The Sixteenth Triennial Conference of the

International Federation of Operational Research Societies

Conference theme:

OR in a globalised, networked world economy

FINAL PROGRAMME

8-12 July 2002

University of Edinburgh

in the centre of Edinburgh

Capital of Scotland

Hosted by the UK Operational Research Society

WELCOME MESSAGE FROM IFORS PRESIDENT

You are warmly and sincerely welcomed to IFORS 2002, the Sixteenth Triennial Conference of the International Federation of the Operational Research Societies, that will be held in Edinburgh, capital of Scotland, from July 8 to July 12, 2002. The conference is hosted by the UK Operational Research Society.

Operational Research as a scientific and professional field has been adapting itself to an evolving world since it was born more than sixty years ago. Because of its intrinsic interdisciplinary nature, ability to tackle real world situations and capacity to support complex decision making processes, OR can provide effective tools for modelling and solving these issues. Indeed, operational researchers can propose structural models of the problem, techniques for the analysis of alternative solutions and methods of validation, implementation and evaluation of the chosen solution. By considering the Conference Theme, i.e., *OR in a globalised, networked world economy*, it is essential that OR carries on a continuous process of updating and growth.

IFORS 2002 will be more than a standard Scientific Conference, as it will also provide many opportunities for practitioners and OR users to exchange ideas and experiences. There will be a lot of opportunities to meet old friends, to establish new contacts, to learn from others.

The Program and Organizing Committees, chaired by Ben Lev and Lyn Thomas, respectively, have arranged exceptional scientific and social activities. I am sure that you will enjoy a lot IFORS 2002. Together with our kind British hosts, I welcome you to Edinburgh.

Paolo Toth, IFORS President

WELCOME MESSAGE FROM THE PROGRAM COMMITTEE CHAIR

On behalf of the IFORS 2002 Program Committee, welcome to ***The Sixteenth Triennial Conference of the International Federation of Operational Research Societies***. The Program committee worked for four years to organize the best possible intellectually stimulating meeting. It is an opportunity to renew old friendships and make new friends, exchange ideas and enhance knowledge.

This is a milestone for IFORS as we close the first Fifty Years of Conferences and start the first conference in the new millennium. The theme of the conference, ***OR in a globalised, networked world economy***, suggested by Costas P. Pappis and approved by the program committee, reflects the role of the various OR disciplines in the world economy.

The Program Committee consists of a diverse group – 25 members from 19 countries and all five continents. This is the first IFORS conference planned and prepared in Cyber Space. All our business, including abstract submission and communication with authors, was conducted via the web, email and electronic media.

We have an exciting program! Three keynote speakers from three different continents, 44 Streams, 375 sessions, 1,067 papers, and 1,806 authors from 63 countries. This is the largest IFORS meeting ever, with the largest number of papers, authors, and delegates. A CD with the program and name list is distributed for your future reference.

On behalf of the Program Committee, I want to offer our thanks to our colleagues and supporting academic institutions: University of Michigan – Dearborn; University of Edinburgh; and the British OR Society. To the stream chairs, session chairs, speakers and all who made this meeting possible, and those of you who attend the conference – without you it would have been impossible.

We extend our warmest welcome and trust that you will enjoy this memorable and exiting meeting.
Have fun in Edinburgh!

Ben Lev, Program Committee Chair

WELCOME MESSAGE FROM THE ORGANISING COMMITTEE CHAIR

On behalf of the Organising Committee of IFORS 2002, let me welcome you to Edinburgh, the capital of Scotland. The Operational Research Society of the UK was delighted to host the first such international conference in Oxford in 1957 and is similarly delighted to host this, the first conference of the new millennium. Edinburgh has a long tradition of scientific discoveries – Napier, the inventor of logarithms, lived here, and Hutton's question about the strata of Salisbury Crags in Holyrood Park was the birth of geology. It also is renowned for its intellectual curiosity and the names of the buildings housing this conference honour the leaders of the Enlightenment and a Nobel Prize winner. We hope this conference will also involve a successful mix of discovery and curiosity. The Scottish people too are very welcoming and proud to show visitors their capital city and the countryside around. It is not surprising that it was Robbie Burns, the most celebrated Scottish poet, who wrote "Auld Lang Syne," the hymn to long lasting friendship. We are sure you will find such friendship and much to enjoy in Edinburgh, both within and outside the conference.

Lyn Thomas, Organising Committee Chair

IFORS EXECUTIVE COMMITTEE

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Conference Secretariat Chris Barrett, UK

Programme At A Glance

Sunday, July 7, 2002	Registration Euro Executive Meeting IFORS General Meeting Welcome Reception in Teviot Row House	2:00 – 6:45 6:00 – 8:00
Monday, July 8, 2002	MA (Parallel Sessions) Coffee Break MO (Opening Session) MP (Plenary Session) Lunch MC (Parallel Sessions) Coffee Break MD (Parallel Sessions) Bar quiz at The Blind Poet Public House	9:30 – 11:00 11:00 – 11:30 11:30 – 12:00 12:00 – 1:00 1:00 – 2:00 2:00 – 3:30 3:30 – 4:00 4:00 – 5:30 8:30
Tuesday, July 9, 2002	TA (Parallel Sessions) Coffee Break TB (Parallel Sessions) Lunch TC (Parallel Sessions) Coffee Break TD (Parallel Sessions) Scottish Dancing with a Ceilidh band at Teviot Row House, George Square and Neeps, Tatties and Haggis	9:00 – 10:30 10:30 – 11:00 11:00 – 12:30 12:30 – 1:30 1:30 – 3:00 3:00 – 3:30 3:30 – 5:00 8:30 9:30
Wednesday, July 10, 2002	Choice of: leave Appleton Tower Glenturret Distillery - Stirling - Stirling Castle Blair Atholl Distillery - Blair Castle - House of Bruar Falkland Palace - St Andrews - Glamis Castle Lindisfarne - Berwick upon Tweed, or Spittle Beach - Lochcarron Scottish Cashmere Wool Centre	9:00 returning between 6:00 – 6:30
Thursday, July 11, 2002	RA (Parallel Sessions) Coffee Break RB (Parallel Sessions) Lunch RC (Parallel Sessions and OR Society President's Medal) Coffee Break RD (Parallel Sessions) Conference Banquet at Murrayfield, home of Scottish Rugby buses leave from Jury's Inn, George Square and Pollock Halls	9:00 – 10:30 10:30 – 11:00 11:00 – 12:30 12:30 – 1:30 1:30 – 3:00 3:00 – 3:30 3:30 – 5:00 7:00
Friday, July 12, 2002	FA (Parallel Sessions) Coffee Break FB (Parallel Sessions) Lunch FP (Plenary Sessions) FD (Parallel Sessions)	9:00 – 10:30 10:30 – 11:00 11:00 – 12:30 12:30 – 1:30 1:30 – 2:30 2:40 – 4:10

General Information

Location and Registration

The conference registration desks, located in the foyer of the Appleton Tower, Edinburgh University, Crichton Street, Edinburgh will be open during the following times each day to provide information and general assistance to all delegates.

Sunday 7 July	14:00 – 18:45
Monday 8 July	08:00 - 17:30
Tuesday 9 July	08:30 - 17:30
Thursday 11 July	08:30 - 17:30
Friday 12 July	08:30 - 16:00

On registering you will have received a conference bag and materials, including a conference badge, which must be worn to conference events. Registered accompanying persons will also been issued with a badge together with tickets for admission to the entire social programme.

All Tickets, which will have to be shown for the Wednesday excursions and the conference banquet, will be provided at registration.

Accompanying persons

Accompanying persons are invited to all the events of the above Social Programme. For further information or private excursions, contact the Edinburgh Tourist Office near Waverley Station, Tel: 0131 473 3666

Information Desks

Information about *all aspects* of the Conference can be obtained from staff at the Information Desk in the foyer of the Appleton Tower. Clansman Monarch will be present in the Appleton Tower to handle accommodation queries on Sunday, 7 July 14:00 – 18:00 and Monday, 8 July 08:00 – 16:00. Clansman Monarch will also man a 'swap shop' for the social excursions, if required, on Monday 13:00 – 16:00 and Tuesday 08:30 – 13:30.

Messages for Conference Participants and Exhibitors

To receive messages by 'phone and fax please ask your correspondent to use the conference office telephone and fax numbers Tel/Fax: 0131 650 4581. All messages will be posted on a message board located in the Foyer of the Appleton Tower. Please note that neither participants nor exhibitors can be contacted by telephone directly. All faxes must clearly display IFORS2002 and the name of the intended recipient.

Participants wishing to exchange personal messages during IFORS2002 should use the message board in the Appleton Tower.

E-Mail Service

E-mail access is available in the Open Access Computing Lab, Level 5 of the Appleton Tower during the following times:

Monday 8 July	08:30 - 17:00
Tuesday 9 July	08:30 - 17:00
Thursday 11 July	08:30 - 17:00
Friday 12 July	08:30 - 15:00

Lecture Rooms

Opening Plenary	Festival Theatre
Presidents Medal	George Square Lecture Theatre
Final Plenary	George Square Lecture Theatre
Session Rooms	Appleton Tower (AP)
	William Robertson Building (WR)
	David Hume Tower (DH)
	Management School (MS)

Photocopying and Fax Facilities

Should you wish to send a fax or make a photocopy please contact the registration staff who will be delighted to assist you. Small charges will be made for this service as follows:

Photocopying	10p per sheet

Fax - National	50p per sheet
Fax - International	£1.00 per sheet

Programme Changes

An updated daily programme will be available at each of the main Conference buildings and on the Internet.

Notice to Speakers and Chairpersons

All lecture rooms have an overhead projector, data projector and screen. Presenters are expected to bring their own laptop computer; there are **NO** laptops available for presenters on site. The rooms will be kept open for 30 minutes after the final session of each day, and will be available from 09:00 – 09:30 Monday morning, for presenters to check compatibility of their computers with data projectors.

Refreshments and Lunches

Tea/Coffee Breaks
Complimentary tea and coffee will be available during the morning and afternoon breaks at the following venues.

- Appleton Tower Concourse
- David Hume Tower Foyer
- Management School Foyer
- William Robertson Building Foyer

Lunch
Lunch and snacks can be purchased in various rooms in the Teviot Row House from 12:00 – 14:00. There are also two licensed bars.

In addition to these there are a number of restaurants, cafes and pubs within a short walk of the conference venue.

Church Service
A feature of the UK conferences for many years has been a short service of Christian worship. This year, we are all invited to join the regular service at historic Greyfriars Presbyterian Kirk on Thursday from 1.10-

1.30pm. Greyfriars stands near the south end of George IV Bridge, at the junction with Candlemaker Row. The entrance to the Kirkyard is directly opposite the new Museum of Scotland. It is a very short walk from the conference site: cross the street from the McEwan Hall, and at the end of Bristo Street, the Kirk will be opposite, across the street. For information about the church see http://www.greyfriarskirk.com/

Social Programme

Sunday 7 July - Welcome Reception, Teviot Row House conference site18:00 – 20:00. All delegates registered accompanying persons and exhibitors are invited to attend. Wine and soft drinks will be served, giving persons the opportunity to meet colleagues in a convivial atmosphere.

Monday 8 July – Bar Quiz at the Blind Poet Pub, 34 West Nicolson Street from 20:30, see "BP" on the location map.

Tuesday 9 July – Exhibitors will hold a reception from 19:30 – 20:30, entrance by ticket only, at Teviot Row House, conference site.

Scottish Evening, which is open to all delegates, Teviot Row House 20:30. An evening of Scottish Entertainment awaits combining traditional Scottish food and wine with Scottish folk music and ceilidh dancing. During the evening delegates will have the opportunity to sample Scotland's favourite dish – haggis, neaps and tatties – followed by a chance to participate in traditional Scottish country dancing.

Wednesday 10 July – Conference excursions:

Coaches for all excursions leave from outside the Appleton Tower at 09:00 returning at 18:00.

Glenturret Distillery – Stirling – Stirling Castle

This outing combines a VIP guided tour and whisky tasting at Glenturret Distillery, Scotland's oldest Highland malt distillery situated on the outskirts of the market town of Crieff, with a visit to **Stirling Castle** – one of Scotland's finest and most impressive castles. Different coaches will visit the attractions in different sequence. The day will allow 1 ½ hours free time in **Stirling**, enabling guests to wander through the cobbled streets of this historic town and eat their packed lunch. The journey by coach will encompass some beautiful Perthshire scenery, and also include magnificent views of the Firth of Forth when crossing the Forth Road Bridge. Participants will spend around 1½ hours at Stirling Castle (guided tours will be

arranged). Around 2 hours will be available at Glenturret, to take the guided tour, taste the whiskies and browse in the shop.

Blair Atholl Distillery - Blair Castle - House of Bruar

This outing will take participants northwards over the Forth Road Bridge and up to Pitlochry, gateway to the Highlands, where the coaches will head to three destinations - **Blair Atholl Distillery**, **Blair Castle** and the **House of Bruar**; different coaches will visit the sites in different sequences. At Blair Atholl, participants will enjoy a guided tour of the distillery, with the chance to sample some of Scotland's 'water of life'. Blair Castle, set in extensive parklands, is the traditional home of the Dukes of Atholl and here participants will spend a total of 2 ½ hours and can enjoy a full guided tour of the Castle, with time to eat their packed lunches in the grounds. A few minutes north of Blair Castle is the House of Bruar, an exclusive and attractive shop selling the best of Scottish clothing, food and sporting equipment.

Falkland Palace - St Andrews - Glamis Castle

This outing will take persons northwards over th Forth Road Bridge to **Falkland Palace**, one of the National Trust for Scotland's flagship properties. After 1 ¼ hours there participants will continue to **St Andrews**, Scotland's home of golf, where they will have 1 ¾ hours to explore this historic university town and eat their packed lunch. **Glamis Castle**, childhood home of the late Queen Mother, will be another destination, and participants will enjoy a guided tour of the Castle and time to wander in the grounds, spending 1½ hours at their leisure. Different coaches will visit the sites in different orders.

Lindisfarne - Berwick upon Tweed, or Spittle Beach - Lochcarron Scottish Cashmere Wool Centre This outing combines a guided tour of the Lindisfarne Heritage centre with time to explore the rest of Holy Island. The journey by coach will take the East Coast tourist route through magnificent coastal scenery to the Borders. Participants will then travel across country through stunning lands steeped in the history of hundreds of years of conflict and reconciliation to “Lochcarron of Scotland”, Scottish Cashmere Wool Centre where they will spend 1 ½ hours and have the opportunity to buy products in their shop plus a guided tour of the Mill. In addition coaches will visit Berwick or Spittle for 1 hour depending on the weather. The packed lunch can be eaten at either of these tours.

Thursday 11 July – Conference banquet at Murrayfield stadium, home of Scottish Rugby. Coaches will leave at 19:00 from 3 pick up points: Jury’s Inn - Jeffery Street; the Appleton Tower and Pollock Halls, on the road outside the main entrance. A reception will be held, weather permitting, on the trackside prior to the dinner, which begins at 20:00. Coaches will return from 22:30 onwards.

International Transactions in Operational Research (ITOR)

All paid registrants, except Student Registrants and Accompanying Person Registrants, will receive free access to the electronic version of ITOR for a three-year period from January 1st, 2003. Details will be sent via the email address you have supplied. However, you will not receive this if:

(a) You have not supplied an email address when you registered (in which case you will receive the printed version of Vol. 10, 2003, sent to the address given on your registration form), or

(b) You inform the publishers (Mr Brant Emery, Senior Marketing Controller, Blackwell Publishing Ltd, 108 Cowley Rd, Oxford, OX4 1JF, UK Direct Tel: +44 (0) 1865 382265, Direct Fax: +44 (0) 1865 381265, bemery@blackwellpublishers.co.uk) that you wish to receive the printed version of volume 10 instead.

If you have not supplied an email address and wish to receive electronic access please inform Mr. Emery at the earliest opportunity.

Sponsor Information

IFORS 2002 is extremely grateful to the following sponsors:

Centre for Mathematical Modelling and Flow Analysis (CMMFA)
http://cmmfa.mmu.ac.uk/ - Part sponsor of the conference bag.

The Centre for Mathematical Modelling and Flow Analysis (CMMFA) is based in the Department of Computing and Mathematics of Manchester Metropolitan University. Our current activities include two projects studying the effects of wave impact on Sea Walls. Global warming is increasing wave heights around the UK coastline, placing a large amount of coastal infrastructure and sea defences at risk.

With partners from six other EU countries we are currently developing risk assessment tools, based on neural networks, for permissible wave overtopping performances of sea walls.

Our expertise - modelling multi-dimensional transient processes.

Defence Science and Technology Laboratory (Dstl)
Part sponsor of the Final Programme

The Defence Science and Technology Laboratory (Dstl) is the centre of scientific excellence for the UK Ministry of Defence. It delivers defence research of the highest calibre, specialist technical services and an ability to track global technological developments. Its analysis capabilities constitute the largest operational research group in Europe and support the UK Government and Armed Forces across a wide spectrum of defence and security issues, from policy formulation to the planning of current operations.

The GROUPSIM Network: A Community for Collaborative Simulation Modelling.
Part sponsor of the Conference bag

The GROUPSIM Network (www.groupsim.com) is a community of academics, industrialists, and vendors who are interested in the emerging field of *Collaborative Simulation Modelling* (CSM). CSM is a term used to refer collectively to new social processes, tools and infrastructure in modelling and simulation offered by new technology support of human-to-human and computer-to-computer collaboration. The focus is on process-based simulation modelling practised in business, manufacturing, and service industries as well as some areas of defence. It includes, but is not limited to, applications of distributed computing such as

- CSCW/groupware
- distributed simulation
- parallel simulation
- web-based simulation

The main mission of the GROUPSIM Network is to create the foundation for the proliferation of integrated collaborative simulation modelling techniques, tools and infrastructure in the larger academic and industrial communities by promoting a discursive forum to promote skills transfer between researchers, vendors, and end users. The two main guiding lights of this work are *evolution not revolution* and *dissemination by demonstration*.

If you are interested in this work, or wish to join the mailing list, then contact the co-ordinator of the GROUPSIM Network (Dr Simon J E Taylor) through the web site or by email simon.taylor@brunel.ac.uk). The GROUPSIM Network is partially supported by EPSRC grant GR/N35304 and is hosted by Brunel University.

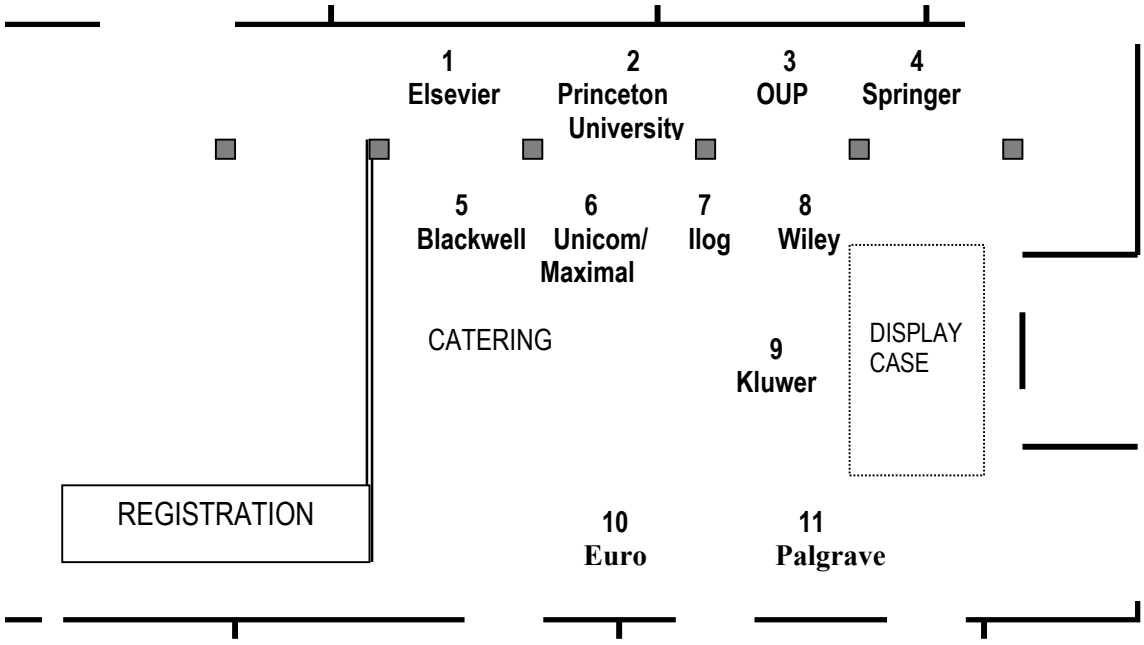
Exhibition Information

IFORS2002 would like to thank the undernoted companies for supporting the Conference Exhibition. We asked each company to describe the services they provide in their own words [IFORS does not endorse any particular product] Exhibitors have described their companies in their own words. We invite you to visit each of their stands during the Conference. All exhibition stands are located in the Appleton Tower Concourse. The opening hours of the exhibition will be as follows:

Monday 8 July	10:30 - 17:30
Tuesday 7 July	09:00 - 17:30
Thursday 10 July	09:00 - 17:30
Friday 11 July	09:00 - 16:00

Some exhibitors will be exhibiting for part of the conference only.

Exhibition Map:



Blackwell Publishing (8 & 9 July) Stand 5

Rachel Chandler, 108 Cowley Road, Oxford OX4 1JF

Tel: 01865 382225 e-mail: RChandler@blackwellpublishers.co.uk

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We are proud to be publishing one of the official IFORS journals and hope that through our partnership we can make International Transactions in Operational Research a leading international journal.

Elsevier Science (8 & 9 July) Stand 1
Anita Olfers, Molenwerf 7, 1014 AG Amsterdam Tel: +31 20 4853003 e-mail: a.olfers@elsevier.nl

Elsevier Science-www.elsevier.com/locate/dsw - Decision Sciences Web offers free of charge: -Table of Contents & Abstracts;-Search facilities;-Access to online sample copies of 14 journals; -Instructions to Authors; A wealth of further journal information; -Preface to each volume and first two pages of each chapter published in the Handbook in Operations Research and Management Science. For access to complete articles please see details on our website.

EURO OFFICE Stand 10
Université Libre de Bruxelles, SMG / EURO CP210/01, Boulevard du Triomphe Campus Plaine, Bâtiment NO, niveau 3, local 2 N3 116B, B-1050 Brussels, Belgium Fax: +32 2 650 5970; office@euro-online.org; http://www.euro-online.org/

What is EURO?

EURO is the "Association of European Operational Research Societies" within IFORS. It is a "non profit" association. Its affairs are regulated by a Council consisting of representatives of all its members and an Executive Committee, which constitutes its board of directors. Its aim is to promote Operational Research throughout Europe.

The members of EURO are normally members of IFORS and comprise the national OR societies of countries located within or nearby (in broad sense) Europe. Each member is represented in the EURO Council by two representatives.

E-mail: office@euro-online.org URL: http//www.euro-online.org

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Sylvia Kors (Exhibits Manager), P O Box 989, 3300 AZ Dordrecht, The Netherlands
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Maximal Software (11 & 12 July) Stand 6
Bjarni Kristjansson, 97 Oxford Road, Uxbridge, Middlesex UB8 1LU
Tel: 01895 819 344 e-mail: info@maximalsoftware.co.uk

Maximal Software is the developer of the MPL Modeling System, a complete graphical model development environment for building mathematical optimization models. Maximal also offers the OptiMax 2000 Component Library (API) that can be used seamlessly to call MPL, from both Visual Basic and C/C++, allowing the model developer to create customized end-user applications that solve real-world optimization problems. Maximal Software has many years of practical experience and expertise in providing innovative solutions for our customers and assisting them in achieving the successful completion of their optimization projects.

Oxford University Press (8 & 9 July) Stand 3
Chris Hall, Academic Division, Great Clarendon Street, Oxford OX2 6DP
Tel: 01865 267 769; Fax: 01865 267 568; e-mail hallc@oup.co.uk

Oxford University Press is widely recognised as one of the world's premier journal publishers, combining traditional values of quality and service with the innovative use of technology. OUP publishes the journals of the Institute of Mathematics and its Applications including the *IMA Journal of Management Mathematics*. This quarterly, peer reviewed journal, publishes papers in selected areas of OR and

management science including financial modelling, risk analysis, model building and optimisation, production processes, logistics, supply chain management and decision making tools. A free online trial subscription to this journal is available to IFORS delegates (see the insert in your delegate pack for details).

Palgrave Macmillan Stand 11

David Bull, Director of Journals, Houndmills, Basingstoke RG21 6XS

Tel: +44 (0)1256 302999; Fax: + 44 (0)1256 320109; email: d.bull@palgrave.com

www.palgrave-journals.com

Palgrave Macmillan is a global academic publisher serving learning and scholarship in the field of higher education, and publishing for the related professional business, management and OR markets.

We are proud to be the publishers of the *Journal of the Operational Research Society* and *European Journal of Information Systems* on behalf of The OR Society and *International Abstracts in Operations Research/IAOR Online* on behalf of IFORS.

You can browse a selection of our publications – books, journals, reference and electronic works - during IFORS 2002, or visit us at www.palgrave.com.

Princeton University Press (8 & 9 July) Stand 2

David Ireland, 3 Market Place, Woodstock, Oxon OX20 1SY

Tel: +44 (0) 1993 814502; e-mail: direland@pupress.co.uk

Please visit the Princeton University Press exhibition stand, to see our range of quality books, all offered at discount prices. Our editor David Ireland would be happy to meet you and tell you about the PUP book programme, our expansion in the sciences and our new European office. If you have plans for writing a book, David would be delighted to discuss this with you.

Springer-Verlag GmbH & Co. KG Stand 4

Dr. Werner A Mueller, Publishing Director Economics and Management Science

Tiergartenstrasse 17, 69121 Heidelberg, Germany W.A.Mueller@Springer.de

A Short Look at the Scientific Publisher Springer

Springer-Verlag is one of the most prestigious international scientific publishers today. Wherever scientific research is carried out, highly qualified experts count themselves among Springer's authors, among them a large number of Nobel prize winners.

Springer publishes annually over 2,600 new books and approximately 500 journals, also available in electronic form. A total of about 19,000 books are currently available, 60 percent of them in English. Besides the German-speaking countries, the USA and Asia are the most important markets. In addition to the headquarters in Berlin and Heidelberg, the subsidiaries in New York, London, and Tokyo in particular develop international publishing Programmes.

UNICOM Seminars/Optirisk Systems (8 & 9 July) Stand 6
Marife O'Aivazian, 1 Oxford Road, Uxbridge. Middx. UB9 4DA
Tel: 01895 819 483; e-mail marife@unicom.co.uk

UNICOM Seminars' mission is to supply leading edge and industrially relevant technical and market information in the fields of IT, management science and financial modelling.

The Company is dedicated to serve a client base of IT professionals, industrial researchers, academics and corporate executives by offering them information products and supporting services in Seminars, Newsletters and Industry Reports.

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Luggage room

Delegates leaving on Friday, 12 July may leave their luggage in the Appleton Tower Lecture theatre 4, which will be manned by a student helper.

Bank Services

The nearest bank and cash dispenser to the conference site can be found at:

The Bank of Scotland, 4 Bristol Square, Edinburgh EH8 9AL.

Opening Hours:	09:00 – 17:00	Monday to Friday.
	10:00 – 14:00	Saturday

This bank is located immediately adjacent to the Management School.

Exchange facilities can also be found at many other banks located throughout the city centre or alternatively at Waverley Train Station and airports.

Useful Telephone Numbers

Public telephones can be found throughout the campus in various locations including the Appleton Tower and Teviot Row House. Public telephones use coins, credit cards or phone cards, which are widely available in shops and post offices. Please note the following:

- To call an Edinburgh number within Edinburgh, it is not necessary to dial the code 0131
- To call a number elsewhere in the UK, you must use the area code which begins 0
- To make an international call dial 00 followed by the country code and area code
- To call the International Operator dial 155
- To call Directory Enquiries dial 192
- To call International Directory enquiries dial 153
- To call the Operator dial 100

The following numbers are for calls made within UK, if you are calling from outside the UK precede with +44 and remove the first 0.

Airports and Airlines

Edinburgh Airport	0131 333 1000
Glasgow Airport	0141 887 1111
London Gatwick	0870 0002468
London Heathrow	0870 0000123
London Luton Airport	01582 405 100
Air France	0845 084511
KLM	0870 507 4074
British Airways	0845 773 3377
British European	0870 607 0555
Delta Air Lines	0800 414 767
Easy Jet	01582 702 900

Trains

Rail Enquiries	08457 484950

Bus Information

National Express	08705 808080
Stagecoach	0906 550 0000
Traveline (local inform.)	0131 225 3858

Taxi Cabs

City Cabs	0131 228 1211
Central Radio Taxis	0131 229 2468

Edinburgh Tourist Board

General Enquiries	0131 473 3666

Car Hire

Avis	0131 337 6363
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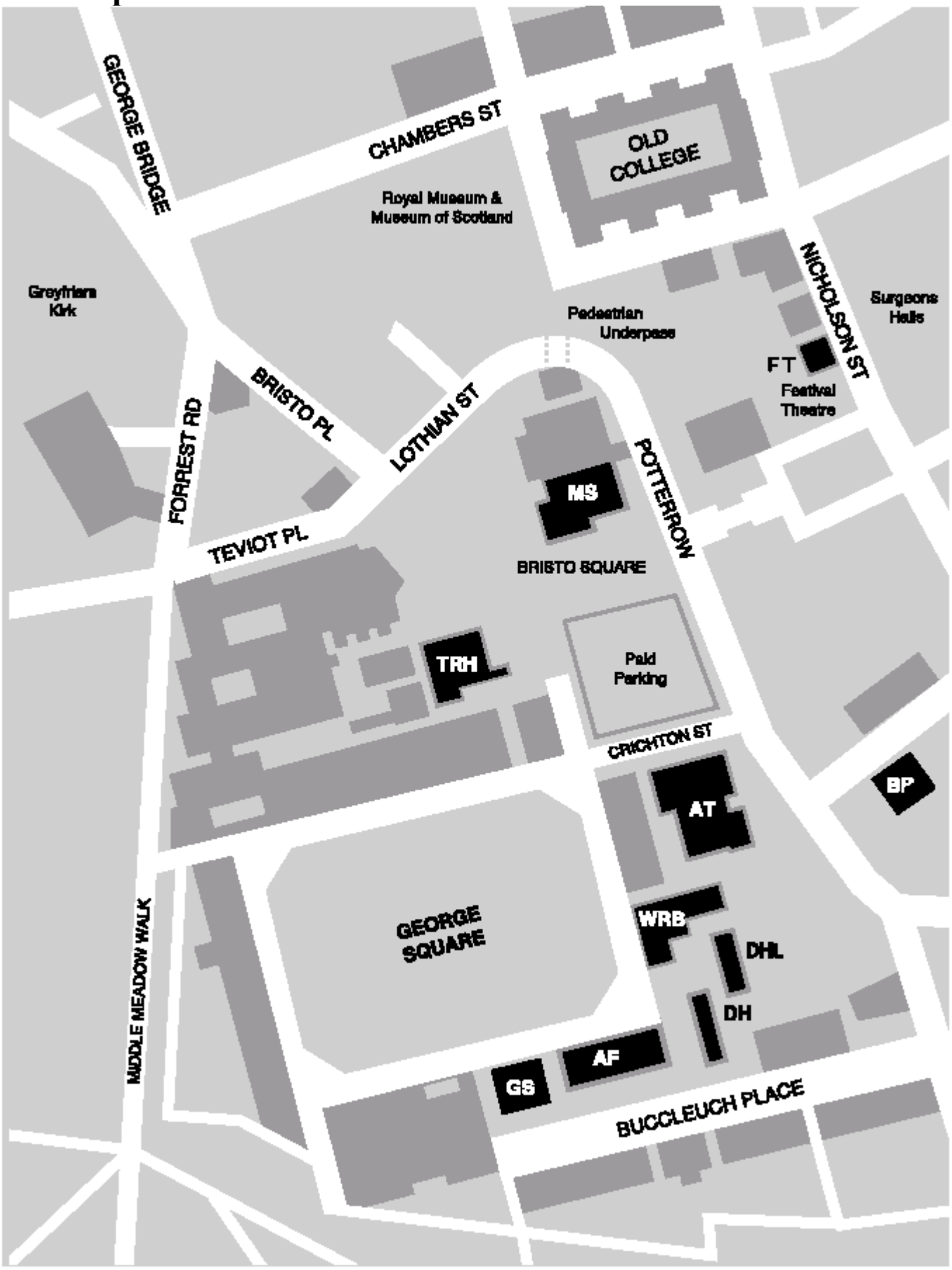
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Country Distribution:

Countries	# of Authors	Countries	# of Authors
United Kingdom	320	Mexico	11
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Denmark	22	Lithuania	1
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IFORS Conferences:

Year	City	Attendance
1957	Oxford, U.K.	
1960	Aix-en-Provence, France	
1963	Oslo, Norway	
1966	Boston, USA	
1969	Venice, Italy	
1972	Dublin, Ireland	
1975	Tokyo/Kyoto, Japan	
1978	Toronto, Canada	
1981	Hamburg, Germany	
1984	Washington, D.C., USA	
1987	Buenos Aires, Argentina	
1990	Athens, Greece	
1993	Lisbon, Portugal	768
1996	Vancouver, Canada	922
1999	Beijing, China	969
2002	Edinburgh, Scotland	1,150*
2005	Hawaii, USA	

* Pre-Registration

Technical Programme

Plenary Lectures

Lecture 1: MP Monday 11:30 a.m. to 1:00 p.m.

Venue: Festival Theatre

OR Alone? Social Capital, Branding, and the OR Professional

Mike Trick

Social capital is the value we get from interactions with others. Broad social trends, particularly in the United States, point to a continuing decrease in the amount of time and effort people make in social capital activities. These trends are particularly worrisome for the OR professional due to our need to interact with others in projects, research, and teaching. To solve this problem, we must redouble our efforts to define and "brand" the OR profession.

Dr. Trick is a researcher and educator in the field of operations research, with a specialization in computational methods in optimization. After receiving his doctorate in industrial engineering from Georgia Tech, Dr. Trick embarked on two years of postdoctoral fellowships, first at the Institute for Mathematics and its Applications in Minneapolis, then at the Institut fuer Oekonometrie und Operations Research in Bonn, Germany. He then joined the faculty of the Graduate School of Industrial Administration at Carnegie Mellon University, first as an Assistant Professor of Operations Research in 1989, currently as Professor of Operations Research and President of the Carnegie Bosch Institute for Applied Studies in International Management, an institute specializing in research and education on international issues. In 1995, he was appointed the founding Editor of INFORMS Online, the electronic information service of the Institute for Operations Research and the Management Sciences, a 14,000 member professional society, and is currently the President of INFORMS. Trick is the author of twenty-five professional publications and is the editor of one volume of refereed articles. Dr. Trick has consulted extensively for such groups as the United States Postal Service, the Internal Revenue Service, Major League Baseball, the Atlantic Coast Conference college basketball league, and many other companies.

Branding OR

James Gibb

The volume of work that most of us would see as OR continues to grow rapidly. However, more and more of this masquerades under labels other than OR. This leads to fragmentation of the profession and prospective clients may fail to recognise the contribution that OR, as a coherent whole, can make. Active branding of OR would benefit for practitioners, academics and our clients.

James Gibb started in Operational Research Executive of the National Coal Board in 1966, working mainly on problems to do with coal products. He subsequently worked for 9 years as an OR consultant for the Dexion Group, where his main interest was in distribution-related OR, specifically vehicle-scheduling and depot-location problems. He continued this interest when he moved to PA Management Consultants in 1978, although he also spent a year consulting for Thames Valley Police. In 1982, he joined the Business Consultancy group at Shell in London, specialising mainly in OR problems relating to Shell's tanker fleet. After a spell as head of Information Planning, he became head of Business Consultancy from 1989-1994. For his last five years in Shell, he was involved in Learning. Initially the focus was on IT learning, but the role later expanded to include many of the management and commercial learning needs of the Shell Group. He retired from the post of Learning Leader - Europe and Africa in 2000. He is currently senior visiting fellow in the OR department of London School of Economics. He has been active in the UK OR Society for a number of years and currently holds the post of President.

Lecture 2: FP Friday 1:30 p.m. to 2:30 p.m.

Venue: George Square Lecture Theatre

OR in for Development in a Fractured Global Order

Francisco Sagasti

Dr. Sagasti, President - FORO Nacional Internacional, Peru and Director of Agenda: PERÚ will draw on his extensive international experience in planning major development programmes. His wide research and consulting background as an OR scientist since the mid-1960s, to outline the opportunities he sees ahead for the thinking of OR scientists to increase its influence on the management of sustainable human development at international, national and local levels. He will relate this theme to the overall conference theme of OR in a Globalised, Networked World Economy.

Francisco Sagasti obtained his Industrial Engineering degree in Lima and his Ph.D. in OR and Social Systems Sciences at the University of Pennsylvania. He has been Chief of Strategic Planning at the World Bank, Visiting Professor at the Wharton School of the University of Pennsylvania, Chairman of the UN Advisory Committee on Science and Technology, and advisor to various ministers, international organizations, government agencies and private firms in Peru and in other countries. He has published more than 200 papers and 20 books on development strategies, science and technology policy; systems thinking and modeling. At present he is Director of Agenda: PERU, research associate at the Institute of Development Studies (Sussex University), advisor to the Primer Minister of Peru and special advisor to the Rector of the University for Peace in Costa Rica.

IFORS: OR for Development Prize Finalist Sessions

Session MA12 Monday, 9:30 - 11:00

Session MC12 Monday, 2:00 - 3:30

Session MD12 Monday, 4:00 - 5:30

Panel and Discussion Sessions

Enhancing Community Capacity through Collaboration, Session RC12

Modeling Science, Session TB22

OR in development, Session TD12

Our most Urgent Need -- Branding the Profession of OR, Session TA14

Tutorials and Semi-Plenary Sessions

Applied Nonlinear Programming, **Leon S. Lasdon***, Session TB5*

Collaboration in E-Business: Business Models and Technology Enablers, **Amiya Chakravarty***, Session RA5*

Development of a web-based course, **Gary R. Waissi**, *Session TC5*

Dialog Mapping, **Jeff Conklin***, Session RB5*

Global Optimization in Modeling Environments, **Janos D. Pinter***, Session RC5*

Measurement and Decisions - Theory, Tools, and Applications, **Jonathan Barzilai***, Session MD5*

The Max-Plus Algebra: A new Approach to Performance Evaluation of DES, **Bernd Heidergott**, Session MC5

The Strategic Choice Approach to Planning under Pressure, **John Kimball Friend***, Session MA5*

Semi-Plenary*: Max-Plus Algebra and its Applications to Railway Systems,* **Geert Jan Olsder***, Session TA16*

Semi-Plenary*: OR Society President's Medal,* **Stewart L. Robinson***, Session RC29*

Stream Organizers

(Max,+)-Approach to Dynamic Event Systems; **Wilfried Seidel**, Germany; **Bernd Heidergott**, The Netherlands

Case studies and OR consultancy; **John Ranyard**, United Kingdom

Community Development and Capacity Building; **Letlibe Jacob Phahlamohlaka**, South Africa

Complementarity in Systems Modelling; **Michael Pidd**, United Kingdom

Complex Societal Problems; **Dorien DeTombe**, The Netherlands

Contributed Papers, **Ben Lev**, United States

Cutting and Packing (SICUP workshop); **Jose Manuel Valerio de Carvalho**, Portugal

Data Envelopment Analysis; **Joe Zhu**, United States; **Lawrence Seiford**, United States

Data Mining; **Hussein Abbass**, Australia

Decision Analysis; **George Wright**, United Kingdom; **Gregory S. Parnell**, United States

Decision Making in Banking and Finance; **Francesco M. Paris**, Italy

Education; **Peter C Bell**, Canada

Electricity Markets; **Shmuel Oren**, United States

Electronic Commerce and e-Business; **Amit Basu**, United States

Environmental Management; **Costas P. Pappis**, Greece

Financial Applications and Operations Research; **Stavros Zenios**, Cyprus

Group Decision and Negotiation Support; **L. Alberto Franco**, United Kingdom

Health Services; **Ruth M. Davies**, United Kingdom

Integer and Combinatorial Optimization; **Young-Soo Myung**, Korea

Integer Programming and Discrete Optimization; **J. Cole Smith**, United States

Invited Sessions; **Ben Lev**, United States

Knowledge Management and Intellectual Capital; **John Steven Edwards**, United Kingdom

Maintenance Replacement and Reliability; **Philip Scarf**, United Kingdom; **Joseph C. Hartman**, United States

Managing International Development; **John Kimball Friend**, United Kingdom

Mathematical Programming Applications; **John M. Wilson**, United Kingdom

Metaheuristics; **Arne Lokketangen**, Norway; **Baikunth Nath**, Australia; **David L. Woodruff**, United States; **Fred Glover**, United States

Military Applications; **Gregory S. Parnell**, United States

Multicriteria Decision Aid; **Johan Springael**, Belgium

Multicriteria Decision Analysis; **Theodor J. Stewart**, South Africa

OR and Strategy; **Frances O'Brien**, United Kingdom

OR and the Global Automotive Industry; **Kenneth Chelst**, United States; **Debra Elkins**, United States

OR for Development Prize Competition; **Goutam Dutta**, India

OR in Development; **Rangalal Bandyopadhyay**, India

OR in Forestry; **Andres F. Weintraub**, Chile

Operations Research in Process Industries; **Goutam Dutta**, India

Revenue Management; **Ian Seymour Yeoman**, United Kingdom; **Una Sinead McMahon-Beattie**, Northern Ireland

Scheduling and Timetabling; **Sanja Petrovic**, United Kingdom

Supply Chain Management; **Hochang Lee**, Korea

System Dynamics; **David C. Lane**, United Kingdom

Telecommunications; **Patrick Soriano**, Canada

The History of Operational Research; **Maurice William Kirby**, United Kingdom

Transportation; **Teodor Gabriel Crainic**, Canada

Tutorial/Semi-Plenary, **Ben Lev**, United States

Vehicle Routing; **Jean-Yves Potvin**, Canada

ACKNOWLEDGMENT

Many individuals contributed to the conference. Special thanks to:

Andres Weintraub who guided us in the early stages of the conference planning;

Paolo Toth whose experience as the Program Chair of IFORS '99 helped us resolves many difficult problems;

Lyn Thomas and Chris Barrett who coordinated our activities with the Organizing and local committee;

Lee Freeman who provided valuable computer programming advice and assistance throughout the project; and finally to Dušan Šimko who designed, implemented, and maintained the database, the web sites, and the software needed for the project.

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Edited by CATHAL M BRUGHA (General Editor), GRAHAM K RAND (Managing Editor), and CELSO REBEIRO (S. American Editor)

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Dedicated to advancing the understanding and development of Operational Research on a global level - ITOR is an invaluable resource for academics and practitioners wanting to insure that they have access to the latest research in all areas of OR and Management Science. The same way IFORS acts as an umbrella organisation for the world - ITOR acts as an independent forum allowing research to reach a global audience.

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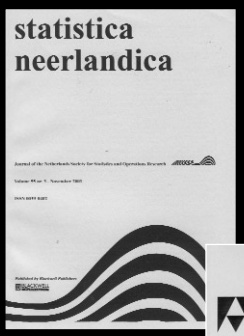

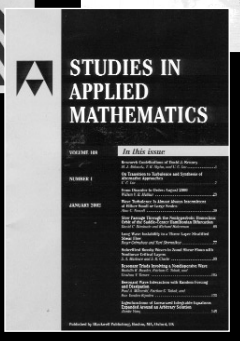

Other journals of interest:

Statistica Neerlandica

Journal of the Netherlands Society for Statistics and Operations Research

Edited by P. H. FRANSES

Volume 56, 2002 | 4 issues per year | ISSN: 0039-0402

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Program:

Code:
M - Monday
T - Tuesday
R - Thursday
F - Friday
A - First Session
B - Second Session
C - Third Session
D - Fourth Session
P - Plenary Session

MO **Opening Session**

Monday 11:30 am to 12:00 am
Venue: Festival Theatre

Chair: **Ben Lev**, University of Michigan-Dearborn, USA

Welcome messages: **Paolo Toth**, IFORS President, Italy
Official opening by local dignitary
Ben Lev - Chair, Program Committee, USA
Lyn Thomas - Chair, Organizing Committee, UK

MP **Plenary Session**

Monday 12:00 a.m. to 1:00 p.m.
Venue: Festival Theatre

Chair: **Paolo Toth**, IFORS President, Italy

Mike Trick, INFORMS President, USA

James Gibb, ORS President, UK

MA1 **Health Services: Performance I**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Davies, Ruth M.**
University of Southampton, United Kingdom

1) *Analytical methods for monitoring performance in health care* , **Sherlaw-Johnson, Chris**, University College London, United Kingdom; **Gallivan, Steve**

In recent years, there have been several high profile cases where performance has been so poor that clinicians have been forced to stop practising. There is, therefore, considerable interest in methods for monitoring performance particularly in relation to deaths or other adverse events. Methods like VLAD which allow for variable case mix are being accepted by surgeons as essential in the surgical audit process. These have been applied in several areas of health care including adult and paediatric cardiac surgery, orthopaedic surgery, carotid surgery, transplantation and intensive care. The talk will discuss some of these applications and will also discuss analytical work that has been carried out to enhance the original VLAD technique.

2) *Towards a synthesis of performance ratings*, **Delesie, Lucas**, University of Leuven-KUL, Belgium

Performance ratings are a hot topic in health care management. International (WHO, OECD...), National (UK, USA...), Organisations (Hospitals, Insurance Companies...), Departments (Medical directors, Head Nurses...) are all involved. The analytical approach dominates in the literature but the policy-makers and executives all demand one global answer: the wood for the trees. Hence, what performance criteria and how to aggregate them? how to aggregate performance ratings across individuals, organisational (sub)parts towards group, department, overall performance? This contribution focuses on the framework, the concepts, their operationalization and the problems of the executive of managing performance. One case-study at least is included.

3) *Are Performance Indicators Necessary or Sufficient for Performance Improvement?*, **Mullen, Penelope M.**, University of Birmingham, United Kingdom

Recent years have seen increasing resort to performance indicators in response to inadequate performance in healthcare. Although their specific role is often not clearly articulated, the underlying assumption appears to be that performance indicators lead to improved performance. However, long experience shows this assumption may be untenable. Performance indicators, by encouraging perverse behaviour and focus on what is measured and measurable, can cause performance to deteriorate. Analysing the construction and effects of various performance indicator systems, this paper contrasts performance assessment with support for performance improvement and asks whether performance indicators are sufficient, necessary, or even useful, in the quest for improved performance in healthcare.

MA2 **Bilevel Programming**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Marcotte, Patrice**
University of Montreal, Canada

1) *A Bilevel Design-Pricing Model*, **Brotcorne, Luce**, Univ de Valenciennes, France; **Forget, Amelie**; **Marcotte, Patrice**; **Savard, Gilles**

In this presentation, we propose a Lagrangian relaxation approach to the solution of a network design - pricing model where a "leader" seeks to maximize profit from the network utilization, while the "follower" minimizes its transportation cost. For a given multiplier vector, the pricing problem is solved by a primal-dual procedure which generates feasible transportation schedules. Moreover, an inverse optimization procedure determines a set of tolls that is optimal with respect to each follower's schedule. This exploration strategy is tested on randomly generated grid networks.

2) *Combinatorial Structures in Nonlinear Programming*, **Scholtes, Stefan**, University of Cambridge, United Kingdom

Bilevel programs or mathematical programs with equilibrium constraints can be thought of as special nonsmooth programs, where the nonsmoothness is introduced through a choice of active constraints in the lower level. The nonsmoothness thus has a combinatorial feature as it is characterized by the choice of a subset of the set of constraint indices in the lower level problem. We study such combinatorial optimization problems in a more general setting and explain how well known active set type approaches to bilevel optimization carry over to other problem with combinatorial constraints. We exemplify our observations by specifying them for optimization problems with max-min type equality or inequality constraints.

3) *Modelling Bilevel Games in Electricity Markets*, **Hu, Xinmin**, University of Melbourne, Australia; **Ralph, Daniel**

Electricity markets facilitate pricing and delivery of wholesale power. Generators submit bids to an Independent System Operator, ISO, to indicate how much power they can produce depending on price. The ISO takes these bids with demand forecasts and minimizes the total cost of power production subject to feasibility of distribution in the electrical network. Each generator can optimise its bid using a bilevel program or mathematical program with equilibrium constraints, with the ISO's problem at the lower level. A Nash equilibrium is a list of bids that is simultaneously optimal for all generators. We present some theory and numerical examples.

MA3 **Practice of OR I**

Contributed session Venue: DH-N

Chair: **Chan, Yan Chong**
Hong Kong City University, China

1) *Planning annualised working hours with a finite set of weekly working hours*, **Corominas, Albert**, Universitat Politecnica de Catalunya, Spain; **Lusa, Amaia**; **Pastor, Rafael**

The working hours per week over the year of each staff member at a department store must be established. The number of weekly working hours must belong to a finite set and the solution is also subject to other constraints. The problem is solved by means of MILP.

2) *An Oriental WSR Approach to OR Practices in China*, **Gu, Jifa**, Professor, Japan; **Tang, Xijin**

In this paper, we address the oriental Wu-li Shi-li Ren-li (WSR) system approach to OR practice in China. After a brief introduction of the concept and working process of the approach, some of WSR's real applications in the fields of evaluation, water-resources management, regional development, labor market development, safety and risk analysis, and information systems development are addressed. The WSR case in water resources management shows that if even good models will still not satisfy users if their own ideas are not absorbed into the models. WSR approach is based on the Oriental philosophy and culture

3) *A Capacity Planning System for a Construction Materials Company*, **Chan, Yan Chong**, Hong Kong City University, China

K Wah Concrete Ltd supply construction materials in Hong Kong with 2 quarries and 7 concrete plants. The demand of construction materials in each area of Hong Kong moves from year to year. A capacity planning system was developed to determine the change of capacities and location of the plants.

MA5 **Tutorial: The Strategic Choice Approach to Planning under Pressure**

Invited session Venue: MS-1

Chair: **Friend, John Kimball**
University of Lincoln, United Kingdom

1) *Tutorial: The Strategic Choice Approach to Planning under Pressure*, **Friend, John Kimball**, University of Lincoln, United Kingdom

Tutorial: An introduction will be given to the philosophy, methods and applications of this participatory approach to strategic decision support, now recognised as one of the leading methodologies of the "soft" OR movement. Since the Strategic Choice Approach originated from the work of the Institute for Operational Research in Britain, it has become widely adopted not only by OR consultants but by urban and regional planners and other practitioners in Europe and the developing world. The emphasis is on incremental commitment through the planned management of uncertainty, either in facilitated group workshops or through informal consulting supported by problem-structuring software.

MA6 **Project Management**

Contributed session Venue: AT-1

Chair: **Lin, Yi-Kuei**
Associate Professor, Taiwan

1) *Resource Constrained Model for Several Stochastic Projects with Different Priorities*, **Gonik, Aharon**, Israel

Several stochastic network projects with different priorities, random durations and limited resources are considered. Each activity requires various types of resources with fixed capacities and starts when it is ready, subject to available resources. The problem is to determine the overall due date for all projects as well as the resources feeding-in moments. Two objectives are imbedded in the model: to minimize the overall performance duration horizon and to maximize the sum of the product of each project priority and the corresponding average probability to meet the deadline. The problem is solved via simulation.

2) *A model for stability in project scheduling*, **Leus, Roel**, KU Leuven, Belgium; **Herroelen, Willy**

Project scheduling generally assumes a deterministic environment within which the pre-computed baseline schedule will be executed. It is of interest to develop pre-schedules that can absorb disruptions in activity durations without affecting the planning of other activities, such that co-ordination of resources and material procurement for each of the activities can be performed as smoothly as possible.

3) *Project Management for Random Activity Duration under Time and Budget Constraints*, **Lin, Yi-Kuei**, Associate Professor, Taiwan

A large-scale project can be modeled as a project network in AOA form (arrows denote the activities and nodes denote the events of the project). We assume the activity duration is an integer random variable with arbitrary probability distribution. Under the project time (the deadline to complete the project) constraint and the budget constraint, this paper studies how to schedule all activity durations of the project. We will proposed algorithms to generate all upper and lower boundary vectors for the project, respectively. All feasible activity durations of the project are among such upper and lower boundary vectors.

MA7 **Decision Making under Uncertainty I**

Invited session Venue: AT-2

Chair: **Ishii, Hiroaki**
Graduate School of Engineering Osaka University, Japan

1) *A complete enumeration for network design problems and its applications*, **Koide, Takeshi**, Univ of Marketing and Dis, Japan; **Shinmori, Shuichi**; **Ishii, Hiroaki**

Many network design problems search the best layout of components considering construction cost and network reliability. We propose a complete enumeration method for the problems, which reduces computational time by detecting isomorphic networks. We also discuss applications of the algorithm to other kinds of network design problems.

2) *Crop Planning Problem with Fuzziness and Randomness*, **Toyonaga, Tasuku**, Osaka University, Japan; **Izutani, Yuko**; **Itoh, Takeshi**; **Ishii, Hiroaki**

The crop planning problem is usually formulated as a linear programming problem. But, in actual cases, the profit coefficients for crops are fixed after the harvesttime, that is, they are not certain values in the cropping period. Therefore we treat the profit coefficients for crops as uncertain elements, especially as fuzzy numbers and propose a crop planning model based on the concept of maximizing the possibility measure for a fuzzy goal. Further, we develop an effective solution procedure for our problem and extend the model to the case where the coefficients are discrete randomized fuzzy numbers.

3) *Genetic Algorithm and Monte Carlo Method for Stochastic Job-shop Scheduling*, **Yoshitomi, Yasunari**, Kyoto Prefectural Univ, Japan; **Yamaguchi, Rie**

Genetic Algorithm in uncertain environments is applied to Stochastic Job-shop Scheduling Problems where the processing times are treated as stochastic variables. The Roulette Strategy is adopted for selecting the optimum solution having the minimum expected value of makespan. Applying crossover based on Giffler & Thompson's algorithm results in two offspring inheriting the ancestor□fs characteristics as the operation completion times averaged up to the parent's generation. The several individuals having very high frequency through all generations are selected as the good solutions. Then, the Monte Carlo method is effectively used for finding the approximately optimum solution among these good solutions.

4) *On Optimal Solutions for L-fuzzy Optimization Problems*, **Saito, Seiji**, Osaka University, Japan

In this study we have two aims in analyzing L-fuzzy optimization problems. One is to establish criterion to existence of optimal solutions for the problems by proving existence theorems of the optimal solutions. The other is to get an algorithm of solving the problems by iteration methods, e.g., generalized Newton method.

MA8 **Empirical Methods in Finance**

Invited session Venue: AT-3

Organizer: **Zenios, Stavros**
University of Cyprus, Cyprus

Chair: **D'Ecclesia, Rita Laura**
Universita di Roma "La Sapienza", Italy

1) *Expectation Hypothesis of the term structure evidence on the Italian market*, **D'Ecclesia, Rita Laura**, Universita di Roma "La Sapienza", Italy; **Musti, Silvana**

The aim of this paper is to verify if the EH theory for the Italian market holds, market which has experienced an increasing role in the international context in the last decade, due mainly to the features size of the Government bond market, third large market in the world after US and Japan. We use a twofold

approach: the first based on the well know fact that interest rates are likely to be non-stationary and therefore we formulate the standard tests of the EH using spreads and changes in interest rates. The second approach uses Vector Error Correction Model (VECM) to specify the dynamics of interest rates (as suggested by Engle and Granger 1987).

2) *Numerical investigations of the Heath-Jarrow-Morton model with forward rate dependent volatility*, **Musti, Silvana**, University di Foggia, Italy; **Chiarella, Carl**

This paper investigates the yield curve evolution in the Heath-Jarrow-Morton framework. The stochastic volatility considered depends on the spot rate and the forward rate: a general algorithm in order to simulate the yield curve evolution over the horizon time is developed. The integral form of the stochastic forward rate process is analyzed and Monte Carlo method is applied to price Zero Coupon Bonds, European Call Options on ZCB and interest rate caps. Control Variate Method is then applied to improve the numerical estimate of call options by using the Hull and White call option closed form solution.

3) *A Methodology for pricing options in an illiquid market*, **Muzzioli, Silvia**, University of Modena , Italy; **Torricelli, Costanza**

In this work we implement a model set up in a previous paper for option pricing in illiquid markets (see Muzzioli-Torricelli (2001)) with data on the DAX-index options market. We construct a binomial tree consistent with the smile observed on a given day and we price, on this type of tree, a set of options with different strikes and maturities. To this end, we set up an algorithm for the derivation of the implied tree and for the pricing of European options on this type of tree. The implementation of the proposed algorithm has been done in Visual Basic.

MA9 **Electric Power Market Modeling I**

Invited session Venue: MS-3

Organizer: **Oren, Shmuel**
University of California, Berkeley, United States

Chair: **Hobbs, Benjamin F.**
The Johns Hopkins University, The Netherlands

1) *Reforms to Electricity Transmission Charging in the UK*, **Green, Richard John**, University of Hull, United Kingdom

The UK is planning to introduce new arrangements for electricity transmission charging. The previously separate markets in England and Wales and in Scotland will be integrated, and a new system for dealing with network congestion is wanted. The regulator's currently preferred option is a separate market for transmission rights, running in tandem with the energy markets of the New Electricity Trading Arrangements. This paper will model generators' behaviour in these markets and consider alternative schemes for transmission access in the light of the regulator's next set of proposals, due to be issued early in 2002.

2) *Progress Towards a Single European Electricity Market An Empirical Analysis*, **Bower, John**, Oxford Inst Energy Stud, United Kingdom

The European Commission sees the creation of a single market for electricity across the EU as a crucial mechanism for increasing competition, controlling market power, and reducing prices. Results are presented from an econometric analysis of spot (day-ahead) electricity prices drawn from electronic exchanges in Norway, Sweden, Denmark, Finland, England & Wales, Germany, Netherlands, and Spain. A precise measure of the degree to which these markets operate as a single 'borderless' market, rather than separate national markets, is attempted for the period 1998 - 2001. Barriers to further integration, and the steps needed to overcome them, are identified.

3) *Electricity Price Behaviour under NETA*, **Evans, Joanne**, The University of Hull, United Kingdom

New Electricity Trading Arrangements (NETA) were introduced in England & Wales on 27 March 2001. These arrangements replaced the Pool system that was seen to be encouraging prices to be above marginal cost. NETA is based on the notion that the majority of electricity is traded forward via bilateral contracts, closer to real time participants close out their contract positions in one of three power exchanges or after gate closure, three and a half hours before real time, in the only central market known as the balancing mechanism. This paper investigates the patterns and determinants of prices in each of the different power markets under NETA and considers whether the downward trend in prices seen a few months after the introduction of NETA has been and will continue to be sustainable.

4) *Modeling Imperfect Competition in the Eastern Interconnection using LCP*, **Helman, Udi** , FERC, United States; **Hobbs, Benjamin F.**

This research presents the results of a large-scale market model of the U.S. Eastern Interconnection structured as a linear complementarity problem (LCP). Several hundred firms are represented at 100 locations. The transmission representation includes 814 flowgates with power transfer distribution factors from each location to a reference bus. The analysis models the period June 2000. Two Cournot models will be examined: one with no third-party arbitrage and another that assumes perfect arbitrage. In addition, the effects of a competitive fringe on arbitrage will be considered. Sensitivity analysis is conducted with respect to daily peak and off-peak hours, demand elasticity, choice of Cournot firms, and changes in transmission capacity. Application of the market models to policy issues, such as merger analysis, is also discussed.

MA10 **Stochastic and Fuzzy Dynamic Programming**

Invited session Venue: MS-4

Chair: **Iwamoto, Seiichi**
Kyushu University, Japan

1) *A Markovization of Adaptive Stochastic Maximum Processes*, **Iwamoto, Seiichi**, Kyushu University, Japan; **Sniedovich, Moshe**

In this paper we examine adaptive stochastic maximum processes and derive dynamic programming functional equations for computing the expected values, variances and probability distributions of random variables associated with such processes. This approach involves the Markovization of non-Markovian processes via invariant imbedding resulting in an expansion of the state space.

2) *Optimal weighting in stochastic environment*, **Iwamoto, Seiichi**, Kyushu University, Japan; **Ueno, Takayuki**

This paper studies a class of optimal weighting problems. We consider two statistics --- weighted sum and weighted minimum --- for the Bernoulli sequence. The problem is to find an allocation which optimizes expected value, variance or threshold probability over the total unit sum. We solve three problems by two methods. One method is direct. It utilizes both character and structure in problem. The other is dynamic programming approach, where the final state model is executed through state expansion.

3) *Optimal Inventory Policies for Start-Up Firms*, **Archibald, Thomas W.**, University of Edinburgh, United Kingdom; **Thomas, Lyn C.**; **Betts, John M.**; **Johnston, Robert B.**

In this age of innovation, strategies that ensure the success of start-up firms are important. Often the main objective of start-up firms is survival probability rather than profit. This theme is explored using Markov decision process models of inventory strategy. The problem is based on a real manufacturing start-up firm. It is shown that although the start-up company should be more conservative in its component purchasing strategy than if it were a well established company it should not be too conservative.

MA11 **Adaptation of Metaheuristics to Continuous Variable Optimization Problems**

Invited session Venue: MS-5

Organizer: **Glover, Fred**
United States
Organizer: **Lokketangen, Arne**
Molde College, Norway
Organizer: **Nath, Baikunth**
Australia
Organizer: **Woodruff, David L.**
UC Davis, United States

Chair: **Siarry, Patrick**
Universite Paris 12, Laboratoire LERISS, France

1) *A New Multiobjective Evolutionary Algorithm for Approximating the Efficient Set*, **Hanne, Thomas**, Fraunhofer ITWM, Germany

We present a new evolutionary algorithm for approximating the efficient set of a multiobjective optimization (MOO) problem with continuous variables. This algorithm is based on populations of variable size and exploits new rules for selecting alternatives generated by mutation and recombination. Together with additional assumptions on the considered MOO problem and further specifications on the algorithm, theoretical issues related to approximation will be discussed.

2) *Continuous Variable Entropy-driven Annealing (EdA)*, **Anjo, Antonio Jose Batel**, Departament de Matematica, Portugal; **Rodrigues, Maria Rosalia**

Entropy-driven Annealing (EdA) is a mathematical model for Simulated Annealing, based on the concept on Entropy, in the Information Theory sense. EdA provides a theoretical framework for a proof of the method's convergence, as well as the totally automatic generation of cooling schedules. All the usual annealing parameters, derived from the model, are generated in run-time and adaptable to the specific problem instance. In this talk, results of EdA's adaptation to Continuous Variable Optimization Problems will be presented and discussed.

3) *An Evolutionary Method for Solving Multi-Modal Optimization Problems*, **Lazzerini, Beatrice**, Dept Information Eng, Italy; **Marcelloni, Francesco**

We propose a method to solve multi-modal optimization problems with continuous variables. The method uses an evolutionary search strategy, which forces the formation and maintenance of sub-populations of solutions. Only local interactions are allowed in order to avoid migration between sub-populations approximating different optima and to prevent the destruction of sub-populations. To this end, specific genetic operators are adopted. A new type of convergence allows the method to terminate with a population having as many individuals as there are optimal solutions. We present results of the application of our method to detect the number and position of cluster prototypes in real-world data sets.

MA12 **OR for Development Prize Competition I**

Invited session Venue: AT-6

Organizer: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

Chair: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

1) *Introduction to IFORS OR for Development Prize*, **Dutta, Goutam**, Indian Institute of Management, Ahmedabad, India

In this paper, the history of IFORS OR for Development Prize would be discussed. This prize competition has evolved over last 15 years.A Statistics of papers of IFORS-1999 and IFORS-2002 would be provied.

2) *A Policy Mechanism For Housing Construction Activity To Achieve Social And Environmental Goals*, **Tiwari, Piyush**, University of Tsukuba, Japan

India faced a shortage of 18.5 million houses in 1991. Carbon dioxide emissions in the manufacture of building materials and lack of affordability of houses are other important issues in developing countries. Affordability of a house is a major determinant of its access. Rising cost of house construction has made it inaccessible to a large proportion of households. This paper interweaves these issues and proposes a housing construction strategy for India. A policy instrument, energy tax, is designed which would enforce the switch in technology and promote those technologies, which are well known as least cost but less adopted.

3) *A Combinational Auction Improves School Meals In Chile*, **Epstein, Rafael**, University of Chile, Chile; **Henriquez, Lysette**; **Catalan, Jaime** ; **Weintraub, Gabriel Y.**; **Martinez, Cristian**

The Chilean State assigns US$180 million yearly to feed 1,300,000 students in the public school system in a single round sealed-bid combinational auction. To improve this NP-complete assignment problem, we constructed an integer linear programming model to decide contract awards optimally among different concession-holders. The model completely changed the nature of the process, generating competition between firms, allowing them to include their scale economies and leading to an efficient resource allocation. This new methodology improved the price-quality ratio of the meals with yearly savings of around US$40 million, equivalent to feed 300,000 children during one year.

MA13 **Electronic Commerce I**

Contributed session Venue: AT-7

Chair: **Venkatadri, Uday**
Dalhousie University, Canada

1) *Agent-based Recommendation System Architecture to Support Multiple Decision Models*, **Kim, Jong Woo**, Chungnam National Univ, Korea; **Lee, Habin**; **Park, Sung Joo**

As a means of one-to-one marketing in B-to-C (Business-to-Consumer) electronic commerce, personalized recommendation techniques are used to determine product recommendation or to select advertisements for display to particular customers. There are several recommendation techniques such as collaborative filtering, rule-based approach, data mining approaches, content-based prediction, Proscal ideal point model, and Bayesian preference model. Previous studies show that there does not exist a dominant technique among them, and product characteristics and data availability are related to choose recommendation decision models. In this paper, an agent-based recommendation system architecture is proposed to use various recommendation techniques collaboratively. The architecture includes individual recommendation agents and a coordination agent to support multiple model-based recommendations. To support model extensibility, model registration mechanism is also designed and prototyped.

2) *The relation between EC and relationship marketing an exploratory study*, **Fang, Wenchang**, Business Administration, Taiwan; **Lee, Ssu-Lang**; **Chu, Suh-Yueh**

We evaluate the relation between Internet on-line service and relationship marketing. Relationship marketing focuses on approaches to build, develop and maintain all successful relational exchanges, and as a result, mutual trust and commitment can be achieved. A growing number of service firms provide the Internet on-line services. Good perceived service quality is obtained when the experienced quality meets the expectations of the customer. It is our purpose to examining the relationship between various EC strategies and relational marketing, we conduct an empirical study in Taiwan¡¦s banks. Individual in-Depth interview and content analysis were used for generating our research model.

3) *Optimization Based Decision Support for Supply Network Planning*, **Venkatadri, Uday**, Dalhousie University, Canada; **Srinivasan, Ashok**

We are interested in operations planning models for supply chain management focussed on firms involved in collaborative and/or competitive behaviour within the eCommerce context. In this context, buyers and suppliers have constant automated information exchange. All parties constantly update production, warehousing, and distribution plans based on negotiations involving product price, features, and due dates. One interesting question, from the supplier's point of view, is how a supplier firm should take part in these negotiations. Of particular interest to us at this point in time is to build an optimization based decision support system that will help an agent of the firm quote due dates and prices. This talk will present a model that we believe addresses this useful need.

MA14 **Decision Sciences in the Global Automotive Industry**

Invited session Venue: AT-8

Organizer: **Chelst, Kenneth**
Wayne State University, United States
Organizer: **Elkins, Debra**
General Motors Research, United States

Chair: **Chelst, Kenneth**
Wayne State University, United States

1) *Stretch Target Setting in Vehicle Product Development*, **Chelst, Kenneth**, Wayne State University, United States; **Sefik, Mustafa**

Jack Welch of GE coined the term "stretch targets" as a managerial strategy that was later widely copied. However, the key decision, "How far to stretch?" has never been structured or modeled. This paper presents a one-variable probabilistic model that answers this question and frame a multi-variable extension. We also summarize the findings of a survey of

stretch target implementation and revision on vehicle product teams.

2) *eRisk Tool for Modeling Design Decisions-A Case Study*, **Monplaisir, Leslie**, Wayne State University, United States; **Chelst, Kenneth**; **Winnard, Nancy**

Late engineering design changes are costly and risky element of product launch in the automotive industry. For example, cost of re-tooling, re-testing, re-processing and re-engineering can be very substantial. Late design changes are risky since product development time constraint does not permit complete verification and testing of new or modified designs, often resulting in poor customer satisfaction and high warranty claims. In this paper we have develop a process to balance the benefits and risks associated with design changes. The methodology that has been implemented as a web-based decision/risk analysis tool (called e-risk) and used by product development engineers.

3) *Evolution of Order to Delivery Concepts in the Automotive Industry*, **Takai, Teri**, Electronic Data Systems, United States; **Oh, Jane**

The most successful automotive companies are the ones who can provide their customers zero-defect, high-quality products. Over the course of product development and manufacturing, the companies forecast and predict future aspects of a product operation by analyzing data of diagnostic test results and making decisions under uncertainties. Decision making process under uncertainty is largely based on application of statistical data analysis for probabilistic risk assessment of the decision. Our focus for the study ther was that the development of metrics and mathematical models is essential but that the accessibility of accurate data was the critical success factor. The automakers are deluged with data but find it expensive and difficult to mine critical information to make decisions. This research emphasizes on studying the evolution of Order to Delivery concepts in the automotive industry and where we see it going.

MA15 **Management Information Systems I**

Contributed session Venue: AT-2B

Chair: **Kanof, Pedro R.**
Johns Hopkins University, United States

1) *A Graph Theoretic Approach to the Analysis of Business Processes*, **Hightower, James K.**, CSU, Fullerton, United States

A Graph Theoretic Approach to the Analysis of Business Processes Implementing large Enterprise Resource Planning (ERP) Systems, such as SAP, generally begins by identifying and, frequently re-engineering, the company's business processes. These processes are often modeled as flow graphs. This paper presents a graph theoretic approach to the analysis of these models. This approach allows us to identify bottlenecks and aids in finding alternative and more efficient structures.

2) *Service-Quality MIS: Improving Service Quality by managing information*, **Yang, Yongheng**, China; **Hui, Yer Van**

In this paper, we propose a conceptual framework for an IT-enabled Service Quality Management Information System (SQMIS), which aims at the effective capture, management, analysis, cultivation and sharing of information and knowledge within a specified enterprise boundary. By identifying the information requirements of each service players, and designing the internal sub-systems of SQMIS and the mechanism for information flow, interaction and sharing, each service player will get the specific information or knowledge to support his/her activities effectively so as to ensure the delivery of high quality service. At the same time, the anticipated SQMIS will help service managers keep their eyes on the information requirements of each service player and information flows within the system. With the aid of SQMIS, the executive managers of service organizations will be more confident of identifying market opportunities, developing new service products, and deploying service capacity.

3) *Method for Planning and Audit Information Technology Solutions Design*, **Kanof, Pedro R.**, Johns Hopkins University, United States

The application of computer-based solutions has passed through many different phases. Today, the heightened need for secure data and systems and to control Information Technology costs increases the urgency to return to the basic methods of management science. I describe a method for integrating the planning of information systems with the design phases in order to facilitate the auditing of the projects and to obtain the correct information at the right time and place.

MA16 **Simulation I**

Contributed session Venue: WR-11

Chair: **Pfund, Michele**
Arizona State University, United States

1) *Useable Distributed Simulation - A Template for the Future*, **Taylor, Simon James Eric**, Brunel University , United Kingdom

Distributed Simulation is a technology that has existed in various forms for around two decades. It currently enjoys widespread use and some success in the defense industry though the mandated High Level Architecture. Distributed Simulation has made little impact on process-based simulation tools and methodologies used in manufacturing and service industries. This presentation investigates the reason for this and, by use of real-world examples, suggests how these industries could practically benefit from the transparent application of this technology.

2) *An Object Oriented Simulation Tool For Power System Analysis and Control*, **Benfarhi, Louiza**, power system engineering, Algeria; **Belkacemi, Mohamed**; **Tolba, Amrane**

SHABAKA is a power system simulator which has been developed, it is an interactive simulation tool designed to analyze and simulate power system operation. It is based on the real world concepts and implemented with the object oriented technique which is applied to each stage of software development . The architecture used to develop the simulation environment allows users to interactively visualize such information and relationships and to gain understanding concerning all the power system applications. The developed SHABAKA is capable of supporting a wide range of applications and allowing modification and maintenance over a long period of time.

3) *The Evaluation Of Deterministic Scheduling Methodologies Using Discrete Event Simulation*, **Pfund, Michele**, Arizona State University, United States; **Fowler, John**

Discrete event simulation (DES) has often been utilized to evaluate the performance of various dispatching rules. Most deterministic scheduling research has focused on developing schedules and evaluating them solely upon deterministic performance, which may not be reflective of actual manufacturing performance. We discuss the development of a testbed that embeds scheduling methodologies within a DES package to emulate the performance of a PWB manufacturing system. In particular, we focus upon efforts required to pass information between the software packages and potential gains / tradeoffs associated with the use of deterministic scheduling algorithms versus dispatching rules in a dynamic manufacturing environment.

MA17 **Optimization techniques for portfolio selection**

Invited session Venue: WR-10

Organizer: **Paris, Francesco M.**
University of Brescia, Italy

Chair: **Paris, Francesco M.**
University of Brescia, Italy

1) *A Decision Support Procedure for Pricing Catastrophe Bonds*, **Jakubowski, Andrzej**, Systems Research Inst, Poland

A new approach to valuation of bonds under the default risk conditions, based on the concept of the investors' two-factor utility function is proposed. The first factor describes the expected average return from the risky investments, while the second - the worst case return. As a class of risky securities the so called catastrophe bonds are considered. For the purpose of the valuation procedure, the new notions of the security safety level, the safety index, as well as a two-rule decision support model are successively introduced. The subjective scale as a measure of the degree of individuals' risk aversion is proposed. The idea of objective and subjective risk components is investigated. The methodology proposed is illustrated by a series of computational examples.

2) *A puzzle in the value of the firm*, **De Giuli, Maria Elena**, University of Pavia, Italy; **Maggi, Mario**; **Magnani, Umberto**

This paper deals with two renowned "Propositions" defining the value of a corporate firm with market traded shares and risky bonds. It points out that: (i} both approaches suffer from some heavy limitations; (ii) they cannot stay together; (iii) some new approach is needed, maybe far from the classic approach.

3) *Selecting optimal portfolios of consumer loans with endogenous probabilities A state preference app*, **Paris, Francesco M.**, University of Brescia, Italy

In our paper we deal with the problem of selecting optimal portfolios of consumer loans by developing a state preference model. It allows us not to explicitly consider the distributional properties of loans' log returns. The model is a static one having the objective to select the loan portfolio maximizing the expected utility of wealth allocated by the bank managers, subject to a number of constraints accounting for basic strategic choices implemented by the bank managers. We specifically address the case of bank managers being able to affect the probabilities associated to alternative loans' payoffs by choosing how to allocate available wealth among their credit applicants. In other words we investigate how the portfolio problem can be handled when the decision maker can contribute to change the probabilities of realizing different economic scenarios.

MA18 **Graph Theory I**

Contributed session Venue: WR-9

Chair: **Yamada, Takeo**
National Defense Academy, Japan

1) *A method for exact reliability of consecutive 2-out-of-(r,r)-from-(n,n):F system*, **Higashiyama, Yoichi**, Ehime University, Japan

A new reliability model, consecutive 2-out-of-(r,r)-from-(n,n):F model, is proposed. The consecutive 2-out-of-(r,r)-from-(n,n):F system consists of a square grid of side n (containing of n*n components) such that the system fails if and only if there is at least one square of side r which includes among them at least two consecutive failed components. For i.i.d. case an algorithm is given for computing the reliability of the system. The algorithm depends on the one-to-one correspondence relation between the representation of the systems and the class of 0-1 matrices having no two consecutive 0's at any square of side r.

2) *Polynomial time algorithms in subclasses of P5-free graphs*, **Schindl, David**, EPFL, Switzerland

The complexity status of the maximum stable set problem in the class of P5-free graphs is still unknown. A characterization of all connected P5-free augmenting graphs is proposed, and its application leads to many new families of subclasses of P5-free graphs where the maximum stable set problem can be solved in polynomial time. http://dmawww.epfl.ch/~schindl/P5free.pdf

3) *Listing up all the minimum spanning trees in a graph*, **Yamada, Takeo**, National Defense Academy, Japan

Given an undirected graph with edges associated with non-negative weights, the minimum spanning tree problem (MSTP) is to find a spanning tree with the minimum weights. MSTP has been well explored, and efficient algorithms are widely known. However, in a graph there may be more than one minimum spanning trees, and we are concerned with the problem of listing up all of them. Based on the divide and conquer paradigm, we develop a recursive algorithm, and implement it as a C program on a UNIX work station. Through numerical tests, we evaluate the performance of the developed algorithm.

MA19 **Large Scale Optimization I**

Contributed session Venue: WR-1

Chair: **Koda, Masato**
University of Tsukuba, Japan

1) *A large-scale active-set augmented Lagrangean method with spectral projected gradients*, **Birgin, Ernesto G.**, DCC - Univ. de Sao Paulo, Brazil; **Martinez, Jose Mario**

A new active-set method for smooth box-constrained minimization is introduced. The algorithm combines an unconstrained method, including a new line-search which aims to add many constraints to the working set at a single iteration, with a recently introduced technique (spectral projected gradient) for dropping constraints from the working set. This method is used in an augmented Lagrangean frame to solve general constrained problems. Global convergence is proved. A computer implementation is fully described and a numerical comparison assesses the reliability of the new algorithm.

2) *Redundant Constraints: a Tool for the Solution of Large Mixed-Integer Nonlinear Programs*, **Liberti, Leo**, CPSE, Imperial College, United Kingdom; **Pantelides, Constantinos**

Convergence of Branch-and-Bound algorithms for the solution of MINLPs is obtained by finding ever nearer lower and upper bounds to the objective function. The lower bound is calculated by constructing a convex relaxation of the MINLP. Redundant constraints are new linear problem constraints which are (a) linearly independent w.r.t. the exisisting constraints; (b) redundant w.r.t. the original MINLP formulation; (c) not redundant w.r.t. its convex relaxation. Thus, they can be successfully employed to tighten the feasible region of the convex relaxation without cutting the feasible region of the original MINLP.

3) *Function Minimization by Noise*, **Okano, Hiroyuki**, IBM Tokyo Research Lab, Japan; **Koda, Masato**

A new function minimization algorithm such that a solution is updated based on gradient information approximated by using noise is proposed. The algorithm generates sample points with Gaussian white noise, and approximates derivatives based on a stochastic sensitivity analysis. Unlike standard trust region methods which calculate gradients with n or more sample points, where n is the number of variables, the proposed algorithm allows the number of sample points to be less than n. Through intensive numerical experiments, the algorithm is shown to find reasonably good solutions for noisy objective landscapes.

MA20 **Optimization in IP Netwoks**

Invited session Venue: WR-2

Organizer: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

Chair: **Fortz, Bernard**
Universite Catholique de Louvain, Belgium

1) *OSPF Metric Optimization for IP Routing and Restoration*, **Yuan, Di** , Linkoping University, Sweden; **Varbrand, Peter**

Routing in IP networks is performed by routing protocols, such as the OSPF protocol. Optimization of the metric in OSPF can significantly improve the routing solution in terms of delay. In this talk we address the problem of metric optimization with the emphasis on the routing restoration aspect. The objective is to optimize the metric for the normal operation state as well as all possible link failure scenarios. The problem is formulated as a multi-objective program, and a heuristic solution algorithm is developed to generate efficient solutions. We illustrate the algorithm performance by numerical results.

2) *A tabu search heuristic for optimizing weights in OSPF routing*, **Amaldi, Edoardo**, Italy; **Bondesan, Stefano** ; **Malucelli, Federico**; **Trubian, Marco**

In the traditional datagram scheme for IP networks, packets are routed hop-by-hop along shortest paths. The commonly used Open Shortest Paths First (OSPF) protocol evenly splits traffic flow at each node among all the outgoing links on a shortest path to the destination. Given a traffic matrix, the service operator can control congestion and balance the flow in the network by dynamically changing the weights of the links. To find good sets of weights, we present a tabu search algorithm based on state-of-the-art shortest path reoptimization techniques. Computational results are reported.

3) *On the evaluation of the reliability of OSPF routing in IP networks*, **Fortz, Bernard**, Universite Catholique de Louvain, Belgium

We study the problem of computing the reliability of a network operated using the OSPF protocol where links fail with given independent probabilities. Our measure of reliability is the expected lost demand in the network. Computing this measure is #P-complete, so we developed approximation methods based on related work for circuit-switched networks. Preliminary results show the robustness of optimized OSPF weights compared to hop-based routing.

MA21 **Geographic Information Systems Applications and OR**

Contributed session Venue: WR-3

Chair: **Rump, Christopher M.**
University at Buffalo, United States

1) *Single and Multiple Criteria Combinatorial Partition Models and Algorithms*, **Pereira, Fernando**, University of Beira Interior, Portugal; **Figueira, José R.** ; **Mousseau, Vincent**

Many real-world problems arising from several fields (geographical systems, political districting, agricultural planning, ...) concerning the partition of a given territory into "homogeneous" zones have been studied through the use of optimisation models. In these problems, three main constraints concerning the zones to be defined must be fulfilled: contiguity, compactness and absence of holes. This paper deals with both a review of single and multiple criteria models for partition problems together with optimisation techniques used to implement these models. In addition, we present a real-world application dealing with the public transportation system in the Paris region.

2) *Automatic Planning And Design Of Sewer Networks* , **Gonzalez Torre, Pilar L.**, Universidad de Oviedo, Spain; **Diaz, Belarmino A.**; **Tuya, Pablo J.**

The European Union is forcing the State members to set up new sewerage covering all the areas with more than 2,000 inhabitants. Therefore, many new systems must be planned for sewage treatment. How to connect the new networks with the old ones in the cheapest way is a hard job, given the complexity of the problem that accepts many different solutions. We developed a DSS connected with a GIS that helps the environmental engineers to identify the most interesting alternatives considering economic cost and social cost (given some environmental constraints). The system was tested by the government of the Principality of Asturias, in the rural areas of the region.

3) *Real-Time Emergency Vehicle Routing for Natural and Man-Made Disasters*, **Rump, Christopher M.**, University at Buffalo, United States; **Frank, William C.**; **Rogova, Galina**

We consider emergency vehicle assignment and routing to hospitals in a real-time information fusion environment in the wake of a natural or man-made disaster such as an earthquake or chemical spill or attack. We perform computational testing of our algorithms in a geographic-based decision support system.

MA22 **Artificial Intelligence, Expert Systems and Neural Networks I**

Contributed session Venue: WR-4

Chair: **Mehta, Kumar**
University of Connecticut, United States

1) *Towards A Human Scheduling Algorithm*, **Aickelin, Uwe**, United Kingdom

The long-term aim of this research is to develop a human-like scheduler that learns during scheduling. This paper will describe the groundwork for this goal by trying to prove the concept of a learning supervisor that solves scheduling problems. The supervisor controls the underlying genetic algorithm and learns new rules and strategies while the scheduling is in process, analogous to a human scheduler who learns while scheduling. Parts of the learning take place at a macro level where the supervisor observes global trends such as solution statistics, useful bounds, possible problem partitions and good genetic algorithm parameters. The other part of the learning takes place at the micro level where the supervisor will observe and control negotiations between the entities to be scheduled.

2) *Adequacy of Training Data for Data Mining Time Series*, **Mehta, Kumar**, University of Connecticut, United States; **Bhattacharyya, Siddhartha**

A crucial issue related to data mining time-series is that of training period duration. The training horizon used impacts the nature of rules obtained and their predictability over time. Longer training horizons are generally sought, in order to discern sustained patterns with robust training data performance that extends well into the predictive period. In dynamic environments, however, patterns that persist over time may be unavailable, and shorter-term patterns may hold higher predictive ability, albeit with shorter predictive periods. Such potentially useful shorter-term patterns may be lost when the training duration covers much longer periods. Too short a training duration can, of course, be susceptible to over-fitting to noise. We report on empirical findings regarding the use of different training horizons in context of learning trading rules for S&P500 data.

MA24 **Fuzzy Sets**

Contributed session Venue: AF-13

Chair: **Shipley, Margaret**
University of Houston-DT, United States

1) *Fuzzy Linear Programming: is it Different from Parametric Linear Programming?*, **Sarker, Ruhul**, University of NSW, Australia; **Mohammadian, Masoud**; **Newton, Charles**

The use of fuzzy linear programming has grown considerably over the past several years where the data are vague and inaccurate. The parametric linear programming technique has been used for many years for similar cases. In this paper, we will analysis the similarities and dissimilarities of fuzzy linear programming with parametric linear programming using numerical example.

2) *A Fuzzy Set Based House of Quality for QFD Decisions*, **De Korvin, Andre**, University of Houston-DT, United States; **Shipley, Margaret**; **Yoon, Jeong Mi**

A model is developed that transitions the QFD, House of Quality tool into a fuzzy set based multi-criteria decision making process. Fuzzy sets are defined for customer desires for specific attributes and combined with fuzzy customer perceptions of marketplace competitiveness of the company with respect to the attributes. For each technical criterion, the decision to change from the present requirement is determined by combining fuzzy sets of customer input with the strength of the relationships between the attributes and the technical criterion, the technical difficulty of making the modification, and the competitive position with respect to that criterion.

3) *Supplier Selection Using Fuzzy Multiple Objective Decision Making*, **Fazel Zarandi, Mohammad Hossein**, AmirKabir University , Iran; **Saghiri, Soroosh**

This paper focuses on the appropriate selection of suppliers and assigning order quantities to them in the case of multiple sourcing with multiple objective and their related constraints using fuzzy decision making approach. In the proposed model, goals, constraints, variables and coefficients are all fuzzy. It is shown that with the application of the fuzzy methodology, the multi-objective problem is converted to a single one that can be solved easily.

MA25 **Mathematical Programming-General I**

Contributed session Venue: AF-14

Chair: **Wee, Hui Ming**
Chung Yuan Christian Univ, Taiwan

1) *Double Programming of Oil Well Trajectory Optimization Design*, **Feng, Enmin**, China; **Wu, Shilei**

The well trajectory design is to select the most feasible section from all sorts of sections and optimize all diathesis of it to gain the shortest curve of well trajectory To solove the problem above firstly we constract a section set which contains all kinds of combinations of segments including vertical lines lines fixed slope curves increasing slope and curves falling slope Secondly found a double programming model whose first programming target is to select the most feasible section and the second is to get the best well trajectory design Uniformity distribution method is used to seek for feasible dots in definition field of the programming efficiently This programming amalgamate different project process for the first time and the design result experimenting on LiaoHe oil wells is satisfied

2) *The First Linear Programming Shoppe*, **Gass, Saul I.**, University of Maryland, United States

We review the early history of linear programming with respect to the solution of linear equations, computer developments, and its origins within the U.S. federal government.

3) *Re-engineering the Supply Chain for Notebook Computer Industry in Taiwan*, **Yang, Po Chung**, Chung Yuan Christian Univ, Taiwan; **Wee, Hui Ming**

Due to recent economic downturn and the increasing global competition, notebook computer industry is facing great challenges to remain competitive. This study seeks to improve the competitiveness of the industry by re-engineering the supply chain process for industry in Taiwan. After identifying the key drivers in the supply chain, we concentrate on the inventory since it is one of the most important drivers that affects the efficiency and responsiveness of the supply chain. Quantitative approach using OR is used to derive the optimal inventory policy in the integrated multi-echelon inventory in the supply chain.

MA26 **Stochastic models I**

Contributed session Venue: AF-18

Chair: **Pacheco, Antonio**
CMA and IST - Lisbon, Portugal

1) *New Product Quality and Timing Under Competition*, **Deshmukh, Sudhakar D.**, Kellogg Management School, United States

We model R&D and new product introduction under competition as a stochastic game. During R&D each firm's product quality improves, but so does the risk of its competitor introducing his product first. We show that in equilibrium each firm sets a minimum threshold and introduces its product the first time its quality exceeds the threshold. We then study how the equilibrium quality and timing of introduction depend on the intensity of competition. In particular, we show that competition among two equally strong firms is socially optimal.

2) *Independent Component Analysis - Mathematical Foundations and Applications*, **Oliveira, Maria Paula**, Universidade Portucalense, Portugal; **Anjo, Antonio Jose Batel**; **Tavares, Ana Helena**; **Martins, Jose**; **Galante, Helena Isabel**; **Almeida, Ricardo**

Independent Component Analysis (ICA) is a statistical technique for transforming an observed multidimension random vector into components that are statiscally as independent from each other as possible. The mathematics involved in this process is the kernel of this communication. In order to obtain the independent components, a fixed point algorithm is used. The convergence of the algorithm will be proved. Some applications of ICA will be mentioned.

3) *Multiobjective Stochastic Programming*, **Kankova, Vlasta**, UTIA AV CR, Czech Republic

We consider a multiobjective problem with mathematical expectation in criteria and probability measure in constraints. The complete knowledge of the probability measure is then a necessary condition. Since this assumption is fulfilled very seldom empirical data very often must "substitute" the unknown probability measure. The aim of the contribution is to investigate properties of such approximations. Stability results (considered w.r.t. the measure parameter) as well as the results on large deviation will be employed to this end. The achieved results will be demonstrated on a problem of unemployment and restructuralization.

4) *Modeling IP traffic using dBMAPs*, **Salvador, Paulo**, IT - Aveiro, Portugal; **Valadas, Rui**; **Pacheco, Antonio**

This paper proposes an algorithm that leads to an accurate fitting of IP traffic. The procedure is based on a detailed modelling of both the packet arrival process and of the packet size distribution. The modelling process is the discrete-time batch Markovian arrival process (dBMAP), which allows for the simultaneous matching of both: (i) the autocovariance and marginal distribution of the packet arrival process and (ii) the distribution of the packet size. We have applied the inference procedure to traffic traces exhibiting long-range dependence and evaluated their queuing behaviour through simulation. Very good results have been obtained, both in terms of queuing behaviour and number of states.

MA27 **Production Management & Manufacturing I**

Contributed session Venue: AF-19

Chair: **Misra, Sheo G.**
Misra Associates, United States

1) *Optimising a production line based on multiserver heterogeneous queues using simulation*, **Tareghian, Hamed Reza**, Iranian Maths Society, Iran; **Shahkar, Gholam Hossein**

In this paper we are concerned with the optimal design of the production line of an industrial unit producing metal parts. We consider this problem in the framework of design and control of multiserver heterogenous M_G_c queues. We study the effect of number of servers and the allocation of desired service rate between the servers on the mean transit time using simulation. We show that to minimise both mean and dispersion of parts transit times, the industrial unit should run its production line with two identical production facilities. This reduces the parts mean transit time by at least 10 percent.

2) *Flexible Machining In An Integrated System*, **Misra, Sheo G.**, Misra Associates, United States

Flexible machining offers productivity, affordability, and enhanced quality. Massive modernization efforts can yield little net result in productivity improvement and cost reduction without adequate condsideration of the specific application. Integrated systems offer the greatest potential for productivity improvement, yet this benefit must be designed into flexible manufacturing systems (EMS) application to ensure success. This paper describes an approach to the successful application of EMS capabilities.

3) *Pooling of inventories under non-normal demand and suboptimal inventory policies*, **Corbett, Charles J.**, United States

We examine how the value of pooling is affected by several factors commonly arising in practice: non-normally distributed demand, with arbitrary dependence structures, and under suboptimal inventory policies. Specifically, we generalize the well-known statement that pooling has less value as demand becomes more positively dependent, from the classic case with normal distributions to arbitrary distributions. The framework discussed here facilitates analysis of models with arbitrary distributions with arbitrary dependence structure, rather than the commonly used multivariate normal distribution. Finally, we analyze the value of pooling under various non-normal distributions and under suboptimal policies, using numerical and empirical demand data.
http://personal.anderson.ucla.edu/charles.corbett/papers/01-004.pdf
http://personal.anderson.ucla.edu/charles.corbett/papers/99-004.pdf

MA28 **Game theory I**

Contributed session Venue: DH-C

Chair: **Pavlovic, Ljiljan Rradivoja**
Faculty of Mathematics, Yugoslavia

1) *On the Quantitative Approach of Apportioning Capital for the Public Project*, **Liu, Wei**, Lakehead University, Canada; **Huang, Wendy**; **Huang, Yuxiang**

To construct the pure or quasi public project, especially a large-scale project or trans-regional one in developing country, like the project of inland waterway dredging, water resource developing or environment improving, is always in a dilemma as to whether to construct or not because of federal short of capital. So it is quite important that there have to be a quantitative approach to apportion the construction capital fairly and effectively among the regions benefited from the project to share the pressure of federal finance. The paper discusses the principles of apportioning capital for public trans-regional project and the possible quantitative approaches. On the basis of game theory, the author develops a synthetical approach of apportioning capital that integrates the cooperative game theory with multi-objective quadratic programming. A practical example of inland shipping infrastructure construction given here shows this approach fair, effective and applicable.

2) *More On The Search For An Infiltrator*, **Pavlovic, Ljiljan Rradivoja**, Faculty of Mathematics, Yugoslavia

We have asymptotically solved a discrete search game on an array of n ordered cells with two players: infiltrator (hider) and searcher, when the probability of survival approaches one. The infiltrator wishes to reach the last cell in finite time and the searcher has to defend that cell. When the players occupy the same cell, the searcher captures the infiltrator with probability 1-z. The payoff to the hider is the probability that the hider reaches the last cell without getting captured.

MC1 **Disease Detection**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Chaussalet, Thierry J.**
University of Westminster, United Kingdom

1) *Screening following GP referral for heart failure is cost effective*, **Thompson, Wayne Anthony**, Cranfield University, United Kingdom; **Round, Alison**; **Chaussalet, Thierry J.**; **Temple, Jonathan Mark Fraser**; **Fone, David**

Objectives: To enable policy makers to assess diagnostic pathways for heart failure in terms of cost (overheads, diagnostic tests, treatment, and future costs due to misdiagnosis) and effectiveness (quality of life or accuracy of diagnoses). Methods: Diagnosis options comprise empirical diagnosis, echocardiograph test, and screening before echocardiograph. Calculations are performed using decision analysis software DATA. Local data values can be incorporated. Cost-effectiveness sensitivity analyses are output. Results: Screening does not appreciably compromise diagnostic accuracy, and can lead to cost saving. Conclusions: The decision tool promotes transparent decision-making for the Wales implementation of the National Service Framework for Coronary Heart Disease.

2) *The Diagnosis of the Alport Syndrome by Pattern Recognition Techniques*, **Patrizi, Giacomo** , University La Sapienza, Italy; **Giannakakis, Costas**; **Nieddu, Luciano** ; **Onetti Muda, Andrea**; **Addonisio, Gabriella**

Alport syndrome is a genetic multi-organ disorder, primarily X-Chromosome linked, although autosomal forms have been reported. Ultrastructural observation indicate highly characteristics lesions and mutations in certain genes have been known to occur. Thus the syntomatology of the syndrome is complex and multi varied. The aim of this paper is to present a pattern recognition algorithm to diagnose, with high precision, patients which may be subject to Alport's syndrome. Thus images of the epidermal basement membrane are studied and a rule to classify them precisely is presented. Theoretical and experimental results are given regarding the possibility of solving this problem.

3) *Heart failure Effectiveness Analysis and Recommendation Tool (HEART) simulation model*, **Thompson, Wayne Anthony**, Cranfield University, United Kingdom; **Xie, Haifeng**; **Chaussalet, Thierry J.**; **Bethel, Jacqueline Ann**; **Fone, David**; **Round, Alison**

Objectives: To inform the Wales implementation of the National Service Framework for Coronary Heart Disease of resource utilisation (weekly consultancy hours and echocardiograph machine slots) and effectiveness (patient and weekly costs, and diagnosis and treatment episodes) of introducing different diagnosis policies for heart failure. Methods: Discrete event simulation using Microsaint software of patients' first pass through diagnosis and treatment following GP referral. Alternative systems are configured comprising empirical diagnosis, echocardiograph test, and screening before echocardiograph. Results: Screening pathway increases throughput with little deterioration in diagnostic accuracy. Conclusions: HEART provides detailed analysis that enables the decision maker to use local data.

MC2 **Congestion Toll Pricing Models and Methods**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Hearn, Donald W.**
ISE Department and Center for Applied Optimization, United States

1) *Computational Methods for Congestion Toll Pricing*, **Hearn, Donald W.** , ISE Department and Center for Applied Optimization, United States; **Bai, LiHui**; **Lawphongpanich, Siriphong** ; **Yildirim, Mehmet Bayram**

We will describe recent progress on the development of computational methods for computing congestion tolls in traffic assignment. The approach centers on the construction of toll sets as polyhedra, then optimization of various objectives, such as minimizing toll revenue or the number of required toll booths, with respect to an appropriate toll set. The approach is applicable in first and second best pricing models for both fixed and elastic demand traffic assignment models.

2) *Modeling Traffic Delays in Dynamic Transportation Networks*, **Perakis, Georgia**, MIT, United States; **Kachani, Soulaymane**

Traffic congestion has become an acute problem in recent years. Furthermore, this problem has become of even greater significance due to the fast growing field of Intelligent Transportation Systems (ITS). Understanding travelers' travel times (delays) is key behind this problem. In this talk we take a fluid dynamics approach to present a macroscopic model for determining analytical forms for travel times. This model incorporates the reaction of drivers to upstream and downstream congestion and link interaction effects. Furthermore, this model can also be incorporated in the dynamic traffic assignment problem.

3) *Minimal Revenue Toll Problem The Case of Stochastic User Equilibrium*, **Stewart, Kathryn**, SBE TRI Napier University, United Kingdom; **Maher, Mike**

The minimal revenue toll problem has, in the case of deterministic assignment, been solved such that the System Optimal solution is obtained, by various methods: Linear Programming (Bergendorff et al, 1997), reduction to multi-commodity max-flow problem (Dial, 2000). The proposed paper intends to develop methodologies to examine the minimal revenue toll problem in the case of Stochastic User Equilibrium, such that the toll sets required would produce a 'Stochastic Social Optimum' flow pattern. Results will be compared with those obtained in the deterministic case.

4) *Optimization And Calibration Of A Yield Management Model*, **Cote, Jean-Philippe** , Univ of Montreal, Canada; **Marcotte, Patrice**; **Savard, Gilles**

We consider a bilevel program that jointly solves the pricing and seat allocation problems for an airline. The model takes

explicitly into account both the structure of the route network and the rational behaviour of customers, while the travelling population is segmented according to criteria (cost, time, quality of service, etc.) whose parameter weights are evaluated by a bilevel inverse optimization procedure. Numerical results on realistic data will be provided.

MC3 Weight Estimation for AHP

Invited session Venue: DH-N

Chair: **Osawa, Keikichi**
Nihon University, Japan

1) *An estimate method and compensation in incomplete Analytic Hierarchy Process*, **Nishizawa, Kazutomo**, Nihon University, Japan

This paper proposes a method to estimate and compensate in incomplete information Analytic Hierarchy Process. The typical estimate methods are Harker method and Two-Stage method. In Harker method, weights are calculated without estimate incomplete comparisons. In Two-Stage method, first, estimate incomplete comparisons and next calculate weights. Therefore, priority of estimated comparisons and actual comparisons are equal. As a result, some problems occurred. In this study, incomplete comparisons are estimated by repeating geometric mean. Finally, all comparisons are compensated by priority of estimate difficulty.

2) *Comparing Priority Weight Estimation Methods under General Error Generation Process*, **Miyake, Chikako**, Nihon University, Japan; **Shinohara, Masaaki**

Four weight estimation methods, EGV(Eigenvector), GMM(Geometric Mean), ENT(Entropy) and HMM(Harmonic Mean), are compared under assumption of general error generation process. This general error generation process simulates changing process of weight vectors in our mind, from true weight vector to measured discrete pairwise comparison matrix. Samples of measured matrices are generated with various types of errors added in the process and the four methods are applied to each sample to estimate the weight. Then, the distance between true weight and estimated weight is evaluated among the four

3) *Statistical Reliability Assessment of Priority Weight for Double-Loop Regular Graphs*, **Harima, Satomi**, Nihon University, Japan; **Miyake, Chikako**; **Shinohara, Masaaki**

When estimating priority weight of n items as in AHP, complete information of nC2 pairwise comparisons is not always available. Moreover, it is not necessary to have complete information. There exists a tradeoff between the amount of pairwise comparison information measured and the accuracy of estimated priority weight. Theory of evaluating statistical reliability of priority weight is presented for the case of regular graphs, and numerical result of the variance of estimated weight is shown for the case of double-loop regular graphs. This numerical table facilitates the selection of more accurate combination of pairwise comparisons.

MC4 Cutting and Packing: 3-d Problems

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Bischoff, Eberhard Ernst**
E.B.M.S., University of Wales Swansea, United Kingdom

1) *Three dimensional palletisation with load interaction considerations*, **Eustace, Colin Murray**, Australia; **Asokanthan, Samuel Francis**

In an attempt to automate the parcel loading process in the mail industry, an on-line, 3D, heuristic based, parcel-stacking algorithm has been developed. A multiple level interaction analysis of the parcels is completed to ensure the resulting palletised load is stable. Loading, weight restrictions and other physical requirements are also addressed.

2) *Method of dynamic sorting for 3-D bin-packing problems*, **Valeyeva, Aida F.**, Russia; **Gareyev, Ilgiz R.**

A NP-hard problem of 3-D bin-packing is considered. Method of dynamic sorting (DS) receives set of the quasi-optimal packing with the same value of the goal functions. Modification of this method performs the real problem of packing of objects in canisters with allowance for of weights of objects and weight-lifting ability of canisters. Keywords: 3-D bin-packing, method of dynamic sorting, canister, packing

3) *Aspects of 3-D Packing*, **Bischoff, Eberhard Ernst**, E.B.M.S., University of Wales Swansea, United Kingdom

The paper deals with 3-D packing problems and focuses particularly on container loading problems. It investigates a wide variety of different problem scenarios encountered in practice and highlights the multi-objective nature of the problem. Stability and weight distribution are only two of the criteria which come into play in addition to the obvious objective of an efficient volume utilisation. The paper examines progress to date in this area and outlines some new approaches to the problem.

MC5 Tutorial: The Max-Plus Algebra: A new Approach to Performance Evaluation of DES

Invited session Venue: MS-1

Chair: **Heidergott, Bernd**
TU Eindhoven, The Netherlands

1) *Tutorial: The Max-Plus Algebra: A new Approach to Performance Evaluation of DES*, **Heidergott, Bernd**, TU Eindhoven, The Netherlands

Tutorial: This tutorial provides an introduction to the (max,+) algebra with a view towards performance analysis and control of DES. First, we introduce the basic concepts of the (max,+) algebra. In a second part, performance analysis and control of deterministic DESs is addressed. Our main example will be public transportation networks. We will discuss the application of eigenvalues and eigenvectors in (max,+) algebra to timetable design and robustness analysis of timetables and present a simple scheme for calculating propagation of delays. Eventually, we discuss applications of (max,+) algebra to ergodic theory and stability analysis of stochastic DES.

MC6 More DEA from Warwick

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Shale, Estelle Antonia**
Warwick Business School, United Kingdom

1) *Selective Proportionality in DEA Models*, **Podinovski, Victor V.**, Warwick Business School, United Kingdom

This paper presents the hybrid returns-to-scale DEA model, which is based on proportionality between selected groups of inputs and outputs. This fills the gap between the constant and variable returns-to-scale models. In some cases, the discrimination of the new model exceeds the discrimination of the constant returns-to-scale model.

2) *Assessing service quality efficiency in retailing*, **Coughlan, Joseph**, Faculty of Business DIT, Ireland

Acquisition and ultimately retention of customers are the dual goals of retailers. In achieving these goals, retailers have invested heavily in the area of improving the service experience for the customer. This research aims to see how efficient stores are at generating service quality from this investment, using Data Envelopment Analysis. A service quality DEA model will be discussed which aims to focus the attention of the retailer on the evaluation of service quality and the further integration of this measure into outlet-efficiency measures.

3) *DEA: division or diversity?*, **Shale, Estelle Antonia**, Warwick Business School, United Kingdom; **Kaltsonis, Christos**

If one looks at the DEA literature as a dispassionate observer, one might conclude that DEA exists as a number of schools of thought rather than a single field. Why do we suggest this? Whether we observe the journals of publication or the distribution of citations there appear to be at least two main 'camps'. We shall label them 'Management Science' and 'Production Economics'. Is this division a figment of our fevered imaginations? Does it matter if our research area has a choice of 'flavours'? Is it an opportunity to be exploited or a threat to the healthy development of DEA?

MC7 Decision Making under Uncertainty II

Invited session Venue: AT-2

Chair: **Yoshitomi, Yasunari**
Kyoto Prefectural Univ, Japan

1) *Facility Location Problem with Min-max and Max-min Criteria* , **Ishii, Hiroaki**, Graduate School of Engineering Osaka University, Japan; **Miichi, Akira**

We consider the public facility location problem such as disposal center which is obnoxious for the residents near it but helpful for the local government and residents far from it. In order to settle it in a suitable site, we consider optimal facility location problem with bi-criteria, minimum distance from the facility to be maximized and maximum distance from it to be minimized. Here negative customers with max-min criterion and positive customers with min-max criterion are located in the mesh points of the rectangular region, distance is rectilinear and the facility also should be located at some mesh point.

2) *Method of Identifying Member's Thought from Voting Data*, **Noguchi, Hiroshi**, University of MDS, Japan; **Ishii, Hiroaki**

This paper show a method of measuring each factor's contribution value to the voting result from social survey. Voting data is generally the poll rate. For analyzing the poll rate, we demonstrate a method that employs quadratic fractional programming and is used to determine the minimum of the criterion called Stress. From this method, we can estimate the reason that the resulting ratios occur with more accuracy than with conventional regression analysis. It should be stressed that we can obtain each factor's contributoion value with a specified condition when each factor's contribution value is plus and the sum of each factor's contribution value is 100. We show these advantages from voting data for members to the opinions of enveroinmental circlating system.

3) *Possibilistic linear programming with interactive fuzzy coefficients*, **Inuiguchi, Masahiro**, Osaka University, Japan; **Tanino, Tetsuzo**

Possibilistic linear programming has been developed under the non-interaction assumption. Without this assumption, in general, the problem becomes intractable. The problem with interactive fuzzy coefficients have not yet discussed considerably, so far. In this paper, we treat the problems with interactive fuzzy coefficients. For interactive fuzzy coefficients, we assume that we know linear fractional function values of uncertain coefficients as fuzzy numbers. We show that the fractile optimization, modality optimization and symmetric models using necessity measures can be solved by iterative use of linear programming techniques.

MC8 **Financial Risk Management Models**

Invited session Venue: AT-3

Organizer: **Zenios, Stavros**
University of Cyprus, Cyprus

Chair: **Vladimirou, Hercules**
University of Cyprus, Cyprus

1) *A framework for measurement and control of risk - 'Optimum Risk Decisions'*, **Kyriakis, Triphonas**, Dr, United Kingdom; **Mitra, Gautam**

A number of alternative models of risk such as: variance, mean absolute deviation (symmetric), expected downside risk, value at risk, conditional value at risk (asymmetric) have been developed to quantify and measure risk. Practitioners often use pricing models and simulation tools for describing the behaviour of random parameters in financial applications. Within the simulation paradigm for a given decision such risk measures are easily computed. We consider a more challenging problem of computing 'optimum risk decisions'. We propose a framework for optimisation which extends the well established stochastic programming paradigm of computing hedged decisions to that of computing the best decision in respect of a given risk measure.

2) *Integrated Market and Credit Risk Asset and Liability Management Models*, **Jobst, Norbert**, CARISMA, Brunel University, United Kingdom; **Zenios, Stavros**; **Mitra, Gautam**

We present stochastic optimisation models for portfolios of integrated market and credit risk sensitive securities. Reduced form pricing models for credit risk are employed for scenario generation to represent uncertainties in credit markets. The approach captures stochasticity in interest rates and credit spreads linked with rating migration processes based on historical data. Linked to stochastic optimisation paradigms, numerical results are presented for tracking corporate bond indices as well as broader asset and liability management problems.

3) *Stochastic Programming Models for International Portfolio Management*, **Vladimirou, Hercules**, University of Cyprus, Cyprus; **Topaloglou, Nikolas**; **Zenios, Stavros**

We develop stochastic programming models for managing multi-currency investment portfolios in the context of scenario analysis. Scenario sets that depict the discrete joint distributions for the uncertain asset returns and the currency exchange rates constitute the necessary inputs to the stochastic optimization models. The scenario generation procedure is based on principles of moment matching and is calibrated using historical market data. The scenario-based optimization models incorporate alternative hedging strategies. Thus, the portfolio optimization models determine jointly the portfolio composition and the appropriate level of currency hedging via forward currency exchange contracts. The models apply the conditional value-at-risk (CVaR) metric to control total risk exposure. The performance of alternative models on international portfolios of stock and bond indices is assessed through empirical experiments using real market data.

MC9 **Electric Power Market Modeling II**

Invited session Venue: MS-3

Organizer: **Oren, Shmuel**
University of California, Berkeley, United States

Chair: **Hobbs, Benjamin F.**
The Johns Hopkins University, The Netherlands

1) *Analysis of short term dynamic behavior of an electric market*, **Ramos, Andres**, IIT-UPCo, Spain; **Baillo, Alvaro**; **López-de-Haro, Santiago**; **Rivier, Michel**; **Ventosa, Mariano Jose**

The model developed is oriented towards the representation of dynamic aspects of the electric market in the short term. The main purpose is to explore the interaction among companies through the offers systematically sent to a day-ahead single-node uniform-price market. The conceptual framework is aimed to shed light on two main questions: 1. How the results of medium term models (i.e., market share objectives, hydro scheduling, system marginal price) are internalized into daily offers. Or, alternatively, how to reach medium term objectives by means of short term offers. 2. How to analyze in detail the market dynamics in case of severe perturbations of market agents behavior (i.e., price wars).

2) *Fitting Electricity Market Models with a Conjectural Variations Approach*, **Ventosa, Mariano Jose**, IIT-UPCo, Spain; **Garcia-Alcalde, Antonio**; **Denis, Rafael**; **Rivier, Michel**; **Ramos, Andres**

The worldwide electricity industry has been embedded in a significant restructuring process toward deregulation and competition during the last decade. Simultaneously, an important research effort has been made to properly incorporate market features within generation operation models. Cournot equilibrium has been one of the theoretical frameworks most widely used to model market behavior. However, it presents relevant weakness related to its high sensitivity to the demand elasticity. This paper proposes the use of firms' conjectural variations to overcome this difficulty and shows a procedure to determine them. The method, designed for long-term operation models, infers the implicit values associated to the firms' residual demand employing only public market information.

3) *Maintenance Games in Electricity Generation*, **Murphy, Frederic H.**, Temple University, United States; **Smeers, Yves**

We investigate the differences between the solutions of open-loop and closed-loop models in a duopoly game of electricity generation with decisions on planned maintenance and electricity generation. In the models firms schedule planned maintenance for their equipment to maximize their profits. In the open-loop game each firm schedules its operating and maintenance decisions presuming both sets of decisions are fixed for the other player. The closed-loop game is a two-stage

game in which each firm optimizes the timing of maintenance in the first stage based on the maintenance schedule of the other player and the solution of a second-stage generation game with the capacities fixed by the first stage.

4) *Market Power and Transmission Policy in the EU*, **Hobbs, Benjamin F.**, The Johns Hopkins University, The Netherlands; **Rijkers, Fieke A. M.**; **Wals, Adrian F.**

The conjectured supply function game of Day et al. is formulated as a linear complementarity problem and is used to model strategic interactions of generating firms in northwestern Europe. Transmission limits are explicitly considered, and the effect of alternative transmission pricing policies upon the intensity of competition and efficiency of the market are considered. Among the policies examined include congestion (LMP) pricing, export taxes, and credits for counterflows. The Day et al. model is extended to simulate the expectation by larger firms that their generation decisions can affect transmission congestion costs.

MC10 **Queueing Models and Analysis**

Invited session Venue: MS-4

Chair: **Luh, Hsing**
Taiwan

1) *On the triadic (0,Q,N,M) policy for the M/M/2 queueing system with finite capacity* , **Wang, Kuo-Hsiung**, National Chung-Hsing Univ, Taiwan

We study two removable servers in the M/M/2 queueing system with finite capacity L operating under the triadic (0,Q,N,M) policy, where L is the maximum number of customers in the system. The number of working servers can be adjusted one at a time at arrival epochs or at service completion epochs depending on the number of customers in the system. Analytic closed-form solutions of the M/M/2 queueing system with finite capacity operating under the triadic (0,Q,N,M) policy are derived. This is a generalization of the ordinary M/M/2 queueing system and the N policy M/M/1 queueing system in the literature. The total expected cost function per unit time is developed to obtain the optimal operating (0,Q,N,M) policy at minimum cost.

2) *The N policy for the general input queue*, **Ke, Jau-Chuan**, Department of Statistics, Taiwan

An imbedded Markov chain is used to study the operating characteristics of a removable server in a G/M/1 finite capacity queueing system, where the removable server operates an N policy. We obtain the stationary probabilities of the number of customers in the system by means of solving simultaneous linear equations. The method is illustrated analytically for exponential interarrival time distribution. Herein develop the distribution of waiting time in the queue, as well as the distribution of busy period. Keywords: G/M/1 queue, Stationary probabilities.

3) *Solving A Closed Queueing Network--A New Approach*, **Luh, Hsing** , Taiwan

Consider a two-stage closed queueing system in which the service times are assumed identically of phase type. If the Laplace-Stieltjes Transforms of service time distributions satisfy a system of equations, then we show that the stationary probabilities on the unsaturated states can be written as a linear combination of product-forms where each component of these products can be expressed in terms of roots of the system of equations. An algorithm is constructed to solve all the stationary probabilities of the queueing network. The complexity of the algorithm is independent of the total number of customers in this system.

MC11 **Advances In Metaheuristics**

Invited session Venue: MS-5

Organizer: **Glover, Fred**
United States
Organizer: **Lokketangen, Arne**
Molde College, Norway
Organizer: **Nath, Baikunth**
Australia
Organizer: **Woodruff, David L.**
UC Davis, United States

Chair: **Voss, Stefan**
University of Technology Braunschweig, Germany

1) *Teaching Metaheuristics within VORMS*, **Voss, Stefan**, University of Technology Braunschweig, Germany; **Reiners, Torsten**

Modern education of OR/MS will include interactive learning methods, in order to build and develop modeling and problem solving skills. We discuss possibilities of supporting the teaching of metaheuristics such as tabu search or the pilot method through interactive learning. Ideas incorporate the use of HOTFRAME, a heuristic optimization framework. The overall setting is the project VORMS (Virtual Operations Research / Managament Science) which is currently performed at six universities within Germany. The presentation will include a survey on VORMS and focus on the advances currently made regarding the teaching of metaheuristics within this project.

2) *General Purpose Metrics in Solution Spaces*, **Woodruff, David L.**, UC Davis, United States

When using optimization in the context of a decision support system, a decision maker would often be more interested in seeing a diverse collection of good solutions rather than the one solution that is in some mathematical sense the optimal solution to an approximate problem with imprecise data. Also, many metaheuristic methods assert the ability to construct a diverse set of solutions. This talk describes and justifies on-going research toward general purpose methods for characterizing diversity. Field research serves to demonstrate and compare various methods. We provide some fundamental research concerning methods that are fully general and do not rely on any knowledge of the problem.

3) *Path Relinking for Multicommodity Network Design*, **Gendreau, Michel**, Canada; **Crainic, Teodor Gabriel**; **Ghamlouche, Ilfat**

In this paper, we study the adaptation of the Path Relinking strategy to the Capacitated Multicommodity Network Design (CMND) problem. Our Path Relinking approach is based on a new class of cycle-based neighborhoods that we proposed recently for the CMND within a simple tabu search heuristic. Several strategies for creating the reference set and several criteria for selecting the initial and the guiding solutions in the relinking process proper are considered and tested on a set of large benchmark instances. Computational results show that using Path Relinking provides significantly better solutions than simple tabu search.

MC12 **OR for Development Prize Competition II**

Invited session Venue: AT-6

Organizer: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

Chair: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

1) *Best Variant Solution Of Copper Ore Transport In Underground Mining*, **Jovanovic, Aca**, COPPER INSTITUTE BOR, Yugoslavia; **Zrnic, Djordje**

Optimization of performances at system level and methodology for obtaining total system performances has not been introduced in modelling of the complex transport systems in mining. Development of modelling, designing and selection of the best variant solution is lagging behind the technical development and solutions of knot paints of transport and haulage system. An integral method was presented with multi-mutual interactive modules (modelling of variant, multi-criterion, taking the system performances at the required level through an iterative method of evaluation and simulation, what results in the "best" solution from starting set of possible variant solutions.

2) *School Location Methodlogy in Urban Areas of Developing Countries*, **Pizzolato, Nelio Domingue**, Catholic University , Brazil; **Barcelos, Fabricio Broseghini** ; **Lorena, Luiz Antonio Nogueira**

The study is concerned with the location of primary schools. Students may elect a public school or a private one if they can afford the corresponding costs. The objective of the study is both the evaluation of the existing network and a relocation proposal. The paper examines the location of elementary public schools in the area of Vitoria, a state capital located in the southeast part of Brazil with about 300,000 inhabitants*. Finally, the practical use of the study and its importance for planning purposes are discussed.

3) *NATIONAL CONTRIBUTION (South Africa): Network Service Scheduling and Routing*, **Groves, George**, Univ of Stellenbosch, South Africa; **Roux, Jeanne Le** ; **Van Vuuren, Jan H.**

NATIONAL CONTRIBUTION from SOUTH AFRICA: We present a graph theoretic heuristic to determine an efficient service route through a transportation network that requires a subset of its edges to be serviced, each a specified (potentially different) number of times. The times at which each of these edges are to be serviced should additionally be as evenly spaced through the scheduling time window as possible, thus introducing a scheduling consideration to the problem. Our heuristic is based on the tabu search method in conjunction with various well known graph theoretic algorithms. This heuristic is implemented as the backbone of a computerised decision support system.

MC14 **Manufacturing in the Global Automotive Industry**

Invited session Venue: AT-8

Organizer: **Chelst, Kenneth**
Wayne State University, United States
Organizer: **Elkins, Debra**
General Motors Research, United States

Chair: **Elkins, Debra**
General Motors Research, United States

1) *On Agile Machining Systems*, **Elkins, Debra**, General Motors Research, United States; **Huang, Ningjian**; **Alden, Jeff**

Agile machining systems can improve resource utilization, enable dynamic “chaining” of capacity to make the right products in the right volumes at the right times (i.e., dynamically assign and re-assign products to plants), and permit rapid and effective response to changing product models. Definitions of dedicated, agile and flexible machining systems are provided to help reconcile academic research with industry application. Two decision models are then developed to explore the financial implications of agility from an industry perspective. The decision models are a first step toward developing business case tools that account for uncertainty in decisions about system agility.

2) *New Sequential Model For Aided Process Planning*, **Garcia-Romeu, Maria Luisa**, University of Girona, Spain; **Ciurana, Quim de**; **Gimenez, Gerusa**; **De Castro, Rudi**

This contribution presents the route definition problem depending on technologic traits. This is focused on the use of Computer Aided Process Planning systems. The engineer know-how is considered essential for the process planning. The objective is to define new sequential steps for aided process planning. The sequential schema will allow to find the sheet route using a methodology process. There are a lot of researchers who proposed their sequential steps. The present work tries to evaluate this kind of works. The evaluation is made with different parts. This parts are chosen using Opitz group technology classification. From results, the paper obtain a new sequential schema which are more consistent with the

manufacture reality.The two relevant ideas in the new schema will be the introduction of new steps and feed back.

3) *Global Simulation Support in Ford's Power Train Operations*, **Ladbrook, John**, Ford Motor Company, United Kingdom; **Taylor, Simon James Eric**

This paper discusses the changes that were required to Ford's Power Train Operations (PTO) simulation environment to ensure the maximum benefit was gained from the investment. The background driving the change was that simulation had been a key tool in the planning and process improvement of Power Train Manufacturing Engineering facilities since the early 80's. User's originally determined the software they were going to use however this approach resulted in low utilization, a high unit cost and a diversity of products used. The objective was to transform an isolated approach taken on two continents into a single one across 5 continents while significantly reducing the unit cost. The method selected was a single software solution that could be distributed across the Ford intranet to anyone in PTO.

4) *Work cell layout optimization in Automotive Assembly*, **Klampfl, Erica**, Ford Motor Company, United States; **Gusikhin, Oleg**; **Rossi, Giuseppe** ; **Aguwa, Celestine**; **Coffman, Gene** ; **Martinak, Terry**

We will present the method and technology used to determine an efficient arrangement of an operator's workspace in an automotive assembly line: the objective is to minimize the path the operator must travel as he/she performs his/her tasks. The mathematical formulations and solution techniques vary depending on work cell specifications and operator preferences. We will also demonstrate the interactive software tool that incorporates our method; this tool provides suggested optimal solutions and allows planning engineers or line operators the flexibility of what-if analysis of the solutions based on their specific preferences and constraints.

MC15 **Management Information Systems II**

Contributed session Venue: AT-2B

Chair: **Kanof, Pedro R.**
Johns Hopkins University, United States

1) *Using forecasting systems experimental and empirical contrasts*, **Fildes, Robert**, Lancaster University, United Kingdom; **Goodwin, Paul**

Forecasting systems are an integral part of the supply chain but little is known about the use of such systems despite their importance. This paper uses two research methods to examine the processes adopted by forecasters when they interact with forecasting support systems (FSS). Forecasters were both interviewed and observed making their forecasts in real time. Recordings of forecasters' actions using an experimental FSS traced the processes they employed. The results of the study yielded valuable insights into how forecasters use the information available to them and how such systems should be designed.

2) *Managing Performance and Knowledge and Learning at the Social Security Ministry*, **Cochrane, Ednea**, United Kingdom

This paper relates a successful experience of implementing a typical Hard OR consultancy project to solve the optimisation of the positioning of Benefit Post in Brazil using Knowledge sharing techniques during the life cycle of the project. This paper describes the details of the methodology used and we believe they can be easily adapted to other real-problem challenges faced by OR consultancy companies today.

3) *Surveying and Indexing of Utilizing Information Technology by Prefectural Medical Associations*, **Ohuchi, Azuma**, Hokkaido University, Japan

In this paper, we propose a method to develop a questionnaire survey and index the utilization of information technology by prefectural medical associations. The method involves conducting a questionnaire survey to assess the utilization by prefectural medical associations in terms of these points, i.e., infrastructure (I), skill (S) and mind (M). Four indices to verify the utilization of IT by prefectural medical associations are proposed, i.e., ISM-index, ISM+- -index, LU-index and LUR-index. The proposed method was applied in carrying out the surveying and indexing of the Hokkaido Medical Association. The result reveals the wide applicability of the method.

MC16 **Simulation II**

Contributed session Venue: WR-11

Chair: **Thiriez, Herve**
Groupe HEC, France

1) *Optimizing inspection strategies for multi-stage process chains: a case study*, **Van Volsem, Sofie**, University of Antwerp, Belgium

In this paper, a tool for optimization of inspection strategy for an integrated multi-stage process chain is proposed. The goal is to define an inspection strategy that will minimize total inspection costs (including rework and scrap costs) while still (statistically) assuring the desired output product quality (in terms of meeting product specifications). First a variation propagation model (based on probabilistic tolerancing) for the process chain is developed. Second, a cost model is established that assigns costs to all inspection consequences. Based on these two models, simulations can be run to determine costs and benefits of different possible inspection plans.

2) *A simulation model for determining optimum capacity in sow farms*, **Pla, Lluis Miquel**, Dep-Mathematics-UdL, Spain; **Babot, Daniel**; **Pomar, Jesus**

The designing of a sow-farm and its capacity is a problem related to the occupancy rate. The capacity of the farm is a strategic decision. The aim in this work is to support the designing and sizing of housing facilities for sows using a herd Markov model. The herd model represents physical

movements of sows among dependencies within a farm. The model is used to explore farmer's scheduling and anticipate different needs of facilities depending on reproduction management as basic determinant of herd dynamics. Resulting designs are compared with common ones used traditionally by project bureaux.

3) *A general-purpose simulation model for toll booth operations*, **Thiriez, Herve**, Groupe HEC, France

Most of the major highways in France have toll booths. With the large number of possible payment modes, different types of vehicles, and the large number of booths available in some locations, it becomes difficult to identify the proper allocation of each booth to one or several vehicle types and one or more payment modes. There are conflicting objectives to optimise : a cost minimization and a minimization of waiting times. The simulation model allows for an efficient trade-off between these objectives. This paper describes a model developed for this purpose, designed in order to be as realistic as possible.

MC17 **LP techniques for portfolio optimization**

Invited session Venue: WR-10

Organizer: **Paris, Francesco M.**
University of Brescia, Italy

Chair: **Ogryczak, Wlodzimierz**
Warsaw University of Technology, Poland

1) *On Extending the Gini Measure to Account Downside Risk*, **Ogryczak, Wlodzimierz**, Warsaw University of Technology, Poland

The Gini's mean difference is one of the classical risk measures resulting in LP solvable portfolio optimization models. The original measure is symmetric. Two different approaches extending the measure to focus on the downside risk are presented.

2) *On portfolio selection in an Assets-Backed Securitization: models and solution algorithms*, **Mansini, Renata**, University of Brescia, Italy; **Pferschy, Ulrich**; **Speranza, Maria Grazia**

Asset-Backed Securitization is an effective tool used to deal on the market with unrated assets (commercial papers, lease contracts) through the issuance of special notes called asset-backed securities. We analyze the problem for a financial institution (typically a bank) of optimally selecting the assets to be converted into notes. In particular, we compare the case in which the assets are characterized by periodic installments based on Italian amortization with the case of the more classical French amortization and show the computational advantages of these two different choices. In both cases outstanding principal nature is exploited in model formulation and to propose solution algorithms.

3) *A Review of MP models for Practical Portfolio Planning*, **Mitra, Gautam**, Brunel University, United Kingdom; **Lucas, Cormac**; **Pirbhai, Mehndi**

We provide an overview of a number of portfolio planning models which have been proposed and investigated over the last forty years. We revisit the mean-variance model of Markowitz and a few other models, such as the Mean Absolute Deviation, Weighted Goal Programming and the Minimax model which use alternative metrics for risk ;these models are compared and contrasted. A number of modelling and computational considerations which include (a) buy-in thresholds for assets, (b) restriction on number of assets (cardinality constraints), (c)transaction roundlots, (d) dedication of cashflow streams, (e) immunization, (f) representation of tax, are discussed.

MC18 **Graph Theory II**

Contributed session Venue: WR-9

Chair: **Levner, Eugene**
Institute of Technology, Israel

1) *Parametric Analysis of Overall Min-Cuts and Applications* , **Aneja, Yash P.**, University of Windsor, Canada; **Nair, K. P. K.**; **Chandrasekaran, R.**

The overall min-cut problem in a capacitated undirected network is well known. Recently Stoer and Wagner gave an elegant algorithm for finding such a cut. We present parametric analysis of such a cut where the capacity of an arc {i,j} in the network is given by min{b{i,j},t}, where t is a parameter ranging from 0 to infinity. Letting function v(t)) denote the min-cut capacity, we develop an algorithm to describe v(t) which involves at most n applications of Stoer and Wagner scheme. We use v(t) to determine an overall min-cut for multiroute flows as defined by Kishimoto. Such multi-route flows have interesting applications in communication networks.

2) *On A New Variant Of Murty's Ranking Assignments Algorithm*, **Pascoal, Marta Margarida Braz**, Maths Dep, Univ Coimbra, Portugal; **Captivo, Maria Eugenia**; **Climaco, Joao Namorado**

In this talk a variant of Murty's algorithm for ranking assignments according to its cost is presented. An implementation is also discussed. It is shown that the worst-case computational complexity is better in this variant than in the original form of the algorithm. Finally, some computational results are presented, allowing the conclusion that the behaviour of the new variant is also better in practice.

3) *Finding extremal paths in AND-OR graphs, hypergraphs and grammars*, **Adelson-Velsky, George**, Bar-Ilan University, Israel; **Gelbukh, Alexander**; **Levner, Eugene**

Generalized Bellman inequalities (GBI) on context-free grammars are derived. They permit to find, in an uniform way, extremal paths in grammars, directed hypergraphs and AND-OR graphs. Among feasible solutions to the GBI, there are minimum-value terminal strings in grammars introduced by Knuth (1977), min-weight B-paths in hypergraphs (Gallo et al., 1993), and critical paths in AND-OR graphs (Adelson-Velsky and Levner, 1999). Given p arcs and n nodes, a new O(np)-time algorithm for finding critical paths in AND-OR graphs is

suggested, which is superior to the complexity of earlier algorithms.

MC19 **Large Scale Optimization II**

Contributed session Venue: WR-1

Chair: **Almeida, Ana Maria de**
Maths Dep, Coimbra Univ, Portugal

1) *A Projected-Secant Algorithm for Mixed Integer Optimization in Hybrid Control Problems*, **Ahmadzadeh, Ali** , North Carolina A T State , United States; **Sayyar-Rodsari, Bijan**; **Homaifar, Abdollah**

We propose a new Projected-Secant based technique for mixed integer optimization of constrained problems frequently encountered in the control of hybrid systems. Hybrid systems arise naturally in a diverse range of applications from automated air traffic control to integrated planning/scheduling and control in a manufacturing enterprise, to goal attainment via cooperative autonomous robots. We will show that in hybrid control problems of practical significance, under reasonable assumptions regarding the rate of change of the objective function in discrete variables, the mixed integer problem can be relaxed (i.e. discrete variables can be treated as continuous variables constrained to $[0,1]$ interval), and that the proposed projected-secant algorithm can be efficiently used to solve the relaxed problem.

2) *Statistical Inference for a Finite Optimal Stopping Problem with Unknown Transition Probabilities*, **Prieto, Tomas**, Spain

We consider a finite optimal stopping problem with unknown stationary transition probabilities. The payoffs are assumed to be known. We estimate the value of stationary deterministic decision rules, which allows to obtain estimators of an optimal decision rule and the optimal value of the problem that are consistent with probability one. Two different methods are compared: the maximum likelihood estimator, which estimates every unknown parameter, and a new procedure, that we will call the stretch estimator, that makes fewer estimations and which turns out to be a more efficient method from a computational point of view.

3) *Trees, Slices and Wheels - a Compaction Algorithm*, **Almeida, Ana Maria de**, Maths Dep, Coimbra Univ, Portugal; **Rodrigues, Maria Rosalia**

Hierarchical approaches to Floorplan Design commonly use trees in order to represent a components' placement, which must then be optimized so that the layout area is minimal. This is known to be a conflicting multicriteria problem. We present an approach for area minimization of k--order hierarchical floorplans, working strictly over the k--ary representation tree. By using NonDominance Theory, we derive an algorithm that produces a minimal solution in poly-polynomial order. This algorithm is able to deal both with wheels and slices, determining the optimal orientation of each individual component. Experimental results will be reported and discussed.

MC20 **Polyhedral approaches to network optimization**

Invited session Venue: WR-2

Organizer: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

Chair: **Fortz, Bernard**
Universite Catholique de Louvain, Belgium

1) *The 2-Edge Connected Subgraph Problem with Bounded Rings*, **Pesneau, Pierre**, Universite Blaise Pascal, France; **Mahjoub, A Ridha**; **McCormick, S. Thomas**

We consider the problem of determining a 2-edge connected subgraph of minimum weight such that every edge belongs to a cycle of length no more than K, where K is a given positive integer. We investigate this problem from a polyhedral point of view. We first give an integer programming formulation for the problem using the natural set of variables. We show that the linear relaxation of this formulation can be solved in polynomial time when the bound on the cycle is less than or equal to 4. We discuss several classes of valid inequalities for the associated polytope. We characterize the dimension of that polytope and describe necessary conditions for these inequalities to be facet defining. Moreover, we study separation routines for some of these inequalities. Using this, we devise a Branch&Cut algorithm for the problem along with a computational study will be presented.

2) *A Branch-and-Cut Algorithm for the Generalized Minimum Spanning Tree*, **Feremans, Corinne** , Universiteit Maastricht, The Netherlands; **Labbe, Martine**; **Laporte, Gilbert**

The Generalized Minimum Spanning Tree Problem (GMSTP) is a variant of the classical Minimum Spanning Tree Problem, in which the vertices are partitioned into clusters and the tree has to include exactly one vertex from each cluster. This problem arises in the design of the interconnection at minimum cost of local networks (telecommunication and transportation networks). New integer linear formulations are presented for the problem. Relationships between the polytopes of their relaxations are established. The facial structure of the polytope associated with the GMSTP is analyzed. New classes of facet-defining inequalities are derived. Efficient separation procedures are implemented. These results are extended to more general polytopes. A branch-and-cut method is developed. Computational results are given. Big instances of the GMSTP that were solved heuristically in the literature are now solved to optimality.

3) *Synthesis of Tree Networks*, **Fortz, Bernard**, Universite Catholique de Louvain, Belgium; **Van Hoesel, Stan P. M.**

We study different models for planning the capacity of telecommunication networks, with the restriction that the capacity has to be installed on a tree. Different versions of the problem are presented, and some polynomially solvable cases are identified, while the general problem is shown to be NP-

hard. For the special case of unit costs in a complete graph, the optimal solution turns out to be a Gomory-Hu tree representing the minimum cuts in the graph. We derive a complete formulation for this special case and outline some links with the all-pair minimum cut problem.

MC21 **The Quadratic Assignment Problem**

Invited session Venue: WR-3

Organizer: **Myung, Young-Soo**
Dankook University, Korea

Chair: **Hahn, Peter M.**
University of Pennsylvania, United States

1) *A hospital facility layout problem finally solved*, **Krarup, Jakob**, DIKU, Univ. of Copenhagen, Denmark; **Hahn, Peter M.**

The 27 year long history of a difficult Quadratic Assignment Problem is reviewed. The problem arose in 1972 when the first author was engaged in the design of a university hospital to be built in Regensburg, Germany. A randomized heuristic was devised at that time, but optimality could neither be proved nor disproved. In 1999 two approaches provided optimal solutions. The first was due to Stuezle, whereby 256 optimal solutions were identified. The second approach, developed by the second author, was a new branch-and-bound enumeration confirming Stuezle's solutions were indeed optimal.

2) *Performance Analysis for Controller Area Network using Quadratic Assignment Formulation*, **Querido, Tania Maia**, CEFET-RJ, Brazil

Due to its hard combinatorial nature, substantial work has been done on the problem of optimizing messages transmission ordering on the Controller Area Network (CAN)- a communication fieldbus well designed for sending and receiving short real-time control messages. The performance of this scheduling mechanism relies on the worst-case analysis. We present a new scheme to bound the worst-case response time of a set of messages in a given period of time. A measure for quantifying the possible delay of messages is proposed and is based on a quadratic assignment formulation, which allows the use of optimization procedures. The SAE benchmark for class C automotive systems concerning safety critical control applications is considered.

3) *Quadratic Assignment Problem Exact Solution Using Level-2 Bounds*, **Hightower, William L.**, High Point University, United States; **Hahn, Peter M.**

The background of the transformational bound viewpoint as it applies to dual ascent techniques to approximate linear programming bounds for the quadratic assignment problem is covered. Results of extending transformational bounding techniques from the level-1 Adams/Sherali relaxation linearization of the quadratic assignment problem to the level-2 relaxation linearization are presented. Bound quality and efficiency are discussed. Results of incorporating the bound into branch and bound code for finding exact solutions of large instances of the QAP in the QAPLIB are presented. Preliminary results of parallelization and the incorporation of cutting plane constraints are included.

MC22 **Artificial Intelligence, Expert Systems and Neural Networks II**

Contributed session Venue: WR-4

Chair: **Ozden, Mufit**
Miami University, United States

1) *Use Of Backpropagation Paradigms In Insulating Transformer Oil classification*, **Mokhnache, Leila**, AI in high voltage, Algeria; **Boubakeur, Ahmed**

We have developed a neural network simulation system to be applied to the electrical insulation and cooling diagnosis using physico-chemical tests database of the sampled oil in the Algerian electric network. The developed neural network uses the Backpropagation algorithm trained by three techniques: Levenberg-Marquard technique and momentum technique and adaptive learning rate one. The role of the network output is to classify the transformer oil dielectric and cooling state and so decide what to do: change the oil, regenerate it, filter it, keep it. This shows promise for the near future; it enables inexperienced engineers to diagnose easily.

2) *Learning Components for Decision Making in Simulation Models (Cooperating Probabilistic Optimizers)*, **Ozden, Mufit**, Miami University, United States

In an earlier work, we built cooperating multiple optimizers for discrete decisions as the integral decision-making components of a simulation model. The optimizers use a novel learning algorithm based on the learning automata theory. Here, we extend the methodology to the continuous decisions within the same framework. Learning takes place continuously with performance feedback on the decisions made in successive short periods in a long simulation run. The performance is considered favorable and the current decisions are reinforced probabilistically if it exceeds a targeted value, which is raised intermittently. In this paper, after explaining the learning mechanism of the optimizers, we will present applications involving continuous and discrete decisions in Monte-Carlo simulation and a discrete-event queuing network.

3) *Probabilistically Learning Components for Continuous Decisions in Simulation Models*, **Ozden, Mufit**, Miami University, United States

In this paper, we build multiple learning optimizers for continuous decisions as an integral decision-making component of a simulation model. The optimizers learn toward the optimal solution efficiently during a long simulation run that is divided into short exploratory periods. At the end of every exploratory period, the optimizers are activated to modify their probabilistic decision-making processes on the basis of a noisy performance evaluation received on their current decisions. Because of the probabilistic nature of their decision-making mechanism, the optimizers prove to be very tolerant of the high noise and correlation that may exist in the short-term

performance evaluations. It will be shown that they culminate in an excellent convergence rate with applications to Monte-Carlo simulation and discrete-event queuing network problems.

MC23 **Data Envelopment Analysis II**

Contributed session Venue: AF-10

Chair: **Tiwari, Piyush**
University of Tsukuba, Japan

1) *A Generalized Model for Data Envelopment Analysis*, **Yun, Yeboon**, Kagawa University, Japan; **Nakayama, Hirotaka**; **Tanino, Tetsuzo**

In this study, we suggest a model called GDEA (Generalized DEA) model, which can treat the above stated basic DEA models in a unified way. In addition, by establishing the theoretical properties on relationships among the GDEA model and those DEA models, we prove that the GDEA model makes it possible to calculate the efficiency of decision making unit incorporating various preference structures of decision makers. Furthermore, we propose a dual approach to GDEA and also show that it can reveal domination relations among all DMUs.

2) *Global efficiency scores in Interval Data Envelopment Analysis*, **Despotis, Dimitris K.**, Professor, Greece; **Smirlis, Yannis G.**

We apply in this paper the global efficiency approach to the case of interval DEA (i.e. DEA with interval input-output data). Our main concern is to improve the discriminating capability of interval DEA. We focus, for this purpose, only on the units that can maintain their efficiency score under common weighting schemes.

3) *A DEA based analysis of housing quality in Japan*, **Tiwari, Piyush**, University of Tsukuba, Japan

In Japan, the number of houses available exceeds the demand in all prefectures. Improving housing quality has gained importance over building new dwelling stock. The thrust of housing policies and programs in Japan is to improve housing quality. Housing quality is a very loosely defined term and there is no consensus in the housing literature on its measurement. Present paper proposes the use of data envelopment analysis approach to estimate a quantifiable measure of housing quality in the Tokyo Metropolitan Region (TMR). The objective of this paper is to compare housing quality in the five prefectures of the TMR and among six tenures of housing choice. The results indicate that the condition of rental housing in general is poor.

MC24 **Multi-Criteria Decision Analysis II**

Contributed session Venue: AF-13

Chair: **Xu, Dong-Ling**
United Kingdom

1) *Comparison between Multiple-choice and Analytic Hierarchy Process: Measuring Human's Feeling*, **Sato, Yuji**, Matsusaka University, Japan

Based on research on public opinion carried out using Analytic Hierarchy Process (AHP), this study shows the following results concerning the comparison of the answers to questions on the same issue, each formatted in a different way: one is multiple-choice and the other is AHP. (1) Compared with results from multiple-choice, AHP yields a different aggregated ranking of alternatives. (2) AHP reveals that in modified multiple-choice, wherein respondents are given the option of indicating their top-two alternatives, the choice of the second-best alternative is independent of the discrepancy in the degree of importance between the best and the second best.

2) *Managing the Notion of Category Size in MCDA*, **Mousseau, Vincent**, LAMSADE, France; **Dias, Luis Candido**; **Figueira, José R.**

We consider the Multiple Criteria Sorting problem in which each alternative ai in a finite set is to be assigned to predefined categories. The concept of category size refers to "the proportion by which an evaluation vector corresponding to a realistic alternative is assigned to the category Ck". Analysing the size of categories in a multiple criteria sorting problem leads to an open question: "Does the use of the notion of category size change the intrinsic nature of the sorting problematic?" The purpose of this paper is to formalize this concept and analyse its usefulness in MCS methods.

3) *Bicriteria shortest hyperpaths in dynamic networks*, **Nielsen, Lars Relund**, University of Aarhus, Denmark; **Andersen, Kim Allan**; **Pretolani, Daniele**

The shortest path problem has been studied for many years. In addition there has recently been a growing focus on the random time-dependent shortest path problem (RTDP), where a best strategy/dynamic path, must be found. RTDP can be transformed into a shortest hyperpath problem and this model allows us to deal with different cost criteria corresponding to e.g. expected or worst case behaviour. But no attempt has been made to find bicriterion dynamic paths. This paper aims at solving the bicriterion shortest hyperpath problem (bi-SBT). This is done using a newly developed k'th shortest hyperpath procedure. Different bi-SBT procedures are developed. Computational tests show that a two-phases approach performs best. Applications to random time-dependent networks are discussed.

MC25 **Mathematical Programming-General II**

Contributed session Venue: AF-14

Chair:

1) *Frechet Subdifferentials of Optimal Value Function*, **Allali, Khalid**, FSTS, Morocco

The study of subdifferentiability of marginal functions is of great interest not only because it is related to the Lagrange multipliers but also because it is connected to the study of the sensitivity of some problems in optimization and optimal control. Generally, the infimum defining the marginal function is required to be attained near the point of interest. The present paper studies the limiting frechet subdifferential of the optimal value function without assuming that the infimum is attained.

2) *Shortest path counting problem and its application*, **Oyama, Tatsuo**, GRIPS, Japan; **Morohoshi, Hozumi**

Shortest path counting problem (SPCP) is the problem asking how many shortest paths contain each edge of the network. We can obtain theoretical results in the form of explicit expressions for special types of networks such as trees, grid type, circular type and so on. We apply these results to estimate the "importance" of each road segment in the city road network. Furthermore, the SPCP can be applied to measure quantitatively the reliability and stability of the network. We show the numerical results to give the reliability and stability of the actual lifeline network as communication, electric power transmission, gas pipeline, and so on.

3) *A Study on the Number of Non-dominated Solutions for* , **Figueira, José R.** , University of Coimbra, Portugal; **Batista, Maria Castelo**

This paper deals with an empirical study on the number of non-dominated solutions for the bi-criteria network flow model. The experiments were made on a set of different problems type. This set contains shortest path instances, transportation and assignment instances, as well as generic network flow models with bound constraints. The approach is based on network flow algorithms. The results show that the number of non-dominated solutions is strongly dependent on the problem type studied. Shortest path problems have a very small number of non-dominated solutions. Key-words: Multicriteria Analysis, Network Flows, Graph Theory.

MC26 **Mathematical Programming-Integer I**

Contributed session Venue: AF-18

Chair: **Wen, Ue-Pyng**
National Tsing Hua Univ, Taiwan

1) *Marriage in Honey-Bees Optimization: An Overview*, **Newton, Charles**, UNSW, Australia; **Abbass, Hussein**

Marriage in Honey Bees Optimization (MBO) is a new heuristic search technique inspired by the marriage process of honey bees. It has been shown to be very effective in solving the propositional satisfiability problem known as 3-SAT (each clause has exactly three literals). It was found to have outperformed well-known algorithms for SAT such as WalkSAT, GSAT and random walk. A number of variations for MBO has been introduced in the literature. The objective of this paper is to present a review of the work done with MBO and summarize the obtained results so far.

2) *Robust linear models by discarding data and regressors simultaneously*, **Hattingh, Giel**, Potchefstroom University , South Africa; **Kruger, Hennie**; **Du Plessis, Thinus**

It is common practice to simplify linear models through reduction of the number of explanatory variables and the screening of data for errors, thus producing more robust models. Mathematical programming techniques are presented that aim towards the development of robust linear models by examining the feasibility of simultaneous reduction of the number of regressors and data trimming. Empirical results will be presented.

3) *Post-optimality Analysis in Assignment Problem*, **Wen, Ue-Pyng**, National Tsing Hua Univ, Taiwan; **Lin, Chi-Jen**

This paper concentrates on post-optimality analysis of the assignment problem. Due to the high degeneracy of the assignment problem, traditional sensitivity analysis, which determines the range in which the current optimal basis remains optimal, is impractical. Thus, changing of the optimal basis does not ensure the changing of the optimal assignment. Herein we investigate the properties of the assignment problem and then propose several lemmas to determine two other types of sensitivity range. The first type is used to determine the range in which the current optimal assignment remains optimal. We further discuss what is the new optimal assignment when the changes surpass the range. The second type of sensitivity range is to determine those values of assignment model parameters for which the rate of change of optimal value function remains constant. An example is presented in order to show that the approaches are useful in practice.

MC27 **Production Management & Manufacturing II**

Contributed session Venue: AF-19

Chair: **Larsen, Christian**
Aarhus School of Business, Denmark

1) *On-line Fault Diagnosis Method Using Fault Patterns* , **Cho, Hyun-Woo**, POSTECH, Korea; **Kim, Kwang-Jae**

A pattern-based diagnosis method is proposed to diagnose a process on-line. We utilize principal component analysis to model and monitor the variability of a process. A triangular representation of process trends in the principal component space is employed to represent various pattern of each fault. These fault patterns are compared with each of the fault library. Likelihood index for cause candidate is introduced, and based on it we make a diagnostic decision to select the cause candidate with the highest likelihood index as an assignable cause. The proposed method is demonstrated using simulated data from Tennessee Eastman process. Several comparative studies on diagnosis resolution and robustness to noise are presented.

2) *Optimizing the Operation of a SPC System*, **Wu, Zhang**, Nanyang Technological Uni, Singapore; **Lam, Yee Cheong**; **Zhang, Sheng**

This article proposes an algorithm to optimize the operation of a control chart system consisting of several individual control charts, each of which is used to monitor a critical process stage in the manufacturing of a product. The algorithm considers all the charts within a system in an integrative and optimal manner. Consequently, the effectiveness of the system as a whole can be significantly improved. The operators can utilize and understand the optimal control chart system as easily as for the conventional system. Some useful guidelines have also been brought forth to aid the users to adjust the control limits of the control charts in a system.

3) *The economic production lot size model with several production rates*, **Larsen, Christian**, Aarhus School of Business, Denmark

We study an extension of the economic production lot size model, where more than one production rate can be used during a cycle. The production rates and their corresponding runtimes are decision variables. We decompose the problem into two subproblems. First we show that all production rates should be chosen in the interval between the demand rate and the production rate, which minimize unit production costs, and should be used in an increasing order. Then, given the production rates, we derive closed-form expressions for the optimal runtimes as well as the minimum average cost. Finally we derive a near-optimal solution to the general problem.

MC28 **Game theory II**

Contributed session Venue: DH-C

Chair: **Leopold-Wildburger, Ulrike**
University of Graz, Austria

1) *The Socialist Dilemma*, **Melo, Jose Prado**, UNITAU, Brazil; **Soma, Nei Yoshihiro**

We introduce a new problem, The Socialist Dilemma, which belongs to the cooperative game theory. The idea is to divide the amount of money of each one among n friends following the rule of giving a pound to the one with less money. If a tie occurs it is decided in favour of the one with the least lexico number. It is shown that this problem is related to the generation of pseudo-random numbers and linear shift registers. The study of transient and orbit patterns will also be presented.

2) *Bilevel Problem Solving Via Hyperbolic Smoothing Technique*, **Xavier, Adilson Elias**, Rio de Janeiro Fed Univ, Brazil; **Arica, Jose Ramon Chavez**

This paper studies the bilevel problem solution. The connections between bilevel problems and semi-infinite problems is analysed. It is proposed the use of the hyperbolic smoothing technique in order to solve a special class of bilevel problems. Preliminar computational results are presented for two small test problems. Keywords: Game Theory, Nonlinear Programming, Smoothing

3) *Voting in EMU*, **Leopold-Wildburger, Ulrike**, University of Graz, Austria; **Irlanbusch, Bernd**; **Schuetze, Joerg**; **Sutter, Matthias**

The Stability and Growth Pact (SGP) in the EU's Economic and Monetary Union (EMU) shall safeguard sound public finances in the EMU member states by allowing to punish countries with excessive deficits. We experimentally examine the voting procedure of the SGP and find that the institutional rules are not satisfactory. As an institutional innovation we test a procedure where fiscal sinners are excluded from voting as suggested by Otmar Issing. It turns out that this modification is surprisingly successful. In addition our study shows that the opportunity to communicate tends to mitigate the pact's shortcomings.

MD1 **Health Services: Performance II**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Delesie, Lucas**
University of Leuven-KUL, Belgium

1) *Efficiency of ambulance services in the Netherlands*, **Kommer, Geert Jan**, The Netherlands

Data Envelopment Analysis (DEA) is used as method to determine the efficiency of the Dutch emergency medical services in the year 1999. After calculation of the DEA-scores, a parametric method is used to try to explain the inefficiencies of the organisations by differences in environmental and organisational characteristics and differences in quality of services. In 1999, the average efficiency score of the 73 Dutch emergency medical services in the analysis was 87%. It was not possible to explain the differences in efficiency by the differences in environmental, organisational or quality characteristics: services with similar characteristics had different efficiency scores.

2) *Performance of Dental Providers on Restorations- A DEA Evaluation*, **Ozcan, Yasar A.** , Virginia Commonwealth Uni, United States; **Coppola, M. Nicholas** ; **Bogacki, Russell**

The purpose of this study is to evaluate the effectiveness of dental providers performing posterior restorations utilizing amalgam and composite materials. A national sample in excess of 300,000 patient encounters and greater than 23,000 dental providers are obtained from the Washington Dental Service. Analysis of specific provider effectiveness is estimated through Data Envelopment Analysis. A variable returns to scale, three input oriented (provider experience, amalgam & composite materials) and one output (survival) model is used to measure effectiveness. The principal finding is the most effective dentists produce posterior restorations that survive almost five months longer than their counterparts. The model indicates that 9.83% of the providers are effective. The most effective dentists are approximately 40 years old. Older and younger providers have less survival times.

3) *Benefits analysis of information system use by MOD Medics*, **Jones, Philip Robert**, United Kingdom; **Harvey, Peter**

This presentation describes a study performed by Dstl, with Qinetiq involvement, to examine the need for improved IT systems to support MOD clinicians working in both routine and operational settings. The presentation: 1) Describes the benefits analysis approach, with a simple interactive demonstration. 2)Outlines the problem and our role. 3) Shows how the benefits maps were developed. 4) Describes how these maps were used to develop stakeholder concensus, provide a tool for option analysis and provide a means to link user and system requirements. 5) Summarise the wider OR inputs to the development of the business case.

MD2 **Dynamic Traffic Assignment I**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Florian, Michael A.**
Cente CCRT, Univers. of Montreal, Canada

1) *Optimal Transit Timetable Setting: A Design Model Following The Scheduled-Based Approach*, **Coppola, Pieruigi**, Univ Of Rome Tor Vergata, Italy

Assessing optimal timetable can improve, to a great extent, effectiveness and efficiency of the transit network, both on the demand-side and on the operator perspective. In facts, optimal timetable is the result, on the one hand, of a good match between bus supply and passenger demand and, on the other hand, of the minimization of the number of the operating bus fleet. Nevertheless, in the literature there is a relative lack of design model specifications for setting timetable in an optimal way. In this paper a modeling framework for transit timetable setting, based on a mathematical programming formulation is presented. In order to simulate how users' travel choices vary with timetable a schedule-based transit assignment model is used. A bi-level solution-algorithm is proposed and the results of preliminary applications of the model to test and realistic networks are presented.

2) *Heuristic Dynamic Assignment based on microscopic traffic simulation*, **Barcelo, Jaime**, Dept Est. & OR, UPC, Spain; **Casas, Jordi**

A common drawback to most of the DTA models is that they do not represent properly spill-back of congestion. Simulation is an approach to overcome the problem. The solution approach to DTA would then consist of two components, an analytical method to determine the path dependent flow rates and a simulation based network loading to determine arc volumes. The improvements in software and hardware technologies have made possible to simulate microscopically real networks of sensitive size. This paper describes a heuristic approach to DTA in which the analytical component is approximated by a stochastic route choice model and the network loading is done by microscopic simulation. Computational results are presented.

3) *A Hybrid Optmization-Mesoscopic Simulation Model of Dynamic Traffic Assignment*, **Florian, Michael A.**, Cente CCRT, Univers. of Montreal, Canada; **Mahut, Michael**; **Tremblay, Nicolas**

The evaluation of ITS measures depends heavily on the use of faster than real time traffic simulation models. Although many micro-simulation traffic models have been developed, their execution times are still too slow for large-scale networks. This has lead to the development of mesoscopic simulation and traffic assigment methods. These are simpler traffic models, which trade off some fidelity of the results for significant gains in computation time. This paper presents an iterative dynamic traffic assignment model inspired from optimization theory, which uses the space-time queue model developed by Mahut to solve the network loading subproblem. Results are presented for a portion of the Stockholm road network, consisting of 220 zones, 2080 links, and 5000 turns.

MD3 **AHP-related Decision Making Model**

Invited session Venue: DH-N

Chair: **Shinohara, Masaaki**
Nihon University, Japan

1) *Study on Canonical Correlation Analysis using p-th power distance*, **Hatazawa, Fumihiro**, Nihon University, Japan; **Shinohara, Masaaki**

Canonical Correlation Analysis (CCA) is often used for decision-making in multi-attribute environment. In order to define new CCA, p-th power distance is introduced into the objective function. Especially, first power and infinity power distance models are studied, corresponding to absolute error minimization and supremum error minimization, respectively. Numerical experimental results show that new CCA solutions are not very much different from conventional CCAs and influence of outlier sample data is decreased. Both of proposed L1-CCA and L-infinity-CCA methods can be formulated as LP problems and can be solved with ease.

2) *Mind Transition Model or A Unified Model of AHP and ANP*, **Shinohara, Masaaki**, Nihon University, Japan; **Miyake, Chikako**; **Osawa, Keikichi**

We propose unified model of AHP and ANP, called MTM□@(Mind Transition Model). With MTM we can analyze how decision maker mind state changes on Markov chain. MTM has parameter p, called mind instability index. When p=1, MTM is reduced to AHP, and when p=0, MTM is reduced to ANP. Priority weight of each item (alternative or criterion) in AHP and ANP can be calculated as stationary probability of corresponding state of the Markov chain. Using Saaty car choice example and fastfood investment example, how mind instability of car-user or investor affects the decision-making result is demonstrated.

3) *Study on Principal Component Analysis using the first power distance*, **Hatazawa, Fumihiro**, Nihon University, Japan; **Osawa, Keikichi**; **Shinohara, Masaaki**

Principal Component Analysis (PCA) is often used in multivariate decision-making. In order to define new PCA, the first power distance is imported into objective function. The first power distance is the sum of the absolute length. Therefore, we try to maximize the absolute value summation of inner product for principal component vector and data vector. Numerical experimental results show that this new PCA solutions are not very much different from conventional PCA result, and the influence of outlier sample data is decreased. Moreover, secondary principal vector can be calculated with commercial NLP package.

MD4 **Cutting and Packing: Skiving and 2-d Guillotine problems**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Scheithauer, Guntram**
Dresden University of Technology, Germany

1) *Relationship between skiving stock and cutting stock problems*, **Zak, Eugene**, Majiq, Systems & Software, United States; **Rennick, Chris**

Classic skiving stock problem (SSP) is about finding the maximum number of finished items that can be skived (glued) from a limited number of smaller stock pieces. Every SSP links to a corresponding cutting stock problem in a way that the pair bears 'duality' relationship.

2) *Cutting Plane Algorithm for the Two-Dimensional Guillotine Cutting Problem*, **Belov, Gleb**, Dresden University, Germany

A cutting plane approach combining Chvatal-Gomory superadditive cutting planes with column generation is applied to the guillotine cutting problem. Appropriate modifications of the column generation procedure and of the rounding heuristic are proposed. A comparison with the branch-and-bound method (mixed-integer modeling) and test results are reported. Keywords: cutting, cutting planes with column generation, heuristics, branch-and-bound

3) *On a two-dimensional guillotine cutting problem*, **Scheithauer, Guntram**, Dresden University of Technology, Germany

A two-dimensional cutting problem is considered where guillotine cuts in lengths and in width direction have to be performed from one side of the rectangular stock material to the opposite. The aim is to find a pattern which maximizes the yield when at least one desired object may be obtained from the small rectangles resulting by the guillotine cuts. A two-dimensional cutting problem is considered where guillotine cuts in lengths and in width direction have to be performed from one side of the rectangular stock material to the opposite. The aim is to find a pattern which maximizes the yield when at least one desired object may be obtained from the small rectangles resulting by the guillotine cuts.

MD5 **Tutorial: Measurement and Decisions - Theory, Tools, and Applications**

Invited session Venue: MS-1

Chair: **Barzilai, Jonathan**
Dalhousie University, Canada

1) *Tutorial: Measurement and Decisions - Theory, Tools, and Applications*, **Barzilai, Jonathan**, Dalhousie University, Canada

Tutorial: Measurement plays a central role in science. We will discuss problems with classical mathematical models of measurement and present a new, simple and powerful measurement theory. The new theory has far-reaching theoretical and practical implications. For example, we will report on a recent case where the validity of a scoring methodology used to evaluate proposals in a large defense project has been the subject of litigation. Based on this theory, we have developed a new, intuitive, flexible, easy-to-use but powerful decision methodology - Preference Function Modeling (PFM). A software package implementing PFM will be demonstrated.

MD6 **Measuring efficiency in agricultural co-operatives**

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair:

1) *Efficiency Of The Non-Citric Sweet Fruit Co-Operatives In The Region Of Lleida (SPAIN)*, **Clop Gallart, Merce**, Universitat de Lleida, Spain; **Sabate Prats, Pere**

The non-citric sweet fruit sector is the most important of the Lleida (Catalonia, Spain) province. In this sector, co-operatives play an important role. Co-operatives are classified into two categories: single and second-degree co-operatives, a fact that can derive in differences in efficiency. That is the reason why in this paper a comparative study of the efficiency level between second-degree and non-associated non-citric sweet fruit co-operatives of Lleida province is carried out, in order to determine the possible incidence of the association of the co-operatives studied on their efficiency. Techniques used are non-parametric, such as Data Envelopment Analysis (DEA).

2) *Efficiency Analysis As An Instrument Of Management Control In Agrarian Co-Operatives*, **Segura, Baldomero**, Univ Politecnica Valencia, Spain; **Vidal Gimenez, Fernando**

The payment for the partners products is the external sign of efficiency in co-operatives. The objective of this work is to relate a measurement of the payment to the technical efficiency obtained by DEA models. The results obtained will allow us to classify the co-operatives in terms of their efficiency; the expression of the payment in terms of distance to the efficient production frontier can become a powerful management instrument that allows to quantify the effects of the policies undertaken by the cooperative direction, in order to move nearer to this frontier production.

MD8 **Modeling Risk and Dynamics**

Invited session Venue: AT-3

Organizer: **Zenios, Stavros**
University of Cyprus, Cyprus

Chair: **Dupacova, Jitka**
Dept. of Statistics, Charles University, Czech Republic

1) *Generating scenarios for asset liability management models*, **Dupacova, Jitka**, Dept. of Statistics, Charles University, Czech Republic

Recommendations for asset liability management that result by solving scenario-based stochastic programs depend on input scenarios which may be obtained in many different ways; choice of representative scenarios is an important issue. Several points which should be regarded (sources of uncertainty, the level of available information, the structure of the solved ALM model) will be discussed.

2) *Minimum Variance Criterion in Stochastic Dynamic Programming*, **Sladky, Karel**, UTIA AV CR, Czech Republic

We investigate how the minimum variance criterion can work in discrete stochastic dynamic programming. This end we adapt notions and notations used in Markov decision processes and in contrast to the classical models (where usually only the expected long run total discounted reward or average reward is considered) we shall also consider variance of the obtained total reward. Alternative definitions of the reward variance along with their mutual connections will be discussed. Finally, attention will be focused on finding policies minimizing the long run reward variance on condition that the average reward is not less than a given value.

3) *How to measure multperiod risk?*, **Pflug, Georg Ch.**, Universty of Vienna, Austria

We introduce a new principle of measuring risk: the degree of foreseeability. In this new concept, a measure of risk is associated to a random variable (r.v.) on a probability space together with a sigma-algebra on it. The combination of both determines the risk: The sigma-algebra is interpreted as the degree of information the decision makes has. If the information is perfect, i.e. the r.v. is measurable w.r.t. the sigma-algebra, then the risk is zero. This concept can be easily carried over to the multiperiod case: Here a sequence of random returns and a sequence of sigma-algebras is given. The multiperiod risk measure has some nice monotonicity and convexity properties, which may also be used as an axiomatic justification for the proposed concept. The calculation of the risk measure requires to solve a multistage stochastic program, but in discrete cases, this is just a tree structured linear program.

MD9 **Electricity Markets in Canada**

Invited session Venue: MS-3

Organizer: **Oren, Shmuel**
University of California, Berkeley, United States

Chair: **Rogers, Scott**
Dept. of Mech. and Ind. Eng., Univ. of Toronto, Canada

1) *Transient Finite Element Simulation Analysis of a Radial Flux Induction Motor - For on Wheel Drive*, **Benoudjit, Azeddine**, University of Batna, Algeria

This paper deals with the transient finite element simulation analysis (FE-SA) of a conceived 7 kW, short stack length, radial flux induction motor, for on wheel drive applications. The approach followed is based on the use of a 2D-FE field solutions combined with the 3D effects modelled by suitable circuit elements, attached to the 2D induction motor model, and the whole is time stepped. To consider the rotor motion, a sliding surface is used. The FEA is achieved using the MEGA-FE program. These FEA simulated results will be compared and discussed with the performances obtained from an optimised design program, using a virtual test rig built with Simulink and Power System Blocks (PSB) under MATLAB environment.

2) *Modelling Electricity Markets in Ontario*, **Rogers, Scott** , Dept. of Mech. and Ind. Eng., Univ. of Toronto, Canada

This talk deals with the newly functioning market in Ontario. We describe the major features of it and discuss a model of the competition among gencos that finds a Nash equilibrium for this market. In particular we evaluate the role of imports from other provinces and states in affecting the nature of the equilibrium.

MD10 **Queuing Theory and Applications IV**

Contributed session Venue: MS-4

Chair: **Li, Hui**
MSVU, Canada

1) *Combined Optimization of Aircraft Maneuvers and RF Measurements*, **Yannone, Ronald Matthew**, BAE Systems - USA, United States; **Carroll, Melvin**

The pilot desires to minimize use of onboard fire control radar to remain silent, relying on passive sensors to detect RF emissions from airborne radars and hot emissions using the infrared sensor. Estimating range passively for air-to-air target engagements is extremely challenging and is the focus of this paper. Combined optimization of the use of RF Doppler and interferometer discrete measurements and sensor aircraft maneuvers to estimate range is used. Scenario parameters and constraints are presented. Ten percent range estimates are achievable under certain RF measurement and scenario conditions.

2) *Production Switching In a Two-Stage System*, **Li, Hui**, MSVU, Canada; **Liu, Liming**

We study a production-switching problem in a system with a dedicated downstream stage and a shared upstream stage. Because of the interactions between the upstream and downstream stations, a threshold production-switching rule is used to control the production of upstream station. We construct a Markov model to characterize the system behavior and derive performance measures analytically. Our threshold rule aims at minimizing the work-in-process level while maintaining a required level of busy probability at the downstream station.

3) *Location of an urban logistic platform*, **Lozano, Angelica**, Universidad Nacional Autonoma de Mexico, Mexico; **Schleske, Enrique**; **Antun, Juan Pablo**; **Munoz, Angeles**

A logistic platform can improve the distribution process and contribute to the management of land use in a metropolis. A good location for a logistic platform could improve traffic conditions and reduce environmental impact of freight transportation. Several criteria must be considered (accessibility for freight vehicles, site availability, land use, environmental impacts, etc.) for determining the location of a logistic platform, depending on the type. A methodology for identifying the best sites to locate a logistic platform, for some types of platforms, is proposed. An application case, in the Metropolitan Zone of Mexico City, is presented.

MD11 **Applied Heuristics Work at Sintef**

Invited session Venue: MS-5

Organizer: **Glover, Fred**
United States
Organizer: **Lokketangen, Arne**
Molde College, Norway
Organizer: **Nath, Baikunth**
Australia
Organizer: **Woodruff, David L.**
UC Davis, United States

Chair: **Lokketangen, Arne**
Molde College, Norway

1) *A Comparative Assessment of Two Methods for Generating Nurse Rosters*, **Froyseth, Helle**, University of Oslo, Norway; **Hasle, Geir** ; **Sjoberg, Dag** ; **Riise, Atle**; **Stolevik, Martin**

To be attractive to nurses, the ability to generate user-friendly, flexible, and individual rosters are crucial for hospitals of today. Fewer human resources should be spent in rostering, so that valuable resources may be allocated to patient work. Based on constraints and objectives from a real hospital unit we developed closely related single-objective and multiple-criteria problem models. Sets of rosters were generated for each model, using integer programming and multi-criteria tabu search, respectively. Assessment by nurses showed that good rosters were generated with both methods. The multi-criteria approach gave better quality results, with less variation in computational effort.

2) *Solving the multi objective long term forest treatment scheduling problem*, **Stolevik, Martin**, SINTEF Applied Mathematic, Norway; **Riise, Atle**

Sustainable long-term forest treatment scheduling is the increasingly complex task of allocating treatments to spatial homogenous forest units. Planners keep facing new restrictions and preferences. The problem includes conflicting optimisation criteria, including income to forest owners, desired harvesting volume profiles, and bio-diversity considerations. A formal description of the problem has been made facilitating the use of this problem as a benchmark. We have developed a decision-support system for this problem. Using a meta-heuristic, the system generates an approximation to the efficient set of solutions. At any time, users may inspect the current set of solutions and interactively guide the search.

3) *Comparing Genetic Algorithms and Tabu Search for multi-objective optimisation* , **Riise, Atle**, SINTEF Applied Mathematic, Norway; **Stolevik, Martin**

Many real world optimisation problems have multiple objectives that may not be aggregated. Conflicting objectives must be optimised simultaneously, and we need to present the user with a diverse set of compromise solutions. Traditionally, many multi-objective problems have been addressed by applying genetic algorithms, exploiting their inherent multiple-solutions representation. Lately meta-heuristic local search methods, like tabu search or simulated annealing, have been applied to multi-objective problems. We have investigated the strengths and weaknesses of local search and genetic algorithms, and of hybridisation between the two, when applied to selected multi-objective problems. We present and discuss the results of these tests.

MD12 **OR for Development Prize Competition III**

Invited session Venue: AT-6

Organizer: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

Chair: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

1) *Logistics Of Tractor Distribution*, **Raghuram, Ganesan**, India

This paper examines critical decision areas in the context of outbound logistics and their analytical resolution (using OR models) for a tractor company which was the market leader in the tractor industry in India. Customer preferences and demands had changed in the context of the competitive environment. The challenges lay in increasing service levels to the customer through improvements in supply chain management and supporting infrastructure.

2) *The Brazilian Air Trafic Control An Integrated Real Time System*, **Sampaio, Adalberto**, CTA-ITA-IEC, Brazil; **Soma, Nei Yoshihiro**

An Air Traffic Control (ATC) system has as its main objective to sustain safe and efficient use the airways/airports resources, and such a system to achieve the objec-tive has to regulate the air traffic flow. With a steady increase of global demand of air traffic in the last years there has been a stringent use of those resources but without a counterpoise growth of their capacities. In this scenario congestion in air traffic net-works occurs bringing as consequence negative impacts to both Air sector and environ-ment. In Brazil the sector problem trend is also present and to minimise it a real time ATC system is suggested.

3) *Managing Tendupatta Leaf Logistics An Integrated Approach*, **Singh, Nitin**, I.I.M, Indore, India; **Shah, Janat**

The collection of tendupatta leaf is a massive operation involving around 2.5 million families, which depend on this activity for their livelihood. The limited time-period & budget, threat of imminent monsoon, mobilising large number of leaf-collectors, conditioning of leaf, bagging, safe transportation and warehousing pose a great challenge in terms of management. We present a decision making process, aided by OR tools, to capture these issues. This OR based methodology helps the Decision-Maker to raise leaf output under the existing limitations on time and budget. It is also found to bring down wastage substantially by enhancing the efficiency in operations.

MD13 **Electronic Commerce II**

Contributed session Venue: AT-7

Chair: **Cochrane, Ednea**
United Kingdom

1) *An Examination of Queuing Theory in Electronic Commerce Systems*, **Brandyberry, Alan A.**, Kent State University, United States

Queuing theory and associated models have been well established and supported in physical queuing systems. This research is an attempt to explore the similarities and differences in queuing behavior between classic physical systems and electronic systems such as found in electronic commerce applications. Issues such as reneging, balking and the effects of network disruptions and slowdowns are explored.

2) *The Role of OR in the Information Era*, **Cochrane, Ednea**, United Kingdom; **Cochrane, James**

This paper discuses the role of OR in the context of a society that has to face the challenge to solve so many new optimisation problems relating to the dissemination of information and also the security issues of an electronic b2b and b2c environment. We believe that there are a range of traditional OR techniques that can be easily adapted and combined with new technology trends in order to help organizations react to the business pressures of today's environment. In the last few years we have been witness to the changes in OR with the introduction of hard-OR, soft-OR, and perhaps now towards trend-OR.

MD14 **The Global Automotive Industry - Manufacturing**

Invited session Venue: AT-8

Organizer: **Chelst, Kenneth**
Wayne State University, United States
Organizer: **Elkins, Debra**
General Motors Research, United States

Chair: **Kozan, Erhan**
Queensland University of Technology, Australia

1) *Optimising a Hybrid Push-Pull Production System for Automotive Components*, **Corry, Paul**, Queensland University of Technology, Australia; **Kozan, Erhan**

This study investigates a hybrid push/pull system producing wheel components and assemblies. The aim is to determine safety stock and replenishment levels for a large inventory situated at the junction point between component production and assembly operations. Components are produced according to a pushing policy and are received into inventory when completed. Wheels are assembled-to-order, drawing components from the inventory as required. Some computational techniques for attaining good solutions are demonstrated.

2) *An Integrated Mat'l Planning and Control Sys. for Mixed Model Multi-Stage Truck Assembly Processes*, **Kozan, Erhan**, Queensland University of Technology, Australia

A stochastic material planning (SMP) model is developed to incorporate uncertainties in timing and amount in demand, and availability of correct parts when needed to satisfy production. The SMP is based on and implemented in a truck production plant and calculated in a MS-Access database. SMP uses the bill of material (BOM) to generate parts requirements for weekly production plan determined by master production schedule which is solved by mixed integer programming. The SMP model is used to reduce the complexity of the BOM and to improve the accuracy of a multi-product production plant.

3) *Resource Constrained Sequencing and Scheduling for Mixed Model Truck Assembly Process*, **Burdett, Robert** , Queensland University of Technology, Australia; **Kozan, Erhan**

This paper addresses the implementation and execution of heuristic solution techniques for solving the large sized resource allocation, sequencing and scheduling problem within a mixed-model truck assembly process. Due to the exact nature and size of the problem modifications and improvements have been made to previously developed algorithms. The primary improvement is a decomposition approach, which allows successively larger simplified sub-problems to be solved. The core of this approach is the use of previously obtained simplified sub-problem solution which are used as the basis for generating starting solution to the next larger sub-problem instance.

MD15 **Practices in Supply Chain Management**

Invited session Venue: AT-2B

Organizer: **Lee, Hochang**
School of Business, Kyung Hee University, Korea, Korea

Chair: **Park, Taeho**
San Jose State University, United States

1) *Direct Shipment from a Factory to Customers*, **Park, Taeho**, San Jose State University, United States; **Loomba, Arvinder**

The conventional delivery of products was to send products in a truck load from a factory to a distribution center (D/C) and unload/store them in the D/C. Then, when orders arrived, the products were sent in a less-than-truck load from the D/C to customers. So, there were extra transportation and warehousing costs occurring in the distribution structure, as compared with shipping products directly from a factory to a customer. Thus, this research presents a direct shipment strategy for reducing logistics costs with a Samsung Visual Media Division case.

2) *Supply Chain Performance based on Competitive strategy and supplier selection criteria*, **Yu, Yung-Mok**, Dankook University, Korea

This study focuses on comparing the strategically well-matched companies with the strategically ill-matched companies in terms of total supply chain performance such as total cash flow time and perfect order. Strategic matchedneess is measured by the consistency between competitive strategic orientation and supplier selection criteria. Some of findings from a mail survey on the Korean companies will be presented and discussed.

3) *Outsourcing and Control Strategies*, **Lojo, Maureen**, Cal State Univ, Sacramento, United States

Current practices in managing supplier relationships in the semiconductor industry will be reviewed and compared. Primary focus is on the degree and scope of outsourcing and on customers' strategies for exerting control over suppliers, both through contractual and operational means. Various measures are used to evaluate and compare the effectiveness of these practices.

MD16 **Multi-Criteria Decision Analysis V**

Contributed session Venue: WR-11

Chair: **Smith, Charles H.**
Virginia Commonwealth U, United States

1) *Environmental Policy and Firm's Competitiveness-A Multicriteria Approach*, **Hontou, Vasso**, NTUA, Greece; **Koutsolouka, Anna**; **Diakoulaki, Danae**; **Papayannakis, Lefteris**

Cost internalization due to environmental policy affects both dimensions of competitiveness either by creating the potential for development-exploitation of differentiation opportunities or by modifying the cost of production. At the firm level, both differentiation ability and cost change are strongly depending on factors such as energy intensity, technology, production process, competitive environment and strategic orientation. The present paper presents a multicriteria approach for classifying firms into discrete categories of possible impact, according to their vulnerability and readiness to comply with the commitments. The resulting Environment-Competitiveness Matrix can be exploited for establishing sustainability strategies and designing effective policies in the industrial sector.

2) *IMGP as a Tool Supporting Insurance Company Decision*, **Ciupek, Bogdan**, University of Economics, Poland

Insurance company activity is connected with the realisation of numerous contradictory goals. It is sometimes difficult to determine hierarchy of particular goals and as a result it makes their efficient realisation difficult. Hence, IMGP constitutes a reliable tool enabling to make decisions in an insurance company. Its application will be illustrated by a simple example.

3) *Issues in Complex Multi-Criteria Portfolio Selection Problems*, **Smith, Charles H.**, Virginia Commonwealth U, United States; **Weistroffer, H. Roland**; **Narula, Subhash C.**

Portfolio selection problems appear in various settings, but most such problems in the OR literature have had very limited interaction among the selected items. We discuss problems where the attributes of individual items are not related in simple ways to the attributes of the portfolios to which they belong.

MD17 **Frameworks for Financial Decisions**

Invited session Venue: WR-10

Organizer: **Paris, Francesco M.**
University of Brescia, Italy

Chair: **Spronk, Jaap**
Erasmus University, The Netherlands

1) *A Multidimensional Framework for Financial-Economic Decisions* , **Spronk, Jaap**, Erasmus University, The Netherlands

Most financial-economic decisions are made consciously, with a clear and constant drive to 'good', 'better' or even 'optimal' decisions. Nevertheless, many decisions in practice do not earn these qualifications, despite the availability of financial economic theory, decision sciences and ample resources. We plea for the development of a mul-ti--dimensional framework to support financial economic decision processes. Our aim is to achieve a better integration of available theory and decision technologies. We sketch a) what the framework should look like, b) what elements of the framework already exist and which not and c) how the decision sciences community can co-operate in its development.

2) *A framework for comparing portfolio strategies*, **Mansini, Renata**, University of Brescia, Italy; **Pouchkarev, Igor W.**; **Speranza, Maria Grazia**; **Spronk, Jaap**

We propose and illustrate a framework for comparing portfolio strategies over a given performance horizon. The performance of the portfolio strategies is compared with the performance of all possible portfolios that could have been constructed for this period, given the same opportunity set and also given the same set of constraints that are relevant for the strategies studied. Within the framework, several performance measures can be used simultaneously.

3) *"Reverse engineering" of managed fund market timing strategies*, **Falbo, Paolo**, University of Brescia, Italy; **Doninelli, Nicola**

In market timing studies the sensitivity of fund returns to the payoff of perfect market timing strategies is usually provided. Nothing is said about the nature of the trading strategies implemented by fund managers. In this work we present a novel method to identify timing activity more than timing ability based on genetic programming and the Henriksson-Merton model. While timing ability is necessarily associated to superior forecasting, timing activity is not. Therefore, we're not testing the EMH from the supply side but attempt to address a slightly different question: do mutual funds use timing strategies? This is an intriguing problem given that we focus on investment style more than on the average profits of market timing.

MD19 **Marketing**

Contributed session Venue: WR-1

Chair:

1) *Partner Relationship Management in IT industry*, **Kim, Hyuncheol**, ETRI, Korea; **Han, Janghui**

Competition in the Information & Telecommunication(IT) industry is tougher than ever, for both operators and their partners. These days, indirect channels account for the majority of sales in a number of business parts. It proves that partner relationship management(PRM) is important. PRM, a new management concept, can provide significant competitive advantage for supporting channel partners as well as customer-based CRM. As a result, PRM can improve the performance of whole related-companies, increase the profits and reduce the cost of operations between partners.This study focus on strategic expansion of PRM in the IT industry and provide an advanced relationship management model.

2) *A New Kind of Model for Pricing Commodity*, **Dai, Feng**, ORSC, China; **Liang, Ling** ; **Zhang, Xue-min**

We had put forward the concept and expression of the PD-Partial Distribution in other paper. Here, give a new kind of model for pricing commodity based on the PD-Partial Distribution. By the model, we can estimate the market profit and the risk of a commodity, and give the optimal price field of a commodity in a market.

MD20 **Wireless Networks II**

Invited session Venue: WR-2

Organizer: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

Chair: **Amaldi, Edoardo**
Italy

1) *Optimizing base station location and configuration in UMTS networks*, **Amaldi, Edoardo**, Italy; **Capone, Antonio** ; **Malucelli, Federico**

In UMTS networks base station location and configuration cannot only be based on signal predictions, but it must also consider the traffic distribution, the power control (PC) mechanism and the signal quality constraints. Integer programming models are presented to support decisions in the planning process. We consider the Signal-to-Interference Ratio (SIR) as quality measure and capture the PC mechanism features at different degrees of details. To find good approximate solutions of these NP-hard problems which are extensions of standard capacitated location problems, we present local search procedures. Computational results are reported for realistic uplink instances.

2) *An Optimization Approach for Resource Management in Multi-hop Radio Networks*, **Yuan, Di** , Linkoping University, Sweden; **Varbrand, Peter** ; **Bjorklund, Patrik**

In this presentation we consider resource management in multi-hop radio networks, where radio units are spread out in some terrain. The problem that we study concerns organizing the radio units into groups, such that simultaneous transmissions are performed without collisions and the radio resources are optimally utilized. We provide the technical background that motivates our study, and present mathematical formulations as well as optimization algorithms.

Numerical results based on realistic data are presented and compared to previous approaches.

3) *Solving the Cumulative Interference Frequency Assignment Problem by Constraint Programming*, **Soriano, Patrick**, École des HEC - Center for research on transportat, Canada; **Ducharme, Alain**; **Pesant, Gilles**

We examine a frequency assignment problem arising in wireless networks where cumulative interference resulting from the different antennas on any given cell is explicitely taken into account. Constraint programming is applied to this problem and different search strategies based on the status of interference levels are explored. A conbined search strategy and the application of search limits is shown to give very good results on a set of realistic generated test problems.

MD21 **State of the Art of Knapsack Problems**

Invited session Venue: WR-3

Organizer: **Myung, Young-Soo**
Dankook University, Korea

Chair: **Pferschy, Ulrich**
University of Graz, Austria

1) *Recent advances in exact algorithms for knapsack problems*, **Pisinger, David**, University of Copenhagen, Denmark

An overview of exact algorithms presented during the last decade will be given. This includes: New dynamic programming recursions, where in partcular primal-dual approaches in the recursion have lead to tighter bounds on the time and space complexity. Methods for deriving tighter bounds by adding valid inequalities to the formulation, and efficient methods for solving the relaxation. Extensions to more general variants of the knapsack problem, including the bounded multiple-choice knapsack problem, collapsing knapsack problem, quadratic knapsack problem etc. New classes of benchmark instances will be presented and the performance of recent algorithms will be compared on these as well as on more classic test instances.

2) *Recent improvements for the approximation of the knapsack problem*, **Kellerer, Hans**, University of Graz, Austria; **Pferschy, Ulrich**

We will present polynomial and fully polynomial approximation schemes (FPTAS) with the best currently known time and space complexities. The new approximation algorithm improves upon previous methods both in time and space. Especially the new space complexity of $O(n + 1/\varepsilon^2)$ is a major step towards practically relevant approximation schemes. Three new main ideas are used: Sophisticated partitioning and reduction of the profit space, faster dynamic programming by applying a more general vector merging procedure and a recursive strategy to reconstruct the final solution set with reduced storage requirements.

3) *Efficient Approximation of the Subset Sum Problem*, **Kellerer, Hans**, University of Graz, Austria; **Pferschy, Ulrich**

Polynomial and fully polynomial approximation schemes, (PTAS) and (FPTAS), with the best currently known time and space complexities are presented. In particular, we drastically improve upon previous methods the space requirements. The new space complexity of $O(n + 1/\varepsilon)$ for the (FPTAS) makes the practical application of this algorithm clearly attractive. The main new ideas are a complicated partitioning and reduction of the profit space, a special variant of "not exact" dynamic programming and a recursive strategy to reconstruct a solution set corresponding to the final solution value.

MD22 **Artificial Intelligence, Expert Systems and Neural Networks III**

Contributed session Venue: WR-4

Chair: **Cochrane, Ednea**
United Kingdom

1) *Facilitating Software Development Time And Cost Estimation*, **Flitman, Andrew Mark**, Australia

Software development projects are known for inaccuracies associated with elapsed time and total cost estimates. Our research has investigated the use of Data Envelopment Analysis (DEA) as a tool for providing meaningful benchmarking of software development project team performance. This relates the time spent on the different phases of a development project to the complexity of the system as defined by its function point count and its user-base. This paper further describes an extension to this research to facilitate its use as a project estimation tool prior to actual commencement of a software development project. The result of this research is a stand-alone tool that allows project managers to assess their estimates against completed projects.

2) *Object Oriented Optimal Power Flow Using Genetic Algorithm*, **Bouktir, Tarek**, Algeria; **Benfarhi, Louiza**; **Belkacemi, Mohamed**

This papers presents the methodology used in the development of an Object Oriented Optimal Power Flow program using an efficient Genetic Algorithm (OOOPF-GA). The Optimal Power Flow (OPF) problem is modelled as a class multy inherited from a Load Flow (LF) class and a Genetic Algorithm (GA) class and has a direct access to a main power system object class. Input and output data can communicate with the OPF computing modules via an object oriented graphic user interface and through an object oriented database. The proposed methodology is illustrated in a case study with the IEEE 30-Bus system. OOOPF-GA appeared to be faster than other OPF-GA methods by more than an 9:1 speed ratio. It show also that the OOOPF-GA is a global method since it converge to the solution from almost any starting point and give a secure control vector.

MD23 **Decision Analysis I**

Contributed session Venue: AF-10

Chair: **Salo, Ahti Antero**
Helsinki Univ of Tech, Finland

1) *Theater Fleet Refurbishment Program (TFRP)*, **Waymire, William J.**, US Army, Germany; **Woodworth, Rich**

The current administration's implementation of a strategy to advance weapon technology using funds generated by foregoing new procurements places a burden on Army maintenance resources. As the fleet ages, maintenance plans and special programs are required to mitigate drops in readiness levels attendant with increasing age and high OPTEMPO. The General Support Center - Europe's Theater Fleet Refurbishment Program (TFRP) is one such special program. The 21st Theater Support Command , which is the parent organization to GSC-E, implemented TFRP to sustain the readiness level of selected U.S. Army wheeled and tracked vehicles within Europe . In this paper, we present our methodology to measure both the readiness impact of TFRP and its cost effectiveness. We apply our methodology to TFRP systems using data from the Logistic Information Data (LIDB) database and discuss our findings from a dynamic programming viewpoint.

2) *Improving the final ranking derived from a fuzzy preference relation via multicriteria optimization*, **Fernandez, Eduardo Rene**, University of Sinaloa , Mexico; **Leyva, Juan Carlos**

The methods for deriving final ranking from a fuzzy preference relation do not perform well in presence of irrelevant alternatives or in case of complex graphs. We propose a new method which rests on the main idea of reducing differences between the global model of preferences captured in the valued relation R and the final ranking via multicriteria optimization, minimizing their strong and weak discrepances, maximizing their concordances and increasing the credibility degree of the crisp preferences relations derived from R. This proposal is more robust than others handling irrelevant alternatives. It can be seen as an intent of conciliating two ways of thinking about decision aid. The normative decision analysis clearly appears as a particular approach of a more general based on fuzzy judgements.

3) *Mean-Risk Analysis of Multiattribute Decision Problems under Uncertainty*, **Gustafsson, Janne Petteri**, Helsinki Univ of Tech, Finland; **Salo, Ahti Antero**

In multiattribute utility theory, the decision maker's (DM) preferences for risk and consequences are captured by a multiattribute utility function. The elicitation of this function, however, is typically based on restrictive assumptions about the structure of the DM's preferences (e.g., additive independence). In this paper, we examine an alternative approach to the modelling of multiattribute decision problems under uncertainty. This approach separates DM's preferences into two components - those for consequences and those for variability (risk) - and captures them through a multiattribute value function and a mean-risk model. Along with many other benefits, this enlarges the set of preferences that can be easily managed in risky decision problems.

MD24 **Location Analysis I**

Contributed session Venue: AF-13

Chair:

1) *Optimal Server Location on a Mesh as an M/M/2(2) Queue*, **Inakawa, Keisuke**, Nanzan University, Japan; **Suzuki, Atsuo**

This paper gives a model in which two urban emergency service units (such as ambulances) cooperate in responding to calls from the public in a city. The city is divided by mesh area with call rates. Given the home locations of the service units, each meshed area are served with priorities depending on the distance to them.Then we apply the M/M/2(2) model where (2) represent a limit number of customers in the system. Our purpose is to find the optimal location of the service units, which minimizes the probability that all two servers are busy.

2) *Undesirable Facility Location Model*, **Ohsawa, Yoshiaki**, University of Tsukuba, Japan

This paper is concerned with the problem to locate an undesirable facility within a polygon with the objectives of maximizing the Euclidean distance to the nearest population center and minimizing the Euclidean distance to the farthest demand. A polynomial-time algorithm for finding the analytical expressions of the efficient set and the trade-off curve for the bicriteria model, based on the k-nearest- and k-farthest-point Voronoi diagrams, is given. Some geometrical features of the efficient set and the trade-off curve are also presented.

3) *Discrete sequential models for competitive location planning*, **Fischer, Kathrin**, Universitaet Hamburg, Germany

A new duopoly model for competitive discrete location planning with variable prices and sequential acting is introduced. It is shown that a number of different well-known and more specialized models, as for example for the p-median problem, the preemptive location problem and the Max Cap problem, can be derived from this model as special cases. In addition, extensions to the oligopoly situation are discussed and robust strategies, especially for the leading player, are developed. A two-player game on a tree network is used as an example to illustrate the results.

MD25 **Mathematical Programming-General III**

Contributed session Venue: AF-14

Chair: **Glen, John J.**
University of Edinburgh, United Kingdom

1) *Optimal Linear Discriminant Function by Integer Programming*, **Shinmura, Shuichi**, Seikei University, Japan

I developed optimal linear discriminant function by integer programing (IP-OLDF)in addition to L1-norm linear discriminant function by LP(LP-OLDF). IP-OLDF minimizes sample error rates and LP-OLDF minimizes total distances by mis-classified cases from critical point. I evaluated these methods with Fisher's liniar discriminant function and quadratic disvriminant function by three kinds of data sets. First data is the famous Fisher's Iris data that is used for test data of discriminant function. Second is the medical data that consists of 19 dependent variables with high multi-colinearity. Last is 104 noramal random data sets that can be checked for internal and external check. Very fantastic results are obtained.

2) *Comparative Analysis Of Models For Transition Vote Estimation*, **Vazquez, Elena**, Uni Politecnica Valencia, Spain; **Romero, Rafael**

A set of mathematical programming models to estimate the vote transition between two elections is proposed. Models are based on aggregated electoral results. A comparative analysis of them using simulated data is carried out as well, in order to determining their effectiveness and optimal behavior.

3) *Categorical variable formation in mathematical programming discriminant analysis models*, **Glen, John J.**, University of Edinburgh, United Kingdom

Classification models generated by statistical or mathematical programming (MP) discriminant analysis techniques are often simplified by ad hoc formation of dichotomous categorical variables from some of the original variables, with a categorical variable taking value 1 if the original variable is above a threshold level and 0 otherwise. In this paper, a MP method for determining the threshold levels for forming the categorical variables and generating the associated discriminant function coefficients is developed. The method is applied to a problem that has been used to demonstrate both standard MP and statistical discriminant analysis methods using the original variables.

MD26 **Mathematical Programming-Integer II**

Contributed session Venue: AF-18

Chair: **Raa, Birger**
Ghent University, Belgium

1) *A classification scheme of the planning annualised working-hour problems*, **Corominas, Albert**, Universitat Politecnica de Catalunya, Spain; **Lusa, Amaia**; **Pastor, Rafael**

Annualised hours (AH) offer the possibility to adjust production capacity to demand, by distributing the working hours over the year (subject to some constraints). We propose a classification scheme of the problems of planning AH that arise in services and in manufacturing as well as an approach for solving them by using MILP.

2) *Approximate Methods for a class of Inventory-Routing Problems*, **Raa, Birger**, Ghent University, Belgium; **Aghezzaf, El-Houssaine**; **Van Landeghem, Hendrik**

In this paper, we propose a mathematical programming model which provides a distribution plan that optimizes distribution and fleet operating costs, as well as the total inventory holding costs, in particular when the inventory management policies used are the EOQ-models. The inventory-distribution problem is modeled as an extended non-linear capacitated VRP. To solve the problem, we developed two approximate methods, one based on the saving concept, and the second inspired by Christofides' method for TSP-problems. Both methods are tested on a set of generated problems with different parameter settings. The results of these tests are reported and commented.

MD27 **Production Management & Manufacturing III**

Contributed session Venue: AF-19

Chair: **Barbosa-Povoa, Ana**
CEGIST - Inst.Sup.Tecnico, Portugal

1) *Relaxed Scheduling with SAP APO - Industrial Context and Modelling*, **Trautmann, Norbert**, University of Karlsruhe, Germany; **Schwindt, Christoph**

We consider a real-world production scheduling problem arising in process industries. At first, we review the production process and discuss pecularities that have to be observed when solving the scheduling problem, e.g., minimum and maximum time lags between individual production steps, alternative resources, resources that have to be synchronized, and sequence-dependent setups. We then show how to model this scheduling problem in SAP APO's module "Detailed Scheduling" and discuss parallels to resource-constrained project scheduling.

2) *Relaxed Scheduling with SAP APO - Solution Method*, **Schwindt, Christoph**, University of Karlsruhe, Germany; **Trautmann, Norbert**

In this talk, we are concerned with an algorithm for detailed production scheduling available in SAP APO. The basic principle of the procedure is to relax the resource constraints arising from the scarcity of production and setup resources, intermediate products, and storage space. Resulting resource conflicts are then resolved by introducing different kinds of precedence relationships among operations competing for the same resources. The algorithm has been implemented as a beam search heuristic enumerating alternative sets of precedence relationships.

3) *Optimal scheduling for flexible job shop operation*, **Gomes, Marta Castilho**, CESUR - Inst. Sup.Tecnico, Portugal; **Barbosa-Povoa, Ana** ; **Novais, Augusto**

The flexible job shop problem is addressed. An integer programming model is presented where production flows may go through different machine group sequences. Job recirculation as well as machine and job dependent set-ups are also considered. Based on the proposed generic scheduling model the need for re-scheduling is studied whereby schedules are adapted to unexpected events during plant operation. Numerical results on a realistic example of a make-to-order, discrete-part manufacturing industry are presented.

MD28 **Scheduling and Timetable VI**

Contributed session Venue: DH-C

Chair: **Muller, Felipe Martins**
UFSM - CT - PPGEP, Brazil

1) *Solving Resource-constrained Project Scheduling Problems by Intelligent Search Techniques*, **Ahsan, M. Kamrul**, Japan; **Tsao, De-Bi**

We propose a mulit-criteria heuristic search algorithm for multiple resource-constrained project scheduling problems. The algorithm is characterized by the heuristic learning process through muti-criteria state selection and search path evaluation. We propose two heuristic procedures based on different weights of state selection criteria. Extensive experimentation with various problem parameters is conducted and computational results of the proposed heuristics are reported.

2) *Fairness in TV coverage of football*, **Johns, Stuart**, Sheffield Hallam Univ, United Kingdom

This paper proposes a number of models designed to ensure equity in the showing of live football matches on television. Most football clubs are dependent on television revenue and the number of times they appear can have a significant influence on the balance sheet. However the television companies wish to maximise the revenue they obtain from advertising. These models are designed to address both of these concerns.

3) *Tabu Search with Adaptive Neighborhood to Unrelated Parallel Machine Scheduling*, **Muller, Felipe Martins**, UFSM - CT - PPGEP, Brazil; **Araujo, Olinto Bassi**

This work deals with the problem of scheduling n independent jobs on m unrelated parallel machines with the objective of minimizing the makespan (the total elapsed time from the start of execution until all jobs are completed). We propose a new metaheuristic that combine Tabu Search with adaptative neighborhood. Four neighborhoods schemes are used and some synergic aspects among them are presented. In addition, a path relinking method is used as intensification strategy. The proposed metaheuristic is compared with other algorithms in order to evaluate the quality of solutions obtained. Results on standard test problems from the literature are reported.

TA1 **Emergency and Hospital Services**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Carter, Michael W.**
University of Toronto, Canada

1) *System Dynamics Modelling for On-Demand/Emergency Health Care*, **Brailsford, Sally C.**, University of Southampton, United Kingdom; **Lattimer, Valerie**; **George, Steve**; **Smith, Helen**; **Tarnaras, Panayiotis**; **Turnbull, Joanne**

Demand for emergency or same-day access to health care in the UK appears to have increased over recent years, and is placing a significant burden on service providers. We have developed a System Dynamics model for the emergency/on-demand system within a large UK city, focussing on the "front doors" or access points to the health care system. The aim of the model is to gain understanding of the system and the interconnections between its component parts, and then to evaluate developments to the system to ensure that people obtain the most appropriate and timely care.

2) *Emergency Services Modelling: a Patient's Perspective*, **Churilov, Leonid**, Dr, Australia; **Liew, Sin Kiew**; **Wassertheil, Jeff**; **Ibrahim, Mohamed**

In this presentation we discuss how simuation, data mining, and other standard OR modelling tools can be used to increase emergency patients awareness of the hospital environment, continuum of care, and patients progression through various stages of this process. The case of Franskton Hospital emergency department, Vic, Australia, will be analyzed to demonstrate the potential of such a patient-centered approach. It is important to note that better outcomes in terms of patients satisfaction can be achieved at a marginal cost by utilizing existing decision support tools currently available within some emergency care facilities.

3) *Modelling the drug order entry process for in-patients*, **Carter, Michael W.**, University of Toronto, Canada; **Geiger, Glen** ; **Fernandes, Dominic**

This paper describes an analysis of delays for in-patients getting medications in a reasonable length of time. The study was initiated based on evidence that there were delay issues within the Internal Medicine ward at Sunnybrook Hospital. We performed a detailed process analysis and conducted a two-week data collection during which all drug orders were tracked at ten minute intervals. A simulation model was used to demonstrate the possible improvement physicians enter the orders directly into a computer. Many issues that we discovered at Sunnybrook are common to most manual drug order entry processes.

TA2 **Models for Air Traffic Management and Airline Operations**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Ball, Michael O.**
University of Maryland, United States

1) *Optimization and Equity Concepts in Air Traffic Management*, **Ball, Michael O.**, University of Maryland, United States; **Vossen, Thomas**

In this paper, we analyze new slot allocation procedures instituted by The Federal Aviation Administration (FAA) from a game theory and optimization perspective. We show that the new procedures may be formalized using well-known concepts of equity and through appropriately defined optimization models. This analysis suggests that the current procedures are heavily "flight-centric" whereas a more "airline-centric" approach may be more appropriate. We then develop new airline centric allocation principles based on a game theoretic analysis. We also describe optimization models for carrying out the required allocation.

2) *The multi-airport capacity allocation problem*, **Dell'Olmo, Paolo**, DSPSA - Univ. of Rome , Italy; **Lulli, Guglielmo**

We describe a multi-airport capacity problem on a network of airport mutually connected. The problem consists in finding, for each time period and for each airport of the network, the optimal balance between the number of arrivals and departures in order to minimise the total delay. We have developed a mathematical model for the strategic version of the problem. Furthermore, we have carried out a computational analysis and evaluation of the proposed mathematical model. We have verified its validity using a series of different size test instances based on partial real data provided by FAA and ENAV (Italian Aviation Administration Agency). Extension to the Collaborative Decision Making will be also discussed. Keywords: Capacity Allocation, Mathematical Modelling, Air Traffic Management.

3) *Design and Analysis of a Large Package Sort Facility*, **McAree, Paul W.**, University of Maryland, United States; **Bodin, Lawrence D.**; **Ball, Michael O.**

At the sort facility in a large overnight package delivery operation, palletized loads are moved in a container (called an inbound ULD) from a plane to a bin, unloaded from the bin and moved by forklift one item at a time from a bin to a rack. At the rack, each palletized load is loaded into a container (called an outbound ULD) and this outbound ULD is delivered to a plane for delivery to its final delivery airport. The purpose of this study is to determine the optimal design of this sort facility that acts as a hub in a hub and spoke system. This study reports the results of our analysis for FedEx.

TA3 **Meta-Heuristics in Routing and Scheduling III**

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Cordeau, Jean-Francois**
HEC Montreal, Canada

1) *Systematic Diversification Metaheuristic for the Vehicle Routing Problem with Time Windows*, **Braysy, Olli** , SINTEF Applied Math, Norway; **Hasle, Geir** ; **Berger, Jean**; **Barkaoui, Mohamed**

We present a new metaheuristic for the vehicle routing problem with time windows. First, several initial solutions are created, followed by an attempt to reduce the number of routes and minimize the total distance, using several new improvement heuristics. We present a new technique for measuring the difference between a pair of solutions, and then use this technique to guide the construction heuristic, as well as to escape from local minima in a systematic fashion. Moreover, the parameter values of the proposed method are adjusted dynamically, thus incorporating a learning effect. Computational results indicate that the proposed metaheuristic outperforms other recent methods.

2) *New Genetic Operators For Solving The RCPSP With Multiple Modes*, **Alcaraz, Javier**, U Politecnica Valencia, Spain; **Maroto Alvarez, Maria Concepcion**

In this paper we propose new genetic operators for solving the multi-mode resource-constrained project scheduling problem. These operators work over a new representation for the solutions, which includes an additional bit indicating the scheduling scheme used to construct the schedule, forward or backward. Moreover, the operators exploit and combine the information in an efficient way. We have designed new crossover procedures and have adapted a mechanism used in a simulated annealing algorithm as a mutation operator in genetic algorithms. Computational results on the standard sets of PSPLIB show the good performance of our algorithm.

3) *A Tabu Search Heuristic for the Static Dial-a-Ride Problem*, **Cordeau, Jean-Francois**, HEC Montreal, Canada; **Laporte, Gilbert**

We present a formulation and a heuristic solution approach based on tabu search for the static version of the dial-a-ride problem. In addition to vehicle capacity constraints, the approach handles maximum transit time constraints, LIFO requests, multiple depots and multiple vehicle types. Computational results are reported on both randomly generated and real-life instances.

TA4 **Cutting and Packing: Approaches to multidimensional problems Rectangular Problems**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Arenales, Marcos Nereu**
Universidade de Sao Paulo, Brazil

1) *Some extensions of the AND-OR graph approach to cutting problems*, **Arenales, Marcos Nereu**, Universidade de Sao Paulo, Brazil; **Gonçalves-Vianna, Andrea Carla**; **Morabito, Reinaldo**

The main objective of this work is the extension of the AND/OR-graph approach to handle practical cases of cutting and packing problems not considered or rarely considered in the literature, such as defective plates, bound on the number of different types of items in a cutting pattern and others. Issues on implementation and computational experiments will be given.

2) *An algorithm for the non-guillotinable two-dimensional packing problem*, **Pinto Ferreira, Maria Eduarda**, ISEP - Dept. Matemática, Portugal; **Oliveira, Jose Fernando**

The problem of cutting a rectangle into smaller rectangular pieces of given sizes is known as the two-dimensional packing problem. In this paper we describe a different approach to the characterization of feasible packing. We use a graph-theoretic characterization of the relative position of the boxes in feasible packing.

3) *A new parallel approach for multi-dimensional packing problem*, **Blazewicz, Jacek**, Poznan Uni of Technology, Poland; **Walkowiak, Rafal**

Data representation by spatial occupancy enumeration can be used to describe geometrical entities within packing and cutting problems. This computer data representation provides the data that can be efficiently computed in vector computers. The solving of packing problems on a vector computer consist in designing procedures for manipulation on matrices defining the allocation space and geometrical entities to be assigned to it. Using this parallel computational geometry technique a family of methods based on controlled reorganization of the solution can be created. In the paper the idea of the approach proposed, solution of arising problems and introductory computational results are presented.

TA5 **Network Design IV**

Contributed session Venue: MS-1

Chair: **Skorin-Kapov, Darko**
Adelphi University, United States

1) *Tree Knapsack Approaches For Local Access Network Design*, **Van der Merwe, David Jacobus**, PU for CHE, South Africa; **Hattingh, Johannes Michiel**; **Drevin, Gunther Richard**

Key concepts: Network design, Tree Knapsack problem, Zero-one integer programming Abstract - In the process of solving many forms of the Local Access Network Design problem, the basic model of the Tree Knapsack Problem (TKP) is used as a building block for the search engine of the solution strategy. New algorithmic strategies based on partitioning are investigated that enables one to solve large problems exactly that are not amenable to direct solution with standard optimization software like OSL of IBM, Empirical results are presented.

2) *On Improving Generalized Subtour Elimination Constraints*, **Gouveia, Luis** , DEIO-CIO Univ. of Lisbon, Portugal; **Lopes, Maria Joao**

The so-called generalized subtour elimination constraints have played an important role in obtaining effective Linear Integer Programming Models for the capacitated minimum spanning tree problem. We start by describing a single-commodity flow (SCF) model previously presented by the authors for the problem with weights associated to the nodes. The coefficients of the linking constraints in this formulation are given by the optimal solution of an adequate subset sum problem. By projecting the set of feasible solutions of the linear programming relaxation of the improved formulation and by using integer techniques for manipulating ILP constraints we obtain several different improved versions of the generalized subtour elimination constraints. The new inequalities are tested in the context of an augmented lagrangean. The results show the impact of using the new inequalities.

3) *On Cost Allocation in Communication Networks*, **Skorin-Kapov, Darko**, Adelphi University, United States; **Boljuncic, Valter**; **Skorin-Kapov, Jadranka**

Modern communication network design often leads to construction of networks, which are efficient with respect to various criteria (cost, throughput, delay, minimum flow, reliability etc.) Moreover, it involves multiple network users and owners, which possibly have conflicting objectives. However, they might cooperate in order to improve their joint efficiency. Clearly, these individuals or organizations will support a globally "attractive" solution(s) only if their expectations for a "fair" share of the cost or profit are met. This work is an overview of some results (some previously published and some new) in the development of cooperative game theory based mechanisms to efficiently compute "attractive" cost/profit allocation solutions for various communication networks.

TA6 **Critical DEA and Realist Frontiers**

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Storbeck, James Edward**
University of Warwick, United Kingdom

1) *Non-Economic Frontiers: Variations on the 'Source-Path-Goal' Schema*, **Storbeck, James Edward**, University of Warwick, United Kingdom

Metaphorical structures conceptualising improvement within measurement systems are examined. Based on a reading of cognitive linguistics, I suggest that 'best practice frontiers' with an imperfective aspectual structure offer a promising variation from the 'source-path-goal' schema of perfective structures in most performance measurement exercises. The latter framework ignores the internal structure of processes, focusing instead on the completion of the action; the former offers the obverse. Finally, I argue that nesting DEA within improvement discourses from the imperfective model allows a departure from standard production economics, and can lead to better understanding of the causal mechanisms of improvement in social systems.

2) *Diabetes Service Delivery - Towards a critical application of DEA*, **Amado, Carla**, United Kingdom

Data Envelopment Analysis (DEA) is a technique for measuring the relative performance of homogeneous decision-making units. Despite its common use as a summative evaluation tool, DEA has limited capacity for formative evaluation. This paper presents a performance assessment framework to formatively evaluate diabetes service delivery in England. This framework was developed in collaboration with four Primary Care Delivery Teams in England, including representatives of managers, health care professionals and patients. The paper continues with a discussion of the methodology used to collect the necessary data, and concludes with a discussion of some preliminary results.

3) *Envelopment and Representation in DEA*, **Amado, Carla**, United Kingdom; **Ye, Hui**; **Storbeck, James Edward**

"Representativeness" has been an important aspect of constructing valid production frontiers in Data Envelopment Analysis (DEA). Indeed, the initial, defining work in DEA (Charnes et al., 1978) associated representativeness of efficient solutions with earlier economic works. In this paper, we return to this concept—representation—and relate it to the notion of the "proper envelopment" of inefficient decision making units (DMUs). Moreover, we explore the implications of envelopment for assessing the validity and meaning of the underlying model of performance. The paper concludes with a discussion of the consequences of this research for broadening the framework for estimating "real" frontiers.

TA7 **Analytical Tools for Homeland Security**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States

Chair: **Stone, George F**
US Army, United States

1) *The Homeland Security Simulation (HLS-Sim)*, **Stone, George F**, US Army, United States; **Lacy, Lee**

American federal, state and local governments are reexamining their standards, procedures and preparedness in light of the shocking events on Sept. 11th. Hundreds of contingency scenarios must be examined to prioritize resources and time. One way to do so is with a simulation of the Homeland Security (HLS) environment using current simulation techniques and programs. DoD simulations could be retrofitted to accommodate such a process. The data requirements for military systems are just as exhaustive and similar in many ways as the civilian systems. The Homeland Security Simulation (HLS-Sim) will reuse military architecture, databases and models.

2) *The Military Institution and the improvement key-techniques*, **Delamare, Sergio Luis Dutra**, Brazil

The main purpose of this survey is to verify how far a military organization that has joined to of Public Administration Quality Program (PAQP) fits the excellence requirements established by the Federal Government Quality Award. Based upon information from a specific military organization, the Center for Naval Systems Analysis, and using Structural Equation Modeling, one has measured the relations of cause and effect based upon the excellence criteria of PAQP. This survey replaces the common practices of subjective evaluations, by providing a scientific aid for an accurate measurement of several parameters that affect in the performance of the organization, therefore improving the decision-making processes.

TA8 **Real Options (Investment Valuation and Decision Making)**

Invited session Venue: AT-3

Organizer: **Zenios, Stavros**
University of Cyprus, Cyprus

Chair: **Martzoukos, Spiros H.**
University of Cyprus, Cyprus

1) *Real Options with Incomplete Information and Venture Capital*, **Martzoukos, Spiros H.**, University of Cyprus, Cyprus; **Trigeorgis, Lenos**

We discuss real options models of managerial intervention oriented towards information acquisition and value enhancement. Examining real options with costly learning and path-dependency, we show that optimal timing of learning leads to superior decision-making and enhances real option value. The model is applied to sequential growth financing (venture capital) when the firm and the venture capitalist have differential beliefs about the probability distribution of future prospects.

2) *Real Option Games with Incomplete Information and Spillovers*, **Martzoukos, Spiros H.**, University of Cyprus, Cyprus; **Zacharias, Lefteris**

We discuss in a duopolistic game theoretic context managerial intervention directed towards value enhancement in the presence of uncertainty and spillover effects. Two firms have

the option, before committing to irreversible investment decision, to do R&D and/or acquire more information. Due to spillovers they act strategically by optimizing their behavior, conditional on the actions of their counterpart. They solve a two-stage game. The first decision is: what is the optimal level of coordination between them? The second decision is: what is the optimal level of R&D effort?

3) *A Stochastic Model of Asset Life*, **Song, Jihe**, The University of Wales , United Kingdom; **Rhys, Huw**

This paper presents a model of asset life under uncertainty. Using the first passage time distributions and central limit theorems, we obtain analytic expressions for an asset's activity and economic lives. The model may have applications to several areas in asset management and corporate finance.

TA9 **Energy Planning and Climate Change**

Invited session Venue: MS-3

Organizer: **Oren, Shmuel**
University of California, Berkeley, United States

Chair: **Kunsch, Pierre L.**
VUB, Belgium

1) *Financial strategies for supporting renewable energies in Belgium*, **Kunsch, Pierre L.**, VUB, Belgium; **Springael, Johan**

Renewable energies are today not competitive in the open electricity market, as their generation costs of electrical kilowatt-hours are much too high. The paper describes instruments (green certificates, subsidies, taxes on fossil fuel, etc.) to promote these energies above the competitive threshold. It is shown that green certificates represent an efficient measure to promote renewable electricity production systems. They are compatible with the European Union rules with respect to competition, and furthermore some experience is available in several countries. A System Dynamics model is used to elaborate quantitatively on their way of functioning taking the Belgian conditions as a reference.

2) *A strategy for reducing Carbon dioxyde emissions in electricity production* , **Kunsch, Pierre L.**, VUB, Belgium; **Springael, Johan**

The paper presents a novel instrument called by the authors negative certificates, or "negacertificates". They are akin to trading permits to be presumably used in the countries of the European Union to achieve in a flexible and efficient way their CO2-reduction objectives. Negacertificates borrow in addition some ideas from "green certificates" used to promote the development of green electricity. The authors believe that some critiques often addressed to trading permits can be avoided in this way, also the need for finding an initial allocation of permits. The paper presents a system dynamics model illustrating the principles of this alternate flexible mechanism in the CO2- debate.

3) *A System Dynamics Model of Emission Trading in Europe*, **Vermeir, Jan** , VUB-CSOO, Belgium; **Pruyt, Erik**

In this paper we will present a system dynamics model of a firm facing a CO2-emission market and an electricity market. The considered CO2-market is the one proposed by the European Commission, where Emission Trading Permits are traded bilaterally, in an environment similar to the one of the GETS2 simulation by Eurelectric and Euronext. The model allows to test different CO2 reduction strategies for the firm.

TA10 **Maintenance Modelling**

Invited session Venue: MS-4

Organizer: **Scarf, Philip**
University of Salford, United Kingdom
Organizer: **Hartman, Joseph C.**
Lehigh University, United States

Chair: **Hartman, Joseph C.**
Lehigh University, United States

1) *Scheduling preventive replacement with cost and reliability criteria*, **Scarf, Philip**, University of Salford, United Kingdom; **Dwight, Richard**

We demonstrate how a required reliability can be used as a decision criterion in a classic age-based replacement policy. The required reliability is formulated as a reliability constraint, which may be specified in terms of the replacement cycle reliability, or in terms of the operational reliability as typically defined by system operators. We show that setting a value for the cost of failure and setting a reliability constraint are equivalent, and thus propose a simple method for checking the consistency of these measures. The approach is illustrated using a real case relating to train traction motors.

2) *Determining condition monitoring intervals-- a hybrid of simulation and analytical approaches*, **Wang, Wenbin**, Dr, United Kingdom

This paper reports on a study for determining condition monitoring intervals. The solution procedure is carried out in two stages. We first propose a static model which is used to determine a fixed condition monitoring interval over the item life. Possible criterion functions to be used are discussed and tested. Once the monitored information indicated the possible abnormality of the item concerned a dynamic approach is employed to determine the next monitoring time at the current monitoring point. For both stages, the optimisation process was performed using a hybrid of numerical and simulation procedures. We finally present a numerical example to demonstrate the modelling methodology.

3) *SUSTAIN - A systems approach to asset management modelling*, **Allard, Crispin**, QinetiQ Consulting, United Kingdom

Recent events in UK Rail highlight the complexity of asset management and the consequences of getting it wrong. SUSTAIN represents infrastructure (e.g. the rail network) as a

whole system. It models the interaction between asset deterioration and the asset management regime, encompassing all types of intervention (maintenance, repairs, renewals, upgrades, inspections and surveillance). Implemented as a Monte Carlo simulation, it predicts the long term impacts of alternative asset management policies on asset condition, performance and cost. This talk will outline the principles underlying SUSTAIN and discuss the experience so far in implementing it in the Rail and Water sectors.

TA11 **Heuristic search for routing and scheduling**

Invited session Venue: MS-5

Organizer: **Glover, Fred**
United States
Organizer: **Lokketangen, Arne**
Molde College, Norway
Organizer: **Nath, Baikunth**
Australia
Organizer: **Woodruff, David L.**
UC Davis, United States

Chair: **Salhi, Said**
University of Birmingham, United Kingdom

1) *A bi-objective heuristic for the collection of garbage*, **Amponsah, Sam**, University of Birmingham, United Kingdom; **Salhi, Said**

The collection of garbage in developing countries is addressed using a heuristic approach.This is a bi-objective problem where both cost and the effect of the environment are considered. A look ahead strategy with some enhancements is proposed and an implementation of tabu search is put forward. Some experiments will be reported.

2) *School Bus Routing in Rural Areas*, **Thangiah, Sam**, Slippery Rock University, United States; **Mennell, William**

School bus routing in rural areas is a mix-fleet multi-depot vehicle routing problem with added complex constraints. The constraints are the capacity of the bus, traveling time of the students, roads used by the buses, pickup time and pickup locations of the students to name a few. The PHOENIX system was designed and implemented to employ digitized routes for solving school bus routing problems. The PHOENIX system and heuristic algorithms used to solve a school bus routing problem with 2400 students will be presented.

3) *Ant colony for vehicle routing with backhauls*, **Wade, Ann**, University of Birmingham, United Kingdom; **Salhi, Said**

An ant system algorithm is designed for the vehicle routing problem with backhauls (VRPB). The mixed VRPB is considered together with a modified version namely the restricted mixed VRPB. The latter allows the user to specify the mix of linehauls and backhauls on a route. Some enhancements to the classical implementation of the ant system for this class of routing problems are proposed; these include the customer-dependent neighbourhood size, initial placement of the ants, updating of the trail and the adaptive use of hybridisation with post optimisation. Results based on test problems from the literature of the VRPB will be presented. The classical VRP will also be tested as a special case of the proposed VRPB-based heuristic.

TA12 **OR in Sustainable Development**

Invited session Venue: AT-6

Organizer: **Bandyopadhyay, Rangalal**
Centre for Applied Systems Analysis in Development, India

Chair: **Del Rosario, Elise**
Operations Research Society of the Philippines, Philippines

1) *OR in Designing Sustainable Development*, **Bandyopadhyay, Rangalal**, Centre for Applied Systems Analysis in Development, India

Concepts related to sustainable economic/social development of a developing country like India are examined in depth and various factors/aspects affecting/ influencing sustainable development are identified. It clearly establishes that sustainable development issues cannot adequately be addressed only by attending to economic aspects. Sustainable development is a multi-disciplinary problem with a number of conflicting criteria. It can be tackled effectively through application of OR. Applications of Operational Research and system approach are likely to significantly help the developing economies like India in progressing towards sustainable development. We develop a framework for applying `OR approaches' for solving the problems of sustainable development. A case study is then discussed. The case study demonstrates the usefulness of the framework. The paper concludes by outlining the steps needed to ensure application of the framework more widely.

2) *Discussant of paper on OR in Designing Sustainable Development*, **Friend, John Kimball**, University of Lincoln, United Kingdom

John Friend will initiate discussion of the key points in the paper on OR in Designing Sustainable Development by Dr. Bandyopadhyay. This will prepare the ground for a period of open discussion involving all participants in this session.

TA13 **Accelerating Electronic Commerce**

Invited session Venue: AT-7

Organizer: **Basu, Amit**
SMU, United States

Chair: **Datta, Anindya**
Georgia Institute of Technology, United States

1) *High Performance E Business through Paralellism*, **Berndt, Donald**, Univ of South Florida, United States; **Birkin, Stanley**

Accelerating e-commerce is an interesting research problem with obvious commercial applications. Improvements in back-end database systems and network infrastructures have improved e-commerce performance. However, the growing demand for customized content generation is a continuing challenge. Numerous new companies offer caching solutions based on content components, such as images, video clips, and the partial results of time-consuming computations. This presentation explores the potential benefits of using parallelism to construct high performance e-business systems involving substantial content generation. Parallelism offers gains in raw processing power and natural caching opportunities. An example parallel programming environment is used to illustrate these two complementary approaches.

2) *Optimization approaches for accelerating dynamic content in E-Business*, **Dutta, Kaushik**, Georgia Tech, United States; **Thomas, Helen**; **Soni, Samit**; **Narasimhan, Sri**

There has been a significant amount of work on caching in the context of the Internet. However, most of this work is focused on caching rich content or caching at coarse granularities, such as HTML pages. One drawback of such coarse granularity caching is that the potential for reuse is often very limited. For instance, even though there may be significant reusability in the lower level objects on a page, the top level object is often unique. We propose a cost/benefit analytical model framework and a set of optimization techniques, which will help identify the "optimal" set of cacheable objects.

3) *Discovering Critical Edge Sequences in E-Commerce Catalogs*, **Dutta, Kaushik**, Georgia Tech, United States; **VanderMeer, Debra**; **Ramamritham, Krithi**

Web sites allow the collection of vast amounts of navigational data - clickstreams of user traversals through the site. These massive data stores offer the tantalizing possibility of uncovering interesting patterns within the dataset. Of significant particular interest to e-businesses is the discovery of "Critical Edge Sequences" (CESs), which denote frequently traversed subpaths in the catalog. CESs can be used to improve site performance and management, increase the effectiveness of advertising, and gather additional knowledge of customer interest patterns on the site. We are interested in developing methods for efficiently and accurately finding CESs in a catalog.

TA14 **Panel Discussion: Our most Urgent Need -- Branding the Profession of OR**

Invited session Venue: AT-8

Chair: **Robinson, Randall**
Formerly INFORMS and McDermott Inc., United States

1) *Panel Discussion: Our Most Urgent Need -- Branding the Profession of Operations Research*, **Robinson, Randall**, Formerly INFORMS and McDermott Inc., United States; **Sharp, Graham**; **List, Barry**

Panel Discussion: Many indicators of our profession's health -- such as number of groups employed in organizations, and membership counts in professional societies -- show either significant decline or stagnation. Although we observe rapid growth in buzzword sectors, usually the work there is not labeled "OR." Our central problem is a collective failure to brand our accomplishments, a failure which has inflicted great damage upon the overall profession. All too often, prospective clients and sponsors don't know or don't value OR. The panelists will give presentations on, and then discuss with the audience, what each of us should be doing, worldwide, to fix this critical problem.

TA15 **Supply Chain Management I**

Invited session Venue: AT-2B

Organizer: **Lee, Hochang**
School of Business, Kyung Hee University, Korea, Korea

Chair: **Choi, Gyunghyun**
Dept. of I.E., Hanyang Univ., Korea

1) *Efficiency Improvement Opportunities on Coordinating the Supply Chain*, **Epstein, Rafael**, University of Chile, Chile

We show how to improve the efficiency of a supply chain through coordinating its links. We analyze the problem at the strategic level, stressing design issues, and at operational level where small changes in practice can bring significant savings or better services. We illustrate these points using practical examples from industries driven by cost like forestry and mining.

2) *Optimization of Surface Component Mounting on the Printing Circuit Board- An Effective Adaptive Al*, **Ferguson, Francis**, United Kingdom; **Cochrane, Ednea**

The purpose of this paper is to describe the development of a self-organizing Artificial Neuron Network algorithm to optimize the sequence of mounting components on a Printed Circuit Board (PCB). The literature survey provides an extensive review of this PCB problem, an explanation about the complexity of this problem and its relationship with the well-known Traveling Salesman Problem (TSP). The results obtained by the prototype software were very promising when compared against other current methods to solve this PCB problem as well as the TSP. We believe that the use of this software would certainly increase production line productivity in an actual factory.

3) *Integrated Multistage Supply Chain Optimization Models*, **Choi, Gyunghyun**, Dept. of I.E., Hanyang Univ., Korea; **Kang, Kyung-Ku**

In this research report, we present some integrated multistage supply chain optimization models. These models consist plants decision and subsequently distribution and inventory decisions. In general, this type of problems are considered as separated problems in which the solution of one problem passes through the next problem as a given parameter, and so on. By exploiting special structures of the problem, we can provide an efficient solution techniques that can leads the combined integrated problem. Also, we present some decomposition methods for the large scale mixed integer problems that perform well to the multistage supply chain decision problems.

TA16 **Semi-Plenary: Max-Plus Algebra and its Applications to Railway Systems**

Invited session Venue: WR-11

Chair: **Olsder, Geert Jan**
The Netherlands

1) *Semi Plenary: Max-Plus Algebra and its Applications to Railway Systems*, **Olsder, Geert Jan**, The Netherlands

Semi Plenary: One of the features that characterize Discrete Event Systems (DESs) is that their dynamics are "event-driven" as opposed to "time-driven". We will concentrate on modelling issues of DESs within the max-plus algebra setting. The main application to be discussed is the design of timetables for trains in the Netherlands and related questions with respect to capacity issues, propagation of delays. Furthermore the design of the high speed train connection between Amsterdam and the Belgian/Dutch border will be discussed. We will briefly dwell upon some theoretical extensions: relationship with Petri nets; numerical procedures for large-scale max-plus systems; imbedding in min-max-plus systems.

TA17 **Integrated MCDA**

Invited session Venue: WR-10

Organizer: **Stewart, Theodor J.**
University of Cape Town, South Africa

Chair: **Belton, Valerie**
University of Strathclyde, United Kingdom

1) *An Integrated Framework for MCDA* , **Belton, Valerie**, University of Strathclyde, United Kingdom; **Stewart, Theodor J.**

The field of MCDA is often seen as a collection of disparate approaches each striving to achieve the same end of facilitating decision making through explicit consideration of multiple criteria. Worse still it is seen by some as a house divided against itself a field fragmented with no firm, unifying foundation or philosophy. We believe, however, that there is a fundamental set of underlying concepts shared by all MCDA approaches and that the unity emerging from this essential diversity must be acknowledged, formalized and promoted. We argue the need for such a unifying framework, go on to make proposals for such a framework and invite discussion on the issue.

2) *Reasoning Maps for Decision Aid*, **Montibeller, Gilberto** , Uni S Santa Catarina, Brazil; **Belton, Valerie**; **Ackermann, Fran**; **Ensslin, Leonardo**

This paper proposes a tool for multi-criteria decision-aid, to be referred to as a reasoning map. It is a network that depicts the means available to a decision-maker along with the connections from these means to the ends that he/she is pursuing. Reasoning maps may be applied to help develop a representation of a decision-maker's problem (thus aiding problem-structuring), and also to support the exploration of the influence that the adoption of a given decision alternative would bring to bear on the achievement of his/her values (thus aiding the evaluation of decision alternatives). The principles of modelling take explicit account of the cognitive limitations of an individual in providing information about his/her preferences and perceptions. A case study, where a reasoning map was used to provide decision aid in a real-world problem, illustrates the method in practice.

3) *MCDS methods in strategic forest management in Finland*, **Kangas, Jyrki Juhani**, Finland; **Kangas, Annika**

Experiences on the use of MCDS methods in Finnish forest management planning are discussed, and conclusions based on comparative analyses of the methods are presented. Plenty of MCDS methods have been tested and applied in forest management planning in Finland; e.g., the AHP and its extensions, outranking, multicriteria approval, SMAA, and numerical optimisation. No single method has been found as universally the best one. Often, use of more than just some single method is justified. In practical applications, methods should be chosen in line with process-wise needs and characteristics, including behavioral aspects.

TA18 **Dialog Mapping**

Invited session Venue: WR-9

Organizer: **Franco, L. Alberto**
Kinsgton Business School, United Kingdom

Chair: **Westcombe, Mark**
Lancaster University, United Kingdom

1) *The Basics of Dialog Mapping* , **Conklin, Jeff**, George Mason University, United States

Dialog Mapping is a facilitation approach to engage a group in collaboratively mapping the conversation they are having. It structures the map in terms of the three basic elements of Issue Based Information Systems (IBIS): Questions, Ideas, and Arguments (for and against). In this talk we will explore how three common yet disruptive moves that are made in design or problem-solving discussions (case making for and against an idea, and challenging fundamental assumptions) can be organized in IBIS, and the impact of having such a shared model of the conversation on the group dynamics.

2) *Improving Meeting Effectiveness Using Dialog Mapping*, **Westcombe, Mark**, Lancaster University, United Kingdom

This talk will present a recent case where Dialog Mapping was applied in a meeting environment to structure a client's problem. It will discuss the nature of the intervention and how Dialog Mapping can improve problem solving and meeting effectiveness. The focus will be on how Dialog Mapping was used as a format to improve the effectiveness of a decision making meeting, rather than as an extended Problem Structuring Method (PSM) workshop. It will discuss the practicalities of using the approach, such as designing the meeting process. It will also explore issues of transferring the Dialog Mapping skills to the participant group.

3) *A Dialogue about Dialog Mapping*, **Pidd, Michael**, Lancaster University, United Kingdom

Dialog Mapping shares many themes with the soft OR community. It is concerned with problem definition, the use of models and the emphasis placed on learning. This discussion session will explore some of the issues raised in the previous two talks against this background.

4) *The Role of the Soft OR Model in Group Decision and Negotiation*, **Yeoman, Ian Seymour**, Napier University, United Kingdom; **Sparrow, John**

What is the role of the model in soft OR? What is its purpose as a group decision and group negotiation device? The model is the central feature in soft OR in which knowledge is negotiated. But questions are raised in how the facilitator uses the soft OR model. The soft OR model acts as a holding device inwhich different forms of knowledge are explored, held or negotaited. The soft OR model becomes a map of cognitive and social negotiation. This negotiation of knowledge happens through cryptic labels of knowledge inwhich knowledge is stored, accessed and transfered. The paper explores the use of knowledge as a negotiation device through soft OR models.

TA19 **Optimization Models for Telecommunications Network Design and Management**

Invited session Venue: WR-1

Organizer: **Smith, J. Cole**
University of Arizona, United States

Chair: **Olinick, Eli Victor**
Southern Methodist University, United States

1) *Omni Directional Cell Planning*, **Whitaker, Roger M.**, Cardiff University, United Kingdom; **Allen, Stuart M.**; **Hurley, Steve**

The location and configuration of infrastructure for cellular (wireless) communication systems is a complex engineering task involving competing objectives. Adequate area coverage is required in addition to satisfying constraints concerning capacity and inteference. In this talk we consider the case where omni-directional transmission equipment is being commissioned. This is particularly relevant to operators in the initial stages of network rollout. We demonstrate that improved lower bounds can be obtained on the minimum number of sites required for area coverage, using an algorithm based on partial backtracking. The associated computational results are presented and discussed.

2) *Hierarchical Cellular Network Design with Channel Allocation*, **Kalvenes, Joakim**, SMU, United States; **Kennington, Jeffery**; **Olinick, Eli Victor**

Cellular network design is a complex process that encompasses the selection and configuration of cell sites and the supporting network infrastructure. We present a net revenue maximizing model that can assist network designers in the design and configuration of a cellular system. The IP determines the size and location of cells, and the specific channels to be allocated to each cell. Cut procedures are developed to efficiently generate tight upper bounds. A lower bound is constructed by solving the discrete optimization model with some of the discrete variables fixed. Computational experiments demonstrate the computational viability of our new procedure.

3) *Improving Network Performance via Incremental Demand Rerouting*, **Olinick, Eli Victor**, Southern Methodist University, United States; **Cai, Qibin**

Over time, changes in the demand pattern and/or upgrades to a telecommunications network may create a situation where the orignally planned routing assignments are now sub-optimal. Network managers are reluctant to make wholesale changes to an established and reliable routing assignment; a complete modification to obtain an optimal assignment is viewed as highly risky. We present procedures to improve a given sub-optimal assignment by making a series of incremental improvements each of which only changes a small number of routing assignments. This strategy is viewed as much less risky since only a few customers are affected by any one change.

TA20 **Network Design III**

Invited session Venue: WR-2

Organizer: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

Chair: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

1) *Willingness to Pay for High-Speed Internet Service and Its Effect on Optimal Network Evolution Path*, **Chang, Suk-Gwon** , Hanyang University, Korea; **Ryoo, Pill-Gye** ; **Leem, Yang-Su**

High-speed Internet access services like ADSL, HFC, PON and B-WLL have been widely deployed worldwide during last decade by many local exchange carriers and local access service providers. In a highly competitive and volatile market

environment, the access service providers are eager to find the optimal network evolution scenarios, facing high risk involved in the huge facility investment and the price/performance sensitivity of the Internet users. This paper analyzes Internet users' WTP (Willingness to Pay) for various Internet service profiles in terms of access speed, QoS and content richness and then integrates it into the multi-period network upgrading decision problem. To optimize the network evolution path, given the user sensitivity to price/performance ratio, an engineering cost-based strategic decision model is developed.

TA21 **Combinatorial Optimization**

Invited session Venue: WR-3

Organizer: **Myung, Young-Soo**
Dankook University, Korea

Chair: **McCormick, S. Thomas**
UBC Commerce, Canada

1) *A Generalized Greedy Algorithm*, **Hartvigsen, David**, University of Notre Dame, United States

It's well known that the greedy algorithm solves some combinatorial optimization problems to optimality (in particular, problems defined on matroids). In this talk we consider a version of the greedy algorithm that can solve more general problems to optimality.

2) *Combinatorial Algorithms for Submodular Function Minimization* , **Iwata, Satoru** , University of Tokyo, Japan

A submoular function is a set function that arises in various fields of operations research. This talk is devoted to recent developments on combinatorial algorithms for minimizing submodular functions. In particular, we present a faster scaling algorithm that improves the previous running time bound by a linear factor of the size of the underlying ground set and a fully combinatorial algorithm that uses only additions, subtractions, comparisons, and oracle calls for the function values.

3) *Max Flow and Min Cut with Bounded-Length Paths*, **McCormick, S. Thomas**, UBC Commerce, Canada

We consider the complexity of the "flow on paths" version of Max Flow and Min Cut when we restrict to paths having at most B arcs. We show that the continuous versions are polynomial even if B is part of the input, but that the integral versions are strongly NP Hard even when B is fixed. We also investigate the gaps between the integral and continuous objective values, and between the constrained and unconstrained objective values.

TA22 **Simulation III**

Contributed session Venue: WR-4

Chair: **Faulin, Javier**
Public Univ of Navarra, Spain

1) *Modelling the Provision of Intensive Care in a large Teaching Hospital*, **Griffiths, Jeff**, Cardiff University, United Kingdom; **Price-Lloyd, Naomi**; **Williams, Janet**; **Smithies, Mark**

Data are presented relating to admissions, lengths of stay, sources of admission, etc in the intensive care ward of a large hospital. Simulation and queueing theory models are proposed to investigate the adequacy of current facilities, and the models are used to explore a range of further scenarios, including changes in arrival profiles, better utilization of available resources, alterations in admission and/or discharge rules.

2) *Using The Monte Carlo Simulation In The Algacea Model For The Logistic Optimization*, **Faulin, Javier**, Public Univ of Navarra, Spain; **Gil Ramirez, Israel**

A modification of the classic algorithm of Clarke-Wright is presented in this work for solving routing problems (VRP). This variant, named ALGACEA, allows the randomization of the previous algorithm by means of Monte Carlo techniques. Likewise, the introduction of the concept of entropy in ALGACEA provides vehicles routes with a more efficient design of load. ALGACEA solves the VRP improving the Savings Algorithm in two ways. Firstly, using the Monte Carlo techniques, the choice of other nodes apart from the maximum saving node is permitted. The ALGACEA algorithm will select the best solution among those results that will have been generated as iterations for a simulation model. Secondly, ALGACEA will allow the construction of a route that can be considered final solution according to the load level of the vehicle. The ideal load ratio is simulated by a Beta distribution. Finally, the precision of this method is contrasted to other well-known routines.

TA23 **Decision Analysis II**

Contributed session Venue: AF-10

Chair: **Dai, Feng**
ORSC, China

1) *A discounted price EOQ model derived without derivatives*, **Wee, Hui Ming**, Chung Yuan Christian Univ, Taiwan; **Chong, Liang Sen**

Researches in EOQ have been very popular recently. This study extends the approaches in previous studies to include the case with temporary discounted price. This is important to energize the slow global economy. Most previous works applied differential calculus to the problem. In this study, two methods are suggested to show that optimal solutions can be derived without using differential calculus. The first formulation is more complex but has greater benefit for high discount rate, while the second method is easier.

2) *Naturalistic study of decision heuristics*, **Johnson, Johnnie Eric**, University of Southampton, United Kingdom; **Bruce, Alistair**

Literature addressing the quality of human judgements, largely based on laboratory investigations, demonstrates that in the face of cognitive overload individuals rely on heuristics designed to simplify decision-relevant information.Laboratory studies suggest that these heuristics lead to systematic biases. Less evidence is available from naturalistic studies. The current naturalistic study explores a frequently reported feature of betting markets, the favourite-longshot bias, whereby longshots are apparently over-bet and favourites under-bet. We seek to discover if this phenomenon arises from biases in bettor behaviour resulting from the use of heuristics or from the application of rational decision rules by bookmakers.

3) *Fuzzy Evaluating and Making Decision with Security Analysis*, **Liang, Ling** , China; **Wei, Jun**; **Dai, Feng**

We present the confidence matrix, and the analytic expression of safety index; Based on the confidence matrix and the safety index, we have got the fuzzy method to prioritize and make decision with safety analysis. By the method, we can solve some problems of priority or decision making which can not be solved by the common method like AHP.

TA24 **Location Analysis II**

Contributed session Venue: AF-13

Chair: **Dejax, Pierre**
Ecole des Mines de Nantes, France

1) *On the use of Additional Objectives by Demand Covering Models*, **Dimopoulou, Maria**, Lecturer, Greece; **Giannikos, Ioannis**

Demand covering models aim in locating facilities in such positions as either to minimize the number of facilities needed or to maximize coverage of a given demand space. Additional objectives often arise in these models. In the present study, we extend the solution of the demand covering models to take into account the additional objectives. Towards this a methodology is developed which produces a series of different solutions of the demand covering models by varying the definition of the demand space. A heuristic algorithm is then generated to define alternative positions of the facilities in the neighborhood of the positions given by each of the above solutions and to examine the satisfaction of the additional objectives. The solutions, which best serve the additional objectives are then selected. Data gathering and manipulation has been made with the help of GIS technology.

2) *Position Determination Of The Nodes Of A Graph According To The Arc Lengths*, **Xavier, Adilson Elias**, Rio de Janeiro Fed Univ, Brazil; **Santos, Ana Flavia Uzeda**

Given a graph G = (V,E) with an measure a(i,j) > 0 that is associated to each arc (i,j) in E, we must find x(i), in a n-dimensional euclidean space, for each i in V, such that the distances between these variables correspond adequately to the measures of the arcs. This problem is associated, for example, to the research of the molecular structure of the proteins. In this work, we propose the hyperbolic smoothing technique in order to transform the derived non-diferentiable problem in a completely differentiable problem. Key words: Nonlinear Programming, Penalty methods, Non-diferentiable Optimization

3) *A location model for reverse logistics and repair services*, **Bostel, Nathalie**, Un. de Nantes, IRCCyN, France; **Dejax, Pierre**; **Lu, Zhiqiang**

Reverse flows have become an important concern of logistic systems planning because of environmental legislation, and economic or customer service reasons. In this paper, we study the facility location and network design problem for a particular case of reverse logistics concerned with repair activities. In a Repair Service Network (RSN), products needing repair or preventive maintenance are sent back from customers to "service centres". We discuss the main characteristics of this type of network including direct and reverse flows. We propose a facility location model for the design of such a network. We present solution algorithms based upon dual ascent and lagrangean relaxation approaches as well as results from experiments and we analyse the impact of reverse flows and repair activities on the design of the logistics network.

TA25 **Mathematical Programming-Combinatoric I**

Contributed session Venue: AF-14

Chair: **Chen, Bo**
United Kingdom

1) *Sports Scheduling Problems based on Networks*, **Suzuka, Ayami**, Univ. of Tsukuba, Japan; **Saruwatari, Yasufumi**

This paper treats a problem of determining the schedule for sports leagues, and investigates a methematical formulation based on networks. We construct an algorithm for solving the problem optimally by incorporating the branch-and-bound method, where minimum cost flow problems are solved to obtain the lower bounds. Some computational results are shown for the case of Japanese professional baseball league.

2) *The Maximum Expectation Problem of Utility Functions over Random Networks -- an application*, **Rasteiro, Deolinda Dias**, ISEC - Coimbra, Portugal; **Anjo, Antonio Jose Batel**

The Stochastic Optimal Path Problem is being studied since 1969. However, few theoretical results are known, even though there is a recognizable applicability. The mathematical model we propose maximizes the expected value of an utility function over a directed network, where the distances related to the arcs are real random variables following gaussian distributions. We will concentrate on the linear, quadratic and exponential cases, presenting a theoretical formulation based on multicriteria models as well as the resulting algorithms. An application to some pratical problems will be presented.

3) *Algorithms for On-Line Bin-Packing Problems with Cardinality Constraints*, **Babel, Luitpold**, Germany; **Kellerer, Hans**; **Chen, Bo**; **Kotov, Vladimir**

The bin packing problem asks for a packing of a list of items of sizes from (0,1]into the smallest possible number of bins having unit capacity. The k-item bin packing problem additionally imposes the constraint that at most k items are allowed in one bin. We present two efficient on-line algorithms for this problem. We show that, for increasing values of k, the bound on the asymptotic worst-case performance ratio of the first algorithm tends towards 2 and that the second algorithm has a Ratio of 2. Both algorithms considerably improve upon the best known result of an algorithm, which has an asymptotic bound of 2.7 on its Ratio. Moreover, we improve known bounds for all values of k by presenting on-line algorithms for k=2 and k=3 with bounds on their Ratios close to optimal.

TA26 **Mathematical Programming-Integer III**

Contributed session Venue: AF-18

Chair: **Nauss, Robert M.**
U. of Missouri-St. Louis, United States

1) *Integer Programming Approach to the Heterogeneous fleet Vehicle Routing Problem*, **Choi, Eunjeong**, KAIST, Korea; **Lee, Taehan**; **Park, Sungsoo**

We consider the Heterogeneous fleet Vehicle Routing Problem (HVRP), a variant of the classical Vehicle Routing Problem (VRP). The HVRP differs from the classical VRP in that it deals with a heterogeneous fleet of vehicles having various capacities, fixed costs, and variables costs. Therefore the HVRP is to find the fleet composition and a set of routes with minimum total cost.

2) *The Multi-Layered Network Design Problem*, **Knippel, Arnaud**, FTRD, France

We address here the problem of designing a network that is built on several layers. This case occurs frequently in practical applications but has not yet been studied extensively as the single layered network design problem is already so hard. An example of application is the design of a virtual network (IP) built on a sparse physical network (WDM). We propose a mathematical formulation without any flow variable or path variable, based on a polyhedral approach. We give numerical results obtained with an exact method and an approximation algorithm.

3) *Solving Large-Scale Generalized Assignment Problems with Multiple Parallel Processors*, **Nauss, Robert M.**, U. of Missouri-St. Louis, United States

A special purpose branch-and-bound algorithm for solving generalized assignment problems(GAP) is adapted for use in a Beowulf-class cluster of parallel PC's. The cluster is made up of twenty 1GHz PC's. The classical GAP is a 0-1 integer program that is NP-hard. We utilize a parallel approach that runs n copies of the algorithm with a minimum of message passing. Varying upper bounds that may or may not be valid are used for each copy. As a test bed we use large, hard problems with up to 4000 binary variables. We contrast results using a single PC with various parallel approaches.

TA27 **Supply Chain Management IV**

Contributed session Venue: AF-19

Chair: **Lian, Zhaotong**
University of Macau, China

1) *Supply Chain Coordination with Non-Stationary Demand: the Value of Information Sharing* , **Chen, Haoxun**, Tech Univ of Troyes, France; **Chu, Chengbin**

The value of information sharing and collaborative forecasting is studied for a supply chain with one supplier and multiple retailers whose demands are non-stationary with normal distributions. An inventory management system is proposed for the supply chain, where the supplier shares demand forecasts of the retailers and its inventory replenishment is based on the forecast demands of the retailers rather than its own demand forecasting. The performance of the system is evaluated analytically under mild assumptions on forecast errors. The system is also compared by simulation with other systems without sharing inventory information or demand forecast for different demand models. Numerical experiments show that the system significantly outperforms others. Moreover, it is shown that the benefit of sharing demand forecast can also be achieved by letting the supplier initially know the retailers' parameter estimates of their demand models.

2) *New Solutions in Supply Chain Management*, **Skomorokhov, Riurik Vasilevich**, Bauman Moscow State Techn, Russia

In conditions of low and mid-volume machine-building manufacturing one of the main goals of supply chain management is providing on-time and maximum fast deliveries of all end items to final consumers. To achieve the goal main producer (which manufactures main parts of end items, assemblies and tests them) should determine most exactly manufacturing dates of all end items for all the manufacturing stages, and obtain minimum possible common manufacturing lead time of the items. Effective solving the problem demands quite different scheduling and timing and such scheduling can be important tool for improving supply chain coordination and performance.

3) *Supply Contracts with Discounts and Uncertain Demands*, **Lian, Zhaotong** , University of Macau, China

This paper studies an important class of supply contracts where the order quantities of a buyer are determined based on the forecast demands for a rolling horizon. The supplier gives different discounts if the buyer orders for the second period, the third period etc., at the beginning of the first period. The buyer can adjust the order quantities in the future periods without lower and upper bounds, but the buyer would lose the discounts or deposits. A multi-dimensional dynamic

programming technique is used to derive the optimal ordering policy by minimizing the total cost in the rolling horizon.

TA28 **Artificial Intelligence in Scheduling**

Invited session Venue: DH-C

Organizer: **Petrovic, Sanja**
University of Nottingham, United Kingdom

Chair: **Tadei, Roberto**
Politecnico di Torino - Dip. Autom. e Informatica, Italy
Chair: **Daskalaki, Sophia**
University of Patras, Greece

1) *Case-based Reasoning in Employee Timetabling: Learning repair strategies from domain experts*, **Petrovic, Sanja**, University of Nottingham, United Kingdom; **Beddoe, Gareth Richard**; **Berghe, Greet Vanden**

The inherent difficulties in eliciting domain knowledge from experts are often encountered when applying artificial intelligence techniques to real-world problems characterised by multiple conflicting constraints. Definitions of optimal solutions are often subjective and highly dependent on the opinions and work practices of individual expers. We developed a case-based reasoning approach to capture concepts of optimality through the storage, reuse, and adaptation of previous repairs of constraint violations. The technique is applied to the problem of rostering nurses at the Queens Medical Centre, Nottingham. An iterative roster repair system is presented that learns repair techniques from nurses with rostering experience.

2) *Railway Timetabeling with Evolutionary Multi-objective Optimization*, **Kolonko, Michael**, TU Clausthal, Germany; **Engelhardt-Funke, Ophelia**

We optimize timetables with respect to scheduled waiting times, mean actual waiting times under random delays, required investment costs and number of vehicles. The optimization uses genetic algorithms combined with simulated annealing. Waiting time stands for the total weighted sum of passenger waiting times on all possible connections in the network. The mean actual waiting times are obtained from a macroscopic simulation based on an anlytical model for the accumulation of random delays along sequences of sections. Results include a cost-benefit analysis of investments into the network and an analysis of the stability of the network under random disturbances.

3) *The genetic local search metaheuristic for multi-objective job shop*, **Kurowski, Krzysztof**, Poland; **Hapke, Maciej**; **Jaszkiewicz, Andrzej**

The genetic local search metaheuristic for solving multi-objective job shop scheduling problem is proposed. Convexity tests, AI methods and statistical tests performed have been applied in order to find efficient genetic operators. Experimental results show that our new approach solves real complex instances and yields good results in reasonable time.

TB1 **Medical Applications I**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Patrizi, Giacomo**
University La Sapienza, Italy

1) *Using simulation to select affordable HIV-AIDS intervention programmes for developing countries*, **Rauner, Marion S.**, University of Vienna, Austria; **Brailsford, Sally C.**; **Flessa, Steffen**

With 36 million individuals living with HIV/AIDS world-wide, this pandemic has now proven to have devastating impacts on the social, economic, and demographic development of many developing countries, where more than 95% of the global total of HIV cases have occurred. Thus, implementing and targeting cost-effective prevention programmes, therapy, and care are critical issues for health care systems in developing countries. We developed a discrete event simulation model to help decision makers allocate scarce resources among affordable current or even future intervention programmes with a special focus on therapy programmes or potential vaccination strategies for pregnant mothers and their offspring.

2) *Cost Trade-Offs in HIV/AIDS: a model-based evaluation*, **Dangerfield, Brian**, University of Salford, United Kingdom; **Fang, Yongxiang**

The efficacy of the new combination antiretroviral therapies in HIV and AIDS is bringing to the fore questions concerning the overall allocation of health resources in this area. Patients offered the new treatment are required to take the medication indefinitely and so the drugs bill is increasing as more and more sero-positive persons are added to the pool of treated persons. Effective prevention expenditure to promote sexual health can reduce future therapy and care costs if new infections are successfully prevented. Discounting of future costs and benefits is appropriate given the long-term effects of preventing new infections. Our model of the epidemiology of HIV/AIDS has been enhanced to allow an evaluation of the trade-offs, given savings on drug and care costs represent an upper bound on prevention expenditure.

3) *Planning services for patients with renal failure using simulation*, **Davies, Ruth M.**, University of Southampton, United Kingdom

Patients with renal failure need long term expensive treatment in order to live. The availability of cadaver kidneys for transplantation remains fairly stable in the UK. The number of patients accepted for treatment, particularly of more elderly patients, is continuing to increase. There effect of this is that there is an expanding demand for expensive dialysis facilities. Simulation is used to explore different policies for treating patients at local and at national levels. We show that, even if donor transplantation can be expanded by the use of many more live donations, the costs of the service will increase significantly over the next ten years

TB2 **Urban freight systems**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Lozano, Angelica**
Universidad Nacional Autonoma de Mexico, Mexico

1) *Day-To-Day Approach For A Path Choice Models In The Transit System: Analyticals Valuations And Simulation Results*, **Russo, Francesco**, Univ Of Reggio Calabria, Italy; **Velona', Pietro**

In transit system assignment, the dynamic process models are receiving an increasing interest due to the necessity to explicitly simulate the system dynamics. The aim of this paper is to evaluate link flows and network performances, such as travel times and levels of service, in day-to-day dynamics. In this paper the formulation of the modal split model is recalled stressing the dependency of within-day and day-to-day dynamics of the transit service. The modal split is influenced by the day-to-day learning components, like in the private transportation systems. Once identified some components subject to day-to-day system modification, some kinds of system dynamics according to different supply evolution typologies are introduced. An analysis of the weight of the control parameters in the dynamic process is developed, considering the stability system conditions.

2) *Planning Models for Freight Transportation in Congested Urban Areas*, **Ricciardi, Nicoletta**, U of Rome La Sapienza, Italy; **Crainic, Teodor Gabriel**; **Storchi, Giovanni**

The first objective of the presentation is to emphasize the growing importance of integrated freight transportation planning and control within urban zones, and point to some of the associated challenges and enabling factors. We then describe a possible organizational and technological framework for the integrated freight transportation in large, congested urban areas, as well as a simple model to study it. Finally, we discuss a number of associated modelling issues: selection of corridors, short-term planning of operastions, choice of centralized versus decentralized control structure, real-time management, shceduling, and routing, etc.

3) *Alternative paths for freight transportation in a megalopolis*, **Lozano, Angelica**, Universidad Nacional Autonoma de Mexico, Mexico; **Granados, Francisco**; **Antun, Juan Pablo**; **Storchi, Giovanni**

Usually, developing cities do not have the reliable information for transportation planning, specially for freight transportation planning. We present a procedure to identify main alternative paths for freight transportation in a huge urban network, where a base O-D matrix is not available. The procedure uses an equilibrium assignment model to estimate traffic flows on links, for each type of vehicle. Territorial analysis is effected in order to classify the zones according to the possibility of producing and/or attracting freight transportation. An application to the Metropolitan Zone of Mexico City is presented.

TB3 **Air Traffic Management Automation**

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Clarke, John-Paul B.**
MIT, United States

1) *Use of DEPARTS For Optimal Departure Scheduling At Busy Airports*, **Cooper, Wayne W.**, MITRE CAASD, United States; **Cormier, Robert H.**; **Foster, J. Glenn**; **Mills, Michael J.**; **Mohleji, Satish C.**

The Departure Enhanced Planning And Runway/Taxiway Assignment System (DEPARTS) has been developed as a laboratory prototype to develop fast-time optimization algorithms and analyze data requirements for a future short-term departure scheduling capability, optimizing the runway assignment and sequencing for all flights planning to push-back from the airport gate at a busy airport in the next 30 minutes. This presentation will describe the problem, the modeling approach, and the experimental results to date. Potential operational benefits will also be described.

2) *Airport Surface Operations Planning: A Two-Stage Solution Methodology*, **Anagnostakis, Ioannis**, MIT, United States; **Clarke, John-Paul B.**

Operational delays in the ground departure flow at congested airports result in economic inefficiencies and adverse environmental impact. Since the runway is a scarce resource that must be shared by different runway operations (arrivals, departures and runway crossings) careful planning of runway operations is required if runway utilization is to be maximized. We present a two-stage solution methodology for Runway Operations Planning (ROP) that takes advantage of the reduced uncertainty in the predicted demand for departure resources in terms of weight class relative to the predicted demand for departure resources in terms of specific aircraft.

3) *Airport Surface Modeling Algorithms for the Surface Management System*, **Brinton, Chris R.**, Metron Aviation, Inc., United States; **Krozel, Jimmy**; **Capozzi, Brian**; **Atkins, Stephen C.**

The Surface Management System (SMS) is being developed by NASA with support from Metron Aviation to provide advanced decision support capabilities for flight operations on and around the airport surface. SMS uses flight plan data, terminal area surveillance and airport surface surveillance data to generate predictions of airport surface operations including demand, queues, flow rates and delays. SMS also generates and provides advisories to tower traffic managers and controllers to implement an efficient plan for surface management. The SMS path planning algorithms generate a conflict free plan for airport surface movement, using heuristics to generate advisories regarding runway assignment, configuration use and eventually taxi route.

TB4 **Cutting and Packing: Heuristics and Metaheuristics**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Valenzuela, Christine Lesley**
Cardiff University, United Kingdom

1) *A Set-Covering Based Heuristic Approach for Bin-Packing Problems*, **Toth, Paolo**, DEIS, Univ. of Bologna, Italy; **Monaci, Michele**

Several cutting and packing problems can be formulated as large size Set-Covering Problems. We propose an approach where both the "column-generation" and the "column-optimization" phases are heuristically performed. Extensive computational results on instances from the literature for the Bin-Packing, the 2-Constraint Bin-Packing and the 2-Dimensional Bin-Packing Problems are presented.

2) *Method ST and method DSS1 for bin-packing problem*, **Valeyeva, Aida F.**, Russia; **Gareyev, Ilgiz R.**

A NP-hard problems of one-dimensional and two-dimensional bin-packing problems is considered. Truncated sorting (ST) performs selection of packing variants by means of exchange of rulers between bars. Method of dynamic exhaustive sorting (DSS1) receives set of the quasi-optimal packing with the same value of the goal functions. The results of numerical experiments are presented. Keywords: bar, truncated sorting method, method of dynamic exhaustive sorting, one-dimensional bin-packing, two-dimensional bin-packing

3) *Tabu search strategy in problems of cutting*, **Ermachenko, Alexandr Ivanovich**, Russia; **Sirazetdinov, Timur Maratovich**; **Usmanova, Andjela Rashitovna**

Considered is the problems of roll guillotine cutting and linear cutting in conditions of piece-production. This problems are NP-difficult. Heuristic methods are used for approximately solving the problems. Amongst such up-and-coming is a method "Tabu search". Descriptions of both two- and one-dimensional algorithms and results of numerical experiments are presented.

TB5 **Tutorial: Applied Nonlinear Programming**

Invited session Venue: MS-1

Chair: **Lasdon, Leon S.**
Mgt Sci and Inf Sys Dept, United States

1) *Tutorial: Applied Nonlinear Programming*, **Lasdon, Leon S.**, Mgt Sci and Inf Sys Dept, United States

Tutorial: Tools for formulating and solving nonlinear optimization models have improved dramatically in recent years. This tutorial will introduce this new technology, describing what it can do, where to get it, and how easily you can use it. It will include algebraic modeling languages, optimization in spreadsheets,the best general purpose NLP solvers,new tools for mixed integer NLP and global optimization, and NLP facilities in current LP systems. Several NLP applications will also be described.

TB6 **Recent advances in DEA**

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Tone, Kaoru**
National Graduate Institute for Policy Studies, Japan

1) *Slacks-based Super-efficiency in DEA* , **Tone, Kaoru**, National Graduate Institute for Policy Studies, Japan

This paper addresses "super-efficiency" issue by using the slacks-based measure (SBM) of efficiency, which the author proposed in his previous paper. The method differs from the traditional one based on the radial measure, e.g. Andersen and Petersen model, in that the latter does not take account of the existence of slacks. We will demonstrated the rationality of our approach by comparing it with the radial measure of super-efficiency.

2) *Theoretical and experimental study on input and output oriented DEA models*, **Ding, Wenhuan**, School of Management, China; **Feng, Yingjun**; **Kang, Yuhong**

Considering the conventional data envelopment analysis (DEA) models used to measure the relative efficiencies of a group of decision making units (DMUs) are limited to either input or output orientation, a new DEA model which is both input and output oriented is proposed in this paper. This model can be treated as a multi-objective programming problem and solved by fuzzy sets theory. The basic idea is to describe the DEA frontiers with fuzzy observation and determine projections for DMUs on the frontiers by using fuzzy optimization approaches. The measurement of efficiencies for DMUs in this case is obtained by comparing the inputs and outputs of DMUs with their projections. Since the input and output oriented DEA model can be transformed into a conventional input or output oriented DEA model by using special membership functions, it is therefore made more adaptive for measurement of efficiencies. Finally, a typical example is given to illustrate the computation methods.

3) *Accounting for the environment in DEA*, **Burley, Henry Thomas**, La Trobe University, Australia

Very elementary DEA formulations assume that the important input variables account for the whole of production, are controllable by the manager and are numerically measured on a ratio measurement scale. This paper illustrates practical

approaches, which discount for the influence of the uncontrollable environment, in measuring managerial performance by DEA methods. Also presented are simple ways of estimating the effects of qualitative variables, both on the binary (0,1) and ordinal measurement scales. Attention is drawn to statistical experimental design aspects, which still need to be considered in DEA interpretations.

TB7 **Maintenance Modeling and Optimization**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States

Chair: **Driscoll, Patrick J.**
US Military Academy, United States

1) *Optimizing condition based maintenance decisions: An application to ship diesel engines*, **Jardine, Andrew K. S.** , University of Toronto, Canada; **Patterson, Jonathan**; **Banjevic, Dragan**; **Resera, Gus**; **Wiseman, Murray**; **Makis, Viliam**

The presentation focuses on the role that proportional hazards modelling can play to identify the key risk factors that should be used to identify the health of equipment from amongs those signals that are obtained during condition monitoring. Economic considerations are then incorporated with the risk estimate to establish optimal condition-based maintenance (CBM) decisions. Application of the resulting CBM optimization approach to analyze a fleet of 55 diesel engines used on ships of the Canadian Department of National Defence, subject to condition monitoring via oil analysis, are presented.

2) *On stability of multiobjective dynamic programmings with fuzzy numbers*, **Li, Dengfeng**, China; **Yang, Jian-Bo**

This paper deals with the stability of multiobjective dynamic programming problems with fuzzy parameters in the objective and the constraint functions. These fuzzy parameters are characterized by fuzzy numbers. To study the stability of such problems under the concept of alpha-Pareto optimality, some basic notions in parametric nonlinear programming problems are redefined and analyzed qualitatively. Also, an algorithm for obtaining any subset of the parametric space which has the same corresponding alpha-Pareto optimal solution is presented. A numerical example is given to illustrate the obtained results.

3) *A mathematical programming approach to reliability systems design*, **Driscoll, Patrick J.**, US Military Academy, United States; **Pohl, Edward A.**

We introduce a new method of optimizing redundancy allocation in multi-cause failure systems that uses several structural reformulation methods developed in discrete optimization whose purpose are to exploit algebraic features present in the underlying structure of the problem.

TB8 **Stochastic Programming Applications in Finance**

Invited session Venue: AT-3

Organizer: **Zenios, Stavros**
University of Cyprus, Cyprus

Chair: **Vladimirou, Hercules**
University of Cyprus, Cyprus

1) *Horizon and stages in applications of stochastic programming in finance*, **Bertocchi, Marida**, Department of Mathematics, Italy; **Dupacova, Jitka**; **Moriggia, Vittorio**

The solution of a decision problem under uncertainty via stochastic programming implies the choice of a suitable programming model taking into account all the characteristics of the real-life problem. Moreover, when multistage stochastic models are chosen, additional rather complicated modeling issues come to the fore. We shall discuss the choice of the horizon and stages in financial applications. Numerical studies will focus on alternative choice of stages and their impact on optimal first-stage solutions of bond portfolio optimization problems. Information on conditioning of our financial problem will be provided.

2) *Modeling Danish Mortgages: The Mortgagor's Perspective.*, **Nielsen, Soren S.**, Technical University of D, Denmark; **Poulsen, Rolf**

Danish Mortgages are financed through bonds that have some features not found in those of other countries, allowing financing through both long and short bonds, the long ones being callable, the short ones denominated in either DKK or EUR. We report on work-in-progress with a multi-stage stochastic program that aims at managing a mortgagor's portfolio of oans optimally. The program implements a novel, two-factor interest-rate model. It is used, for instance, to establish and evaluate strategies for refinancing. Risk-averse as well as risk-neutral mortgagors are modelled.

3) *Nonlinear Stochastic Programming Models for Insurance Products with Guarantees*, **Consiglio, Andrea**, University of Palermo, Italy; **Saunders, David** ; **Zenios, Stavros**

Increasing competition has lead the insurance industry to introduce more complicated and innovative policies. Modern policies come with guarantees on the minimum rate of return, bonus provisions and surrender options. We study the problem of asset and liability management for participating insurance policies with guarantees. Earlier work has focused on the products issued by Italian insurers, which have a fixed participation rate. In this work, we study the products offered by UK insurance companies, where the insurer has greater freedom in determining the bonus policy. This greater freedom constitutes an embedded optionality which significantly complicates the ALM problem as well as the pricing of the products. The asset and liability management problem results in a nonlinear stochastic programming problem. We present extensive numerical results for the ALM problem, as well as discussing methods for pricing the products.

TB9 **Power Market Design**

Invited session Venue: MS-3

Organizer: **Oren, Shmuel**
University of California, Berkeley, United States

Chair: **Chao, Hung-po**
EPRI and Stanford University, United States

1) *Alternative models of electricity forward and spot market equilibrium in the presence of market pow*, **Kamat , Rajnish** , Department of IEOR, United States; **Oren, Shmuel**

We analyze a two period duopoly model where sellers make forward commitments at forward prices and then offer adjustment quantities at spot market prices against the residual demand. We compare the Nash equilibrium with a "no arbitrage" relationship between forward and spot prices vs. an alternative sequential market clearing assumption.

2) *Risk Management in Electricity Market Design*, **Chao, Hung-po**, EPRI and Stanford University, United States

In power market design, a distinction can be made between public and private risks. While efficient allocation of private risks can be achieved through trading of risk management contracts and derivatives, the management of public risks, such as system reliability and market power, is a matter of policy decision in market design. In electricity restructuring, an efficient risk management strategy is essential to attract private capital for investment, support efficient spot markets, and manage supply shortages under extreme conditions. However, the design of an effective risk management strategy is complicated by 1) long investment leadtime, 2) non-storability of electricity, and 3) an asymmetric information structure. Further, the separation between public and private risks is difficult statistically because they both contribute to the price volatility that is commonly observed. The California energy crisis in 2000 reflects a failure of risk management in market design.

3) *Stochastic Unit Commitment Problem*, **Shiina, Takayuki**, CRIEPI, Japan; **Birge, John R.**

The unit commitment problem is an important problem for electric power utilities. The problem is to determine the schedule of power generating units and the generating level of each unit. The decisions are which units to commit at each time period and at what level to generate power meeting the electricity demand. We propose an algorithm that is based on the Lagrange relaxation and dynamic programming to solve the stochastic unit commitment problem. The algorithm decomposes the problem into single unit problems which can be solved by the dynamic programming on the scenario tree.

TB10 **Warranty Modelling and Analysis**

Invited session Venue: MS-4

Organizer: **Scarf, Philip**
University of Salford, United Kingdom
Organizer: **Hartman, Joseph C.**
Lehigh University, United States

Chair: **Newby, Martin**
City University, United Kingdom

1) *Optimal Reliability Improvement for Used Items Sold with Warranty*, **Chattopadhyay , Gopinath**, Queensland University of Technology, Australia; **Murthy, D. N. Prabhakar**

The sale of used products is increasing and the market for products is becoming more competitive. The dealer of used items can improve the reliability of an item through actions such as overhaul and upgrade of one or more components. This results in additional costs and is worthwhile only if it is less than the reduction in the warranty servicing cost. The paper deals with two models to decide on the optimal strategies for reliability improvement that minimise the total (warranty servicing + reliability improvement) cost to the dealer when items are sold with Free Replacement Warranty (FRW) and Money Back Guarantee (MBG) policies.

2) *The Need to Clean and Adjust Data in Warranty Modelling*, **Christer, Tony**, University of Salford, United Kingdom; **Ward, Heidi**

The difficulty of collecting data for warranty modelling is well known and recognised. Even when it is available, what is recorded is usually the date of a warranty claim, whereas what reliability engineers require is the date of item failure. These two dates are, in the absence of further information, usually assumed to be the same. This paper examines a little closer the consequences of this assumption. Of particular interest is an indication of the likely order of error introduced into modelling the consequences of decisions relating to extending warranties and re-design options.

3) *Warranty Servicing and Customer Satisfaction*, **Jack, Nat** , University of Abertay , United Kingdom; **Murthy, D. N. Prabhakar**

Customer satisfaction with a purchased product depends on product performance and on the service provided during the post-sale period. Product performance depends on the decisions made during the design and manufacturing stages, the product's operating environment, and its usage intensity, but only the first of these variables is under the control of the manufacturer. The quality of post-sale service depends on the actions of the service agent who is employed by the manufacturer. We provide a framework to study how product performance and service performance affect customer satisfaction. Models are constructed to assist the manufacturer make optimal service performance decisions, allowing for the implications of customer dissatisfaction on the business.

TB11 **Metaheuristics for Combinatorial Optimization**

Invited session Venue: MS-5

Organizer: **Glover, Fred**
United States
Organizer: **Lokketangen, Arne**
Molde College, Norway
Organizer: **Nath, Baikunth**
Australia
Organizer: **Woodruff, David L.**
UC Davis, United States

Chair: **Rego, Cesar**
University of Mississippi, United States

1) *Improved Results on the 0-1 Multi-Knapsack Problem*, **Vasquez, Michel**, LGI2P EMA-EERIE, France

In previous works [Solving Large Scale Combinatorial Problems in 0-1 Variables by Tabu Search, Phd Thesis, 2000] and [A Hybrid Approach for the MKP01, IJCAI01] we presented an algorithm that combines linear programming and tabu search and that gives best results on the OR-library benchmarks [Chu and Beasley, A Genetic Algorithm for MKP01, JoH98]. Embedding this algorithm in a partial enumerative technique and a variables fixing heuristic improves again our previous results. Furthermore sub problems with less than 100 variables were generated from the 500 original ones. CPLEX70 fails to solve them in 3 days with a 2GO-600MHz CPU.

2) *A Stem-and-Cycle Ejection Chain Algorithm for the Asymmetric TSP* , **Gamboa, Dorabela**, IPP-ESTGF, Portugal; **Rego, Cesar**

We describe the implementation of an effective Stem-and-Cycle ejection chain method for the Asymmetric TSP. We report computational findings that show the impact of several algorithmic components which are critical for performance.

3) *A hybrid approach for solving the 0-1 multidimensional knapsack problem*, **Wilbaut, Christophe**, University of Valencienne, France; **Hanafi, Said**; **Freville, Arnaud**; **Balev, Stefan**

We propose a hybrid method combining adaptative memory procedure and dynamic programming using list representation to explore the search space for solving the 0-1 multidimensional knapsack problem. The efficiency of our approach lies in the partitioning of the set of variables into two subsets. The first subset is chosen as small as possible according to the memory requirements of dynamic programming. The size of this subset depends on the machine and the number of constraints. During a preprocessing phase, all subproblems for which the second part is fixed are solved using the dynamic programming method. Our method has been tested on randomly generated data sets and seems attractive for solving large-scale instances. Moreover it can be applied to other combinatorial optimization problems.

TB12 **OR in Developing Countries**

Invited session Venue: AT-6

Organizer: **Bandyopadhyay, Rangalal**
Centre for Applied Systems Analysis in Development, India

Chair: **Datta, Subhash**
Management Development Institute, India

1) *Modelling for Prevention of Mother to Child Transmission of HIV*, **Shanani, Arjan K.**, University of Southampton, United Kingdom; **Harper, Paul R.**; **Pozniak, Anton**; **De Senna, Valter**; **Vieira, Israel Teixeira**

The prevalence of HIV in the population, and in pregnant women, is very high in the developing countries. This means that HIV infection is a very serious threat for people and society in the developing countries. A major source of infection for babies is mother to child transmission of HIV which can occur during pregnancy, delivery, and through breastfeeding. Intervention options for reducing the risk of transmission from mothers to babies include drug treatment, caesarean section delivery, and modifications of infant feeding practice. Detailed models that provide quantitative information for evaluating practical intervention options are discussed in this paper.

2) *Improving Healthcare Delivery System At The Block Level*, **Datta, Subhash**, Management Development Institute, India

There exist disparities in access to healthcare facilities from region to region, particularly in remote rural areas in India. To improve the healthcare delivery at the local level, it is necessary to augment the existing infrastructure with allocation of resources, management of existing facilities and creation of new facilities. The present study analyses the disease profile, location of facilities and other infrastructure, and develops a spatial model for improving the healthcare services in two remote rural blocks in India.

3) *Model for Evaluation of Fuel Alternatives for India*, **Sikdar, Arijit**, Management Dev Institute, India; **Mookerjee, Amit**

This paper looks at the road transport sector where fuel has a critical impact not only on the economies of the road sector but also on the whole economy. Policy interventions have been in the area of price control (administered price mechanism- APM) and supplies (imports and licensing domestic capacity) have given way to new areas of intervention, namely, use of specific fuels in specific vehicle types for specific purposes with the limited objective of pollution control. The paper develops an OR model for optimizing fuel type utilization taking into account the various consequences concerned with variables like usage pattern (e.g. passenger, freight, etc.), vehicle types (e.g. car, bus, trucks, etc.), pollution, and the various costs and supply constraints.

TB13 **Design and Analysis of Online Market Mechanisms**

Invited session Venue: AT-7

Organizer: **Basu, Amit**
SMU, United States

Chair: **Gupta, Alok**
University of Minnesota, United States

1) *Combinatorial Bidding with Applications to Financial Markets*, **Crainic, Teodor Gabriel**, Dept. management et technologie, UQAM and CRT, Ude, Canada; **Abrache, Jawad**; **Gendreau, Michel**

Recent mechanisms in financial markets trade assets in bundles. We describe a new vocabulary that allows to express complex bundle structures, particularly required in these markets. We then present and discuss the optimization formulations required to solve the corresponding combinatorial allocation problems that is, to determine quantities of bundles allocated to participants and the associated prices. Algorithmic issues will also be addressed.

2) *Analysis of consumer bidding strategies in online multi-unit auctions.*, **Bapna, Ravi**, University of Connecticut, United States; **Goes, Paulo**; **Gupta, Alok**; **Jin, Yiwei**

We use real auction data collected from hundreds of multi-item auctions conducted on the Internet, and develop models to evaluate and explain the strategies adopted by bidders. In particualr, we study participation strategies, jump-bidding, late bidding or sniping, as well as differences between naive and experienced bidders. We evaluate the efficiency of different strategies as related to the consumers' surplus and study the effect of the auction mechanism design parameters on the bidders' behavior.

TB14 **Transportation I**

Contributed session Venue: AT-8

Chair: **Bronmo, Geir**
Norway

1) *Transport Optimisation in an Automatic Container Handling System*, **Parra Asensio, Andreas**, Germany; **Steenken, Dirk**

Applying automatic equipment in container terminal operation systems is a current trend. The paper describes a new, automated container terminal in the port of Hamburg. The main components are: - Automatic Guided Vehicles (AGVs) for the container transports, - automatic gantry cranes (RMGs) for the yard operations and semi-automatic quay cranes to load and unload containers to/from ships. The control system serves for optimal allocation of container jobs to transport and stacking equipment (AGVs, RMGs) and for synchronisation of the different transport phases. Extensive simulation studies were performed before architecture, optimisation and synchronisation methods were implemented in the IT control system.

2) *Integrated Vehicle and Crew Scheduling*, **Huisman, Dennis**, Erasmus Univ Rotterdam, The Netherlands; **Freling, Richard**; **Wagelmans, Albert P. M.**

This paper deals with models, relaxations and algorithms for integration of vehicle and crew scheduling in the multiple-depot case. We extend some mathematical formulations for the integrated vehicle and crew scheduling problem for the single-depot case, which are already proposed in the literature, to the multiple-depot one. Furthermore, we discuss corresponding Lagrangian relaxations and Lagrangian heuristics. To solve the Lagrangian relaxations, we use column generation applied to set partitioning type of models. The paper is concluded with a computational study using real life data from Connexxion, the largest bus company in the Netherlands.

3) *Long-term vessel fleet scheduling*, **Bronmo, Geir**, Norway; **Fagerholt, Kjetil**

Many shipping companies operating a vessel fleet are engaged in tramp shipping where they have contract commitments for a given percentage of their fleet capacity, while they try to utilise the remaining capacity to maximise the profit on spot cargoes. A success criterion for such a shipping company is the ability to have the proper fleet size and to engage in the right contracts in any market situation. In this paper, we present a heuristic algorithm for evaluating how a vessel fleet can optimally handle a set of contracts in addition to optional spot cargoes.

TB15 **Supply Chain Management II**

Invited session Venue: AT-2B

Organizer: **Lee, Hochang**
School of Business, Kyung Hee University, Korea, Korea

Chair: **Maturana, Sergio**
Pontificia Universidad Catolica de Chile, Chile

1) *Modeling and simulation of the Wine Industry Supply Chain*, **Vera, Jorge**, Universidad Catolica, Chile; **Maturana, Sergio**; **Auger, Andres**; **MacCawley, Alejandro**

The coordination of the supply chain in the wine industry is very important to produce high quality wines. In particular, the interactions that occur between the grape growers and the first part of the wine making process are critical and require perfect timing in a tight time window where there are many uncertain factors. We developed a mathematical and simulation model to optimize the operations of this part of the supply chain that should serve as the basis for a decision support system for a wine producer. Some early results are shown that indicate that potential of this approach.

2) *Introducing Lean Supply Chain Management in the Construction Industry*, **Alarcon, Luis Fernando**, Universidad Catolica, Chile; **Maturana, Sergio**; **Deprez, Marcel**; **Sotomayor, Daniel**

The Chilean construction industry has not adopted modern management practices as quickly as other industries. This

helps explain why the productivity in this sector has fallen behind. As part of a research project that is introducing modern production management practices in several Chilean construction firms, we apply the lean approach to analyze the supply chain of one of these firms. We apply value stream mapping and other tools to analyze the interactions between the entities that are involved in the construction of multistory buildings in order to help identify opportunities for improvement in the different processes. Early results are shown.

3) *An Agent-based simulation of a Collaborative Marketplace Supply Chain*, **Maturana, Sergio**, Pontificia Universidad Catolica de Chile, Chile; **Contreras, Rodrigo**

The introduction of e-marketplaces may improve the supply chain management of firms that share common needs. In an e-marketplace, firms can buy and sell products through the Internet very efficienctly. E-marketplace design, however, is complex and can affect the feasibility of the approach. Modeling the interaction between the different types of participating firms is crucial. We developed an agent-based simulation model of a collaborative marketplace for hotels, restaurants and hospitals in Chile that a firm was going to implement. This multiple agent model can help design the marketplace and estimate the savings that could be generated for the participating firms.

TB16 **Analysis of Stochastic Max-Plus Linear Systems**

Invited session Venue: WR-11

Organizer: **Seidel, Wilfried**
Universitaet der Bundeswehr , Germany
Organizer: **Heidergott, Bernd**
TU Eindhoven, The Netherlands

Chair: **Baccelli, Francois**
INRIA ENS, France

1) *Asymptotics of Closed Queueing Networks with Subexponential Service Times* , **Ayhan, Hayriye**, Georgia Instit of Techn, United States; **Palmowski, Zbigniew**; **Schlegel, Sabine**

For a K-stage cyclic queueing model with N customers and general service times we give an explicit expression for the $n^{\rm th}$ departure time from each queue. Starting from this expression we analyze the asymptotic tail behavior of cycle times and waiting times given that at least one service time distribution is subexponential. Further, we show that the tail of the residual of a subexponential service time seen by an arriving customer is of the same order as the service time itself, where the asymptotic constant depends on the queue length on arrival.

2) *Subexponential Asymptotics for Stationary Open (max,plus) Linear Systems*, **Baccelli, Francois**, INRIA ENS, France; **Foss, S.**; **Lelarge, Marc**

In this paper we derive the tail asymptotics for the steady state response times in open (max,plus) linear systems with subexponential service times. We give the exact tail asymptotics of both local and global response times for general reducible topologies in function of the (max,plus) Lyapunov exponents of the communication classes.

TB17 **MCDA in Natural Resource Management I**

Invited session Venue: WR-10

Organizer: **Stewart, Theodor J.**
University of Cape Town, South Africa

Chair: **Stewart, Theodor J.**
University of Cape Town, South Africa

1) *Value-Focussed Thinking and The Management Of Helen Reef, Palau*, **Ridgley, Mark A.**, University of Hawaii, United States; **Guilbeaux, Michael**; **Sakarias, Sabino**

The astounding biodiversity of Helen Reef, a remote Micronesian atoll in Palau's Southwest Islands, is threatened with decimation from illegal harvesting by rogue foreign fishermen. Linked with the fate of Helen Reef is the future of the Tobian people, Helen's rightful owners who have experienced mass emigration to the national capital from Tobi Island, the nearest base from which to manage Helen. Effective deterrence of such incursions, as well as management of local exploitation, is hampered by the severe limitations on management resources and the logistical challenges posed by the atoll's remoteness. This paper discusses the ongoing development of Helen Reef management strategies, concentrating on the role of value-focussed thinking in clarifying objectives and designing alternative interventions. We focus on two specific applications, the development of a biological survey and the formulation of a development plan, with the latter also employing the AHP.

2) *What Matters Most in Fisheries Management--Value or Probability Judgments?*, **Kim, Jong Bum**, The Johns Hopkins Univ, United States; **Hobbs, Benjamin F.**; **Koonce, Joseph F.**

A Bayesian analysis of lower trophic level research programs for improving Lake Erie fisheries management requires both attribute weights and subjective probabilities for a highly parameterized ecological model. Six fishery managers provided both types of judgments. A comparison of the results of 36 possible combinations of weights and probabilities show that both types of judgments can have a large effect on optimal fishery policies and the expected value of information, with value judgments being most sensitive. This is fortunate, as the managers also express more confidence in their weight assessments (by the tradeoff method) than in the subjective probability assessments.

3) *A Decade of Experience in Applying MCDA to Water Resource Management Problems*, **Stewart, Theodor J.**, University of Cape Town, South Africa; **Joubert, Alison**

During the past 10 years we have been involved in a series of projects in which MCDA concepts have been applied to water and land use planning in South Africa. In this paper, we shall

trace the development of this work from a relatively technical application of multiattribute value theory to the evolution of an integrated MCDA and group problem structuring approach. The development was given impetus by the promulgation of a new water act in South Africa which mandated broad public consultation in water resources planning. Increasingly, MCDA is being seen to provide the framework under which such consultation can take place in an efficient and effective manner. We will review lessons which have been learnt, and the implication of these lessons for future implementation of MCDA in such contexts.

TB18 **Journey Making**

Invited session Venue: WR-9

Organizer: **Franco, L. Alberto**
Kinsgton Business School, United Kingdom

Chair: **Ackermann, Fran**
University of Strathclyde, United Kingdom

1) *Journey Making - a whistle stop tour*, **Eden, Colin**, University of Strathclyde, United Kingdom; **Ackermann, Fran**

Journey Making is an approach to strategy development and strategic problem solving. Starting with understanding the issues and what they mean for the organization's aspirations, the approach then provides groups with the means to consider these and other aspirations, and their ability to realise these (existing competencies). This draft strategic direction or business model can then be examined in the light of external influences to ensure its robustness and feasibility. The cycle is completed as the process of implementation and the monitoring of progress gives rise to new developments and considerations. This presentation provides an overview of the approach and some of its key components.

2) *Journey Making in Action -working with Further Education* , **Ackermann, Fran**, University of Strathclyde, United Kingdom; **Eden, Colin**

This presentation explores the use of Journey Making - focusing upon recent work carried out with a Further Education College faced with a need to respond to external pressures to consider the issue of merging. The intervention unusually had two objectives. The first and more obvious was the consideration of the strategic issue. Here it was important not only to involve the Management Team but also members of the Board. The membership therefore was a form of stakeholder management. The second objective was to provide three MBA graduates wishing to use the methodology in their own consultancy work with an opportunity to further their experience with the methodology and associated techniques. Thus, the presentation reflects on both the process of working on the issue, as well as skills transfer.

TB19 **Integer Programming**

Invited session Venue: WR-1

Organizer: **Smith, J. Cole**
University of Arizona, United States

Chair: **Lougee-Heimer, Robin**
IBM Research, United States

1) *The Common Optimization Interface for Operations Research (COIN-OR) Initiative*, **Ralphs, Ted K.**, Lehigh University, United States

The COIN-OR (www.coin-or.org) initiative is a consortium of researchers in both industry and academia interested in the development of interoperable, open source software tools for optimization. The goals of the project include supporting and promoting such development by hosting a software repository, facilitating the establishment of interface standards, and providing for software what the open literature provides for theory. This talk will be a brief introduction to the COIN-OR project and the open source development model, as well as an overview of the optimization software tools currently available in the repository.

2) *An Exact Solution Approach to the Cutting-Stock Problem*, **Lougee-Heimer, Robin**, IBM Research, United States; **Ladanyi, Laszlo**; **Lee, Jon**

We present a new approach for solving the cutting-stock problem to optimality and report on our computational experience. Our method utilizes open-source software components available in the COIN-OR repository at http://www.coin-or.org.

3) *A Framework for High-Performance Parallel Branch, Constrain, and Price*, **Saltzman, Matthew J.**, Clemson University, United States; **Ladanyi, Laszlo**; **Ralphs, Ted K.**

We describe the design of a library for building discrete optimization algorithms. This modular, object-oriented library consists of three layers: ALPS--a highly scalable, parallel module for tree search algorithms of any kind, including optimization. BiCePS--a generalized branch-constrain-price methodology for optimization, supports generation and bounding of primal objects (variables) and dual objects (functions) in the context of Lagrangian duality. BLIS--a realization of the optimization methodology for mixed-integer programming, implements a branch-cut-price algorithm on top of BiCePS. The framework is the next generation of the BCP component of the COIN-OR open source optimization project (www.coin-or.org).

TB20 **Wireless Networks I**

Invited session Venue: WR-2

Organizer: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

Chair: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

1) *Multi-commodity flow algorithms: implementations and application*, **Chiou, Suh-wen**, Tatung University, Taiwan

A multi-commodity flow problem is to find a feasible flow that satisfies the demand of each source to the sink in a directed network while the flow on each edge is within its capacity. In this paper we implement polynomial-time combinatorial approximation algorithms for -optimal multi-commodity flow problems. A new algorithm Optima is proposed and good test results are obtained. Application of Optima to a system-optimized multi-user network flow problem is given where substantially good test results have shown the capacity of Optima in dealing with problems of multi-commodity flow associated.

2) *DOCAF: A Commercial Tool for Solving the Frequency Allocation Problem in Cellular Networks - Part II*, **Bourjolly, Jean-Marie**, Concordia University-CRT, Canada; **Dejoie, Leslie**; **Ding, Ke**; **Dioume, Oumar**; **Lominy, Michel**

We present DOCAF, a commercial package built through a university-industry research project that enables operators to manage their cellular networks more effectively through solving the frequency allocation problem. We also make a case for integrating products such as DOCAF with tools for cell dimensioning and radio frequency planning, and for interfacing them with a geographical information system... (DOCAF works for AMPS, TDMA IS136 and GSM networks).

3) *Solving the Frequency Assignment Problem with Polarization by Local Search and Tabu*, **Galinier, Philippe**, Ecole Polytechnique - CRT, Canada; **Bisaillon, Serge**; **Gendreau, Michel**; **Soriano, Patrick**

The Frequency Assignment problem with polarization (FAPP) arises in so-called radio-link telecommunication networks. The version studied here is a complex constrained optimization problem that was the subject of the ROADEF challenge 2000. In this kind of problem (like the RLFAP, 1993), there are some electromagnetic constraints that impose given distances between pairs of frequencies but also some other additionnal constraints. In the FAPP, a link is now caracterized not only by a frequency but also by a bipolar variable called the polarization, what makes all the constraints more complex. For the problem, we propose a local search approach based on Tabu that includes some original features, including a specialised neighborhood, heuristics to determine critical variables and values, different diversification techniques, an auto-adaptative mechanism to set the tabu list and a pre-processing based on consistency techniques heritated from constraint programming.

TB21 **Integer programming and network design**

Invited session Venue: WR-3

Organizer: **Myung, Young-Soo**
Dankook University, Korea

Chair: **Dahl, Geir**
University of Oslo, Norway

1) *Mixed Integer Models for the Optimization of Gas Networks*, **Martin, Alexander**, TU Darmstadt, Germany; **Moeller, Markus**; **Moritz, Susanne**

A gas network basically consists of a set of compressors and valves that are connected by pipes. The task of the transient technical optimization is to optimize the drives of the gas and to set in the compressors cost-efficiently such that the required demands are satisfied. This problem leads to a complex mixed integer nonlinear optimization problem. We approach it by approximating the non-linearities by piece-wise linear functions leading to a huge mixed integer program. We study the polyhedral consequences of this model and present some new cutting planes. Our preliminary computational results show the benefits when incorporating these cuts into a general mixed integer programming solver.

2) *Polyhedral Properties of certain 0-1 Knapsack Polytopes* , **Dahl, Geir** , University of Oslo, Norway; **Foldnes, Njaal**

Starting with an application in telecommunications, we are led to study a certain class of multiple knapsack problems. This class has assignment restrictions, i.e. for each item there is given a restricted subset of knapsacks where the item may be placed. In particular, we focus on the case when the items fall in only two classes: those of unit weight, and those of weight p. We present valid inequalities for the associated polytope, and preliminary computational results to illustrate their usefulness.

3) *Separation of Rank Rounded Metric Inequalities for the Network Loading Problem*, **Avella, Pasquale**, Universita del Sannio, Italy; **Mattia, Sara**; **Sassano, Antonio**

Given a directed graph G(V,A) and a set of origin-destination traffic demands, the Network Loading Problem (NLP) consists of finding minimum cost integer capacities to be installed on the arcs of G, which guarantee that traffic demands can be shipped simultaneously. Let $\mu in \Re^n$ be a metric defined on the arcs of G. The "capacity" formulation of NLP is defined by Metric Inequalities of the form $\mu x \geq \mu d$. When μ is integer, they can be strengthened to Rounded Metric Inequalities by rounding-up the right-hand side, i.e. $\mu x \geq \lceil \mu d \rceil$. When $\mu_e \in \{0,1\}, e \in A$ we refer to them as Rank Rounded Metric Inequalities. They generalize well known classes of facet-defining inequalities, such as Cut and Partition Inequalities. We study separation algorithms for Rank Rounded Metric Inequalities and report computational experience on test instances.

TB22 **Panel Discussion: Modeling Science**

Invited session Venue: WR-4

Chair: **Willemain, Thomas Reed**
Rensselaer Polytechnic Institute, United States

Chair: **Wallace, Willam A.**
Rensselaer Polytechnic Institute, United States

1) *Panel Discussion: Modeling science*, **Wallace, Willam A.**, Rensselaer Polytechnic Institute, United States; **Willemain, Thomas Reed**; **Brooks, Roger**; **Gass, Saul I.**; **Powell, Stephen G.**

Panel discussion on issues concerned with the art, craft and science of modelling.

TB23 **Decision Analysis III**

Contributed session Venue: AF-10

Chair: **Knott, Cynthia Lynne**
GWU, United States

1) *Reengineering and Decision Support for National Higher Education System*, **Sepehri, Mehron**, Sharif Univ of Technology, Iran; **Zarei, Behrouz**; **Mashayekhi, Ali N.**

Models are used to formulate and reengineer various processes within higher education at national level, such as hiring of academic staff and student registration. Use of Simulation and Porter's Value Chain help reengineer activity streams and then provide vital information for critical decisions. Decomposition of macro-level processes and measurement system are used. Special attention is given to systems dynamics and executive information system. A pilot system is now operational and other models are developed. Models are tested in Iran's ministry of higher education, and applicable to emerging countries as well as companies using extensive manpower.

2) *Modified CAPM for farmland investing*, **Segura, Baldomero**, Univ Politecnica Valencia, Spain; **Ribal, F. Javier**

In this work, we have introduced a modified CAPM for portfolio selection when the correlations between the returns are numerous at a high level. We have carried out an application to the farmland market, because in this market the correlation problem is very usual, so investors are not really minimizing risk.

3) *An alternate approach to developing a total celebrity rating model using AHP*, **Knott, Cynthia Lynne**, GWU, United States; **StJames, Melissa**

Using the Analytic Hierarchy Process to develop an over-all rating of a celebrity is a new approach to enhance the Q-Rating procedure currently in practice. The Q-rating approach has recieved critisism on its usefulness because it only considers likability of the celebrity. Using the AHP model approach allows users to input judgements as to how they feel about a celebrity with a specific set of criteria in mind. For example, "how intelligent(trustworthy/credible/likable/etc) do we believe Mariah Carey is compared to Tiger Woods?" The model is an improvement over the Q-rating system because it includes a more complete set of attributes and, more importantly, has the ability to capture and analyze tradeoffs among those attributes. Another improvement is that as situations change or evolve, the model can be easily updated to capture new information. This allows for celebrities ratings to change over time and be more accurate given all available information.

TB24 **Practice of OR II**

Contributed session Venue: AF-13

Chair: **Yelland, Phillip Michael**
Sun Microsystems Inc, United States

1) *A valuation model for diamonds based on Internet published data*, **Cardoso, Margarida G.M.S.**, ISCTE, Portugal; **Chambel, Luis**

Cut diamonds are hard to value given the number and type of properties used in price construction (carat, color, clarity, cut and others). This project aims to develop a valuation model for cut diamonds based on Internet published data using Regression Trees (CART and CHAID) and Neural Networks (using Backpropagation). The results obtained are compared with the Rappaport price lists (an industry-wide adopted price indicator).

2) *Short time scheduling in a call centre with limited variability of timetables*, **Olivella, Jordi**, U Politecnica Catalunya, Spain

This paper continues an OR43 exposed work. Grupo Idea is a 6,000 workers call centres concern owned by the spanish electrical company Iberdrola. An innovative policy based in stability of timetables is applied in one of its centres. A tool optimising the surplus percentage taking account of real available workers and desired number at each moment of the day is described. It is satisfactorily used by the company. Reactions in the company are analysed. Absenteeism rose and a tighter control was necessary. Productivity and quality are improving. The success of new methods is not leading to its use in more centres of the group.

3) *Experience with Forecasting Using Dynamic Linear Mixture Models*, **Yelland, Phillip Michael**, Sun Microsystems Inc, United States; **Lee, Eunice**

This paper discusses investigations undertaken at Sun Microsystems Inc. into practical forecasting applications of the Bayesian Dynamic Linear Models described in the seminal work of Harrison and West. Particular emphasis is placed on the use of “class I mixture models”, which use Bayesian model averaging to help accommodate model uncertainty.

TB25 **Mathematical Programming-Combinatoric II**

Contributed session Venue: AF-14

Chair: **Figueira, José R.**
University of Coimbra, Portugal

1) *Italian National Contribution: Recovering Beam Search - A hybrid heuristic method for combinatorial optimization problems*, **Della Croce, Federico**, Politecnico di Torino, Italy; **Ghirardi, Marco**; **Tadei, Roberto**

The proposed method applies a beam search strategy with constant beam width where the nodes evaluation process is based on the weighted sum of the nodes upper and lower bounds. Once a node selected by the beam and the corresponding partial solution are derived, a further test is applied to check whether the current partial solution is dominated by another partial solution with the same level of the search tree. If this is the case, the latter solution becomes the new current partial solution. This step allows to recover from previous wrong decisions of the beam search procedure and can be seen as a local search step on the partial solution. The proposed method is reasonably general-purpose and applicable to a wide range of combinatorial optimization problems.

2) *An interior-point branch-and-price algorithm for the bin packing problem*, **Elhedhli, Samir**, University of Waterloo, Canada

We propose an exact solution approach for the bin packing problem that integrates interior-point techniques, Lagrangean relaxation and branch-and-bound; which we refer to as “an interior-point branch-and-price method”. The columns are generated at a central dual solution that is computed by an interior-point cutting plane method. We start by comparing the quality of the Lagrangean bound to other bounds from the literature and describe its computation using the analytic centre cutting plane method (ACCPM). We then detail the use of the bound within a branch-and-bound scheme where we effectively exploit information accumulated at the parent node to warm start the solution of child nodes. We present promising numerical results.

3) *An Interactive Decision Support Tool Dedicated to the Bi-Criteria {0,1}-Knapsack Problem*, **Gomes da Silva, Carlos**, ESTG-Leiria, Portugal; **Figueira, José R.** ; **Climaco, Joao Namorado**

Several authors had extensively studied the mono-criterion knapsack problem. Nevertheless, many real-world situations require the incorporation of more than one criterion. The difficulty inherent to the generation of all non-dominated solutions, even in the bi-criteria case forbids the successful resolution of large size instances. However, even when that generation is possible, the greatest computational effort is useless because the DM is either not able or not interested in considering all the generated solutions. In this paper we present an interactive DSS dedicated to the bi-criteria case. This tool was built regarding an "open/exchange" communication interactive approach and considers several interaction options.

TB26 **Multi-Criteria Decision Analysis I**

Contributed session Venue: AF-18

Chair: **Tozer, Peter R.**
Pennsylvania State, United States

1) *A decision tool for investments choice based on multicriteria analysis*, **Belmokhtar, Oumhani**, ENP ALGER, Algeria; **Lamraoui, Tewfiq**

The aim of this work is to elaborate a decision making tool for the investment problem based on a multicriteria approach (Promethee). This approach takes into account a series of criteria whose combination defines the set of feasible solutions. These solutions are then filtered in order to choose the best suitable solutions.

2) *Time-cost tradeoff models under time and cost chance constraints*, **Laslo, Zohar**, NACE, Israel

Any stochastic extension of the CPM time-cost tradeoff model requires definition of time and cost distributions for each resource allocation. On the basis of clean fractile method, models of time-cost tradeoffs with both time and cost chance constraints have been developed. Those models cover time distribution that is either affected by resource allocation (research and development) or not affected (production and construction), and cost which is given in the form of cost price or fixed cost. The models are realized via multi-objective procedures. Keywords: Project management, stochastic CPM time-cost tradeoffs model, time-cost chance constrains, clean fractile method.

3) *Visualising Sensitivity Analysis in MCDA A Case Study*, **Hodgkin, Julie**, University of Stirling, United Kingdom; **Belton, Valerie**

Whilst multicriteria decision support systems such as V•I•S•A provide a tool for users to explore the implications of multi-dimensional sensitivity analyses, they do not offer guidance in “where to look”. Recent work has focused on analysing different ways in which “intelligence” can be incorporated in V•I•S•A, in particular in ensuring comprehensive sensitivity analysis. Part of this work has focused on how to visualise, through 2 dimensional displays, the results of multi-dimensional sensitivity analyses. The presentation will demonstrate the use of two softwares developed and discuss a case study in which the systems were used.

TB27 **Supply Chain Management V**

Contributed session Venue: AF-19

Chair: **Petrovic, Dobrila**
Coventry University, United Kingdom

1) *Pricing Outsourcing in the Supply Chain*, **Skintzi, Georgia**, Greece; **Ioannou, George**; **Prastacos, Gregory P.**

The new economy introduces significant pressures to enterprises, calling for investments in value-adding assets together with expanded control over the entire supply chain. Typical manufacturers have accumulated for years, competences in traditional aspects of supply chain management, while they attempt to gain additional ones via capital-intensive acquisitions. In this paper we propose an effective approach to supply chain control expansion based on the option pricing techniques of finance theory. We consider supply chain nodes as assets that can be operated by small firms under two-way option-like contracts with manufacturers, and use finance methods to price such outsourcing alternatives. To illustrate the potential-robustness of our approach we present cases for warehouse management and logistics, and compare our results for various market and financial parameters with traditional acquisitions.

2) *Implementing Supply-Chain Optimisation Models in an Algebraic Modelling Language*, **Pindoria, Sandip**, Maximal Software, Ltd, United Kingdom; **Kristjansson, Bjarni**

Supply-Chain Management solutions are increasingly utilising optimisation models to provide better decision-making information. We will discuss how supply-chain optimization models can be implemented in an algebraic modelling language, such as MPL, leading to reduced development times. We will demonstrate a standalone supply-chain application written in Visual Basic that incorporates an optimisation model.

3) *Two-Level Management and Control of Supply Chain in the Presence of Uncertainty*, **Petrovic, Dobrila**, Coventry University, United Kingdom; **Xie, Ying**; **Burnham, Keith**

This paper considers a supply chain (SC) that includes production facilities and inventories between them. The SC operates in non-deterministic environment with uncertainties in customer demand and production rates. They are described by imprecise terms defined by fuzzy sets. Management and control of SC are performed on two levels:(i) local optimization on infimal level, (ii) coordination on supremal level. The method proposed has three steps: (1) decompose SC control problem into independent subproblems which refer to SC constituent parts, (2) solve subproblems independently and get locally optimal solutions,(3)coordinate local solutions on supremal level in a way to obtain balanced control across SC as a whole. Steps (2) and (3) are iteratively repeated until a satisfactory SC performance is achieved.

TB28 **Multiobjective Scheduling and Timetabling**

Invited session Venue: DH-C

Organizer: **Petrovic, Sanja**
University of Nottingham, United Kingdom

Chair: **Tadei, Roberto**
Politecnico di Torino - Dip. Autom. e Informatica, Italy

1) *The role of flexible resources in retail supply chains*, **Broekmeulen, Rob A. C. M.**, TU Eindhoven, The Netherlands

We consider the distribution processes in the supply chain of retailers where the warehouse operations at the distribution centres are the bottleneck of the process. This bottleneck situation is caused by higher delivery frequencies, tighter time windows and decreasing flexibility of warehouse operations due to mechanization. We propose an approach for allocating flexible resources in the supply chain which enables the construction of a robust plan. Such a robust plan has to meet the delivery time windows at acceptable cost levels for handling and transportation under varying circumstances.

2) *Pareto-optima generation for minimizing number of tardy jobs and maximum tardiness*, **Della Croce, Federico**, Politecnico di Torino, Italy; **Grosso, Andrea**; **Tadei, Roberto**

We study the bicriterion problem of minimizing the number of tardy jobs and the maximum tardiness on a single machine, which is considered open from the point of view of computational complexity. A hierarchical version of the problem has been tackled by Gupta, Hariri and Potts [1] by means of a very efficient branch and bound method. We consider solution procedures for searching the Pareto-optima for the problem, experimenting both pure combinatorial and lagrangian lower bounds. The computational results will be presented at the Conference. References: [1] Gupta, J. N. D., Hariri, A. M. A. and C. N. Potts, "Single-machine scheduling to minimize maximum tardiness with minimum number of tardy jobs", Ann. Oper. Res. 92 (1999), 107--123.

3) *Enumeration of strict Pareto optima for a scheduling problem with early tardy cost*, **Esteve, Bertrand**, LI, France; **Aubijoux, Charly**; **Chartier, Alexandre**; **T'Kindt, Vincent**

Consider the problem of scheduling N jobs with distinct due dates on a single machine with inserted idle times allowed. We introduce N early/tardy costs that have to be minimized, thus we consider a multicriteria scheduling problem. Each criterion reflects the weighted deviation of a job by comparison to its due date. This problem is NP-hard. We provide heuristic algorithms to approximate the set of strict Pareto optima. They are based on greedy heuristics and a local search. Computational experiments will be presented at the time of the conference.

TC1 **Medical Applications II**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Davies, Ruth M.**
University of Southampton, United Kingdom

1) *A micro-simulation model for assessing primary prevention strategies for coronary heart disease*, **Babad, Hannah**, LSHTM, United Kingdom; **Sanderson, Colin**;

Naidoo, Bhash; **White, Ian**; **Wang, Duolao**; **Castelnuovo, Emanuela**

A discrete-event model has been developed for use in assessing effects on morbidity, mortality and health care resources of primary prevention strategies for coronary heart disease (CHD). Demographic and CHD risk profiles are assigned to each member of a simulated population. Times to disease events, conditional on these profiles, are sampled from probability distributions that are derived from a new analysis of the Framingham study on CHD. Changes in risk factors or health status modify these times. Outcomes of modelling primary intervention strategies for smoking, blood pressure and cholesterol are described and their cost implications compared.

2) *A simulation of the prevention and treatment of coronary heart disease*, **Cooper, Keith** , University of Southampton, United Kingdom; **Davies, Ruth M.**; **Roderick, Paul**

The purpose of the simulation is to evaluate policies for the treatment and prevention of coronary heart disease (CHD). Discrete event simulation models of primary prevention and of the treatment of patients with CHD have been linked together to provide an overview of the whole system. This paper describes the problems encountered in linking the models, especially in relation to the relatively different sizes of the populations. We look at issues of validation and sensitivity analysis. Illustrative results will show the impact of prevention policies on treatment resources.

3) *Protein folding: theory, results and Health Care implications*, **Patrizi, Giacomo** , University La Sapienza, Italy; **Cifarelli, Claudio**

From an amino acid chain, it is important to determine where the folds in the chain occur and the angles that the amino acids assume respect to each other and to the protein structure, since a protein's properties are closely related to these aspects. Thus therapies can be designed in Health Care by constructing appropriate proteins and genetic disorders can be identified by determining abnormal amino acid strings with respect to function. Theoretical and experimental results will be given regarding the secondary (folds) and tertiary (angles) structure of proteins from its primary (chain) structure, using the PDB database.

TC2 **Dynamic Traffic Assignment II**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Nuzzolo, Agostino**
Univ Of Rome Tor Vergata, Italy

1) *Short-Term Prediction Of Ride-Occupancy For Transit Networks With Intelligent Transport Systems*, **Nuzzolo, Agostino**, Univ Of Rome Tor Vergata, Italy; **Crisalli, Umberto**; **Coppola, Pieruigi**; **Rosati, Luca**

This paper presents a system of models used to predict transit vehicles arrivals and loads by the use of information available at stops through ITS, in order to give real-time information to users about transit system functioning. It consists of a run-based supply model, a time-dependent demand model and a within-day assignment model, which includes a schedule-based dynamic path choice model. Supply and demand are real-time updated by ITS to give precise inputs to the within-day assignment model, for an accurate information either for users at stops about waiting times and loads of arriving transit vehicles or for the transit system control room to support fleet management strategies.

2) *Dynamic Schedule-Based Modellng Of Transit Networks: State-Of-The-Art And Future Developments*, **Nuzzolo, Agostino**, Univ Of Rome Tor Vergata, Italy; **Russo, Francesco**; **Crisalli, Umberto**

This paper presents a general framework of public transport modelling, describing the two possible modelling approaches and the state of the art focusing on path choice and assignment models. Different supply, path choice and assignment models have to be specified in relation to service and user characteristics. In particular the schedule-based approach is deepened describing different specifications of models for both high and low frequency transit services, typical of urban and extraurban areas, respectively.

3) *Dynamic Schedule-Based Assignment Models For Transit Networks: Theoretical And Operative Aspects*, **Nuzzolo, Agostino**, Univ Of Rome Tor Vergata, Italy; **Russo, Francesco**; **Crisalli, Umberto**

This paper describes a class of schedule-based dynamic assignment models for transit networks. These models allow us to define more coherent user behavioural hypotheses in path choice models, which are the core of assignment models, in relation to service and user characteristics. The dynamic evolution of the transit system, considering both a single day period (within-day dynamic) and a sequence of day periods (day-to-day dynamic) for different types of transit systems (high and low frequency services) is investigated, as well as some application results are presented.

TC3 **Dynamic Routing Problems**

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Kleywegt, Anton**
Georgia Institute of Technology, United States

1) *Stabilized Column Generation for a Scheduling Problem* , **Desrosiers, Jacques**, GERAD and HEC, Canada; **Ben Amor, Hatem**

The stabilized version of a problem introduces bounded surplus and slack variables. To account for dual information, these are penalized in the objective function of the primal formulation. We present the theoretical aspects of a stabilized column

generation approach and some recent computational results for the Bus Driver Scheduling problem in urban transit. This proposed procedure is also suitable for the so-called crossover from an optimal interior point solution to an optimal extreme point or basic solution.

2) *A Multilayered Resource Scheduling Problem*, **Simao, Hugo P.** , Princeton University, United States; **Powell, Warren B.**; **Cheung, Raymond K.**

We consider the problem of simultaneously routing drivers, tractors, trailers and product to serve vendor managed tanks for a chemical gases company. We provide a compact formulation of the problem which is quite general. We then propose a general labeling algorithm that produces tours that not only satisfy production-quality work rules, but also manages the inventory levels in the tanks. Numerical results are presented, and we discuss the progress of the implementation and adoption of this system.

3) *The Dynamic Stochastic Newspaper Routing Problem*, **Kleywegt, Anton**, Georgia Institute of Technology, United States; **Elmaghraby, Wedad**; **Griffin, Paul M.**; **Keskinocak, Pinar**; **Koenig, Sven**

In the newspaper routing problem, newspapers have to be delivered to a given set of customers, using a given set of vehicles, in minimum time, i.e., the last delivery should take place as early as possible. We consider a dynamic stochastic newspaper routing problem in which arcs are obstructed randomly, and vehicles may be assigned to customers and rerouted dynamically. The problem is motivated by robot navigation applications.

TC4 **Cutting and Packing: Genetic Algorithms**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Wang, Pearl Y.**
Goerge Mason University, United States

1) *A Hybrid Genetic Algorithm for Solving a 1.5-D Cutting Problem* , **Goncalves, Jose Fernando**, DEMEGI - Faculdade de Engenharia do Porto, Portugal

This paper presents a hybrid genetic algorithm for solving a 1.5-D cutting problem, common in the home-textile industry. The genetic algorithm generates sets of cutting patterns, which are used by a sequential heuristic procedure. Experimental tests on a set of random generated problems with known optimal solution validate the quality of the approach.

2) *Two-dimensional bin-packing problems: development of genetic algorithms*, **Mukhacheva, Anna**, Russia; **Chiglintsev, Artem**; **Smagin, Mikle**; **Mukhacheva, Elita**

The two-dimensional bin-packing is considered as the basic problem for the case. The paper deals with the development of genetic algorithms in two directions of research: the classical genetic algorithm and the block structure genetic algorithm. The first direction realizes the I.P.Norenkov's methodology that uses ordinary heuristics representing the gene's alleles and hybridization of the algorithm with the sequential value correction method. The second direction realizes the algorithm based on the bin-packing block structure.

3) *Algorithms for Placing Soft Rectangles Using Slicing Floor plans*, **Valenzuela, Christine Lesley**, Cardiff University, United Kingdom; **Wang, Pearl Y.**

Soft rectangles represent components that have a fixed area but maintain some flexibility in their height and width dimensions. We have developed various heuristic and genetic algorithms that will simultaneously optimize the shapes of the basic rectangles in the layout while searching for the best global placement.

TC5 **Tutorial: Development of a web-based course**

Invited session Venue: MS-1

Chair: **Waissi, Gary R.**
University of Michigan-Dearborn, United States

1) *Tutorial: Development of a web-based course*, **Waissi, Gary R.**, University of Michigan-Dearborn, United States

Tutorial: In this tutorial we will be looking at development of a web-based second level statistics course for the webMBA program at the University of Michigan-Dearborn. Topics covered include: teaching a quantitative course via the web, structure and design of the course, demonstration of the course features (including animations of models), interaction with students and creating a learning community. As part of this tutorial you will receive access to the course content (e-book: Applied Statistical Modeling), which you may use in your own course.

TC6 **Issues in Data Envelopment Analysis I**

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Morita, Hiroshi**
Osaka University, Japan

1) *Estimation of efficiencies using Kalman filter and stochastic efficiency model*, **Ueda, Tohru**, Seikei University, Japan; **Hoshino, Kenichi**

Firms are being operated over long years. Thus, we should evaluate their efficiencies, based on their historical data relating to finance. We shrink each historical data into a distribution function with a mean and a variance estimated by Kalman filter. Then, we apply stochastic efficiency model to shrunk data of electrical products firms and department stores. We propose a new efficiency measure called by the modified efficiency score and compare it with such existing measures as DEA efficiency scores and super efficiency scores of Andersen et al.

2) *Comparison Of DEA Softwares*, **Sinuany-Stern, Zilla** , Ben-Gurion University, Israel; **Friedman , Lea**; **Nener , Ifat**

In this study we compare several commercial DEA softwares . Several criteria were used such as: cost, types of DEA model available (CCR, BCC, super efficiency, cost efficiency, malmequist, cross-efficiency), types of outputs (weights, improvements, peer-groups, virtual, graphs) ,input and output form , size. Special features (i.e. bounds).The paper discusses some problems encountered in the theory and practice of DEA as reflected by these softwares.

3) *Economies of Scope by Data Envelopment Analysis*, **Morita, Hiroshi**, Osaka University, Japan

DEA not only measures efficiency, but also can measure "economies of scale" and "allocative efficiency." "Economies of scope" shows whether the range made into the object of activity is suitable. Although a merger of the same kind is generally performed when there are economies of scale, a merger of a different kind is performed when there are economies of scope, and when there are resources that can be used in common, the economy of the range exists. In this paper, we discuss how to estimate the economies of scope quantitatively using DEA.

TC7 **Modeling the Changing Face of War: Military Operations Research in the 21st Century**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States

Chair: **Parnell, Gregory S.**
United States Military Academy, United States

1) *Scheduling Military Deployments*, **Hodgson, Thom J.**, North Carolina State Univ, United States; **King, Russell E.**; **Thoney, Kristin A.**; **Trainor, Timothy E.**; **Melendez, Barbra**

Sensitivity analysis in military deployment planning is an important function given the high-dollar and long-term nature of decisions that address the nation's strategic mobility needs. To perform this, planners need fast, personal computer-based tools. In this research, a deployment of military units is modeled as a supply chain scheduling problem in which items of unit equipment are jobs moving between air/seaports (factories) on planes and ships (inter-factory transportation). Our decision support package, the Deployment Scheduling Analysis Tool (DSAT), is based on a job shop scheduling system developed at NCSU which is proven to solve large problems to near-optimality very quickly.

2) *Joint Warfare System An Analysis Tool for the Future*, **McIntyre, Gregory A.** , Joint Warfare System Office, United States

The Joint Warfare System (JWARS) is scheduled to replace several legacy models such as MIDAS, TACWAR, THUNDER, CEM and SUMMITS. JWARS is the first perception based campaign-level model that is designed to provide “balanced” representation of joint (and combined) warfare. JWARS will provide users with a representation of joint warfare to force assessment studies, operational planning and execution, system effectiveness and trade-off analyses, and concept and doctrine development. This presentation will cover various aspects of Command and Control; Intelligence, Surveillance, and Reconnaissance; behavior modeling; building/establishing perception; data management; and output analysis in support of the various types of study application.

3) *Information Operations Research*, **Deckro, Richard F.**, United States; **Parnell, Gregory S.**

Information operations are a key factor in military operations in the 21st century. Information, and the control of information, has always been critical to military commanders. The asymmetrical threat posed by information operations offers many unique technical, operational, and governmental challenges. Unlike many military fields, even a single person or a non-national group can mount effective information operations campaigns from any virtual location, including one inside a nation’s borders. This presentation provides an overview of current operations research contributions and challenges in the field of information operations.

TC8 **Modeling languages and environments for optimization**

Invited session Venue: AT-3

Chair: **Fourer, Robert**
Northwestern University, United States

1) *WWW-NIMBUS for Multiobjective Optimization*, **Ojalehto, Vesa** , University of Jyvaskyla, Finland; **Miettinen, Kaisa** ; **Makela, Marko M.**

NIMBUS is an interactive multiobjective optimization method capable of solving nondifferentiable and nonconvex problems. We describe the NIMBUS algorithm and its implementation WWW-NIMBUS. To our knowledge WWW-NIMBUS is the first interactive multiobjective optimization system on the Internet (since 1995). We introduce the latest developments, e.g., possibility to maintain a database of promising comprise solutions. In addition, different scalarizing functions as well as single objective solvers are available. We also describe possibilities of different Modeling Languages for importing and exporting optimization problems to and from the WWW-NIMBUS optimization system.

2) *An Introduction to Mosel*, **Heipcke, Susanne**, Dash Optimization, United Kingdom; **Colombani, Yves**

Mosel is a new environment for modeling and solving problems. It includes a language that is both a modeling and a programming language combining the strengths of the two concepts: there is no separation between a modeling statement and a procedure that actually solves the problem. Thanks to this synergy, one can program a complex solution algorithm by interlacing modeling and solving statements. Mosel offers a dynamic interface to external solvers provided as modules that directly extend the vocabulary and capabilities of the language. This modular architecture can also be used as a means to open the environment to software other than solvers (e.g. databases).

3) *AMPL / LGO Solver Option for General Nonlinear Optimization*, **Pinter, Janos D.**, Pinter Consulting Inc, Canada

AMPL is a high-level computer language designed to support model development in mathematical programming [1]. A new solver option callable from AMPL has been developed on the basis of LGO, an integrated solver system for general nonlinear - specifically including global - optimization [2, 3]. In this talk, we shall introduce the AMPL-LGO solver option, highlight its main features, and present a few illustrative numerical examples. References [1] Fourer, R., Gay, D.M., and Kernighan, B.W. (1993) AMPL - A Modeling Language for Mathematical Programming. Boyd & Fraser, Danvers, MA. (Originally published by the Scientific Press.) [2] Pintér, J.D. (1996) Global Optimization in Action. Kluwer Academic Publishers, Dordrecht Boston London. [3] Pintér, J.D. (2001) Computational Global Optimization in Nonlinear Systems. Lionheart Publishing Inc., Atlanta, GA.

TC9 Modelling and Forecasting Electricity Prices

Invited session Venue: MS-3

Organizer: **Oren, Shmuel**
University of California, Berkeley, United States

Chair: **Bunn, Derek**
United Kingdom

1) *Large Scale Neighborhood Search for Routing and Scheduling* , **Ergun, Ozlem**, United States; **Orlin, James B.**

We concentrate on a very large scale neighborhood (VLSN) search technique based on compounding independent moves (CIM) such as 2 opts, swaps, and insertions. We show that using network flow techniques for searching the neighborhood and efficient data structures: 1) the complexity of CIM neighborhood search algorithms for some single machine scheduling problems can be improved from the previously known bounds, and 2) the CIM neighborhood search algorithms can be extended to more complicated problems such as the VRP and some parallel machine scheduling problems. We present the results of a related computational study on the capacitated VRP.

2) *Modelling the Brazilian Spot Price Series*, **Souza, Reinaldo Castro**, PUC-Rio, Brazil

The worldwide process of restructuring of the electrical sector has also reached Brazil in the nineties and is today still in the implementation stages. According to the new rules, the Wholesale Energy Market, created in September 2000 is the responsible for the commercialisation of energy among market agents, using the "Short Run Marginal Costs" (SRMC) as the clearing spot price. In this paper we discuss the spot price monthly series for each one of the sub-markets (N, NE, S, SE) and Brazil as a whole. We propose statistical and computational intelligent methods to model such series. Finally, this research is conducted jointly by reserch teams from PUC-Rio and CEPEL (Brazilian Power Research Institue)

3) *Evolutionary Modelling of Industry Structure*, **Oliveira, Fernando**, London Business School, United Kingdom; **Bunn, Derek**

In this paper we model the relation between the structure of an electricity company (asset ownership and vertical integration) and its performance in the market using Finite Automata Dynamic Gaming. We use a multi-agent computational model of the E&W electricity industry to analyze the evolution of different corporate structures, through activity in the capital markets, rewarded through relative performance in the spot market. The price effects of such strategic evolution are also identified.

TC10 Equipment Replacement Analysis

Invited session Venue: MS-4

Organizer: **Scarf, Philip**
University of Salford, United Kingdom
Organizer: **Hartman, Joseph C.**
Lehigh University, United States

Chair: **Jack, Nat**
University of Abertay , United Kingdom

1) *Optimal Equipment Replacement in the Presence of Technological Change*, **Smith, Robert L.**, University of Michigan, United States

We show how to find an optimal next replacement decision, undistorted by end-of-study effects, in the presence of technological change.

2) *Multiobjective Vehicle Replacement*, **Bean, James**, University of Michigan, United States; **Grande, Darby**

We address the life-cycle evaluation of a multiobjective vehicle replacement problem including economic, energy and emissions criteria. We develop a genetic algorithm that simultaneously evolves solutions across the pareto optimal frontier.

3) *Finite Horizon Equipment Replacement*, **Hartman, Joseph C.**, Lehigh University, United States

The finite horizon equipment replacement problem is generally solved with dynamic programming. As general software packages are not available to implement dynamic programming solutions, a number of linear and integer formulations have been proposed. We examine these different formulations from computational, analytical and intuitive perspectives.

TC11 **Metaheuristics for ILP and MIP Problems**

Invited session Venue: MS-5

Organizer: **Glover, Fred**
United States
Organizer: **Lokketangen, Arne**
Molde College, Norway
Organizer: **Nath, Baikunth**
Australia
Organizer: **Woodruff, David L.**
UC Davis, United States

Chair: **Rego, Cesar**
University of Mississippi, United States

1) *Scatter Search for Unconstrained Binary Quadratic Programming*, **Rego, Cesar**, University of Mississippi, United States; **Amini, Mohammad**; **Alidaee, Bahram**; **Glover, Fred**; **Kochenberger, Gary**

Unconstrained Binary Quadratic Programming (BQP) problems are found effective in modeling a variety of combinatorial optimization problems. We propose a new evolutionary method for BQP problems based on a structured adaptation of Scatter Search. This study introduces and tests a variety of alternatives for executing various components of the overall scatter search framework. Extensive computational experimentation, which includes the largest and most comprehensive problem testbed examined to date are presented and discussed.

2) *Scatter Search for General MIP Problems*, **Pedroso, Joao Pedro**, LIACC and DCC-FCUP, Portugal; **Rego, Cesar**

We provide a new metaheuristic framework for general Mixed integer Programming (MIP) problems based on scatter search. We show how the particular evolutionary design processes of scatter search are especially well-suited for MIP applications, and we provide computational comparisons with branch-and-bound and other metaheuristics on standard benchmark problems.

3) *Local Branching or how to enhance a MIP solver*, **Lodi, Andrea**, DEIS, University of Bologna, Italy; **Fischetti, Matteo**

We propose a general framework to enhance the capability of a general MIP solver to find good heuristic solutions for a MIP problem involving set of binary variables. The method is based on the exploration of neighborhoods which are generated through linear inquealities imposing that just a subset of the binary variables in a feasible solution can be changed. A large set of computational experiments on hard MIPs is presented, and various extensions including the use of the neighborhood constraints within an exact branching scheme are discussed.

TC12 **Aspects of Development**

Invited session Venue: AT-6

Organizer: **Bandyopadhyay, Rangalal**
Centre for Applied Systems Analysis in Development, India

Chair: **Friend, John Kimball**
University of Lincoln, United Kingdom

1) *Strategic Budgeting For Socio-Economic Improvement*, **Randall, Paul**, Namibia

Poverty is increasingly being defined by reference to a range of socio-economic indicators; as are countries' wider developmental, and other, objectives. Government Republic of Namibia (GRN), with the assistance of UK funded Operational Research, has developed a unique framework approach to associating those indicators with measures of GRN activities. That approach recognises the primacy of purpose in determining the appropriateness of possible performance indicators. The framework, representing various dimensions of public sector performance, has now been integrated into the national Budget, providing a new currency for debates on priorities. It is also a critical piece of the governance jigsaw that is critical to sustaining development - underpinning a range of other projects. This paper describes the structuring of the framework, and work to ensure functionality within the workings of the central government machinery, are described.

2) *What I learnt from STD Control Projects in Russia*, **Turner, Howard**, Government OR Service, United Kingdom

The paper presents an account of what the author learned from participating in activities aimed at controlling sexually transmitted diseases and HIV/AIDS in the Russian Federation in the period September 1998 to June 2000, and offers some suggestions as to what relevance these learning points may have for other people and other settings.

TC13 **Workflow and E-Business**

Invited session Venue: AT-7

Organizer: **Basu, Amit**
SMU, United States

Chair: **Kumar, Akhil**
University of Colordo, Boulder, United States

1) *Configuration and E-commerce*, **Moeller, Jesper**, IT University, Copenhagen, Denmark

Configuration software has become an essential component in e-commerce as an increasing number of customers engage in transactions through the Internet and demand more information, responsiveness and flexibility, and require increased personalization. Configurators are rule-based software systems that enable a customer to build complex products according to her own content preferences while meeting the producer rules. Configurators allow customers to select among an abundance of available options and features, and utilize logic rules to prohibit incompatible or inefficient combinations of features. In this talk I describe what a configurator is and motivate why configuration software is important in e-commerce.

2) *Design and implementation of inter-organizational workflow processes for E-Business*, **Kumar, Akhil** , University of Colordo, Boulder, United States

An understanding of inter-organizational workflow processes is becoming increasingly important in the context of E-Business applications. This talk gives an overview of techniques for modeling and implementing inter-organizational processes.

3) *An Integration of Agent and Activity-Centric Approaches to Process Modeling*, **Santanam, Raghu T.**, Arizona State University, United States; **Jayaraman, Bharat**; **Rao, H. Raghav**

This paper presents an integrative approach to organizational modeling that combines both agent-centric and activity-centric approaches. While the activity-centric approach captures the mechanistic components of a process (including workflow, decision, and information aspects), the agent-centric approach captures the human component (incentive and agency aspects). To illustrate the modeling approach, we present two process examples in an Investment Management scenario: (i) a front-end investment products sales process, which highlights the mechanistic and agency aspects of process modeling; and (ii) a delegated investment process, where the agency aspects and incentives are more important.

TC14 **Transportation II**

Contributed session Venue: AT-8

Chair: **Li, Mingzhe**
Fukuoka University, Japan

1) *A Branch-and-Cut Algorithm for Multi-Depot Vehicle Scheduling Problems*, **Mesquita, Marta**, Inst Superior Agronomia, Portugal; **Paixao, Jose Pinto**

Vehicle Scheduling Problems play an important role in urban mass transit companies. We address the NP-Hard case where a set of timetabled trips has to be operated by vehicles housed at k>=2 different depots. We consider an ILP multicommodity flow based formulation and derive new families of valid inequalities to strengthen the linear relaxation. We show that some of these inequalities are facet-defining for the convex hull of the set of feasible solutions. These results are embedded into a branch-and-cut algorithm which is evaluated by using random generated and real-life problems.

2) *Optimised Vehicle Routing at a Seaport Container Terminal*, **Steenken, Dirk**, GOR, Germany

The paper reports about the logistic and optimisation systems applied at the Burchardkai Container Terminal in Hamburg, which handles 2.2 mio container units a year. The main components of the system are: - a satellite based positioning system to precisely localise containers in the yard - a real time decision system to select optimal stack positions in the yard - online optimisation systems for the routing of the transport vehicles minimising empty ways and waiting times. The optimisation system combines several specific algorithms and lead to a gain in productivity of 45% at the landside operation (truck, railway) and 10% at the quayside.

3) *Some Properties of Radial Principal Roads of an Urban City*, **Li, Mingzhe**, Fukuoka University, Japan

The properties such as the average distance travelled by commuters are very important for urban engineering since they could provide one important measure of the traffic efficiency of an existing city or of a city design. Here, we would like to discuss such interesting properties of radial principal roads with numbers n within an urban area, which are considered as one of quite good description of public transport systems in most cities.

TC15 **Supply Chain Management III**

Invited session Venue: AT-2B

Organizer: **Lee, Hochang**
School of Business, Kyung Hee University, Korea, Korea

Chair: **Zhao, Xiande**
chinese university of hong kong, China

1) *Performance of three inventory policies in a two-echelon supply chain*, **Lau, Ronald S. M.**, HKUST, China; **Zhao, Xiande**

The coordination of logistics and inventory decisions in a supply chain has a fundamental, significant effect on the supply chain performance. Any attempts to reduce the supply chain costs and to improve the service levels must consider the complex interactions across a wide spectrum of business organizations and their individual replenishment decisions. Using a simple simulation model for a two-echelon supply chain, this research attempts to gain a better understanding of the impact of different environmental factors and decision parameters on the supply chain performance.

2) *The impact of information sharing on a three-level supply chain*, **Zhou, Qiang**, CUHK, China; **Zhao, Xiande**

Information flows are as important as product flows among members in a supply chain. Although some studies have examined the impact of information sharing on supply chain performance, most studies have only investigated demand or inventory information sharing in a two level supply chain. This paper is designed to examine the impact of different types of

information sharing in a three level supply chain involving retailers, manufacturers and suppliers. The shared information will include demand, inventory, available capacity, and planned production or transportation information. Using data collected from a manufacturing company, we will build mathematical programming and compute simulation models to examine the performance impact of information sharing on the whole supply chain and different parties. The findings from this study will provide guidelines for practitioners to selectively share information and fully realize the benefit of information sharing.

3) *Managing a supply chain for perishable products- A case study*, **Lam, Kokin** , City University of HK, Division of Commerce, China; **Lau, Ronald S. M.**

Managing a supply chain for perishable products is more difficult and thus requires careful logistical planning and design. This presentation explores the challenges and opportunities of establishing a Floral Distribution Center (FDC) in Hong Kong. The basic premise is that for Hong Kong to have a competitive niche in flower distribution business, any proposed FDC must provide efficient auction processes and logistics supports that are parallel to the ones in the Netherlands and Miami, USA. This research serves to provide relevant information and identify those issues for determining the feasibility of operating a FDC in Hong Kong.

TC16 **Applications of Max-Plus Algebra in OR**

Invited session Venue: WR-11

Organizer: **Seidel, Wilfried**
Universitaet der Bundeswehr , Germany
Organizer: **Heidergott, Bernd**
TU Eindhoven, The Netherlands

Chair: **Heidergott, Bernd**
TU Eindhoven, The Netherlands

1) *Polynomial algorithms for Taylor expansions of Max-Plus systems*, **Jean-Marie, Alain**, LIRMM, France; **Heusch, Michael**

Following Baccelli & Schmidt, several authors have shown that Taylor series expansions of functionals of stochastic (max,+) systems can be computed using a certain family of multivariate polynomials Pk. However, the complexity of algorithms for a numerical evaluation of these polynomials was so far exponential with respect to the number of variables, which limited the range of applicability of the technique. Using a novel characterization of the polynomials Pk, we obtain algorithms of polynomial complexity. We discuss the numerical efficiency of these algorithms, and give some illustrations.

2) *Long-term capacity analysis of tunnels on a railway line*, **De Kort, Antoine Francois**, Ministry of Transport, The Netherlands; **Heidergott, Bernd**; **Ayhan, Hayriye**

We report on a capacity analysis for HSL South, a new high-speed railway line between the Netherlands and Belgium. We examined whether the planned layout of three of its tunnels allows processing of the load of traffic planned for the years 2005-2015. Our analysis shows that this is impossible, that is, additional tunnel tubes are needed. The analysis is a new type of application of the (max,+) semi-ring. Specifically, it is “timetable”—free (to address the long—term nature of the problem) and (max,+) techniques are used to model the constraints imposed by the infrastructure. Furthermore, the model includes stochastic travel times to reflect delays.

3) *Tail Probability of Waiting Times in Max-Plus - Linear Systems*, **Ayhan, Hayriye**, Georgia Instit of Techn, United States; **Seo, Dong-Won**

Max-Plus linear systems can be used to represent a class of queueing networks such as acyclic or cyclic fork-and-join queueing networks, finite or infinite capacity tandem queueing networks with various types of blocking, synchronized queueing networks and so on. We first develop explicit expressions for the tail probability of transient waiting times in Poisson driven (max,+) linear systems. Furthermore, starting with these exact expressions for the tail probability of transient waiting times, we also provide exact expressions for the tail probability of stationary waiting times in a certain class of (max,+) linear systems with deterministic service times. As an application of our results, we consider the problem of maximizing the long run average throughput subject to a probabilistic constraint on stationary waiting times in (max,+) linear systems with deterministic service times.

TC17 **MCDA in Natural Resource Management II**

Invited session Venue: WR-10

Organizer: **Stewart, Theodor J.**
University of Cape Town, South Africa

Chair: **Stewart, Theodor J.**
University of Cape Town, South Africa

1) *Group decision and distributed technical support*, **Norese, Maria Franca**, Politecnico di Torino, Italy; **Toso, Francisco**

A group of forty five decision makers (local authorities and representatives from the communities) worked together for sixteen months, with a facilitator group, to identify criteria which are commonly judged relevant to analyze the consequences of a plant location. Two MC models, one for an incinerator and the other for a waste dump, were elaborated and an ELECTRE method was used to compare sites and rank them, with the aim of selecting the first best sites for which an Environmental Impact Assessment procedure will be activated. A virtual team, from different organizations, supported this work from a technical point of view. This kind of 'distributed support' to a multicriteria decision required actions of coordination and knowledge filtering and interpreting. The presentation proposes an analysis of this decision process, its interesting results and its criticality.

2) *Multi-Objective Optimization by using Generalized DEA*, **Yun, Yeboon**, Kagawa University, Japan; **Arakawa, Masao**; **Ishikawa, Hiroshi**; **Nakayama, Hirotaka**

In multi-objective optimization, there exist many Pareto optimal solutions, which are considered as candidates of decision-making solution. It is an issue how decision makers choose a solution from Pareto optimal solutions. Specially, if the number of objective function is more than three, it is difficult not only to figure Pareto optimal solutions, but also to choose a decision-making solution from them. In this paper, we suggest an aspiration level approach to the GDEA, and show that several Pareto optimal solutions closest to an aspiration level of decision makers can be listed up by the proposed method.

3) *Multiple Criteria Decision Analysis and Organisational Self-assessment*, **Yang, Jian-Bo**, United Kingdom; **Xu, Dong-Ling**

In an increasingly competitive world market, it is essential that organisations regularly monitor where they are doing well, what have stagnated and what needs to be improved. Self-assessment against the EFQM (European Foundation for Quality Management) Excellence Model provides an appropriate performance measurement framework to facilitate such monitoring. The EFQM model has nine main criteria and many sub-criteria. Self-assessment against the EFQM model is in essence a multiple criteria decision analysis (MCDA) problem. In this paper, the authors will discuss the relationship between self-assessment and MCDA, the role of decision modelling in self-assessment, and the features of such MCDM models. Different MCDM models for optional EFQM models will also be discussed.

TC18 **Strategic Choice**

Invited session Venue: WR-9

Organizer: **Franco, L. Alberto**
Kinsgton Business School, United Kingdom

Chair: **Rosenhead, Jonathan**
United Kingdom

1) *New Directions in the Strategic Choice Approach*, **Friend, John Kimball**, University of Lincoln, United Kingdom

In the first part of this presentation, an introduction to the Strategic Choice Approach will be briefly presented. Strategic Choice is an approach to planning based on incremental progress, which recognizes the need to distinguish between decisions that need to be made now, and those that are best left open for future resolution. This is expressed through a 'progress package' that also incorporates a balance between those areas of uncertainty to be tackled now by specific exploratory options (i.e. investigations, consultations or negotiations), and those that should be addressed, if at all, through some form of contingency planning. The second part of this presentation will discuss the potential application of the Strategic Choice in new areas, including the management of international development projects and multi-organizational partnerships.

2) *Use of Strategic Choice-based Processes in Multi-organizational Partnerships*, **Franco, L. Alberto**, Kinsgton Business School, United Kingdom

This presentation will first describe and discuss the development and application of Strategic Choice-based processes for inter-organizational learning in construction partnerships. The approach which was developed has been called the Cross Organizational Learning Approach (COLA). COLA uses Strategic Choice-based workshops to identify and review critical incidents and project successes, in order to generate a limited set of key actions to feed back both to project partners and to future joint projects. The presentation will then describe and discuss the evaluation of the experience as seen by the members of a particular partnership. A number of themes related to the apparent success of COLA as a learning generation tool will be identified.

3) *Use Contexts for Strategic Choice*, **Rosenhead, Jonathan**, United Kingdom

Problem Structuring Methods (PSMs) are a family of methods for decision support that assist groups of diverse composition to agree a problem focus and make commitments to consequential action. This discussion session will concentrate on the Strategic Choice Approach, a PSM that has been mostly applied in multi-organizational contexts. Starting with an examination of the suitability of Strategic Choice for use in inter-organisational contexts, the discussion will then move towards the exploration of the factors that may stand in the way of it being adopted as part of organisations' operating practices.

TC19 **Applications of Discrete Optimization in the Manufacturing and Service Industries**

Invited session Venue: WR-1

Organizer: **Smith, J. Cole**
University of Arizona, United States

Chair: **Villalobos, J. Rene**
Arizona State University, United States

1) *Distribution Strategies for Mexican Plants in a US Market*, **Villalobos, J. Rene**, Arizona State University, United States; **Vega, Benjamin**; **Griffin, Paul M.**

This presentation discusses general distribution strategies for a hypothetical Mexican company with customers in the USA operating under different levels of the North American Free Trade Agreement?s (NAFTA) implementation. The results show that the current restrictions on cross-border cargo shipments and the transportation cost structure for international shipments makes unattractive the use of Mexican distribution centers, despite low labor costs, to serve the U.S. customer base.

2) *Comparison of Information Gained and Additional Search Costs for Three Screening Protocols*, **Griffin, Susan O.**, Centers for Disease Cntrl, United States; **Beltran, Eugenio D.**; **Griffin, Paul M.**; **Heiden, Kathleen**

Tooth decay can be measured at the person, tooth, or tooth surface level. Collecting data at the surface level is difficult and costly but provides information both on cases (proportion

experiencing decay) and severity (number of decayed surfaces). National clinical surveys in the U.S. collect surface data (ALL). States have adopted an alternative protocol - screen until find untreated decay (SEARCH). SEARCH provides information on cases but not severity. Because studies indicate that decay is concentrated in molars, we consider a third protocol – screen molars (MOLAR). Although MOLAR misses cases, it might provide better information on severity than would SEARCH. We use data from NHANES III (permanent dentition, school children, aged 8-17 years) to calculate the incremental search cost (additional screened surfaces) per incremental outcome (additional detection of cases and severity of decay) for the three protocols.

3) *Data Aggregation For Capacity Management in High Mix Production Environments*, **Leon, V. Jorge**, Texas A and M University, United States; **Lee, Yongwoo**

A methodology for data aggregation is developed to support capacity management in a high mix production environment. Individual demand items are represented by a vector of attributes that define the load that each item imposes on the production resources. The methodology attempts to reduce the dimensionality of the problem by: (1) clustering items with similar standard times into a manageable number of groups and ,in turn, (2) applying discriminant analysis to determine significant attributes. Experimental results will be presented to demonstrate the efficacy of the methodology using random generated problems and data extracted from a real scenario in the semiconductor industry.

4) *Design of Serial Assembly Lines Under Labor Turnover* , **Montano, Adrian F.** , Arizona State University, United States; **Mar, Luis**; **Munoz, Luis F.**; **Villalobos, J. Rene**

Labor turnover can be very detrimental to the performance of traditional serial assembly lines. It has been shown that high turnover rates can reduce annual production throughput in serial assembly lines by more than 16% when these lines operate under a balanced work allocation strategy. In this presentation we discuss the benefits of alternative, dynamic-work allocation, production methods such as the Bucket Brigades over traditional lines in an environment subject to high labor turnover rates. In particular we explore the optimal design parameters of lines operating under the concepts of bucket brigade and modified work sharing to better absorb the variability introduced by labor turnover.

TC20 **Reliability I**

Contributed session Venue: WR-2

Chair: **Doyle, E. Kevin**
Bruce Power, Canada

1) *Variance reduction in Monte Carlo evaluation of residual connectedness network reliability*, **Urquhart, Maria E.**, UDELAR - Uruguay, Uruguay; **Cancela, Hector**

Residual connectedness network reliability measures are a natural model for the probability that the surviving parts of a network can communicate, in the event of node failures. Exact evaluation of these measures is a #P-hard problem, so other alternatives like Monte Carlo simulation must be explored. Recursive Variance Reduction is a simulation technique which allows to improve the accuracy of standard Monte Carlo by partitioning the state space of the underlying network into subspaces that are recursively sampled. We show how this technique can be adapted for computing residual connectedness reliability in the case of networks where nodes can fail. We prove that for a given sample size, RVR simulation is more accurate than standard Monte Carlo, leading to better estimates.

2) *Robust Estimation for Systems with Both Markovian Jumping Parameters and Uncertainties*, **Shi, Peng**, Defence Science and Technology Organisation, Australia

The problem of robust estimation for uncertain hybrid systems possessing time-varying norm-bounded parameter uncertainty is studied. One class of hybrid systems under consideration is linear continuous-time systems with sampled-data measurements. Our aim for this kind of systems is to design an estimator, which either provides an optimized guaranteed bound for the error variance irrespective of the uncertainty, or guarantees the induced L2-norm of the operator from the noise signals to the estimation error is to be within a prescribed bound for all admissible uncertainties. Our main attention in this paper is the systems with Markovian jump parameters, which is very appropriate to model plants whose structure is subject to random abrupt changes. A linear matrix inequality approach is proposed for solving the hybrid estimation problem.

3) *Stochastic Maintenance Optimization in the Nuclear Industry*, **Doyle, E. Kevin**, Bruce Power, Canada

The current implementation of Computerized Maintenance Management Systems (CMMS) across the Nuclear Industry will at eventually provide the quality of data needed by stochastic maintenance optimization techniques. Using subjective probability determinations from expert practitioners to demonstrate direct plant feasibility will result in Operational Research spearheading the next phase of industry optimization.

TC21 **Integer programming in telecommunications**

Invited session Venue: WR-3

Organizer: **Myung, Young-Soo**
Dankook University, Korea

Chair: **Wessaely, Roland**
Konrad-Zuse-Zentrum, Germany

1) *Optimality Criteria and Algorithms for the Design of UMTS Networks*, **Schmeink, Michael**, RWTH Aachen, Germany; **Mathar, Rudolf**

We investigate optimal radio coverage and supply in UMTS networks. The method is to select a limited number of base transmitter stations from a pool of candidates in an optimal

way. Since third generation mobile systems are interference limited, we consider the carrier-to-interference ratio both for down and up-link connections. To address environmental sustainability the received power at certain test locations is limited. Some real world solutions for the inner city of Munich are shown.

2) *Optimal design of survivable MPLS networks*, **Wessaely, Roland**, Konrad-Zuse-Zentrum, Germany

In todays data networks, MPLS is getting more and more accepted as the protocol to implement cost-efficient and manageable data networks. We present a mixed-integer programming model for cost optimal design of MPLS networks. In the model, the installation of hardware at the nodes and on the links of the network are incorporated, as well as the routing problem under normal operation and in all single component failures. We present a branch-and-cut algorithm to solve this problem and show the results of computational experiments with realistic data.

3) *Polyhedral methods for IP network optimization*, **Bley, Andreas**, Konrad-Zuse-Zentrum, Germany

The standard routing protocol of the Internet is "Open Shortest Path First", which sends data packets from origin to destination along shortest paths. The shortest paths are computed according to link weights set by the network administrator. In this talk we address the problem of minimizing the maximum link congestion. Given a network with fixed link capacities, our goal is to compute routing weights such that the maximum relative link load induced by the corresponding shortest path routing of some given traffic demands is minimized. We present a mixed-integer linear programming model of the problem and discuss some classes of valid and facet-defining inequalities of the associated polyhedron. Computational results obtained by a cutting plane algorithm based on this formulation are report for several sets of world data.

4) *Lagrange relaxation based heuristics for multi-stage antenna location and configuration*, **Rottembourg, Benoit Daniel**, Bouygues, France; **Chauvet, Fabrice Francois Marie**

Our contribution addresses the multi-stage dimensioning problem of optimizing the evolution of an existing mobile network within a 3 years horizon. Knowing forecasted demand, the problem, starting with an initial mobile network, consists in i) choosing candidate sites where to install new Radio Base Stations and ii) upgrading the equipment on existing Stations. The objective is to minimize upgrade cost with respect to installation constraints and marketing based covering requirements. The size of this integer program (with up to 10 million variables) forbids standard linear solutions and advocate decomposition techniques. We propose a Lagrange relaxation, where each antenna independently solves its own evolution through dynamic programming. In order to improve the quality of the Lagrange heuristics we embed it into a Constraint Programming framework and use generic branching strategies guided by the "reduced costs" deduced from the Bellman values of the antenna configurations.

TC22 **Education**

Contributed session Venue: WR-4

Chair: **Wanrooy, Gerard L.**
Elsevier Science, The Netherlands

1) *Comprehension of an electronic document- what readers do and do not do*, **Protopsaltis, Aristidis**, United Kingdom; **Bouki, Vasilliki**

This study aims to investigate the cognitive aspects of discourse processing in an electronic environment with the use of think-aloud protocols. This study is a pilot study and it is part of a more extensive research. A cognitive model has been proposed to account for reading comprehension in an electronic environment. An experiment has been designed to assess this model. The objectives of the experiment are to study the cognitive processes and the reading strategies that are necessary during the reading of information on the WWW. Eight subjects have taken part in this pilot phase of the experiment. The subjects read the document for as long as they felt confident that could answer questions about it. All subjects answer the same set of questions.

2) *ScienceDirect contents availability functionality*, **Wanrooy, Gerard L.**, Elsevier Science, The Netherlands

ScienceDirect is the world's largest scientific database. This presentation outlines: 1. What ScienceDirect contains 2. Who has access to it 3. What functionality is available

3) *Internet-based OR-Exercises and Assessment*, **Werners, Brigitte**, Ruhr-University Bochum, Germany

Virtual OR/MS is a joint research project to enable interactive learning of Operations Research methods and applications. One main part is the advancement of our Internet-based exercises and assessment program.It is started in 1997 and regularly used as a supplement to our courses. Frequent evaluations have shown that it helps to improve the quality of teaching and education in an university.

TC23 **Decision Analysis IV**

Contributed session Venue: AF-10

Chair: **MacKay, David B.**
Indiana University, United States

1) *Investigating Bias in Subjective Probability Revision*, **McNaught, Ken R.**, Cranfield University, United Kingdom; **O'Brien, Sophie**

We present a comparison of direct subjective probability judgments with probabilities calculated from simpler component subjective estimates, combined via Bayesian revision. The experiment involved the elicitation of conditional probability tables to populate a Bayesian network model supporting a military situation assessment. Subjects participating in the experiment were then asked to make numerous direct probabilistic judgments in the light of various streams of

evidence presented to them. We present the results of our experiment and discuss them in relation to information needs, information gathering and decision support.

2) *Trading off reliability and performance - decision support for product development* , **Bedford, Tim**, Strathclyde University, United Kingdom; **Walls, Lesley**

Various semi-qualitative decision tools are used in product development. Some have arisen in the quality movement, such as Quality Function Deployment (QFD), or are inspired by a cost-analytical approach such as Life cycle costs and Combined Operational Effectiveness and Investment Appraisal (COEIA), while other like multicriteria analysis come directly from decision analysis. These methodologies are frequently seen as competing alternatives. In this talk we use influence diagrams to give a unified framework for these methods to illustrate where the conceptual differences lie, and discuss the steps needed to extend them to full utility-based decision models.

3) *Combining Consumer and Expert Data in Product Design Decisions*, **MacKay, David B.**, Indiana University, United States

Consumer goods designers face the difficult task of combining consumer and expert data. The task is difficult because products are perceived differently by the two groups. Each group may also provide different types of judgments. This paper proposes and evaluates a maximum likelihood procedure for simultaneously evaluating data of different type and precision from consumers and experts. The procedure is shown to be superior to methods where the data sets are modeled sequentially. It is also shown to be superior to methods where data from the expert set are used to "reparameterize" consumer set estimates.

TC24 **Location Analysis III**

Contributed session Venue: AF-13

Chair: **Pelegrin, Blas**
Universidad de Murcia, Spain

1) *Cellular Networks--Base Station Location, Channel Allocation and Emergency Notification*, **Batta, Rajan**, university at buffalo, United States; **Akella, Mohan**; **Rogerson, Peter**

A mixed integer-programming problem is proposed, which integrates into the same model the base station location problem, the frequency channel assignment problem and the emergency notification problem. Properties of the formulation are proposed. The performance of the model is analyzed by extensive numerical tests. Tradeoffs are analyzed in these experiments.

2) *Compact model and bounds for a combined location-routing problem*, **Fernandez, Elena**, Tech Univ Catalonia , Spain; **Albareda-Sambola, Maria**; **Diaz, Juan A.**

We consider a combined Location/Routing problem to find a set of plants to open and a set of routes to service clients so as to minimize the overall costs. We define an auxiliary network and give a compact formulation of the problem in terms of a set of paths in the network with additional constraints. The LP solution to the model is used in a rounding procedure that gives the initial solution for a Tabu Search heuristic. We propose a different lower bound, based on the structure of the problem. Computational results are also presented.

3) *Price Equilibria In Competitive Location Problems*, **Pelegrin, Blas** , Universidad de Murcia, Spain; **Garcia Perez, Maria Dolores**

In this paper we study the existence and determination of price equilibria for some spatial competition models when locations are known. Such equilibria rarely exist in models with a mill price policy, however they can be found when variable prices are considered. It is assumed that each price is lower bounded by a fixed level and demand is inelastic. On a tree network, the locations for which an equilibrium with mill price competition exists are obtained. On a general network in which a variable prices policy is considered, though an equilibrium in prices could not exist, it is shown that a unique e-equilibrium exists whatever the location of the competitors are. Extensions to planar location models are considered. Finally, some conclusions are presented.

TC25 **Mathematical Programming-Combinatoric III**

Contributed session Venue: AF-14

Chair: **Yamada, Takeo**
National Defense Academy, Japan

1) *New Approach to Jobs Sequencing and Allocating*, **Skomorokhov, Riurik Vasilevich**, Bauman Moscow State Techn, Russia

In scheduling job shop production there are two main functions - sequencing and allocating. At the same time, the job shop scheduling problem is devoted to sequencing jobs only, although parallel machines are essential tool for reducing lead time. When we have parallel machines at any operation, we have to combine the functions within manufacturing scheduling. In the most common and difficult case, because of different productivities of some parallel machines, the job shop scheduling problem is multicriteria. For this case we developed new approach and tools for best possible combining the functions and more effective sequencing and allocating jobs.

2) *Some constrained partitioning problems and majorization*, **Flatberg, Truls**, University of Oslo, Norway; **Dahl, Geir**

We consider some constrained partitioning problems for a finite set of objects of different type. We look for partitions that are size- and type-similar, and for a pair of such partitions that are very different. The motivation stems from a problem involving the partitioning of students into smaller groups. The problems

are analyzed and given precise mathematical formulations. The notion of majorization is central to this discussion. A special case of one of the problems leads to an interesting result concerning the packing of matchings in a bipartite graph.

3) *Algorithms to solve the knapsack constrained maximum spanning tree problem*, **Yamada, Takeo**, National Defense Academy, Japan

The maximum spanning tree problem and the knapsack problem are well explored in combinatorial optimization, and algorithms are now available to solve fairly large instances of these problems. In this talk, we consider a combination of these problems, which requires to find the maximum spanning tree under a knapsack-type constraint. Based on Lagrangian relaxation, we introduce an upper bound as well as a lower bound, and develop a branch-and-bound algorithm. The developed algorithm is further accelerated by a novel "shooting method" The algorithm is evaluated through a series of numerical tests.

TC26 Mathematical Programming-Integer IV

Contributed session Venue: AF-18

Chair: **Nygreen, Bjorn**
Norwegian University of Science and Technology, Norway

1) *A Mixed Nonlinear Programming Model for Designing Water Distribution Networks*, **Goncalves, Graca Marques**, CIO-FCUL, FCT-UNL, Portugal; **Pato, Margarida Vaz**

The complexity of this problem has led to the development of solution procedures in which it is partitioned into a hierarchy of subproblems solved one at a time. In attempting to improve the previous results, we have developed a MINLP model tackled through a decomposition-based algorithm. Computational results are reported.

2) *Machine-Based Lagrangian Decomposition for Job Shop Scheduling Problem*, **Imaizumi, Jun**, Toyo University, Japan; **Arai, Tomohiro**; **Morito, Susumu**

Lagrangian heuristics proposed by Luh and others have been successfully applied to job shop scheduling problems to minimize job tardiness. Luh's approach relaxes machine capacity constraints to obtain a relaxation problem decomposable by jobs. A different relaxation approach is possible by relaxing job precedence constraints to obtain a relaxation problem decomposable by machines. This paper compares these two approaches of Lagrangian relaxation from qualitative and quantitative view points. A numerical study shows 1)how lower and upper bounds are updated, 2)how strong is the extent of oscillation of lower bounds, 3)how strong are the final lower/upper bounds after enough computations, among others.

3) *Optimization of routing in oil and gas gathering networks*, **McKinnon, Ken**, Edinburgh University, United Kingdom; **Nygreen, Bjorn**

Networks of pipelines are used to connect oil and gas wells to central production plants where the oil, gas and water are separated. We consider networks where there are alternative routings between the wells and the production plants. The outputs of wells depend nonlinearly on the pressure in the gathering pipelines. We discuss the problem finding the valve setting which maximize the output of the network and show how to model this as a MILP. We describe how to obtain sharp formulations of parts of the problem and present results from some real networks.

TC27 Supply Chain Management VI

Contributed session Venue: AF-19

Chair: **Daskin, Mark**
Northwestern University, United States

1) *Measuring Imputed Costs in the Semiconductor Equipment Supply Chain*, **Cohen, Morris A.**, The Wharton School, United States; **Ho, Teck H.**; **Ren, Justin Z.**; **Terwiesch, Christian**

We consider order fulfillment for customized capital equipment. Prior to receiving a firm purchase order from the customer, suppliers receive a series of shared forecasts. The supplier must decide when to begin order fulfillment; trading off starting too early, leading to holding or cancellation cost, against starting too late, leading to loss of goodwill. We collect detailed data on shared forecasts, orders, and delivery dates for a supplier-buyer dyad in the semiconductor industry. Assuming a rational supplier, we estimate that imputed values for the cancellations costs are much higher than holding costs. Thus suppliers delay commencing order fulfillment, thereby negating the effect of forecast sharing.

2) *Optimising stock distribution for supply chain networks*, **Chiou, Suh-wen**, Tatung University, Taiwan

An optimal stock distribution model is proposed in this paper for one warehouse and multi-retailers in a two-echelon based supply chain network. An EOQ based inventory policy has been adopted at each retailer outlet in which the transportation cost incurred in the distribution network is determined by the resulting network flows. New algorithms for determining the optimal order quantity at each retailer outlet subject to variable transportation cost are presented. Empirical studies are conducted on a variety of distribution networks where the large numbers of retailers are taken into account.

3) *A Multi-Scenario Approach to Integrated Inventory Location Modeling*, **Daskin, Mark**, Northwestern University, United States; **Snyder, Larry**; **Teo, Chung-Piaw**

A multiple scenario model for integrated inventory-location modeling is formulated. Solution of the problem using Lagrangian relaxation is outlined and computational results for problems with up to 150 nodes and 10 scenarios are presented. The proposed method can also be used for multi-product inventory-transportation design problem.

TC28 **Production Scheduling**

Invited session Venue: DH-C

Organizer: **Petrovic, Sanja**
University of Nottingham, United Kingdom

Chair: **Sterna, Malgorzata**
Poznan University of Technology, Poland

1) *A Graphs Approach to a Hierarchical Production Planning Problem*, **Aboun, Nacera**, E N P ALGER, Algeria; **Belmokhtar, Oumhani**; **Hallal, Mohamed Nassim**

A hierarchical production planning system has been defined through a graph model. The size reduction has been achieved by (1) decoupling machine capacity through partitioning the graph and (2) abstracting grouped parts and operations by virtual entities. A two level decision is made on virtual entities and, by disaggregating, on real world entities.

2) *A metaheuristic method for a real FMS*, **Blazewicz, Jacek**, Poznan Uni of Technology, Poland; **Pesch, Erwin**; **Sterna, Malgorzata**

The research concerns a scheduling tool for a flexible manufacturing system located at the Poznan University of Technology. It contains two CNC machines and a measurement centre, three stores and a robot of a linear routing. FMS realises customer orders for a small batches of different products in a one shift manner. The production environment is modelled as an extended mixed shop system, i.e. a job shop with open shop sections, for which a taboo search approach has been proposed to optimise feasible production plans

3) *Scheduling of Surface Mount Technology Lines by Mixed Integer Programming*, **Sawik, Tadeusz**, Univ of Mining and Metall, Poland

A new mathematical programming approach is presented for scheduling of printed wiring board assembly in SMT (Surface Mount Technology) lines. A SMT line consists of several processing stages in series, separated by finite intermediate buffers, where each stage has one or more identical parallel machines.The objective is to determine an assembly schedule for a mix of boards, so as to complete the boards in minimum time. Mixed integer programming formulations are presented for scheduling with machine blocking of various configurations of SMT lines that are found in the electronics industry. The proposed models can be used for optimization of assembly schedules by using commercially available software for discrete programming. Numerical examples are provided to illustrate the proposed approach.

TD1 **Hospital Services I**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Chaussalet, Thierry J.**
University of Westminster, United Kingdom

1) *Conditional Phase-type Distributions for Modelling Patient Length of Stay in Hospital*, **Marshall, Adele**, NO RECORD, ; **McClean, Sally**

The proportion of elderly in the population is continuing to increase putting an added strain on medical resources. In order to effectively manage the care of the elderly, hospitals need to accurately model the length of stay of the patients in hospital. This paper uses conditional phase-type distributions for modelling the patient length of stay of a group of elderly patients in hospital. The model incorporates the use of Bayesian belief networks with Coxian phase-type distributions, a special type of Markov model that describes the duration of stay in hospital as a process consisting of a sequence of latent phases.

2) *OLAP and Simulation for Modelling the Flow of Patients*, **Vasilakis, Christos**, University of Westminster, United Kingdom; **El-Darzi, Elia**; **Millard, Peter H.**

OLAP tools are increasingly becoming the de facto standard in the business world for analytical databases as they are characterised by powerful data browsing functionality and capabilities of creating and executing analytical data models. There is a limited number of attempts to use this information technology technique in an OR environment. In this paper, we discuss the applicability of OLAP for modelling the flow of patients. It is used for estimating the values of the parameters of an established simulation model that models the flow of patients in a hospital department. Furthermore, it is used to analyse the results of the simulation experiments.

3) *Evaluating Intermediate Care Services using Soft and Hard OR techniques*, **Kotiadis, Kathy**, United Kingdom

The Department of Health, Health Authorities and Social Services Departments are investing heavily in Intermediate Care Services. Intermediate care (IC) services for older people are involved in the process of convalescence and rehabilitation. This paper takes a look at a multimethodology of ‘soft’ and ‘hard’ OR techniques to evaluate IC services for older people. It presents a study using a multimethodology comprising of Soft Systems Methodology to understand IC and Discrete-event simulation to model IC services.

4) *Census based bed occupancy planning - a South Australian case study*, **Mackay, Mark Andrew Maio**, University of Adelaide, Australia; **Millard, Peter H.**

Many developed countries, including Australia, are experiencing a rapid ageing of their population. Comparisons using the average length of stay and midday census profiles for hospital bed planning were undertaken for a large metropolitan tertiary hospital in South Australia. Midday was when the greatest numbers of patients were present. Assumptions regarding the mix of services and the age profile of the patients were made. Differences in bed requirements were found to exist. The ability to use census data that reflects the age profile and the busiest time of day should be important for planning resources.

TD2 **Dynamic and Stochastic Fleet Management I**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Regan, Amelia C.**
University of California, Irvine, United States

1) *Revisiting the Probabilistic Traveling Salesman An Examination of New Heuristics*, **Regan, Amelia C.**, University of California, Irvine, United States; **Herrmann, Jiri**; **Lu, Xiangwen**

In this work we examine some new heuristics for the probabilistic traveling salesman problem. First we examine the performance of a class of partition-based heuristics which solve a set of computationally expensive PTSP sub-problems explicitly. Then, we examine the performance of a class of related, but much more efficient, heuristics which mimic the behavior of the heuristics in the first class. While based on theoretical analysis, this work is primarily empirical, relying on simulation analysis.

2) *Analytical Examination Of A Heuristic For The Probabilistic Traveling Salesman Problem*, **Lu, Xiangwen** , University of CA, Irvine, United States; **Regan, Amelia C.**; **Irani, Sandra**; **Herrmann, Jiri**

In this research we examine a heuristic algorithm for the probabilistic traveling salesman problem. In this problem, a set of nodes require a visit with known probability. The problem is to construct the a priori tour with the least expected cost. This tour is followed in such a way that nodes not requiring service are simply skipped. No constant guarantee heuristics for the PTSP are currently known. Our research examines some conditions that would imply the existence of such a heuristic. Further, we develop a quasi-polynomial constant guarantee heuristic for the special case in which all the probabilities are equal.

3) *Real-time coordination in vehicle routing systems*, **Erera, Alan L.**, Georgia Inst of Tech, United States; **Daganzo, Carlos F.**

We consider operating strategies utilizing real-time control for vehicle routing systems in which state information is uncertain when planning. Efficient dynamic control can substantially reduce fleet and operating costs in such systems, even when the number of real-time decisions allowed is small. We discuss analytical methods for design of such systems, including continuous approximation approaches.

TD3 **Intelligent heuristics for vehicle routing**

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Thangiah, Sam**
Slippery Rock University, United States

1) *Multi-terminal backhauling: exact and heuristic approaches*, **Currie, Robert**, University of Birmingham, United Kingdom; **Salhi, Said**

The problem of full load pick up and delivery problem with time windows is investiogated. A 0-1 LP formulation is first given and strenthened and small instances were solved. A hybrid algorithm that chooses dynamically between the the least insertion and the regret rule is put forward. This is enhanced by a constructive post optimiser and tabu search. Encouraging results when compared to Lp relaxation and benchmarks.

2) *A Procedure for Constrained Aircraft Path Planning*, **Nygard, Kendall**, North Dakota State Univ, United States; **Hennebry, Michael**

Military aircraft are free to follow very flexible flight paths, and it is desirable to complete their missions while minimizing exposure to threat. Paths are constrained by fuel. We describe a network optimization procedure that generates multiple paths within corridors at alternative levels of threat exposure. The procedure employs Delaunay triangulations at varied levels of resolution. Computational experience is given.

3) *Multi-Depot VRP with Time Windows: A Distributed Computer Systems Approach*, **Thangiah, Sam**, Slippery Rock University, United States; **Shmygelska, Olena**

Multi-depot VRP with Time Windows involves servicing a set of customers within earliest and latest time windows with vehicles from multiple depots. The objectives of the problem are, first, minimize the total number of trucks and , second, minimize the total distance traveled. The constraint is the capacity of the trucks and servicing the customers within the required time widow. A distributed computer architecture using heuristic algorithms for solving the problem is explained. Comparison and computational experience with traditional heuristic algorithms is presented.

TD4 **Cutting and Packing: Exact Approaches to 1-d Problems**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

1) *Cutting stock within a production planning problem - exact solutions*, **Respicio, Ana**, DI/CIO - Univ. Lisboa, Portugal; **Captivo, Maria Eugenia**

This paper presents a multi-item production planning problem integrating the one-dimensional cutting stock problem. Our integer programming column formulation is tackled using a branch-and-price algorithm. We discuss the column generation subproblem, the branching scheme and the insertion of cutting planes. Computational results are reported. Keywords: Cutting stock problem, production planning, integer programming.

2) *The Coprinting Problem*, **Peeters, Marc**, KULeuven, Belgium; **Degraeve, Zeger**

The Co-printing Problem originates in the printing of tetra-bricks in the beverage industry. Combining different brick types in one printing pattern, consisting of a given number of bricks, reduces inventory. With each brick, some colors are associated. The combined number of colors for the whole pattern cannot exceed a given limit. We derive lower bounds, heuristics, reduction criteria and dominance rules. We use those elements in a branch-and-bound solution procedure. Next we present an Integer Programming formulation for which a branch-and-price procedure is developed. Computational results using real-life data sets illustrates the efficiency of the procedures.

3) *A branch-and-price algorithm for the one-dimensional cutting stock problem*, **Valerio de Carvalho, Jose Manuel**, Universidade do Minho, Portugal

We present a framework to solve exactly one-dimensional cutting stock problems using branch-and-price that is based on the flow decomposition theorem, where flows in networks are decomposed into paths and cycles. We search an integer flow decomposition by using branching strategies that impose constraints on the arc flows. Computational results are presented.

TD6 **Issues in Data Envelopment Analysis II**

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair:

1) *Productive Efficiency and Management Efficiency*, **Feng, Yingjun**, School of Management, China; **Lu, Hui**

In order to make the measure of productive efficiency a better tool for the managerial group of an organization to keep on improving their performance, a combination of Analysis Hierarchy Process (AHP) and Data Envelopment Analysis (DEA) is proposed to assess the management efficiency of an organization. The measure consists of the measurement of both precious and present strength in a generalized sense of an organization by AHP and the assessment of the relative efficiency of its growth in strength of an organization against those of other organizations by DEA. The application of the measure to the assessment of R&D management efficiency at 30 universities in China indicates that the universities with higher management efficiency have improved their strength disregard their precious standing. And the measure is proved to be effective in motivating the managerial group of an organization to keep on improving their performance.

2) *Benchamrking Using Value Efficiency Analysis*, **Korhonen, Pekka**, Helsinki School of Econom, Finland; **Syrjanen, Mikko**

In this paper, we develop an approach for benchmarking. The approach is based on the use of Data Envelopment Analysis (DEA) and its extension - Value Efficiency Analysis. Initially, the DM chooses a set of the units (s)he considers good examples for other units to be evaluated. Each unit will be compared to those benchmarking units. The DM is free to decide during the interactive evaluation process which kind of features (s)he would like to emphasize. The approach can be applied in a group decision problem as well. In this case, the set of the most preferred units of group members are a basis for benchmarking.

TD7 **Project Albert-An International Collaboration**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States

Chair: **Brandstein, Alfred George**
Marine Corps Combat Development Command, United States

1) *Making Modeling and Simulation Useful in Answering Important Military Questions*, **Brandstein, Alfred George**, Marine Corps Combat Development Command, United States

Almost all important military questions, be they about force structure, course of action analysis, strategy or tactics, involve considerations, which are beyond the scope of the modeling and simulation commonly used to support the decision process. Project Albert is an international collaboration where we have developed a class of models, called distillations, that may help delineate the richness of possibilities needed to support decision-makers. We further have developed methods to extract and create information from these distillations. This information, together with traditional methods in operations research is combined to inform the decision-maker through a process we call Operational Synthesis.

2) *Data Farming and Homeland Defense*, **Horne, Gary Edward**, MITRE Corporation, United States; **Friman, Henrik**

Understanding nonlinearity is essential to understanding today's military operational environment, especially with regard to many emerging missions such as humanitarian assistance, peace support operations, and homeland defense. Project Albert is an effort exploring methodologies to help reach this understanding. Data Farming is the Project Albert process for iteratively executing distillation models and using data perceptualization and synthesis techniques to explore the resultant data. As would be expected, the resulting data is of

high dimensionality and often requires massively parallel computers to effectively explore. Here the techniques for Data Farming are described in the context of a homeland defense application.

3) *Project Albert International Workshop Results*, **Bjorkman, Eileen**, US Air Force, United States; **Colton, Trevor**; **Horne, Gary Edward**

Project Albert is question based and as such working groups are formed around mutual questions regardless of the nationality or discipline of the participants. The groups use distillations that allow agents to interact with each other and produce emergent behaviors and data farming to assist in investigating a large possibility space. At a recent international workshop, participants attempted to apply various combinations of Project Albert distillations to address questions in the areas of Control Operations, Force Mix, Precision Maneuver, Mission Area Analysis, and Peace Support Operations. This presentation focuses on the methodology used and the results from the workshop.

TD9 **Software Tools for OR**

Contributed session Venue: MS-3

Chair: **Meyr, Herbert**
University of Augsburg, Germany

1) *The SAS Module for applied OR*, **Olsen, Barbara Biorn**, SAS Institute, Denmark

SAS Institute (Statistical Analysis System) is a multinational company founded in 1976. Among the software packages developed, SAS/OR is specially designed for a variety of OR applications. We account for its versatility in practice and the particularly user-friendly interface. A discussion of recent case studies conclude the talk.

2) *OR Methods in Advanced Planning Systems*, **Meyr, Herbert**, University of Augsburg, Germany

The lack of Enterprise Resources Planning Systems to support planning and the recent progress in communication and information technology promoted the genesis of so-called "Advanced Planning Systems" (APS). These commercial decision support systems ought to optimize and integrate supply chain planning by use of OR methods. However, the interest of APS vendors to reveal these methods seems to be quite low. This paper tries to review - as far as possible - the use of OR methods within APS.

TD10 **Decision Modelling for maintenance and repair**

Invited session Venue: MS-4

Organizer: **Scarf, Philip**
University of Salford, United Kingdom
Organizer: **Hartman, Joseph C.**
Lehigh University, United States

Chair: **Scarf, Philip**
University of Salford, United Kingdom

1) *Monitoring and Maintenance Of Spares And One Shot Devices*, **Newby, Martin**, City University, United Kingdom

Components or subsystems are kept in store and are called out by orders from manufacturers of complete systems or end users. Limited imperfect non-destructive testing can be carried out and can give false positives and false negatives. Levels of reliability of individual components and the optimal inspection regime for required levels of reliability in the delivered components are determined. A general model is formulated to allow for various inspection policies and errors in diagnosis. The model highlights the need to distinguish between the reliability of individual items and of the stock as a whole.

2) *Optimal Asset Life Estimation Of Major Equipment*, **Ansell, Jake**, University of Edinburgh, United Kingdom; **Archibald, Thomas W.**; **Thomas, Lyn C.**

The costs associated with maintenance, repair and replacement of major equipment can be measured in £bn. Therefore the need for optimal strategies are crucial. Unfortunately the modelling is rarely sufficiently sophisticated to reflect the diversity of the plants involved. A methodology is developed for incorporating plant specific information to find optimal solutions. It uses Lawless and Nadeau amendment to Cox regression employing kernel smoothing. The optimal solutions have been found by using a discrete time standard stochastic dynamic programming formulation based on Kijima's virtual age model. Illustration of the approach is based on the UK Water Industry.

3) *Assessing the effectiveness of Condition Based Maintenance Techniques*, **Black, Mary**, University of Salford, United Kingdom; **Brint, Andrew Timothy**; **Brailsford, John**

CBM is viewed by the Utilities as the future for network Asset Management. However available data sets are poor as item condition histories are not present. This leads to uncertainty when choosing a CBM policy. This paper looks at the solution quality of different CBM approaches on these data sets.

TD11 **Metaheuristics For Boolean And Continuous Optimization**

Invited session Venue: MS-5

Organizer: **Glover, Fred**
United States
Organizer: **Lokketangen, Arne**
Molde College, Norway
Organizer: **Nath, Baikunth**
Australia

Organizer: **Woodruff, David L.**
UC Davis, United States

Chair: **Siarry, Patrick**
Universite Paris 12, Laboratoire LERISS, France
Chair: **Voss, Stefan**
University of Technology Braunschweig, Germany

1) *Tabu search based on the Nelder-Mead simplex method for nonlinear continuous optimisation*, **Pedroso, Joao Pedro**, LIACC and DCC-FCUP, Portugal

We propose a meta-heuristic for non-linear programming, based on tabu search and on the Nelder and Mead simplex algorithm. The algorithm is extended for being suitable for both unconstrained and constrained optimisation. We explore several possibilities for escaping local optima, based on non-improving moves which are executed when a local optimum is detected. As in tabu-search, in that situation the best non-improving move is chosen; after that, improving moves become tabu as long as the simplex method would drive the current solution to the previous local optimum.

2) *Surrogate Constraint Guidance for Boolean Optimization Problems*, **Hvattum, Lars Magnus**, Molde College, Norway; **Lokketangen, Arne**; **Glover, Fred**

We describe local search heuristics for the Boolean Optimization Problem with search guidance based on the use of Surrogate Constraints. More specifically we look at how adaptive memory and surrogate constraint processes can be used as guidance for both constructive and local search heuristics for these types of problems. We also show the benefit of having an adaptive move guidance function balancing the tradeoff between having focus on attaining feasibility and obtaining a good objective function value. Extensive computational tests are reported, showing favourable results.

3) *Hybrid Heuristic-Stochastic Method For Continuous Optimization*, **Sakalauskas, Leonidas**, Inst of Math Informatics , Lithuania

We develop the method for continuous optimization following to a scheme of genetic algorithms, when populations are generated by stochastic way. Let consider for example the standard error function (EF)of Neural Network learning see S.Raudys (2001). Statistical and Neural Classifiers: An integrated approach to design). Let the initial population of size N from individuals with weights be generated and sampling estimates be introduced. Next populations are generated following from the probability distribution using these estimates from the previous population. We prove conditions when the process of population evolution converges, appropriately changing the population size and variance. The rate of convergence is studied generating populations by stochastic way and comparing that with genetic coding. Thus, the approach considered enables us to study some genetic algorithms from the point of quasi-stochastic optimization methods.

TD12 **Panel Discussion: OR in development**

Invited session Venue: AT-6

Organizer: **Bandyopadhyay, Rangalal**
Centre for Applied Systems Analysis in Development, India

Chair: **Bandyopadhyay, Rangalal**
Centre for Applied Systems Analysis in Development, India

1) *Panel Discussion: OR in Development*, **Bandyopadhyay, Rangalal**, Centre for Applied Systems Analysis in Development, India

The chair of the panel explains his thoughts on the objectives of this integrative discussion, before introducing the members of the panel. Then he invites each member of the panel to speak in turn, so that each can introduce some points of discussion before the general discussion starts. Finally, the chair of the panel opens up the discussion to other participants.

TD13 **Environmental Management II**

Contributed session Venue: AT-7

Chair: **Folkmann, Michael**
DIKU, Univ. of Copenhagen, Denmark

1) *Computer Modeling Municipal Solid Waste (MSW) Transit Time Using Monte Carlo Simulation*, **Bieda, Boguslaw**, Poland; **Wajs, Wieslaw**

Modeling the transit time contaminants in porous media is a very usefull tool for estimating the life-cycle assessment of a modern municipal solid waste landfill. The transport of contaminants in a soil is represented by the one-dimentional form of the advection-dispersion equation.The computer program CONTRANS written in MATLAB has been used for calculation of transit time to estimate the thickness of compacted clay liner of a landfill. This paper employs probabilistic model with inputs parameters based on the values determined using Monte Carlo Simulation. A sensivity analysis was performed using Crystal Ball®, a forecasting program, to determine the relative influence of the basic parameters from the advection-dispersion equation for reactive solute transport in saturated soil of a landfill. Data for the model came from few landfilds from Krakow region in Poland.

2) *Set Cover models applied to wildlife conservation in Africa*, **Folkmann, Michael**, DIKU, Univ. of Copenhagen, Denmark

Area selection within wildlife conservation is traditionally based on heuristics of varying quality. For a specific wildlife conservation project in Africa we have in cooperation with Zoological Museum University of Copenhagen and Cambridge University found exact solutions to a series of large-scale instances of SET COVER. The model is at present extended to accommodate additional constraints (ecoregions, budget, manpower). Computational experience is reported and suggestions for further research are provided.

TD14 **Transportation III**

Contributed session Venue: AT-8

Chair: **Koshizuka, Takeshi**
University of Tsukuba, Japan

1) *Developing a system for sea transport between Norway and Europe*, **Ulstein, Nina Linn**, Norway; **Nygreen, Bjorn**

A number of Norwegian companies collaborate to create a common shipping service between Norway and Europe. The aim is to reduce costs and lead-times by combining loads and using new ship technology. This requires the possible construction of 5-8 new Ro-Ro ships, with investments of about 1.5 MNOK. Construction of the fleet and possible routes, as well as pricing and regulations for the collaboration project are considered. This multi-trip vehicle routing problem with pickup and delivery and time windows is solved to give some guidance to the collaboration.

2) *A Study of Yield Management Problem for Repositioning Empty Containers*, **Leung, Stephen C. H.**, City University of HK, China; **Lai, K. K.**

Yield management in maritime transportation operations concerns about the reposition of empty container due to the imbalance of international trading resulting in imbalance in supply and demand patterns of empty containers. In this paper, we will first identify the parameters which affect the current operations in allocating and routing empty containers. Then we examine several yield management policies under different criteria and parameters. Data from one of the largest shipping companies in Hong Kong are used in a case study.

3) *Distance distribution in an arbitrary region and its application to the daily trip in Tokyo*, **Koshizuka, Takeshi**, University of Tsukuba, Japan

In the present paper, we discuss the measure of the point pairs whose distance are less than a distance r in a given area. By differentiating this measure with respect to r, we get the function $f(r)$ which is called by distance distribution. Using a formula in Integral Geometry, we calculate the distance distribution numerically in an arbitrary region such as governmental districts. Therefore we estimate the distance distribution for the daily trip in Tokyo to compare this with the ordinary method which is measured by center points of districts.

TD15 **Queuing Theory and Applications I**

Contributed session Venue: AT-2B

Chair: **Griffiths, Jeff**
Cardiff University, United Kingdom

1) *Threshold Start-up Control Policy for Polling Systems with Batch Arrivals.*, **Thomo, Lida**, University Of Macedonia, Greece

In this paper we study a non-symetric polling system that is being served exhaustively by a single server. After the system becomes empty, the server restarts the service only if there have arrived N customers. It is assumed that the arrivals at the stations are generated by compound Poisson processes. We find the mean waiting time of a customer as function of the threshold number N of customers, that should arrive at the system before the service restarts.

2) *Optimization of Real-Time Multiserver System with Several Different Channels*, **Ianovsky, Eduard**, Ben-Gurion University, Israel; **Kreimer, Joseph**

Optimality conditions for real-time multiserver system with large number of identical servers (e.g. machine controllers or unmanned air vehicles) and several different channels (e.g. assembly lines or surveillance regions) working under maximal load regime are presented. Real-time system is characterized by its timely response to external stimuli. Jobs are executed immediately upon arrival, conditional on system availability. That part of the job which is not processed in real time upon arrival is lost forever (storage of non-completed job is impossible). Queueing of jobs is forbidden. Limiting values of system availability and its loss penalty function as well as optimal assignment probabilities are obtained.

3) *Time-Dependent Queue Lengths at Bulk-Service Queueing Systems*, **Griffiths, Jeff**, Cardiff University, United Kingdom; **Williams, Janet**; **Salmon, Rachael**

A simple exact formula for the time-dependent queue length at a batch-service queueing system of the type M/M(0,N)/1 is presented in terms of its Laplace Transform. This transform is inverted to provide a very close approximation for the queue length for all values of the traffic intensity. Reference will be made to important applications in traffic management, lift (elevator) provision, etc.

TD16 **Network Calculus**

Invited session Venue: WR-11

Organizer: **Seidel, Wilfried**
Universitaet der Bundeswehr , Germany
Organizer: **Heidergott, Bernd**
TU Eindhoven, The Netherlands

Chair: **Thiran, Patrick**
EPFL, Switzerland

1) *Numerical Evaluation of Max-Plus - linear Stochastic Systems*, **Heidergott, Bernd**, TU Eindhoven, The Netherlands

We present a scheme for evaluating finite horizon performance characteristics of (max,+)-linear systems. Our approach is based on a MacLaurin series expansion of the performance characteristic with respect to an artificial parameter presenting

the level of stochasticity of the system. We will illustrate our approach with numerical values for the waiting time in a G/G/1 queue.

2) *On Probabilistic Network Calculus*, **Vojnovic, Milan**, EPFL, Switzerland; **Le Boudec, Jean-Yves**

Deterministic Network Calculus provides an elegant way to compute performance bounds, e.g. bounds on backlog, delay-jitter, loss ratio, and like. Such bounds are deterministic worst-case bounds. In some cases it is practically sensible that individual flows, which share a network element, are supposed statistically independent. In this case, the results of deterministic Network Calculus would yield very conservative bounds on the actual performance. In our work we show some results of Probabilistic Network Calculus that gives bounds that hold in probability, but while accounting for statistical independence, yield tighter estimate of the performance.

3) *Some results of deterministic network calculus applied to communication networks*, **Thiran, Patrick**, EPFL, Switzerland; **Le Boudec, Jean-Yves**

Network Calculus is a set of recent developments, based on min-plus and max-plus algebra, which provide a deep insight into flow problems encountered in networking. In this talk, we review a few of these problems (such as the greedy shaper, the window flow controller, the optimal multmedia shaper, the packetizer, the lossy node) and we show how the residuation theorem can be successfully applied in a quite straightforward manner to obtain important results in the context of computer networks.

TD17 **Internet Optimization Services**

Invited session Venue: WR-10

Chair: **Fourer, Robert**
Northwestern University, United States

1) *Interactions between Modeling Languages and Internet Optimization Services*, **Fourer, Robert**, Northwestern University, United States; **Dolan, Elizabeth**; **More, Jorge**; **Munson, Todd**

Modeling languages are a key factor in the popularity of online optimization servers, particularly for experimentation, benchmarking, and prototyping. Conversely, the availability of solver services via the Internet may be starting to have an effect on how modeling languages and their supporting environments are designed and implemented. Using our experience with the NEOS Server as an example, we describe a number of current interactions between modeling languages and Internet optimization services, and make some predictions concerning future developments.

2) *Optimisation Service Provider (OSP): An on-line platform for optimisation based decision support*, **Koutsoukis, Nikitas Spiros**, Dr, United Kingdom; **Kyriakis, Triphonas**; **Mitra, Gautam**

The OSP project aims to provide practitioners access to optimisation software tools, and optimisation based vertical solutions in four sectors: finance, supply chain, energy and utilities, agriculture and environment. We use the Internet as a platform and adopt the ASP model to develop an OSP for both analysts and end-users.

3) *Approaches to Embedding Optimization* , **Saigal, Sanjay**, ILOG, United States

The classical "matrix generation" approach to engineering optimization-based software has been supplanted with newer methods promising better browser integration and faster time to market. These methods are based on Microsoft's COM paradigm and its primary rival - the Java-based approach advocated by Sun and other vendors. Another software trend on the horizon relates to Web Services and Microsoft's .NET strategy. We describe the impact of these new technologies on modeling tools and optimizers from ILOG and other vendors.

TD18 **Workshop on acquiring the skills of soft OR**

Invited session Venue: WR-9

Chair: **Westcombe, Mark**
Lancaster University, United Kingdom

1) *Workshop on acquiring the skills of soft OR*, **Westcombe, Mark**, Lancaster University, United Kingdom; **Conklin, Jeff**

Younger members of the soft OR community are invited to this network meeting organised by the Modelling Strategic Problems Group. The workshop will involve an open discussion facilitated by Jeff Conklin of CogNexus Institute, Washington DC. Soft OR approaches such as SSM, cognitive mapping and strategic choice are increasing popular amongst OR analysts. The skills involved as a process consultant or facilitator using these approaches are often difficult to acquire, or even to understand. This session will provide a forum to discuss the issues involved in developing these skills and an opportunity to exchange ideas and experience. The session will introduce and make use of the Dialog Mapping methodology to demonstrate some of the skills involved in facilitating decision making. The aim of the Modelling Strategic Problems Group is to establish a network of members that will be employing soft OR methods over the next generation. Visit: http://www.lancs.ac.uk/users/incism/

TD19 **Discrete Optimization**

Invited session Venue: WR-1

Organizer: **Smith, J. Cole**
University of Arizona, United States

Chair: **Sherali, Hanif D.**
Virginia Tech, United States

1) *Strong valid inequalities for the single-constraint mixed-integer set*, **Atamturk, Alper**, University of California, United States

Mixed-integer rounding cuts from single-constraint mixed-integer set relaxations of MIP have been shown to be very effective in solving general MIP problems recently. In this talk, we present several classes of facet-defining inequalities for the single-constraint mixed-integer set. We show their connections with the mixed-integer rounding inequalities.

2) *Novel Approaches for Solving the Maximum Clique Problem*, **Pardalos, Panos M.**, University of Florida, United States

We consider several continuous global optimization approaches for solving the maximum clique problem on general graphs. Computational results for solving a variety of maximum clique problems will be reported.

3) *Valid Facetial Inequalities for a Generalized Vertex Packing Problem*, **Smith, J. Cole**, University of Arizona, United States; **Sherali, Hanif D.**

The traditional vertex packing problem on an undirected graph identifies the largest weighted independent set of nodes, where an independent set is defined as a set of nodes whose induced subgraph contains no edges. In this talk, we examine a generalized vertex packing problem (GVP) in which one violation to the independent set restriction is permitted, i.e., one edge may exist within the subgraph induced by the chosen set of nodes. We provide a characterization of facetial valid inequalities for this class of generalized vertex packing problem, and identify polynomial-sized convex hull representations for certain specially structured subgraphs.

TD20 **Reliability II**

Contributed session Venue: WR-2

Chair: **Ozekici, Suleyman**
Koc University, Turkey

1) *Reliability Enhancement Modelling - Feedback from Use*, **Walls, Lesley**, Strathclyde University, United Kingdom; **John, Quigley**; **Hodge, Russell**; **Marshall, Jane**

A statistical model has been developed to aid decisions about reliability throughout product design. A formal evaluation process has captured views of relevant engineers, managers and analysts during implementation within an avionics product development process. The findings of the evaluation provide insight into the perceived usefulness of the data collection, analysis and results provided by the model. Elicitation procedures for engineering judgement provide insight into potential failure modes and a prior distibution for input to the model. Rules for filtering relevant complex service data for related products have been developed. Interpretation of key reliability indicators remains challenging.

2) *A Markov decision model for a multi-queue single-server system*, **Rodrigues, Rita de Cassia Meneses**, INPE, Brazil; **Carvalho, Solon Venancio**

A queueing system with one server, M parallel and independent queues, and finite capacity is considered. Customers arrive in each queue according to a Poisson process, and the service times have general distribution. It is assumed that each queue has a setup time with general distribution. The server must decide whether to remain serving the current queue or begin serving the immediately next one, without knowing the number of customers in each queue. This system is modeled as a semi-Markov decision process with partial information. The objective is to minimize the system's long-run expected average cost (holding plus rejection costs).

3) *Reliability of Software with an Operational Profile*, **Ozekici, Suleyman**, Koc University, Turkey; **Soyer, Refik**

We discuss stochastic and statistical issues to model software reliability in the presence of an operational profile. The software system is used under a randomly changing operational process so that the failure characteristics depend on the specific operation performed. The operational process describes, in a probabilistic sense, how the software is utilized by the users. Failures occur exponentially with a rate that depends on the operation. As soon as a failure is experienced, the fault that caused the fault is removed immediately with certainty. We discuss several issues related to software reliability and statistical inference.

TD21 **Network Design I**

Invited session Venue: WR-3

Organizer: **Myung, Young-Soo**
Dankook University, Korea

Chair: **Gouveia, Luis**
DEIO-CIO Univ. of Lisbon, Portugal

1) *Logical and physical design issues for "1+1" protection network planning*, **Voss, Stefan**, University of Technology Braunschweig, Germany; **Hoeller, Holger**; **Fricke, Matthias**

Large telecommunication networks can be operated only if they have a clear structure. To achieve this the network is divided into certain regions with a high-bandwidth backbone to connect them. The backbone is divided into two separate networks to enhance survivability. We address the problem of designing such a structure for a fibre-optical SDH-network consisting of some thousands of nodes. Considering the requirement for 1+1 path protection, this leads to a two-connected network design problem. Additionally, WDM-technology is examined. Heuristic algorithms for these problems are described and evaluated using test data and real data from an existing telecommunications network in Germany.

2) *On the Diameter Constrained Minimum Spanning Tree Problem*, **Gouveia, Luis** , DEIO-CIO Univ. of Lisbon, Portugal; **Magnanti, Thomas**; **Requejo, Cristina**

The Diameter constrained spanning tree problem seeks a least cost spanning tree subject to a bound imposed on the number of edges in the tree between any node pair. We compare several modelling approaches for solving the case when the diameter parameter is odd, which seems to be harder to solve than the case with D even. These approaches are based on different and equivalent properties of a tree which had diameter no more than an odd integer number D.

3) *An algorithm for the graph disconnectivity problem*, **Myung, Young-Soo**, Dankook University, Korea

We consider the graph disconnectivity problem, which is to find a set of edges such that the total cost of removing the edges is no more than a prespecified budget and the weight of nodes disconnected from a designated source by removing the edges is maximized. The problem is known to be NP-hard. We present an integer programming formulation for the problem and develop an algorithm that includes a preprocessing procedure for reducing the problem size, a heuristic for providing a lower bound, and a cutting plane algorithm for obtaining an upper bound.

TD22 **Decision Support Systems I**

Contributed session Venue: WR-4

Chair: **Martinez, Elena**
Universidad Complutense, Spain

1) *A General Framework for Controlling Time Constrained NPD Projects*, **Dragut, Andreea Bogdana**, Eindhoven U of Technology, The Netherlands; **Bertrand, J. W. M.**

Until recently the modelling and analysis research of new product development (NPD) assumed an early partial or complete product definition of the new product. We introduce a general framework that supports the dynamic achievement of the new product definition, taking into account not only a highly dynamic market situation, but also a high technological uncertainty that affects both the number and the content of the design tasks involved in the NPD. In the framework decisions on the dynamic adaptation of the performance specification of the design tasks are combined with the dynamic allocation of design tasks to engineers.

2) *Expert Systems To Aid University Students With Decision Making Processes*, **Martinez, Elena**, Universidad Complutense, Spain; **Redondo, Raquel**; **Rua, Antonio**

This work is devoted to describe an expert system that is being specifically designed for university students to help them with Decision Making Processes. This expert system will allow to simulate a real problem, to give the possibility of solving problems that require high degree of knowledge to little specialised individuals, as well as to avoid all monotonous operative necessary to solve a problem, that, normally, leads the students to give up and not to find the solution. This expert system is integrated by different subsystems that are also described in this paper.

3) *Learning by doing: pairwise comparisons and the consistency of the decision-maker*, **Temesi, Jozsef**, Budapest Univ of Econ , Hungary

Various formulas have been suggested to measure the consistency of the decision-maker (DM) in the methods using pairwise comparison in order to determine the weights of criteria in MADM problems, eg. in Saaty, Th. (1980): The Analytic Hierarchy Process, McGraw Hill and in Gass, S.I.-Rapcsák, T.(1998): On synthesizing group decisions, Decision Support Systems, 22, 59-63. This paper applies those measures in a learning process of improving the DM's consistency, where the DM is allowed to change some of his/her pairwise comparisons in a systematic way.

TD23 **Decision Analysis V**

Contributed session Venue: AF-10

Chair: **Yang, Jian-Bo**
United Kingdom

1) *Practical ways to deal with incomparability and compensation within Multi-attribute value theory*, **Belton, Valerie**, University of Strathclyde, United Kingdom; **Pictet, Jacques**

The notions of acceptable compensation and incomparability are central to multicriteria decision analysis and are well elaborated in the context of outranking methods. However, within the framework of multi-attribute value theory they are not formally considered, although skilled facilitators may informally take account of them in applications. In this paper we consider the significance of these concepts within the MAVT framework and propose practical mechanisms to alert the analyst to situations which may merit further consideration.

2) *Bayesian Learning Procedure for a Partailly Observable Markov Process and its applications*, **Nakai, Toru**, Japan

This paper deals with Bayesian learning procedure for a partially observable Markov process and its applications to sequential decision problems. For this purpose, we consider an inequality called generalized multivariate total positivity of order two, which also has an order preserving property concerning the expectation of non-decreasing functions. We treat a Bayesian learning procedure under several assumptions. All informations about the unknown state are summarized by probability measures on the state space, and an order is denoted by using this inequality. There exist some relationships between prior and posterior information, and we obtain a property used to analyze the sequential decision problems. Finally, we consider some applications.

3) *The Intelligent Decision System and Its Applications in Supplier Assessment*, **Xu, Ling**, UMIST, United Kingdom; **Yang, Jian-Bo**

Supplier assessment is an important step in supply chain management and can be modelled as a multiple attribute assessment problem of both a quantitative and qualitative nature. This paper will demonstrate how Intelligent Decision System (IDS), a decision support tool, handles different types of information (qualitative, quantitative, random, deterministic and some missing data) in supplier assessment. It also illustrate how IDS provides not only average scores and ranking, but also distributed results of suppliers so that the diversity of a supplier's performance will also be revealed.

TD26 **Mathematical Programming-Integer V**

Contributed session Venue: AF-18

Chair: **Jensson, Pall**
University of Iceland, Iceland

1) *Optimum Covering of Plane Domains by Circles Via Hyperbolic Smoothing Method - Computational Results*, **Xavier, Adilson Elias**, Rio de Janeiro Fed Univ, Brazil; **Oliveira, Antonio A. Fernandes**

This paper considers the optimum covering of plane domains by a predetermined number of circles problem. The mathematical modeling of that problem leads to a min-max-min problem which, in addition to its intrinsic multi-level nature, has the significant characteristic of being non-differentiable. In order to overcome these difficulties, we have developed a smoothing strategy, called Hyperbolic Smoothing, using a special infinitum differentiable smoothing function. The final solution is obtained by solving a sequence of differentiable subproblems which gradually approaches the original problem. A simplified algorithm, containing only the essentialities of the method, is presented. For purposes of illustrating the potentialities of the method, computational results for a set of big problems are presented. Keywords: Localization Problems, Min-Max-Min Problem, Nondifferentiable Programming, Smoothing

2) *Quick Heuristics to Schedule Operations in Robotized Cloth Cutting*, **Romanin-Jacur, Giorgio**, University of Padova, Italy; **Filippi, Carlo**

A special machine cutting figures and collecting them from a moving cloth roll is considered. Every cloth piece sequentially crosses the working areas of six identical cutting robots and three further robots collecting figures of different sizes. A feasible schedule states the operation sequence for every robot, so that each figure is allocated to one cutting robot and one collecting robot respecting its own "visibility" time windows. The problem consists in obtaining in a few seconds a feasible schedule maximizing a linear function of robot slack times. We propose quick heuristics which evidenced good effectiveness in actual instances.

3) *Optimization of production planning in fish farming*, **Jensson, Pall**, University of Iceland, Iceland; **Gunn, Eldon A.**

In this paper two size structured optimization models for production planning in a salmon farm are presented. A Markov model approach is used to represent the evolution of the size distributions in each pen. The first model is a Linear Programming model for analyzing long-term production strategy. In the second model integer variables assure that harvesting schedules are in accordance with the harvest selection practice of the company in question. The Mixed Integer Programming model proposed can be used for short term scheduling of partial or full harvesting from individual pens.

TD27 **Supply Chain Management VII**

Contributed session Venue: AF-19

Chair: **Kiesmueller, Gudrun**
The Netherlands

1) *Analysis of supply network structures*, **Fiala, Petr**, University of Economics, Czech Republic

A supply network is defined as a network of organizations that are involved, through linkages, in the different processes and activities that produce value in the form of product and services in the hands of the ultimate customer. In our model we assume a structure of network systems with sets of potential suppliers, producers, distributors, customers etc. The sets are interconnected by physical, financial, information and decisional flows. The analysis and design of the network supply systems has been an active area of research. There are some possibilities to design some centralised or decentralised structures of the systems with different performance measures. The Analytic Network Process (ANP) is the method that makes it possible to deal systematically with all kinds of dependence and feedback in the system. The ANP approach seems to be an appropriate method for performance measuring of supply networks.

2) *An analytical solution to availability in supply chains*, **Dejonckheere, Jeroen**, GE Control Systems , Belgium; **Disney, Stephen**; **Farasyn, Ingrid**; **Janssen, Freek**; **Lambrecht, Marc**; **Towill, Denis**; **Van de Velde, Wim**

Using a z-transform model of a generic production and inventory control system, this paper discusses analytical solutions to the production and inventory control problem. In particular, availability functions are studied using closed form expressions for bullwhip and inventory variance when demand is an independently and identically distributed normal distribution. These expressions allow for analytical determination of a comprehensive range of customer service measures directly from the system model without recourse to simulation. These mathematical models, utilising z-transforms and statistics, enable a fundamental understanding of production and inventory control systems significantly beyond existing published analyses.

3) *Dynamic Product Acquisition in Closed Loop Supply Chains*, **Minner, Stefan**, University of Magdeburg, Germany; **Kiesmueller, Gudrun**

We consider a closed loop supply chain where demands can either be satisfied from manufacturing new products or by buying back used products from customers and upgrading their

functionality by remanufacturing. Product life cycles and seasonal aspects are modelled within a continuous time framework. The manufacturing and remanufacturing policies as well as the best buy back strategy for used products are determined by an optimal control approach.

TD28 **Timetabling**

Invited session Venue: DH-C

Organizer: **Petrovic, Sanja**
University of Nottingham, United Kingdom

Chair: **Daskalaki, Sophia**
University of Patras, Greece

1) *Efficient Solutions for the University Timetabling Problem through Integer Programming*, **Daskalaki, Sophia**, University of Patras, Greece; **Birbas, Theodore**

The University Timetabling problem is modelled using a 0-1 Integer Programming approach and is solved for each individual department. All hard constraints in a timetable construction process are modelled as constraints of the IP model, while soft constrainst are approached through suitable cost coefficients for the objective function. In this paper several approaches for selecting cost coefficients are examined along with their impact in the resulting optimal solution.

2) *Cricket World Cup - Optimal scheduling of matches and ticket sales*, **Fatti, Libero Paul**, Univ of the Witwatersrand, South Africa

The 2003 World Cricket Cup will be held in South Africa. The talk will discuss the formulation and solution of the problem of scheduling the 42 first-round matches to the 24 days allocated for them. The problem of allocating tickets to different "packages" in order to maximise ticket sales and ensure that the less popular matches and venues do have sufficient audiences, will also be discussed.

3) *Mixed Level Models for Employee Timetabling*, **Chan, Peter**, University Joseph Fourier, France; **Joseph, Rémy-Robert**; **Fallet, Valentine**; **Weil, Georges**

We propose an object-oriented model that combine features from 2 or more levels of detail, incorporating demons that propagate changes from one level to another. This model can be used in different types of solvers such that heuristics can be built that see and handle constraints at several levels.

RA1 **Health Services: Strategic Planning**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Gallivan, Steve**
University College London, United Kingdom

1) *The Use of Problem Structuring Methods in Strategic Health Planning*, **Thunhurst, Colin Peter**, University College Cork, Ireland

Problem structuring methods have emerged as a powerful weapon in the armoury of operational research over the past twenty years. This paper will present and discuss the value of adopting formal problem structuring methods as part of the strategic health planning process. It will draw upon the author's recent experience of assisting the Government of the North West Frontier Province of Pakistan to develop a 'Master' Health Plan for the Federally Administered Tribal Areas of Pakistan. It will consider the value of adopting similar methods in developed health systems.

2) *Agreeing a strategy for the delivery of children's health services*, **Cushman, Mike**, United Kingdom; **Rosenhead, Jonathan**

There was a broad measure of convergence among health care professionals in a central London Health Authority that a new strategy for children's health care provision was necessary. It was agreed that changes and trends in patterns of care delivery and specialist staffing required a reduction in the number of inpatient units, the introduction of ambulatory care units, and an extension of community based provision. The aim of the engagement reported here was to convert this 'in principle' agreement into a specific consensual proposal on the content of services, the scale of rationalisation and expansion, and locations. The Strategic Choice Approach was used in a series of workshops with representatives of all stakeholders, supported by detailed investigations between workshops with a core group. This process is analysed in terms of the role of the management of ambiguity and specificity in negotiating potentially contentious issues.

3) *Monitoring Health Care Performance by Analytical Hierarchy Processing* , **Ahsan, M. Kamrul**, Japan; **Bartlema, Jan**

The purpose of this study is to monitor performance of health care systems pertinent to strategic planning or project evaluation. We consider a phase of the Delphi method and of the Analytical Hierarchy Processing (AHP) approach. Necessary data was collected from a EU funded government health care project of Bangladesh. We develop guidelines to analyse the performance of different health care activities of a Thana Health Complex (THC) and multi-criteria performance evaluation of ongoing activities between THC□fs. Results from AHP are discussed for implementation in decision-making and managerial policymaking process, towards improvement of overall health-care performance

RA2 **Dynamic and Stochastic Fleet Management II**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Regan, Amelia C.**
University of California, Irvine, United States

1) *Fleet Management and Freight Exchanges*, **Crainic, Teodor Gabriel**, Dept. management et technologie, UQAM and CRT, Ude, Canada; **Chang, Tsung-Sheng**; **Gendreau, Michel**; **Powell, Warren B.**

Access to electronic markets may greatly contribute to enhance a carrier's productivity and profitability, if done right. Intelligent advisors may prove the critical factor to achieve these goals. We discuss a number of important design issues, including: relations between advisors and the company's procedures, participation to several, possibly diverse, markets simultaneously, combinatorial bidding. We describe one class of advisors for container or full load carriers that is tightly coupled to the carrier's planning system. The ``planning'' component of the advisor determines what bids are interesting and initial prices. It takes the form of a dynamic and stochastic multi-resource allocation formulation. The ``negotiation'' component conducts the actual participation to the auctions. Its structure depends on the time allocated to bid.

2) *Solving a Large Scale Driver Management Problem Using Informational Decomposition*, **Powell, Warren B.**, Princeton University, United States; **Simao, Hugo P.**

The problem of optimizing the flows of drivers for a major LTL motor carrier is too large to formulate as a single problem. We propose a decomposition scheme based on the actual decision-making structure within the organization. Historical patterns are used to divide activities based on the source of the decision, rather than traditional decompositions based on geography. We solve individual informational subproblems using nonlinear approximations of other subproblems that are impacted by decisions made in the home problem. We describe an adaptive strategy for estimating these functional approximations. Numerical results are reported.

3) *Dyamic Large Fleet Operation with Demand Priorities under Saturated Conditions*, **Kim, Yongjin**, Univ of Texas at Austin, United States; **Jaillet, Patrick**; **Mahmassani, Hani S.**

We consider the operation of a large fleet of trucks for truckload service, with multiple priority classes of demand, under saturated conditions. Time window constraints and limted fleet capacity preclude serving all load requests. We consider the associated online truckload routing and scheduling problem, along with the decision to accept or reject requests. The demands are revealed only as the routes are executed. Dynamic operation strategies for large fleet accommodating various customer requirements are presented and evaluated using extensive simulation experiments.

RA3 **Meta-Heuristics in Routing and Scheduling I**

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Ghaziri, Hassan**
Lebanon

1) *Experiments with a Genetic Algorithm for the Vehicle Routing Problem*, **Baker, Barrie M.**, Coventry University, United Kingdom

A Genetic Algorithm (GA) for the basic vehicle routing problem is compared with the well-known approaches of tabu search and simulated annealing. The GA developed here draws upon an approach used for the generalised assignment problem, with a representation that specifies, for each customer, the vehicle number to which it is assigned. The pure GA produced distances averaging 2.35% above the best known results obtained using tabu search and, when neighbourhood search was incorporated, the GA produced distances averaging only 0.5% above the best known values.

2) *Effective LS Algorithms for VRP with General Time Window Constraints*, **Ibaraki, Toshihide**, Kyoto University, Japan; **Kubo, Mikio**; **Masuda, Tomoyasu**; **Uno, Takeaki**; **Yagiura, Mutsunori**

We propose local search algorithms for the vehicle routing problem with general time window constraints, in which one or more time windows are allowed for each customer. Dynamic programming is used to determine the optimal start time to serve the customers so that the total time penalty is minimized.

3) *Self-Organizing Feature Maps for the Vehicle Routing Problem with Backhauls*, **Ghaziri, Hassan**, Lebanon; **Osman, Ibrahim H.**

In the Vehicle Routing Problem with Backhauls (VRPB), a central depot, a fleet of homogeneous vehicles and a set of customers to be visited are given. The set of customers is divided into two subsets. The first one consists of customers with known quantity of goods to be collected and the other one is with known quantity of goods to be delivered. The VRPB objective is to find a route; starting and ending at the depot that services all customers in a given order at the minimum cost. In this paper, we develop a self-organizing feature map algorithm, which uses unsupervised neural network concepts. The definition of the architecture of the neural network and its learning rule are its two main contribution. The implemented algorithm is compared with other approaches in the literature on a standard benchmark test problems.

RA4 **Cutting and Packing: More 3-d Problems**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Goncalves, Jose Fernando**
DEMEGI - Faculdade de Engenharia do Porto, Portugal

1) *Three-dimensional layout optimal problem in parabolic cylindrical space*, **Feng, Enmin**, China; **Zhang, Xu**

In this paper, we discuss the layout problem of the rectangular group with performance constraints in the parabolic cylindrical space, which is based on the layout problem about the artificial satellite module. This three-dimensional layout problem with performance constraints is partitioned into finite subproblems by virtue of graph theory, the action of group on sets, orbits and so on, such that each subproblem overcomes its on-off nature about optimal variable. Finally, we present the specific formula for the orbit number in the set of graphs determined by symmetric group.

2) *Heuristics for the three-dimensional Bin Packing Problem with packing stability*, **Silva, Jose Lassance**, Federal University Ceara, Brazil; **Soma, Nei Yoshihiro**

It is introduced here a set of heuristics for the three-dimensional Bin Packing Problem and in addition to the usual minimisation of the total number of bins as its objective function, the guarantee of a stable packing of items within the bins is also required. The criteria for such stable packing are developed in details. Extensive computational tests comparing the suggested set of heuristics with the Martello, Vigo and Pissinger (2000) algorithms are also presented.

RA5 **Tutorial: Collaboration in E-Business: Business Models and Technology Enablers**

Invited session Venue: MS-1

Chair: **Chakravarty, Amiya**
Tulane University, United States

1) *Tutorial: Collaboration in E-Business: Business Models and Technology Enablers*, **Chakravarty, Amiya**, Tulane University, United States

Tutorial: Collaboration with stakeholders in the value chain can infuse richer content through interfaces by enabling cross-enterprise sharing of resources, processes, and data. Collaboration with suppliers or customers may entail new business models for logistics, inventory and production planning, product-development, dynamic pricing, affiliate marketing, CPFR, auctions, and e-marketplaces. The major categories of technology enablers would be access, application sharing, process sharing, and free-form interaction that may use Web browsers, message brokers, and adaptors. In this session we discuss (a) business models of collaboration, (b) technology enablers, and (c) strategic implications, with examples from industry and/or the relevant analytical models.

RA6 **Issues in Data Envelopment Analysis III**

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Sherman, David**
Northeastern University, United States

1) *Towards an evaluation of the information society development - an international comparison with DEA*, **Badillo, Patrick-Yves**, Universite de la Mediterranee, France; **Bourgeois, D.**

The objective of the research is to evaluate and compare the different stages and processes of the information society development in an international perspective. Based on data concerning the development of the information society (telephone lines, television sets...), we will analyze the state of information society performances for many countries.

2) *Benchmarking with Quality-adjusted DEA* , **Sherman, David** , Northeastern University, United States

Benchmarking is a widely cited management accounting method to identify and adopt best practices as a means to improve performance. Data envelopment analysis (DEA) has been demonstrated to be a powerful benchmarking methodology, particularly when seeking to improve productivity in organizations where multiple inputs and outputs need to be assessed to identify best practices. Most DEA benchmarking studies have excluded quality, even in applications to services like health care and airplane maintenance. This limits the practical value of DEA in organizations where maintaining and improving service quality is critical to achieving performance objectives. Alternative methods incorporating quality in DEA benchmarking literature are demonstrated. A new, more sensitive quality adjusted DEA methodology - Q-DEA- is proposed and demonstrated.

3) *Valuation of product differentiation with DEA framework*, **Baik, Cheolwoo**, Seoul National University, Korea; **Lee, Jeong-Dong** ; **Kim, Tai-Yoo**

In this study, we propose a mechanism to test whether a product will survive or not among the highly differentiated products in the market. Methodologically, we combine the hedonic theory that has been developed in the demand analysis in the realm of economics and the DEA framework that has been developed in the field of OR/MS. The proposed mechanism is applied to the notebook computer market. We show that the mechanism successfully differentiate the 'good' ones from 'bad' models. Moreover, we provide the value of each technical specification that can be used in the new product development process.

RA7 **Advances in Decision Analysis**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States
Organizer: **Wright, George**
Graduate School of Business, United Kingdom

Chair: **Keller, L. Robin**
U. of California, Irvine, United States

1) *Perspectives of Multiple Stakeholders on Management of Water Pollution*, **Keller, L. Robin**, U. of California, Irvine, United States; **Guyse , Jeffery L.** ; **Biswas , Dipayan**

During the summers of 1999-2000, the near-shore ocean water in Huntington Beach, California, USA repeatedly exceeded allowable pollution levels, resulting in many summer beach closures. The focus of this decision analysis project is on management of water pollution in the Talbert Marshland and near-shore ocean water. Stakeholders to this system include water systems managers, city and local government officials, local business owners, beachgoers, surfers and surfing promoters, tourists, residents and environmental groups. We construct and compare hierarchies of multiple objectives regarding the management of this system from different stakeholder groups. We then trace the evolution of the pollution management problem.

2) *Regression Analysis: What criterion to choose?*, **Narula, Subhash C.** , Virginia Commonwealth U, United States; **Wellington, John F.**

For regression analysis, besides the most popular least squares criterion, today we may also choose from several other criteria. However, the choice of the criterion is not always clear or obvious. Our objective in this presentation is to share some ideas, from theoretical and practical considerations, to choose one or more criteria in a given situation. We illustrate the ideas with examples.

3) *Options Thinking for Strategy Evaluation of New eBusinesses*, **Bodily, Samuel E.**, Darden Sch., U. Virginia , United States

A potential investor in a new ebusiness is ready to deny funding on the basis of simple expected monetary value. Further reflection identifies potential downstream options. Some are important in the case of partial, but incomplete, success: to abandon the business idea and sell the technology, or to switch to new technology and keep the website. Other options, to expand, or to include buyout provisions, become important in the case of preliminary success. Decision analysis is used to value these options, in some instances employing Monte Carlo simulation. The fundamentals of options thinking are summarized.

RA8 **Integer Programming Algorithms**

Invited session Venue: AT-3

Chair: **Lodi, Andrea**
DEIS, University of Bologna, Italy

1) *A Polyhedral Approach to Linear Arrangement Problems*, **Letchford, Adam Nicholas**, United Kingdom; **Amaral, Andre**

The Linear Arrangement Problem (LAP) is a well-known (and strongly NP-hard) special case of the Quadratic Assignment Problem. At present, exact algorithms for the LAP are capable of solving only fairly small instances. The main reason for this difficulty is the lack of good lower bounds. We present a new 'distance-based' formulation and explore the associated polyhedron. Several classes of valid inequalities are derived, along with separation algorithms. Preliminary computational results show that this approach can yield competitive lower bounds quickly.

2) *Approximation Algorithms for Ordered Vector Packing Problems*, **Pferschy, Ulrich**, University of Graz, Austria; **Caprara, Alberto** ; **Kellerer, Hans**

We consider the d-dimensional vector packing problem, which is a generalization of the classical bin packing problem in which each item has d distinct weights and each bin has d corresponding capacities. For the case in which the vectors of weights associated with the items are totally ordered an asymptotic polynomial-time approximation scheme is constructed. As a corollary, we also obtain such a scheme for the bin packing problem with cardinality constraint. The result is extended to instances with constant Dilworth number, i.e. instances where the set of items can be partitioned into a constant number of totally ordered subsets. We use ideas from classical and recent approximation schemes for related problems, as well as a nontrivial procedure to round an LP solution associated with the packing of the small items.

3) *Optimizing over SemiMetric Polytopes*, **Rinaldi, Giovanni**, IASI, Italy; **Frangioni, Antonio**; **Glover, Fred**; **Lodi, Andrea**

The semimetric polytope associated to a complete undirected graph is an important structure in combinatorial optimization, and it is related to several relevant optimization problems such as the max-cut problem. A family of facet-defining inequalities for the semimetric polytope, the so-called triangle inequalities, often provide a quite tight approximation of the polytope, which results in strong bounds on the related optimization problems. Unfortunately, the corresponding linear program, which has a number of variables and constraints that are respectively quadratic and cubic on the number of nodes of the graph, is usually very degenerate and almost impossible to solve efficiently, for large graphs, even when using state-of-the-art linear programming software and constraints generation techniques. We propose a new algorithm that is capable of efficiently optimizing any linear function over the polytope defined by all the triangle inequalities associated to one fixed node.

RA9 **Complex Societal Problems I**

Invited session Venue: MS-3

Organizer: **DeTombe, Dorien**
Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Chair:

1) *An introduction to the field of Complex societal problems* , **DeTombe, Dorien**, Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Complex societal problems like in Europe the recent difficulties in the Agro-industry as the Mad-Cow disease and the Foot- and Mouth disease, and the continue problems with in the area of transportation. The process knowledge comes from facilitators. These are scientists or practitioners working in this field of complex societal problems using methods derived from their original field combined with methods specially created for the field of handling societal problems. Handling societal problems include knowledge, power and emotion. There is a growing interest in the field of complex societal problems from an interdisciplinary group of researchers all over the world focussing on methods and tools for handling complex societal problems.

2) *Prioritising innovative research areas in a group decision conferencing process*, **Wijnmalen, Diederik J. D.**, TNO, OR & BM Division, The Netherlands

This presentation reports on a consulting process aimed at making a group of high-ranked officials decide on investment priorities regarding a broad range of innovative research areas. Not only the research areas were competing, the officials themselves also represented different parts of a very large Dutch government organisation. In a series of decision conferences and preparatory elicitation steps in-between, a prioritisation methodology was first accepted and then carried out based on expert knowledge and multi-criteria analysis. This presentation will focus on the process, the methodology and the type of information used, not on results.

3) *Analysis of Taxonomies in OR*, **Bowen, Ken**, Dep. Mathem., University of London,, United Kingdom; **Brugha, Cathal M.**

This paper considers several taxonomies, including types of operational researchers, and types of game playing. It compares them with some underlying management strategy and with some traditional systems used in China. It explores their common features. One is that they all can be related to three sets of dichotomies. Another is that some relate to processes, and others describe archetypes. This latter difference occurs both in the Western and the Chinese taxonomies. It explores the importance of this distinction for understanding the way these taxonomies were formed.

RA10 **OR Consultancy - Some Diverse Cases**

Invited session Venue: MS-4

Organizer: **Ranyard, John**
Lancaster University, United Kingdom

Chair: **Nicholls, Miles G.**
Swinburne University of Technology , Australia

1) *OR Consultancy*, **Clarke, Steve**, Luton Business School, United Kingdom; **Lehaney, Brian Alexander**; **Evans, Huw David**

Information Sharing in U.K. Emergency Services This presentation describes a consultancy into the Emergency Services in two major U.K. Counties, during 2000/1, looking at ways of enhancing communication and information sharing between them to improve operational efficiency. Emergency Services exhibit considerable independence in the way they operate, but operationally make efforts to coordinate their activities to the benefit of the public whom they are seeking to serve. The systems, both human and technical, for facilitating this coordination are continually the focus of enhancement. A key part of the study involved a critique of three Government funded initiatives (under the “Invest to Save” budget) which had the same overall purpose, but which had decided on a particular, and costly, approach. Cultural, resource and other constraints are considered, leading to clear proposals for the ways forward, and raising important questions about current approaches to the problem.

2) *Applications Of Mixed Mode Modelling Methodologies To Smaller Organisations*, **Enright, Michael**, Swinburne University of T, Australia; **Nicholls, Miles G.**

This paper examines the relationship between marketing and production regimes in manufacturing-capable organisations. Using recent, published research by the authors, it compares and contrasts the relative emphases placed on these functions by larger and smaller organisations. It finds that for larger organisations, sequential, often 'hard' methodologies predominate. For smaller organisations, the longer-term planning functions may often be expressed through external, prior experiences, leaving the mixing of the remaining, shorter term planning - both marketing and production varieties - more in the realm of 'softer' methodologies. This emphasis on intuitive approaches in smaller organisations and on discursive methodologies in larger organisations does not preclude the development of modelled approaches for the former, but special considerations need be introduced into the modelling process.

3) *Managing The Phillip Island Nature Park: A Judgment-Analytic Study*, **Dhir, Krishna S.**, Berry College, United States

Ecosystems are generally complex and difficult to model. Subjectivity plays an important role in every aspect of decision-making in ecosystem management, including the task of problem diagnosis, assessment of cause-effect relationships, and formulation of strategic alternatives. This paper describes a computerized procedure to identify, measure, and report managers' judgment orientations. This information would prove invaluable in developing management policies for conservation of ecosystems. An illustrative case of the Phillip Island Nature Park in Victoria, Australia, is provided as an example of how the procedure described here can be used for both research and practical application purposes.

RA11 **Economics II**

Contributed session Venue: MS-5

Chair: **Luptacik, Mikulas**
Vienna Univ of Economics, Austria

1) *Comparative Researches of Partial Distribution in the Securities Investment Field*, **Sun, Ke-wei** , China; **Dai, Feng**

The conception of partial distribution has been proposed previously. This paper presents some comparison between the application of partial distribution and that of logarithmic normal distribution in securities investment field. In some respects, the former is better than the latter, which can reflect accurately the process of securities price changing.

2) *Investment Model - A Transition Economy Case*, **Pankova, Vaclava**, Czech Republic

Optimisation behavior of firms respects interest rates, output and capital prices when looking for a desired capital stock level. That is why a common form of a partial adjustment investment model is specified as optimising a demand for capital, hence in a neo-classic way. Using the transition economy data of the Czech Republic, the parameters of the model are estimated and its forecasting qualities tested. Paper relates to GA 402/00/0461 project.

3) *Eco-Efficiency Analysis of an Economy*, **Luptacik, Mikulas**, Vienna Univ of Economics, Austria

In the paper the efficiency of an economy is defined by the linear program based on the input-output model with make and use tables that maximizes the level of domestic final demand - given its proportions - for given amounts of primary factors, labour and capital. For the notion of the eco-efficiency this concept is extended by taking into account pollutants or the undesirable outputs produced in the economy. The degree by which a net output vector - for given stocks of capital and labour and for given environmental standards - could be extended, is a measure for the eco-efficiency of an economy. The approach is illustrated by the data of the Austrian economy.

RA12 **Building Capacity through Community Facilitation**

Invited session Venue: AT-6

Organizer: **Phahlamohlaka, Letlibe Jacob**
University of Pretoria, South Africa

Chair: **Snyman, Maritha**
University of Pretoria, South Africa

1) *Champions in Community Development - Three South African Case Studies*, **Snyman, Maritha**, University of Pretoria, South Africa; **Phahlamohlaka, Letlibe Jacob**

Community development researchers have long acknowledged that irrespective of their socio-economic conditions, all communities engaging in self-help initiatives possess some embedded wisdom. They already understand their own situations and needs. However, this wisdom and understanding must be accessed and harnessed in order to result in meaningful community development. The people who facilitate such self-help initiatives are referred to differently in the literature. They are called community workers, change agents, development facilitators, champions etc. We prefer to call them champions. Our aim in this paper is to investigate the roles of champions in three "successful" South African community based organisations.

2) *Effective Communication In Community Development Facilitation*, **Janse van Rensburg, Ane**, South Africa

It is often stated that projet implementation is a key obstacle to sustainable development. The main problem is a lack of skilled development administrators. Many development professionals are not schooled in dealing with the 'human dimension' of development. This paper presents a profile of Clara Masinga, winner of the World Bank's Community Builder of the Decade Award. Through her understanding of the 'human dimension' of development, she capacitated 200 volunteers to take responsibility for their own development. The paper focuses specifically on the communication approach that underlies her succesful community development facilitation.

3) *Some initial experiences in facilitating the establishment of an IT community centre in a township*, **Ittmann, Hans Willem**, CSIR, South Africa

The world finds itself in the information and knowledge era. Closing the digital divide is one of the critical initiatives in many developing countries such as South Africa. Close collaboration with those effected is critical while such initiatives should be self-sustainable in the long-term. This paper outlines a real case study to close the digital divide. It illustrates "problem structuring" methods used in assisting and facilitating the establishment of an IT community centre in one of the larger townships in South Africa. Enthusiasm, passion, energy and dreams are great but in the end success in such an initiative requires structure, formal plans, different scenarios, interaction with different stakeholders, etc. All these will be addressed in this paper.

4) *A model for the implementation of successful community education services*, **Engelbrecht, Gawie Stoltz**, South Africa

This paper reports on a tested model for the successful development, implementation, and sustenance of community development, -education and -services by Technikon Pretoria in the KwaMhlanga district of the Mpumalanga Province of South Africa. Successful, effective and pro active community development, -education and -service programmes, as part of the vision and mission of a tertiary education provider in South Africa has the advantage of not only creating but also integrating local and ground level aspirations of people living in a rural, poor and underdeveloped areas with the national policies, guidelines, goals and objectives of the South African government.

RA13 **Introduction to Education Stream**

Invited session Venue: AT-7

Organizer: **Bell, Peter C**
Canada

Chair: **Bell, Peter C**
Canada

1) *A Top-Down Approach to Business Modeling (workshop)*, **Powell, Stephen G.**, Tuck School at Dartmouth, United States; **Grossman, Thomas A.**

Modeling--the act of creating a useful model of a business process--is an art that is difficult to teach. We present a set of principles for attacking unstructured modeling problems. We demonstrate how to teach modeling using a real-world case study.

RA14 **Replacement and Maintenance**

Contributed session Venue: AT-8

Chair: **Beichelt, Frank Erich**
University Witwatersrand, South Africa

1) *Repair Strategies in an Uncertain Environment (MDP and Stochastic Game Models)*, **Kim, Yeek-Hyun**, United Kingdom; **Thomas, Lyn C.**

This seminar deals with repair strategies which maximise the time until a catastrophic event- There is a vital need for the equipment, and it is unable to respond. We examine the case where the need for the equipment varies overtime according to a Markov chain, and describe the form of the optimal policy. We also look at conflict situations where the environment is controlled by an opponent. In this case the opponent's actions force the need for the equipment, and this situation is modelled as a stochastic game.

2) *A First Passage Time Problem in Scheduling Replacements*, **Beichelt, Frank Erich**, University Witwatersrand, South Africa

A purely cost-based maintenance policy is proposed: A system is replaced by a new one as soon as the total maintenance cost reaches or exceeds a given level c. The maintenance cost is modelled by general stochastic processes with nondecreasing sample paths. Examples show that this "total repair cost limit replacement policy may lead to cost savings between 4% and 30% in comparision to the deterministic economic lifetime approach. The policy seems to be ideal for scheduling cost-optimum replacement cycles for complex systems subjected to drift failures and for scheduling overhaul intervals of industrial plants.

3) *Optimal Policies for playing Variable Wager HI-LO*, **Freeman, James Macdonald**, School of Management, United Kingdom

Use of the HI-LO procedure in the gaming industry is ubiquitous. Optimal playing strategies are therefore of interest to gamblers and machine providers alike. Players' tactics necessarily depend on the goals being pursued. New results determined for a variable wager version of the game are reconciled with those obtained asymptotically using long-established methods.

RA15 **Operations Research in Process Industries I**

Invited session Venue: AT-2B

Organizer: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

Chair: **Gupta, Diwakar**
University of Minnesota, United States

1) *Optimization Based Dss For Process Industries In Two Process Industries*, **Dutta, Goutam**, Indian Institute of Management, Ahmedabad, India

In this paper we introduce an optimization based decision support system for strategic planning. The DSS is built on five fundamental elements: Materials, facilities, activities, Storage-areas and Times. The possible use of same optimization based decision support system for strategic planning in two process industries are also discussed.

2) *Strategic Use of Inventory in Integrated Steel Mills*, **Gupta, Diwakar**, University of Minnesota, United States; **Denton, Brian**

Integrated Steel Mills (ISMs) typically operate in make-to-order manufacturing mode, which results in long delivery lead times. Recent market forces have increased pressure on ISMs to reduce delivery times significantly. Some are therefore exploring the option of satisfying a portion of their demand by converting strategically placed semi-finished inventory into finished products. We describe a stochastic programming model that can be used as a tool to choose which semi-finished products should be made to stock, and their target inventory levels. We report on heuristic solution methods and present examples based on data from a particular ISM.

RA16 **The History of Military Operational Research in Britain and America**

Invited session Venue: WR-11

Organizer: **Kirby, Maurice William**
Lancaster University, United Kingdom

Chair: **Lawrie, Norman**
University of Strathclyde, United Kingdom

1) *OR Studies before World War II*, **Koenigsberg, Ernest**, University of California , United States

Operations Research is condsidered as having started in Britain in the late 1930s in the study of how newly developed RADAR could be used in air defence. There is ample evidence that research was done in WW1 in convoy size and defence (UK) in anti-submarine warfare (US) and between the wars in commercial areas such as inventory planning, mail order shipments and the effectiveness of advertising (US). Further, the role of statistics in industry, as an aid to executive decisions, was recognised by the RSS when it formed a subsection on industrial research(1934-5). This session is devoted to the pre-history of OR, OR cases prior to the use of the term OR. While the work was not carried out by mixed teams working with operating officers, it was analysis of pressing operational problems. These studies would be suitable for publication in the OR journals of the 1950s and 1960s. In this session we will discuss this early work in the military, telephone industry and commercial areas.

2) *OR in World War One: Viscount Tiverton as an OR Pioneer*, **Kirby, Maurice William**, Lancaster University, United Kingdom

World War One gave rise to studies of military tactics which would later have been deemed to be consistent with the methodology of OR as applied in World War Two. This was especially the case in relation to the justification for and organisation of convoys and sound ranging on the Western Front. This paper highlights the work of Viscount Tiverton in relation to aerial bombardment. It will be shown that his focus on bombing objectives, choice of aerodromes for launching offences and analysing the causes and correction of bombing errors anticipated much of the work carried out by operation researchers attached to Bomber Command in World War Two.

3) *Blackett's legacy: military operational research since 1945*, **Forder, Roger**, Ministry of Defence, United Kingdom

Although OR originated within the military domain, and its development up to the end of World War II is well documented, historical studies of OR in the post-War era have tended to focus on its diffusion into the civil sphere. However, defence has continued to be a major application area for OR. During the last 50 years, the scope of the work expanded, the issues of principal concern have changed and changed again, and many new methods have been brought to bear, partly reflecting developments in OR generally but also responding to the demands of an ever-evolving strategic environment

RA17 **Credit and Risk Management**

Invited session Venue: WR-10

Chair: **Hand, David J.**
Department of Mathematics, United Kingdom

1) *Does Reject Inference Really Increase the Accuracy of a Credit Scorecard?*, **Crook, Jonathan Nicholas**, Credit Research Centre, United Kingdom; **Banasik, John**

The estimated parameters of application scorecards may not be accurate estimates of the parameters that would relate to the population of all applicants because rejected applicants are usually excluded from the training sample. This paper will use an (almost) complete sample of applicants to compare the predictive accuracy of three models: one using the complete sample, one based only upon those cases that would normally be accepted, and one based on accepted cases but using reject inference. For the latter two models the exercise will be repeated for different acceptance thresholds.

2) *Importance of Life Stages in Propensity and Retention in Financial Services*, **Ansell, Jake**, University of Edinburgh, United Kingdom; **Harrison, Tina**; **Archibald, Thomas W.**

The current business climate emphasises relationships and customer retention. Paramount to this is predicting when individuals will make a purchase, surrender a policy or defect. Traditional analyses, relying on regression approaches, have failed to yield sufficient understanding of behaviour in this context. One approach that is appropriate is survival analysis. Based on a randomly generated sample of financial services customers, six lifestage segments were identified. The analysis was based on the customer propensities arising in the different lifestages. Comparisons are made between traditional regression and survival approaches. The results have practical marketing implications for customer retention on a segment-by-segment basis. Keywords: Customer retention; Lifestage segmentation; Financial services; Survival analysis.

3) *Building Relevant Scorecards*, **Hand, David J.**, Department of Mathematics, United Kingdom

In many two-class predictive classification problems in retail banking, one class is much larger than the other. In such situations it is very important that the predictive classification rule or scorecard is optimised to match the relative severity of the two kinds of misclassification - attention must be focussed on particular (typically, extreme) parts of the data space. This fact has been largely ignored in modern statistical model building, where it has generally been asserted that the model building and predictive stages can be carried out separately. Examples of the consequences of this are given.

RA18 **Strategic Development: Process & Methods I**

Invited session Venue: WR-9

Organizer: **O'Brien, Frances**
Warwick Business School, United Kingdom

Chair: **O'Brien, Frances**
Warwick Business School, United Kingdom

1) *Management Science Or Operation Research In A Globalized Economy*, **Hebbar, Chandrashekara Kusumakara**, Mangalore University, India

Prior to the 20th century, business organization functioned in a less complex environment from today. Managers of the contemporary organizations must cope with a dynamic world of today. Consequently the decision making task of modern management is more demanding than ever. Even though contemporary institution faces an increasingly complex

environment dealing with business problems. Management Science (MS) is the discipline devoted to developing procedures to help in the process of making decisions. This approach provides systematic way to handling decision-making problems. Our greatest technical accomplishments have been achieved by using scientific methods. But how did this methodology come to be applied to decision problems. The study of MS gives satisfactory answer to this question. In the light of the above the present paper attempts to highlight the role of MS [O R] in the globalized economy .

2) *Strategies in small organisations - process and methods*, **Vidal, Victor Valqui**, Denmark; **Soerensen, Lene**

Strategic development in small organisations are characterised by uncertainty and conflicts. We discuss how a successful strategy development process is supported by soft approaches. Three small cases are presented. We conclude small organisations need simple techniques but are more dependent upon a facilitator and his ability to support the process.

3) *Futures Methods and their use in Strategic Analysis for DSTL*, **Bolland, Benjamin Christopher**, United Kingdom

This paper presents the results of a review of methods and techniques used by organisations to help them plan for the future. A wide range of methods will be described but the focus will be on some of the most commonly used methods such as scenario based planning. The paper then assesses the potential benefits and limitations of these methods. In particular, there will be an examination of the suitability of such methods and techniques to strategic analysis, as practised by Dstl.

4) *Stakeholders Matter - Techniques for their identification and management*, **Ackermann, Fran**, University of Strathclyde, United Kingdom; **Eden, Colin**

Over the last decade many managers and researchers increasingly have recognised that paying attention to stakeholders, both within and outside of the organization, is an important component when developing strategy. Understanding which stakeholders are likely to take notice of the intended strategy and what their particular support or sabotage processes may be, can yield valuable insights into possible management options. This paper discusses three techniques that have been developed through their use with both public and private organizations

RA19 **Routing I**

Contributed session Venue: WR-1

Chair: **Mourao, Maria Candida**
Inst Sup Economia Gestao, Portugal

1) *A Management Logistic System Integrating Inventory Management and Routing*, **Custodio, Ana Luisa**, Portugal; **Oliveira, Rui Carvalho**

In many distribution systems, reductions in cost and/or service improvements may be achieved by adopting strategies for inventory reposition that frequently need to explore scale economies, which arise by getting full load shipments, and require the combination of deliveries in distinct locals into a same route. After distinguishing, in a real world application, between items with regular and sporadic demand, a heuristic (developed by Viswanathan and Mathur) was implemented, for the first type of items, to determine simultaneously replenishment frequencies with routes to be used by the distribution process. The objective was minimize the long-term average costs of inventory and routing, considering an infinite time horizon. Allocation of the remaining items to the routes created by the heuristic was based on the total necessity of the corresponding clusters.

2) *Multi-Objective Heuristic Algorithm for the Routing School Buses Problem.*, **Tareghian, Hamed Reza**, Iranian Maths Society, Iran; **Mirazavi, Seeid Reza** ; **Naji Azimi, Zahra** ; **Taheri, Seeid Hassan**

In this Paper, we present a heuristic algorithm for solving the routing problem for buses of schools, industrial units, goverment offices and .... In this algorithm, in addition to the usuall optimality criteria such as minimisation of journey lengths and number of buses, we consider this time-windows and also bus load and journey length balance. We consider this multi objective problem in the context of scatter search. In other words, our solution procedure considers each objective sparately. we construct initial solutions with known heuristics and by combining promising solutions improve upon the final solution. A summary of computational results with real data is presented. Keywords : Routing, Time windows, scatter search, transportation, heuristics.

3) *Finding Feasible Solutions for a Refuse Collection Problem*, **Mourao, Maria Candida**, Inst Sup Economia Gestao, Portugal; **Amado, Ligia**

Finding a set of routes that minimizes the total collecting cost of the household refuse in Lisbon can be done by solving a Capacitated Arc Routing Problem (CARP) with side constraints. In this paper we propose a new heuristic method to generate feasible solutions to the problem. These solutions are built concerning also the minimization of the vehicles bad turns. We present the computational results obtained with a set of test problems in order to evaluate the performance of this new heuristic.

RA20 **Graph Related Models**

Invited session Venue: WR-2

Organizer: **Wilson, John M.**
Business School, Loughborough University, United Kingdom

Chair: **Wilson, John M.**
Business School, Loughborough University, United Kingdom

1) *Linear programming based heuristics for the weighted maximal planar graph*, **Osman, Ibrahim H.**, School of

Business, American University of Beirut, Lebanon; **Hasan, Merza**; **Abdullah, Ali**

The weighted maximal planar graph (WMPG) problem attempts to find a sub-graph from a given weighted complete graph such that the sub-graph is maximal planar and has the highest sum of arc weights. In this talk we will introduce a number of heuristics based on the linear relaxation of a new integer programming (IP) formulation. Computational results for instances of sizes up to 100 nodes are reported and compared with other heuristics in the literature in terms of solution quality and computation time.

2) *A branch and cut algorithm to solve the water network design problem*, **Hadjiconstantinou, Eleni**, Imperial College, United Kingdom; **Rappos, Efstratios**

We consider the problem of designing reliable water distribution netoworks. Given an undirected graph, the objective is to find the minimum cost network layout that satisfies demand and the edge capacity constraints and a pre-specified level of reliability implemented via edge conectivity. We formulate this problem as a mixed-integer programme and solve it using a branch and cut algorithm. Lower bounds are onbtained from a LP relaxation of this formulation. Various classes of valid inequalities are applied to improve the quality of the resulting lower bounds. Preliminary computational results will be presented for a set of randomly generated problems.

3) *The Out-of-Kilter algorithm applied to traffic congestion*, **Wackrill, Patricia Anne**, United Kingdom

Topics: Nonlinear Mathematical Programming Routing. The Out-of-Kilter algorithm finds a minimum cost assignment of traffic to routes through a network by minimising a linear function. The measure of traffic congestion to be reduced is a non-convex quadratic function. It is represented as a series of linear objective functions. These are minimised using the Out-of-Kilter algorithm in a heuristic method. The cost functions are carefully chosen to avoid one of the pitfalls of Beale's method. The method does not guarantee optimality but has produced optimal results with networks small enough for an integer linear programming method to be feasible.

RA21 **Military OR I**

Contributed session Venue: WR-3

Chair: **Wu, Tzu-li**
Chinese Naval Academy, Taiwan

1) *Components of Trust in the Dutch Military*, **Van der Kloet, Irene Ellen**, Military Academy NL, The Netherlands

Trust is an important aspect of military operations: leaders and subordinates must trust each other in order to fulfill their tasks well. But what is trust? Many researches deal with one indicator of trust, but it is assumed in this study that there are more indicators for trust. Based on previous theory, an empirical research has been done among 355 soldiers in the Royal Netherlands Army, prior to their deployment abroad, as to the components of trust. A theoretical model is presented and tested, resulting in indicators of trust for military personnel.

2) *Verification of Agent Based Distillation Movement Algorithms*, **Gill, Andrew William**, DSTO, Australia; **Grieger, Dion**

Agent based distillations (ABD's) are low-resolution abstract models, used to explore questions associated with land combat operations. Movement of agents within the EINSTein and MANA ABD's is based on a simple attraction-repulsion weighting system and an associated numerical penalty function. The relative simplicity of these ABD's seems to have led to the general acceptance of their associated movement algorithms, without significant verification efforts. This paper analyses these movement algorithms and finds unwanted behaviour and suggests improvement to the penalty function based on relative distances, a cumulative functional and simulated annealing.

3) *Application of MCDM to Anti-Air Warfare target selection*, **Wu, Tzu-li**, Chinese Naval Academy, Taiwan

The general objective of a combat vessel commander responsible for Anti-Air Warfare (AAW) is to protect the vessel from enemy air attack. The concerned criteria to a successful defense are minimizing the damage of own vessel while trying to maximize the kill of threats. Focus will be on a typical Navy combat vessel but the result can be applied to any single-point anti-air defense. This research applied the multi-criteria decision making technique – a variant of min-max optimization to analyze optimal strategies. Examples from different AAW scenarios will be used to illustrate the theory.

RA22 **Production Management & Manufacturing IV**

Contributed session Venue: WR-4

Chair: **Brueggemann, Wolfgang**
University of Birmingham, United Kingdom

1) *An Optimization Method for Simulation-Based Job Shop Scheduling with Capacity Adjustment*, **Arakawa, Masahiro**, Kansai University, Japan; **Fuyuki, Masahiko**; **Inoue, Ichiro**

An optimization method for simulation-based scheduling with capacity adjustment is proposed in order to eliminate tardy jobs in a job shop production. The proposed method introduces a few parameters which can control job allocation and capacity adjustment simultaneously, and an optimal schedule is sought for on the parameter space spanned by the parameters. Furthermore, a local search method is adopted in order to shorten the computation time to search for an optimal solution on the parameter space. The effectiveness of the proposed method is demonstrated by using scheduling data obtained from a practical large-scale system.

2) *Due-Date Assignment with Unit Processing-Time Jobs*, **Mosheiov, Gur**, Hebrew University, Israel; **Oron, Daniel**

We address a due-date assignment problem on parallel identical machines. Jobs have unit processing time and share a common due-date. The objective is to find the optimal schedule and due-date that minimize the total earliness, tardiness and due-date costs. Based on several properties of an optimal schedule, we introduce a polynomial time solution for the problem, which contains(i) optimal job allocation to machines, (ii) optimal schedule (i.e., starting times on the different machines), and (iii) optimal due-date value.

3) *Comparison of different production functions*, **Brueggemann, Wolfgang**, University of Birmingham, United Kingdom

In the range of efficient production speeds, efficient factor substitution can be observed for so-called Gutenberg-Technologies. Under mild assumptions, it is possible to compute the marginal rate of substitution as well as the elasticity of substitution in this range and to state these in simple closed-form expressions which only depend on the chosen speed of production. Application of the latter result to different situations with specified functions of factor usage yields that it is possible in the case of one output and two inputs to identify all CES-functions as product functions of associated Gutenberg-Technologies. But there are also cases of Gutenberg-Technologies with simple functions of factor usage where the elasticity of substitution of the resulting product function is not constant. Hence, the CES-functions turn out to be a proper subset of Gutenberg-Technologies in this case.

RA23 **Risk Management and Analysis**

Contributed session Venue: AF-10

Chair: **Wolf, Frederick George**
Pacific Lutheran Universi, United States

1) *Technical Study Showing The Inadequacy Of Applying The Proposed New Regulation*, **Simoes Gomes, Carlos Francisco** , CASNAV , Brazil; **Ayres, Fernando**

This work is part of a study, sponsored by Petrobras (Brazilian Petroleum Company), to the IMO (International Maritime Organization) Council, to demonstrate that the maintenance of the service life of a group of ships (defined beforehand) to beyond the dates proposed by the new 13G Regulation would not result in an increase in the risk of pollution through oil spills when related to the solution intended to become obligatory. This work shows only the logical, probabilistic and economical facts that support the study. Key-word: risk, oil, double-hull

2) *A Two-Stage Stochastic Programming Framework for Transportation Planning in Disaster Response* , **Barbarosoglu, Gulay**, Bogazici University, Turkey; **Arda, Yasemin**

This study proposes a two-stage stochastic programming model to plan the transportation of vital first-aid commodities to disaster-affected areas during emergency response. A multi-commodity multi-modal network flow formulation is developed to describe the flow of material over an urban transportation network. Since it is difficult to predict the timing and magnitude of any disaster and its impact on the urban system, resource mobilization is treated in a random manner, and the resource requirements are represented as random variables. The two stages are defined with respect to information asymmetry which discloses uncertainty during the progress of the response.

3) *A Conceptual Model of High Consequence System Safety*, **Wolf, Frederick George**, Pacific Lutheran Universi, United States

This paper presents a conceptual model of high consequence system safety. The model integrates variables derived from three major schools associated with organizational literature and from the disipline of engineering. The model is used to analyze serious accidents involving nuclear submarines. The conceptual model provides a framework for integrating four distinct perspectives concerning the reliability and safety of complex technical systems. It also provides a context for understanding risks associated with a broad range of high consequence systems.

RA24 **Multi-Criteria Decision Analysis III**

Contributed session Venue: AF-13

Chair: **Mathieson, Graham Leslie**
UK MoD, Dstl, United Kingdom

1) *A multi-criteria approach to solve the CVRP with fuzzy demands*, **Werners, Brigitte**, Ruhr-University Bochum, Germany

The uncertain and vague demands in a CVRP are modeled using fuzzy sets. As a consequence several goals have to be considered to find a good solution: The possibility to serve the demand has to be high, the total distance traveled has to be low. Additionally, the possible quantity of the demand served has to be high to maximize sales. A fuzzy multi-criteria approach is developed that bases on a mixed integer linear mathematical programming model. The first compromise solution can interactively be modified to meet the decision maker's requirements with respect to the different criteria.

2) *Applying the adaptive control methodology to the case of divestitures in a large international group*, **Kunsch, Pierre L.**, VUB, Belgium; **Chevalier, Alain**; **Brans, Jean-Pierre**

The present paper is a contribution to the validation of the newly developed methodological framework called "Adaptive control methodology " (ACM) introduced in a previous paper. It combines the techniques of adaptive control theory with system dynamics (SD) and group multicriteria decision aid (GMCDA). In the following, the usefulness of practical use of this framework is set in perspective by comparing it with recurrent financial and acquisition processes in a multinational group. As a result of this comparison, some lessons can be drawn on the way the pratical implementation of the theoretical framework can be eased. As a byproduct recommendations are made on how to influence in a constructive way recurrent divestiture processes in the real world.

3) *Future developments for Multi-Criteria (Decision) Analysis*, **Mathieson, Graham Leslie**, UK MoD, Dstl, United Kingdom; **Simmons, Colin**

The widespread use of multi-criteria analysis to support corporate decision-making has led to a very varied level of quality in decision support. Methods developed for multi-critria (decision) analysis have often been used to facilitate expert panels seeking to analyse evidence rather than make executive decisions. The scale of MC(D)A often grows too large for the model to be comprehensible to those providing weights, or for assumptions about linearity and independence to hold true. The authors' experiences have led them, independently, to seek for improvements in the form of MC(D)A methods and tools and in the rigour of their application. This paper describes the results of a workshop held under the auspices of the ORS to address these issue.

RA25 **Inventory I**

Contributed session Venue: AF-14

Chair: **Chen, Frank Youhua**
Chinese Univ of Hong Kong, China

1) *Just-In-Time replenishment as a company start-up strategy*, **Betts, John M.**, Monash University, Australia

The decision of whether a manufacturer should replenish certain components Just-In-Time in order to reduce the risk of cash-shortfalls during the company's start-up phase is analysed for the case when the company is subject to a capital constraint. A simulation study is used to determine the long-run performance of a case study company under various start-up strategies in order to determine the investment policy that maximises the long-term profit adjusted for the risk of company failure. The analysis introduces benefits arising from JIT reducing inventory volatility, and consequent risk of company failure, which are not considered under traditional analysis.

2) *Scanbacks and Mail-in Rebates: Manufacturer's Tools against Forward Buying*, **Arcelus, Francisco Javier**, Univ of New Brunswick, Canada; **Srinivasan, Gopalan**

This paper evaluates the role of scanbacks and mail-in rebates as manufacturers' tools for the prevention of retailers forward-buying practices in the modern B2B marketplace With scanbacks, the determination of the retailer's compensation is based on actual performance normally measured by scanner data. It allows the manufacturer to tie its discount policy to the magnitude of the retailer's pass-through to the final customers. With the mail-in rebate, the manufacturer passes on directly to the final customer some discount, normally in the form of a coupon, upon proof of purchase. A numerical example is included

3) *Applications of Fractional Programming in Stochastic Inventory Problems*, **Chen, Frank Youhua**, Chinese Univ of Hong Kong, China

We will describe a number of applications of Fractional Programming in solving stochastic inventory problems. Examples include the classical (s, S) and several more recent models. When the direct procedures to some of those problems exist, the FP method provides an insightful alternative and possesses certain advantages in algorithm design. In the cases where there do not exist exact, direct computational procedures, the FP method leads to exact and simple algorithms. Examples will be illustrated and a bibliography is provided.

RA26 **Metaheuristics and Tabu search I**

Contributed session Venue: AF-18

Chair: **Gouvea, Elizabeth Ferreira**
UFRN, Brazil

1) *Simulation-optimisation of buffer size in MWMC(*)*, **Farahi, Mohammad Hadi**, Iranian Maths Society, Iran; **Tareghian, Hamed Reza**

In this paper, the problem of determining the optimal buffer size is considered, such that the lines throughput is maximised. An object oriented simulation-optimisation model based on tabu search and simplex method is developed and used in the metal department of the largest car manufacturing company in Iran. Simulation is used to model the manufacturing process and tabu search together with simplex method is used to find the global optima. Using these models it is shown that the total amount of buffers in the line can be reduced by at least 10 percent without any adverse effect on the lines maximum throughput. (*): Mashhad Wheel Manufacturing Company.

2) *A Transgenetic Algorithm to the Traveling Salesman Problem*, **Goldbarg, Marco Cesar** , UFRN, Brazil; **Gouvea, Elizabeth Ferreira**; **De Souza, Cesar Miranda Paula**

This work presents an evolutionary algorithm for the Traveling Salesman Problem, TSP. The algorithm named ProtoG is based on the Computational Transgenetics metaphor and can be classified as an intracellular algorithm, since it has no sexual reproduction. Computational Transgenetics aims at informing an evolutionary process that may be accomplished according to the prokaryotic recombination paradigm. The pieces of information used by the transgenetic algorithm are based on minimum spanning trees, Christofides' heuristic, and linear assignments. The work reports results of applying a ProtoG algorithm to solve instances of the TSPLib benchmark.

3) *An Intracellular Algorithm to Color Graphs*, **Gouvea, Elizabeth Ferreira**, UFRN, Brazil; **Goldbarg, Marco Cesar** ; **Costa, Wagner Emanoel**

This work presents an evolutionary algorithm named ProtoG for the Graph Coloring Problem, GCP. The algorithm is based on the Computational Transgenetics metaphor and can be classified as an intracellular algorithm, since it has no sexual reproduction. Computational Transgenetics aims at informing an evolutionary process that may be accomplished according to the prokaryotic recombination paradigm. The pieces of information used by the transgenetic algorithm to color a graph

are based on maximum cliques, independent and representative sets.The work reports experimental results of applying a ProtoG algorithm to solve the instances of the DIMACS benchmark.

RA28 **Data Envelopment Analysis VII**

Contributed session Venue: DH-C

Chair: **Arocena, Pablo**
Univ Publica de Navarra, Spain

1) *Ratio-cum-product estimators using successive sampling*, **Luengo, Amelia Garcia** , Universidad de Almeria, Spain; **Rodriguez, Eva Artes**

The problem of estimation of the ratio of two population means for the current occasion based on the samples selected over two occasions, using auxiliary information on two variables for the first occasion, has been considered. Double-sampling ratio-cum-product estimators for estimating the ratio of two means from the matched portion of the sample are presented. Expressions for the optimum estimators and their variances have been derived. The values of the optimum matched proportions have been computed. The gain in efficiency of the proposed estimate over the direct estimate using no information gathered on the first occasion is computed. An empirical study is made.

2) *DEA vs Stochastic Frontier Estimation with Panel Data*, **Arocena, Pablo**, Univ Publica de Navarra, Spain; **Arcelus, Francisco Javier**

This paper identifies and suggests solutions for three potential pitfalls, which may occur when comparing parametric and non-parametric distance function estimators in the presence of panel data. First, efficiency estimation techniques use a year-to-year or a cumulative up-to-the-year approach. Parametric and non-parametric efficiency estimators are not comparable because they do not use the same reference technology. The second pitfall refers to the non-parametric treatment of the time trend embedded in panel data, as compared to the specific functional form of the parametric approaches. Third, can mixed distance functions be computed parametrically? A numerical illustration is included.

3) *Epistemology of Data Envelopment Analysis*, **Gattoufi, Said**, Sabanci University, Turkey; **Oral, Muhittin**; **Reisman, Arnold**

Periodically, professionals in a given field must reflect and assess where the field has been, where it is heading, and what if anything, should be done to change that field's course. This article discusses the statistical trends of the Data Envelopment Analysis (DEA) literature: (1) In terms of objective findings such as the number of articles published per year in refereed journals over the entire lifespan of the field; authorship data and the publishing outlets of choice statistics. (2) In terms of classifications of judgments as to content based on a number of dimensions. Among such dimensions are those differentiating articles on the basis of a DEA-specific taxonomy and on a classification scheme previously applied to other OR/MS subdisciplines differentiating contributions to theory as opposed application and on the basis of several well defined research strategies invoked by the authors.

RB1 **Health Risks I**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Brailsford, Sally C.**
University of Southampton, United Kingdom

1) *Identifying Myco bacterimTuberculosis Infection In Children*, **Rangaraj, R. Selvaraj**, Department of Statistics, India; **Govindasamy, G. Gopal**

Tuberculosis is the single largest infectious disease. The infection rates rise as age advances.An effort is made from an experiment with a finger prick blood specimen from healthy and infected population using ELISA antigens (r38kDa, PPD and 30kDa) using neural network for classification. It is shown that the occurrence of local maxima is related to specific classes. A new method of initialization of weights from input to hidden nodes and from hidden nodes to output on the study population (0-14 years) suggests a different cut-off point for the children. Modified initialization (on the input weights to hidden nodes and weights from hidden nodes to output) consisting of two classes (definitely infected and not infected) on sensitivity and specificity are demonstrated.

2) *Pattern Recognition Methods in Medical Diagnosis*, **Patrizi, Giacomo** , University La Sapienza, Italy; **Nieddu, Luciano** ; **Patrizi, Gregorio**

Diagnosis requires generality and specificity. False positives and false negatives must be avoided and to this end modern Pattern Recognition approaches are advantageous. The aim of this paper is to present an algorithm, used in diagnosis, which gives very accurate results both in theory and in practice. The original experimental results concern Alzheimer's disease, Colon Cancer, Osteoporosis, and marked improvements on well known diagnostic problems for breast cancer, dermatology, echocardiograms and heart disease are also shown for comparative purposes. All this suggests a powerful method in diagnostics and a fruitful methodology in Science.

3) *Infection spread in a health care environment*, **Gallivan, Steve**, University College London, United Kingdom

Compared with the general population, staff and patients of hospitals or care homes are disproportionately exposed to infections such as influenza. In principle, staff vaccination programmes are one way to combat this however it is difficult to evaluate their effectiveness. A prototype model will be described of infection spread within a health care environment. This uses stochastic analysis to reflect the dynamics of disease progression and infection and also to take account of the progression of patients through their care pathway. The latter is a key element of the model since it determines the frequency and duration of contact between patients and different categories of health care staff and visitors.

RB2 **Recent Impacts of Information Technology on Freight Transportation Systems**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Regan, Amelia C.**
University of California, Irvine, United States

1) *Bidding Strategies and Performance of Online Transportation Marketplaces*, **Mahmassani, Hani S.**, Univ of Texas at Austin, United States; **Figliozzi, Miguel**; **Jaillet, Patrick**

We consider real-time carrier bidding strategies for shipper loads in online transportation marketplaces. The strategies differ in terms of information availability (to the carrier), extent to which overall fleet operations are optimized, and learning strategies based on prior experience. A simulation-based modeling framework is developed to evaluate the performance of different bidding strategies by carriers under different marketplace and auction rules. The strategies are evaluated in terms of individual carrier market share and profitability, and well as shipper utility.

2) *Combinatorial Auctions from the Carrier Perspective an Examination of Alternative Strategies*, **Song, Jiongjiong**, Univ of CA, United States; **Regan, Amelia C.**

In this work we examine combinatorial auctions from the carriers' perspective. We assume that carriers (trucking companies) must bid for a set of shipper lanes (freight movements) and that they may bid on single lanes or groups of lanes. We examine methods for pricing their bids so as to gain as much advantage as possible.

3) *Freight Exchanges: Issues, Models, and Tools*, **Gendreau, Michel**, Canada; **Crainic, Teodor Gabriel**

Electronic business has a significant impact on transportation and logistics activities. In particular, the emergence of electronic market places for freight load impacts carriers and shippers alike. We examine a number of important issues related to the design and operations of electronic freight exchanges: the type of market operation - periodic, continuous, etc. -, the type of market clearance mechanism - combinatorial or not -, design of market rules, the optimization formulations required to determine the participants' allocations and the corresponding prices, the associated solution methods, etc. We also examine the need for and main characteristics of advisors to participants that is, of models and methods that may help carriers, for example, 1) combine efficiently the market information and their own planning and operations procedures, as well as 2) conduct negotiation on possibly several diverse markets.

RB3 **Meta-Heuristics in Routing and Scheduling II**

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Osman, Ibrahim H.**
School of Business, American University of Beirut, Lebanon

1) *Phenotypical population methods reviewed*, **Greistorfer, Peter** , Karl-Franzens-Universität, Austria

We discuss the use of metaheuristic population maintenance in the context of non-genetic encoding, present a review of advanced Tabu Search (TS) methods and summarize the idea of Path Relinking. The main focus is on the Scatter Search (SCS) strategy that builds upon the combination of solutions in quite a different way than Genetic Algorithms do. The theoretical part of this paper is supplemented by a report on the computational experience which has been made for routing problems. These results, partially extended to pure permutation problems, show that SCS, especially when combined with TS, is a very competitive method.

2) *Solving a Generalized VRP using Variable Neighbourhood Descent and Meta-Heuristics*, **Dahl, Tore**, SINTEF Applied Mathematic, Norway; **Hasle, Geir** ; **Hvattum, Lars Magnus**; **Kloster, Oddvar**

Extended models of the VRP are needed to adequately represent characteristics of real life routing problems. We have developed a VRP model that generalizes the multiple-depot PDPTW. It accommodates a mixture of pickups, deliveries, direct orders, and single visits. Multiple time windows, multiple capacity dimension constraints, and compatibility constraints are included in the model. On the basis of classical VRPTW operators, a suite of extended construction and neighbourhood operators have been developed and embedded in an overall search strategy based on Guided Local Search and Variable Neighbourhood Descent. The approach yields excellent results on new test problems from the literature.

3) *Multiprocessor Task Scheduling in Multi-Stage Flow Shops: A Genetic Algorithm* , **Oguz, Ceyda**, Hong Kong Poly University, China; **Cheung, Bernard**

We present a Genetic Algorithm for multiprocessor task scheduling problem in multi-stage flow-shop environments. We discuss two new crossover operators that we developed by taking the characteristics of our problem into consideration. We also present the implementation of some well-known crossover operators from the literature. We then introduce three strategic moves, which are mixed with random mutations so that the algorithm will not be trapped in some local minima. We next show how the partial reshuffling enhances the performance of our algorithm. We conclude with the results from our experimental analysis on the performance of our algorithm.

RB4 **Cutting and Packing: Nesting Problems I**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Milenkovic, Victor Joseph**
University of Miami, United States

1) *How CLP can help solving Nesting Problems*, **Carravilla, Maria Antonia**, FEUP, Portugal; **Ribeiro, Cristina**; **Oliveira, Jose Fernando**

The satisfaction of geometric constraints is at the core of nesting problems. We will present a CLP formulation making use of the geometric constraints generated by the use of nofit polygons. This approach is very flexible with respect to the use of problem features for extra constraints and search control.

2) *The Irregular Nesting Problem Involving Triangles and Rectangles*, **Faina, Loris**, Department of Mathematics, Italy

The paper introduces a new geometrical method for a general 2-dimensional irregular nesting problem. An efficient algorithm is derived. Several statistic tests and a numeric estimate of the asymptotic performance bound testify the validity of the algorithm.

3) *The Dense Border Filling Heuristic for Translational Strip Packing*, **Milenkovic, Victor Joseph**, University of Miami, United States

Dense border filling is a new heuristic for strip packing which, unlike leftmost placement, is guaranteed to include the optimal layout and finds it in practice. A border is a set of polygons, and each polygon in a border must touch a polygon in the previous border. An algorithm is given for testing a sequence of borders for feasibility. Feasible border sequences are heuristically evaluated based on packing density with allowance for a jagged right border for non-terminal sequences. The best few sequences are extended by one border and the best few of these are kept. This heuristic finds the optimal packing in many cases.

RB5 **Tutorial: Dialog Mapping**

Invited session Venue: MS-1

Chair: **Conklin, Jeff**
George Mason University, United States

1) *Tutorial: Dialog Mapping*, **Conklin, Jeff**, George Mason University, United States

Tutorial. This is a fast-paced and interactive tutorial designed to teach participants how to create IBIS maps of conversations while they are happening. The tutorial will teach the basics of the IBIS grammar (questions, ideas, pros and cons) and give participants practice in structuring conversations into these rhetorical elements. Practice exercises will be both written and interactive, in pairs or larger groups. This is not a software tutorial; no software skills are required.

RB6 **Applications of DEA to the Banking Industry**

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Casu, Barbara**
Aston Business School, United Kingdom

1) *Efficiency and Productivity Change in EU Banks* , **Casu, Barbara**, Aston Business School, United Kingdom; **Girardone, Claudia**

This paper investigates efficiency and productivity change in the EU banking industry during the 1990s using parametric and non-parametric frontier techniques. Employing Malmquist Total Factor Productivity indices, the results find evidence of productivity growth during the period under investigation. These findings are consistent with those derived from the application of a parametric cost frontier. Productivity growth is decomposed into technical efficiency and technological change. The approach has been further extended by decomposing the technical efficiency change into scale efficiency and "pure" technical efficiency. The results suggest the analysis of the components of total productivity change using different methodological approaches, can lend important insights into the effects of changing business conditions.

2) *A decomposable measure of Profit Efficiency - Application to Portuguese Bank Branches*, **Portela, Maria Conceicao A. Silva**, Portuguese Catholic Unive, Portugal; **Thanassoulis, Emmanuel**

Organisations which are for-profit have an interest in knowing their potential for profit augmentation. Profit efficiency is a measure of this potential. In this paper we develop a measure of profit efficiency in terms of input and output adjustments required to reach the maximum attainable profit. We then decompose the measure into its technical and allocative components. Furthermore, the issue of scale effects on profit efficiency is also addressed. We illustrate our approach to measuring and decomposing profit efficiency using data on a set of Portuguese bank branches. Keywords: DEA, Profit, Efficiency, productivity.

3) *Assessment of bank branches' cost efficiency with price uncertainty*, **Camanho, Ana Santos**, University of Porto, Portugal; **Dyson, Robert**

This paper enhances cost efficiency measurement to account for scenarios of incomplete information on input prices. It develops a method for the estimation of a confidence interval for the cost efficiency measure when only the maximal and minimal values of input prices can be estimated for each DMU. The bounds of the confidence interval are obtained from DEA

assessments in the light of the most favourable and the least favourable price scenario for each DMU. These assessments are based on extensions to the DEA model that incorporate weight restrictions of the form of input cone assurance regions. The models developed are used for the assessment of bank branches' performance. The results show that the DEA models can provide robust estimates of cost efficiency in situations of price uncertainty.

RB7 **Decision Analysis and Behavioral Theory**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States
Organizer: **Wright, George**
Graduate School of Business, United Kingdom

Chair: **Tavares, Luis Valadares**
CESUR-IST, Portugal

1) *A Model To Support The Search For Consensus With Conflicting Rankings - Multitrident*, **Tavares, Luis Valadares**, CESUR-IST, Portugal

A general problem of collective decision making can be formulated in terms of the N rankings of a discrete set of alternatives expressing the preferences of the N members of the group. Helping to reach a consensus is quite important for team building and organizational development and several contributions were developed by different disciplines like Organizational Sciences, Human Resources Management and Operational Research. However, very few models were proposed to support the process of reaching consensus and such models assume a concept of distance between rankings implying an assumption of equal distance between adjacent alternatives. Unfortunately, this hypothesis is hardly acceptable in most cases. In this paper, a model is proposed to search for a ranking in terms of the weights space avoiding the previous assumption and providing useful insights to help decision makers adopting such ranking as a consensus decision.

2) *The Value of Meteorological Forecasts to the US Navy*, **Regnier, Eva** , Naval Postgraduate School, United States; **Wash, Carlyle**

Meteorological forecasts and have saved thousands of lives and millions of dollars to the U.S. Navy. Naval operations are inherently susceptible to large weather related losses, but the mobility of many of the Navy's assets gives them the flexibility to benefit from short-term forecasts. We describe the major uses of meteorological forecasts in the Navy, how these generate economic value, and how improving both the quality and the communication of forecasts and better application of decision analysis, can add to this value. In particular, we consider the value of meteorologist-generated ship routing and the prediction of tropical cyclones.

3) *A multi-attribute motivational model of consumer choice based on a new outranking relation*, **Tavares, Luis Valadares**, CESUR-IST, Portugal

Multiple models have been proposed to describe different patterns of consumer behaviour, that is becoming more complex and diversified (so called "post modern consumer"), but little attention has been given to explore the potential of the approach based on pairwise comparisons. In this paper, a new model of consumer choice is developed considering that: A - the space of the perceptual attributes includes two sub-spaces: A1) the motivational attributes which are responsible for the generation of a motivational drive or force: A2) other relevant decisional attributes. B - the process of choice is modelled by an outranking relation that is quite appropriate to describe pairwise comparisons.

RB8 **MCDA Applied Methodology**

Invited session Venue: AT-3

Organizer: **Springael, Johan**
Vrije Universiteit Brussel, Belgium

Chair: **Bana e Costa, Carlos A.**
Technical University of Lisbon, Portugal

1) *An Approach to Account for Uncertainty in MCDM and Its Applications*, **Kalika, Vladimir Isaak**, NRERC, Haifa University, Mount Carmel, 31905 , Israel

An approach is proposed to select a predetermined number of ?reasonable? alternatives from their vast initial set according to multiple criteria and accounting for uncertainty factors. This approach uses an intuitive methodology to account for uncertainty, based on performing multi-variant computations (MVC) and finding their "stable-optimal" solutions in a framework of performing a multi-level hierarchical system of MVC series. Each level of this system includes a totality of scenarios, having the same nature for this level and reflecting a certain direct or random varying the problem conditions and parameters. The approach maybe applied for various appropriate problems (economic, environmental, financial).

2) *The design process: a multiple criteria planning perspective*, **Kazakci, Akin Osman**, LAMSADE - CNRS, France; **Tsoukias, Alexis**

Designing a new product, process, service or a scenario for a complex decision problem is an essential activity in all private and public organisations. Despite many useful ideas and representations that have been proposed to understand and/or to support the design activities, an intuitive and operational formalism describing this complex process still lacks. In this paper we propose a multiple criteria planning perspective aiming to help to elaborate a formal representation of the design activities. Such an approach opens interesting relationships with well known formalisms in artificial intelligence and planning and offers potentialities for coherent integration of different aspects of the process and the implementation of existing support tools.

3) *Creating win-win strategies for rural development: a socio-technical process*, **Bana e Costa, Carlos A.**, Technical University of Lisbon, Portugal; **Ensslin, Leonardo**; **Holz, Elio**

We describe a participatory intervention which objective was to guide the building of a “win-win” strategy to “dissolve” the conflict between public concerns and the private interests of farmers, in a microbasin. Two separate multicriteria value models were used to evaluate the status quo from both perspectives, and to generate and evaluate rural development actions for improving it. Then, six strategies (portfolio of actions) were conceived. The final merge of the two models allowed performing extensive sensitivity analyses to answer “what-if” questions, during the discussion of the strategies, to achieve an agreement on a way forward.

RB9 **Complex Societal Problems II**

Invited session Venue: MS-3

Organizer: **DeTombe, Dorien**
Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Chair: **Bowen, Ken**
Dep. Mathem., University of London,, United Kingdom

1) *Handling the complexity of large cities*, **DeTombe, Dorien**, Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Most answers that are given to these problems are short term, disciplinary, isolated answers. Basic solutions to complex societal problems often need a long-term integrated and interdisciplinary approach, which takes much effort of all the people involved. A way to handle these complex societal problems in large cities is to use the COMPRAM method. The COMPRAM method combines a fast short-term approach, the Quick Start Workshop, with a Basic Approach, a long-term approach. In the Quick Start Workshop an inventory of the problems is made based on urgent, and not so urgent problems. The handling of urgent problems can start right away. Then the whole problem is analyzed in the Basic Approach. This is step 1 to 6 of the Compram method. This approach takes much more time, however, this is the only way to really find out what the causes of a complex societal problem are and to find out how to handle the causes. Keywords: complex societal problems, methodology, large cities

2) *Structuring Complex Multi-Actor Situations: Visualizing Interdependance, Influence And Cooperation*, **Enserink, Bert**, TBM TU Delft, The Netherlands

Managing the interface between the competing demands of different stakeholders, individuals, groups, departments and organizations, is a main challenge for process managers. Information on stakeholder values, objectives, means and varying problem perceptions must be obtained and structured to provide strategic information to the process manager. In this paper a case study is presented of an interactive network analysis made for strategic policy making for diffused pollution in a Dutch province. The information was generated by the use of a Group Decision Support System (GDSS) and mapped according to participants appraisals and scores on influence and cooperation.

RB10 **Optimisation in Action**

Invited session Venue: MS-4

Organizer: **Ranyard, John**
Lancaster University, United Kingdom

Chair: **Ryan, David M.**
University of Auckland, New Zealand

1) *Bicriteria Robustness versus Cost Optimisation in Airline Pairings*, **Ryan, David M.**, University of Auckland, New Zealand; **Ehrgott, Matthias**

Besides constructing pairings with minimal cost, airlines should also construct pairings which are robust in that schedule disruptions are less likely to propagate into the future. The two objectives of cost and robustness are treated in a bicriteria optimisation to generate "efficient" pairings which do not allow a simultaneous improvement in cost and robustness. In this talk we will describe the model formulation based on a set partitioning model and discuss aspects of the computation which enable integer solutions to be found within reasonable time.

2) *Control strategies of the bleaching process at pulp mills*, **Flisberg, Patrik**, Division of Optimization, Sweden; **Ronnqvist, Mikael**

In pulp mills, the bleaching process involves a number of steps. We describe a solution approach in two stages that makes it possible to establish target values for the control loops that minimize oscillations, cost (e.g. added chemicals) and environmental impact. The first stage is to establish approximate functions describing each production step. These functions are developed based on experiments and empirical results. Then a second nonlinear optimization problem is formulated and solved that make use of the approximate functions together with linking constraints. The ouput is the controls to be used. The system is implemented and currently tested at Billeruds pulp mill Skärblacka.

3) *Radiation Therapy Planning by Multicriteria Optimisation*, **Ehrgott, Matthias**, University of Auckland, New Zealand

In radiation therapy dose distributions must satisfy the conflicting goals of effectively destroying the tumour while at the same time avoiding dangerous overdosing in surrounding tissue and organs at risk. We present a multicriteria model of the problem and show how to find a solution in which deviations from prescribed dose levels are balanced for all organs under consideration. Such a solution can serve as a starting point for the search for a best treatment plan among a precomputed representative set of "efficient" solutions in an on-line database environment.

RB11 **Economics III**

Contributed session Venue: MS-5

Chair: **Callen, Jeffrey**
University of Toronto, Canada

1) *Free Riding Behavior and Performance Monitoring in Retail Chains*, **Buvik, Arnt**, Molde College, Norway; **Rokkan, Aksel**

This article explores the problem of free riding behavior in voluntary retail chains. Based on principal-agency theory and transaction cost analysis, the authors analyze the antecedents to free riding behavior in voluntary retail chains and examines whether it is possible to handle the problem of free riding behavior by specific monitoring arrangements. Hypotheses are developed and tested on a sample of 70 voluntary chains. The empirical findings show that the size of the chain has an interaction effect on the association between monitoring arrangements and free riding behavior. In voluntary retail chain with a great number of participants, monitoring arrangements imposed by the chain administration reduces the free riding behavior significantly, while this effect is absent in voluntary chains with few actors.

2) *The Performance Consequences of In-house Performance Measures*, **Callen, Jeffrey**, University of Toronto, Canada; **Morel, Mindy**; **Fader, Chris**

This paper tests whether the use of in-house operational performance measures to supplement traditional financial performance measures has performance consequences at the plant level. In particular, we test whether JIT plants are more likely than conventional plants to benefit from in-house performance measures. Our sample consists of 61 JIT and conventional plants operating in the Canadian automotive parts manufacturing industry. The empirical evidence indicates that in-house performance measures have positive performance consequences on plant efficiency and plant profitability, especially in a JIT environment.

3) *A Dynamic, Oligopolistic, Spatial, Nash-Cournot Equilibrium Model For Open Hydroelectricity Markets*, **Velasquez Bermudez, Jesus**, DecisionWare Ltd, Colombia

A dynamic, oligopolistic, spatial, Nash-Cournot equilibrium model to determine spot prices and hydroelectricity dispatch (medium and long term) in an open market is described. The market structure is composed by a spot market and a long term market based on financial instruments for future risk hedging. The equilibrium model has two levels: the first is related with the competitive spot market and the second with the market agents who are simulated individually as Nash players.

RB12 **Community OR in the United Kingdom**

Invited session Venue: AT-6

Organizer: **Phahlamohlaka, Letlibe Jacob**
University of Pretoria, South Africa

Chair: **Friend, John Kimball**
University of Lincoln, United Kingdom

1) *Building Community OR Capacity in Dynamic Envirnments*, **Herron, Rebecca Joy Michell**, University of Lincoln, United Kingdom

Dynamic environments present their own operational challenges. This example from Lincoln in England reviews how a local community research network has improved its capacity to engage in Community O.R. within an environment of rapid change. Changes of accountability, stakeholders, organisational structure and levels of internal and external 'connectivity' are all considered. Strategies used to build Community OR capacity at individual, group and sector levels will be explored. A brief 'Annual Report to Stakeholders' will also be presented from the Community O.R. Unit at Lincoln.

2) *Roles for OR People in the Voluntary and Community Sectors*, **Martin, Dick**, Dick Martin Associates, United Kingdom

The voluntary and community sectors in the UK are changing rapidly. The role that OR people can play in their development is largely determined by views of "What is OR?'. The paper draws on the author's practical work in organisations over the past decade, including a centre for unemployed people and a women's refuge. He contends that OR people can have a major influence if they draw upon all their strengths and develop others, rather than limiting themselves to a toolbag of techniques. There are close parallels with issues concerning OR and developing countries and with OR intervention in general.

RB13 **A Bottom-Up Procedure for Optimization Modeling (workshop)**

Invited session Venue: AT-7

Organizer: **Bell, Peter C**
Canada

Chair: **Grossman, Thomas A.**
University of Calgary, Canada

1) *A Bottom-Up Procedure for Optimization Modeling (workshop)*, **Grossman, Thomas A.**, University of Calgary, Canada; **Powell, Stephen G.**

Modeling - the process of creating a model - is essential for OR. It is an art that is difficult to learn. We attempt to formalize this art via a procedure that students (or anyone) can follow when modeling an unstructured business situation. We discuss open research questions around modeling and the use of models.

RB14 **Integrated production systems in forestry**

Invited session Venue: AT-8

Organizer: **Weintraub, Andres F.**
University of Chile, Chile

Chair: **Ronnqvist, Mikael**
Division of Optimization, Sweden

1) *Decision support with a model for Customer Optimized Timber in the wood chain* , **Liden, Bertil**, SkogForsk, Sweden

An integrated optimization system, CustOpT, can analyse the possibilities for the chain forestry-sawmill-planing mill to work more customer-oriented. The primary modelling components are the bucking, sawing and planing processes. The main controlling inputs are customers demands and trees to be harvested. Detailed description of log sorting, sawing, drying and grading is included in the mathematical model. A system for simulating the bucking process is also integrated within the model. CustOpT is developed in co-operation with a Swedish company to be used as a decision support system on a tactical level. Results from a case study will be presented.

2) *Mitigating forest fragmentation in long-term planning using the shape index*, **Ohman, Karin**, SLU, Sweden; **Lamas, Tomas**

The fragmentation of old forest is one aspect that has to be approached also in long term forest planning. In the literature a number of measures of the spatial structure exist. However, very few are evaluated regarding their usefulness in long term forest planning. The object of this study is therefore to investigate the appropriateness of one of these measures, the shape index, for mitigating the fragmentation of old forest. The shape index is evaluated by solving a two objective problem with simulated annealing, which aims at maximizing the net present value and at minimizing the shape index.

3) *Integrated production system for pulp mills*, **Carlsson, Dick**, Sweden; **Bredstrom, David**; **Mason, Andrew**; **Lundgren, Jan**; **Ronnqvist, Mikael**

Production of pulp at pulp mills involves many actors and components. The central part is the production planning. Around this we have transportation, storage and distribution planning. We describe a supply chain system that integrates all parts into a single model. This IP model is solved using a combination of time aggretaion, column generation and special branch and bound techniques. We give numerical results from a major Swedish forest company.

RB15 **Operations Research in Process Industries II**

Invited session Venue: AT-2B

Organizer: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

Chair: **Tripathy, Arabinda**
Indian Institute of Management, Ahmedabad, India

1) *Operations Strategy for Process Industry*, **Tripathy, Arabinda**, Indian Institute of Management, Ahmedabad, India

The characteristic of process industry is significantly different from other industries (non process - engineering industry). The parameters like investment/ employee, output / employee, output / capital employed, etc are significantly different for process industry. Uninterrupted production, high capital productivity are some of the major concerns for process industry. All these call for a significantly different strategy for process industry. The paper develops the rational for various strategic issues and addresses some of the new challenges for process industry. Key words: Process Industry, manufacturing strategy.

2) *A System Dynamic Simulation Model for a Blast Furnace*, **Dutta, Goutam**, Indian Institute of Management, Ahmedabad, India; **Ashtekar, Medha**

The quality and productivity of the hot metal in a blast furnace depends on a large number of input and operating variables. The complex interactions of technological variables and financial variables have been simulated with the system dynamic techniques. The model has been tested with the real data of one steel company of Southeast Asia.

3) *Successful Implementation of Soft Projects in a Process Industry*, **Tripathy, Arabinda**, Indian Institute of Management, Ahmedabad, India

Though ERP has been implemented in many organisations, there are very few cases where full benefit of the system has been derived. A case study is presented here, narrating certain approaches for better ERP implementation. Some of the actions relate to facilitating group processes for effective participation, use of coaches to provide role clarity in the changed circumstances and the like. The case provides certain learning for implementation of Soft Projects.

4) *A Survey of Non-Optimization Models in Integrated Steel Plant*, **Dutta, Goutam**, Indian Institute of Management, Ahmedabad, India; **Basu , Sankarshan**

In this paper, we survey about 70 papers summarizing the applications of non-optimization techniques in an integrated steel plant. The papers are grouped by functions; Queuing Theory, Simulation Techniques, Statistical Process Control, Artificial Intelligence and other applications. We conclude the paper with scope for further research in this area.

RB16 **The History of Operational Research in Britain and Europe**

Invited session Venue: WR-11

Organizer: **Kirby, Maurice William**
Lancaster University, United Kingdom

Chair: **Haley, Brian**
United Kingdom

1) *OR in Denmark - the first 95 years*, **Krarup, Jakob**, DIKU, Univ. of Copenhagen, Denmark

The first International Conference on Operational Research was held at Oxford, England, in 1957 and became the forerunner of the series of triennial conferences organised ever since by IFORS. Judging from the Proceedings (December 1957) one cannot say that Denmark played a particularly flattering role at that event. However, as will be accounted for, OR in Denmark spans nevertheless no less than 95 years. Early milestones include the introduction of probability theory into telephony (1907) and the series of works by Agner Krarup Erlang (1878-1929) by which the foundations of queuing theory were laid.

2) *Russell Ackoff: The Intellectual Journey of an OR Pioneer'*, **Kirby, Maurice William**, Lancaster University, United Kingdom

Russell Ackoff has had a distinguished career in Operations Research both as an academic and practitioner. His influence on the development of the discipline in the US and the UK in the 1950s and 1960s was considerable. Yet during the 1970s Ackoff began to register increasing disillusion with the course and conduct of OR on both sides of the Atlantic. His rejection of the established paradigm was writ large at the British OR Society's Conference in 1979. This paper traces the evolution of Ackoff's thought in order to explain the sources of his disillusion and the impact of his recantation.

RB17 **Why complementarity in systems modelling?**

Invited session Venue: WR-10

Organizer: **Pidd, Michael**
Lancaster University, United Kingdom

Chair: **Pidd, Michael**
Lancaster University, United Kingdom

1) *Complementarity in modelling*, **Pidd, Michael**, Lancaster University, United Kingdom

Recent years have seen an interest in so-called 'soft' methods in OR, which contrast with 'hard' methods. However, rather than seeing these as opposites, perhaps they should be seen as complements, with their combination providing a powerful way of tackling wicked problems in practice. Funded by the EPSRC, the INCISM network exists to explore this complementarity and to feed its results into research and into practice.

2) *Complexity and Complementarity*, **Lyons, Michael Hamilton**, BTexact , United Kingdom

The study of non-equilibrium physical and chemical systems led to the development of the concept of complex adaptive systems (CAS). Techniques to model CAS grew out of a 'hard', positivist view of the world. CAS concepts have been extended to include social systems such as economies and organisations. In the process, the notion of 'complexity' has developed. When applied to social systems, the discussion often takes the form of metaphor and analogy. 'Complexity' encompasses both 'hard' and 'soft' views. This paper examines the role of agent-based models (used to simulate complex systems) in a decision-making process which draws on (metaphorical) notions of complexity.

3) *A Taxing problem: complementarity using SSM and data mining*, **Cooper , Ceri** , Inland Revenue, United Kingdom; **Brown, Joyce**

The talk will outline how SSM was used in a review of aspects of the tax system. It will also describe the uses of hard OR (eg datamining) on this project, and how the various approaches used (both soft and hard) complemented each other to reach a successful outcome to the study.

RB18 **Strategic Development: Process & Methods II**

Invited session Venue: WR-9

Organizer: **O'Brien, Frances**
Warwick Business School, United Kingdom

Chair: **Christensen, Anne Broen**
Denmark

1) *Strategy creativity and facilitation*, **Christensen, Anne Broen**, Denmark; **Vidal, Victor Valqui**

Strategic development in organisations is now a question of facilitating the process in a creative way rather than selecting the right method. Here we will be focusing on the facilitation process and the role of the facilitator.

2) *Meta-Analysis of Strategic Futures*, **Purvis, Mike**, Dstl, United Kingdom

This presentation covers our meta-analysis for the Cabinet Office of the published body of "Strategic Futures" work. The analysis described key drivers for change and assessed the different approaches used in Futures thinking, their treatment of uncertainty and the degree to which their views on drivers agreed or diverged.

3) *Evaluating strategic decision making the Brunswikian Way*, **Harries, Clare**, University of Leeds, United Kingdom

When a decision is described in terms of outcomes, values and probabilities we can evaluate decision making in terms of coherence (application of a particular decision making model), or in terms of correspondence (making the decision with the best outcome over a number of trials). When decisions are described terms of multiple plausible scenarios, researchers and practitioners have avoided such well-structured evaluations and different criteria for goodness are mooted. In this paper I present coherence and correspondence evaluation models for both scenario-based and decision analytic decision making. Thus decision techniques can be compared for individuals making decisions in different environments.

RB19 **Routing II**

Contributed session Venue: WR-1

Chair: **Christiansen, Marielle**
Norway

1) *Recyclables collection planning - a case study in central Portugal*, **Teixeira, Joao**, Univ Catolica Portuguesa, Portugal; **Antunes, Antonio**; **Sousa, Jorge Pinho de**

The Portuguese Centro Litoral system for collecting recyclables comprises 2173 ecopoints and 3637 containers (for glass, paper/cardbord, and plastic/metal), spread over 7,000 km2. This paper describes a study made to determine an efficient recyclables collection plan, and analyzes the first practical impacts of the plan's implementation. The plan identifies the routes to be followed by the collection vehicles and the type of recyclables to be collected along each route during the working days of a four-week planning cycle. To support the planning process a Decision Support System has been designed that uses several efficient heuristics and a GIS to enhance the interaction with the planner.

2) *A direct trip algorithm for the split delivery routing problem*, **Archetti, Claudia**, University of Brescia , Italy; **Speranza, Maria Grazia**

We consider the split delivery vehicle routing problem where a fleet of vehicles must serve a number of customers. Each vehicle has a maximum capacity k. The demand of a customer may be larger than the vehicle capacity. A customer may be served more than once, also when the demand is smaller than the vehicle capacity. The distances satisfy the triangle inequality. No constraint on the number of available vehicles is considered. Each vehicle starts from the depot and returns to the depot at the end of each tour. The objective is to minimize the total distance travelled by the vehicles. In this paper we analyze the performance of an algorithm which serves the customers by direct trips until the demand of each customer is lower than the vehicle capacity and then finds on the reduced instance the optimal solution. We show that in some cases this algorithm finds the optimal solution of the original instance. In the other cases we obtain a bound on the worst case performance.

3) *Optimization-based planning within the shipping industry - yesterday, today and tomorrow*, **Christiansen, Marielle**, Norway; **Fagerholt, Kjetil**

Ocean shipping is the major transportation mode for international trade. The trend goes towards an increase in the use of ships due to the continuous growth in the world population, combined with product specialization and depletion of local resources. In addition, the shipping industry has a monopoly regarding transportation between continents for large volumes. Transportation optimization has been one of the big research topics within the OR-field. However, the attention to ship routing and scheduling has been relatively low. We discuss some of its reasons and focus on the research activity today. Finally, we indicate some of the challenges within ship routing for the future.

RB20 **Heuristic and IP Models - Part I**

Invited session Venue: WR-2

Organizer: **Wilson, John M.**
Business School, Loughborough University, United Kingdom

Chair: **Wilson, John M.**
Business School, Loughborough University, United Kingdom

1) *Models and techniques for bookmobile routing and scheduling*, **Wilson, John M.**, Business School, Loughborough University, United Kingdom; **Foulds, Leslie**; **Wallace, Stein**

A bookmobile is a specially adapted bus or van used as part of the outreach operations of public library systems in Norway. They are used to deliver/collect library materials (books, audio, periodicals, and music) to and from lender groups in more remote areas. The question of how best to utilize the bookmobile's resources leads to a vehicle scheduling and routing problem. We report on models and solution techniques (IP and heuristic) and the outcome of applying them.

2) *Scheduling cranes on a track*, **Liu, Jiyin**, Hong Kong Uni of Sc - Tec, China; **Jiang, Yun**

This paper will describe the problem of scheduling cranes on a track. A general MILP model for the problem will be described.

3) *Bag rationalisation for a food manufacturer*, **Glass, Celia**, City University, United Kingdom

A food manufacturer is rationalising the type of bags used to pack their products in with a view to achieving savings. Names and product characteristics are printed on bags and bags are of various colours. The problem of minimising both cost and colour conflicts is modelled as either a 0-1 IP problem or a variant of the graph colouring problem. A previously intractable problem can be decomposed using the proposed approaches and pre-processing and then solved using commercially available IP software. The solution was subsequently implemented.

RB21 **Military OR II**

Contributed session Venue: WR-3

Chair: **Moffat, James**
Dstl , United Kingdom

1) *The Architecture and Application of the Wargame Infrastructure and Simulation Environment (WISE)*, **Taylor,**

Mark, Dstl, United Kingdom; **Wright, Susan Clare**; **Pearce, Paul Victor**; **Robinson, Alan**

Dstl is in the process of bringing into service a new generation of models to improve its ability to examine defence issues. This paper concentrates on one of this new generation of models, the Wargame Infrastructure and Simulation Environment (WISE). In addition to its C2 functionality, WISE is designed to operate as either a simulation or wargame, in which the players replace a node in the command chain and act from that perspective. The paper covers the overall approach to the design and implementation of WISE, outlines its key features and discusses lessons learnt from its first major application.

2) *Control and the Fractal Dimension of the Battlespace*, **Moffat, James**, Dstl , United Kingdom; **Witty, Susan**

The probability and amount of control a force has over a battlespace can be shown to be a function of the fractal dimension of a battlespace. Earlier meta-modelling of the ISAAC combat model has suggested that the type or style of warfare undertaken by a force is also a function of the fractal dimension. This paper looks at the relationships between the behaviour of forces in the battlespace and the fractal dimension and the conclusions that can be drawn form analysis of these functions.

3) *One Application Of Thor In A Process Of Personal Evaluation*, **Simoes Gomes, Carlos Francisco** , CASNAV , Brazil; **Valle, Rogerio**; **Gomes, Luiz F. Autran M.**

One of the great difficulties of Command Systems is the correct identification of feasible alternatives for solving the problem being studied and, later on, the priority of the selected alternatives. The selection and priority of alternatives are made under the influence of quantitative and qualitative approaches, which frequently conflict, to each other. The classification of the qualitative approaches is also hindered by the fact that the decision-makers groups sometimes possess (own) different judgments of values. This work proposes a solution for this type of problem and, also, for a problem of personnel's selection using the multicriteria analysis.

RB22 **Production Management & Manufacturing V**

Contributed session Venue: WR-4

Chair: **Enns, Silvanus T.**
University of Calgary, Canada

1) *Improving Manufacturing Efficiency by Operations Reversal*, **Oflezer, Oyku**, Sabanci University, Turkey; **Catay, Bulent**; **Unluyurt, Tonguc**

Current market conditions require product proliferation. This increases the cost and complexity of the manufacturing processes. Reengineering the manufacturing system can improve performance by reducing complexity. Reversal of two consecutive operations is such a reengineering effort. We analyze the behaviour of a 2-stage manufacturing system with multiple feature options in terms of total variance of production quantities. We investigate under which circumstances operations reversal is beneficial.

2) *Postponement in Mass Customization Manufacturing Supply Chain*, **Zhou, Dehua**, Cambridge University, United Kingdom

Mathematical modelling is used to analyze how postponing operational activities affects the performance in various objectives in a manufacturing supply chain that provides high variety and customization products. The final stage manufacturer provides a mixture of make-to-order and make-to-stock products to customers. Both delivery and production lead-times vary according to the emergency degree of order. Lead-times are associated with price or cost premiums. We derive the criteria for decision-making on whether to postpone a certain operational activity in face of certain market and customer demand characteristics. Numerical simulation results will be presented to illustrate how the model can be used.

3) *MRP parameter selection based on queuing and feedback*, **Enns, Silvanus T.**, University of Calgary, Canada

There is lack of prescriptive methods for setting MRP lot sizes and planned lead times effectively. Recent research has suggested that queueing solutions for the multi-item capacitated lot-sizing problem can provide guidance in setting these input parameters. This research investigates lot-sizing and flowtime prediction based on M/G/1 assumptions. Planned lead times based on such flowtime predictions are excessive. However, if M/G/1 lot sizes are used with planned lead times based on exponentially-smoothed feedback on actual order completion times, performance improves. Results are based on testing multi-item, multi-level scenarios on a test bed linking an MRP planning system to a shop simulation system.

RB23 **Practice of OR III**

Contributed session Venue: AF-10

Chair: **Van Gunsteren, Lex A.**
Techn Univ Delft, The Netherlands

1) *Montecarlo simulation for solving risk management problems in Casinos*, **Lopez-Zafra, Juan Manuel**, Univ Pontificia Comillas, Spain

Being one of the most studied Casino games, not only from the statistical point of view, there is however a lack in explaining its standing rule. What we pretend here is to show, using Montecarlo simulation, why the current standing rule is optimal for Casinos. We will first present the real risk management problem faced by an important Spanish Casino when introducing automatic shuffling machines, and then go into the simulation model built for solving it. Finally we will summarize the main hits of the research.

2) *Non-linearity of stakeholders' preferences in open design*, **Van Gunsteren, Lex A.**, Techn Univ Delft, The Netherlands; **De Graaf, Rein P.**

In Open Design methodology the preferences of stakeholders are assumed to be of a linear nature. For instance, the price per square meter for a parking lot is kept the same for a relatively small parking lot and for a large one. The stakeholder may be prepared, however, to pay more per square meter for a small parking lot to be used by VIPs only. This paper offers a method to take such non-linear preference behavior into account. The relevant stakeholder has to specify three equivalent alternatives, instead of two as required in the linear case. A numerical example shows that the non-linearity of stakeholders preferences can significantly affect the outcome. The method implies the assumption that the non-linear preference behavior follows an exponential pattern. http://www.bk.tudelft.nl/users/barendse/internet/leerstoel_BI/LvanGunsteren/onderzoek/ifors/paper_deGraaf&vanGunsteren.doc

3) *Validation Of The Coherent Market Hypothesis Using Neural Networks And South African Data*, **Myburgh, Gustav**, University of Stellenbosc, South Africa; **Gevers, Willem Rudolf**

This study is an investigation of the validity and application of the Coherent Market Hypothesis using real data from the JSE Securities Exchange. Artificial Neural Networks were applied as computational aids to determine the parameters of the model. The main objective was to demonstrate the CMH's usefulness as a forecasting tool in both a quantitative as well as qualitative capacity. The results of the quantitative analysis were not as significant or valuable as expected. Some qualitative insights are obtained.

RB24 **Multi-Criteria Decision Analysis IV**

Contributed session Venue: AF-13

Chair: **Serrao, Amílcar J.**
Universidade de Evora, Portugal

1) *A Framework for strategic control and planning in Corporate Organisations* , **Kunsch, Pierre L.**, VUB, Belgium; **Chevalier, Alain**; **Brans, Jean-Pierre**

The purpose of the paper is to test and to develop the capabilities of a conceptual framework for strategic control and planning in corporate organisations, called adaptive control methodology. A comparison is made to the current practice in a large multinational organisation in the food industry sector(BSN/DANONE). Three case studies analysed in previous papers are briefly described. These results are generalised in order to provide a typology of these problems in terms of important characteristics: the length of the time horizon, the more or less recurrent character, the existence of uncertainties, irreversibility or real options in the planning and control processes. These elements lead to successive developments and improvements in the initial framework. In this way the latter is brought to better match real-case problems in a broad range of strategic applications such as budget preparation, mergers and acquisitions, divestitures, process and post-merger reengineering.

2) *Consistent Sampling and Web Modelling for Pairwise comparisons*, **Alresheedy, Melfi**, United Kingdom; **Lucas, Cormac**

The use of pairwise comparisons is widespread in MCDM. A large number of alternatives (i.e. more than 10) resulting in a large number of comparisons may overload the decision maker. We use a linear model with an additive comparison scale to: 1) Show its theoretical and practical advantages. 2) Present a sampling methodology for the comparisons based on optimising consistency. 3) Explore use of the Web in making reliable decisions for both individual and distributed groups of people. The proposed methodology with its minimal computation and simplicity can be used in conjunction with the linear model.

3) *An alternative weighting criterion - the mutual information method*, **Serrao, Amílcar J.** , Universidade de Evora, Portugal

The assignment of weightings to each criterion is a crucial step in multi-criteria decision-making analysis. This paper develops a weighting method called the mutual information method. This method based on the concepts of entropy and mutual information reduces equivocation and error significantly on the part of the decision-maker in determining the weights to be used in a multi-criteria decision-making problem.

RB25 **Mathematical Programming-Linear I**

Contributed session Venue: AF-14

Chair: **Malpica Angarita, Jaime U.**
Univ. Nacional - Colombia, Colombia

1) *Estimation of an Optimal Solution of a LP Problem with Unknown Objective Function*, **Prieto, Tomas**, Spain

We consider a linear programming problem with unknown objective function and we wish to estimate its optimal solution. We observe random variables related to the LP problem. The stochastic estimation algorithm that is defined is based on the simplex method. We do not estimate the objective function so that the estimation technique is thought up just to estimate an optimal basis, avoiding estimations that then turn out to be unnecessary. The stochastic algorithm converges with probability one to optimal solutions and its speed of convergence is of order inversaly proportional to the sample size.

2) *A Determination Way for Initial Basis of Linear Programming*, **Shen, Maoxing**, Associate Professor, China; **Chen, Yongge**; **Cheng, Zhifeng**

The big M method and the two-phases way are usually adopted to construct a unit matrix as a initial basis for LP. But, these schemes often make one confusion in thinking clue and complication in calculation. Aim at this point, we establish the association between the elementary transformation of matrix and the concept of initial feasible basis, a determination way for initial feasible basis of linear programming is presented here.

The basic idea is two steps that come into operation of a series of elementary transformations of matrix to the augmented matrix of linear programming model first so as to perform a unit matrix in the augmented matrix, then arrange this result into a simplex tableau to solving the LP problem subsequently. The presented scheme is concisely, convenience and making the solving procedure clearly in practice. Some examples are given to demonstrate these characteristics in this paper.

3) *A "Feasible" Direction Search For Linear Programming Problem Solving*, **Malpica Angarita, Jaime U.**, Univ. Nacional - Colombia, Colombia

The study presents an approach to solve LPPs with no artificial variables at all. A pair of dual programs (a primal linear minimization problem in standard form and its dual linear maximization problem) is used. A partial dual problem is solved by a "feasible" direction search (exploiting the regularities of the polyhedron, possibly polytope) but the primal feasibility and the complementary slackness (Karush-Kuhn-Tucker) conditions help to verify the feasibility and optimality of the solution of the partial (remaining restrictions are added by using dual simplex iterations) or whole dual problem.

RB26 **Metaheuristics and Tabu search II**

Contributed session Venue: AF-18

Chair: **Fernandes, Susana**
DEIO-FCUL and FCT-UALG, Portugal

1) *Finding robust solutions using tabu search*, **Sorensen, Kenneth**, University of Antwerp, Belgium

We show that tabu search and other local search techniques can be effectively used to find solutions that are both robust and of high quality. The concept of robust evaluation function is introduced. In a robust evaluation function, a number of solutions are first perturbed and then combined into a single measure of both robustness and solution quality. We show that this concept extends tabu search so that it searches for robust solutions without requiring large modifications to the tabu search algorithm itself, thus rendering the technique very flexible and practically useable. The proposed procedure is tested for a simple tabu search procedure, the optimisation of a continuous function of a single variable on a finite domain. For this type of problems, we find an approximation of the number of perturbed evaluations that are needed to create a good robust evaluation function.

2) *Minimizing Earliness And Tardiness Penalties In A Single Machine Problem With A Common Due Date*, **Ronconi, Débora P.**, University of Sao Paulo , Brazil; **Hino, Celso M.**; **Mendes, André B.**

This work addresses the single-machine scheduling problem with a restrictive common due date. The performance measure considered is the minimization of the sum of earliness-tardiness penalties of the jobs. Since this problem is NP-hard, we investigate the application of tabu search and genetic algorithm in order to obtain good solutions in a reasonable time. Hybrid strategies are included to improve the performance of the methods. The proposed approaches are examined through a computational comparative study with 280 benchmark problems. These algorithms are able to achieve better results for problems with problems up to 1000 jobs.

3) *A tabu search method with path relinking for the job shop scheduling*, **Fernandes, Susana**, DEIO-FCUL and FCT-UALG, Portugal; **Pedroso, Joao Pedro**

We describe a meta-heuristic for job shop problem including phases of construction, local search, path relinking, strategic restarting. Construction is done by sequencing one bottleneck machine at a time. Each time a new machine is included in the solution a variable depth local search, using pairs of critical operations, is done with tabu search. After local optimum is found, procedure restarts, considering the one machine subproblem with a machine whose sequence has been changed in the previous iteration. A list of elite partial solutions is kept, with the purpose of executing path relinking after local search. Path relinking chooses most different elite solutions to be relinked, making use of a measure of distance between solutions in the neighbourhood space. The best acyclic solution found at this stage is used to continue the construction phase.

RB27 **Revenue Management Applications**

Invited session Venue: AF-19

Organizer: **Yeoman, Ian Seymour**
Napier University, United Kingdom
Organizer: **McMahon-Beattie, Una Sinead**
University of Ulster, Northern Ireland

Chair: **McMahon-Beattie, Una Sinead**
University of Ulster, Northern Ireland

1) *Airline Revenue Management - the Reservation Process Control via Dynamic Programming*, **Bilegan, Ioana Codruta**, LAAS-CNRS and ENAC TA, France; **Achaibou, Karim**; **Cosenza, Carlos A. N.**; **Mora-Camino, Felix**

In this communication, the design of a Decision Support System for improving the reservation process control of an airline company is considered. A new recursive Dynamic Programming model for maximum expected revenue evaluation is defined, which, contrarily to other approaches, takes explicitly into account daily booking requests arrivals. The expression of the probability to have, during a decision period, a k-th demand for a given fare class is established. Then, a practical Backward-Recursion Dynamic Programming algorithm can be implemented, leading to the design of an on-line optimisation module for Revenue Management.

2) *Maximise revenue from marketable packages on a game ranch*, **Hearne, John Woodville**, University of Natal, South Africa

Outfitters acquire animals for marketing to hunters. The outfitters need to construct packages comprising a mix of species to attract trophy hunters. Once packages have been compiled an Lp can be solved to determine how many packages of each type should be marketed. What if there are

other packages that could improve the results? Column generation methods can generate these packages. The outfitters problem is based on a certain number of animals being available for hunting. A further problem is what stock (species populations) should be on a game ranch to generate optimal number of marketable packages.

3) *Revenue Management on Hubs and Hotel Networks*, **Talluri, Kalyan T.**, Universitat Pompeu Fabra, Spain

We discuss a new algorithm for revenue management for hubs and line networks. Line networks arise as the underlying network for revenue management problems for hotels, rental-car companies, cruise-lines and railways. We discuss upper-bounding potential expected revenue and the performance of heuristics.

RB28 **Scheduling and Timetable VIII**

Contributed session Venue: DH-C

Chair: **Soric, Kristina**
Faculty of Economics, Croatia (Hrvatska)

1) *Using individual forecast of absenteeism in labour force scheduling* , **Olivella, Jordi**, U Politecnica Catalunya, Spain

An evaluation method of the probabilities of absenteeism according to the individual conditions of workers is described. These probabilities are used in labour force scheduling to minimise the risk that a minimum level of capacity was not reached due to absences.

2) *Three-machine scheduling with partially ordered processing routes*, **Strusevich, Vitaly**, University of Greenwich, United Kingdom

We consider three-machine shop scheduling problems in which the processing route is given by an acyclic digraph, the same for all jobs. In the classical open shop problem such a graph is empty, while for the flow shop it is a chain. We consider approximation algorithms and present their worst-case analysis for the problems with the processing graphs containing one or two arcs.

3) *A Heuristic for One Machine Scheduling Problem*, **Soric, Kristina**, Faculty of Economics, Croatia (Hrvatska); **Drmac, Zlatko**

Each of N jobs is to be processed on a single machine. Only one job can be processed at any given time. Each switch from one job to another requires sequence dependent setup time. The objective is to find a processing order which minimizes the weighted sum of start times. The problem is defined as a grouping problem. A heuristic based on spectral graph partitioning is presented with some computational results. Key words: single machine scheduling problem, sequence dependent setup times, grouping problem

RC1 **Finance and Banking I**

Contributed session Venue: DHL-B

Chair: **Osorio, Maria Auxilio**
Aut University of Puebla , Mexico

1) *Optimum Portfolio Choice in a Financial Market with Switching Risk Profile*, **Cajueiro, Daniel Oliveira**, ITA, Brazil; **Yoneyama, Takashi**

This paper addresses the problem of choosing the optimum portfolio in the context of continuous time jump diffusion models. The aim is to maximize the wealth of a small risk-averse investor that operates in this financial market. The new feature of this paper is to consider that the volatility of the stock is subject to random and discontinuous jumps over time, which are modeled by a continuous time Markov chain, that may be a result of significant changes in the financial structure, aggregate supply shocks or shifts in economic policies and political regimes. Firstly, it is shown that the risk profile of the financial market can be estimated by means of the associated quadratic variation process. Thus, the optimal control problem is formulated and the Hamilton-Jacobi-Bellman equation is solved to yield the solution.

2) *The Credit Rating Prediction Models for Korean Industrial Firms*, **Shin, Dong-Ryung**, Dankook University, Korea

Credit rating is the opinions of rating agencies on the relative ability and willingness to make timely payments on corporate bonds or commercial paper. It is intended to forecast the probability of default, as well as, the likelihood of severity of loss if default occurs. In the rating process, the rating agencies are known to utilize various financial and nonfinancial information. This paper aims to develop a credit rating prediction model for Korean industrial firms. For developing the predictin model, we used multiple discriminant and logistic regression analysis. In this paper, we also provided some new financial ratios which have not been presented in previous studies.

3) *Wrappers and Post Tax Optimal Investments*, **Osorio, Maria Auxilio**, Aut University of Puebla , Mexico

We use a stochastic programming approach in scenario trees to obtain returns of different set of assets, named wrappers, used by several banks in the UK. Wrappers have special taxation, depending on different client's future situations. In this way, investments are more attractive, and models to obtain optimal investments more complicated.

RC2 **Freight Transportation**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Powell, Warren B.**
Princeton University, United States

1) *An Information-Theoretic Approach to Modeling Car Distribution*, **Topaloglu, Huseyin**, Princeton University, United States; **Powell, Warren B.**; **Melkote, Sanjay**

We use the problem of modeling car distribution problems to illustrate the modelling of information. We illustrate both the organization and flow of information, as well as concepts of knowability and actionability. We also illustrate the use of patterns to capture incomplete information. The result is an adaptive, dynamic optimization model for freight car distribution. We report on our work to implement this at a major railroad.

2) *Effects of VRP optimization on fleet management - a case study*, **Johannessen, Bjarne**, SINTEF Applied Math, Norway; **Hasle, Geir**

The use of advanced fleet management tools with VRP optimization is rapidly increasing. However, few quantitative analyses of the effects of optimization have been published. As a case study based on the operations of a typical transportation company, we registered the detailed driving routes for a fleet of lorries over a period of several weeks, in order to quantify the savings potential. We compared the routes "as driven" with routes generated by a sophisticated VRP solver. Although there are a number of issues related with this type of comparison, our study shows that there is a considerable savings potential.

3) *The Node-dispatching Problem and Service Network Design*, **Crainic, Teodor Gabriel**, Dept. management et technologie, UQAM and CRT, Ude, Canada; **Dall'orto, Leonardo Campo**; **Leal, Jose Eugenio**

The scheduling version of the service network design problem is often formulated as a very large optimization problem on a space-time network. We examine a solution strategy that calls upon the dynamic ressource decomposition methodology proposed by Powell and et. Central to this methodology is the one-node dispatch problem. We present the formulation, discuss solution methodolies, and present computational results.

RC3 Vehicle Routing Applications I

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Eglese, Richard William**
Lancaster University, United Kingdom

1) *Optimizing vehicle routes with non-additive costs: A case study*, **Lysgaard, Jens**, Aarhus School of Business, Denmark

We consider a practical vehicle routing problem at a company delivering products on a daily basis to geographically dispersed customers. At the time of writing the company is planning their routes manually every day. After the routes have been planned, the actual deliveries are made by a transportation company. One of the remarkable characteristics of this routing problem is that the costs of visiting customers are in general non-additive, as a result of the specific charges that have been negotiated with the transportation company. In our study we consider the optimization of routes under these circumstances.

2) *A Tabu Search Algorithm for the CARP using Lower Bounds*, **Brandao, Jose C. S.**, Universidade do Minho, Portugal; **Eglese, Richard William**

In the Capacitated Arc Routing Problem (CARP) a required subset of edges of a graph are to be serviced by a set of vehicles of the same capacity. The problem is to find a minimum cost set of routes meeting that requirement. There are many applications of this problem, usually containing some additional constraints, such as garbage collection, mail distribution, road cleaning, etc. In this research we solve the CARP using a new tabu search algorithm, which incorporates the use of good lower bounds for the CARP.

3) *Vehicle Routing in Practice - Issues and Approaches*, **Eglese, Richard William**, Lancaster University, United Kingdom; **McCabe, Christopher**; **Maden, William**

Practical distribution problems involving vehicle routing are usually far more complex than the standard Vehicle Routing Problem (VRP) described in the literature. Additional features may include delivery time windows, different unloading times at different customers, different types of commodity (which give rise to constraints on the way the vehicles can be loaded), different vehicle capacities, picking up from suppliers, multiple trips for a vehicle with one driver and legal restrictions on driving time allowed. Examples are given of distribution problems and approaches that are able to address effectively the additional complexities that are important in practice.

RC4 Cutting and Packing: Nesting Problems II

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Oliveira, Jose Fernando**
FEUP - INESC Porto, Portugal

1) *A survey on nesting problems*, **Oliveira, Jose Fernando**, FEUP - INESC Porto, Portugal

Algorithms for nesting problems have been developed since the sixties, with more emphasis in the last decade. In this talk the main approaches to nesting problems resolution will be presented, both based on (meta-)heuristics, constructive and improvement heuristics, and exact techniques. This will include a brief presentation of techniques to handle the geometric layer of the problem.

2) *Iterated local search implementation for the irregular stock cutting problem*, **Bennell, Julia Allison**, University of Southampton, United Kingdom

Layout and stock cutting problems involving irregular shapes arise in a number of different industries, and as a result the variety of mixes of size, shape, and complexity of the pieces vary significantly from problem to problem. Thus, it is difficult to develop a general solution approach that will work well over the full range of problem types. The complex geometry coupled with the combinatorial complexity of the problem means that using some form of local search is an attractive proposition. However, the success of such approaches is dependent on parameter setting, move type and neighbourhood structure. This paper employs the very simple and flexible search structure of iterated local search, which requires minimal parameter tuning, in order to investigate the success of a variety of neighbourhood structures.

3) *Solving nesting problems with meta-heuristics*, **Gomes, Antonio Miguel**, FEUP - INESC Porto, Portugal; **Oliveira, Jose Fernando**

Meta-heuristics have been successfully applied to a wide range of combinatorial optimization problems, including Cutting&Packing (C&P) problems. In this talk GRASP, Simulated Annealing and Tabu Search algorithms for nesting problems, C&P where the small items have irregular shapes, will be presented together with computational results concerning their comparison.

RC5 Tutorial: Global Optimization in Modeling Environments

Invited session Venue: MS-1

Chair: **Pinter, Janos D.**
Pinter Consulting Inc, Canada

1) *Tutorial: Global Optimization in Modeling Environments*, **Pinter, Janos D.**, Pinter Consulting Inc, Canada

Tutorial: The objective of continuous global optimization (GO) is to find the 'very best' solution of complex nonlinear decision models which may also have a number of local solutions. GO is an emerging field of significant theoretical and computational challenge, as well as of obvious practical importance. An illustrative list of important GO application areas may include systems of nonlinear equatons and inequalities; data classification; nonlinear model fitting (calibration); minimal energy models and packing problems in computational physics, chemistry and biology; 'black box' system optimization; chemo- and radiotherapy; engineering equipment design; financial and econometric modelling, as well as numerous other fields. In the tutorial, we will discuss and demonstrate the use of GO software in several widely available modeling and optimization environments. Application examples from some of the areas mentioned above will also be presented.

RC6 Efficiency in Higher Education I

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Westermann, Georg H. F.**
Hochschule Harz, Germany

1) *Measuring And Disaggregating Added Value In Secondary Schools Using DEA*, **Simpson, Gary**, Aston Business School, United Kingdom; **Charlesworth-May, Andrew**; **Thanassoulis, Emmanuel**

Data Envelopment Analysis is used for measuring added value within UK Secondary Schools for pupils at GCSE stage (age 16). Initially school level data are considered. Factors that impact GCSE results are identified including pupil prior attainment and gender. The robustness of the results is investigated. We then progress to the use a large data set at hierarchical level from pupil upwards. The analysis of multi-level data decomposes pupil performance to components attributable to the pupil, the school and so on. The practical application of our approach within schools to identify good practice and raise attainment is then discussed.

2) *Measurement of the Research and Development Management Efficiency of Universities in China*, **Feng, Yingjun**, School of Management, China; **Lu, Hui**; **Bi, Kexin**

More and more importance has been attached to the R&D activities in research-based universities in China to further enhance their competitiveness. In order to be a better tool for motivating the managerial group of an university to keep on improve their R&D management performance, a combination of Analysis Hierarchy Process (AHP) and Data Envelopment Analysis (DEA) is proposed to assess the R&D management efficiency of universities. The measure consists of the measurement of a university's previous and present R&D strength by AHP and the assessment of the relative efficiency of its growth in R&D strength against those of other universities by DEA. The application of the measure to assess the R&D management efficiency of 30 research-based universities in China indicates that the universities with high R&D management efficiency have improved their strength disregard their original R&D standing. Such a measure is proved to be effective in finding good R&D management practice.

RC7 Giving interpreting and taking advice I

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States
Organizer: **Wright, George**
Graduate School of Business, United Kingdom

Chair: **Budescu, David V.**
University of Illinois, United States

1) *Aggregation of probability judgments from asymmetric sources*, **Budescu, David V.**, University of Illinois, United States; **Rantilla, Adrian K.**; **Karelitz, Tzur M.** ; **Yu, Hsiu-Ting**

We investigate the case of a DM who obtains probabilistic forecasts regarding the occurrence of a target event from J asymmetric advisors. Asymmetry is induced by manipulating the amount of information available to each advisor, and the accuracy of the advisors' previous forecasts. Results from two experiments indicate that the DM's final estimate can be described as a weighted average of the forecasts, where the weights are sensitive to both sources of asymmetry. The DM's confidence is a function of the number of advisors, the number of cues, the level of inter-judge overlap in information, and the distribution of cues over judges.

2) *Strategies for Combining Opinions*, **Soll, Jack Bennett**, INSEAD, France; **Larrick, Richard P.**

We compare several strategies for combining quantitative from two judges. In our framework, each judge is susceptible to bias and error, and errors may be correlated. The objective is to minimize MAD for a series of questions. The chasing strategy (going with one judge's guess) outperforms simple averaging when the difference in expertise is high, when the probability of detecting the better judge is high, and when the bracketing rate (percentage of questions for which the two estimates bracket the criterion) is low. Our empirical studies suggest that conditions tend to favor averaging rather than chasing. This finding is consistent with decades of research in the forecasting literature. Nevertheless, participants in our studies typically do not average.

3) *Advice taking dissonance and attitude change*, **Yaniv, Ilan**, Hebrew University, Israel

We investigated how decision makers seek and use advisory opinions as a function of their expertise, the quality of the advice and the distance of the advice from their initial opinion. In previous work we found that people tend to discount advice. Individuals also develop reputation for advisors in an asymmetric fashion, such that good reputation is more easily lost than gained. The present results show that the discounting of the advice increases as the distance between the advice and the initial opinion increases (and the results of the buying rates were consistent with this finding). The results are related to earlier findings in the area of attitude change where the response to influence is curvilinear function of the distance of the message from the receiver's original attitude. The similarities and differences between advice use and attitude change are discussed.

RC8 **MCDA Methodology I**

Invited session Venue: AT-3

Organizer: **Springael, Johan**
Vrije Universiteit Brussel, Belgium

Chair: **Brans, Jean-Pierre**
VUB, Belgium

1) *Testing the robustness of results with the DSS MACBETH*, **Vansnick, Jean-Claude**, University Mons-Hainaut, Belgium; **Bana e Costa, Carlos A.**; **De Corte, Jean-Marie**

The basic ideas of MACBETH (a new way for building numerical scales from qualitative judgements, on the basis of measurement rules) were presented for the first time at IFORS 13. A software implementing these ideas, and allowing not only to test the coherence of judgements but also to suggest modifications if necessary, was presented at IFORS 14. A new software version designed for MCDA was presented at IFORS 15. This talk will be devoted to the presentation of one of its important new features: the robustness analysis of results of an additive model stemming from a "MACBETH-type" questioning procedure.

2) *Quantifying trade-offs between multiple criteria in the formation of preferences*, **Sant'Anna, Annibal Parracho**, UFF, Brazil; **Gomes, Luiz F. Autran M.**

In this article trade-offs between criteria in the formation of preferences are quantified by applying regression analysis. Trade-offs are determined by constant weights and inconsistencies credited to the variability in the forms of measurement applied to each criterion. Ways to measure the value assigned to each option according to each criterion that will allow for the real trade-off weights to be elicited are then discussed. In order to estimate these weights measuring global and partial preferences for a reasonably large set of options and fitting a linear model are proposed. A numerical application example is included in the article.

3) *An MCDA in a Multi Functional Context to Improve Individual Performance and Synergy Between the Part*, **Sanneman, Gustavo Daniel Roig** , Usina-Hidrelétrica-Itaipu, Brazil; **Ensslin, Leonardo**

This work presents a proposal for the employment of the MCDA methodology for the systemic evaluation of organizational performance. A constructionist perspective was chosen for dealing with the performance problem. A case study is developed to better illustrate, and in greater detail, the impact exerted by the theoretical considerations upon the practical level. Demonstration is provided on how, based on the process used, it is possible to construct a wider vision embracing the performance problem as well as an identification of the most critical factors affecting the organizational synergy. It is by means of both perspectives that, in this proposal, an understanding is reached that can be used by managers to identify actions for improvement the system.

RC9 **Complex Societal Problems III**

Invited session Venue: MS-3

Organizer: **DeTombe, Dorien**
Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Chair: **DeTombe, Dorien**
Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

1) *Helping Small IT Companies in Identifying What Drives Web Development*, **Petkov, Don**, Montclair State Univ, United States; **Petkova, Olga**; **Fry, Gareth**

The Critical Success Factor theory has been applied to regional small IT companies' web software development in a new way, transforming it from a tool for consultants into an easily accessible guiding source for self-help community operations research through web technology, reflecting cultural and industry specific local issues.

2) *Dynamic Modeling of Ethnic Conflicts*, **Penzar, Drazen**, Inst for Defense Studies, Croatia (Hrvatska); **Srbljinovic, Armano**

The paper presents two formal models of ethnic conflicts: an agent-based model of ethnic mobilization and a system-dynamics model of societal conflicts. Models are based on recent social-science theories of preconditions, causes and dynamics of ethnic violence, and on experience in former Yugoslavia in last two decades. We present architecture and main models' elements, and roughly compare their dynamics with observed patterns of behavior in Yugoslav crisis. We conclude that computerized modeling of ethnic conflicts and similar complex social behavior can not predict or accurately replicate real-world events, but can help developing and understanding relevant scientific concepts and theories.

3) *Social interventions seen from a practical perspective*, **Soerensen, Lene**, Denmark; **Vidal, Victor Valqui**; **Christensen, Anne Broen**

Creating a succesful intervention is a challenging task. We discuss the intervention process in small organisation complex problem situations. A case study is presented which identifies various discussion points but emphasises the role of the facilitator

RC11 **Economics IV**

Contributed session Venue: MS-5

Chair:

1) *Modeling of Interconnection Charge between Telecommunications Networks*, **Lu, Ting-Jie**, VC of Beijing ORS, China

A lot of efforts have been contributed to the problem of interconnection between telecommunications networks by using LRIC method. Because of their different marketing powers, the negotiations of interconnection charge are still like a tangly bargaining. The reasons are as follows: 1) the methods that have been applied in industrialized economy may not be suitable for the new networking economy; 2) besides interconnection model of large network with small one, some new patterns such as different charge rates, transmission providers with ISP or value added service providers etc. In this paper, we give an economic explanation of the bargaining and then by using the model of FRC by Reinhard Saelten, the equilibrium point is found out. Therefore we could do some detailed analysis for the connecting point and for the asymmetry regulation policies.

2) *A Global Robustness Measure for Input-Output Projections in the ESA and SNA*, **Wolff, Reiner**, University of Fribourg, Switzerland

Input-output (interindustry) data are in wide use in empirical research and constitute an integral part of the European System of Accounts (ESA) and of the System of National Accounts (SNA). In a strict sense, however, these data are merely estimates of the true economic relationships. Therefore, we suggest a measure of robustness of input-output projections with respect to errors or changes in the underlying Leontief matrix. Our measure is based on the mathematical theory of norms. We discuss alternative numerical-computing algorithms and provide bounds and approximation formulas. The paper concludes with a large set of empirical sample applications.

3) *A Theoretical Analysis of the Use of Different Economic Criteria for Risk Evaluation applied to a Ca*, **Teixeira Araujo, M.Madalena**, Universidade do Minho, Portugal

The case study Property Redevelopment in Caracas: An Investment Decision (*), analyses 17 decision alternatives for a property reutilization in Caracas. To deal with the huge differences in the variances of the alternatives' NPV the case study proposes the use of a very conservative risk criterium – the probability of the NPV of the investment being less than zero. Another criterium adopted for risk analysis was the NPV's Expected Utility. In this paper we propose two other criteria to complement the study – The IRR and the Hurwicz criterium to deal with uncertain prospects. We believe that the results of the use of the two proposed criteria can help to focus the attention on the most economically attractive projects. (*) on Case Studies in Decision Analysis, by P.J. Moore et.al., Penguin Books, 1976.

RC12 **Panel Discussion: Enhancing Community Capacity through Collaboration**

Invited session Venue: AT-6

Organizer: **Phahlamohlaka, Letlibe Jacob**
University of Pretoria, South Africa

Chair: **Engelbrecht, Gawie Stoltz**
South Africa

1) *Institutional Collaboration in Community Education*, **Phahlamohlaka, Letlibe Jacob**, University of Pretoria, South Africa; **Engelbrecht, Gawie Stoltz**

This paper describes how a formal tertiary education provider (KwaMhlanga campus of Technikon Pretoria) and an informal, non profit and non governmental organization (Siyabuswa

Education and Improvement Development Trust (SEIDET)) organized, structured, synchronised and managed their activities to develop, deliver and sustain quality education to people living in a rural area of the Mpumalanga Province of South Africa. Various participatory approaches as developed and implemented within a very poor, rural and under developed area will serve as examples and guidelines as to the different phases needed in order to develop a successful community education programme.

2) *Panel discussion*, **Engelbrecht, Gawie Stoltz**, South Africa; **Phahlamohlaka, Letlibe Jacob**; **Ittmann, Hans Willem**; **Mariba, Matseke Jerry**; **Schultz, Cecilia Maria**

Phase 1 Presentation of paper by Gawie Engelbrecht and Jackie Phahlamohlaka - Institutional Collaboration in Community Education Phase 2 Introduction of Hans Ittmann, Cecile Schultz and Jerry Mariba each will share their experience and expertise regarding institutional collaboration in capacity building and community development. Phase 3 Audience will then pose questions to the panel regarding the above mentioned and the panel will lead the discussion.

RC13 **Issues in OR MS Education**

Invited session Venue: AT-7

Organizer: **Bell, Peter C**
Canada

Chair: **Belton, Valerie**
University of Strathclyde, United Kingdom

1) *An ORMS approach to allocating resources for special education*, **Petty, Nicola Ward**, University of Canterbury, New Zealand

There is little research into the most effective and equitable way to allocate educational resources to learners with vision impairment, a low incidence group. The move to educating learners with vision impairment in classes with their sighted peers has not been accompanied by research to determine desired resource levels. Levels of service are generally determined by the funding available. This research uses the ORMS process to inform decision makers and has parallels in areas such as health and social work. The session will provide an overview of this interesting and complex problem situation and the solution method.

2) *Developing the Reflective Practitioner - Designing an Undergraduate Class*, **Belton, Valerie**, University of Strathclyde, United Kingdom; **Thornbury, Helyn**

The increasing emphasis on reflection in learning and development within higher education has particular relevance to the practice of management science, which acknowledges the importance of the "reflective practitioner". In this paper we describe a class offered to final year undergraduate management science students at the University of Strathclyde since 1992, which emphasizes student centred learning and explicit reflection. The students design the class themselves, including the assessment process, to meet their learning objectives with regard to becoming a successful MS practitioner. The class will be described from the perspective of the responsible academics using Cowan's three-part model of reflection for, in and on action, illustrated by commentary from a student cohort.

3) *An Applied OR Course in Indian Institute of Management*, **Dutta, Goutam**, Indian Institute of Management, Ahmedabad, India

This paper describes the author's experience of developing and teaching an applied OR/MS course at Indian Institute of Management,Ahmedabad. Started with 5 students three years back, the current registration stands at 33. Based on methodological inputs, articles from the journal Interfaces and Edelman Award Videotapes, the course demonstrates how OR teaching may be made useful to the business schools in India.

RC14 **Modelling Agro-Forestry Systems**

Invited session Venue: AT-8

Organizer: **Weintraub, Andres F.**
University of Chile, Chile

Chair: **Romero, Carlos**
Technical University of Madrid, Spain

1) *Seeking for an Aggregated Index of Agricultural Systems Sustainability: A Multi-Criteria Approach*, **Minguez, M. Inés**, Technical Univ of Madrid, Spain; **Romero, Carlos**

Let us consider i = 1,2,..., n agricultural systems to be evaluated according to j = 1, 2,..., m indicators of sustainability. The main question posed in the paper is the determination of the system or mix of systems with best performance in terms of aggregated sustainability. In order to address this problem several procedures based upon goal programming and compromise programming are proposed. The proposed methods are applied to some real cases of agricultural sysytems in Spain.

2) *Multiobjective Programming For Agriculture and Forestry Management and Valuation*, **Zekri, Slim**, ESA Mograne, Tunisia

Estimation of economic impacts on farmers and rural population of changes on policies and/or climate change are of great help to decision makers. Multiple criteria techniques have not been sufficiently disseminated among forest analysts and decision makers. The recent theoretical developments in the field of multiple criteria in relation to the core of economic theory offer new applications of these techniques mainly in the domain of environmental valuation assets. Currently traditional appraisal techniques are being in use to monetise the advantages of forest. Compromise programming is a technique that could help mitigate the problems inherent to the above mentioned methods and allow for estimation of the opportunity costs of the natural non marketable assets.

3) *Sustainable mountain development investment evaluation: Cost-Benefit versus Multicriteria Analysis*, **Merlo, Maurizio**, University of Padova, Italy; **Kazana, Vassiliki**

The best known alternative modeling frameworks to assess "the welfare gain" of any investment in the context of the mountain areas sustainable development are the Multi-Criteria Analysis (MCA) and the Cost-Benefit Analysis (CBA). Both frameworks have some common features,as well as some important differences. This paper provides a comparative analysis of the issues related to both frameworks with regard to MEDMONT, an EU funded research project in progress, aiming at developing an integrated framework for evaluating investment in the context of sustainable development of the mountain Mediterranean areas.

RC15 **Information Systems Integration for Supply Chain Management**

Invited session Venue: AT-2B

Organizer: **Lee, Hochang**
School of Business, Kyung Hee University, Korea, Korea

Chair: **Kim, Chaiho**
Santa Clara University, United States

1) *An Agent-based DSS for Supply Chain Management* , **Lee, Hochang**, School of Business, Kyung Hee University, Korea, Korea; **Kim, Min-Yong**

This paper deals with a collaborative decision making procedure of web-based DSS for supply chain management (SCM). The seemingly autonomous DSS dedicated to each of mutually exclusive problem domains forms a communication network and cooperates each other for better SCM decision making. Modeling internet communication among web-based DSS enhances connectivity and openness of the network and therefore enables flexible and case responsive formation of the heterogeneous members, which is appropriate to the dynamic SCM environment. We also propose a hub-spoke information sharing model for the DSS network. In the hub-spoke model, an information hub at the center facilitates information exchange between DSS's and controls the conversations defined by the series of XML messages between agents of DSS. A product ordering scenario where supply decision is made upon customer order is used to demonstrate the SCM decision procedure through a collaboration of the web-based DSS.

2) *Supply Chain Management - B2B Collaboration for the Next 10 Years*, **Peters, Andru M.**, San Jose State University, United States

Supply Chain Management [SCM] concepts of moving materials and information through the global inventory pipeline quickly, efficiently, and with accuracy, is key to business survival in the next 10 years. Insuring that the various SCM business models used in managing information and materials are understood, specifically the collaborative B2B models involving the manufacturer, customer, and transportation provider. The question to be answered: "The Enterprise Survival Plan - where is the company going, and how is it going to get there?"

3) *Supply Chain Integration Through XML Web Services*, **Kim, Chaiho** , Santa Clara University, United States

This paper will discuss components of XML Web Services such as SOAP transport protocol, WSDL, and UDDI information model. It will then examine how XML Web Services will impact the information systems of the participants of a supply chain. It will present a number of case studies of such change.

4) *Collaboration in the high-technology industry*, **Agrawal, Naren**, Santa Clara University, United States; **Agrawal, Niti**

Supply chain collaboration is being recognized as a competitive imperative. Not surprisingly, therefore, collaboration has been the focus of substantial academic research and commercial ventures. We will discuss preliminary findings about the nature and extent of supply chain collaboration from a recent empirical study in the high-technology manufacturing industry.

RC16 **Technology Foresight in Europe**

Invited session Venue: WR-11

Chair: **Tavares, Luis Valadares**
CESUR-IST, Portugal

1) *Development Policies in European Union and Technology Foresight An experiment in Portugal*, **Tavares, Luis Valadares**, CESUR-IST, Portugal

A national Technology Foresight project was developed in Portugal on 1999 and 2000, (ET2000) with the major objective to understand and to boost the contribution of Engineering and Technology, E&T, to improve the competitiveness of portuguese firms. This project was based on multiple networks promoting debate and interchange of perspectives between policy makers administration, business and university experts. The work carried out was oriented to support the design and the implementation of policies to develop Portugal as a knowledge-economy using E&T as a main comparative advantage achieving higher levels of internationalization, competitiveness and sustainability. Major features of ET2000 as well as its contribution to policy making are presented in this paper.

2) *A Participatory Process for Prospective Research and Development Program Evaluation*, **Gustafsson, Tommi Valtteri**, Helsinki Univ of Tech, Finland; **Salo, Ahti Antero**

Recently, we were in charge of carrying out the final evaluation of a research and development (R&D) program for the Finnish forest cluster. The assignment consisted of two parts: ex post evaluation of R&D projects and appraisal of technological prospects. Towards this end, we organised fifteen workshops where project managers and steering groups' members actively evaluated completed projects and discussed prospects for improving the competitiveness of the cluster. In facilitating the process, we relied on a computer-based voting tool and multi-criteria decision making models. Detailed feedback from workshop participants is presented.

3) *Technology and Organizational Productivity in the Portuguese Financial Sector*, **Pereira, Manuel**, Portuguese Cathol Univ, Portugal; **Tavares, Luis Valadares**

The impact of Information Technology on productivity of organisations has been discussed in the information systems literature but no sound conclusions were found. This paper presents the findings of a mixed approach, qualitative and quantitative, where perceptions of clients and employees were combined with management data, to understand the productivity of organizations. Using the results of this research, a function was designed to assess the impact of IT on productivity of service sectors.

RC17 **Strategy/Strategic Planning/Futures**

Contributed session Venue: WR-10

Chair: **Correa, Eliezer J.**
UCV, Venezuela

1) *Strategic performance evaluation using DEA*, **Grifell-Tatjé, Emili**, U Autonoma de Barcelona, Spain; **Marquès-Gou, Pilar**

The purpose of this paper is to propose two measures of strategic performance evaluation from which a definition of sustainability of strategic performance is derived. The main property of the measures is that they can be decomposed into partial measures of performance by using mathematical programming frameworks based on Data Envelopment Analysis. This decomposition is valuable for strategic management in order to explore the sources of competitive advantage and its sustainability. The approach of the paper connects the field of productivity with strategic management.

2) *Recursive Public Policies And Citizenship*, **Espejo, Raul**, University of Lincoln, United Kingdom; **Zarama, Roberto**

This paper offers a critical analysis of a hypothesis that emerged from the authors' experience working for two years in the transformation of the educational system of Colombia. The hypothesis is that to produce an educational system with desirable properties it is necessary to enact a requisite organization. This is an organizational system that recognizes the nation's citizens as its owners, that is, as the stakeholders with declarative power to start or end the transformation-actions that produce it, thus citizens are responsible for the construction- reconstruction of the ethical-political horizons of the nation's educational system.

3) *TollSim - Simulation and Evaluation of Toll Stations*, **Correa, Eliezer J.**, UCV, Venezuela; **Nino, Norelva N.**; **Metzner, Christiane E.**

This work presents a stochastic simulation model and experimentation for a toll system developed for a highly concurred toll in Venezuela followed by a discussion of performance and economic indicators. Although mathematical models for resource problems have been developed, their use is not widespread, particularly in developing countries were toll systems are manually operated. The main objective of TollSim is to start building an infrastructure and infostructure to be used in a decision support system for management of traffic related issues in a technologically-excluded region. The model was developed using an object-oriented approach and implemented in MODSIM-III, SIMGRAPHICSII and SIMDRAW.

RC18 **Systems Methodology**

Contributed session Venue: WR-9

Chair: **Pacheco, Antonio**
CMA and IST - Lisbon, Portugal

1) *System Dynamics Modelling for Supply Chain Management--A Case Study on TESCO/P&G Supply Chain*, **Ge, Yongli**, United Kingdom; **Yang, Jian-Bo**; **Proudlove, Nathan Charles**; **Spring, Martin**

Increasing competitive pressures and market globalisation are forcing firms to develop supply chains that can quickly respond to customer needs. In this paper, the construction of a system dynamics model is reported using the TESCO/P&G supply chain system as one example. Using the model, the authors investigated the cause of the dynamic behaviour and the source of amplification from the downstream to the upstream of the chain. In the paper it will be shown how the use of information technology and the cooperation between different parts of the chain can improve the performance of the whole chain. It will also be shown how traditional control theory can be employed in the design of ordering and production policies.

2) *Burstiness descriptors for DMAPs*, **Nunes, Claudia**, IST, Mathematics Dep, CMA, Portugal; **Pacheco, Antonio**

In Internet and wireless networks, the traffic stream is characterized by the superposition of classes of services (video, voice, ftp, etc), with different statistical properties. One of the key problems in the analysis, planning and control of these networks is the bursty nature of the resulting aggregated traffic process. In this work we address the statistical characterization of the number of arrivals during bursts and a gaps for DMAPs (a class of processes widely used to model arrival processes exhibiting bursty behaviour). We study marginal characteristics (expected value, variance, etc.) of the duration of burst and gaps in DMAPs, as well as their dependence structure (including correlations), obtaining new and interesting results. The analysis is illustrated through numerical results.

RC19 **Renewable and Natural Resources**

Contributed session Venue: WR-1

Chair: **Orman, Alexander**
Shell, United Kingdom

1) *Performance Optimisation of a Photovoltaic Induction motor Pumping System*, **Betka, Achour**, Algeria; **Moussi, A.**; **Asher, G.M.**

The performances of a photovoltaic pumping system based on an induction motor and centrifugal pump are degraded once insolation varies far from the value called nominal, where the system was sized. To surmount this handicap, an improvement of these performances by the optimization of motor efficiency (a non-linear criterion) is described in this paper. Obtained results are compared with those of two systems said:constant motor efficiency (IEEE paper) and constant airgap flux operation (PHD work, 2000). The simulation results show that the proposed system allows at the same time to combine the performances of the system with constant efficiency (improved efficiencies and pump flowrate) and the simplicity of implementation provided by the system with constant airgap flux.

2) *Column Generation for a Non-temporal Harvest Model with Spatial Constraints* , **Martins, Isabel**, Portugal; **Constantino, Miguel**; **Borges, José G.**

We present an integer programming model for a non-temporal forest harvest problem with constraints on the clearcut size and on the total area of old growth patches with a minimum size requirement. The model has a very large number of variables for operationally sized problems which precludes the use of exact solution methods. We propose the column generation technique to solve the linear relaxation of the model and a procedure that constructs solutions to the problem from linear programming solutions. Computational results for test instances and for a real life instance that corresponds to a large portuguese forest are reported.

3) *Logistics planning for gas transportation*, **Orman, Alexander**, Shell, United Kingdom

We study the generation of a delivery programme for liquefied natural gas according to different supply chain configurations. A sophisticated planning tool has been developed which can prepare schedules of deliveries in order to satisfy customer requirements at a minimum cost. Through our modelling work, our customer is able to obtain a better understanding of how elements in the system interact, explore bottlenecks and assess where significant improvements to the system configuration are possible.

RC20 **Network Design II**

Invited session Venue: WR-2

Organizer: **Soriano, Patrick**
École des HEC - Center for research on transportat, Canada

Chair: **Mendiratta, Veena B.**
United States

1) *Reliability Analysis of Distributed Telecommunications Systems*, **Mendiratta, Veena B.**, United States

This talk presents a hierarchical modeling approach for analyzing network reliability of a distributed telecommunications switching system for Voice Over Packet applications. The aspects of reliability that are addressed include the following: node cluster partial and total availability; path availability; lost calls; and service availability as applicable to distributed systems.

2) *On the Reliable WDM Network Design Problem -- A General Approach*, **Chamberland, Steven** , CRT and Polytechnique, Canada

In this paper, we tackle the reliable wavelength division multiplexing (WDM) network design problem. This design problem consists to find the number of wavelengths on each link, the routing metrics (that ensure the routing of all lightpaths and the successful rerouting of the reliable lightpaths for all failure scenarios of interest to the network planner) and the wavelength assignment to lightpaths (only if wavelength paths are used). The objective is to minimize the wavelength utilization cost. A mathematical programming model is proposed for the problem. The model is adapted for the single link failure and for the single node failure scenarios. Since the problem is NP-hard, we propose two heuristics to obtain solutions for real-size instances of the problem. Finally, numerical results are presented and analyzed.

3) *Routing in WDM Ring Networks*, **Stidsen, Thomas**, Technical University of D, Denmark

Optical WDM networks will constitute an important part of the future back-bone communication networks since they facilitate very high bandwidths. Because of the socalled wavelength continuation constraint and the need for protection many of the networks will be networks of rings. This creates a new kind of routing problem which we show belongs to a more general class of routing problems. Further we will demonstrate how these can be optimized using a branch and price algorithm.

RC21 **Military OR III**

Contributed session Venue: WR-3

Chair: **Mathieson, Graham Leslie**
UK MoD, Dstl, United Kingdom

1) *Representing Human Decision-making in Air Combat Operational Analysis Modelling* , **Shakir, Lucy Amanda**, Dstl Analysis, United Kingdom

Air combat outcome is well known to be heavily influenced by human factors. System effectiveness studies of air weapon systems therefore need air combat modelling amenable to rapid changes in human parameters, to quantify the effect of human variability. The requirement of studies for such modelling was explored, applying guidelines on human modelling, and canvassing expert opinion on human factors important to combat outcome. Future studies that would be made possible by such modelling were identified. Models of human decision-making were investigated for their potential to meet the requirement, in order to select one for incorporation in air combat modelling.

2) *Genetic Algorithm for Air Defense Target Optimal Assignment Based on Space Description*, **Tang, Xiaobing**, China; **Shen, Maoxing**

Air defense target optimal assignment is an important problem in air defense system. A genetic algorithm for target assignment is presented based on minimum norm theory in the spatial viewpoint. And then, the procedure of this algorithm is given, including the fitness function designing, the crossover operator, the mutation operator and the duplication operator. The validation of this algorithm is also tested by a simulation way. In this way, the target information and the kill probability of every surface to air missile weapon system are generated randomly. This just shows that the approach is fit for multi channel system.

3) *Benefits Analysis - A multi-purpose assessment approach*, **Mathieson, Graham Leslie**, UK MoD, Dstl, United Kingdom

Benefits Analysis has evolved from roots in multi-criteria analysis, causal mapping and multi-methodology. It is a systematic method for formulating complex, multi-factor investment appraisal problems where non-financial benefits dominate the decision-maker's value system. Such decision problems abound in military OR, particularly the management of equipment capability and research. Benefits Analysis connects qualitative and quantitative OR methods and facilitates rigorous multi-methodology. This paper describes the principles Benefits Analysis and discusses its application to a variety of real problems, including research management, capability management, balance of investment, business case development, and benefit quantification strategies.

RC22 **Decision Support Systems II**

Contributed session Venue: WR-4

Chair: **Bisdorff, Raymond**
CUNLUX-EGI, Luxembourg

1) *Scenario Analysis for Knowledge DB*, **Matsuda, Toshiko**, Faculty of Economics, Chuo University, Japan

When any unexpected accident occured,related historical records will be reffered to solve the problem. The more the problem is complex,the more the way of problem solving has many branches and a decision story will be followed by a scenario in accordance with a set of conditions. In such systems,quick response in the form of vebal description is required generally,searching knowledge databases for scenario.In the paper,a trial for generation of logic tables to link inquries set and knowledge databases will be considerd. As an example,the case of disastrous marine incident will be taken.

2) *A multicriteria DSS for group decisions using value functions with imprecise information*, **Dias, Luis Candido**, FEUC and INESC Coimbra, Portugal; **Climaco, Joao Namorado**

The current version of VIP Analysis is a decision support software that incorporates complementary approaches to deal with the aggregation of multicriteria performances by means of an additive value function under imprecise information. This paper outlines a GDSS based on VIP Analysis. This new GDSS intends to support decision panels in choice problems, based on consensus or on some majority rule. Its purpose is not to impose an aggregated model from the individual ones. Rather, the GDSS is designed to reflect to each member the consequences of his/her inputs, confronting them with analogous reflections of the group members' inputs.

3) *Decision aid for the experienced decision maker*, **Bisdorff, Raymond**, CUNLUX-EGI, Luxembourg

In this communication, we present the 'Human Expertise Centred Decision Aid' (HECDA) approach, a general methodological framework for a decision aid specifically addressing the experienced decision maker. Proposed methods and tools range from - the cognitive assistance for formal problem delimitation and solidifying a given decision expertise, to - operator guidance and 'Check as You Decide' assistance. Three industrial case studies, concerning respectively production scheduling, control and maintenace, will illustrate the HECDA methodology from a practical application point of view.

RC23 **Data Envelopment Analysis III**

Contributed session Venue: AF-10

Chair:

1) *Tradeoff Analysis using DEA*, **Asmild, Mette**, CMTE, Univ. of Toronto, Canada; **Paradi, Joseph C.**; **Reese, David N.**

Because of the piecewise linear nature of the frontier in DEA, estimated marginal rates of substitution are only valid for infinitesimal or small finite changes for one or more variables. Since analyzing the impact of very small changes is not adequate for many situations, this paper develops methods by which larger tradeoffs can be evaluated in an interactive manner. The methods are capable of handling both scalar and additive changes, and basic pair-wise tradeoffs are generalized in order to assess tradeoffs between two or more variables.

2) *Evaluation Of Telephone Services In Brazil Using DEA*, **Milioni, Armando Zeferino**, Brazil; **Avellar, Jose Virgilio Guedes** ; **Polezzi, Alexandre Olympio Dower**

We analyze the relative efficiency of 34 Brazilian Landline Telephone Services Companies under different focuses, using Data Envelopment Analysis. We formulate different models within different contexts, centered in the achievement of the Universality and Quality goals imposed by the Brazilian National Agency of Telecommunications. Using real data, we compare the solutions of each model in the search for overall efficiency.

3) *A DEA Analysis of Electricity Market Characteristics and Energy Supply Industry Efficiency* , **Gracceva, Francesco**, ENEA Italy, Italy

Electricity market reforms aim to improve the Energy Supply Industry efficiency. In this work different DEA models are used to assess the relationship between the efficiency of some electric companies and the characteristics of the market in which they operate. In addition to the usual DEA results (i.e. companies efficiency score with indications about the inputs that inefficient companies should modify), a substantial result is the efficacy shown by DEA methodology to merge and synthesize economic and financial information. This fact suggests a possible utilization of DEA methodology to improve the balance sheets analysis.

RC24 **Inventory II**

Contributed session Venue: AF-13

Chair: **Kiesmueller, Gudrun**
The Netherlands

1) *Overlooked Implications Of Standard Assumptions In Two-Echelon Inventory Models*, **Lau, Amy Hing-Ling**, Hong Kong Polytechnic U, China; **Lau, Hon-Shiang**

Many manufacturer-retailer inventory models specify arbitrarily the demand function (of price) and the retailer's pricing policy (e.g., it may a Stackelberg-optimizing price or a fixed percentage markup). We present an assortment of unexpected and/or counter-intuitive effects of demand-curve forms and retailer-pricing policies on the system's optimal solutions. For example, two hardly distinguishable demand curves can lead to huge differences in the optimal decisions -- which is problematic because it would be very difficult to ascertain which of the two near-identical curves fits the market better. These effects must be properly handled in order to produce reliable two-echelon models.

2) *The impact of information sharing in supply chains*, **Dejonckheere, Jeroen**, GE Control Systems , Belgium; **Disney, Stephen**; **Lambrecht, Marc**; **Towill, Denis**

We compare the performance of a traditional supply chain with that of an information enriched supply chain where customer demand data is shared throughout the chain. Two types of replenishment rules are analysed: order-up-to (OUT) policies and smoothing policies. For the OUT policies, we show that information sharing significantly reduces, but does not eliminate, bullwhip at higher levels in the chain. For the smoothing policies, we show that information sharing is capable of eliminating bullwhip. Control theory is used to gain valuable insights into the dynamic behaviour of supply chains thus enabling "best fit" of algorithms to operational requirements.

3) *Reducing Production Variability in a Stochastic Hybrid Manufacturing - Remanufacturing System*, **Kiesmueller, Gudrun**, The Netherlands; **De Kok, A. G.**

This paper addresses the problem of product recovery management for a recovery system with different leadtimes for production and remanufacturing. We investigate three different reasonable policies with respect to production variability and cost performance and show which policy to use in a special situation.

RC25 **Mathematical Programming-Linear II**

Contributed session Venue: AF-14

Chair: **Greben, Jan M.**
CSIR, South Africa

1) *Solving Network Problems with Interior Point Methods and Preconditioned Conjugated Gradient Method*, **Gentile, Claudio**, IASI-CNR, Italy; **Frangioni, Antonio**

In this work we analyze the computational effectiveness of a new set of preconditioners for the iterative approximate solution, via a Preconditioned Conjugate Gradient (PCG) method, of the ``critical" linear systems to be solved at each step of an Interior Point (IP) method applied to Linear Min Cost Flow (MCF) problems. The new preconditioners are based on the characterization of a new class of graphs, the Brother-Connected Trees (BCT), and do not suffer the fill-in phenomenon. Since BCTs contain a spanning tree for the original graph, they provide us with better preconditioners, from the spectral standpoint, than the tree-based ones (proposed by Resende and Veiga). Several variants of BCT and tree based preconditioners are compared. The tests allow us to assess under which conditions the newly proposed preconditioners outperform those proposed in the literature, leading to more efficient IP approaches to MCF problems.

2) *Short-Term Hydroelectric Scheduling Combining Network Flow and Interior Point Approaches* , **Oliveira, Aurelio R.**, University of Sao Paulo, Brazil; **Soares, Secundino**; **Nepomuceno, Leonardo**

The short-term hydroelectric scheduling is formulated as a network flow and solved by interior point methods. The predictor-corrector version is developed and the resulting matrix structure explored leading to fast iterations since impedance matrices are not computed. For each time interval, the linear algebra reduces to solving two linear systems measuring either the number of buses or independent loops. Either matrix is invariant and factored off-line. The only matrix which changes has the number of generators and is not function of time intervals. Numerical experiments are performed to IEEE and Brazilian power systems achieving fast convergence in all instances tested.

3) *A Heuristic Method to solve LP-like problems**, **Greben, Jan M.**, CSIR, South Africa; **Payne, Danie F.**

In order to balance the electricity loads amongst different economic sectors and geographical areas, we encounter an LP (Linear Programming)-like problem. Experts in forecasting the N area loads and the M sector loads provide constraints on the N*M individual area-sector forecasts, which are given between lower and upper limits. Rather than solving this problem as an

LP problem for N*M variables, we propose a heuristic method that characterises the areas and sectors by means of N+M parameters. The resulting set of linear equations can be solved exactly, and the N+M parameters give us direct insight in the quality of the forecasts for the individual areas and sectors. *This work was funded by ESKOM

RC26 **Metaheuristics and Tabu search III**

Contributed session Venue: AF-18

Chair: **Possani, Edgar**
University of Southampton, United Kingdom

1) *Crane Scheduling for a Plate Storage*, **Hansen, Jesper**, DTU, Denmark; **Kristensen, Torben Feld Holmgaard**

Odense Steel Shipyard produces the worlds largest container ships. The first process is handling arrival and storage of steel plates until they are needed in production. We consider the problem of scheduling two gantry cranes sharing tracks. The cranes carry out the movements of plates into, around and out of the storage The system is required to create schedules for the cranes and be able to handle disruptions during the execution of the schedule. Disruptions considered are changes in due dates, machine breakdown and changes in operation times. The approach taken is a hybrid of meta-heuristics, simulation and control.

2) *Optimal control of double-deck elevator group using genetic algorithm*, **Sorsa, Janne**, KONE Corporation, Finland; **Siikonen, Marja-Liisa**; **Ehtamo, Harri**

In this article, a model for real time optimal routing of double-deck elevator group is considered. This problem has not been much considered in the literature earlier. Genetic algorithm is used to solve the resulting optimization problem. Simulation results show improvement to the known methods. The proposed method has also good potential to be implemented in reality.

3) *A Heuristic to minimise the maximum lateness for a batching machine using anexponential neigbourhood*, **Possani, Edgar**, University of Southampton, United Kingdom; **Potts, Chris N.**

A batching machine is one that can process several jobs simultaneously. Applications can be found in the manufacturing of circuit boards, and chemical processes that take place in kilns. This paper considers the problem of scheduling jobs on a single batching machine to minimize the maximum lateness, where there is a limit on the number of jobs that can be processed simultaneously in a batch. We develop an iterated descent heuristic, which uses a novel exponential neighbourhood that can be searched in polynomial time. We present and discuss extensive computational results.

RC27 **Database Modeling**

Contributed session Venue: AF-19

Chair: **Bosch, Maximo**
University of Chile, Chile

1) *On-line Analytical Processing for person trip database*, **Kawano, Hiroyuki**, Kyoto University, Japan

In the near future, in order to analyze the status of traffic flow, we will be able to use person trip databases, which record the time and positioning data collected by PHS, mobile phone with GPS and other handy terminals. In this paper, we discuss the applicability of OLAP (On-line Analytical Processing) for person trip databases. We propose the basic calculators and data structures based on the techniques of data cube. By using the traffic data of Hanshin Expressway in Osaka, we also evaluate the performance of our proposed algorithms.

2) *Evolutionary Modeling Of Time-Use Vectors*, **Fischer, Ilan**, Ben-Gurion University, Israel; **Sullivan, Oriel**

A computer simulation based on a genetic algorithm was constructed to generate the process of development of the use of time among large population samples across long time-spans. Empirical data from time-use diaries was used to validate the simulation outcomes and to serve as a base for simulations into the future. We show how the addition of empirically-derived (activity preference) and theoretical (economic constraint) evolutionary selection pressures alters the process and the forecasts of the simulation. The wider significance of the project lies in the fusion of a forecasting methodology based upon an evolutionary simulation with empirical social science data.

3) *Segmenting Customers with POS data at a retail store*, **Bosch, Maximo**, University of Chile, Chile; **Musalem, Andres**

In this work we present an approach to segment customers by their shopping basket, that is by the set of items they buy in one visit. The information used was ticket data registered at the point of sale. This data was organized in a product by product matrix which via Multidimensional Scaling (MDS) produced an n dimensional scale. Then the clustering of tickets using their position in these scales produced the desired segments. Characterization of this segments by day of the week, time of the day, promotional proness among others allows management to adjust their store decisions.

RC28 **Scheduling and Timetable I**

Contributed session Venue: DH-C

Chair: **Ketabi, Saeedeh**
The University of Isfahan, Iran

1) *Parallel Machine Scheduling Systems With Convex Resource-Dependent Processing Times*, **Shabtay, Dvir**, Ben-Gurion University, Israel; **Kaspi, Moshe**

We consider some problems in single machine and identical parallel machine scheduling systems where job-processing times are controllable through the allocation of a common limited nonrenewable resource. In the single machine scheduling system our objective is to determine simultaneously the jobs sequence and the resource allocation for each job such as to minimize a regular performance measure. In the parallel machine scheduling system our objective is to determine simultaneously the jobs assignment and sequence, and the resource allocation for each job such as to minimize a regular performance measure.

2) *Preemptive scheduling on a single machine to minimize total tardiness*, **Tian, Zhongjun**, China; **Ng, Daniel C. T.**; **Cheng, Edwin T. C.**

The single machine total tardiness problem is important in practice, but the study for this problem is focused on the non-preemptive model with equal release times. We could hardly find a paper about the preemptive model with unequal release times in the literature. In this paper, we try to investigate the latter model. Some special cases are discussed and some algorithms are provided.

3) *A random sequential method for the course timetabling*, **Ketabi, Saeedeh**, The University of Isfahan, Iran

In the course timetabling problem we need to schedule a large number of events, course and lecturers, to the available time slots. In this paper an integer program for the problem at the university of Isfahan is presented. Then a very simple search method, which is essentially a heuristically implicit enumeration, is described for solving the problem.

RC29 **Semi-Plenary: OR Society President's Medal**

Invited session Venue: GS

Organizer: **Ranyard, John**
Lancaster University, United Kingdom

Chair: **Robinson, Stewart L.**
Warwick Business School, United Kingdom

1) *The Evaluation of Damage and Studies to Aid Rebuilding in Kosovo*, **Neighbour, Michael R.**, Germany

War forced the majority of Kosovo's population from the province and resulted in wholesale destruction of buildings. This paper will present the analysis work of OAB at HQ NATO Kosovo Force, evaluating the true situation. Work was based on a coordinated survey by aid agencies and the military, which provided vital statistics on infrastructure condition. Other studies included an unbiased estimate of the population by ethnicity and identification of villages at high altitude, to prioritise aid delivery before the early onset of winter. As the situation and demands changed, studies had to be undertaken in short timeframes using novel approaches.

2) *Re-engineering a Supply Chain in the Public Sector*, **MacCarthy, Bart** , University of Nottingham, United Kingdom; **Buxton, David**; **Napier, Simon**

Government agencies rely on many thousands of different printed forms and other types of stationery. A major challenge in this type of environment is to ensure high levels of service reliability whilst controlling stock holding. Here we present a case study that has analysed, modelled and successfully reengineered a complex supply chain for printed materials. Areas discussed include Pareto analysis, simulation, forecasting and Decision Support Systems. The study has significance for similar high volume, multi-item replenishment systems that are increasing across the service economy.

RD1 **Health Risks II**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Mullen, Penelope M.**
University of Birmingham, United Kingdom

1) *Pattern Recognition in Human Assisted Reproduction*, **Patrizi, Giacomo** , University La Sapienza, Italy; **Manna, Claudio** ; **Moscatelli, Clair**; **Nieddu, Luciano**

A key problem in human assisted reproduction is to select suitable embryos for implantation. The suitability of the embryo is crucial in bringing forth a livebirth and many different criteria have been suggested. The aim of this paper is to present a recent method which has given very good results and compare it with some other well known ones. Thus theoretical and experimental results will be given. Also various methods of representation of the features of the images will be examined so as to meet a frequent criticism of medical experts, that pattern recognition methods do not provide medical criteria for the choice.

2) *VCJD Risk Assessment*, **Hare, Andre**, Department Of Health, United Kingdom; **Bennett, Peter**; **Townshend, Jeremy**

Assessment and management of the potential risk of transmission through surgery Variant Creutzfeldt-Jakob Disease (vCJD) thought to be the human form of mad cow disease, is a fatal degenerative disease. Operational Research assessed the risk of vCJD being transmitted from patient to patient via material adhering to surgical instruments using a series of models to generate a range of scenarios for surgical transmission and potential clinical cases. Further analyses looked at the cost and potential life-years saved from improved decontamination procedures. This underpins the current strategy of large scale investment to upgrade hospital sterilisation.

3) *A Generic Simulation Model of Accident and Emergency Departments*, **Riley, Jackie**, Glasgow Caledonian Uni, United Kingdom

The flow of patients through the Accident and Emergency Department and in particular the waiting times experienced by patients within the A&E department is an issue making regular appearances in the U.K. news. A Generic Visual Interactive Simulation Model for Accident and Emergency Departments has been created. The model is capable of being re-configured with respect to resources as required, and of analysing the resulting data. This presentation will preview the model and show how automatically analysed data can be provided to the user, from a set of resource allocation experiments.

RD2 Container and port management

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Cheung, Raymond K.**
Hong Kong University of Science and Technology, China

1) *Terminal location integrated with ship routing*, **Ronnqvist, Mikael**, Division of Optimization, Sweden; **Carlsson, Dick**; **Gunnarsson, Helene**

Södra Cell AB owns three pulp-mills. Ships, trains and trucks are used for supplying customers. Coupled with each harbour there is a terminal. From each terminal, the products are transported to delivery points by truck, train or both combined. Recently, two new pulp-mills were acquired, which has led to a surplus of terminals. We have developed a mathematical model that selects which terminals are to be used. A new feature combines a facility location aspect with ship routing. The solution procedure includes route generation. Results based on evaluations and implementation at Södra are presented.

2) *Storage space assignment in container terminal yards*, **Wan, Yat-wah**, HK Univ of Sci and Tech, China; **Liu, Jiyin**

We study the problem of assigning containers to storage spaces in container terminal yards and solve it using a rolling horizon approach. For each planning horizon, the problem is decomposed into two levels and each level is formulated as a mathematical programming model. The first level determines the total number of containers to be placed in each storage block in each time period. The second level allocates the available spaces to containers associated with each vessel. Experiments with practical data show that the method significantly reduces the workload imbalance in the yard, avoiding possible bottlenecks in terminal operations.

RD3 Vehicle Routing Applications II

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Dejax, Pierre**
Ecole des Mines de Nantes, France
Chair: **Dauzere-Peres, Stephane**
IRCCyN - Ecole des Mines de Nantes, France

1) *Simultaneous optimisation of loaded containers transportation and empty containers repositioning* , **Feillet, Dominique**, Ecole Centrale Paris, France; **Dejax, Pierre**; **Gendreau, Michel**

This work addresses a tactical freight transportation problem arising in the automotive industry for the annual planning of part transport between plants. A first purpose is to obtain a transportation plan that satisfies periodic origin-destination demands for loaded containers. Two kinds of itineraries are available, one-way trips and round trips, at different prices. As the transportation of containers tends to accumulate empty containers on certain sites, a second purpose is to devise itineraries that permit the repositioning of empty containers. This problem is tackled with a solution procedure based on a Branch and Price method. It shows the effectiveness of a global optimisation compared to a sequential one. We present the modelling and solution approaches as well as experimentation results on actual data from the automotive industry.

2) *Fast algorithms for general arc routing problems*, **Lacomme, Philippe**, LIMOS, France; **Prins, Christian**; **Ramdan-Cherif, Wahiba**

The academic CARP (Capacitated Arc Routing Problem) cannot tackle realistic problems found for instance in urban waste collection. An extended model called ECARP (Extended CARP) is proposed to handle complications like mixed graphs, forbidden turns, intermediate facilities, etc. We generalize in a non-trivial way three classical CARP heuristics (Path-Scanning, Augment-Merge and Ulusoy's heuristic) and describe efficient implementations based on common data structures. These heuristics are evaluated thanks to a random generator of large-scale street-like networks (up to 1000 arcs). They quickly provide good initial solutions for metaheuristics.

3) *Pick-Up And Deliveries From Depots With Different Sub-Graphs In The Solution*, **Halskau, Oyvind**, Molde University College, Norway; **Gribkovskaia, Irina**

Vehicle Routing Problems (VRP) are encountered in many practical situations. VRP with the added complexity of pick-up and deliveries will in general make the planning problem more difficult. We consider a restricted situation where all demands start and at the depot We relax the VRP restriction that all customers shall only be visited once. This relaxation can lead to several different routing options in terms of sub-graphs constituting the overall solution. One such solution can be a so-called lasso-solution. We offer an exact model for solving such pick-up and delivery problems where the vehicles can follow different kinds of sub-graphs when performing the service to the customers. The model will be applied on a real life situation concerning the distribution of beverage from a regional producer in Western Norway. Keywords: Vehicle routing problem, pick-up and delivery

RD4 Cutting and Packing: Pattern Sequencing

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Yanasse, Horacio Hideki**
Instituto Nacional de Pesquisas Espaciais, Brazil

1) *A sequence problem in practical Trim optimisation*, **Schreck, Helmut P.**, TietoEnator MAS GmbH, Germany

In practical trim optimisation there appear sequencing problems in many circumstances. We report about a special problem that is caused by logistic problems concerning the resulting items. It could be solved within the trim optimisation by combining a linear programming approach with graph theoretical concepts.

2) *An approach for the generation and sequencing of cutting patterns in the cutting stock problem*, **Pileggi, Gisele**, Universidade de Sao Paulo, Brazil; **Morabito, Reinaldo**; **Arenales, Marcos Nereu**

We develop an integrated approach to deal with the generation and sequencing of cutting patterns for the cutting stock problem, which considers the tradeoff between the waste of material and the maximum number of open stacks. Computational results are presented to illustrate the performance of the approach.

3) *A cutting and sequencing integrated model*, **Yanasse, Horacio Hideki**, Instituto Nacional de Pesquisas Espaciais, Brazil; **Pinto, Maria Jose**

We propose a mathematical programming model that integrates the cutting stock problem with pattern sequencing. A decomposition method is being suggested for solving this model. Limited computational results will be presented.

RD6 Efficiency in Higher Education II

Invited session Venue: AT-1

Organizer: **Seiford, Lawrence**
University of Michigan, United States
Organizer: **Zhu, Joe**
Worcester Polytechnic Institute, United States

Chair: **Westermann, Georg H. F.**
Hochschule Harz, Germany

1) *Efficiency in University Central Administrative Services*, **Casu, Barbara**, Aston Business School, United Kingdom; **Thanassoulis, Emmanuel**

This paper describes an attempt to evaluate the cost efficiency of UK university central administration. The funding councils of UK universities have progressively evolved elaborate systems for measuring university performance in teaching quality and research. Indeed, funding of universities is linked to their performance in research. The allocation of resources between academic and administrative activities, on the other hand, has so far not been subject to scrutiny. Yet, expenditure on administration is typically some 30% of that allocated to academic activities. This paper sets up a DEA framework to identify practices leading to cost-efficient central administrative services in UK universities.

2) *Benchmarking Universities - A Framework and the German Case*, **Westermann, Georg H. F.**, Hochschule Harz, Germany

Efficiency oriented budgeting is a very up-to-date feature in the discussion of restructuring universities throughout Europe and especially in Germany. Within this context the benchmarking of universities plays a crucial role as a tool to uncover and punish as well as eliminate inefficiencies. The aim of this paper is twofold: (1) To develop a benchmarking framework in order to standardize the measurement approach for university efficiency with respect to the three possible outputs teaching, research and administration. (2) To apply the framework to departments of German universities in order to prove the applicability of the suggested benchmarking process.

3) *Including Principal Component Weights to Improve Discrimination in Data Envelopment Analysis*, **Adler, Nicole**, Hebrew University, Israel; **Golani, Boaz**

This research further develops the combined use of principal component analysis (PCA) and data envelopment analysis (DEA). The aim is to reduce the curse of dimensionality that occurs in DEA when there are an excessive number of inputs and outputs in relation to the number of decision-making units. Three separate PCA-DEA formulations are developed in the paper utilising the results of principal component analyses to develop objective, assurance region type constraints on the DEA weights. The first model applies PCA to grouped data representing similar themes, such as quality or environmental measures. The second model, if needed, applies PCA to all inputs and separately to all outputs, thus further strengthening the discrimination power of DEA. The third formulation searches for a single set of global weights with which to fully rank all observations. In summary, it is clear that the use of PCs can noticeably improve the strength of DEA models.

RD7 Giving interpreting and taking advice II

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States
Organizer: **Wright, George**
Graduate School of Business, United Kingdom

Chair: **Budescu, David V.**
University of Illinois, United States

1) *Default strategies and learnt strategies in opinion aggregation*, **Harries, Clare**, University of Leeds, United Kingdom; **Yaniv, Ilan**; **Harvey, Nigel**

We present two studies that evaluate how people combine advice and how they respond to outlying opinions. They use discounting strategies to combine a small sample of opinions taken only once. In a learning paradigm with feedback and outlying opinions that may or may not be accurate it is easy to reinforce a discounting strategy. It is relatively more difficult to counteract this default approach. The results suggest that discounting strategies are a default because of an ease-accuracy trade-off. The relative advantage of different strategies changes as their ease and accuracy change as experience is gained.

2) *How to choose an advisor*, **Fischer, Ilan**, Ben-Gurion University, Israel; **Harvey, Nigel**; **Budescu, David V.**

The first part of the talk reviews three cue learning experiments. People received various levels of training, followed by participation in judge advisor sessions comprising variable quality advice levels. All judges took more advice from advisors more experienced than themselves. The second part of the talk examines whether experience is indeed a good indicator of advisors expertise. Results form an experiment driven by a Cognitive Classification Structure model, distinguish between the conditions under which experience is indeed a good indicator of performance (and confidence) and those that result in poor or none correlated variables.

3) *Combining Opinions: Why don't people average?*, **Soll, Jack Bennett**, INSEAD, France; **Larrick, Richard P.**

In estimation and forecasting, simply averaging judgments is a highly effective way to reduce error. However, in a series of studies we find that people typically do not average. Rather, many people employ the "chase the expert" strategy. They make a guess about which person knows more about a given question, and put high weight on that person. "Chase the expert" has a high cost; most participants would have done better with averaging. We identify two reasons why people disfavor averaging:(1)overconfidence in ability to identify the true expert, and(2)misconceptions about the benefits of averaging.

RD8 **MCDA Methodology II**

Invited session Venue: AT-3

Organizer: **Springael, Johan**
Vrije Universiteit Brussel, Belgium

Chair: **Slowinski, Roman**
University of Technology, Poland

1) *Characterization of 'max', 'min' and 'order statistics' multicriteria aggregation functions*, **Denis, Bouyssou**, LAMSADE-CNRS, France; **Greco, Salvatore**; **Matarazzo, Benedetto** ; **Pirlot, Marc**; **Slowinski, Roman**

We characterize MAX, MIN and ORDER STATISTICS multicriteria aggregation functions by giving some specific cancellation properties in the style of conjoint measurement approach. The interest of these aggregation functions is due to their ordinal character. The proposed axioms concern a product space where each dimension is a criterion with its own domain. Given a comprehensive preference relation in this space, we induce from it a scale of each considered aggregation function. Other known axiomatizations assume that the scale is given a priori.

2) *Characterization of Sugeno integral and associative operator for multicriteria aggregation*, **Greco, Salvatore**, University of Catania, Italy; **Matarazzo, Benedetto** ; **Slowinski, Roman**

We consider some aggregation functions permitting to obtain a synthetic evaluation in multicriteria decision problems: Sugeno integral and associative operators. Special cases of Sugeno integrals are also considered: maxmin-weighted sum and ordered weighted maximum or minimum. We give an axiomatic characterization of them in terms of specific cancellation properties in the style of conjoint measurement approach. Moreover, we prove that each one of these aggregation functions can be represented in terms of a set of "if…, then …" decision rules having a specific syntax.

3) *Individual Mate Selection Under Competing Objectives*, **Tozer, Peter R.**, Pennsylvania State, United States; **Stokes, Jeffrey R.**

Dairy breeders were asked to rank three objectives and then weight the importance of each objective relative to the others. This information was then used to determine weights to be used in a multiple-objective integer program designed to select individual mates for a herd of 76 Jersey cows with known genetic background and cow net merit. The results of the multiple-objective models show that rank and relative importance of producer objectives can affect the portfolio of sires selected. Producers whose primary objective was to maximize expected net merit had a range of average expected progeny net merit of $306 to $310, but the level of expected progeny inbreeding was from 6.99% to 10.45% and a semen cost per conception of $35 to $41.

RD9 **Complex Societal Problems IV**

Invited session Venue: MS-3

Organizer: **DeTombe, Dorien**
Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Chair: **Enserink, Bert**
TBM TU Delft, The Netherlands

1) *Policy Evaluation - a case for MCA? Political acting as complex societal problem*, **Schuh, Bernd**, Univ of Economics Vienna, Austria; **Giokas, Georg**

Political and social actions are subject to objective success measures due to legal constraints (see e.g. EU-Regulations on evaluations; the Marakesh Agreement establishing the WTO). This procedure of measuring the success/ failure of a public intervention is commonly referred to as evaluation within a complex societal context. Traditional evaluation methodologies assume that evaluations always arrive at a ?best possible solution? by implicitly reducing the complexity of the problem.

Multicriteria Analysis on the other hand, seems to suit better in such a context. Therefore this paper tries to show possible applications of MCA methods in a policy evaluation context. Strengths and weaknesses will be listed. All these findings are based upon case studies in different political and administrational environments.

2) *Research Methodologyand Ontological Notions of Complex Societal Problems*, **Ivanov, Oleg**, St.-Petersburg State Univ, Russia

Three ontological notions of complex societal problems:objective,subjective,and objective-subjective can be outlined.The single initial notion of subject study and subject of social action-the most important principle of complex approach as a relatively new methodological conception of modern science and modern social practice.The author deals with the underlying principles of complex approach.

3) *Formalizing political theories using a dynamical systems approach*, **Springael, Johan**, Vrije Universiteit Brussel, Belgium; **Macharis, Cathy**; **Geeraerts, Gustaaf**

A mathematical model describing the behaviour of and the interactions between three political actors is set up using dynamical systems. Each actor is represented by means of its relative power, whereas the type of interaction is depending on the ``status quo'' or ``revisionistic'' character of the different countries. The model is solved numerically through simulation. The results of the simulations allow a better understanding of international political relations as well as the analysis of the underlying assumptions of several political theories.

RD10 **Case Studies I**

Invited session Venue: MS-4

Organizer: **Ranyard, John**
Lancaster University, United Kingdom

Chair: **Ranyard, John**
Lancaster University, United Kingdom

1) *Rationalising a public sector 'production industry'*, **Norman, Michael James**, United Kingdom

All medicines are produced in premises that have been granted a manufacturing licence. In addition, most have an individual product licence, which specifies the ingredients – both active and non-active – and the packaging, including the labelling. However, there are occasions when a patient might require a treatment that involves a medicine that is not one of those with a product licence. In these situations, a medicine is specially made for the patient; such medicines are called “specials”. There are up to 100 NHS Trusts where these specials are manufactured and a project was set up to examine this 'industry' to define the risks if some or all of these sites closed down and, if this was a significant risk, what should be done. Following this initial work, an implementation project was initiated to take forward the recommendations of the risk analysis. The talk will follow both projects from inception to the point where the implementation is well underway.

2) *"It's for me daughter's wedding, guv"*, **Dixon, Paul Martin**, HM Customs and Excise, United Kingdom

(Revenue Evaded from Cross Channel Smuggling) Most people's experience of HM Customs & Excise is the slightly scary moment associated with entering the country with goods from near and far. However, behind the scenes, OR specialists are busy calculating the amount of duty evaded or lost to the country through the purchase of goods abroad. Much is properly and legally brought into the UK for personal use, but much is also smuggled into the country. This talk will address the sampling process and methodology associated with calculating the revenue evaded from smuggling across the English Channel.

3) *Because OR's complicated enough...*, **Brown, Michael**, Abbey National Plc, United Kingdom; **Sykes, Alice**

GSConsulting provides consultancy solutions to the complex problems facing different areas throughout Abbey National. Providing quality deliverables and winning business requires more than good robust analysis and solutions. We are asked all sorts of questions; What will be the impact of changes in this product or process? Should I make the changes all at once? Which will deliver most benefit? The questions are simple enough, the answers are more difficult. What would make life less complicated? We will explain and demonstrate how we have made life less complicated for our clients without compromising our approach and the techniques we use.

RD11 **Education, Innovation and Distance learning**

Contributed session Venue: MS-5

Chair: **Redondo, Raquel**
Universidad Complutense , Spain

1) *OR Education in the UK*, **Gilchrist, Warren**, Sheffield Hallam Universi, United Kingdom

The Author has carried out a study of OR Education in the UK on behalf of the OR Society. The paper considers the current state of the art and also some of the main issues the education community has to face in the UK, and probably in the wider world.

2) *New Computer Tool To Help Students To Prepare Decision Theory Lessons*, **Redondo, Raquel**, Universidad Complutense , Spain; **Martinez, Elena**; **Rua, Antonio**

This work is intended to describe a computer work tool that is, mainly, being designed by professors in Statistics and O.R. II Department, Complutense University of Madrid, to help students to prepare Decision Theory lessons. The tool pretends to be a new way to motivate and attract pupils to the study of the subject. In order to make the tool interesting, it is been designed in a modular way with different modules to treat theoretical concepts, practical tests, suggestions to summarise and get the important concepts of the subject, etc. and it is plenty of colour and fun.

RD12 **Systems Thinking and Community Development**

Invited session Venue: AT-6

Organizer: **Phahlamohlaka, Letlibe Jacob**
University of Pretoria, South Africa

Chair: **Ochoa Arias, Alejandro Elias**
Centro de Sistemologia Interpretativa, Venezuela

1) *An Interpretive-Systemic exegesis of Community Development*, **Ochoa Arias, Alejandro Elias**, Centro de Sistemologia Interpretativa, Venezuela

The existence of discourses asking for community development and, simultaneously acknowledging the inevitability of globalization are hallmarks of the current political discourse. It seems relevant to understand the grounds upon which these two discourses seems to agree and disagree in order to unfold a meaning of community development that becomes central to re-define the commonly held notion of globalization. The grounds are formulated by referring to the concepts of citizenship, social justice and global issues. It concludes showing Systems Thinking for Community Development as an inquiring framework about the historical and cultural contingencies that allows the co-existence of these two discourses in the present.

2) *Architecture of the process of Community Operational Research*, **White, Leroy A.**, South Bank University, United Kingdom

Ackoff stated that 'in decision making, account should be taken of aesthetic values because they are relevant to quality of life'. This is more relevant today where there is an increase in the complexity of the situation where choices need to be made and/or issues surrounded a decision(s) need to be deliberated and considered. In this paper the issue of the space and surrounding that may impact on decision-making in large groups will be explored. The challenge in developing appropriate spaces for community OR lies in how to ensure that there is an overall plan so that the different people and groups are able to work together towards accomplishing the overall objectives.

3) *Economy of Communion - Systemic Factors in an Emerging Culture*, **Linard, Keith Thomas**, Business Dynamics Centre, Australia; **Gold, Lorna**

The Economy of Communion is an experience of social economy sprung from the praxis of the Focolare Movement, an ecumenical and inter-religious organisation with roots in the Catholic Church. This radical social phenomenon is played out in overlapping and intersecting local and global networks. Businesses operating within the paradigm form communications and 'thought' networks spanning the globe, but function typically within local markets. Within a mere decade this ideal has spread to over 100 countries, attracted some 800 firms, generated almost 100 academic theses, and been accorded major international recognition. This paper examines the systemic philosophical, organisational and cultural factors associated with the dissemination of this phenomenon.

RD13 **Teaching OR/MS with cases (workshop)**

Invited session Venue: AT-7

Organizer: **Bell, Peter C**
Canada

Chair: **Bell, Peter C**
Canada

1) *Teaching OR/MS with cases (Workshop)*, **Bell, Peter C**, Canada; **Haehling von Lanzenauer, Christoph**

The objective of this workshop is to introduce OR instructors to the use of cases. We will discuss and demonstrate some of the opportunities that cases present to enhance the OR course.

RD14 **OR in Forestry - Landscape Perspectives**

Invited session Venue: AT-8

Organizer: **Weintraub, Andres F.**
University of Chile, Chile

Chair: **Martell, David L.**
Faculty of Forestry, University of Toronto, Canada

1) *Dynamic optimization of harvest openings using Tabu Search* , **Richards, Evelyn W.**, University of New Brunswi, Canada

A graph model and Tabu Search algorithm was developed to optimize harvest timing over a medium-term planning horizon. The model uses graph search methods and variable green-up periods to ensure feasibility with respect to opening size, adjacency delay and green patch size. Openings are dynamically created during the tabu search procedure to avoid reducing the feasible region by apriori defining harvest blocks.

2) *Do Landscape Perspectives Require Model I?*, **Gunn, Eldon A.**, Dalhousie University, Canada

Model I linear programming formulations of forest management problems are known to require many more variables to represent the forest dynamics than equivalent Model II formulations. As a result, commercial forest management software has focussed on Model II. However, current modelling includes a large number of quasi-spatial issues. We may not care about the precise coordinates of a stand but we may need to know that it is in a particular landscape, watershed, ecoregion, ecodistrict, riparian buffer or viewscape. Such quasi-spatial issues are easily included in Model I formulations. We discuss these and other modelling advantages as well as computational approaches.

3) *Living with uncertainty when managing flammable forest landscapes*, **Martell, David L.**, Faculty of Forestry, University of Toronto, Canada

Fire is a natural component of the circumpolar boreal forest region and it has both beneficial impacts on natural ecosystem processes and detrimental impacts on public safety, property and industrial timber production. Forest management planners now incorporate potential fire losses in their harvest planning procedures but their primary objective typically stresses timber production. This paper describes how stochastic fire processes can influence timber production and explores how the benefits of fire can be assessed and incorporated in forest management planning.

RD15 **Queuing Theory and Applications II**

Contributed session Venue: AT-2B

Chair: **Van Ackere, Ann**
HEC Lausanne, Switzerland

1) *A Channel Allocation for Two-tier Cellular System*, **Xin, Zhan-Hong**, Mei-Qin Fang, China

A two-tier cellular system consists of a number of small microcells overlaid by one large macrocell. In such a system, the channel allocation algorithms are studied with two different call admission strategies to minimize the total blocking and dropout rates. Results are obtained by approximately analysing and computer simulating.

2) *The Optimal Service Policies in an Queue with Consecutive Vacations*, **Song, Yu**, Japan

In this research, we consider a single server queueing system with Poisson arrivals and multiple vacation types, in which the server can choose one of several types of vacations to take when he finishes serving all customers in the system. Upon completion of a vacation, the server may either take another vacation with a certain probability or check the number of customers waiting in the system. In the latter case, if the number of customers is greater than a critical threshold, the server will resume serving the queue exhaustively; otherwise, he will take another vacation. It is shown that this infinite buffer queueing system can be formulated as a finite state semi-Markov decision process. With this finite state model, we can determine the optimal service policy to minimize the long-term average cost of this vacation system.

3) *Mode Locking and Chaos A Deterministic Queueing Model with Feedback*, **Van Ackere, Ann**, HEC Lausanne, Switzerland; **Haxholdt, Christian** ; **Larsen, Erik R.**

We consider a deterministic queueing system with two forms of feedback: (i) the service rate increases in queue length and (ii) the arrival rate depends on customers' perception of past waiting times. The model exhibits sustained oscillation, mode-locking, quasi-periodic behaviour, and chaos, implying that a deterministic queuing system can exhibit unpredictable behaviour. The customer's decision to seek service is a two-stage process: (i) deciding whether or not to use a facility, and (ii) deciding the frequency of visit (constant or time dependent). The model applies to any situation where an increase in demand lowers the quality of service.

RD16 **The History of Operational Research in Europe and India**

Invited session Venue: WR-11

Organizer: **Kirby, Maurice William**
Lancaster University, United Kingdom

Chair: **Kirby, Maurice William**
Lancaster University, United Kingdom

1) *OR in India - A Historical Analysis*, **Bandyopadhyay, Rangalal**, Centre for Applied Systems Analysis in Development, India

The paper traces the introduction and subsequent growth of OR in India from the mid 1950s. It identifies similarities and differences of growth profile of OR in India with that noticed in developed economies (mainly UK and USA). The paper also analyses the various factors/forces influencing the growth profile of OR society in India and OR in academic areas and areas of applications in industry, services and national planning. Strengths and weaknesses of OR in India are then diagnosed. Based on the historical analysis of growth and appraisal of strengths and weaknesses likely future growth of Indian OR is projected. Steps needed for strengthening its vigorous and relevant growth in future are then identified

2) *E U R O: OR in Europe. The past, the present, the future.*, **Brans, Jean-Pierre**, VUB, Belgium

EURO was created on January 29, 1975 at EURO 1 in Brussels thanks to the powerful initiative opf Professor H.J. Zimmermann. At that time four basic instruments for the promotion of OR were set up: The Organisation, the EURO K conferences, the EURO Working groups, and EJOR the European Journal of OR. In 1983 three additional major instruments were initiated: the MINI EURO conferences, the EURO Gold Medal and the EURO cooperation toolbox later on. It is my intention to give an overview of all these EURO activities. Some challenges for the future will be proposed.

RD17 **Mapping approaches in OR**

Invited session Venue: WR-10

Organizer: **Pidd, Michael**
Lancaster University, United Kingdom

Chair: **Paterson, George D.**
Shell International, United Kingdom

1) *Mixing methods - the use of cognitive or cause maps*, **Ackermann, Fran**, University of Strathclyde, United Kingdom; **Eden, Colin**

Cognitive or cause mapping has been extensively used for helping groups and individuals with problem solving, strategy development and other messy, complex problems. In these cases the mapping technique, which may be undertaken manually or with computer support, is used on its own. However alongside this, mapping has been used as a precursor to other methods such as Multi Criteria Analysis, System Dynamics, Spreadsheet analysis etc. This presentation explores whether there are differences in each of these applications, what these differences are, and what this might suggest when combining methods

2) *Hypertext-augmented Collaborative Modeling* , **Conklin, Jeff**, George Mason University, United States

A hard, formal model evokes precision and rigor; a soft model allows for incomplete and conflicting information. New approaches to collective problem solving combine three elements: one or more modeling frameworks (formalisms, notations), hypertext software projected on a shared display screen, and facilitation. This hypertext-augmented collaborative modeling can efficiently create high levels of shared understanding and shared commitment. Success on wicked problems depends on flexibly combining both hard and soft modeling frameworks in a semi-structured hypertext database. Success also depends on the facilitator's fluency with the framework(s), skill with the software, and skill in engaging the group with the shared display.

3) *'How was that decided?' A process/tool for hard decisions*, **Mackenzie, Adrian** , Lancaster University, United Kingdom; **Westcombe, Mark**; **Warren, Ian** ; **Sommerville, Ian** ; **Pidd, Michael**

There is a tension between building 'soft' models that aid decision-making and 'hard' models that act as living records. Soft-OR focuses on group process and developing collective cognitions of problems. The models produced are rarely reused since they act as the means and not the end. Software engineering, or design in general, is interested in producing documents that can be used later by the group or others, such as the build or maintenace team, auditors, or other project teams. We are experimenting with an approach that can help the decision making and leave tracks that can be followed by others.

RD18 **OR & Strategy Case studies**

Invited session Venue: WR-9

Organizer: **O'Brien, Frances**
Warwick Business School, United Kingdom

Chair: **O'Brien, Frances**
Warwick Business School, United Kingdom

1) *Modelling in a Very Real Environment: Techniques and Issues Found in Off-Trade Market for the No 1 Brewer in UK*, **MacMillan, Gordon Douglas Fraser** , Scottish Courage Brands, United Kingdom

Scottish Courage Brands (SCB) operates in a highly competitive market with both consumers and customers becoming more sophisticated and demanding. To meet its objectives SCB needs to be to be proactive in handling competitive and market dynamics. Through a new department created with OR in mind, SCB has modelled relationships with Competitor Key Brands and Key factors to optimise volume and associated profit. The techniques have included Elasticity Analysis, Complex Regression and Multiple Regression in order to create models encompassing as many relevant issues as possible. A good understanding of what key drivers and interaction taking place has been established and SCB has been able to more confidently define and execute strategy and tactics in a very complex and demanding market place.

2) *Developing an e-teaching and learning vision for the University of Warwick*, **Meadows, Maureen**, Warwick Business School, United Kingdom; **O'Brien, Frances**; **Dyson, Robert**

This paper will discuss an exercise in vision development conducted with staff and students at the University of Warwick. The exercise was commissioned to assist in the planning of technology provision for teaching and learning over the next decade. The focus of the exercise was to develop a vision and associated action plans for e-learning for the university. The visioning methodology will be presented along with some of the interim results of the project. Issues concerning the development of participative visioning methodologies more generally will also be discussed.

3) *Integrating balanced scorecard into logistics strategic management-Taiwan case*, **Liou, Cheng-Hwai**, Accounting Department, Taiwan

Balance Score Card (BSC) has received much attention from managers. Going beyond the scope of traditional performance evaluation, it involved in the enterprise vision and strategy. Definitely, BSC is going to play an aggressive role in action-oriented strategy. Taiwan is going to join WTO,how to correctly calculate product costs and effectively evaluate the performance of management is critical to the establishing and maintaining of competitive advantages. The research is going to apply AHP to integrate BSC in logistics management to deal simultaneously with internal and external environment, as well as objective and subjective factors. This integrated system is expected to induce innovation, improve customer service, and enhance financial performance. Also, we are going to do case study and empirical analysis of logistic companies. Key Word!GBalance Score Card (BSC) !AAnalytical Hierarchy Process(AHP)!ALogistics!AStrategic Management

4) *Strategic Architecture and Business Dynamics*, **Warren, Kim**, London Business School, United Kingdom

Both investors and managers need reliable approaches to estimating firms' future earnings. This paper examines two cases, Marks & Spencer and Exodus Communications – a failed web-hosting firm – to illustrate a rigorous, usable and fact-based approach to laying out a firm's architecture of resources. The system dynamics framework is ideally suited to representing this architecture, and offers a great deal of insight without the need to build computer simulations. The approach offers a robust and generally applicable formulation of a firm's

strategic architecture, which determines its performance through time..

5) *Successful Strategic Project Management in the UK Upstream Oil and Gas Sector*, **Asrilhant, Boris**, Petrobras , Brazil; **Dyson, Robert**; **Meadows, Maureen**

This work aims to explore the elements and the role of techniques in facilitating successful strategic project management, as applied to the UK upstream oil and gas sector. First, the literature on techniques applied to managing projects is briefly reviewed. Second, an exploratory investigation describes and validates fifty multidisciplinary elements involved in strategic project management and explores the extent to which techniques address, in theory, these elements. Third, a questionnaire identifies success elements involved in strategic project management and the extent to which techniques address these elements in practice. Finally, sets of techniques for successful strategic project management are proposed.

RD19 **Understanding knowledge management in organisations**

Invited session Venue: WR-1

Organizer: **Edwards, John Steven**
Aston Business School, United Kingdom

Chair: **Edwards, John Steven**
Aston Business School, United Kingdom

1) *Knowledge Management – what is the value of Intellectual Capital?*, **Coakes, Elayne**, University of Westminster, United Kingdom; **Sugden, Gill** ; **Bradburn, Anton**

We discuss the findings from surveying KM practitioners, and semi-structured interviews with KM champions, in large service organisations throughout the United Kingdom. Results indicate high degrees of correlation between the promotion of expert communities and the exploitation of knowledge. At present, there are no universally consistent standards for measuring KM benefits as added value delivered to organisations. We refer to the work of Lucier and Torsilieri (1997) who advocate a set of metrics to evaluate KM outputs in terms of business value enabling inter-organisational comparisons that are linked to operating measures thus providing a meaningful baseline for comparisons.

2) *Performance Measurement and Knowledge Management* , **Delesie, Lucas**, University of Leuven-KUL, Belgium; **Croes, Ludo**

Socrates defined knowledge management in his discussion with Alcibiades as "gnauton seauton; know yourself". Many organizations are re-discovering this ancient principle by way of balanced scorecards, key performance indication or performance measurement. This paper argues that the key issue stays synthesis, to see the wood from the trees, rather than analysis. This pertains to physical properties, e.g. ? or production figures, as well as non-physical properties, e.g. customer satisfaction, competence. This paper illustrates these points for a business example, e.g. an insurance company. It discusses the issues and draws some conclusions.

RD20 **Heuristic and IP Models - Part II**

Invited session Venue: WR-2

Organizer: **Wilson, John M.**
Business School, Loughborough University, United Kingdom

Chair: **Darby-Dowman, Kenneth**
Brunel University, United Kingdom

1) *The allocation of shared costs - fairness versus efficiency*, **Butler, Martin**, Ireland; **Williams, H. Paul**

The problem of efficiency verus fairness is considered in relation to the splitting of costs for shared facilities between the users. This is considered as a result of a problem of sharing the cost of the provision of central computer facilities in a large university, but the basic problem is widespread. An LP model is considered in order to minimise costs. The dual of the model is shown to give a fair solution according to criteria resulting from cooperative game theory.

2) *Two-period travelling salesman problem applied to milk collection in Ireland*, **Williams, H. Paul**, London School of Economic, United Kingdom; **Butler, Martin**

We describe an important extension of the travelling salesman problem (TSP) in which some nodes are visited in both of 2 periods and the remaining nodes are visited in either 1. The problem arose with regard to milk collection in Ireland where some farms lacking storage facilities and required every day collections but others were content to have collections every other day. A number of possible IP formulations are will be given. Valid cutting planes are defined for this problem which result in an, otherwise prohibitively, difficult problem becoming solvable by a combination of cuts and B&B. Some of these cuts are generalisations of the subtour elimination and comb inequalities for the single period TSP.

3) *Integrating Mixed Integer Programming and CLP for solving a Facility Location problem*, **Darby-Dowman, Kenneth**, Brunel University, United Kingdom; **Lucas, Cormac**

We examine a problem in which, given a set of demand points, the objective is to determine the minimum number of supply points that cover demand whilst complying with time constraints on deliveries. A set of sites is provided as potential locations for the supply points and an MIP model is presented. An alternative CLP formulation is also developed. The two are combined to create a hybrid formulation. In this the CLP solver is able to exploit the LP bounds of the MIP problem. By analysing properties of the problem structure, the results of investigating alternative search strategies are presented. Variables, based on cost parameters, are introduced to guide the search. It is shown that speed up can be achieved for this model representation in spite of the increased problem size.

The model is further developed as an integer GP and computational experience is reported for all these models.

RD21 **Finance and Banking II**

Contributed session Venue: WR-3

Chair: **Chapman, Chris**
University of Southampton, United Kingdom

1) *Risk measures for asset allocation models*, **Ortobelli , Sergio**, University of Bergamo, Italy; **Giacometti, Rosella**

This paper analyzes and compares the properties of risk measures commonly used in asset allocation problems. We propose a comparison both on theoretical and empirical basis of risk measures such as STD, MAD, Safety-First, Cvar and Gini. For this purpose we consider allocation models for investors characterized by different and parameterized utility functions under the hypothesis of return distributions depending on two parameters (expected return and risk measure). The comparison is based both on historical and alpha-stable simulated returns.

2) *Application of Goal Programming to Asset and Liability Management under Crisis*, **Tektas, Arzu**, Bogazici University, Turkey; **Gunay, Emine Nur**

Efficient asset-liability management plays a crucial role in a bank's success.The aim is to maximise bank's profit as well as control and minimise risk.A group of risk related objectives such as liquidity, solvency, capital adequacy, interest rate are defined with different priority levels specified by bank management.This multiobjective decision problem is subject to a number of internal and external constraints such as financial, legal requirements and institutional policies. The problem is formulated as a Goal Programming model and applied to a commercial Turkish bank.This article brings new evidence on the performance of an emerging market bank by comparing the asset-liability management for years 1998 and 2001;before and after the financial crisis in Turkey. The crisis has shown how shifts in market perceptions can create trouble even if objective conditions haven't changed. The study may shed light for bank management that wants to avoid devastating effects of crisis.

3) *Constructively Simple Probabilities*, **Chapman, Chris** , University of Southampton, United Kingdom; **Ward, Stephen**

Clarification of the relationship between data based objective probabilities and issues which must be accommodated in subjective judgements is the concern addressed. Two examples will be used, drawn from consultancy based research contracts, one with Railtrack (a safety issue) and one with the MOD (schedule/cost issues).

RD22 **Decision Support Systems III**

Contributed session Venue: WR-4

Chair: **Hazen, Mark Gerald**
DREA, Canada

1) *Supporting the decision process using an evolution model*, **Papamichail, K. Nadia**, Manchester Business School, United Kingdom; **Robertson, Ian**

A theoretical model of the decision process has been developed in order to better integrate the decision concept with models of business processes. A particular interest is to implement coordinative support for the decision-making process. This work describes the case study of an actual decision process undertaken in a not-for-profit organization to validate this model. The longitudinal process is mapped as dependent activities, and the theoretical model in turn maps to each of these activities as different phases of an evolution. Thus the model supporting the decision process does not possess an explicit model of the process, rather it is a generic model that evolves in a way that suits the pattern of activities needed for that particular decision problem. The novelty of the approach stems from the use of process-support technologies for understanding and improving decision-making practices.

2) *Layout modelling and construction procedure for a fair*, **Widmer, Marino**, Uni Fribourg - DIUF, Switzerland; **Schneuwly, Patrick**

This talk tackles a subset of layout problems that is not a subject of the scientific research to date: the arrangement of the exhibition spaces in a fair. A fair is a large scale exhibition for goods and services; for example a trade fair or a regional fair. The layout problem of fairs consists in finding an acceptable layout for both the exhibitors, the visitors, and the organiser of the fair. A model for representing the layout of fairs is presented: the adjacency model. Based on the adjacency model, a construction procedure is developed that leads to the generation of alternative layout solutions. Numerical results for the layout of a real fair are reported.

3) *Finding Robust Solutions to Multi-static Sonar Tactical Development Problems*, **Hazen, Mark Gerald**, DREA, Canada

Multi-static active sonar problems are characterised by large numbers of transmitters and receivers operating in complex environments. Given the complexity, an important problem is the development of sensor deployment tactics. However, the combination of Monte Carlo simulation and large parameter spaces often limits the number of potential deployment patterns that can be practically examined. Recent increases in computer power are now making the use of Global Optimisation routines feasible for searching the parameter space. The usefulness in the tactical development process of a hybrid Simulated Annealing/ Downhill Simplex algorithm, is investigated. Initial results show that two main issues need to be resolved: (1) the impact of Monte Carlo errors on convergence of the algorithms and (2) defining meaningful measures of solution robustness.

RD23 **Data Envelopment Analysis IV**

Contributed session Venue: AF-10

Chair: **Mukherjee, Shyama Prasad**
Calcutta University , India

1) *Technological Progress And Productivity Growth In The Sandstone Of The Parana State Northwest*, **Pereira, Marcelo Farid**, UEM-Sobrapo, Brazil; **Da Silveira, Joao Serafim Tusi** ; **Pizzolato, Nelio Domingue**; **Samohyl, Robert Wayne**

Starting in the 1970's the Brazilian agricultural sector experienced an important process of modernisation. However, some regions were not able to introduce technological innovations. One of such areas was the sandstone of the Northwest of the State of Parana, whose production system does not use practically any technology that provides gains of productivity. Given this we decided to develop a study whose main objective is to evaluate the evolution of the productivity indicators of 21 municipal districts of the area, in the period from 1970 to 1995. The model used in the analysis was based on Malmquist Index. Results obtained indicate expressive losses of productivity.

2) *Performance Evaluation of Commercial Bank Branches in Canada Using DEA*, **Paradi, Joseph C.**, CMTE, Univ. of Toronto, Canada; **Schaffnit, Claire**

We assess overall efficiency of commercial branches of a large Canadian bank using DEA. We consider two production models: look at resource usage, useful to the branch manager and incorporate financial results to serve senior management. We introduce non-discretionary factors to reflect specific aspects of the branch environment: risk factors and economic growth. Both input and output multipliers are constrained by market prices and managerial preferences to obtain effectiveness measures. The cost-minimization study yielded valuable results on the performance of individual branches and at the district level. Output oriented models reflected the Bank's recent emphasis towards growth in some areas.

3) *Three Aspects Of DEA Revisited*, **Mukherjee, Shyama Prasad**, Calcutta University , India; **Majumdar , Amit Chandra**

The article considers three aspects of DEA, viz., emphasizing the significance of planning of inputs and outputs by DMUs and hence extending DEA to cover effectiveness, efficiency and productivity as three different measures of organisational performance ; proposing some new analyses for evaluating and comparing efficient units among themselves ; and suggesting a method for examining the role of time on DEA results.

RD24 **Analytic Hierarchy Process I**

Contributed session Venue: AF-13

Chair: **Kinoshita, Eizo**
Meijo University, Japan

1) *An AHP Model for Sequencing Manufacturing Strategic Action Plans*, **Quezada, Luis Ernesto**, University of Santiago, Chile; **Cordova, Felisa Margarita**; **O'Brien, Christopher**

This paper presents a model for sequencing manufacturing strategic action plans within a process of formulating a manufacturing strategy. A methodology has been developed previously to formulate a manufacturing strategy,which produces as a result a Manufacturing Strategic Index (SMI, which is a measure of the competitive advantage provided by the manufacturing area of a company. It also generates action plans to improve the index. This paper proves that the index cannot be used to sequence the action plans and that other criteria should be considered. For this reason, a AHP model has been developed to support their sequencing. Basically, the model defines a number of criteria and rank the action plans against those criteria. Apart from the SMI, some of the criteria may be investment cost, competences created and implementation. This paper also shows a case study to illustrate the application of the model.

2) *Mathematical Structures of Analytical Network Process and Concurrent Convergence Method*, **Kinoshita, Eizo**, Meijo University, Japan; **Sekitani, Kazuyuki**

This study discusses mathematical structures of Analytic Network Process(ANP) and Concurrent Convergence Method(CCM) which are decision making systmes based on Analytical Hierarchy Process. By formulating ANP and CCM as eigenvalue methods for super-matrices, we analyze mathematical properties of their weight vectors and illustrate relationship between them with a simple example.

3) *An Expert Judgment Based Study of Accident Risk in the Istanbul Channel*, **Or, Ilhan**, Bogazici University, Turkey; **Tayanc, Demet**; **Turker, Yasin**

This study investigates possible factors contributing to accident risks in the Istanbul Channel, based on expert judgment, elicited and structured through the Analytic Hierarchy Process (AHP). First, risk contributing factors / mitigating measures are established; their significant states defined and appropriate, simple questions formulated to assess their expected relative impacts. Next, different groups of stakeholders are interviewed, and their responses are compiled within AHP framework. Results obtained provide overall and group based quantitative profiles of the relative importance of various factors and measures; they also facilitate the development of a "risk level measurement tool", which can be used during real time monitoring of the Channel.

RD25 **OR for Development**

Invited session Venue: AF-14

Organizer: **Dutta, Goutam**
Indian Institute of Management, Ahmedabad, India

Chair: **Tripathy, Arabinda**
Indian Institute of Management, Ahmedabad, India

1) *A Total System Intervention for School Children* , **Harmse, Marthi**, Vaal Triangle Technikon, South Africa; **Pothas, Anne Marie**; **De Wet, Andries G.**

Since its beginning the Operations Research (OR) profession has struggled to reach a concise definition agreed upon by all OR practitioners and with meaning to non-practitioners. OR therefore has been subjected to a continuous process of reflection and development. The paper contributes to this process by describing one intervention in social affairs novel to OR, namely OR for street children. The methodology of Action Research according to the CRASP model is followed. The model is adapted to research OR, by applying a Total Systems Intervention approach. This methodology is briefly described and the rest of the paper is structured accordingly.

RD26 **Military OR IV**

Contributed session Venue: AF-18

Chair: **Mathaisel, Dennis F. X.**
Babson College, United States

1) *US Army Recapitalization Reliability Modeling And Optimization*, **Briand, Daniel** , Sandia National Labs, United States; **Thompson, Bruce M.**

The U.S. Army is beginning an extensive program to transform its Legacy Force through a major Recapitalization effort. Sandia National Laboratories' detailed reliability modeling methodology and genetic optimization will predict the impact of proposed recapitalization upgrades then optimize the upgrades to provide the greatest performance improvement within budget constraints.

2) *Multicriteria Synthesis of Survivable Networks*, **Malashenko, Yurii E.**, Computing Centre of RAS, Russia; **Novikova, Natalia M.**; **Pospelova, Irina I.**

We consider the problem of synthesizing multiuser network systems. This problem for an unknown demand vector corresponds to multicriteria maximization. We suppose nonrandom external influences reducing the capacity of arcs of the physical network graph. In this case, we come to the multicriteria maximinimax problem with the criteria vector composed of the values of commodity flows. Given approach allows constructing optimal structure of the network with respect to the specified set of possible influences.

3) *An Application of Value Stream Mapping for Maintenance Operations*, **Mathaisel, Dennis F. X.**, Babson College, United States; **Comm, Clare L.**

Value stream maps, traditionally used in manufacturing to identify waste in production streams, employ lean concepts by helping practitioners think of flow instead of discrete processes. In this paper, a high-level value steam map is developed and applied to maintenance operations to eliminate non-value added activities.

RD27 **Pricing Management**

Invited session Venue: AF-19

Organizer: **Yeoman, Ian Seymour**
Napier University, United Kingdom
Organizer: **McMahon-Beattie, Una Sinead**
University of Ulster, Northern Ireland

Chair: **McMahon-Beattie, Una Sinead**
University of Ulster, Northern Ireland

1) *Dynamic Pricing: The New Diversity of Revenue Management*, **Blair, Montgomery**, PROS Revenue Management, United States; **Yeoman, Ian Seymour**

Revenue Management is traditionally about the optimization and capacity allocation models. The concept of pricing is sometimes seen as exogenous or secondary. The challenge of revenue management moves to integrate optimization, inventory allocation and pricing into one continuous process, in which revenue and pricing are inseparable as the semantics suggest. But how do we bridge the theory and practice into one continuum, that brings together inventory control, market segmentation, optimization to capitalize on price elasticities? Therefore, we intend to facilitate a discussion about this new diversity of Revenue Management

2) *Dynamic Pricing and Inventory Management*, **Perakis, Georgia**, MIT, United States; **Kachani, Soulaymane**

Dynamic pricing has become very important in the recent years in a variety of arenas including airline revenue management as well as inventory control and supply chain management. In this talk we present a fluid dynamics model that includes joint pricing, production and inventory decisions in a multi-product environment. Our model does not assume perishable products and incorporates the element of competition. Moreover, it models the delay of price in affecting demand.

3) *Dynamic Pricing Strategies in Manufacturing*, **Swann, Julie**, Georgia Tech, United States; **Chan, Lap Mui Ann**; **Simchi-Levi, David**

We examine the problem of coordinating dynamic and fixed pricing strategies with production scheduling decisions in a manufacturing firm where demand is assumed to be a general stochastic function. We consider partial planning strategies, where one decision is made at the beginning of the horizon and a second decision is delayed until the beginning of each period. We develop several heuristics for the strategies based on deterministic approximations and analyze the worst-case performance. Computational analysis is performed to develop insights about the performance of the heuristics.

RD28 **Scheduling and Timetable II**

Contributed session Venue: DH-C

Chair: **Maroto Alvarez, Maria Concepcion**
Universidad Politecnica, Spain

1) *Train Planning and Timetabling---a Kind of Open Vehicle Routing Problem with Soft Time Windows*, **Fu, Zhuo**, Central South University, China; **Eglese, Richard William**

Train planning and timetabling problem can be formulated as Open Vehicle Routing and Scheduling Problem with Soft Time Windows. This paper describes the problem and present heuristics for its solution. The main objectives are to minimise the customers penalty and service cost. Numerical results are presented.

2) *A hybrid genetic algorithm to solve a lot-sizing and scheduling problem*, **Staggemeier, Andrea Toniolo**, UWE, United Kingdom; **Clark, Alistair Richard**; **Aickelin, Uwe**

This paper reports a lot-sizing and scheduling problem, which minimizes inventory and backlog costs on m parallel machines with sequence-dependent set-up times over t periods. Problem solutions are represented as product subsets ordered and/or unordered for each machine m at each period t. The optimal lot sizes are determined applying a linear program. A genetic algorithm searches either over ordered or over unordered subsets (which are implicitly ordered using a fast ATSP-type heuristic) to identify an overall optimal solution. Initial computational results are presented, comparing the speed and solution quality of the ordered and unordered genetic algorithm approaches.

3) *Flexible Manufacturing in the Ceramic Tile Industry using Genetic Algorithms*, **Maroto Alvarez, Maria Concepcion**, Universidad Politecnica, Spain; **Ruiz Garcia, Ruben**

The Spanish ceramic tile industry has evolved greatly in recent years. After a decade of improvements in manufacturing, today's plants are capable of mass producing tiles with little human intervention. However, the planning has not changed much and scheduling orders do not follow optimization processes. This problem is now even worse as orders become smaller, due dates are shortened and more and more different products must be offered to remain competitive. We evaluate the capabilities of the professional software to obtain feasible schedules in a reasonable amount of time, by using heuristics such as the genetic algorithms.

FA1 **Health Services: Emergency Services**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Harper, Paul R.**
University of Southampton, United Kingdom

1) *Identification of Regime Switching in Emergency Bed Demand*, **Jones, Simon Andrew**, Kingston University, United Kingdom; **Joy, Mark Patrick**; **Pearson, Jon**

Previous research has shown that SARIMA models can produced good forecasts of emergency bed demand. However, these forecasts tend to break down when hospital managers need them most, during bed crises. This paper employs SETAR and Markov switching models to investigate whether these breakdowns could be the result of regime switching. Clear evidence for regime switching is found. These models produce better out of sample forecasts than the SARIMA models. Furthermore, we find that one of the regimes is associated with adverse events such as long waiting times in A&E and cancelled operations.

2) *Forecasting Bed Requirements for Emergency Admissions to Acute Hospitals* , **Proudlove, Nathan Charles**, MSM, UMIST, United Kingdom; **Dewhurst, Frank William**

For the past 3 years researchers at UMIST have been providing capacity planners at the NW Region of the National Health Service with demand forecasts which are used in planning hospital-level service provision and monitoring demand, particularly during the critical winter periods. Daily forecasts of emergency admissions and consequent bed requirements are produced for each of the 4 geographical areas of the region, split into 5 patient categories. The work consists of time-series forecasting of emergency admissions volumes, based on 8 years of daily-admissions history, and modeling of length-of-stay distributions, based on records of all patients discharged over two years.

3) *Planning and Management of an Emergency Ambulance Service*, **De Angelis, Vanda**, University La Sapienza, Italy; **Storchi, Giovanni**; **Felici, Giovanni**

The problem of the planning and management of the emergency ambulance service in an area, within budget constraints, is tackled here from two points of view: choosing the geographical location of ambulance bases in order to keep the travel time from the nearest base to the client below a target value; calculating the number of ambulances to allocate at each base in order to keep the probability that an ambulance is available at the nearest base above a certain target value. The area considered in this paper is the city of Rome. Data was supplied by the Rome Emergency Service.

FA2 **Network Design for Transportation and Logistics**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Gruenert, Tore**
RWTH Aachen, Germany

1) *Network Optimization Problems with Piecewise Linear Costs using the Overflow Model*, **Ketabi, Saeedeh**, The University of Isfahan, Iran

In this paper the multicommodity network flow problem is considered in which the costs of flows are piecewise linear.

This problem arises in many communication and telecommunication network design problems. A new model, the Overflow Model, is used to formulate the problem and a lagrangian relaxation method is discussed.

2) *Network Design - Modeling and Solving in the Airline Context* , **Kliewer, Georg**, University of Paderborn, Germany; **Koberstein, Achim**

The airline network design problem appears in the long-term planning phase of an airline. The goal is to decide for a given flight network which arcs can be eliminated or added. The proposed solution must take the passenger flow in the network into account and also the aircraft flow of the airline. The passenger flow is modeled as a minimum cost multicommodity flow. The model for the aircraft flow considers different aircraft types, balancing conditions, aircraft availability, etc. We work with path-based multicommodity flow models because of the fact that a passenger travel path is strictly constrained, e.g. the path length cannot be too long. We present several metaheuristic algorithms (e.g. simulated annealing) which make use of an CPLEX-based column generation procedure. A comparison with an exact solution procedure is given. We discuss results obtained for benchmark data and also for the flight network of Lufthansa.

3) *Neighborhood Search and Evolutionary Algorithms for p-hub Transportation Networks*, **Reinholz, Andreas**, University of Dortmund, Germany; **Heinrichmeyer, Hilmar**

We present several combinations out of Neighborhood Search (NS) and Evolutionary Algorithms (EA) for a real world optimization task which is based on the so called p-hub problem and considers the two criteria transportation costs and service quality (arrival time at the depots). Our approaches are using the two variation operators “changing the location of a hub” and “changing the allocation of a depot to a hub” as mutation operators for EA and as neighborhood generating operators for NS. The implemented methods are compared in a large empirical investigation with up to 100 runs per instance and method.

FA3 **Vehicle Routing with Time Windows**

Invited session Venue: DH-N

Organizer: **Potvin, Jean-Yves**
Montreal University, Canada

Chair: **Ichoua, Soumia**
Centre for Research on Transportation, Canada

1) *Real-time vehicle dispatching with time windows and forecasted demands*, **Ichoua, Soumia**, Centre for Research on Transportation, Canada; **Gendreau, Michel**; **Potvin, Jean-Yves**

We study the benefits that can be gained in real-time dispatching systems by exploiting information about future demands. More precisely, we propose and analyze a strategy that introduces dummy customers (representing forecasted requests) in vehicle routes to provide a good coverage of the territory. The intent is to meet forecasted needs efficiently. Our analysis is based on a series of computational experiments performed in a simulated pick-up only environment.

2) *Multi-Depot Supply-Chain Management Including Local Repairs*, **Chan, Yupo** , University of Arkansas, United States; **Eren, Bahtiyar**

Most supply-chain-management models do not consider repairs that could be done locally. We formulate a model that includes such an option. Also, inventories can be shared among depots, setting aside direct shipment from a factory. A stochastic program of vehicle location-routing is constructed, whereby the shipment pattern and delivery itineraries (over time) are explicitly identified. Generalized Benders' decomposition is used to solve the huge stochastic program. Preliminary result suggests that lateral resupply, repair and the resulting efficiency are particularly useful in emergency situations.

3) *Incremental costs in vehicle routing and scheduling*, **Dullaert, Wout**, University of Antwerp, Belgium; **Braysy, Olli** ; **Johannessen, Bjarne**

Good estimates of the incremental cost of customers or customer types are essential for pricing routing services. The additional cost of routing a customer acts as a price-floor: the freight rate should at least cover the additional cost of servicing that customer. To our knowledge, the strategies developed in this paper are the first for determining the incremental cost of a customer and estimating cost driving effect of customer characteristics. They generate vital cost information that allows large distribution companies to evaluate and possibly redesign their price structures.

FA4 **Cutting and Packing: AI Methods**

Invited session Venue: DH-S

Organizer: **Valerio de Carvalho, Jose Manuel**
Universidade do Minho, Portugal

Chair: **Oliveira, Jose Fernando**
FEUP - INESC Porto, Portugal

1) *Modeling the Cutting and Packing Problems with Graph Approach*, **Chan, Stephen L. C.**, Hong Kong Baptist Univers, China; **Wong, Eddy C. C.**

We explored a model for one-dimensional cutting and packing problems, which is based on the Gilmore and Gomory's approach. In our model, new sets of variables are formed by using the digraph representation. Incidence matrix of digraph is then applied to formulate the configuration of the incremental patterns with side constraints. Furthermore, heuristics were developed and used in pre-processing, resulting in some partial solutions, which are optimal. In addition, we modified our model to handle the generalized problem with different stock/bin sizes, prices and supplies considerations. Computational results of the test cases obtained from the OR-Library will be reported.

2) *AI search methods to solve constrained two-dimensional cutting stock problems*, **Oberholzer, Jan Adriaan**, PU for CHE, South Africa; **Hattingh, Johannes Michiel**; **Steyn, Tjaart**

The constrained two-dimensional cutting stock problem, often called the trim loss problem, involves the identification of an optimal cutting pattern to employ on a sheet of material. Lately, some researchers have tried to use artificial intelligence search techniques in the exploration of the search tree. Since trim loss problems are often basic in the assortment problem, we consider the performance of some of the algorithms with respect to good cutting patterns as well as time complexity.

3) *Sicup Business Meeting*, **Oliveira, Jose Fernando**, FEUP - INESC Porto, Portugal

This is a business meeting

FA5 **Data Mining**

Invited session Venue: MS-1

Organizer: **Abbass, Hussein**
University of New South Wales, Australia

Chair: **Newton, Charles**
UNSW, Australia

1) *Machine Learning using Multi-objective Programming Techniques*, **Nakayama, Hirotaka**, Konan University, Japan; **Yun, Yeboon**; **Yoon, Min**; **Asada, Takeshi**

Recently, support vector machines (SVM) for machine learning are attracting researchers' interest due to its simplicity and high performance. In pattern classification problems with two class sets, its idea is to find a maximal margin separating hyperplane which gives the greatest separation between the classes in a high dimensional feature space. This task is usually performed by solving a quadratic programming problem. This paper suggests a new method for SVM using multi-objective linear programming techniques along with several practical examples, e.g., portfolio selection in financial engineering and land slide disaster problems in civil engineering.

2) *An Higher-order Markov Chain Model for Categorical Data*, **Ching, Wai ki**, University of Hong Kong, China; **Ng, Michael K. P.**

In this paper we study an higher-order Markov chain model for analysing categorical data sequences. We propose some efficient estimation methods for the model parameters. Different data sequences such as DNA, song and wind-speed are used to illustrate the predicting power of our proposed models. We also apply the developed higher-order Markov chain model to the server logs data. The objective here is to model the users' behaviour in accessing information and to predict their behaviour in the future. Our tests are based on two realistic web logs. Our model shows a marked improvement in precision and applicability.

3) *Process Control Using Classification Trees with Boosting*, **Suzuki, Hideo**, Japan

This research presents a method for process control, based on boosting classification trees, which can detect and recognize unnatural patterns on sequential process data. AdaBoost algorithm is used. That is, classification tree algorithm is rerun many times and the computed trees are combined using voting. The subsamples that are used for training each tree are chosen in a manner which concentrates on the ghardest examples. The Boosting classification trees are trained to detect and recognized unnatural patterns, such as shifts, trends, peaks and trends. Simulation experiments are provided to select a set of parameters and to test the proposed method.

FA6 **Closed Loop Supply Chains I**

Invited session Venue: AT-1

Organizer: **Pappis, Costas P.**
University of Piraeus, Greece

Chair: **Bloemhof, Jacqueline**
Erasmus University Rotterdam, The Netherlands

1) *One and two way packaging in the dairy sector*, **Bloemhof, Jacqueline**, Erasmus University Rotterdam, The Netherlands; **Van Nunen, Jo**; **Vroom, Jurriaan** ; **Van der Linden, Ad**; **Kraal, Annemarie**

Choosing packaging material for dairy products and soft drinks is an interesting issue at the moment. Discussions arise on the costs impacts and environmental impacts of both one way packaging and reusable packaging. The aim of this article is to develop an evaluation tool providing costs and environmental impacts of the PC-bottle and the GT-packs in the dairy sector, considering forward and return flows. The evaluation tool enables the user to analyse the costs and environmental impacts of a supply chain with and without return flows using scenario analyses with respect to the use of various carrier types and the number of return loops.

2) *Product design and closed loop supply chain for a refrigerator*, **Krikke, Harold**, Center Applied Research, The Netherlands; **Bloemhof, Jacqueline**; **Van Wassenhove, Luk N.**

We look at the joint decision of product design and closed loop supply chain network design for a refrigerator. Optimisation occurs over the full product life cycle (from cradle to grave) by a multicriteria MILP model. There are three possible product designs, each has different cost and environmental functions. Demand occurs at regional warehouses in Europe, suppliers are also available at various locations in Europe. Location-allocation for forward and reverse facilities are optimised given a set of allowed locations, in combination with optimal product design. The model is run for different scenarios, e.g. for future EU legislation.

3) *Inventory strategies for systems with fast remanufacturing*, **Teunter, Ruud H.**, Erasmus University, The Netherlands; **Van der Laan, Erwin**; **Vlachos, Dimitrios**

We analyze hybrid manufacturing/remanufacturing systems with a long lead time for manufacturing and a short lead time for remanufacturing. We review the classes of inventory strategies for hybrid systems in the literature. These are all based on equal lead times. For systems with slow manufacturing and fast remanufacturing, we propose a new class. An extensive numerical experiment shows that the optimal strategy in the new class almost always performs better and often much better than the optimal strategies in all other classes.

FA7 **Group Decision Making**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States
Organizer: **Wright, George**
Graduate School of Business, United Kingdom

Chair: **Mostaghimi, Mehdi**
Southern CT State Univ, United States

1) *Basic Quasirationality*, **Lahiri, Somdeb**, South Africa

In this paper we attempt to arrive at axiomatic characterizations of choice functions which are subrational and where chosen elements are a subset of the solution set obtained by maximizing a binary relation. We also try to provide axiomatic characterizations of choice functions where choice sets contain at least one solution obtained by maximizing a binary relation. We call such choice functions quasirational. A particular type of quasirational choice functions are what we call consistent choice functions. We provide an axiomatization of such solutions in this paper as well. (Also affiliated with: Indian Institute of Management, Ahmedabad-380 015, India.)

2) *Modeling Ambiguous Risk and the Effect of Outcome Discrepancy* , **Jia, Jianmin**, Chinese Univ of Hong Kong, China

We develop a choice model based on a tradeoff between the mean and variation of random expected utility due to probability ambiguity. We show that the effect of probability ambiguity on preference is determined jointly by three factors: 1) the attitude of a decision maker toward ambiguity, 2) the average amount of probability ambiguity, and 3) the discrepancy between the utilities of choice outcomes. For a certain degree of probability ambiguity, larger utility differences of choice outcomes lead to larger preference uncertainty and greater impact on the overall preference evaluation.

3) *A Value Focused Thinking Approach to Improving the Upham Brook Watershed*, **Merrick, Jason**, Virginia Commonwealth U, United States; **Parnell, Gregory S.**

In an effort to integrate environmental and socio-economic objectives in the decision making process, an eight member interdisciplinary team built a multi-objective decision analysis model. The team used Value Focused Thinking to determine what actions should be taken to achieve maximum improvements in an urban watershed. The model used environmental indicators comparable to nationally used indicators, or data that was readily available. The results obtained from the initial data collection from Upham Brook watershed is compared to a hypothetically perfect watershed named Utopia. Comparing the scores for Upham Brook to Utopia reveals where programs to improve the watershed can be focused to get the maximum effect. The multi-objective decision analysis model can be used in different situations to analyze what management actions will be most effective to maximize watershed health.

4) *Strategic design in experts-assisted decision making process*, **Mostaghimi, Mehdi**, Southern CT State Univ, United States

In an experts-assisted decision making paradigm, the information collection design becomes a strategic variable under a weak assumption that the final decision is dependent on the design used to collect information as well. Thus, a decision maker can strategically select a design which serves his/her objective the best. This research uses a Bayesian estimation methodology for combining experts information with a decision maker s prior. An information collection process is designed by setting constraints on this model. Several designs are developed using such controlled factors as a one-stage versus a two-stage decision process, experts rank ordering, and group versus individual lobbying/consultation.

FA8 **MCDA and Mathematical Programming**

Invited session Venue: AT-3

Organizer: **Springael, Johan**
Vrije Universiteit Brussel, Belgium

Chair: **Siskos, Yannis**
University of Piraeus, Greece

1) *Assessing multicriteria prediction models based on socio-economic data*, **Siskos, Yannis**, University of Piraeus, Greece; **Grigoroudis, Evangelos**

Multiple regression models based on linear programming are well-known flexible and powerful prediction tools. The minimisation of deviations between predicted and actual values are modelled using goal programming techniques. The application presented in this paper concerns the prediction of the construction and building activities in Greece through a set of socio-economic criteria. Besides the model of Wagner, linear regression analysis considers several alternative fitting criteria, and a stepwise regression process (forward selection, backward elimination) as well. Furthermore, ordinal regression analysis is examined and the respective results are presented. In all cases, the linear programming formulation gives the ability to perform post-optimality analysis, which indicates the stability of the provided results.

2) *An MCDM Model for Media Selection in Dual Market Role*, **Kwak , N. K.** , Saint Louis University , United States; **Lee, Chang W.** ; **Kim , Ji Hee**

An optimal advertising media selection is a strategic factor for the operations of both traditional and e-business environments. This paper presents the case that considers two options:

industrial and consumer products. In order to resolve the strategic decision-making about dual market high technology products, a mixed integer goal-programming model is developed to facilitate the advertising media selection process. The preemptive priority ordering is established by the analytic hierarchy process. The problem is solved lexicographically using the WinQSB multiphase simplex method, based on the data obtained from the e-business industry in Korea. The satisfying solution is identified and analyzed.

3) *A Combinatorial Multicriteria Approach For Corporate Funding Under Policy Constraints*, **Mavrotas, Georges**, NTUA, Greece; **Diakoulaki, Danae**; **Caloghirou, Yannis**

Corporate funding is a typical multicriteria decision situation where the decision- maker is called to single out the most attractive alternative(s) among a large number of applications. The decision problem becomes more complex if, in addition to the multiple evaluation criteria, the decision-maker has to comply with specific limitations imposing a combinatorial consideration of the examined alternatives. The present paper presents a combined MCDA-Integer Programming approach that takes into account both, the performances of the applications in the evaluation criteria, and the imposed policy constraints. The developed approach is applied in a real decision situation concerning the funding of industrial firms from governmental institutions wishing to combine the evaluation process with specific sectoral and/or regional priorities. Keywords: multicriteria decision aid, integer programming, fractional programming, finance

FA9 **Complex Societal Problems (Workshop)**

Invited session Venue: MS-3

Organizer: **DeTombe, Dorien**
Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Chair: **DeTombe, Dorien**
Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

1) *Complex Societal problems Theory and Practice*, **DeTombe, Dorien**, Greenhill-Waterfront Sc Inst ComplexSocietal Probl, The Netherlands

Traditional the content of the sessions of the conference on the topic of complex societal problems are discussed with all the participants of the conference stream of complex societal problems. Which new things are developed in the field. What did we learn. Which progress is made on theory, and in practice. What are the interesting current questions in the field? How will we continue in the future? Which new urgent complex societal problem can be signaled. The questions will reflect theory and every day life practice. All people interested in this subject are invited to join the workshop.

FA10 **Case Studies II - Military Applications**

Invited session Venue: MS-4

Organizer: **Ranyard, John**
Lancaster University, United Kingdom

Chair: **Ranyard, John**
Lancaster University, United Kingdom

1) *Monitoring of KLA Compliance to Demilitarise*, **Neighbour, Michael R.**, Germany; **Bailey, Peter**; **Hawthorn, Marcus**; **Lensing, Connie**; **Robson, Hamish**; **Smith, Stuart**

General Ceku (KLA) signed an undertaking to demilitarise in June 1999. OAB at NATO HQ Kosovo Force developed and implemented compliance monitoring of this agreement. This case study will look at that monitoring procedure. The original agreement was complex, but the monitoring procedure enabled a fair, rational and auditable analysis of KIA compliance with weekly reports. Due to the political situation, it was imperative that data was current. This case study also examines procedures adopted for long term monitoring of demilitarised KLA militia.

2) *Negotiations in Military Conflicts*, **Murray-Jones, Peter**, QinetiQ, United Kingdom

Today's military must broker agreements, remain impartial and do their up most to avoid escalating a conflict. Peace Operations or War Against Terrorism requires a new approach compared with traditional warfare which, at present, has to be learnt empirically. However, a development of mathematical Game Theory□called Drama Theory□is trying to change this. Drama Theory conceptualises the situation of a Commander in a □confrontation□ it enables him to better orchestrate his negotiation strategies. Here I discuss the negotiation problems faced by a commander, and how Drama Theory is being used to improve them.

3) *The use of Decision Conferencing within MOD Centre*, **Robertson, Stewart**, Dstl, United Kingdom; **Pett, Jeremy Graham**; **James, Andrew**

Whilst traditional operational research can and does have a role to play in the annual balance of investment activity undertaken within MOD Centre, it was decided towards the end of 2000 to adopt decision conferencing to aid this process. This paper outlines the rationale for adopting decision conferencing, describes how it has been implemented and identifies the benefits, drawbacks and general issues arising, both cultural and technical, based on a year of practical experience.

FA11 **OR in Government and Public Policy**

Invited session Venue: MS-5

Chair: **Ball, Robert**
University of Stirling, United Kingdom

1) *Risk transfer and value for money in PFI projects*, **Ball, Robert**, University of Stirling, United Kingdom

Our research has demonstrated that value for money in PFI projects depends on the value of risk transfer. The probabity of risks and their value ,however,is largely subjective and in addition some risks are already transferred in conventional finance. The paper covers a case study which looks at the validity of the procedure for calculating the value of risk transfer. It includes interviews with appropriate officials and a detailed critique of the probability distributions used and the assessment of likely value of risk. The presentation will give considerable insight into whether PFI projects really offer value for money compared wih conventional finance.

2) *Estimating Collision Risk in UK Upper Airspace*, **Dacre, Marcus James**, NATS, United Kingdom

This talk outlines work carried out by the Safety Analysis section in NATS in support of a major change to UK airspace - the introduction of a Reduced Vertical Separation Minimum (RVSM) for aircraft flying between 29,000 and 41,000 feet. Prior to implementation, the predicted collision risk was compared with an internationally agreed Target Level of Safety. A collision risk model was developed to account for the risk arising from both technical and operational (human) errors. The model was populated using radar data, incident reports, measurements from specially designed height monitoring units, and records of airspace usage.

FA12 **Development Co-operation in a Fractured Global Order**

Invited session Venue: AT-6

Organizer: **Friend, John Kimball**
University of Lincoln, United Kingdom

Chair: **Rosenhead, Jonathan**
United Kingdom

1) *Participatory Approaches to the Design of Development Strategies*, **Sagasti, Francisco**, FORO Nacional Internacional, Peru

PERU is a recently completed seven-year project designed to consult stakeholders throughout the country in the design of a national development strategy for the 21st century. As Director of the Agenda: PERU team, Dr. Sagasti, will describe the systems framework and participatory methodology that underpin the design of this major project, and indicate its outcomes so far.

2) *A Systems Approach to the Work of Multilateral Development Banks*, **Sagasti, Francisco**, FORO Nacional Internacional, Peru

In understanding the work of international institutions, a framework of systems thinking is advocated. Dr. Sagasti will focus on the role of the multilateral development banks. He will draw on his experience as Head of Strategic Planning at the World Bank; on his subsequent consultancy assignments with other multilateral development banks; and on two recent projects with the Institute of Development Studies at the University of Sussex on the provision and financing of global public goods.

3) *Use of Multi-dimensional decision criteria in poverty reduction*, **Sagasti, Francisco**, FORO Nacional Internacional, Peru

This presentation will focus on the use of systems approaches and multi-dimensional decision criteria to define priorities for poverty reduction. The experience of the Social Compensation Fund of Peru, FONCODES, in introducing such a methodology will be discussed.

FA13 **WWW-Education Topics**

Invited session Venue: AT-7

Organizer: **Bell, Peter C**
Canada

Chair: **Haehling von Lanzenauer, Christoph**
Freie Universitaet Berlin, Germany

1) *Using metadata in web-based learning of ORMS*, **Suhl, Leena**, University of Paderborn, Germany; **Kliewer, Natalia**; **Kassanke, Stephan**

Within the European project OR-World and the German project Virtual ORMS, several universities and enterprises are jointly developing system architecture and content for web-based learning of ORMS. We use metadata standards, such as LOM, LMML and QTI in order to separate content from representation and guarantee reusability of learning material. We discuss the system architecture and present examples of content for optimisation and logistics as well as interactive case studies.

2) *A Distance Learning Approach to Teaching Management Science and Statistics*, **Lawrence, John A.**, Ca State Univ., Fullerton, United States

Although there is no universal approach for offering distance learning over the internet, it has nonetheless emerged as a formidable way to offer instruction for many types of courses. One approach that has been successfully used for teaching introductory statistics and introductory management science/operations research courses in a College of Business is presented. The successes and failures of this approach as compared to other distance learning methods and suggestions for preparing distance learning courses are discussed.

3) *WWW-based cases in OR/MS: A contradiction in itself?*, **Haehling von Lanzenauer, Christoph**, Freie Universitaet Berlin, Germany; **Staehly, Paul**; **Trela, Jeannette**

The value of using cases in OR/MS education results from the opportunities which the interactive teaching/learning style provides. Given the trend towards distance learning we report on the development of case material for the internet. The challenge here is to transfer - as much as possible - the rich learning experience resulting from the classroom discussion to

the WWW-environment. Our approach to this challenge will be demonstrated.

4) *Case Study Berger Electric Motors Ldt*, **Haehling von Lanzenauer, Christoph**, Freie Universitaet Berlin, Germany; **Staehly, Paul**

The Topic is Outsourcing and related problems. Confrontation with two alternatives to calculate the highest acceptable price for the negotiation with a subcontractor. The concept of duality is a necessary tool to figure out the problem of outsourcing. A third correct alternative will be developed and will be the base to clarify the two contrary alternatives. Furthermore the case study is useful to demonstrate how to sale own capacities to third party customers or to determine the amount of payments by insurance companies in case of insured lost revenues.

