CMS RESEARCH UPDATES MARCH 2014

Centre for Maritime Studies

Research Highlight 1: Vessel Weather Routing Dynamic and Stochastic Ocean Weather Environment, By Dr Chen Weidong (Track Leader: A/Prof Stephane Bressan)

Problem Statement

International shipping is a contributor to Global Greenhouse Gas (GHG) emissions, responsible for approximately 2.7% (i.e. 870 million tons) of global CO_2 emissions in 2007 (UNEP, 2009). As the world economy's reliance on the global trade of goods, materials, and petroleum continues to rise, CO_2 emissions of shipping sector is expected to climb to between 2500 and 3650 million tons by 2050 (UNEP, 2009). In view of this, the International Maritime Organization is working on introducing practices and regulations to reduce greenhouse gas emission from shipping industry.

In a deterministic model, weather forecast is considered accurate. This is unrealistic. We consider a stochastic model in which weather effects are modeled as stochastic processes. We use look-ahead policy to solve the problem thus modelled. Deterministic model is used to foresee the effects of choosing the vessel's speed at each time instance. Even with these approximations, look-ahead procedures can be computationally demanding. Using the algorithms we aforementioned, the computational time can be significantly reduced.

Formulation of Minimum Fuel Consumption Problem

A port of call is a port for a vessel to load or unload cargo, obtain supplies, or undergo repairs on her service route. Let n be the number of port of calls. Starting from the initial port of call, we label the subsequently port of calls by numbers 1, 2… The distance between the port of call i and the port of call 1 is denoted by d_i and the total distance of the voyage is given by D, namely $d_1 = 0$ and $d_n = D$. The position of the vessel at time t ϵ [0; T] along the voyage is presented by a function x: [0; T] → [0;D], where t = 0 denotes the present time and T is the maximum time horizontal will be considered. At time instance t = 0, we require that $x(0) = d_1$. The speed of the vessel at time instance t is denoted by v(t), which is bounded by the minimum possible speed V_{min} and the maximum possible speed V_{max}. The bunker price at port of call i is given by c_i and we assume that the vessel will bunker to its full capacity at each port.

Minimum Fuel Consumption Problem with Stochastic Weather

Let (Ω, F, $\{Ft\}_{t>0}$, P) be a given filtered probability space, on which a stochastic process Φ (d; t) is given. As in the deterministic case Φ (d; t) presenting the influence of ocean weather.

A solution of the stochastic problem needs to be {Ft}t>0 adapted, meaning that at any time instance t the all the relevant past information of the system. At time t, the bunker consumption rate is given by F(Φ (x(t); t); v(t)).

A policy determines a decision given the available information in time instance t. The expected cost function is given by:

$$\mathcal{J}(v) = \mathbb{E}\left[\sum_{i=2}^{n} c_i \int_{\bar{t}_{i-1}}^{t_i} F(\Phi(x(t),t),v(t))\,\mathrm{d}t + \sum_{i=1}^{n} P_i(t_i)\right].$$

A popular method in practice for approximately solving stochastic dynamic programming is using the lookahead policy. It uses a point forecast of future information to create a deterministic model over the horizon. Suppose at time instance t' the vessel is on her way, at position x', to the port of call I'. All the relevant past information of the system $F_{t'}$ is known. We can formulate the following problem:

$$\begin{aligned}\min\ & c_{i'} \int_{t'}^{t_{i'}} E\left[F(\Phi(x(t),t),v(t))|\mathcal{F}_{t'}\right]\mathrm{d}t + \\ & \sum_{i=i'+1}^{n} c_i \int_{\bar{t}_{i-1}}^{t_i} E\left[F(\Phi(x(t),t),v(t))|\mathcal{F}_{t'}\right]\mathrm{d}t + \sum_{i=i'}^{n} P_i(t_i)\\ \text{subject to: } & x(t') = x',\\ & v \in \mathcal{V}.\end{aligned}$$

Research Highlight 1: Vessel Weather Routing Dynamic and Stochastic Ocean Weather Environment, By Dr Chen Weidong (Track Leader: A/Prof Stephane Bressan)

