Abstract

The aim of thesis is to present some macroscopic models for supply chains and networks able to reproduce the goods dynamics, successively to show, via simulations, some phenomena appearing in planning and managing such systems and, finally, to deal with optimization problems.

Depending on the observation scale supply networks modeling is characterized by different mathematical approaches: discrete event simulations and continuous models. Since discrete event models (Daganzo 2003) are based on considerations of individual parts, their main drawback is, however, an enormous computational effort. Then a cost-effective alternative to them is continuous models, described by some partial differential equation. The first proposed continuous models date back to the early 60's and started with the work of Baumol (1970) and Forrester (1964), but the most significant in this direction was Daganzo (1997), where the authors, via a limit procedure on the number of parts and suppliers, have obtained a conservation law (Armbruster-Marthaler-Ringhofer 2004, Dafermos 1999), whose flux involves either the parts density or the maximal productive capacity.

Then, in recent years continuous and homogenous product flow models have been introduced and they have been built in close connection to other transport problems like vehicular traffic flow and queuing theory. Extensions on networks have been also treated.

In this work, starting by the historical model of Armbruster - Degond - Ringhofer, we have compared two different macroscopic models, i.e. the Klar model, based on a differential partial equation for density and an ordinary differential equation to capture the evolution of queues, and a continuum-discrete model, formed by a conservation law for the density and an evolution equation for processing rate. Both the models can be applied for supply chains and networks.

Moreover, an optimization problem of sequential supply chains modeled by the Klar approach has been treated. The aim is to find the configuration of production according to the supply demand minimizing the queues length, i.e. the costs of inventory, and obtaining an expected pre-assigned outflow. The control problem is solved introducing and minimizing a cost functional which takes into account the final flux of production and the queues representing the stores. The functional is not linear, so to find its minimum, the vectors tangent method is introduced. This technique is based on the choice of an input flow which is a piecewise constant function, with a finite number of discontinuities. Considering on each of them an infinitesimal displacement which generates traveling temporal shifts on processors and shifts on queues, we are able to compute numerically the value of the variation of functional respect to each discontinuities. Finally, we use the steepest-descent algorithm to find, via simulations, the optimal configuration of input flow, according to the pre-fixed desired production.