



IJIE 2004 Program Overview

	Time	Room		
		Session A 403.402	Session B 403.403	Session C 403.404
Saturday 27 November 2004	7:00 – 8:00 p.m.	Registration (<i>Engineering Atrium</i>)		
	7:00 – 9:00 p.m.	South Pacific Wine & Cheese Reception (<i>Engineering Atrium</i>)		
Sunday 28 November 2004	Opens at 8:00 a.m.	Registration (<i>Engineering Atrium</i>)		
	8:00 – 8:50 a.m.	Breakfast (<i>Engineering Atrium</i>)		
	8:50 – 9:00 a.m.	Welcome (401.439)		
	9:00 – 10:00 a.m.	Plenary Session I (401.439) Professor Andrés Weintraub		
	10:00 – 10:30 a.m.	Morning Tea (<i>Engineering Atrium</i>)		
	10:30 – 12:00 p.m.	Session A1	Session B2	Session C3
	12:00 – 1:00 p.m.	Lunch (<i>Engineering Atrium</i>)		
	1:00 – 2:30 p.m.	Session A4	Session B5	Session C6
	2:30 – 3:00 p.m.	Afternoon Tea (<i>Engineering Atrium</i>)		
	3:00 – 4:30 p.m.	Session A7	Session B8	Session C9
	4:30 – 5:30 p.m.	IJIE Editorial Board Meeting (401.401)		
	6:30 – 7:00 p.m.	Board Banquet Cruise Ship - Fuller's QuickCat II (30 minute walk to <i>Ferry Building, Quay Street</i>)		
	7:00 – 9:30 p.m.	Conference Banquet Cruise (<i>Waitemata Harbour</i>)		
	Monday 29 November 2004	Opens at 8:00 a.m.	Registration (<i>Engineering Atrium</i>)	
8:00 – 8:50 a.m.		Breakfast (<i>Engineering Atrium</i>)		
8:50 – 10:20 a.m.		Session A10	Session B11	Session C12
10:20 – 10:50 a.m.		Morning Tea (<i>Engineering Atrium</i>)		
10:50 – 11:00 a.m.		IJIE Announcements & Invitation (401.439)		
11:00 – 12:00 p.m.		Plenary Session II (401.439) Professor Oli Madsen		
12:00 – 1:00 p.m.		Lunch (<i>Engineering Atrium</i>)		
1:00 – 2:30 p.m.		Session A13	Session B14	Session C15
2:30 – 3:00 p.m.		Afternoon Tea (<i>Engineering Atrium</i>)		
4:00 p.m. – 6:00 p.m.		IJIE Lion Red Brewery Tour (380 <i>Khyber Pass, Newmarket</i>)		
Tuesday 30 November 2004		Day Tours Auckland, Bay of Islands, & Rotorua (Help with Bookings is available at the Registration Desk on Sunday and Monday)		



ORSNZ Program Overview

	Time	Room	
		Session A 401.439	Session B 403.401
Saturday 27-Nov-04	7:00 – 8:00 p.m.	Registration (Engineering Atrium)	
	7:00 – 9:00 p.m.	South Pacific Wine & Cheese Reception (Engineering Atrium)	
Sunday 28-Nov-04	Opens at 8:00 a.m.	Registration (Engineering Atrium)	
	8:00 – 8:50 a.m.	Breakfast (Engineering Atrium)	
	8:50 – 9:00 a.m.	Welcome (401.439)	
	9:00 – 10:00 a.m.	Plenary Session I (401.439) Professor Andrés Weintraub	
	10:00 – 10:30 a.m.	Morning Tea (Engineering Atrium)	
	10:30 – 12:00 p.m.	ORSNZ Session 1A	ORSNZ Session 1B
	12:00 – 1:00 p.m.	Lunch (Engineering Atrium)	
	1:00 – 2:30 p.m.	ORSNZ Young Practitioner Prize Session	
	2:30 – 3:00 p.m.	Afternoon Tea (Engineering Atrium)	
	3:00 – 4:10 p.m.	ORSNZ Young Practitioner Prize Session	
	4:10 – 6:00 p.m.	ORSNZ AGM (401.439) ORSNZ Council Meeting (401.439)	
	6:30 – 7:00 p.m.	Board Banquet Cruise Ship - Fuller's QuickCat II (30 minute walk to Ferry Building, Quay Street)	
	7:00 – 9:30 p.m.	Conference Banquet Cruise (Waitemata Harbour)	
Monday 29-Nov-04	Opens at 8:00 a.m.	Registration (Engineering Atrium)	
	8:00 – 8:50 a.m.	Breakfast (Engineering Atrium)	
	8:50 a.m.	IJIE Sessions Start	
	9:10 – 10:20 a.m.	ORSNZ Session 2A	ORSNZ Session 2B
	10:20 – 10:50 a.m.	Morning Tea (Engineering Atrium)	
	10:50 – 11:00 a.m.	IJIE Announcements & Invitation (401.439) ORSNZ Young Practitioner Prize Presentations	
	11:00 – 12:00 p.m.	Plenary Session II (401.439) Professor Oli Madsen	
	12:00 – 1:00 p.m.	Lunch (Engineering Atrium)	
	1:00 – 2:30 p.m.	ORSNZ Session 3A	ORSNZ Session 3B
	2:30 – 3:00 p.m.	Afternoon Tea (Engineering Atrium)	
3:00 – 4:30 p.m.	ORSNZ Session 4A	ORSNZ Session 4B	

