Advanced Production Planning  
PhD Programme HEC  
Summer 2010  
Course outline

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Course Summary

Production Planning is one of the important tasks done within the Operations Management function. It is a complex and challenging task. Therefore, the use of optimization models for production planning is widespread. The course will provide an in-depth study of the main concepts, models and solution approaches in deterministic production planning.

The course consists of the three following modules:
   Part I: Overview of planning problems  
   Part II: Solution approaches  
   Part III: Extensions of models

Course Objectives

- Introduce the students to the basic models in production planning.  
- Discuss the main solution techniques related to deterministic production planning.  
- Show how the basic models can be extended to take into account all types of industrial issues, both at the operational level and the more tactical level.  
- Challenge the students to identify, analyse, model and solve typical production planning problems and explain this correctly.
Teaching Approach

In class, we will make use of a variety of teaching methods including lectures, class discussions and exercises.

The students need to be familiar with the basics of Linear and Integer Programming (at a MSc. or PhD level).

Course Material

Compulsory book and articles:

Books:

Articles:
See detailed class sessions

Grading Scheme

Assignments (40%)
Research Project (40%)
Class participation (20%)

All components are individual.

Research Project

The students will have to find a relevant topic related to the main issues in the course and write a research report on this. The contribution can be made in the form of a thorough literature review, a theoretical contribution related to models or solution approaches and/or a computational study. The proposal will be discussed in class, and each student will have to present his work in the final class.
Detailed Course Outline

Part I: Overview of planning problems

Session 1: The Hierarchy of Planning
Course overview
The bigger picture: Advanced Planning Systems
Dynamic versus static demand
Scheduling versus lotsizing
Introduction of three basic lotsizing models:
  • Capacitated Lotsizing
  • Continuous Setup Lotsizing
  • Discrete Lotsizing and Scheduling

Literature:

Session 2: Machine Scheduling
Performance measures for scheduling
Single and parallel machine scheduling
Job shop scheduling
Time indexed formulations

Literature:
Session 3: Static demand: The Economic Lot Scheduling Problem

- The basic Economic Order Quantity model (EOQ)
- EOQ with quantity discounts
- The Economic Production Quantity model
- Planning multiple items on one machine

Literature:


Pinedo, M., 2005, Chapter 7: Economic Lot Scheduling, in: Planning and Scheduling in Manufacturing and Services, Springer.

Session 4: Dynamic demand: Single Item Lotsizing: formulations and properties

- Standard formulation
- Wagner-Whitin Property for uncapacitated lotsizing
- Network Reformulation
- Simple plant location formulation
- \((l,S)\)-inequalities
- Dynamic Programming

Literature:


Part II: Solution approaches

Session 5: Multi-item Capacitated Lotsizing: Lagrange decomposition

Capacitated Lotsizing
Multi-item problems
Introduction to decomposition approaches
Lagrange decomposition for capacitated lotsizing
Solving lotsizing problems using subgradient optimization

Literature:


Session 6: Capacitated Lotsizing: Dantzig-Wolfe decomposition and Column Generation

- Standard decomposition: capacity as complicating constraint
- Equivalent MIP Dantzig-Wolfe reformulation
- Branch-and-Price approaches
- Alternative decomposition: demand as complicating constraint
- Comparing the resulting lower bounds
- Combining Column generation and Lagrange Relaxation

Literature:


Session 7: Cutting planes and MIP-based heuristics for production planning

- Cutting Planes
- The approximate network reformulation
- Mixed Integer Programming based heuristics for lotsizing:
  - Truncated MIP
  - Diving
  - Relax-and-Fix
  - Relaxation Induced Neighbourhood Search
  - Local Branching
  - Fix-and-Optimize

Literature:


Helber, S., Sahling F., A fix-and-optimize heuristic (check reference)


Session 8: Meta-Heuristics for production planning

Genetic Algorithm,
Tabu Search
Simulated Annealing in Lotsizing

Literature:


Part III: Extensions of production planning models

Session 9: Multi-Level Lotsizing

Multi-level formulations:
  Serial systems
  Assembly systems
  Distribution systems
  General systems

Literature:


Session 10: Production Planning under Uncertainty

Introduction to stochastic programming
Lot sizing under uncertain demand
Capacity planning under uncertain demand
Two stage problem with recourse
Interpretation of downside risk
The value of information

Literature:

Session 11: Extended Models

Backlogging
Single and multi item variants
Parallel machines
Lotsizing with substitution
Setup Carry-over
Sequence dependency

Literature:


Session 12: Applications

Applications of Lotszing in different industries:
- Production planning at a tire manufacturing
- Planning issues in the Process industry
- Sourcing in the steel industry
- Strategic planning in the car manufacturing industry
- Integrated production and distribution planning

Literature:


Session 13: Student Presentations

The students present the results of their research project in class.

Additional references

Books

Pinedo, M., 2005, Planning and Scheduling in Manufacturing and Services, Springer.

Review Articles: