Title: A reactive decision support system for freight intermodal barge transportation services

Financial support: Doctoral Contract

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Research Team: Decision, Interaction and Mobility (DIM)

The candidate needs a strong background in Computer Sciences and/or in Operations Research including methods of modeling and optimization, discrete-event system simulation, as well as algorithms and data structures in C/C++ language; multi-agent systems knowledge would be appreciated. French language is not required. The scholarship is open to all nationalities.

An international internship of six months will have to be completed during the PhD thesis period, with the Professor T.G. Crainic, the Director of the Intelligent Transportation Systems Laboratory of the CIRRELT (Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation), Montreal, Canada.

PhD Project

In the context of freight intermodal transportation, the goal of this research is to contribute to the development of sustainable transportation systems, and to allow and improve the modal transfer towards less polluting transportation modes, especially concerning the inland waterway network.

Taking advantage of a well-designed decision support system to manage intermodal transport activities is an essential asset. Up to now, many research initiatives and industrial projects tackled the complex problem of intermodal transportation chains organisation, with a particular interest towards railways, as a “greener” transportation alternative. Nevertheless, from this point of view, just a few published studies discuss about the inland waterway as an intermodal transportation alternative (Caris, 2011).

As a general framework, the approach of this type of transportation problems is as follows: on the basis of an existing demand knowledge, the service network design is done and services are planned on the middle-term (weeks, months), followed by the operational level activities optimisation on the short-term (hours, days) in order to minimise costs. The revenue management approach allows, at the operational level, the optimal assignment of services available capacities with respect to the forecasted demands, in order to maximise expected revenues of a company.

One of the innovative aspects of this research work is the application of revenue management concepts and thus the use of differential pricing strategies based on reasonable criteria for the clients. These policies are
successfully applied in many different sectors, and are used by commercial airlines, for passenger transportation, for more than 30 years now. The concepts of revenue management have been proposed, in a basic form, in 1972 (Littlewood, 1972) and have not ceased to be developed and to gain in applications diversity (Boyd and Bilegan, 2003) since. Revenue management has become today a well-established research field in the domain of Operations Research (Talluri and van Ryzin, 2004). The constraints and specificities of applying revenue management to intermodal barge transportation make this research problem a challenging topic, which constitutes the central point of the doctoral study.

The second original aspect of this thesis is to provide demand forecasting by the use of a client behaviour modelling based on the multiagent system paradigm. Clients will be modelled with software agents that allow the definition of a typology of clients (by using roles), as well as of individual properties for each client. This “agentification” of clients allows the realization of more realistic simulations of their behaviours than by the use of classical models. The “agentification” of service suppliers will also allow them to analyse, test and validate several strategies of transportation service offers. Some recent works have already shown the interest and pertinence of this approach (e.g. Cleophas 2012).

Those two approaches will lead to the design of a reactive decision support system to help the process of planning and management of intermodal transportation operations. The implementation of the decision support system will be done through the design of dedicated software, which will have to analyse the feasibility, the profitability and finally the acceptability of each incoming demand. This analysis and the decision-making will be done on the basis of the newest available information in the system, with respect both to the demand and to the transportation services offer. Information will be updated on a regular basis or in real-time, thus ensuring the reactivity of the system.

At the methodological and theoretical level, the project is concerned with problems of the following type: demand modelling and forecasting, optimal capacity allocation, stochastic and dynamic systems simulation and optimisation, and decision support systems design. At the application and implementation level, the project will benefit from the direct collaboration with a trans-frontier consortium made up of several major actors in maritime and river navigation and in inland waterway infrastructure management, in the Northern France and Belgium, who work together for the development of sustainable and integrated intermodal transportation innovative solutions.

**Key-words:** revenue management, agent-based simulation, demand modelling, stochastic simulation, dynamic systems, decision support systems, intermodal freight transportation, inland waterway navigation.

**Bibliography:**
Littlewood, K. (1972), Forecasting and Control of Passenger Bookings, AGIFORS Proceedings, 12, 95-117

To apply, please send by e-mail, to the thesis supervisors, the following documents: an extended CV (including a list of publications and scientific/technical reports), a certificate with scores and ranking during the last three years of academic studies, at least two letters of recommendation (or contacts of at least two referees) and a letter describing the motivations and the professional project of the candidate.