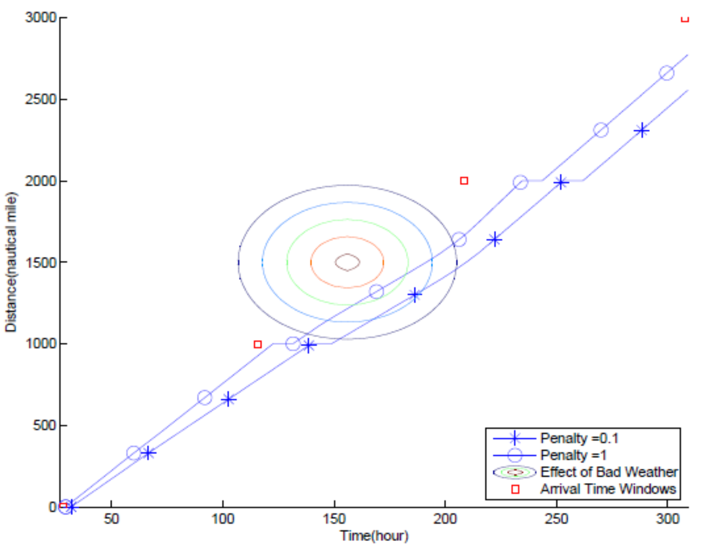
Results

We compare the result of deterministic model (DP) and stochastic model (SP) by substituting their results into each of the 100 realizations and taking average.

In all cases, the stochastic model performs better than the deterministic model. Furthermore stochastic model becomes more superior to deterministic model when weather conditions are more fluctuating. Considering the huge amount of operational costs for a liner shipping company, this means a significant total cost reduction.

For each α, as the penalty cost increases, the cost saving of the stochastic model solved by lookahead policy compared with the deterministic model decreases. For example, when α = 0.02, the average cost saving decreases from 5.13% to 2.91%. The possible reason is that high penalty cost will reduce the ability of the stochastic model to avoid adverse weather.

Vessel Position (In Adverse Weather)



We study the case when a significant adverse weather condition is injected in the middle of the voyage. The closer to the center the worse the weather. The red square presents the departure time window of the first port of call and arrival time windows of the rest port of calls.

Model Comparisons

$c_i' = 0.00$

α	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020
SP	161.708	162.150	162.886	163.916	165.253	166.951	169.030	171.408	174.063	177.152
DP	161.855	162.736	164.194	166.227	168.831	172.001	175.731	180.006	184.826	190.175
$\frac{DP-SP}{DP}$	0.09%	0.35%	0.77%	1.31%	1.95%	2.62%	3.28%	3.94%	4.59%	5.13%

$c_i' = 0.01$

α	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020
SP	161.726	162.195	162.983	163.989	165.334	167.032	169.126	171.486	174.174	177.295
DP	161.869	162.773	164.264	166.301	168.906	172.074	175.811	180.093	184.907	190.273
$\frac{DP-SP}{DP}$	0.09%	0.35%	0.75%	1.31%	1.94%	2.61%	3.26%	3.92%	4.55%	5.09%

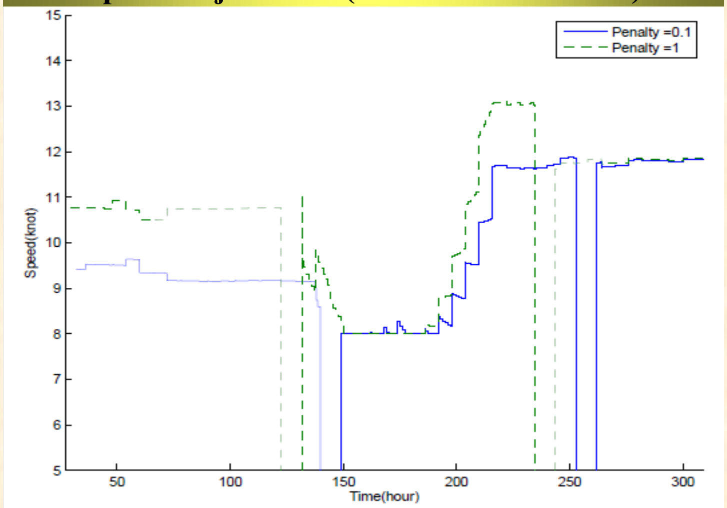
$c_i' = 0.10$

α	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020
SP	161.721	162.232	163.077	164.259	165.762	167.661	169.917	172.337	175.262	178.748
DP	161.863	162.772	164.279	166.382	169.079	172.365	176.225	180.655	185.687	191.003
$\frac{DP-SP}{DP}$	0.09%	0.33%	0.71%	1.20%	1.78%	2.39%	3.00%	3.69%	4.24%	4.55%

$c_i' = 1.00$

α	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020
SP	161.726	162.289	163.288	164.754	166.676	169.086	171.941	175.224	178.786	182.870
DP	161.863	162.772	164.279	166.379	169.073	172.388	176.212	180.604	185.599	191.046
$\frac{DP-SP}{DP}$	0.08%	0.29%	0.58%	0.91%	1.28%	1.63%	1.98%	2.32%	2.66%	2.91%

Speed Adjustment (In Adverse Weather)



When the vessel's arrives at port, it will stay at the port for 9 hours, which include entry time, unloading time, loading time, idle time and exit time. These port times are presented by gaps in the above diagram.

