



# Considering environmental aspects in production planning problems

## 1 Context

DecisionBrain <sup>1</sup> is a software company that specializes in providing optimization solutions primarily in the fields of production planning and workforce management. The range of problems varies from routing problems to scheduling problems to very complex multi-level lot-sizing problems. DecisionBrain develops an optimization library (called the Planning Engine) that uses IBM ILOG CPLEX and that aims at solving a large variety of lot-sizing problems.

Lot-sizing problems aim at determining a production or distribution plan that satisfies demands over a planning horizon discretized into periods ([1], [2]). The objective is to find a production plan that minimizes the total production, inventory and setup costs. Lot-sizing problems are very common in manufacturing and logistics ([3]), and the complexity of the problems varies depending on the constraints that are considered, but problems with limited production capacity are usually *NP-hard*.

Despite the significant works in the scientific literature on production planning, relatively few works have focused on the consideration of environmental constraints or objectives; especially with regards to the energy consumption ([4]) or carbon emission constraints ([5]). Environmental considerations are very rare in industrial applications, where the main objectives usually are the demand satisfaction and the processing and holding costs. Environmental aspects are not yet explicitly considered in the model solved in the Planning Engine. However, not only with regards to the environmental impact, there are also real economical incentives into considering environmental constraints, for instance due to the scarcity and the prices of energy.

## 2 Internship

Being able to model environmental aspects in lot-sizing problems and measuring the impact that having environmental limitations can have on the other objectives would be a really efficient way to convince manufacturers to consider some of these aspects when building their production plans. The objectives of this internship are consequently to:

- Perform a **state of the art** on the consideration of environmental impacts in lot-sizing problems,
- Define, implement and analyze indicators to **measure the environmental impacts** of the production plans,
- **Perform numerical analysis** based on industrial instances to measure the environmental impact of cost-optimal production plans,
- **Take environmental considerations into account** in the model solved in the Planning Engine and analyze the impact on the quality of the production plans obtained.

This internship would ideally be followed by a PhD thesis in collaboration with Campus Georges Charpak Provence (Gardanne, 13, France) of Mines Saint-Etienne, on the subject of integration between lot-sizing and scheduling and the consideration of environmental aspects such as the energy consumption.

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<sup>1</sup><https://www.decisionbrain.com/>

### 3 Practical information

**Environment** This internship will be based at DecisionBrain (75010, Paris).

**Date** The start of the internship is flexible but is expected to be in Spring 2023.

**Profile** Candidates must be M2 level student (2nd year of MSc or last year of “cycle ingénieur”). They must have a solid background in computer science, good programming skills, and a particular liking for operational research.

**Contact** Candidates must send their CV, a letter of motivation and their master marks to:

- mehdi.charles@decisionbrain.com,
- daniel.godard@decisionbrain.com,
- dauzere-peres@emse.fr.

### References

- [1] Ford W. Harris. How Many Parts to Make at Once. *Factory, The Magazine of Management*, 10(2):135–136, 1913.
- [2] Yves Pochet and Laurence A. Wolsey. *Production planning by mixed integer programming*. Springer series in operations research and financial engineering. Springer, New York ; Berlin, 2006.
- [3] Raf Jans and Zeger Degraeve. Modeling industrial lot sizing problems: a review. *International Journal of Production Research*, 46(6):1619–1643, March 2008.
- [4] Christophe Rapine, Guillaume Goisque, and Ayse Akbalik. Energy-aware lot sizing problem: Complexity analysis and exact algorithms. *International Journal of Production Economics*, 203:254–263, 2018.
- [5] Nabil Absi, Stéphane Dauzère-Pérès, Safia Kedad-Sidhoum, Bernard Penz, and Christophe Rapine. Lot sizing with carbon emission constraints. *European Journal of Operational Research*, 227(1):55–61, 2013.