FA14 OR in Forestry - Transportation and Routing

Invited session Venue: AT-8

Organizer: **Weintraub, Andres F.**
University of Chile, Chile

Chair: **Ronnqvist, Mikael**
Division of Optimization, Sweden

1) *A forest supply chain*, **Weintraub, Andres F.**, University of Chile, Chile; **Epstein, Rafael**

We consider operational activities in the Chilean forest industry as a supply chain , starting with standing trees as raw material, until they exit the chain as logs, pulp, sawtimber or other products. We present briefly models that have been successfully implemented to support specific decisions in short term harvesting, machine location , and transportation . By analyzing the activities integrated into a supply chain it is possible to evaluate further possible gains through integration along the chain, including sawmills and other plants. We compare the forest supply chain with the traditional manufacturing one. One notable difference is the absence of a significant bullwhip effect

2) *A Column Generation Approach for the Log Truck Scheduling Problem*, **Palmgren, Myrna**, Dept of optimisation, Sweden; **Ronnqvist, Mikael**

The log truck scheduling problem is one of the most complex routing problems where both pickup and delivery operations are included. It consists in finding one feasible route for each vehicle in order to satisfy the demands of the customers and in such a way that the total transport cost is minimised. We use a mathematical formulation of the log truck scheduling problem that is a generalised set partitioning problem. We then apply a column generation algorithm for solving the LP relaxed model and a branch and price algorithm for obtaining integer solutions. Numerical results from Swedish forestry companies will be presented.

3) *Routing of forwarders*, **Forsberg, Mattias**, SkogForsk, Sweden; **Ronnqvist, Mikael**

At harvest areas forwarders are used to collect log piles and move them to adjacent forest roads. We describe a system that automatically collects information through a GIS system and optimization methods that establish routes. The system has been tested and results are given.

FA15 Queuing Theory and Applications III

Contributed session Venue: AT-2B

Chair: **Takahashi, Yutaka**
Kyoto University, Japan

1) *Simulation Study on Contents Delivery Protocol with TCP-friendly for Streaming-applications*, **Adachi, Naotoshi**, NAIST, Japan; **Kasahara, Shoji**

We propose a TCP-friendly rate control for contents delivery network to guarantee application-level QoS. We define application-level jitter for the measure of QoS guarantee and investigate it under several network conditions by simulation. With numerical examples, we discuss the efficiency of the proposed scheme and the fairness with TCP connections.

2) *A Base Station Allocation Policy for IMT-2000 Systems*, **Takahashi, Misa**, Lecturer, Japan; **Yamada, Takako**; **Takahashi, Yukio**

We propose a base station allocation policy for IMT-2000 mobile phone systems. We consider a situation where a region is to be covered by two different kinds of cells, macro cells and micro cells, each of which has its own base station at the center. We compare several variants of allocation policies through simulation experiments and show that a better allocation is obtained by a simple algorithm stated in the paper. Further, we show that the use of two kinds of cells/base stations is effective to get more flexible allocation for time variations of user locations.

3) *Modeling and Performance Evaluation of Bluetooth Using Polling Models*, **Kanan, Keisuke**, Kyoto University, Japan; **Takahashi, Yutaka**

In this paper, we model a wireless network operated under Bluetooth and analyze its performance. We propose two models. The first one is intended to characterise the following three important features, 1) each device can leave a piconet to which it is connected at any time, 2) it can join a piconet if the number of members is less than eight, 3) it can be a member of multiple piconets simultaneously. The second one is sophiscated to improve the first in describing the system more precisely. Concerning scheduling of packets to be transmitted, we consider three algorithms, exaustive, round robin and fair exaustive algorithms. Under exaustive scheduling, we mathematically derive various performance measures such as sojourn time, inter--vist time and waiting time. As the result, it is concluded that in the case of symmetric (resp., asymmetric) traffic, exaustive (resp., fair exaustive) algorithm is the best in performance when traffic rate is moderate.

FA16 **System Dynamics Modelling I**

Invited session Venue: WR-11

Organizer: **Lane, David C.**
London School of Economics, United Kingdom

Chair: **Lane, David C.**
London School of Economics, United Kingdom

1) *Product Development Resource Allocation Policies with Foresight*, **Ford, David N.**, Dept of Civil Engineering, United States; **Joglekar, Nitin**

Existing allocations of limited resources among development activities are primarily proportional to the work waiting for each activity. These policies are myopic in that they ignore the fact that activities create work for each other. How can project managers use foresight in resource allocation to shorten project durations? A fully concurrent product development project was modeled in equivalent control theoretic and system dynamics forms. Simulations of resource allocation based on static foresighted weightings of backlogs demonstrate the benefits of foresight. Simulations of two rework fractions reveal a counter-intuitive lower benefit of foresight with more rework.

2) *Japan-Population-Model*, **Uchino, Akira**, Senshu University, Japan

The rate of birth in advanced countries is decreasing while the aged population grows. The birth number of 2.1 or more per each woman is said to be crucial to sustain the population in one country. This value in Japan is only 1.38, and this indicates a necessity of immediate response. I present a Japan-Population-Model to show what happens in the 21st century. Institute of Population Problems, Ministry of Health and Welfare in Japan, has been building "Population Projections for Japan" every five years. The model has been developed using the projection with system dynamics point of view. The model is not only effective in policymaking by itself but also critical for one main sector of Japan National model.

3) *A Systems-Dynamics Theory of Practice* , **Mashayekhi, Ali N.**, Sharif University of Tech, Iran

A big challenge in system dynamics practice is to influence the mental models of management team and their decisions based on the insights from such a practice. The paper presents a theory of practice that can guide applications of system dynamics to have more influence on management thinking and practice in the real world systems. The theroy is formulated around a generic problem sensing and solving process as occur in the real world. It provides guidelines from data collection and problem formulation stage to policy implementation. An example of the application of the theory and its results is also provided.

FA17 **Hard and soft approaches in OR**

Invited session Venue: WR-10

Organizer: **Pidd, Michael**
Lancaster University, United Kingdom

Chair: **Eden, Colin**
University of Strathclyde, United Kingdom

1) *Dealing with Hard and Soft issues in a large IT Project*, **Paterson, George D.**, Shell International, United Kingdom

This paper will identify some hard and soft aspects of a large IT infrastructure project being carried out within Shell. How these have been addressed in practice will then be described, and the relationship with soft OR techniques considered.

2) *Integrating hard and soft methods An approach applied to the management of intensive care*, **Kowalczyk, Ruth**, Lancaster University , United Kingdom

The increasing complexity of the healthcare system generates a need for qualitative as well as quantitative methods in health research. The provision of an intensive care service is particularly complex, in that ICUs are themselves extremely diverse and there are a large number of factors that influence any patient's treatment or unit's success. To support the use of qualitative and quantitative methods the researcher adopts a framework and an ontology that enable the integration of the two. This presentation will demonstrate the way in which different analyses can be woven together providing a clearer understanding of the intensive care service.

3) *Using a GDSS to Aid Input- Output Identification In DEA*, **Casu, Barbara**, Aston Business School, United Kingdom; **Shaw, Duncan** ; **Thanassoulis, Emmanuel**

In DEA (a quantitative modelling technique), operating units are compared on their outputs relative to their inputs. The identification of an appropriate input-output set is of decisive significance to avoid bias when assessing the units relative performance. This paper reports on a novel approach used for identifying a suitable input-output set for assessing central administrative services at universities. A computer-supported GDSS (using qualitative modelling) was used to enable analysts to access information pertaining to the boundaries of the unit of assessment and the corresponding input-output variables. The approach provides for a more efficient and less inhibited discussion of input-output variables.

FA18 **Strategic Development: Process & Methods III**

Invited session Venue: WR-9

Organizer: **O'Brien, Frances**
Warwick Business School, United Kingdom

Chair: **Huber, George P.**
University of Texas, United States

1) *Considerations in Strategic Choices -- Upsizing, Downsizing, and Redirecting the Firm*, **Huber, George P.**, University of Texas, United States

As the pace of change increases in the environments of business organizations, firms will more frequently be faced with strategic choices about upsizing, downsizing, and redirection. Following the resource-based theory of the firm, we articulate the multiple criteria for making choices in each these types of strategic situations and describe the necessary data and judgments associated with each criterion in each situation.

2) *The use of models and methods for strategic planning: Towards an holistic view of strategy*, **Philpott, Elly**, University of Luton, United Kingdom; **Hamblin, David**; **Baines, Tim**; **Kay, Gwyn**

Formulating manufacturing business strategy is often fragmented in as much as current tools address upstream and downstream vertical integration with horizontal integration, or more recently, horizontal and infrastructural integration. Rarely do tools address all of these dimensions in an holistic manner. The research described in this paper is that undertaken in the MAPSTRAT project; a scoping study with industrial partners aiming to satisfy this business need. A comprehensive literature study is described which is contextualised using six case studies. The paper stresses the importance of 'joined up thinking' and outlines plans for an appropriate tool that is under development.

FA19 **Knowledge Management - the way forward**

Invited session Venue: WR-1

Organizer: **Edwards, John Steven**
Aston Business School, United Kingdom

Chair: **Edwards, John Steven**
Aston Business School, United Kingdom

1) *Retaining the Firm's Knowledge During Downsizing and Divestitures*, **Huber, George P.**, University of Texas, United States

Downsizings and divestitures subject the firm to the loss of the knowledge stored in the minds of those knowledge workers who are let go. This paper examines the different forms of downsizing and divestitures and identifies the types of mind-resident knowledge loss inherent in each. It then describes managerial actions that can attenuate the loss of each of these types of knowledge.

2) *Selecting Knowledge Management Strategy to Match Organisational Culture*, **Patrick, Keith**, South Bank University, United Kingdom; **Phillips, Nigel**

Writers about Knowledge Management both academic and practitioner give emphasis to the importance of the 'right' environment including the elements of an appropriate organisational culture and the development of trust. While these discussions often imply there is an 'ideal' knowledge management culture they rarely give any details of its form nor do they suggest how it might be realized. We present an analysis of models of trust and methods for assessing the nature of the organisational culture. From this analysis we argue that (1) a healthy culture is one that fosters a high level of trust amongst its members, (2) there are a number of markedly different health cultures, (3) all healthy cultures naturally support KM, (4) different KM strategies are appropriate for different organisational cultures. A model is developed that provides a departure point to enable organisations to determine an appropriate approach.

3) *Does OR have a place in knowledge management?*, **Edwards, John Steven**, Aston Business School, United Kingdom; **Alifantis, Athanasios** ; **Hurrion, Robert D.**; **Ladbrook, John**; **Robinson, Stewart L.**; **Waller, Tony**

This paper reflects on the role(s) that OR can play in knowledge management. The reflections are stimulated by the authors' involvement in a recent project concerned with unplanned maintenance in an automobile manufacturing facility. This centred on attempting to interface a knowledge-based system to a simulation model in order to incorporate the behaviour of the maintenance supervisors in the simulation. Aspects for discussion include the development of the model, the role of the simulation in helping to discover the knowledge of the maintenance supervisors, and how to help improve the learning of the maintenance supervisors.

FA20 **Mathematical Programming Models**

Invited session Venue: WR-2

Chair:

1) *A Branch and Bound Algorithm for the Network Dimensioning under Uncertainty Problem* , **Andrade, Rafael**, France Telecom, France; **Lisser, Abdel**; **Maculan, Nelson**; **Plateau, Gerard**

Quality of service in telecommunication networks depends on the Network Design. Developing a stochastic branch and bound framework to deal with the capacity planning under uncertain demands problem in telecommunication networks is the main purpose of this paper. In special, we restrict the investment in extra link capacities to be integer variables. As demands are allowed to be rejected, by penalizing the telecom market by the unsatisfied requests, then we are interested in determining a suitable set of investment minimizing the involved costs. The Benders decomposition was used as base method to solve the problems involved in the partition process.

2) *Column Generation for a Non-temporal Harvest Model with Spatial Constraints* , **Martins, Isabel**, Portugal; **Constantino, Miguel**; **Borges, José G.**

We present an integer programming model for a non-temporal forest harvest problem with constraints on the clearcut size and on the total area of old growth patches with a minimum size requirement. The model has a very large number of variables for operationally sized problems which precludes the use of exact solution methods. We propose the column generation technique to solve the linear relaxation of the model and a procedure that constructs solutions to the problem from linear programming solutions. Computational results for test

instances and for a real life instance that corresponds to a large portuguese forest are reported.

3) *Designing a timetable under strict legal constraints*, **Azmat, Carlos Salvador**, Uni Fribourg - DIUF, Switzerland; **Widmer, Marino**

In the current economical and industrial conditions, with the fluctuation of the demand, designing a timetable to define a work schedule for each employee is not an easy task. Moreover, due to legal and cost constraints, it is hopefully not always possible to engage and dismiss the employees according to the production requirement. In this paper, a three-step method to assign the daily work for full-time employees working on one shift is presented. It takes into account a set of strict legal constraints (in particular the one concerning the holidays) and it guarantees that the defined workforce is minimal, when it is assumed that the employees are able to perform each task in the workshop.

FA21 **Finance and Banking III**

Contributed session Venue: WR-3

Chair: **Hunjak, Tihomir**
Assistent Professor, Croatia (Hrvatska)

1) *Continuous-Time American Option Pricing with Uncertainty of Stock Prices*, **Yoshida, Yuji**, University of Kitakyushu, Japan; **Yasuda, Masami**; **Nakagami, Jun-ichi**; **Kurano, Masami**

A mathematical model for American put option with uncertainty is presented and the randomness and fuzziness are evaluated by both probabilistic expectation and linear ranking functions. An optimality equation for the optimal stopping problem in a fuzzy stochastic process is derived and an optimal exercise time is given for the American put option. American option model with uncertainty is demonstrated and it is shown that the optimal fuzzy price is a solution of the optimality equation under a reasonable assumption. The writer's/seller's optimal expected price in the American put option are presented.

2) *An approach to estimation of acceptable parameters of debt restructuring*, **Kislitsyna, Julia**, MIPT, Russia

Nowadays many Russian manufacturers have huge outstanding tax debt. At the same time the deficit of working capital still remains the issue of the day for overwhelming majority of them. Thus, on one hand, they should pay their debts off. On the other hand, excessive debt withdrawals may result in rapid reduction in turnover and shutdown. Considering this problem both from the point of view of integral sum of tax proceeds maximization, and growth of the manufacturer (it's transformation to a profitable one) helps to estimate acceptable parameters of tax debt restructuring, profitable both for the manufacturer and nation.

3) *A method for ranking bank branches based on cross-efficiency*, **Hunjak, Tihomir**, Assistent Professor, Croatia (Hrvatska)

Data Envelopment Analysis (DEA) is a method for measuring diverse types of bank branch efficiency. However, the potential for full utilization of DEA is limited when the number of bank branches is insufficient in relation to the total number of inputs and outputs that are the basis for their comparison. This paper demonstrates how bank branches could be more precisely ranked on an equal set of data as in DEA when the total number of bank branches is insufficient for full utilization of DEA. A partial ordering relation based on the cross-evaluation matrix is introduced to solve such ranking problems.

FA22 **Decision Support Systems IV**

Contributed session Venue: WR-4

Chair: **Feinberg, Eugene A.**
SUNY at Stony Brook, United States

1) *Individual Choice and Equity in Employee Timetabling Decision Support Systems*, **Joseph, Rémy-Robert**, Univ J Fourier Grenoble, France; **Chan, Peter**; **Fallet, Valentine**; **Weil, Georges**

We present some social choice theory models, both to take into account preferences and choices of employees, customers and employers, and to define criteria giving a better modelling of social values as equity. These models are then combined with a dynamic constraints framework, and solved with an adjusted global constraints-based branch-and-bound algorithm.

2) *Decision support for milkcollection; an unusual case in dairy-industry.*, **Claassen, Frits G. D. H.**, Wageningen University, The Netherlands; **Hendriks, Theo H. B.**

The market for specific and unusual branches in dutch dairy-industry is growing annually. However, the continuous imbalance between (fresh) milk supply and -demand has urged the sector for a different approach to the (daily) vehicle routing problem of milkcollection. In this presentation we will describe the environment and role of an interactive decision support system with a strong focus on planning support. We discuss how OR-model(s), optimization techniques, structured data queries and analysis tools can support different (conflicting) approaches to the planning of milkproduction and -collection.

3) *Generalized Pinwheel Problem*, **Feinberg, Eugene A.**, SUNY at Stony Brook, United States; **Curry, Michael**

Consider a non-preemptive infinite horizon service system with a single server characterized by a service time and a maximum allowable time between consecutive services. We provide a rigorous Markov Decision Process formulation and develop a dynamic programming algorithm for determining a feasible schedule. We then relax the constraints in order to invoke a semi-MDP. This semi-MDP is used to generate a non-randomized policy which generates a schedule of jobs. We have developed an algorithm which searches this schedule for a feasible sub-sequence which is feasible and can be implemented periodically.

FA23 **Data Envelopment Analysis V**

Contributed session Venue: AF-10

Chair: **Yoon, Moon-Gil**
Hankuk Aviation Universit, Korea

1) *Assessing feasibility and estimating total cost of strategic production plans with ABC and DEA*, **Donoso, Patricio**, EAPUC, Chile; **Singer, Marcos**

We study the problem of Assessing feasibility and estimating total cost of strategic production plans with ABC and DEA. two techniques: one related to Activity Based Management (ABM) and a new one based on a convexity conjecture related to Data Envelopment Analysis (DEA). The empirical validation is performed in a Chilean steel plant and in a set of fruit packing plants, where both methods are tested on their capability for estimating the total cost and the feasibility of monthly plans. The benefit of our technique is that it provides a new cost paradigm, while the feasibility assessment can be appended to any method based on mathematical programming.

2) *An application of DEA for evaluating both qualitative and qantitative factors* , **Yoon, Moon-Gil**, Hankuk Aviation Universit, Korea

Data Envelopment Analysis(DEA) has received significant attention in different areas as a powerful tool for measuring the relative efficiency of Decision Making Units(DMUs). This tool has also been applied for ranking alternatives and for evaluating multiple criteria decision situations. For analyzing each DMU or alternative, it is necessary to evaluate both qualitative and quantitative factors simultaneously. In this paper, we consider an integrated DEA model providing the relative efficiency of DMUs based on the evaluation of qualitative and quantitative factors in a single framework. In this model, we modify Cook and Kress model to evaluate the qualitative factors by using the ordinal data, and use Charnes, Cooper and Rhodes model with some modifications to calculate the whole efficiency of each alternative. Finally, our model is applied to evaluate the performance of ISPs in Korea.

3) *Common Weights by Cobb-Douglas Production Function for Ranking Units by the DEA context.*, **Friedman , Lea**, Ben-Gurion University, Israel; **Hadad , Yossi**

Common Weights by Cobb-Douglas Production Function for Ranking Units by the DEA context. In this paper we develop a method for finding common weights for measuring the technical efficiency of similar units based on multiple inputs and multiple outputs. In our method, the common weights are being estimated according to a production function based on Cobb-Douglas (log Linear) function. For an one output and several inputs, using the Cobb-Douglas function for the technical efficiency is a well known method. The main contribution of this study is that we shall do it for several output variables. The advantage of this method is first to find the degree of homogeneity of all the sample and to find its return to scale. The second advantage is to rank all the units on one scale according to their common weights. We compare the technical efficiency with the common weights, to the DEA. A numerical example is added to illustrate our method comparing to the DEA.

FA24 **Analytic Hierarchy Process II**

Contributed session Venue: AF-13

Chair:

Common Weights by Cobb-Douglas Production Function for Ranking Units by the DEA context. In this paper we develop a method for finding common weights for measuring the technical efficiency of similar units based on multiple inputs and multiple outputs. In our method, the common weights are being estimated according to a production function based on Cobb-Douglas (log Linear) function. For an one output and several inputs, using the Cobb-Douglas function for the technical efficiency is a well known method. The main contribution of this study is that we shall do it for several output variables. The advantage of this method is first to find the degree of homogeneity of all the sample and to find its return to scale. The second advantage is to rank all the units on one scale according to their common weights. We compare the technical efficiency with the common weights, to the DEA. A numerical example is added to illustrate our method comparing to the DEA.

2) *An Expert Module to Improve Matrix Consistency in AHP*, **Ishizaka, Alessio**, University of Basel, Switzerland; **Lusti, Markus**

With AHP, the calculated priorities are plausible only if the comparison matrices are consistent or near consistent. This condition is reached if, within the pairwise comparison process, the transitivity and reciprocity rules are respected. We describe the implementation of a Prolog application which helps the decision-maker to build a consistent matrix or a matrix with a controlled error. An expert module detects rule transgressions, explains them (How-explanations), suggests alternatives (What if- explanations) and gives hints on how to continue the comparison process. http://www.wwz.unibas.ch/wi/members/Ishizaka/IFORS2002.pdf

FA25 **Mathematical Programming-Nonlinear**

Contributed session Venue: AF-14

Chair: **Hertog, Dick Den**
Tilburg University, The Netherlands

1) *Application of I-divergence for decision models*, **Nagy, Tamas**, University of Miskolc, Hungary

This paper deals with a type of the decision problems. We formulate the decision problem as an optimization one. Our aim is to find an universal valuation vector which takes all the criteria into consideration with the given weights. We want the universal valuation vector to be such that it fits well to the given

valuation vectors considering the criteria. In the finding of the best fitting we use the I-divergence. In the second part of this paper we give a method for determining the weights of the criteria.

2) *A lot sizing model applied to the soft drink industry*, **Rangel, Socorro**, UNESP, Brazil; **Ferreira, Deisemara**

This paper investigates properties of a mixed integer model applied to solve the production-planning problem of a soft drink company. The company produces soft drinks bottles in different flavors and sizes. A production unit is made up of a conveyor belt and machines that wash the bottles, fill them with a combination of syrup and carbonic gas, and then seal, label and pack them. The production of a different flavor and/or size involves machine set up time and costs. It is also taken in account the capacity of the production unit, and the capacity and availability of syrup mixing tanks.

3) *Constrained Optimization Involving Expensive Function Evaluations*, **Hertog, Dick Den**, Tilburg University, The Netherlands; **Brekelmans, Ruud**; **Driessen, Lonneke**; **Hamers, Herbert**

This paper presents a sequential method for constrained non-linear optimization problems. The principal characteristics of these problems are very time consuming function evaluations and the absence of derivative information. Local linear approximations of the real model are obtained with help of weighted regression techniques. If the geometry of the points that determine the local approximations becomes bad, i.e. the points are located in such a way that they result in a bad approximation of the actual model, then we evaluate a geometry improving instead of an objective improving point. In each iteration a new local linear approximation is built, and either a new point is evaluated (objective or geometry improving) or the trust region is decreased. http://cwis.kub.nl/~few5/center/staff/hertog/Cdp21-87.pdf

FA26 **Scheduling and Timetable VII**

Contributed session Venue: AF-18

Chair: **Escudero, Laureano F.**
Univ Miguel Hernandez, Spain

1) *Schedule generation schemes for the job-shop problem with setup times*, **Artigues, Christian**, LIA, France; **Lopez, Pierre**; **Buscaylet, Fabrice**

We consider a variant of the job-shop scheduling problem (JSP) with sequence dependent setup times between operations sharing the same machine. We study several classical schedule generation schemes (SGS) : the non-delay scheme (SGS1), the scheme based on Giffler-Thompson algorithm (SGS2) and the “strict order” SGS of Carlier (SGS3). In the classical JSP, SGS2 and SGS3 characterize the same subset of so-called active schedules, dominant for makespan minimization. We show that this equivalence does not hold for the setup case and that SGS2 looses its dominance property. Computational experiments are carried out on randomly generated instances.

2) *The two hoist case in the Cyclic Hoist Scheduling Problem* , **Mateo, Manuel**, Faculty of Engineering, Spain; **Companys, Ramon**

The problem solved is the Cyclic Hoist Scheduling Problem with two identical hoists. The use of bounds for the cycle time leads to reduce the number of considered sequences and subsequences compared with the potential number. So, general procedures in literature may be adapted taking advantage of this fact.

3) *On large-scale resource-contrained project scheduling*, **Escudero, Laureano F.**, Univ Miguel Hernandez, Spain; **Salmeron , Javier**

We consider the resource constrained problem: Given a set of (usually, multiperiod) projects to be executed along a multi-year horizon subject to a set of constraints (such as budget restrictions, resource availability, precedence relationships, exclusivity and implication constraint in the projects execution, etc), find a feasible project scheduling that maximizes a given merit function. We present a 0-1 model and a variety of strategies within a Fix-and-Relax algorithmic framework approach for yielding quasi-optimal solutions, with enormous differences in run-time performance. Computational experience on a set of real-life cases is reported.

FA27 **Pricing and the Customer**

Invited session Venue: AF-19

Organizer: **Yeoman, Ian Seymour**
Napier University, United Kingdom
Organizer: **McMahon-Beattie, Una Sinead**
University of Ulster, Northern Ireland

Chair: **Blair, Montgomery**
PROS Revenue Management, United States

1) *Variable Pricing, Trust and the Consumer*, **McMahon-Beattie, Una Sinead**, University of Ulster, Northern Ireland; **Yeoman, Ian Seymour**

The traditional world of revenue management has been concerned with allocation of capacity to pricing decisions. Revenue management models developed by Belobaba (1989), Botimer (1999) and Weatherford (2002) have been concerned with such problems. However, these approaches to capacity allocation have little influence over the variables of pricing. In times of uncertain worlds/markets, unpredicability and choas the community of OR is faced with a new challenge and science. As allocation models have no valid data sets, revenue management must turn to propositions of pricing in order to find a new agenda. One such proposition, is the maintenance of trust. McMahon-Beattie and colleagues (2002) explore this dimension by explaining the interactions of revenue, pricing and trust within the context of ongoing buyer-seller relationships. Suggesting are made, for avoiding possible conflict between revenue management concepts and ongoing customer relationships.

2) *Revenue Management under a General Discrete Choice Model of Consumer Behavior*, **Talluri, Kalyan T.**, Universitat Pompeu Fabra, Spain

Customer choice behavior, such as ``buy-up" and ``buy-down", is an important phenomenon in a wide range of revenue management contexts. Yet most revenue management methodologies ignore this phenomenon - or at best approximate it in a heuristic way. In this paper, we provide an exact and quite general analysis of this problem. The choice model is perfectly general and simply specifies the probability of purchasing each fare product as function of the set of fare products offered. The control problem is to decide which subset of fare products to offer at each point in time. We show that the optimal policy is of a simple form. Namely, it consists of 1) identifying the ordered family of ``nondominated" subsets at each point in time opening one of these sets S_k, where the optimal index k is increasing in the remaining capacity x.

3) *The Price-Value Perception of Hotel Guests in Switzerland*, **Varini, Kate**, Switzerland; **Engelmann, Ralph**

In recent research on competencies required to effectively manage revenue, it was discovered that, in order for hotels to effectively manage revenue and price rooms, a high awareness of what different hotel guests segments value is required. The knowledge of segment specific differences strongly influences a hotel's ability to optimise its offer and maximise revenue. This paper will discuss a study that analysed the pricing strategy in Swiss hotels – in the months prior and post the September 11th event. The difference between the bases that hotels use to price their rooms/products and the customer perception of price in relation to the value they feel they receive, is revealed. The study was carried out using a base of 40 hotels in city and resort locations in Switzerland and series of 200 hundred interviews with different customer segments. A conjoint measurement software was used and scenario based questionnaires developed.

FA28 **Scheduling and Timetable III**

Contributed session Venue: DH-C

Chair: **Sevaux, Marc**
Univ of Valenciennes, France

1) *Time Constrained NPD Projects - Scheduling and Due Dates Setting of Design Tasks*, **Dragut, Andreea Bogdana**, Eindhoven U of Technology, The Netherlands; **Bertrand, J. W. M.**

We formulate mathematically a framework for the work organization at the development team level in a hierarchically controlled time-constrained product development project. The description of the main characteristics of the project follows the line of the recent empirical research on new product development projects. Thus, we assume specific workload constraints for the engineers, as well as stochastic durations of tasks. In this framework, first a re-scheduling decision is taken for the design tasks scheduled, and not finished by the engineers in previous review periods. After, the scheduling and due dates setting take place. Solutions are proposed for the problems considered.

2) *A machine-order search space for job-shop scheduling problems*, **Choi, Shiu Hong**, The Hong Kong University, China; **Yang, Feng Yu**

This paper proposes a machine-order search space, derived from machine-based decomposition, for job-shop scheduling problems. A complex job-shop problem may be broken up into a number of single-machine problems, which are solved based on the sequences described in the machine-order search space. The solutions are subsequently put together to create a full schedule, which is optimal or near optimal in most time. Such approach significantly reduces the computational effort required to obtain optimal or near optimal schedules, particularly in comparison with the traditional methods using the solution space. A phasing-in enumerative algorithm is developed and implemented to incorporate the machine-order space for job-shop problems.

3) *Scatter search and GA a one machine scheduling problem comparison*, **Sevaux, Marc**, Univ of Valenciennes, France; **Thomin, Philippe**

The general one machine total weighted tardiness problem is one of the most difficult scheduling problem. In the general case only few results exists. When a solution is represented by a permutation of the jobs, it is easy to build a genetic algorithm procedure and apply usual crossover and mutation operators. A new metaheuristics, scatter search, can use the same type of representation (permutation). A comparative study between the two approaches is conducted on this one machine scheduling problem. The general behavior of the two methods differs. The study will point out these differences.

FB1 **Health Services: Access to Services**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Mould, Gill**
University of Stirling, United Kingdom

1) *A Departments' structure free Method for Determining Beds Requirements at the Hospital*, **Nguyen, Jean-Michel**, PIMESP CHU NANTES, France; **Six, Patrick**; **Le Beux, Pierre**; **Lombrail, Pierre**

Goal of study. The aim of this work is to develop a generally applicable method depending only on the expected inpatients numbers. Design and Setting. Three parameters (accessibility, occupancy, and efficiency) are defined. A decision rule is then based on the minimization of two functions of this three parameters. An algorithm is developed by adding one bed with daily assessment of the three parameters. Main Results. This method is successfully applied to a department in a general hospital. Robustness and reproducibility of the method are evaluated by simulations. None of the criteria is dependent on

specific department characteristics, showing that this method is applicable to different ward.

2) *Modelling for the Geographical Distribution and Organisation of Health Services*, **Harper, Paul R.**, University of Southampton, United Kingdom; **Shanani, Arjan K.**; **Bowie, Cameron**

Examples of geographical distribution and organisation of health services are the location of outpatient departments within a city and the provision of particular services such as cardiac, cleft lip and palate, and dental services, across a region. Important issues in the provision of services include the location of the service centres, service capacities, geographical distribution of patients, and ease of access to the health services. This paper describes the development of geographical simulation models for evaluating various options for the provision of services. Case studies will illustrate the practical importance of the modelling approach.

3) *Ambulatory Care and The Effect On Existing Inpatient Services*, **Bowers, John**, University of Stirling, United Kingdom; **Jeffrey, Susanne**; **Mould, Gill**

Ambulatory Care provides an efficient means of treating routine elective patients. The philosophy aims to identify patients who have the least risk of complications and can attend for surgery at specialised walk-in walk-out centres. The implication is that the remaining inpatient facilities deal only with the more complex cases. It has been found that procedure times for inpatient operations are significantly longer than those for Ambulatory Care patients. Without the availability of the more routine patients with shorter procedure times it is often difficult to make effective use of inpatient operating sessions. Computer simulation has been used to demonstrate the scale of this effect. It has been found that although Ambulatory Care can increase the throughput of routine elective patients it can have a detrimental effect on the throughput of the remaining inpatients in some circumstances.

FB2 **Network Models**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Ricciardi, Nicoletta**
U of Rome La Sapienza, Italy

1) *Multicommodity Flow Equilibration*, **Storchi, Giovanni**, U of Rome La Sapienza, Italy; **Crainic, Teodor Gabriel**; **Ricciardi, Nicoletta**; **Simeone, Bruno**

Given a capacitated network and a set of origin-destination pairs on the network with non negative demands, the general problem is to find feasible (with respect to the arc capacities and demands) flow distributions that are balanced. That is, for each origin-destination pair, the flow is distributed ``as evenly as possible'' among the paths used to transport the demand. Applications for this class of multicommodity network flow problems arise in transportation and telecommunications. Depending on the specific applications, several models may be developed. We present and analyze a number of formulations and explore interesting algorithmic avenues

2) *On-line Efficient Determination of Multi-activity Tourist Itineraries*, **Caramia, Massimiliano**, IAC - CNR, Italy; **Crainic, Teodor Gabriel**; **Ricciardi, Nicoletta**; **Storchi, Giovanni**

This study deals with the on-line real-time computation of tourist itineraries. Two different types of paths may be requested: Sequential activity paths, where each of the main activities specified by the user have to be performed separately and in the order specified by the user; Mixed-activity paths, where there is no particular order on activities. The goal is to find, simultaneously, the best paths in each cat egory according to the user-specified preferences. We discuss issues and models and explore algorithmic avenues.

FB4 **Electrical Power Systems I**

Contributed session Venue: DH-S

Chair: **Kristinsdottir, Birna P.**
Iceland

1) *Hedging Strategy and Portfolio Optimization in the Power Market using CVaR*, **Luethi, Hans-Jakob**, Switzerland; **Unger, Gustaf**

This paper discusses how a utility can optimize its portfolio of generating assets and financial contracts in a risk framework. Further it is shown how the operational flexibility of a hydro plant can be used to hedge adverse movements in its portfolio. We show how, in particular the volume risk, which is not hedgeable with standard contracts, can be managed through an intelligent dispatch strategy. Despite the incompleteness in the market we try to quantify the value of this operational flexibility.

2) *Optimal performances determination of PM machines used in the photovoltaic pumping system*, **Chabane, Mabrouk**, University of Batna, Algeria; **Azoui, Boubekeur**

The paper treats the geometrical optimised of permanent magnet machines. A subnumerical model is proposed to study and optimise the PM machines structures. This method allows easily to determine the influence of the different geometrical parameters. The principal object of this study is to optimise the structure of the PM machine used in the photovoltaic pumping system. According to the rotor construction, two topologies are considered: surface mounted magnet and inset magnet. The final objective is to adapt the PM machines to the photovoltaic pumping system of small power and testing them in the laboratory test facility.

3) *Optimization of geothermal power plant design*, **Kristinsdottir, Birna P.**, Iceland; **Jensson, Pall**; **Thorsteinsson, Jon A.** ; **Thorolfsson, Geir**

A methodology to optimally design a geothermal power plant, that is based on the Kalina technology, is presented. An optimization formulation that minimizes the net present value for the lifecycle cost for the powerplant is set forth. The optimization formulation can be used to determine optimal values for various design parameters in the power cycle as well as determining the best structure and types of equipment in the power cycle. A solution procedure is presented and used in a case study to optimally design a power cycle.

FB5 **Data Classification and Applications**

Invited session Venue: MS-1

Organizer: **Abbass, Hussein**
University of New South Wales, Australia

Chair: **Yearwood, John**
University of Ballarat, Australia

1) *Bayesian Data Mining of the Australian Adverse Drug Reactions Database*, **Harvey, Jack T.**, Australia; **Turville, Christopher**; **Barty, Simon M.**

The Australian adverse drug reactions database derives from 120,000 reports over 30 years, including many instances of multiple drugs and multiple reactions. There are several thousand different drugs and reactions, and so the drug-reaction table is large and sparse. To aid rapid expert assessment of new reports, Bayesian statistical models are being used to re-evaluate historical data and to provide early indications of emerging trends. Bayesian methods provide more balanced detection criteria than either descriptive statistics such as relative risks which are subject to large sampling variation for rare co-occurrences, or statistical significance levels which are conversely weighted towards the most common co-occurrences. Some early results are presented.

2) *An algorithm for clustering based on nonsmooth optimization techniques*, **Bagirov, Adil**, University of Ballarat, Australia; **Rubinov, Alex**; **Yearwood, John**; **Soukhoroukova, Nadejda**

We reduce the problem of cluster analysis to the unconstrained optimization problem with the nonsmooth objective function. A discrete gradient method of nonsmooth optimization are applied to solve latter problem. An algorithm for clustering based on this approach are proposed and studied. Numerical experiments using some real-world datasets have been carried out. We report and discuss the preliminary results of these experiments. Results of experiments show the effectiveness of the proposed approach.

3) *A Fuzzy Derivative Approach to Classification of outcomes from the ADRAC database*, **Mamedov, Musa**, Australia; **Saunders, Gary**; **Yearwood, John**

The Australian Adverse Drug Reaction Advisory Committee (ADRAC) database has been collected and maintained by the Therapeutic Goods Administration. In this paper we study a part of this data (Card2) which contains records having just reactions from the Cardiovascular group. In this data 1570 drugs and 5 meta-reactions (formed out of 131 reactions related to this group) were used. Drug-reaction relationships are presented by a vector of degrees which shows the degrees of occurrences of each meta-reaction. These degrees are called Hidden reactions. In this work we examine these relationships in classification problems. The Fuzzy Derivative Method is used for classification. We make prediction of good and bad outcomes on the basis of both real observed reactions and Hidden reactions. The results obtained show that in prediction, Hidden reactions work better than real observed reactions. (Section: Data Classification and Applications)

FB6 **Closed Loop Supply Chains II**

Invited session Venue: AT-1

Organizer: **Pappis, Costas P.**
University of Piraeus, Greece

Chair: **Karacapilidis, Nikos I.**
University of Patras, Greece

1) *D-M Tools in the Interpretation of LCA of Extended Supply Chains*, **Daniel, Stavros E.**, Greece; **Pappis, Costas P.**; **Tsoulfas, Giannis T.**

The role of Life Cycle Analysis in identifying and measuring the environmental impact of extended supply chains, i.e., chains involving both forward and reverse activities, is very important. In the final phase of Life Cycle Analysis, that is Interpretation, alternative policies may be ranked and opportunities for the reduction of the environmental burdens may be identified and valuated. The opportunities for improvement may be based either on Inventory Analysis or on Impact Assessment. For this purpose critical parameters have to be chosen and evaluated and sensitivity analysis be applied. In this paper decision-making tools, including mathematical models, are used for the evaluation, comparison and selection of alternative policies regarding supply chains planning. The proposed analysis is applied to the results of Life Cycle Analysis in the case of recovery of lead-acid batteries.

2) *Integrating Software Agents Technology in Returns Management* , **Karacapilidis, Nikos I.**, University of Patras, Greece; **Kokkinaki, Angelika I.**; **Pappis, Costas P.**; **Dekker, Rommert**

Focusing on the case of used PCs, this paper describes a web-based system that enables users to delegate tasks related to returns management to software agents acting upon their interests. The system performs configuration detection and benchmarking of end-of-use PCs. The outcome of this process, carried out by a "trusted-third-party" agent, may then be exploited by the system's buyer-agents that act proactively to match return offers with their actors' (e.g., Original Equipment Manufacturers) collection requests. A multiple-criteria decision support tool for comparative evaluation of requests and recommendation about the optimal recovery optionhas been also integrated in the system's seller-agents.

3) *Assessment Parameters for the Measurement of the Environmental Performance of Supply Chains*, **Tsoulfas, Giannis T.**, Greece; **Pappis, Costas P.**; **Daniel, Stavros E.**

Life Cycle Analysis does not always manage to provide working answers to policy questions. For instance, there are several activities with serious impact (not necessarily emissions) on the environment, which are not taken into account. In addition, it adopts a descriptive approach, while a prescriptive approach may be more environmentally significant. In this paper, environmental principles and practices applicable to the planning of logistics networks (including reverse networks) are used as a reference in order to define assessment parameters to be included in effective models for the measurement of the environmental performance of supply chains.

FB7 **Military Decision Analysis**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States
Organizer: **Wright, George**
Graduate School of Business, United Kingdom

Chair: **Parnell, Gregory S.**
United States Military Academy, United States

1) *Multiple Objective Portfolio Analysis*, **Parnell, Gregory S.**, United States Military Academy, United States; **Stokes, Brian** ; **Burk, Roger C.**

In several recent decision analysis applications, multiple objective decision analysis is used with optimization to develop the optimal resource allocation. While the applications have been increasing, we believe that fundamental modeling issues have not be adequately addressed. This paper develops a framework for alternative multiple objective value models. The framework includes value models that identify the value of individual projects and value models that identify the value of the portfolio of projects. We illustrate each approach and discuss the practical and mathematical assumptions required for each approach.

2) *Discounting Measures of Effectiveness*, **Felli, James C.**, Naval Postgraduate School, United States; **Wall, Kent D.**

We consider the effectiveness of a system from a production perspective and discount marginal changes over time to determine a discounted measure of system effectiveness. We argue that this method is better suited to cost-effectiveness analysis than traditional effectiveness measures, particularly when alternatives are perishable or have different procurement schedules.

3) *Performance Analysis in the Selection of Imagery Intelligence Satellites*, **Burk, Roger C.**, US Military Academy, United States; **Deschapelles, Carolina**; **Doty, Karl** ; **Gayek, Jonathan E.**; **Gurlitz, Thomas**

The U.S. National Reconnaissance Office made innovative use of quantitative performance analysis in a multi-billion-dollar source selection for a new generation of picture-taking intelligence satellites. Within the framework of a multiattribute decision analysis value decomposition, a variety of techniques was used to develop metrics for each attribute and measure the contribution of each metric to overall system value. These methods included linear, non-linear, and integer optimization, continuous and discrete-event simulation, network flow analysis, and a genetic algorithm. Performance analysis incorporated the diverse needs of intelligence users and ensured an affordable system that would best meet critical national security requirements.

FB8 **MCDA in transport systems**

Invited session Venue: AT-3

Organizer: **Springael, Johan**
Vrije Universiteit Brussel, Belgium

Chair: **Springael, Johan**
Vrije Universiteit Brussel, Belgium

1) *A multicriteria multi-agent dynamic optimisation model for traffic congestion* , **Springael, Johan**, Vrije Universiteit Brussel, Belgium; **Kunsch, Pierre L.**; **De Smet, Yves**; **Van de Vijver, Bart**

The use of multiple agents is combined with multicriteria decision analysis in such a manner that behavioural distribution of certain processes in society can be modelled. These distributions serve as input for dynamical models involving feedback structures which influence on themselves the different agents. The presence of damping feedback loops, which are supposed to be sufficiently strong, will then generate an optimization process at the level of the societal behaviour distribution. The latter is shown through the numerical simulation of a dynamical system which includes the multiple agents and their restricted multicriteria intelligence. These concepts are applied in a model handling the congestion distribution wave.

2) *A Hybrid Genetic Algorithm for Multiobjective Flowshop Scheduling*, **Armentano, Vinícius A.**, Universidade de Campinas, Brazil; **Arroyo, José E. C.**

This paper addresses the flowshop scheduling problem with multiple objectives in such a way as to provide the decision maker with approximate Pareto optimal solutions. In order to find such solutions, we propose a new hybrid genetic algorithm with desired features such as: preservation of diversity in the population and use of a parallel multiobjective local search so as intensify the search in distinct regions. The algorithm is tested on a large set of instances involving up to 80 jobs and 20 machines, and its performance is compared with exact algorithms and two genetic algorithms proposed in the literature.

3) *Customer satisfaction benchmarking analysis An application to the Greek airline industry*, **Grigoroudis, Evangelos**, DSS Laboratory, Greece; **Siskos, Yannis**; **Tzanakis, Michael**

Customer satisfaction measurement offers a quantitative measure for performance, while it gives the ability of benchmarking by determining the strong and the weak points of any business organisation compared to the competition. A variation of the MUSA methodology for satisfaction benchmarking analysis and an application to the Greek airline industry are presented through this paper. The main objectives of the methodology are the planning and implementation of improvement actions, the adoption of best practices and the inspection of satisfaction evolution. Besides customer behaviour analysis and satisfaction analysis for each airline company, provided results are focused on the performance comparison, globally and per service characteristic. Furthermore, combining these results with financial performance indicators, the industry satisfaction barometer and the level of customer loyalty can be evaluated.

FB9 **Forecasting I**

Contributed session Venue: MS-3

Chair: **Angusamy, Ajitha**
Malaysia

1) *Forecasting the population of Kuwait*, **Alkhatrash, Seham A.**, University of Salford, United Kingdom; **Baker, Rose D.**

We forecast the population of Kuwait to the year 2020. Such forecasting is needed for Government planning, as the birthrate in Kuwait is much higher than in the UK. The analysis is unusual in that it uses comprehensive fertility, mortality and population data collected in Kuwait and not previously available, and in that a model is fitted to data by maximum-likelihood methods. This enables confidence intervals on the forecasts to be computed. A sensitivity analysis is also carried out.

2) *Location Assessment of Outlet Networks*, **Mendes, Armando B.**, Azores University, Portugal; **Themido, Isabel Hall**

Location Assessment of Outlet Networks is a complex decision. The complexity derives mainly from the enormous amount of data that should be considered. Variables of geographical nature are used to evaluate the accessibility of the several locations, while the demographic ones allow the store's trade area evaluation. Socioeconomic variables are indispensable in the potential customers' characterization, and competition ones are used for the evaluation of the new store market share. The methods are multiple, varying from simple analogy forecast models to very complex ones, which can incorporate causal models in a gravitacional or logit structure. More recent developments as the use of meta-heuristics such as genetic algorithms for the global problem of the multi outlet chain configuration, or the use of Voronoi tessellations in store trade area delimitation, are also presented. Finally the Geographical Information Systems' role on the decision support process is equally explored.

3) *Forecasting The Demand Of Speciality Chemical Products*, **Omar, Mohamed khaled**, Dr, Malaysia; **Rahman, Noor Lela** ; **Angusamy, Ajitha**

Integrating planning and forecasting activities is the main the main theme of this research. Many researcher addressing planning problem has treated forecasting as a separate activities from the planning and scheduling. A hierarchical framework, which comprises of forecasting module, an aggregate planning module and disaggregate planning module has been developed and tested for a specialty chemical firm. The proposed architecture framework, through proof-of-concept implementation, has improved the quality of decisions. This study is concerned with managing demand uncertainty and report on the impact of forecasts accuracy on managing demand uncertainty.

FB10 **Case Studies III**

Invited session Venue: MS-4

Organizer: **Ranyard, John**
Lancaster University, United Kingdom

Chair: **Ranyard, John**
Lancaster University, United Kingdom

1) *Redesigning a freight company network in 8 weeks!*, **Hubert, Iain**, United Kingdom

As part of Cap Gemini, Ernst & Youngs OR group, I was asked to join a project that we were undertaking with a UK freight company. The brief was to model their network and find some improvements in 8 weeks. In that time I managed to produce a model of the network that could be understood by not only the client, but also by my fellow consultants, and then through the application of optimisation, was able to show that they could save up to 2 million pounds a year, just by changing which depots served which areas.

2) *Electricity Demand Forecasting in the New Trading Environment*, **Duncan, Stephen John**, Cap Gemini Ernst and Young, United Kingdom

In 2001, the rules in the Electricity market changed from the old pool system to one based on Trading just like any other commodity. Suppliers need to forecast demand from their customers and agree contracts to purchase the appropriate amount. Any difference between the demand and the amount purchased - whether positive or negative - results in added cost for the company. It is therefore important for accurate demand forecasting. This case study covers the background of the Trading environment and a forecasting system used by an electricity supplier.

3) *Streamlining Engineering Support*, **Parkin, Jane**, Huddersfield University, United Kingdom; **Rice, Stephen**

A major engineering company services approximately 25000 pieces of equipment ranging from pallet trucks to sophisticated cranes on both a regular maintenance and emergency call-out basis and operates through 12 service managers, 30 fleet

controllers and 500 service engineers based at 15 depots throughout mainland Britain. The company believed significant savings could be achieved by rationalizing its depot network. However, following extensive analysis work further savings that involved a radical change in operational methods were identified without jeopardizing the levels of service which are critical to the business

FB11 **Economics I**

Contributed session Venue: MS-5

Chair: **Dai, Feng**
ORSC, China

1) *The Investment Analytic Process based on the Partial Distribution*, **Dai, Feng**, ORSC, China; **Shao, Jin-Hong**

Based on the PD-Partial Distribution, We provide a new kind of method for investment analysis, the Investment Analytic Process (IAP). IAP can measure the average income, average profit and the market risk of an investment. By the method, we also can calculate the profit and market risk of investment in variable value field. Finally, the practice application of IAP is shown by two examples.

2) *A genetic algorithm for exploiting a fuzzy preference model of R-D portfolio problems*, **Fernandez, Eduardo Rene**, University of Sinaloa , Mexico; **Navarro, Jorge Adalberto**

The R&D portfolio problems in public organizations needs a special treatment because a) the quality of projects is generally described by multiple conflicting criteria, one of them (often not the most important) may be the monetary benefit, and b)the fund requirements are not known with accuracy, the concept of what is a sufficient support should be handled in more flexible way reflecting the natural fuzziness of the set of projects adequately supported. We propose here a non linear preference model developed from normative Multiattribute Value Theory and using fuzzy sets to model some sources of imprecision.The optimization problem is very complex to be solved by standard non linear programming techniques, and therefore we propose an elitistic and constrained genetic algorithm for solving it. Our proposal performed very well in a few examples achieving an improvement about 20% in the quality of solutions in comparison to typical heuristic ways.

3) *An Introduction to Critical Realism*, **Ahadi, Ali**, Government, United Kingdom

The talk will be about the philosophy of social research and will introduce the main schools of thought one of which is critical realism. The contents will be structured as follows: -What is philosophy/What is research -Schools of thought (1): Positivism and the emphasis on scientific method -Schools of thought (2): Critical Realism the need for methodological pluralism -What about OR? -Case Study: Regional Variation in Appellant Success rates at Tribunals -Conclusions

FB12 **Managing Complex Development Projects**

Invited session Venue: AT-6

Organizer: **Friend, John Kimball**
University of Lincoln, United Kingdom

Chair: **Rand, Graham K.**
Lancaster University Management School, United Kingdom

1) *Learning from Negotiated Project Engagements - a Framework for Interaction*, **Friend, John Kimball**, University of Lincoln, United Kingdom; **Phahlamohlaka, Letlibe Jacob**

An interactive framework is introduced for capturing the learning to be extracted from successive development projects involving engagement of diverse people and organisations contributing variously as project agents; as project hosts; and as external project sponsors. The framework originated in a Tavistock Institute study to review the experience of thirteen completed action research projects involving field collaboration between operational researchers and social scientists. A brief interactive demonstration of the use of the framework to explore the lessons from a recent project in Africa will lead into discussion of the potential for wider use in learning from experience in international development.

2) *Approaches to development of Strategic Project Management Capability*, **Crawford, Lynn Heather**, UTS, Australia; **Costello, Kerry Lynette**

The two presenters of this paper have been working with government agencies in Australia to develop project management approaches that are responsive to the challenges of organisational change, performance improvement and service delivery programmes and projects. A methodology has been progressively advanced through action research within the framework of soft systems thinking. The aim is to make sense of the dynamics of project management within a complex organisational context. The development by the research team of both theory and practice will be illustrated by case studies of work with two Australian government agencies.

FB13 **Environmental Management I**

Contributed session Venue: AT-7

Chair: **Tozer, Peter R.**
Pennsylvania State, United States

1) *A Genetic Algorithm for the Optimization in River Water Quality Management*, **Sung, Kiseok**, Kangnung National University, Korea; **Cho, Jaehyon**

Finding the optimal solution in the river water quality management is hard with the non-linearity of the water quality model. Many suggested methods using the linear programming, non-linear programming and dynamic

programming, can give not give an optimal solution of sufficient accuracy and satisfaction. We studied a method to find an optimal solution in river water quality management in the aspect of the efficiency and the cost of the waste water treatment facilities satisfying the water quality goals. In the suggested method, we use the QUAL2E water quality model and the genetic algorithm. A brief result of the project to optimize the water quality management in the Youngsan river is presented.

2) *Strategic Selection of Sustainable Product Improvement Alternatives Under Fuzzy Data Uncertainty*, **Halog, Anthony Basco**, Japan

The research is focused on how companies can be assisted in design of products so that quality, environmental & cost (QEC) requirements of stakeholders in the life cycle stages of product system are addressed at an early stage. The consideration of these 3 design requirements leads to multi-attribute decision situation with regard to selection of optimal product system improvement concept. The main objective is to develop decision-oriented life cycle approach that integrates QEC parameters at the early stage of product development. A 4-phase conceptual approach was developed which includes: (1) identification of QEC requirements; (2) generation of alternatives and construction of sustainable concept comparison matrix where fuzzy terms were adopted; (3) fuzzy linguistic decision support system to select the optimal sustainable product improvement alternative; and (4) sensitivity and statistical analyses. Rankings of sustainable options with respect to QEC attributes are reported.

3) *Managing Soil Nutrient Loading: Conflict or Compromise?*, **Stokes, Jeffrey R.**, Pennsylvania State, United States; **Tozer, Peter R.**

While nitrogen-leaching problems are relatively well documented, phosphorus run-off is fast gaining attention as the next big nutrient related environmental problem associated with large, highly concentrated livestock operations in the U.S. While most past research has focused on regulation and taxation as mechanisms for managing excessive soil nutrients, we propose an alternative. A compromise programming model is developed to assist farm and feed mill operators in formulating dairy rations with both cost and nutrient excretion objectives. Results suggest that modest reductions in nitrogen loading and significant reductions in phosphorous loading can be accomplished with minimal increases in the cost of feeding dairy cows. The approach taken also lends itself to an explicit quantification of the tax required to induce alternative feed rations that are more environmentally friendly.

FB14 **OR in Forestry - tactical planning**

Invited session Venue: AT-8

Organizer: **Weintraub, Andres F.**
University of Chile, Chile

Chair: **Ronnqvist, Mikael**
Division of Optimization, Sweden

1) *Harvesting Planning*, **Karlsson, Jenny**, Department of Mathematics, Sweden; **Ronnqvist, Mikael**

The problem we consider is harvesting planning on a tactical and operative level. On a tactical level the total planning period is one year and on the operative level plans are made for a total planning period of 5 weeks. The problem is to decide which areas to be harvested during each time period so that the industries receive the required amount of assortments. There are a large number of aspects to consider. Tactical and operative harvesting plans are produced by two different models. The results from the tactical model give data to the operative. Both models are mixed integer linear problems. Computational results will be presented.

2) *Procurement policy and market position of a saw mill* , **Eriksson , Ljusk Ola** , SLU , Sweden; **Wikstrom , Peder**

A saw mill can be characterised as a processing link transforming lumber into components for further refinement. There is thus a need to balance customers against processing facilities and raw material supplies. A model that facilitates this analysis is presented. It is based on the assumption that processing equipment is fixed but that lumber purchases and customer demands can be varied. The model consists of a dynamic programming model encapsulated by the Frank and Wolfe algorithm.

FB16 **System Dynamics Modelling II**

Invited session Venue: WR-11

Organizer: **Lane, David C.**
London School of Economics, United Kingdom

Chair: **Lane, David C.**
London School of Economics, United Kingdom

1) *Defining developmental problems for policy intervention*, **Saeed, Khalid**, WPI, United States

Developmental problems are invariably perceived as existing conditions, which must be alleviated. This often removes a policy from the factors that created the problem in the first instance. Problem articulation for policy intervention as practiced in system dynamics modeling requires on the other hand that a problem is viewed as an internal behavioral tendency found in a system so its causes can be determined before a corrective action is initiated, which is presented in this paper as an effective process to articulate developmental problems. This process is illustrated by redefining the problem of food security.

2) *Preventive maintenance programs from a system dynamics perspective*, **Maier, Frank H.**, Germany

OM literature regards preventive maintenance programs as important to minimize machine downtime. Several success stories document impressing outcomes of the concept. However, empirical research found that by far not all operations achieve the promised successes. Possible reasons for the failure of preventive maintenance programs are self-confirming

attributions caused through positive feedback loops. This is the starting point for the development of a system dynamics model of preventive maintenance. The model is used to investigate whether the unsuccessful plants in the database are likely to show the temporary dominance of the self confirming attributions. Based on the empirical data this model explains the outcome of preventive maintenance programs much better than statistical analysis.

3) *The Adaptive Control Methodology*, **Brans, Jean-Pierre**, VUB, Belgium; **Pruyt, Erik**

The Adaptive Control Methodology, from concept to practical implementation. The Adaptive Control Methodology (ACM) combines an information phase, a system dynamics modeling and testing phase, a multiple criteria decision aid phase and a post-implementation montoring and control phase. Until now, however, the ACM remained quite general and highly conceptual. We will try to illustrate with new insights and procedures how to turn the conceptual ideas of the ACM into a practically implementable method for complex policy purposes.

FB17 **Client needs in OR I**

Invited session Venue: WR-10

Organizer: **Pidd, Michael**
Lancaster University, United Kingdom

Chair: **Lyons, Michael Hamilton**
BTexact , United Kingdom

1) *Use of 'soft-OR' models by client - what do they want from them*, **Eden, Colin**, University of Strathclyde, United Kingdom; **Ackermann, Fran**

This presentation will address the use of 'soft-OR' models from the perspective of the client. It will draw on several hundred interventions using SODA/Journey-making. It will argue that for the client of 'soft-OR'client implementation and political feasibility considerations are absolutely paramount. They want models to contribute to reaching agreement within a group of managers, or a manager and their own team. Flexibility in the use of tools and techniques during a workshop, where a wide range are likely to be used contingently, is an expected skill of the consultant. This means that it is difficult to prepare, other than process design. Typically visual interactive modelling dominates. If quantitative models are constructed then this will derive from incrementalism - moving slowly towards quantitative modeling. Managers demand absolute transparency with a preference away from spurious accuracy and towards quick and 'dirty' models.

2) *Mental Models and Learning in System Dynamics Practice*, **Morecroft, John**, London Business School, United Kingdom

System dynamics uses mathematical models as ‘transitional objects’ for individual and team learning. The approach is illustrated with a model of BBC World Service built with its management team. Samples of model structure illustrate how the modelling process draws on the team’s mental models. Objective knowledge of real operating constraints is combined with socially constructed views of operating policy to arrive at a feedback representation and simulator.

3) *The Hard/Soft Distinction in Management Science*, **Checkland, Peter**, Lancaster University, United Kingdom; **Holwell, Sue**

The difference between 'hard' and 'soft' management science is now well-accepted, at least in Europe, but is rarely defined. Statements are made to the effect that 'hard' methods are appropriate in dealing with well-defined (usually 'technical') problems, a 'soft' approach is in messy ill-defined problems. This is not untrue, but tells us nothing about how 'hard' and 'soft' approaches differ. This paper examines classic OR and Soft Systems Methodology as examples of hard and soft management science, in order to develop a clear definition of the hard/soft distinction. This shows clearly the complementarity of the two approaches, and draws attention to the surprising neglect of PROCESS in the hard tradition, and suggests how it can be addressed.

FB18 **Strategic Development: The role of OR - past, present and future**

Invited session Venue: WR-9

Organizer: **O'Brien, Frances**
Warwick Business School, United Kingdom

Chair: **O'Brien, Frances**
Warwick Business School, United Kingdom

1) *The Future of OR - a UK perspective*, **O'Brien, Frances**, Warwick Business School, United Kingdom; **Meadows, Maureen**

This paper explores the future of the OR discipline from the perspective of different stakeholder groups within the UK OR community. A variety of groups have participated in a visioning exercise where they discussed 'how do we want OR to be in the future?', using materials prepared by the authors. The paper outlines the methodology used for conducting the visioning sessions and summarises some of the key themes that have emerged from the group discussions.

2) *Strategic Operations Research and the Edelman Prize Finalist Applications 1989-1998*, **Bell, Peter C**, Canada

We contacted people who were familiar with almost all of the applications that were Edelman finalists 1989-1996. We will review the post-Edelman history of these applications and discuss the strategic importance of the private sector applications and the sustained impact of the public sector and military applications.

3) *Workshop / Panel Discussion - The OR contribution to strategy*, **Meadows, Maureen**, Warwick Business School, United Kingdom; **O'Brien, Frances**

This workshop begins by outlining the objectives of a new study group of the UK OR Society. It will summarise the topics

that have been presented at recent meetings. It will then go on to take the form of a panel discussion where some of the speakers in this stream will be invited to lead a discussion on the OR contribution to strategy.

FB19 **Knowledge Management and Intellectual Capital in organisations**

Invited session Venue: WR-1

Organizer: **Edwards, John Steven**
Aston Business School, United Kingdom

Chair: **Edwards, John Steven**
Aston Business School, United Kingdom

1) *Management in 'Risk Society': Re-considering Rationality, Technology and Control*, **Persson, Per-Arne** , Swedish Army Command, Sweden

Management within global business and modern organizations means highly controlled activities and sophisticated control technologies. Research and industries exploit efficient use of information technology (IT) for the integration of human practices through coordinating mechanisms, but socially acceptable technologies may be overshadowed by contextual conditions and dominant views on rationality and organizing. Re-reading the foundations of Western management, contextualizing technology, action and rationality, promotes a social understanding of 'risk society' and what are 'best control practices'. Science and Operations Research(OR) are neither self-explanatory nor "natural". Problemsolving by OR rationality merits being re-considered after the September 2001 events, especially in developing countries. Keywords: Organization science, rationality, technology, management science, discipline.

2) *What UK managers think about knowledge management*, **Edwards, John Steven**, Aston Business School, United Kingdom; **Shaw, Duncan** ; **Collier, Paul M.**

Several facilitated small group workshops have been conducted for various UK organisations. Participants covered a range of people with responsibility for knowledge management, from director level downwards. The aim of each workshop was to enable participants to consider how their organisation acquires, shares, retains and utilises knowledge (now and in the future), and what metrics are most appropriate. This presentation reviews the findings from these workshops.

FB20 **Airline Applications II**

Contributed session Venue: WR-2

Chair: **Perry, Jonathan Eric Hayward**
British Airways plc, United Kingdom

1) *A new algorithm for scheduling aircraft fuelling*, **Linke, Andreas**, Hochschule Magdeburg, Germany; **Jakobides, Frank**

Due to a steady increase in the air traffic combined with an enormous cost pressure, aircraft services will have to be optimised in order to reduce ground time and gain more efficiency. As for aircraft fuelling, the objective is to reduce the number of required tank vehicles. For that purpose a new algorithm has been developed to support the scheduler who manages the fuel orders. The algorithm is easy to implement, time efficient, adaptable to constraints and insensitive to flight delays. For the Frankfurt airport with more than 400 fuel orders per day for a single fuelling company, the algorithm leads to a significant reduction of vehicles.

2) *Aircraft taxi planning* , **Marin Gracia, Angel**, Univ Politecnica Madrid, Spain; **Martinez Gimenez, Jesus**; **Salmeron , Javier**

Air traffic growth causes new significant congestion on air traffic system. In this context the delays like consequence of airport ground traffic represent an increase percentage of the total system delay. Some modelizations of the problem provide tools to assist ground controllers in choosing the best taxiways and the best configuration of holding points for aircrafts. This tool could be used by airport designers to evaluate the correct system capacity assignment. Accurate and approximate methods are evaluated to obtaining operative solution that could be used in real problems.

3) *Where do all the passengers go? Calculating Airline Network Profitability*, **Perry, Jonathan Eric Hayward**, British Airways plc, United Kingdom

Calculating the profitability of an airline's network requires evaluating many influencing factors including demand, competition and consumer preference. The prevalent consumer choice models are QSI and Logit. Experiences from British Airways show that when evaluating which model to use and to make the best use of their outputs requires a careful balance between business knowledge and mathematical modelling.

FB21 **Finance and Banking IV**

Contributed session Venue: WR-3

Chair:

1) *Evaluating Real Options in Natural Resource Investments by Simulation*, **Cortazar, Gonzalo**, Universidad Catolica Chile, Chile

We evaluate natural resource investments under a real options approach using Monte Carlo simulation methods. Real options models of natural resource investments are very powerful but difficult to solve using traditional numerical methods. This imposes restrictions on the number of risk factors and stochastic processes used, which may limit the applicability of this approach. New simulation methods developed for valuing

American-type financial options may be successfully used to solve relatively complex problems. We illustrate this new approach solving the Brennan and Schwartz (1985) model of a copper mine.

2) *Does Benchmarking Help?*, **Ansell, Jake**, University of Edinburgh, United Kingdom; **Moles, Peter**; **Smart, Alison**

Benchmarking is used widely throughout companies to assess the performance against that of leading companies in the field. In fund management it is used to compare a fund manager against the universe of fund management companies. In this paper we explore the concept of benchmarking within fund management particularly in asset allocation. This exploration includes the selection of appropriate benchmarks. There are some major problems with benchmarking which include the risk involved and measures taken to deal with it such as risk adjustment. Finally we advocate that the trustees need to interact with the fund managers if the fund is to develop in the way they desire. This should include an understanding of the organisational aspects of the fund managers' role.

3) *Risk budgeting in a downside risk framework*, **Takehara, Hitoshi**, University of Tsukuba, Japan

We shall propose a new framework for risk budgeting in this paper. It is ussually assumed that returns from the securities are normally distributed. Empirical results, however, shows that the return from the actively managed portfolio such as pension fund do not follow the normal distribution. To solve this problem, we propose a new method to optimize the manager structure based on the downside risk model.

FB22 **Decision Support Systems V**

Contributed session Venue: WR-4

Chair: **Leung, Janny**
Chinese Univ of Hong Kong, China

1) *A new modelling approach for multi-depot vehicle scheduling in public transport*, **Suhl, Leena**, University of Paderborn, Germany; **Mellouli, Taieb**; **Kliewer, Natalia**

In this talk we present an efficient modelling and solution method for vehicle scheduling in public transport under consideration of practical aspects like multiple depots and vehicle types for each scheduled trip as well as depot capacities. Our solution methods are based on an aggregated network flow model considering problem-specific time-space structure. The network size grows linearly with the number if scheduled trips. Traditional approaches suffer from quadratic growth. The presented model enables fast solutions procedures for real-world vehicle scheduling problems with thousands of trips under direct application of standard optimization software.

2) *Geometry of a Set of Probability Measures Satisfying Subjective Bounds*, **Wortman, Martin**, Texas A and M University, United States; **Klutke, Georgia-Ann**

The assignment of probability measure is central to most decision analysis methodologies. It is sometimes impractical to rely only upon statistical methods when making this assignment, and event probabilities must be specified on the basis of an analyst's intuition and experience. In this talk, we consider the sensitivity of probability models to variations in assigned measure. Geometric properties of a set of feasible measures, constrained by orderings on certain event probabilities, will be explored.

3) *Map-Based Logistics Support with Stochastic Routing*, **Leung, Janny**, Chinese Univ of Hong Kong, China; **Wong, Jacky Chi-Fat**; **Fung, Paul Tze-Wa**; **Cheng, Chun-hung**

This talk describes an on-going project to develop a map-based system for distribution planning. The system consists of a bilingual database containing a multi-layered system of map images of several districts in Hong Kong, solution algorithms, and an interface for displaying map-images of the proposed routes and schedules developed. The underlying database uses a network representation of the road segments. Algorithmic modules include: shortest-paths evaluation between any specified origin-destination pairs (point-and-click) on the map, heuristics for order assignment and delivery fleet routing with time windows, and optimisation-based heuristics for planning and dynamic re-routing with stochastic travel times.

FB23 **Data Envelopment Analysis I**

Contributed session Venue: AF-10

Chair: **Jablonsky, Josef**
University of Economics, Czech Republic

1) *A Further Approach to DEA Sensitivity Analysis* , **Guan , Jiancheng** , China; **Wang, Junxia**

A new model of DEA sensitivity analysis is presented to deal with the relative error existed during computing. Based on this model, the sufficient and necessary conditions to keep the classification (efficient or inefficient) when single DMU changes are proposed. Nevertheless, a worst case when all DMUs change is discussed. Then the sufficient condition of keep classification in the worst case is put forward. In the last section, an example is offered to verify the result. Keywords DEA (Data Envelopment Analysis), Sensitivity analysis, Efficient, Inefficient, Perturbation, Stable. http://sem.buaa.edu.cn/download/guanjiancheng/IFORS_GuanWang111.doc

2) *On Network DEA Model for Allocation of Resources*, **Lunge, Harihar S.**, Shri Shivaji Science Coll, India

When researchers apply DEA to specific industries or situations, they have often added more structure to the model to better suit the application.We model the networks as the constraint set or reference technologies of DEA models.Network DEA model is a family of models with linear constraints. This paper describes the network DEA model for allocation of resources. Keywords: DEA, Networks

3) *Simulation experiments with random DEA models*, **Jablonsky, Josef**, University of Economics, Czech Republic

Standard DEA models are based on exact inputs and outputs. The paper formulates DEA models supposing that inputs and outputs are random variables with given continuous probabilistic distributions. Under this assumption the efficiency scores for evaluated production units are random variables. The aim of the paper is to describe the properties of the random efficiency scores by means of simulation experiments. The experiments are realised within the MS Excel environment together with LINGO optimisation solver and Crystal Ball add-in application for simulation analysis in spreadsheets.

FB24 **Military OR V**

Contributed session Venue: AF-13

Chair: **Stahel, Albert A.**
Swiss Military College, Switzerland

1) *Simulation Of Spanish Soldier Workforce*, **Pla, Lluis Miquel**, Dep-Mathematics-UdL, Spain; **Michavila, Narciso**

The Spanish Forces (SF) is facing the challenge of strengthing the new system of soldiers enrollement after the suspension of conscription in 2001. Consequently, there is a need of attracting a sufficient quantity of applicants to meet existing enrollment targets. Reasons for that are a strong economy, changing demographics and fierce recruiting competition from external agencies. The current recruiting situation is expected to not only continue in the coming years but to further deteriorate, therefore a main objective is to avoid understaffing SF. In order to evaluate the impact of the unpredictable shortage of applicants on SF, the SIDICON model are presented.

2) *An Application of Linear Programming in the Defence Environment*, **Walmsley, Nicholas Simon**, United Kingdom; **Hearn, Paul**

Operational Analysis (OA) techniques are used extensively by the Ministry of Defence (MoD) to inform their decision making process. One particular type of OA study frequently undertaken is a Balance of Investment (BoI) study. This paper focuses on a recent BoI study whose aim was to identify the optimum mix of vehicles that should be procured to fill a large number of identified requirements/roles for a fixed cost. There will be a description of the methodology employed (highlighting the formulation and application of Mixed Integer Linear Programming (MILP) techniques) alongside a brief discussion of the implication of the results and other issues associated with the complexity of the problem.

3) *Dissymmetric warfare versus asymmetric warfare*, **Stahel, Albert A.**, Swiss Military College, Switzerland

The terrorist attacks of the 11 September belong to the area of asymmetric warfare. A terrorist organisation, al-Kaida, planned and executed attacks on the symbols of world economy and the centre of the US power flying suicide attacks with hijacked passenger aircraft. Two important centres of gravity where thus hit and destroyed. The Bush administration was forced to take action against al-Kaida and their hosts, Afghanistan's Taliban rulers, who had refused to hand over Mr bin Laden. The US used their bomber forces to destroy positions and strongholds of the Taliban. The Pentagon exploited its dissymmetric advantage stemming from Airpower against the asymmetric warfare of the Taliban and al-Kaida. The question now arises whether in future wars will be decided by the use of Airpower on the principles of dissymmetric warfare or whether this war was just another episode of dissymmetric versus asymmetric warfare.

FB25 **Stochastic models II**

Contributed session Venue: AF-14

Chair: **Archibald, Thomas W.**
University of Edinburgh, United Kingdom

1) *On the efficient development of an hospital system - a case study in Northern Portugal*, **Antunes, Antonio**, Universidade de Coimbra, Portugal; **Pires, Cristina**; **Bana e Costa, Carlos A.**

The Portuguese Norte Region (25,000 km2, 4,000,000 inhabitants) went through major demographic and social transformation in the recent past, which led to important changes in the demand for health care facilities. This paper presents a study aimed at identifying efficient directions for the development of the region's hospital system. The following objectives were considered: minimization of cost, maximization of accessibility, and maximization of coverage. The main tool used for the preparation of the study was a hierarchical facility location-allocation model.

2) *Supply Chain Coordination under Stochastic Demand*, **Tomasgard, Asgeir**, NTNU SINTEF, Norway; **Hoeg, Erik S.**

In this paper we present supply chain optimisation models for the meat industry. The focus of the decision support models is to maximize expected profit subject to uncertain demand and shortfall costs. This is done by co-ordination of production and inventories in different regions and at different levels in the supply chain. The models describe decisions at the operational and tactical levels and the links between them. We consider the situation with uncertain demand and present mathematical models based on stochastic linear programming.

3) *Component Commonality and Advertising in Start-up Companies*, **Possani, Edgar**, University of Southampton, United Kingdom; **Thomas, Lyn C.**; **Archibald, Thomas W.**

Start-up companies are a vital ingredient in the success of a globalised networked world economy. We present a markov decision model to analyse survival probabilities of start-up companies. The model includes purchasing, and ordering costs, as well as the influence of marketing, loans, and component commonality in the inventory decisions.

FB26 **Airline Applications I**

Contributed session Venue: AF-18

Chair: **Lin, Cheng-Chang**
National Cheng Kung Univ, Taiwan

1) *The Airline Capacity Planning Problem for Low Traffic Sectors*, **Avittathur, Balram**, IIM Calcutta, India; **Sinha, Bani Kumar**

Owing to severe congestions at major airports and growing passenger discontent with non-direct flights, the traditional hub and spoke network is expected to increasingly give way to direct routes network. The airline capacity planning problem for low-traffic sectors is comparatively more complex. Bigger aircraft have high operational cost economies in comparison to small aircraft. However, owing to low traffic, demand-capacity matching is more complex when an airline fleet comprises only of big aircraft. Usage of big aircraft in low-traffic sectors also implies infrequent schedules, which again is a practice that generates discontent among passengers. In this paper, our aim is to formulate the airline capacity planning problem for low-traffic sectors with the objective of minimizing total operational cost. An attempt is also made to apply this model in a real-life situation in India.

2) *Integrated disruption management in operations control*, **Larsen, Jesper**, IMM, DTU, Denmark; **Larsen, Allan** ; **Clausen, Jens**; **Saxtorph, Jesper**

Disruption management in the airline industry involves decisions concerning mainly crew and aircraft but also passengers in situations where unforeseen events have disrupted the existing flight schedules. This could be bad weather causing massive delays or crew reporting sick just a few hours before start of their duty. Disruption management aims to recover the operation of an airline through a series of reassignments of crew and aircraft. Previous efforts have been few and concentrated on recovering just a single resources (aircraft, flight crew or cabin crew). As the resources are highly integrated a more holistic approach will lead to solutions of better quality. We will present a solution methodology and results for a solution approach.

3) *A generalized hub-and-spoke network design problem*, **Lin, Cheng-Chang**, National Cheng Kung Univ, Taiwan; **Chen, Sheu-Hua**

In a hub-and-spoke network, centers are points of pickup and delivery (departure and arrival) while hubs are points of consolidation (transit). The configuration substantially reduces partial loads (flights). Even though the handling costs (transit times to travelers) may increase slightly, the overall operating cost to the carriers is lower. In practice, there are three types of hub-and-spoke networks, pure, stopovers, and stopovers with center directs. In this research, we propose a generalized directed and capacitated network structure suitable for all three types. We develop and test an implicit enumeration exact algorithm using the FedEx Asia-One air express network.

FB27 **Cost, Revenue & Pricing**

Invited session Venue: AF-19

Organizer: **Yeoman, Ian Seymour**
Napier University, United Kingdom
Organizer: **McMahon-Beattie, Una Sinead**
University of Ulster, Northern Ireland

Chair: **Yeoman, Ian Seymour**
Napier University, United Kingdom

1) *Performance Monitor The Opportunity Costs of RM*, **Anderson, Chris K.**, Ivey School of Business, Canada; **Blair, Montgomery**

Revenue Management (RM) brings rational approaches to pricing for goods and/or services with a limited shelf life. The practice of dynamically pricing a perishable product across different market segments continues to be applied across an ever-increasing set of business arenas. While numerous consulting and software development firms preach the bottom line impacts of RM practice, little effort is put forth to monitor the success of RM systems once in place. The continued success of revenue management hinges upon the ability to link organizational performance to the pricing and capacity decisions of RM systems. This link both reinforces the financial gains attributable to RM and indicates opportunities for future improvement. We outline Performance Monitor, a phased approach to performance measurement designed and implemented at Dollar Rent A Car. We focus on the impact of RM practice via a dissection of the lost revenue opportunities of historic decisions

2) *Optimal Pricing and Inventory Management of Substitutable Products* , **Karakul, Mustafa**, University of Toronto, Canada; **Chan, Lap Mui Ann**

We consider the introduction of a new product, which can also be used as a substitute to a well-established existing product. It is assumed that the price and the demand of the existing product are known. Our objective is to maximize the profit while making optimal combined pricing and ordering decisions for these substitutable products. This study extends both the newsboy problem with pricing, and the inventory management of substitutable products. We show that there is at most one local maximum. Keywords: Pricing, revenue management, inventory control, unimodality, substitution

3) *Discount cash-flow analysis: a firm-centred approach*, **Fox, Roland P.**, University of Salford, United Kingdom; **Baker, Rose D.**

Discounted cash flow (DCF) is widely used to appraise the viability of risky capital projects, with an interest rate determined by the beta of the project derived from the CAPM. We replace this with a firm-centred or Management Science approach that does not make this link with the Market. Risk aversion is now modelled via a utility function to be elicited from the firm, and a floor and ceiling is assumed for future returns. We illustrate the difference between our methodology and the conventional approach with an example.

FB28 **Scheduling and Timetable IV**

Contributed session Venue: DH-C

Chair: **Lee, Yusin**
National Cheng Kung Univ, Taiwan

1) *A minimax parallel processors scheduling problem*, **Pelikan, Jan**, University of Economics, Czech Republic

There are n independent jobs on m parallel processors and one common source, i.e. power supply capacity, production area, production capacity of a equipment. For each job the time duration and intensity of common source consumption are given. The total intensity of the consumption of the source is the sum of the intensities of the simultanously processed jobs on parallel processors. The maximum of the total consumption intensity over the given time interval is minimized by the job scheduling.

2) *A New Genetic Algorithm For A Parallel Machine-Scheduling Problem*, **Palominos, Pedro**, University of Santiago, Chile; **Quezada, Luis Ernesto**; **Carreno, Alex**; **Valenzula, Juan**; **Donoso, Alejandro**

The present work has the objective of proposing a heuristic that is more efficient than those found in the literature, for the problem of programming N tasks in a system of identical parallel machines. The objective is to minimize the maximum weighted absolute lateness, by means of Genetic Algorithms. The proposed algorithm is based on a binary matrix, where the columns represent the tasks and the rows represent the machines. The algorithm was parameterized by means of an experimental design. The results obtained are superior to Cheng and Gene´s heuristic, for the same problems.

3) *A Model for the Travel Opportunity Train Scheduling Problem*, **Lee, Yusin**, National Cheng Kung Univ, Taiwan

In this research we develop a mixed integer program for the travel opportunity train scheduling problem. For a given single-track railroad system, a set of trains and a set of travel demand, the model yields a timetable for the train services that provides appropriate travel opportunities for the travel demands. Travel demands are specified with their desired origin station, destination station, departure time, and arrival time. The travel demands are satisfied either by direct service, or by appropriately arranged train services that allow the traveler to complete the desired trip by transferring between trains. A computational example is provided.

FP **Closing Plenary Session**

Friday 1:30 p.m. to 2:30 p.m.
Venue: George Square Lecture

Chair: **Lyn Thomas**, University of Southampton, UK

Elise del Rosario - report from Competition for OR in Development Prize

Rangalal Bandyopadhyay - report from stream on OR in Development
Letlibe Jacob Phahlamohlaka - report from stream on Community Development and Capacity Building
John Friend - report from stream on Managing International Development

Paolo Toth introduces the Plenary Speaker Francisco Sagasti

Francisco Sagasti, Peru

Closing remarks by:
IFORS 2005 Conference: **Martine Labbe**, BE, Program committee Chair and **Jeff Arthur**, USA, Organizing Committee Chair
Lyn Thomas - Chair, Organizing Committee, UK
Ben Lev - Chair, Program Committee, USA
Paolo Toth - IFORS President, Italy

FD1 **Hospital Services II**

Invited session Venue: DHL-B

Organizer: **Davies, Ruth M.**
University of Southampton, United Kingdom

Chair: **Rauner, Marion S.**
University of Vienna, Austria

1) *A subproblem-centric approach to the nurse scheduling*, **Ikegami, Atsuko**, Seikei University, Japan; **Niwa, Akira**

Scheduling nurses involves two sets of constraints: "shift constraints" for maintaining a certain level of skill for each shift and "nurse constraints" for the workload for each nurse. We define a subproblem for a specific nurse to minimize the degree of violation for the shift constraints subject to his/her nurse constraints and the other nurses' schedules specified by a trial solution. Starting from an appropriate trial solution, our approach solves this subproblem for each nurse and accepts the best solution from the results as the next trial solution. It continues this process until the objective value is zero.

2) *Understanding Ambulatory Care* , **Mould, Gill**, University of Stirling, United Kingdom; **Bowers, John**; **Jeffrey, Susanne**

In a drive for greater throughput of elective patients a number of Acute Trusts are proposing Ambulatory Care facilities. These are essentially walk-in walk-out centres which undertake routine elective surgery. One of the philosophies behind Ambulatory Care is that many aspects of the elective surgery can be de-skilled and hence undertaken by specialist nurses. A study has been undertaken in collaboration with Aberdeen Royal Infirmary to understand the throughput of patients through such a planned Ambulatory Care facility. Computer simulation has been used to understand the throughput of patients through alternative designs of the facility and to identify resource constraints.

3) *Modelling for the Provision of Hospital Beds and Medical Staff*, **Shanani, Arjan K.**, University of Southampton, United Kingdom; **Costa, Andre Xavier**; **Harper, Paul R.**; **Dale, Jana**

Decisions about patient flows, number of beds and staffing levels in a hospital have to be made in the face of complexity, uncertainty, variability, and scarce resources. Decisions based on calculations that use average values only for patient flows and staff needs are likely to underestimate the required resources and thus to provide false assurances about the levels of expected service from the hospital. We discuss the development and use of detailed models, at the level of individual patients, which have evolved through the joint work of hospital professionals and Operational Researchers. These models help in planning and managing capacities.

FD2 **Optimization Problems in Railway Applications**

Invited session Venue: DHL-C

Organizer: **Crainic, Teodor Gabriel**
Dept. management et technologie, UQAM and CRT, Ude, Canada

Chair: **Toth, Paolo**
DEIS, Univ. of Bologna, Italy

1) *An Information-Theoretic Model of Locomotive Operations*, **Bouzaiene-Ayari, Belgacem**, Princeton University, United States; **Powell, Warren B.**

We present an optimization model for real-time locomotive operations based on the principle of modeling the organization and flow of information. We model expert knowledge by combining engineering costs with patterns of behavior that reflect elements not explicitly captured by the cost model. This approach allowed us to overcome the numerous data and modeling problems that are the common cause for failure of classical optimization model. The algorithmic strategy is an "optimizing simulator" which is based on approximate dynamic programming with functional approximations. The model has been accepted as an operational planning tool at two major U.S. railroads.

2) *Real time traffic regulation and moving block signalling systems*, **Pacciarelli, Dario** , Universita Roma Tre, Italy; **Mascis, Alessandro**; **Pranzo, Marco**

Due to the complexity of the rail operations, railroad commonly operates by developing off-line timetables. When unforeseen events occur, such as the temporary unavailability of resources, it is necessary to partially modify in real time the plan of operations on which the timetables are based. This on-line process is called conflict resolution. In this talk, we describe optimization algorithms for conflict resolution and speed regulation in a rail network operating with the moving block signalling technology. The system was developed within the EC-funded project COMBINE and tested via simulation in the Dutch part of the high-speed line under construction Paris-Brussels-Amsterdam.

3) *A Global Model for Railway Crew Planning*, **Caprara, Alberto** , University of Bologna, Italy; **Monaci, Michele**; **Toth, Paolo**

Crew planning is a typical problem arising in the management of large railway companies. Given a set of train services to be performed every day, the problem calls for a set of crew rosters covering the train services with the minimum number of crews. The process of constructing the rosters from the train services has been historically subdivided into three independent phases, called pairing generation, pairing optimization, and rostering optimization. In this paper, we propose an integer linear programming model for the overall problem and discuss solution approaches that do not decompose the problem into phases. Computational results on real-world instances are presented.

FD4 **Electrical Power Systems II**

Contributed session Venue: DH-S

Chair: **Anderson, Edward James**
AGSM, Australia

1) *Pricing Electricity Options Using Stochastic Optimization*, **Velasquez Bermudez, Jesus**, DecisionWare Ltd, Colombia

Multiples effects of decision environment in pricing electricity options are studied using a stochastic optimization model for electricity trading. The factors studied are: demand level, demand uncertainty, generation level, load curve, contracts, alternative bids, integrated decisions and option structure. Additionally, the study considers the effect of four decisions utility function: maximize the expected income, maximize the minimal income, maximum regret and expected income plus conditional value-at-risk constraints. The results demonstrate that methodologies of pricing options based only on the probabilistic characteristics of the future spot price ignore important aspects that affect the "optimal" price of the options.

2) *System dynamics, multi-agent and multi-criteria modelling of Electricity Markets.*, **Pruyt, Erik**, VUB-Brussels, Belgium

First a system dynamics model will be presented to sketch the emerging European re-regulated electricity market, together with four connected markets: the stock markets, the derived power markets, the emission markets and weather markets. Then we will focus on the power trade in a Multi-Agent power auction model. In this model the agents trade simultaneously on the five different markets with different market set-ups. The goal of the multi-market set-ups is to take the technical and economical imperatives into account as well as social and ecological considerations. The results of the Multi-Agent Model will be used in a second systemdynamics model and MCDA procedure to assess the performance of the different overall systems.

3) *Undercutting and overcutting for generator offers in an electricity market*, **Anderson, Edward James**, AGSM, Australia; **Xu, Huifu**

Wholesale electricity markets sometimes allow a participant to obtain the maximum profit by slightly undercutting the offer of another player. In this case an exact optimal solution will not exist and we will need to consider epsilon-optimal solutions. We analyse these markets by considering a related problem for which an optimal solution is bound to exist. In the case that generators have contract cover we need to consider "overcutting" as well as "undercutting". Our analysis uses the market distribution function to capture the stochastic elements of the problem, but allows this function to be discontinuous in price.

FD6 **Scheduling and Environment**

Invited session Venue: AT-1

Organizer: **Pappis, Costas P.**
University of Piraeus, Greece

Chair: **Pappis, Costas P.**
University of Piraeus, Greece

1) *Scheduling Fire Fighting Tasks Using the Concept of "Deteriorating Jobs".*, **Rahaniotis, Nikos P.**, Greece; **Pappis, Costas P.**; **Voutsinas, Theodore G.**

In fire fighting, time and effort required to control a fire increase if the beginning of the fire containment effort is delayed. Fire suppression strategies emphasize initial, direct and massive attack to the fire or containment of its perimeter within predetermined or natural barriers. Several demand-covering models have been proposed for deploying available fire fighting resources in proper positions so that a forest fire is attacked within a specified time limit. This paper considers the problem of scheduling a single fire fighting resource when there are several fires (igniting simultaneously) to be controlled. A model is proposed based on the concept of "deteriorating jobs".

2) *Scheduling rework jobs with deteriorating processing times*, **Voutsinas, Theodore G.**, Greece; **Pappis, Costas P.**

Scheduling problems appearing in the literature usually concern jobs with constant processing times. Recently, a particular class of problems, namely, scheduling problems where processing times are deteriorating over time has attracted considerable attention. In this paper we study a single machine scheduling problem, where defect items are reworked instead of getting scrapped, while jobs rework times are deteriorating over time. The deterioration function can be a general convex and growing function F (linear, exponential, polynomial etc.). A sequence policy minimizing the makespan is presented.

3) *Scheduling Maintenance Using the Concept of Deteriorating Jobs*, **Voutsinas, Theodore G.**, Greece; **Pappis, Costas P.**; **Rahaniotis, Nikos P.**

Scheduling maintenance has attracted the attention of many researchers. In the case of preventive maintenance, a machine is usually supposed that breaks if it is not maintained for a long time. In this paper the scheduling problem of a maintenance facility that is responsible for the maintenance of n machines of a production system is considered. Each machine has an efficiency that deteriorates over time according to a known convex and growing function. The machines' efficiency is improved with maintenance. The objective is to find a maintenance sequence policy that optimizes the overall efficiency of the system.

FD7 **Preference Measurement - Utility AHP and PFM**

Invited session Venue: AT-2

Organizer: **Parnell, Gregory S.**
United States Military Academy, United States
Organizer: **Wright, George**
Graduate School of Business, United Kingdom

Chair: **Brugha, Cathal M.**
University College Dublin, Ireland

1) *The AHP is Not a Valid Methodology*, **Barzilai, Jonathan**, Dalhousie University, Canada

The AHP is a variant of Miller's Hierarchical Process. It violates the fundamental principles of the theory of measurement and is not a valid methodology. Earlier analysis of the AHP by Belton & Gear mis-identified the problems and proposed a correction that does not address the underlying errors. Dyer's analysis too is limited to the symptoms of these errors. We will review errors related to scale type; measurement units; the "relative importance" interpretation; hierarchical decomposition; normalization; eigenvector, etc.

2) *Classification of Measurement Models - Implications for Utility Theory*, **Barzilai, