

Université catholique de Louvain
École polytechnique de Louvain
Département d'ingénierie mathématique (INMA)
Center for Operations Research and Econometrics (CORE)

Voie du Roman Pays 34, L1.03.01, 1348 Louvain-la-Neuve, Belgique
Tél. : + 32 (0) 10 47 43 21 - fax : + 32 (0) 10 47 43 01
E-mail : corsec-core@uclouvain.be
<http://www.uclouvain.be/core>

In this thesis we consider different joint production and transportation problems.

We first study the simplest two-level problem, the uncapacitated two-level production-in-series lot-sizing problem (2L-S/LS-U). We give a new polynomial dynamic programming algorithm and a new compact extended formulation for the problem and for an extension with sales. Some computational tests are performed comparing several reformulations on a NP-Hard problem containing the 2L-S/LS-U as a relaxation.

We also investigate the one-warehouse multi-retailer problem (OWMR), another NP-Hard extension of the 2L-S/LS-U. We study possible ways to tackle the problem effectively using mixed integer programming (MIP) techniques. We analyze the projection of a multi-commodity reformulation onto the space of the original variables for two special cases and characterize valid inequalities for the 2L-S/LS-U. Limited computational experiments are performed to compare several approaches.

We then analyze a more general two-level production and transportation problem with multiple production sites. Relaxations for the problem for which reformulations are known are identified in order to improve the linear relaxation bounds. We show that some uncapacitated instances of the basic problem of reasonable size can often be solved to optimality. We also show that a hybrid MIP heuristic based on two different MIP formulations permits us to find solutions guaranteed to be within 10% of optimality for harder instances with limited transportation capacity and/or with additional sales. For instances with big bucket production or aggregate storage capacity constraints the gaps can be larger.

In addition, we study a different type of production and transportation problem in which clients place orders with different sizes and delivery dates and the transportation is performed by a third company. We develop a MIP formulation and an algorithm with a local search procedure that allows us to solve large instances effectively.

Rafael Augusto de Melo was born on November 1, 1982 in Ipatinga (Brazil). He holds a bachelor's degree from Universidade Federal de Lavras and a master's degree from Universidade Federal Fluminense, both in computer science. He did his Ph.D. in applied mathematics with specialization in discrete optimization at the Center for Operations Research and Econometrics, Université catholique de Louvain, under the supervision of Laurence Wolsey. He defended his thesis in November 2011.

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RAFAEL AUGUSTO DE MELO

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