Additive manufacturing nesting and scheduling problem considering multi-material parts

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Abstract. Additive manufacturing has received a lot of research attention in the manufacturing industry in recent years. This innovative manufacturing process has been proven to be more economical and more responsive to market changes compared to traditional manufacturing. Recent development in technology made it possible for manufacturers to implement additive manufacturing to accommodate orders of large production volume and different kinds of materials used. However, few studies have investigated the production scheduling problem considering parts composed of multi-materials in additive manufacturing. Therefore, this study proposes a production nesting and scheduling problem considering multi-material parts in additive manufacturing. The aim is to minimize the tardiness of part production using the optimal production plan while considering the characteristics of a powder-bed fusion-based 3D printer. Part nesting prevents contamination of parts by constraining parts composed of different materials from overlapping. We develop a mixed-integer linear programming model for the multi-material parts nesting and scheduling problem and validate the model with small-sized instances using the CPLEX Optimization Studio. Experiment results show that jobs requiring more types of material parts cause more setup time due to the material changeover time and increase the total production completion time. In addition, increasing the number of jobs minimizes the part tardiness, but it increases the computational time. The proposed model can obtain an optimal part nesting and scheduling solution in an additive manufacturing environment considering multi-material parts, which contributes to the productivity improvement with an optimal production scheduling plan and increases the production flexibility by accommodating orders consisting of parts with different materials.

Keywords: Additive manufacturing, Parts nesting, Multi-material parts scheduling, Mixed-integer linear programming