Master’s thesis:
The value of recourse in stochastic programming in production planning

Topic:
In make-to-stock environments, production planners have to take decisions under demand uncertainty. Lot-sizing is a key step in production planning that aims at satisfying the uncertain demand while balancing setup and inventory costs. Before the realization of the demand, decisions have to be made both on the periods in which to produce and on the size of the lot.

In practice, it is common to deal with uncertainty by implementing a production plan in a rolling horizon fashion. The demand for future periods is estimated using forecasts and the optimal plan is calculated over a finite prediction horizon. The decisions for the first period(s) are implemented and the schedule is rolled forward. The procedure is then repeated at the next planning period. However, frequent updates of demand forecasts and uncertainty in the processes may lead to high variations in successive production plans. The resulting planning instability may be especially detrimental for the firm if the processes have low flexibility. A firm may then decide to update its production plan less often, for instance applying one of the strategies to deal with planning instability in stochastic production planning as proposed in [1].

In stochastic programming, the decisions to take under uncertainty can be split in two sets. Here-and-now decisions have to be taken before realizations of the stochastic process and wait-and-see decisions can wait for realizations of the uncertainty and react to it. The stochastic formulations are then closely linked to the flexibility of the production processes: they reflect how often a firm can revise its production plan and adapt to realizations of the demand. The value of recourse was investigated for instance in [2] for production planning using two scenario-based stochastic approaches or in [3–4] for capacity expansion.

By quantifying the cost improvements of stochastic approaches with more recourse, the value added of having more flexible production processes is investigated. The results would provide fruitful insights to identify the value of investing in more flexible processes.
The goal of this project is therefore:
- to link various levels of recourse in existing stochastic programming approaches with varying levels of flexibility in the production processes, and
- to compare the performance of selected stochastic approaches through numerical studies. Sensitivity analysis of the simulation parameters would highlight suitable application cases for the different stochastic methods.

Tasks:
Your tasks will be to:

1. Conduct a literature review on the lot-sizing problem and stochastic programming (in particular: two-stage stochastic programming and scenario-based stochastic approaches).
2. Propose stochastic formulations and implementation strategies that represent different levels of flexibility in the processes.
3. Investigate exact and/or approximate solution methods.
4. Evaluate the solution methods through numerical simulations.

Prerequisites:
You should have taken the course “Modelling, Optimization and Simulation in Operations Management” or an equivalent course and have an understanding of mathematical modelling and optimization. A first experience with stochastic optimization is a plus.

References:


Contact:
Please send a short mail including CV and transcript of records to Alexandre Forel (alexandre.forel@tum.de). The project topic and start date can be discussed.