equipment planning to increase effectiveness and efficiency of capital-intensive factory planning processes

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In recent years various new challenges for factory planning projects arove, increasing the project complexity. Among these challenges are growing productivity, energy and resource efficiency, volatile markets and stricter regulations by national authorities. The consequence of an increased complexity is longer planning durations for factories. At the same time product and process life cycles have decreased significantly, leading to the request to shorten factory planning periods. Due to this mismatch, it is critical to increase planning efficiency and effectiveness.
The analysis of factory planning processes and case studies indicated significant potential to increase factory planning efficiency and effectiveness. This can be done by improving the integration of the manufacturing equipment planning into the overall factory planning project. Current factory planning approaches only handle reactively the planning of manufacturing equipment in the later planning phases of factory planning projects. This causes coordination problems and increases the risk of iterations when information input from the equipment planning is not available to other planning fields. Moreover the interdependencies between the different planning fields in relation to the equipment planning are not systematically managed. This causes project delays, increased costs, problems with regulations and a reduced flexibility to adapt the enterprises production capacities.
Based on the analysis and a literature review, requirements for the methodology to improve the integration of equipment planning in factory planning projects have been derived. The methodology should be initiated in the early phases of factory planning and be able to design manufacturing equipment modules based on the available rough data of early planning phases. Also the methodology should consider the effect of official authorization procedures on both, the development of manufacturing equipment and the planning processes. Additionally, the methodology should create a modular equipment planning structure based on the designed manufacturing equipment structure. Furthermore, the equipment planning structure needs to be coordinated with additional planning tasks of the overall factory planning project.
Consequently, a methodology was developed to proactively plan the manufacturing equipment structure in the early stages of factory planning projects, to characterize the equipment structure and to derive planning modules from it. Further, the methodology integrates the equipment planning modules into the overall factory planning process in coordination with the other central planning fields.
The first part of the methodology includes a procedure to develop the future manufacturing task of the factory based on representative products and their

structure. Additionally, the required manufacturing processes are linked with the product structure, so that manufacturing equipment modules can be derived. The developed manufacturing equipment model is analyzed for future technological changes by the utilization of the technology calendar. Based on the results the manufacturing modules are adapted to the analyzed changes. A quality gate was further designed to verify the planning steps of the first part and to decide which manufacturing modules are possible subject of official authorization procedures before they can be realized and integrated in the factory.

The second part describes the steps necessary to derive periphery equipment structures, needed to support the manufacturing modules with operating supplies or to handle manufacturing waste. The periphery equipment is also structured in modules. The combination of the manufacturing modules and the periphery modules are representing the overall equipment structure of the factory. All equipment modules are characterized based on a developed schema. The results of the analysis are used to calculate the needed data to decide which equipment module requires an official authorization process. The second part of the methodology also closes with a quality gate that verifies the planning results and structures the final decision making in regards to the official authorization procedures.

The third and final part of the methodology contains the procedure to derive planning modules based on the equipment modules and its characteristics. Further, the planning modules are integrated in the project structure of the overall factory planning project in regards to their characteristics and linked to the other planning fields.

The planning method was validated, in all steps, by utilizing it in a complex green field factory planning project in the precious metals industry. The methodology proved to be of practical use. It enabled and improved the integration of the equipment planning in the overall factory planning processes, increasing planning efficiency and effectiveness.