The ORSNZ Conference organisers gratefully acknowledge sponsorship from

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Conference Program

Saturday, 27 November 2004



Registration

SOUTH PACIFIC WINE & CHEESE RECEPTION

Engineering Atrium

7:00 p.m. to 8:00 p.m.

7:00 p.m. to 9:00 p.m.

Sunday, 28 November 2004



Registration

Breakfast

Engineering Atrium

8:00 a.m. to 4:00 p.m.

8:00 a.m. to 8:50 a.m.



PLENARY SESSION I

Welcome

Plenary Speaker: Professor Andrés Weintraub

Department of Industrial Engineering
University of Chile

Plenary Title:

Open Challenges in Forest Modeling and Algorithms: Applications
and Methodology

Abstract:

See Page 18 for abstract

Engineering 401.439

8:50 a.m. to 9:00 a.m.

9:00 a.m. to 10:00 a.m.

Morning Tea

Engineering Atrium

10:00 a.m. to 10:30 a.m.



A1: Service Quality & Behaviors

Sun 10:30 a.m. to 12:00 p.m.

Chair: K. H. Chai

Engineering 403.402

- 1) *A Systematic Approach to Meeting Consumers' Kansei Needs*
Z-Y. Chen, K-C. Tan, and K-H. Chai
- 2) *On The Measurement and Analysis of Service Quality in Web-Based Information Systems*
K. C. Tan, Y. Li, and M. Xie
- 3) *Production's Short-Sighted Behaviors and their Impacts on Manufacturing Engineering*
L. Quang
- 4) *Integrating Product and Service Qualities for Total Customer Satisfaction – A Preliminary Framework*
R. Yu, C. K. Hin, and T. K. Chuan



B2: Manufacturing I

Sun 10:30 a.m. to 12:00 p.m.

Co-Chairs: J. S. Kwah & S. C. Oh

Engineering 403.403

- 1) *Improvement of Geometric Error in Surface Grinding Process using Taguchi and Response Surface Methodologies*
J-S. Kwak and L-Z .Chi
- 2) *Development of an Automatic Dimensioning and Tolerancing System in Process Planning*
S.C. Oh
- 3) *Optimization of Oil Seal Component Formulation using Parameter Design*
C-H. Wang and Y. Hsu



C3: Clustering & Routing

Sun 10:30 a.m. to 12:00 p.m.

Chair: **D. L. Wei**

Engineering 403.404

- 1) *Ant Colony Optimization for Location Routing Problems*
D. L. Wei
- 2) *Formation of Standardizable Module Clusters*
T. Dhananjay and V. Allada
- 3) *Application of Ant Colony System for Clustering Analysis*
R.J. Kuo, H.S. Wang, T-L Hu, and S.H. Chou
- 4) *Empirical Analysis for the Multidimensional Knapsack Heuristics based on the Various Correlation Structure*
Y. K. Cho, J. T. Moore, and R. R. Hill



1A: Risk & Uncertainty

Sun 10:30 a.m. to 12:00 p.m.

Chair: **Kevin Wood**

Engineering 401.439

- 1) *The BEST Algorithm for Stochastic Mixed-Integer Programs: Bootstrapping to Make It Better*
Susan M. Sanchez, R. Kevin Wood
- 2) *A Measure of the Variability of Revenue to an Auctioneer: A Look at the Revenue Equivalence Theorem.*
Fernando Beltrán, Natalia Santamaría
- 3) *Fuzzy Reasoning and Optimization Based on a Generalized Bayesian Network*
Han-Ying Kao
- 4) *Applications of fractals to weather and electricity hedging decisions*
Michael Lauren



1B: Applications

Sun 10:30 a.m. to 12:00 p.m.