To avoid or limit the effect of this adverse weather conditions, a vessel can adjust the departure times and adjust the speed. One strategy is to reduce the vessel speed and delay the arrival time, and likewise another strategy is to increase the speed and bring forward the departure time.

Conclusions

The model and the solution we propose are generic enough to be applicable to any bunker consumption model and any weather conditions model. Our empirical, numerical and comparative performance evaluation of the proposed model and solution on the case shows that it is superior to the deterministic solution under fluctuating weather condition. We believe that our model is generic, practical, efficient and effective enough to be implemented to give operational-level decision support to lower the overall bunker cost.

Research Highlight 2: Study on Berth Planning Problem in a Container Seaport: Using an Integrated Programming Approach, By Dr Song Liying (Track Leader: A/Prof Anthony Chin)

Research Objective

This paper provides an integrated solution for two common processes in a container seaport: namely, the Berth Allocation Process (BAP) and the Crane Scheduling Process (QCSP).

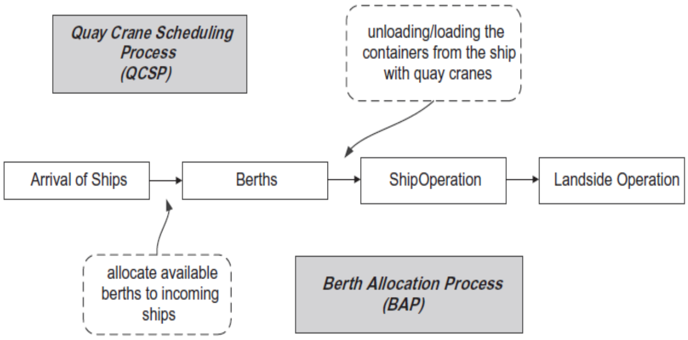
The BAP is at the upper level which is a NP-hard problem, while the QCSP, at the lower level, is a mixed-integer linear problem. A Bi-Level Programming problem (BLP) has a hierarchical structure in which an upper-level and a lower-level decision maker have to select their strategies to optimize their individual objective functions. However, the upper-level decision maker has to understand how the lower-level optimizer would react to a given upper-level decision and acts accordingly, while the lower-level optimizer can respond only according to given decisions of the upper-level problem. Hence, this paper aims to:

(1) Formulate a bi-level programming model to investigate the combined BAP and QCSP system.

(2) Optimize the BAP and QCSP processes simultaneously.

(3) Extend the QCSP model with one vessel to more than one vessel to be operated.

Interrelationship—BAP and QCSP



Upper Level Problem— BAP

SBAP addresses the ship-berth-order assignment with the goal of minimizing the waiting and handling time of incoming ships. The SBAP assumes that before the berth plan is determined, all the ships have arrived and that every potential ship-berth-order assignment is feasible, otherwise, the berth scheduling process is considered to be dynamic (DBAP).

Lower Level Problem — QCSP

A container seaport with several berths is considered and the planning period is [0, T]. Assume that at time t = 0, there are S mooring ships, denoted as 1, 2, . . . m, . . . s, . . . S, staying at the berth for loading or unloading work. Ship m has Hm holds, numbered as (m, 1), (m, 2), . . . , (m,Hm). There are K quay cranes, numbered as k ϵ K = {1, 2, . . . K}, to undertake the loading or unloading jobs.

P^s_j represent the time required to perform task j in ship s when one crane is allocated to that hold H_j. r_k is the earliest available time of quay crane k. The QCSP aims to allocate quay cranes to each hold over time in order to minimize the total operational costs of the quay crane.

Integrated BI-Level Programming

Upper Level Problem

Berth Allocation Process (BAP)

$$\min F(x_{ijk}, W_{ij}(x_{ijk}))$$

Subject to

$$\sum_{i=1}^{I}\sum_{k=1}^{T} x_{ijk} = 1,\ j = 1,\cdots,T$$

$$\sum_{j=1}^{T} x_{ijk} \le 1, i = 1,\cdots,I, k = 1,\cdots,T$$

$$x_{ijk} \in \{0,1\}, i = 1,\cdots,I, j = 1,\cdots,T, k = 1,\cdots,T$$

Lower Level Problem

Quay Crane Scheduling Process (QCSP)

$$\min f(x_{ijk}, W_{ij})$$

Subject to

$$Y^s_k \le W_s \quad \forall k = 1,2,\ldots K \quad \forall s = 1,2,\ldots S$$

$$\sum_j X^{ks}_{0j} = 1 \quad \forall k = 1,2,\ldots K \quad \forall s = 1,2,\ldots S$$

$$\sum_j X^{ks}_{jT} = 1 \quad \forall k = 1,2,\ldots K \quad \forall s = 1,2,\ldots S$$

$$\sum_k \sum_i X^{ks}_{ij} = 1 \quad \forall s = 1,2,\ldots S \quad \forall j \in \Omega$$

$$\sum_j X^{ks}_{ij} - \sum_j X^{ks}_{ji} = 0 \quad \forall i \in \Omega \quad \forall k = 1,2,\ldots K \quad \forall s = 1,2,\ldots S$$

$$D^s_i + t^s_{ij} + p^s_j - D^s_j \le M(1 - X^{ks}_{ij}) \quad \forall i,j \in \Omega \quad \forall k = 1,2,\ldots K \quad \forall s = 1,2,\ldots S$$

$$D^s_i + p^s_j \le D^s_j \quad \forall i,j \in \Omega \quad \forall s = 1,2,\ldots S$$

$$D^s_i - D^s_j + p^s_j \le M(1 - Z^s_{ij}) \quad \forall i,j \in \Omega \quad \forall s = 1,2,\ldots S$$

$$Z^s_{ij} + Z^s_{ji} = 1 \quad \forall i,j \in \Omega \quad \forall s = 1,2,\ldots S$$

$$\sum_{v=1}^{k}\sum_{u\in\Omega} X^{vs}_{uj} - \sum_{v=1}^{k}\sum_{u\in\Omega} X^{vs}_{ui} \le M(Z^s_{ij} + Z^s_{ji}) \quad \forall i,j \in \Omega \quad \forall s = 1,2,\ldots S$$

$$D^s_j + t^{ks}_{jT} - Y^s_k + p^s_j \le M(1 - X^{ks}_{jT}) \quad \forall j \in \Omega \quad \forall k = 1,2,\ldots K$$

$$r^s_k - D^s_j + t^{ks}_{0j} + p^s_j \le M(1 - X^{ks}_{0j}) \quad \forall j \in \Omega \quad \forall k = 1,2,\ldots K$$

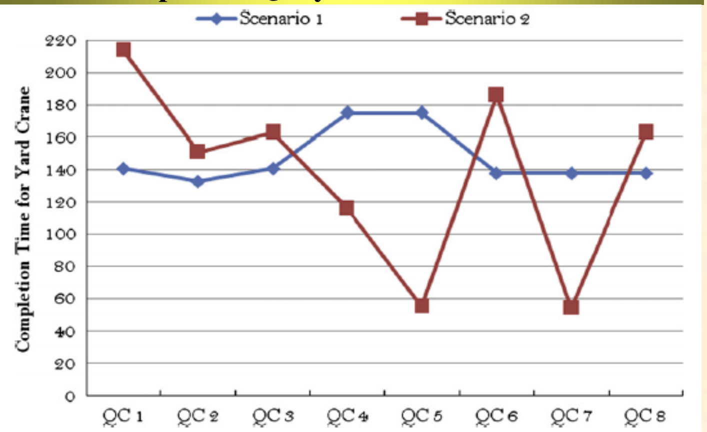
$$X^{ks}_{ij}, Z^s_{ij} = 0 or 1 \quad \forall i,j \in \Omega \quad \forall s = 1,2,\ldots S \quad \forall k = 1,2,\ldots K$$

$$Y^s_k, D^s_j \ge 0 \quad \forall s = 1,2,\ldots S \quad \forall k = 1,2,\ldots K$$

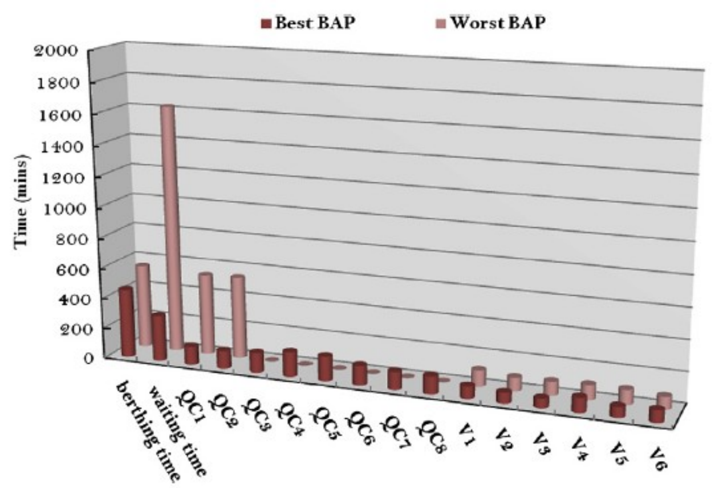
$$W_{s_i} \le W_{m_i} \quad s_i, m_i \in \Gamma$$

Research Highlight 2: Study on Berth Planning Problem in a Container Seaport: Using an Integrated Programming Approach, By Dr Song Liying (Track Leader: A/Prof Anthony Chin)

Optimal Quay Crane Schedules



Best & Worst Berth Schedules



Results - Numerical Example

The numerical example presents the best and the worst berth allocation schedule, leading to the shortest/longest mooring time for all ships in the diagram shown above (454 min and 551 min, respectively). Furthermore, the waiting time for berthing under the best and worst scenario is 302 min and 1624 min, respectively. The average duration for berthing (including the waiting time) for the 6 vessels modeled in this numerical example was 1149 min (19.2 h). This is backed up by the fact that the average turn-around time of a container vessel in Singapore is 1.8 days and the average vessel's berthing time is about 19.4 hr.

The numerical example was modeled closely using real operational data from Pasir Panjang container terminal operated by Port of Singapore Authority (PSA).

Optimal Berth Allocation

Berth number	1	2	3	Total
Scenario 1				
Service order for ships	3–1	6–4	5–2	
Berthing time (min)	141	175	138	454
%	31	39	30	100
Waiting time (min)	88	114	100	302
%	29	38	33	100
Scenario 2				
Service order for vessels	6-3–4	5	2–1	
Berthing time (min)	214	116	186	516
%	41	22	37	100
Waiting time (min)	255	0	117	372
%	69	0	31	100

Conclusion

The BLP approach aims to characterize the mutually consistent relationships between those two processes and simultaneously identify an integrated solution for both. The overall objective was to minimize the total waiting time and operating time for the incoming vessels while efficiently scheduling the quay cranes. A revised Genetic Algorithm and a Branch-and-Bound method (B&B) were then applied for the solutions of upper and lower level problems, respectively. This research also performed a numerical example to evaluate the efficiency of this bi-level programming model. In addition, the results suggested that the balanced workload of quay cranes should be preferred.

Contributions

The contributions of the paper to the literature are summarized as follows:

- this paper develops an integrated mathematical model and solution algorithm to optimize the BAP and QCSP simultaneously, and contributes a new methodology to current port operations;
- this study proposes a real case study by applying the methodology to PSA Singapore's Pasir Panjang container terminal, and illustrates the feasibility and applicability of the proposed methodology.

Acknowledgement

This research was funded by Beijing Jiaotong University Research Foundation (T10JB00030).

Published Technical Papers (with Abstracts)

1. Shuaian Wang, Qiang Meng, (2014), Liner shipping network design with deadlines. *Computers & Operations Research*, Vol 41, 140–149.

Abstract:

It is crucial for a liner shipping company to design its container shipping network. Given a set of port-to-port container shipment demands with delivery deadlines, the liner shipping company aims to design itineraries of port calls, deploy ships on these itineraries and determine how to transport containers with the deployed ships in order to maximize its total profit. In this paper we first demonstrate NP-hardness of this problem and subsequently formulate it as a mixed-integer non-linear non-convex programming model. A column generation based heuristic method is proposed for solving this problem. Numerical experiments for container shipping on the Asia–Europe trade lane show that the proposed solution algorithm is efficient to find good quality solutions.

2. Tingsong Wang, Qiang Meng, Shuaian Wang, Zhijia Tan, (2013), Risk management in liner ship fleet deployment: A joint-chance constrained programming model. *Transportation Research Part E: Logistics and Transportation Review*, Vol 60, 1–12.

Abstract:

This paper provides a tangible methodology to deal with the liner ship fleet deployment problem aiming at minimizing the total cost while maintaining a service level under uncertain container demand. The problem is first formulated as a joint chance constrained programming model, and the sample average approximation method and mixed-integer programming are used to deal with it. Finally, a numerical example of a liner shipping network is carried out to verify the applicability of the proposed model and solution algorithm. It is found that the service level has significant effect on the total cost.

3. Shuaian Wang, Qiang Meng, Zhiyuan Liu, (2013), Containership scheduling with transit-time-sensitive container shipment demand. *Transportation Research Part B: Methodological*, Volume 54, 68–83, August.

Abstract:

This paper examines the optimal containership schedule with transit-time-sensitive demand that is assumed to be a decreasing continuous function of transit time. A mixed-integer nonlinear non-convex optimization model is first formulated to maximize the total profit of a ship route. In view of the problem structure, a branch-and-bound based holistic solution method is developed. It is rigorously demonstrated that this solution method can obtain an ε-optimal solution in a finite number of iterations for general forms of transit-time-sensitive demand. Computational results based on a trans-Pacific liner ship route demonstrate the applicability and efficiency of the solution method.

Published Technical Papers (with Abstracts)

4. Zhiyuan Liu, Qiang Meng, Shuaian Wang, (2013), Speed-based toll design for cordon-based congestion pricing scheme. *Transportation Research Part C: Emerging Technologies*, Volume 31, June 2013, Pages 83–98.

Abstract:

The cordon-based Electronic Road Pricing (ERP) system in Singapore adopts the average travel speed as an index for evaluating the traffic congestion within a cordon area, and the maintenance of the average travel speed within a satisfactory range is taken as the objective of the toll adjustment. To formulate this practical speed-based toll design problem, this paper proposes a mathematical programming with equilibrium constraint (MPEC) model with the objective of maintaining the traffic condition in the cordon area. In the model, the network users' route choice behavior is assumed to follow probit-based stochastic user equilibrium with elastic demand, asymmetric link travel time functions and continuous value-of-time. A distributed revised genetic algorithm is designed for solving the MPEC model. Finally, a network example based on the ERP system is adopted to numerically validate the proposed models and algorithms, and further indicates that the computation speed can be improved greatly by using a distributed computing system.

5. Zhiyuan Liu, Qiang Meng, Shuaian Wang, Zhuo Sun, (2014), Global intermodal liner shipping network design. *Transportation Research Part E: Logistics and Transportation Review*, Vol 61, 28–39.

Abstract:

This paper presents a holistic analysis for the network design problem of the intermodal liner shipping system. Existing methods for liner shipping network design mainly deal with port-to-port demand. However, most of the demand has inland origins and/or destinations. Thus, it is necessary to cope with inland origin–destination (OD) pairs involving a change in transport mode from inland transportation to maritime shipping. A method is first proposed to convert inland OD demand to port-to-port demand. Then, a framework for global intermodal liner shipping network design is proposed. Finally, the proposed methodology is applied to and numerically verified by a large-scale network example.

6. Dong Yang, Ghim Ping Ong & Anthony Theng Heng Chin, (2013), An exploratory study on the effect of trade data aggregation on international freight mode choice. *Maritime Policy & Management: The flagship journal of international shipping and port research*, published October 2013.

Abstract:

As part of a comprehensive regional or global maritime trade modeling framework, it is often necessary to determine the modal share of commodity flow between countries. Typically, this is resolved by either using a constant empirical value (such as the commodity value-weight ratio) or applying statistical models to determine mode choice or share. Whilst the latter method tends to provide a more rational solution, it is constrained by the appropriate choice of trade data classification level during model development. This paper therefore explores the potential impact of trade data aggregation (in terms of trade data classification level) on commodity mode choices derived from discrete choice models. Using international commodity flows between continents, discrete choice models can be developed to compare the modal split between air and sea transport. By considering four different international trade routes and three trade classification levels, the paper shows that detailed commodity trade classification may not necessarily lead to better results. Using the Harmonized Commodity Description and Coding System (or HS System) as an example, it was found that it may be more effective developing models using HS two-digit commodity trade data for the purpose of international freight mode choice studies for the purpose of regional or global maritime trade modeling.

Published Technical Papers (with Abstracts)

7. Shuaian Wang, Qiang Meng, Zhiyuan Liu, (2013), Bunker consumption optimization methods in shipping: A critical review and extensions. *Transportation Research Part E: Logistics and Transportation Review*, Vol 53, 49–62, July.

Abstract:

It is crucial nowadays for shipping companies to reduce bunker consumption while maintaining a certain level of shipping service in view of the high bunker price and concerned shipping emissions. After introducing the three bunker consumption optimization contexts: minimization of total operating cost, minimization of emission and collaborative mechanisms between port operators and shipping companies, this paper presents a critical and timely literature review on mathematical solution methods for bunker consumption optimization problems. Several novel bunker consumption optimization methods are subsequently proposed. The applicability, optimality, and efficiency of the existing and newly proposed methods are also analyzed. This paper provides technical guidelines and insights for researchers and practitioners dealing with the bunker consumption issues.

8. Shuaian Wang, (2014), A novel hybrid-link-based container routing model. *Transportation Research Part E: Logistics and Transportation Review*, Vol 61, 165–175.

Abstract:

Container routing determines how to transport containers from their origins to their destinations in a liner shipping network. Container routing needs to be solved a number of times as a sub-problem in tactical-level decision planning of liner shipping operations. Container routing is similar to the multi-commodity flow problem. This research proposes a novel hybrid-link-based model that nests the existing origin-link-based and destination-link-based models as special cases. Moreover, the hybrid-link-based model is at least as compact as the origin-to-destination-link-based, origin-link-based and destination-link-based models in the literature.

CMS Research Seminars

1. Intermodal Hub-and-Spoke Network Design under Nested Logit Route Choice Model, by Researcher Dr Wang Xinchang (Track Leader: A/Prof Meng Qiang)

Seminar Abstract:

This talk is about an ongoing work on hub-and-spoke network design for intermodal freight transportations. A mathematical program with equilibrium constraints (MPEC) model is developed for this particularly concerned problem. This model uses a fixed-point formulation as constraints to reflect the SUE-based route choice of intermodal operators given a network design decision of the network planner. Two solution approaches are used to solve the relaxed version of the MPEC model. The possibility of using a global optimization algorithm is also discussed.

2. Transportation Infrastructure Design Considerations for an Underground Container Yard Facility , by Researcher Dr. Farhan Javed (Track Leader: Dr Raymond Ong)

Seminar Abstract:

Owing to the increasing rate of containerization of world's general cargo, distribution patterns have evolved into a hub and spoke network. Container terminals across the globe are handling local as well as transshipment container traffic, and the trend is accelerating as larger container ships come into service and the advantages of hub and spoke operations become more apparent. Almost 20% of the world's current international container port traffic constitutes empty containers based on a study by Drewry Shipping. The dwell time of empty containers is usually longer as compared to laden, and therefore it is operationally advantageous to store them underground right beneath a container terminal. Moreover, an underground container storage system may also significantly increase the storage capacity of the container terminal. Nevertheless, one of the key requirements of efficient underground container storage is an adequate transportation scheme for containers. This presentation highlights major considerations involved in the design of vertical and horizontal transportation system for empty containers.

3. Containership Routing and Scheduling in Liner Shipping: An Overview, by Researcher Dr Wang Shuaian (Track Leader: A/Prof Meng Qiang)

Seminar Abstract:

This presentation reviews studies from the past 30 years that use operations research methods to tackle containership routing and scheduling problems at the strategic, tactical and operational planning levels. These problems are first classified and summarized, with a focus on model formulations, assumptions, and algorithm design. The presentation then gives an overview of studies on containership fleet size and mix, alliance strategy, and network design (at the strategic level), frequency determination, fleet deployment, speed optimization, and schedule design (at the tactical level), and container booking and routing, and ship rescheduling (at the operational level). Research on containership routing and scheduling lags behind practice, especially in the face of the fast growth of the container shipping industry and the advancement of operations research and computer technology. The purpose of this presentation is to stimulate more practically-relevant research in this emerging area.

CMS Research Seminars

4. An Analysis of P3 Alliance , by Researcher Ms Song Chunxue (Track Leader: A/Prof Anthony Chin)

Seminar Abstract:

The controversial giant P3 Alliance (consisting of top 3 container shipping lines of the world: Maersk, MSC& CMA CGM) is under muster of concerned parties. Once it gets approval, there will appear a new layout of the shipping world. This presentation will give a simple analysis of P3 Alliance in three aspects: 1. How the P3 network stack up? 2. Which archetypes of liner shipping alliance does P3 tend to be? 3. How will P3 Alliance affect industry?

5. Micro-simulation Model Extension for Car Clearance in Old Woodlands Checkpoint, by Researcher Mr Yang Jiasheng (Track Leader: Prof Fwa)

Seminar Abstract:

Land border crossing between Singapore and Malaysia are known to experience severe imbalance of travel demand and capacity of processors. Especially, in peak travel periods, this is already the case at high traffic area. The land border crossing authorities have to address problems of congestion and national security in the operation of existing systems and further to address these problems as one part of infrastructure extension plans. In this topic, in order to understand the characteristics of traffic processing time and delay at the expanded crossing area, the traffic micro-simulation model has been extended to model and analyze the expanded car processors of Woodland Checkpoint System under different scenarios of travel demand and customs processing times. The comparison between simulation and measure clearly illustrates the effectiveness of the extended traffic micro-simulation model for the estimation of traffic delay at the expanded crossing area.

6. Spatial Analysis of Maritime Accidents Using Geographic Information System, by Visiting Researcher Mr. Huang Daozheng (Track Leader: A/Prof Meng Qiang)

Seminar Abstract:

Despite the tremendous efforts of different maritime organizations to achieve a safe and secure maritime transportation system, the losses of maritime accidents and incidents are still increasing. This paper analyzes the spatial distribution of maritime accidents occurring from January 1, 2002 to December 31, 2011 based on the Marine Casualties and Incidents module in Global Integrated Shipping Information System (GISIS). Geographic Information System (GIS), an effective and efficient tool for spatial analysis with high visualization, is used to carry out the analysis. Hot spot analysis of maritime accidents identifies the hot spots areas and buffer analysis is used to calculate accidents that occurred in coastal areas. Finally, the following two important results are obtained from the analysis. Firstly, hot spots are identified. The area around the UK is the area with the greatest number of accidents, and the coastal areas around East Asian countries (such as China, Japan, and Korea) and the Mediterranean Sea are the areas with the next highest number of accidents. These results compare well with a previously published paper. Secondly, maritime accidents may not frequently occur in the open sea; however, accidents frequently happen in coastal areas with 51.1% of the total accidents happening within 25 miles of the continents and 62.2% within 50 miles.

CMS Research Seminars

7. A Brief Introduction to Simplicial Complexes, by Researcher Dr Chen Weidong (Track Leader: A/Prof Stephane Bressan)

Seminar Abstract:

In mathematics, a simplicial complex is a topological space of a certain kind, constructed by "gluing together" points, line segments, triangles, and their n-dimensional counterparts. This talk will give a brief introduction on simplicial complexes and its application on complex network.

8. Park-and-Ride Network Equilibrium with Heterogeneous Commuters and Parking Space Constraint, by Researcher Dr Wang Hua (Track Leader: A/Prof Meng Qiang)

Seminar Abstract:

This paper first develops the dynamic user equilibrium (DUE) model of heterogeneous commuters' travel choice behaviors including departure time and path/travel mode choices in a schematic park-and-ride (P&R) network. Commuters have three transportation modes - private car, rail transit and the combination of private car and rail transit (i.e., intermodal transportation mode) to choose in a peak period. Two types of DUE patterns are derived with or without the parking space constraint. In this study, an optimal P&R parking fee scheme is proposed, where commuters' travel choice behaviors are characterized by the developed tri-modal multi-class DUE model. The optimal P&R parking fee scheme is formulated as a bi-level program in which the upper level problem is to find the optimal parking fee of improving network performance, and the lower level problem is to evaluate the network performance in equilibrium. In view of the fact that the DUE solution may not be unique, we aim to improve the network performance in the worst and the best cases. Through numerical tests, it is demonstrated that parking space constraint has a significant influence on the departure and route choices of commuters, and it should be considered as an important factor in the P&R commuting pattern analysis and the parking fee management in order to avoid misleading decision.

9. Matheuristics: Combining the Strength of Both (integer) Linear Programming Techniques and Heuristics, By Dr Du Yuquan (Track Leader: A/Prof Meng Qiang)

Seminar Abstract:

This talk closely focuses on the optimization algorithm design in combinatorial optimization problems, which are often encountered in the field of transportation. As we know, for a long time, heuristics and mathematical programming based methods are considered as conflicting ones and used separately. However, this talk will introduce several ways to combine the strength of mathematical programming and (meta)heuristics, including (a) relaxation for guiding metaheuristic search, (b) exact methods to exploit the neighborhoods of metaheuristics, (c) solution merging, and (d) integrating the relaxation techniques and metaheuristics into the customized B&B tree.

CMS Research Seminars

10. Boundary Estimation of Probabilistic Port Hinterland for Intermodal Freight Transportation Operations, By Dr Wang Xinchang (Track Leader: A/Prof Meng Qiang)

Seminar Abstract:

This talk is about the estimation of probabilistic port hinterland for intermodal freight transportation. We first give a definition of the probabilistic hinterland of a port. By assuming that the disutilities of all intermodal routes are Gaussian distributed, a mathematical model is then developed to represent the port hinterland. A Monte Carlo sampling algorithm is proposed to graphically determine the probabilistic port hinterland boundaries. A numerical example is finally provided to demonstrate our approach.

11. Technical and Operational Energy Efficiency Measures for Ships - An Introduction, By Ms Sou Weng Sut, Maggie (Track Leader: Dr Raymond Ong)

Seminar Abstract:

International shipping is a significant contributor to Global Greenhouse Gas (GHG) emissions. The International Maritime Organization (IMO) is currently working to establish GHG regulations for international shipping. In order to minimize GHG emissions, various energy efficiency measures have been proposed recently. In this presentation, an introductory study on different state-to-the-art technical and operational energy efficiency measures will be delivered.

12. Modeling Pedestrian Traffic Delays at an International Border Crossing, by Researcher Dr Farhan Javed (Track Leader: Dr Raymond Ong)

Seminar Abstract:

Border crossings are important to international trade and tourism. However, pedestrian traffic operations at these crossings can be made more efficient has been a concern to the agencies running the immigration operations. Very little, however, is known about the characteristics of pedestrian-processing time and delay at these crossings. This lack of understanding makes it difficult to evaluate the potential impact of changes in operating policies and physical plants. To alleviate this problem, this presentation details the processing time characteristics at a border crossing and proposes a delay model for planning applications.

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