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Multi-Objective Optimization of Assembly Manufacturing Factory Setups

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Abstract : Factory setup lifecycles are most often described and prepared in CAD environments; the preparation is based on experience and inputs from several cross-disciplinary processes. Early in the factory setup preparation, a so-called block layout is created. The intention is to describe a high-level view of the intended factory setup and to claim area reservations and allocations. Factory areas are then blocked, i.e., targeted to be used for specific intended resources and processes, later redefined with detailed factory setup layouts. Each detailed layout is based on the block layout and inputs from cross-disciplinary preparation processes, such as manufacturing sequence, productivity, workers' workplace requirements, and resource setup preparation. However, this activity is often not carried out with all variables considered simultaneously, which might entail a risk of sub-optimizing the detailed layout based on manual decisions. Therefore, this work aims to realize a digital method for assembly manufacturing layout planning where productivity, area utilization, and ergonomics can be considered simultaneously in a cross-disciplinary manner. The purpose of the digital method is to support engineers in finding optimized designs of detailed layouts for assembly manufacturing factories, thereby facilitating better decisions regarding setups of future factories. Input datasets are company-specific descriptions of required dimensions for specific area reservations, such as defined dimensions of a worker's workplace, material façades, aisles, and the sequence to realize the product assembly manufacturing process. To test and iteratively develop the digital method, a demonstrator has been developed with an adaptation of existing software that simulates and proposes optimized designs of detailed layouts. Since the method is to consider productivity, ergonomics, area utilization, and constraints from the automatically generated block layout, a multi-objective optimization approach is utilized. In the demonstrator, the input data are sent to the simulation software industrial path solutions (IPS). Based on the input and Lua scripts, the IPS software generates a block layout in compliance with the company's defined dimensions of area reservations. Communication is then established between the IPS and the software EPP (Ergonomics in Productivity Platform), including intended resource descriptions, assembly manufacturing process, and manikin (digital human) resources. Using multi-objective optimization approaches, the EPP software then calculates layout proposals that are sent iteratively and simulated and rendered in IPS, following the rules and regulations defined in the block layout as well as productivity and ergonomics constraints and objectives. The software demonstrator is promising. The software can handle several parameters to optimize the detailed layout simultaneously and can put forward several proposals. It can optimize multiple parameters or weight the parameters to fine-tune the optimal result of the detailed layout. The intention of the demonstrator is to make the preparation between cross-disciplinary silos transparent and achieve a common preparation of the assembly manufacturing factory setup, thereby facilitating better decisions.

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