Chair: **Golbon Zakeri**

Engineering 403.401

- 1) *Paradigm Shift in Manufacturing Operation Through Implementation of Intelligent Dispatching*
MA Chik, Ibrahim Ahmad, Mohd Yusoff Jamaludin
- 2) *Stochastic Economic Balance Principles for Project Planning: Feeding Buffers, Crashing, and Sequencing*
Dan Trietsch
- 3) *Matlab splines utilized from GAMS*
Michael Ferris and Golbon Zakeri
- 4) *The Impact of JIT Replenishment and Road Traffic Congestion on Distribution Costs*
Lincoln Wood and Jay Sankaran

Lunch

Engineering Atrium

12:00 p.m. to 1:00 p.m.



A4: Complex Processes & Fuzzy Reliability

Sun 1:00 p.m. to 2:30 p.m.

Chair: **M. Kempf**

Engineering 403.402

- 1) *Quality Prediction in Complex Product Development Processes*
M. Kempf
- 2) *On Adaptive Risk Assessment in Complex Large Scale Processes with Reduced Computational Complexities*
W. Galia
- 3) *A Fuzzy Reliability Analysis by Transforming a Triangular Fuzzy Strength to a Random Strength*
D. Yuge, N. Zheng, and C. Wang
- 4) *Fuzzy Reliability Analysis using Interference Area Method*
R. Yu, K. H. Chai, D. Yuge, N. Zheng, and C. Wang



B5: Manufacturing II

Sun 1:00 p.m. to 2:30 p.m.

Chair: F. C. Tien

Engineering 403.403

- 1) *Development of a Defect Inspection System for Color Filter Panel*
Y-M. Chiang
- 2) *Using Asynchronous Hopfield Neural Network for Stereo Matching*
M.-L. Liu and F-C. Tien
- 3) *Modeling and Simulation of Brake Hoses to Avoid Interference During Operation of Vehicle*
J. Rodriguez, M. Keil, J. Thomas, and M. Hemmye
- 4) *Testing for Thermal Distortion of Chemically-Bonded Sands for Better Dimensional Control*
J. Rodriguez, S. Ramrattan, A. Choudhury, and M. Keil



C6: Genetic Algorithms

Sun 1:00 p.m. to 2:30 p.m.

Chair: L. Tiacci

Engineering 403.404

- 1) *A Resource Allocation Method using Genetic Algorithm and Simulation*
B.K. Moon and K.K. Cho
- 2) *Applying the Value Engineering and Genetic Algorithm to Assess the Product-Part-Changes*
H-S. Wang and Z-H. Che
- 3) *A Genetic Algorithm for Balancing Mixed-Model Assembly Lines with Parallel Workstations*
L. Tiacci, S. Sietta, and A. Martini
- 4) *Comparison of a Genetic Algorithm and a Simulated Annealing Approach for the Mixed-Model Assembly Line Balancing Problem*
L. Tiacci, S. Sietta, and A. Martini

 **YPP: Young Practitioner Prize**

Sun 1:00 p.m. to 2:30 p.m.

Chair: **Andrew Mason**

Engineering 401.439



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Optimal Decision Technologies, www.optimal-decision.com*



- 1) *Fishing Trawler Scheduling for Integrated Fisheries*
Mohammad Babul Hasan
- 2) *Locomotive Allocation for Toll NZ*
Sanjay Patel
- 3) *Column Generation for Capacity-Expansion Planning of Electricity Distribution Networks*
Kavinesh Singh
- 4) *Improved Column Generation for the Air New Zealand Tours-of-Duty Problem*
Martin Young

Afternoon Tea

Engineering Atrium

2:30 p.m. to 3:00 p.m.

 **A7: Repairable & Complex Systems**

Sun 3:00 p.m. to 4:30 p.m.

Chair: **R. Guo**

Engineering 403.402

- 1) *A Virtual State Analysis of Repairable System via Fuzzy Logical Functions*
R. Guo and C.E. Love
- 2) *Fuzzy System Age Analysis of Repairable System via Interval-Valued Fuzzy Set Approach*
R. Guo
- 3) *Interval Estimation for the Imperfectly Maintained System with Age Reduction*
C-Y. Cheng
- 4) *The Modeling of Imperfect Preventive Maintenance with Degradation*
C-Y. Cheng



B8: Quality

Sun 3:00 p.m. to 4:30 p.m.

Chair: D. L. Santos

Engineering 403.403

- 1) *A Neural Network Approach for Developing Shorter and Non-Biased Intervals for Process Capability Index Estimators*
D. L. Santos
- 2) *The Inspection Criteria for Variable Control Charts for Out of Control Period*
S. Komolavanij
- 3) *The Experimental Design Application For Quality Improvement on a Filling and Packaging Seal Process of a Fruit Sauce Production*
C. Vongpisal, S. Jongprasithporn, N. Sabua, and J. Tipmontian
- 4) *A Quality Passport System for I.C. Engine Assembly Lines Using a Six-Sigma Approach*
A. Surve, D.L. Santos, and K.M. Henry



C9: Human Factors I

Sun 3:00 p.m. to 4:30 p.m.

Chair: H. S. Jung

Engineering 403.404

- 1) *Risk Factors Influencing Project Success in Thai Construction Projects: An Exploratory Study*
Y. Pruksachat
- 2) *Integration of Design and Analysis Systems Considering Easy-to-Use*
H.S. Jung, W.S. Cho, and K.K. Cho
- 3) *The Comprehensibility of Traffic Signs: A Review*
A. W.Y. Ng and A. H.S. Chan
- 4) *Musculoskeletal Disorders in Korea: Present Situation and Prospect*
C-H. Kim, D-C. Lee

 **YPP: Young Practitioner Prize**

Sun 3:00 p.m. to 4:10 p.m.

Chair: Andy Philpott

Engineering 401.439



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Optimal Decision Technologies, www.optimal-decision.com*



- 1) *Determining Knot Points For Spline Regression Models*
Matthew Gordon
- 2) *Optimal Core-Edge Storage Area Network Design*
Timothy Thompson
- 3) *Better Base Locations for the Melbourne Ambulance Service*
Sarah Kirkpatrick



**ORSNZ AGM
ORSNZ Council Meeting**

Engineering 401.439

4:10 p.m. to 6:00 p.m.



IJIE Editorial Board Meeting

Engineering 401.401

4:30 p.m. to 5:30 p.m.



CONFERENCE BANQUET

Ferry Building, Quay Street

Board Cruise Ship (Fuller's QuickCat II)

6:30 p.m. to 7:00 p.m.

Please make your own way down to the Fullers Ferry Terminal, Quay St, where you can board the Fullers QuickCat II ferry for the dinner cruise. The Ferry Terminal is a 30 minute walk from Engineering. Please wear your name tag badge on the boat.

Waitemata Harbour Cruise

7:00 p.m. to 9:30 p.m.

Monday, 29 November 2004



Registration (Engineering Atrium)

Breakfast

Engineering Atrium

8:00 a.m. to 4:00 p.m.

8:00 a.m. to 8:50 a.m.

 **A10: Manufacturing III**

Mon 8:50 a.m. to 10:20 a.m.

Chair: Y-D. Jeong

Engineering 403.402

- 1) *Analysis of Filling Imbalances Factor in Multi-Cavity Injection Mold using Taguchi Method*
C. M. Kang and Y-D. Jeong
- 2) *Study on Thin Plate Injection Molding Process for Mg Alloy*
T. H Kang, I. K. Kim, and Y. S. Kim
- 3) *Recent Research on High Speed Cutting and Micro-Grinding for Making Fine Mold Surface*
Y. M. Hwang, H. M. Park, and M. K Ha

 **B11: Scheduling & Loading**

Mon 8:50 a.m. to 10:20 a.m.

Chair: C. Wu

Engineering 403.403

- 1) *A Combination of Volume Utilization and Weight Distribution in 3-Dimensional Container Loading*
S. Pokharel, W. L. Lee, and L. W. Dong
- 2) *A Data Mining Based Approach to Solve the Order Batching Problem*
C. Wu
- 3) *Hybrid Procedure for the Workforce Scheduling Problem with Variable Energy Capacities*
Y. Kriangchai and S. Nanthavanij
- 4) *A Novel Approach to Find the Minimum Number of Warehouses with the Product Compatibility Constraint*
C. Wu



C12: Stochastic Systems

Mon 8:50 a.m. to 10:20 a.m.

Chair: **T. Arthanari**

Engineering 403.404

- 1) *A Graphical Method for the Pursuit of Optimal or Near-Optimal Stochastic Balance*
T. Arthanari and D. Trietsch
- 2) *Application of Queuing Theory to the Aircraft In-Flight Service – A Simulation Approach*
H.P. Chiu and S.R. Cheng
- 3) *Applying Data Warehouse and On-Line Analytic Processing Techniques on Human Resource Management*
L.C. Huang and L.F. Kuo



2A: Routing

Mon 9:10 a.m. to 10:20 a.m.

Chair: **John F. Raffensperger**

Engineering 401.439

- 1) *Application of Column Splitting to the Travelling Salesman Problem.*
John F. Raffensperger
- 2) *Maritime Patrol Modelling and Planning*
David Galligan
- 3) *Stochastic Optimization: Rowing to Barbados*
Geoff Leyland and Andy Philpott



2B: Forestry & Agriculture

Mon 9:10 a.m. to 10:20 a.m.

Chair: **Alastair McNaughton**

Engineering 403.401

- 1) *Recent Progress on the Area Restriction Problem of Forest Harvesting*
Alastair McNaughton
- 2) *Yield Frontier Analysis of Forest Inventory*
Stuart Mitchell and K. Kim
- 3) *Hay Harvesting Operations Scheduling Subject to Probabilistic Activity Duration and Machine Failure*
L R Foulds

Morning Tea

Engineering Atrium

10:20 a.m. to 10:50 a.m.



Engineering 401.439

PLENARY SESSION II

**IJIE Announcements & 2005 Invitation
ORSNZ Young Practitioner Prize Ceremony**

10:50 a.m. to 11:00 a.m.

Plenary Speaker: Professor Oli Madsen
Director of the Centre for Traffic and Transport
Technical University of Denmark

11:00 a.m. to 12:00 p.m.

Plenary Title: The Vehicle Routing Problem with Time Windows - Survey and Recent Developments

Abstract: See Page 18 for abstract

Lunch

Engineering Atrium

12:00 p.m. to 1:00 p.m.

 **A13: Manufacturing Systems &
Product Networks**

Mon 1:00 p.m. to 2:30 p.m.

Chair: V. Allada

Engineering 403.402

- 1) *Power Law Distribution in Product Networks*
A. Sankaran and V. Allada
- 2) *Characterization of the Manufacturing Strategies of Several Industries in Juarez, Mexico*
S. A. Noriega and F. J. Lopez
- 3) *Deploying a Data Warehouse of Manufacturing Execution Systems*
K. Y. Chen



B14: Process Modeling & Planning

Mon 1:00 p.m. to 2:30 p.m.

Chair: J. Jiao

Engineering 403.403

- 1) *Two-Stage Model for Flow-Shop Production Planning with Different Machines*
H. S. Wang, Z. H. Cheb, and Y. J. Sha
- 2) *Modeling Process Variety using Colored Object-Oriented Petri-Nets with Changeable Structures*
K. Prasanna, L. Zhang, and J. Jiao
- 3) *Multiple Optimization of a Flexible Manufacturing System using a Multivariate Quadratic Loss Function*
T. A. Wa-Muzemba



**C15: Enterprise & Economic
Evaluation Tools**

Mon 1:00 p.m. to 2:30 p.m.

Chair: D. Ben-Arieh

Engineering 403.404

- 1) *Visualized Accounting by using Excel VBA Programs*
K. Okazaki
- 2) *Development of the Cost Evaluation System for Governmental Database Construction Projects*
S. Yongwon, H. O. Lee, S. J. Kim, and S. W. Hwang
- 3) *Modeling a Virtual Manufacturing Enterprise*
D. Ben-Arieh and K. Grabill



3A: Scheduling

Mon 1:00 p.m. to 2:30 p.m.

Chair: **Andrew Mason**

Engineering 401.439

- 1) *Solution of the Airline ToD Problem using Severely Limited Subsequence*
James Priestley
- 2) *Multi-Criteria Methods for Unit Crewing in the Airline Tour-of-Duty Planning Problem*
Bassy Tam
- 3) *Elastic Constraint Branching, the Wedelin Lagrangian Heuristic and Staff Scheduling*
Andrew Mason
- 4) *Solving the Classroom Assignment Problem Using Integer Programming*
H. Waterer and D.M. Ryan



3B: Truth, Lies and Influence

Mon 1:00 p.m. to 2:30 p.m.

