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Editorial

While public transport or transit systems have arguably been in existence much longer than road traffic systems, the mathematical analysis techniques so necessary for the proper planning of transit operations have lagged far behind those for road traffic systems. For example, the body of literature available on the design of multi-route transit network is miniscule in comparison to the literature on the coordination of traffic signals along an urban road. The idea for this Special Issue grew out of the organization of the Advanced Study Institute (ASI), which was sponsored by the Croucher Foundation (`http://www.croucher.org.hk/`) for the dissemination of knowledge and the formation of international scientific contacts on advances in modeling transit systems.

In the ASI International Workshop (`http://www.cse.polyu.edu.hk/~cehklam/asi-9-13dec02.pdf`) on advanced modeling for transit operations and service planning, held at the Harbour Plaza Metropolis, in Hong Kong from 9th to 13th December 2002, experts from Asia, Europe and North America have presented papers on advanced methods and new techniques for improving transit planning and operations [6]. Among them, a number of papers are focused on the subject of transit modeling which is of particular interest to mathematicians and researchers involved in development of mathematical models and solution algorithms. These papers are worthy of further elaboration and expansion.

On the other hand, practicing engineers appear to have disregarded most of the wealth of mathematical insights that have been available in the literature for more than a decade [7]. The literature on dynamic traffic assignment is a good example [8]. However, transport planners and traffic engineers, particularly in Hong Kong and Asia, are facing ever-greater pressure in congested road networks [5]. Reliability and control issues have become very important and critical in making the transport system more efficient [4], particularly with the advanced traveler information systems (ATIS). The need to optimize road traffic signals and to minimize the delays at individual signalized intersection, as well as the system as a whole under the environment with ATIS, to help travelers making intelligent decisions [1] for their travel choices, has increased. As tightening constraints raise serious questions about the cost-effectiveness of existing transit services, improvements which can be implemented in the short run and long term are continuously sought [3]. Collectively, these pressures have focused attention on advanced models and efficient algorithms for modeling both transit and road transport systems.

This Special Issue is devoted to the subject of mathematical modeling for transport and to provide a broader platform for dissemination of the recent research findings by those experts who have attended the ASI workshop in Hong Kong. This Special Issue addresses the important and timely problems of how to model the complicated transit systems and the intelligent transportation systems by making use of new algorithms and advanced modeling techniques. It will provide important references for determining the effects of introducing these new methods and models, and thus assist transportation professionals and scientists in understanding the transportation problems scientifically and mathematically. In total, five papers are included in this issue and they are presented as follows.

In the first paper, Wan and Lo present an interesting and useful mixed-integer programming formulation for a difficult multiple-route transit network design problem. The idea of this study is interesting in the sense that the node labels are introduced so that the multi-route structure and the flow on each segment of the route are explicitly represented. Furthermore, the optimal line frequency can be determined simultaneously with the proposed route structure. The model formulation proposed by this paper provides a promising starting point for extending the research on transit network design problems and devising efficient solution algorithms for practical size networks.

In the second paper, Kurauchi *et al.* propose a new transit assignment model, in which two important conditions that are embedded in the transit networks, i.e. the capacity constraint of transit lines and common lines problems, are considered simultaneously. They propose the use of absorbing Markov chains [2] to solve the capacity constrained transit network loading problem taking common lines into account. In the proposed model formulation, the failure-to-board probability depends on boarding demand, passengers already on board, and transit line capacity, which in turn depends on the failure-to-board probability. The authors present a fixed point problem which defines the equilibrium and can be solved by the method of successive averages (MSA). The methodology is demonstrated by a small example. However, the application of the proposed model to more complex networks, particularly those with circular transit lines, is required. The proposed model is useful for planning future transit services, especially during the peak hour periods when the passenger demand exceeds the line capacity.

In the third paper, Lam *et al.* investigate the congestion effects at transit stations on the estimation of transit passengers by Origin–Destination (O–D) pairs. The authors present a bi-level programming approach in which the upper level minimizes the sum of error measurements in passenger counts and O–D matrices, and the lower level is a frequency-based stochastic transit assignment model. In the lower-level model, for a given O–D matrix, three unknown variables, namely the passenger overload delays at public transport stations, transit line frequencies, and link flows are simultaneously and endogenously determined. The lower-level problem can be formulated as either a logit-type or probit-type SUE transit assignment problem. A heuristic solution method is developed to solve the bi-level problem although without rigorous convergence proof. Application of the proposed model and solution algorithm is illustrated with a case study on a simplified transit network connecting the Hong Kong International Airport to urban areas.

The fourth paper of this Special Issue is on assessment of ATIS impacts in congested road traffic networks with multiple user classes. In order to assess the impacts of Advanced Traveler Information Systems (ATIS) in road networks with traffic queues, Huang and Lam propose a multi-class dynamic user-equilibrium assignment model in which the simultaneous route and departure time choice problem is formulated as a discrete-time, finite-dimensional variational inequality (VI) problem. The proposed model consists of two criteria regarding the travelers' behaviors in queuing networks, i.e., the deterministic dynamic user equilibrium for travelers equipped with ATIS and the nested logit-based stochastic dynamic user equilibrium for unequipped travelers. The VI problem is converted to an equivalent "zero-extreme value" minimization problem that can be solved by a route/time-swapping process. It iteratively adjusts the route and departure time choices to reach closely to an extreme point of the minimization problem. Some insights about the impacts of ATIS are obtained on the basis of a numerical example, e.g., ATIS is likely to improve the network travel cost (or time) marginally. This may be true for commuter trips during normal peak hour periods. However, the advanced traveler information systems are claimed to be able to solve traffic jams quickly in situations with non-recurrent congestion. In view of these circumstances, there is a need to develop a modeling framework that can incorporate dynamic system optimization principle under further relaxed assumptions.

In the fifth paper, Wong and Wong investigate an optimization problem for minimizing delay at isolated signal-controlled intersections. The proposed method integrates the design of lane markings and signal settings, and considers both vehicular traffic and pedestrian movements in a unified framework. While the capacity maximization and cycle length minimization problems are formulated as Binary-Mix-Integer-Linear-Programs (BMILPs) that are solvable by standard branch-and-bound routines, the problem of delay minimization is formulated as a Binary-Mix-Integer-Non-Linear Program (BMINLP). It is noted that this paper combines the considerations of lane markings, signal phase groupings and durations, and cycle time for an isolated intersection in order to minimize delay. All these considerations add to the complexity of the formulation, making it a BMINLP, which is hard to solve. In this paper, the authors solve the problem using a cutting plane method and compare its performance with a heuristic search procedure. There are two innovations seen in this paper: first, individual lane regulations are considered in the optimization process and second, pedestrian delays are included in the delay minimization.

Owing to the diversity of mathematical models for transport, the papers presented in this special issue are by no means exhaustive. However, they do provide general coverage of various important areas on this subject. The editors wish that this issue will bring state-of-the-art methodologies for modeling transport to the attention of mathematicians and researchers, and that it will inspire and stimulate new research opportunities and efforts in the field. After all, it is hoped that this would improve the planning, design and operation of both transit and road transport systems and help promote their use to improve the efficiency of transportation networks in our cities.

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Guest Editors

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