Chair: **Jim Sheffield**

Engineering 403.401

- 1) *Cooking the Evidence - A Recipe for Discursive Truth*
Jim Sheffield
- 2) *Eating Your Own Cooking - Evaluating Discursive Truth*
Jim Sheffield
- 3) *Academic Plagiarism: An Analysis of Current Technological Issues*
Conor J. Mills and John Paynter
- 4) *Influence Diagrams: A Rough Set Approach*
Chia-Hui Huang and Han-Lin Li

Afternoon Tea

Engineering Atrium

2:30 p.m. to 3:00 p.m.

 **4A: Multiple Objectives & Location**

Mon 3:00 p.m. to 4:30 p.m.

Chair: **Matthias Ehrgott**

Engineering 401.439

- 1) *Connecting Efficient Knapsacks: Experiments with the Equally-Weighted Bi-Criteria Knapsack Problem*
Cameron Walker and Michael O'Sullivan
- 2) *A Decision Support System for Radiation Therapy Treatment Planning*
Ines Winz
- 3) *Solving a Large-scale Dynamic Facility Location Problem with Variable Neighbourhood and Token Ring Search*
R. Velasquez and M. T. Melo
- 4) *A Heuristic for the Discrete Biobjective p-Median Location Problem*
Matthias Ehrgott and Bassy Tam

 **4B: Electricity**

Mon 3:00 p.m. to 4:30 p.m.

Chair: **Andy Philpott**

Engineering 403.401

- 1) *A Theoretical Framework for Zonal Electricity Markets*
E. Grant Read and Deb Chattopadhyay
- 2) *Pricing Implications of Security Constrained Dispatch*
Bhujanga B Chakrabarti and E Grant Read
- 3) *HERO (Hydro-Electric Reservoir Optimization)*
G. Pritchard, G. Zakeri and A. Philpott
- 4) *Single-Unit Commitment Problems in Electricity Pool Markets*
Andy Philpott



380 Khyber Pass, Newmarket, Auckland

IJIE LION RED BREWERY TOUR

Board Transport Vehicles **4:00 p.m. to 4:05 p.m.**

Meet in front of the Engineering Building on Symonds Street

Tour **4:15 p.m. to 5:45 p.m.**

Return to Engineering Building **6:00 p.m.**

Organized portion of IJIE conference adjourns @ 6:00 p.m.

PLENARY SESSION I

Plenary Speaker: **Professor Andrés Weintraub**

Professor of Industrial Engineering
Department of Industrial Engineering
The University of Chile

Plenary Title: Open Challenges in Forest Modeling and Algorithms: Applications and Methodology

Plenary Abstract:

The use of Operations Research in forest decision making has been very successful for several decades. From strategic decisions to detailed short term operations in harvesting and transportation, applications have been used in many countries. Recently spatial problems derived from environmental considerations have attracted attention, leading to hard combinatorial problems. Other areas of problems come from uncertainty considerations, in particular prices and consideration of fires and other disturbances. The integration of the forest supply chain is also becoming a topic of interest. In general, the methodologies used concentrate on Linear Programming (LP), Mixed Integer LP, Heuristics, Metaheuristics and Simulation. In this talk we discuss what has been accomplished in these areas, but mostly focus on open problems which have not been solved yet. The challenges are in how to model reality realistically and in solution algorithms to solve difficult problems.

PLENARY SESSION II

Plenary Speaker: **Professor Oli Madsen**

Director of the Centre for Traffic and Transport
Technical University of Denmark

Plenary Title: The Vehicle Routing Problem with Time Windows - Survey and Recent Developments

Plenary Abstract:

This paper surveys some recent solution methods and results in connection with the vehicle routing problem with time windows (VRPTW). The VRPTW is an extension of the classical capacity constrained vehicle routing problem. In the VRPTW the service at each customer must start within an associated time window. We assume that the time window is hard, i.e. if a vehicle arrives too early, the vehicle must wait until the time window opens, and it is not allowed to arrive late. In the case of soft time windows these can be violated, but then a penalty is imposed. The VRPTW appears in many real life situations, for example deliveries to supermarkets, bank and postal deliveries, industrial refuse collection, school bus routing, security patrol service, and urban newspaper distribution.

Approximate methods such as metaheuristics will be mentioned but focus will be on exact methods such as decomposition, Lagrangean relaxation, and Branch and Cut. The computational results will be based on the Solomon test problems and the extended Solomon test problems with problem sizes up to 1000 customers.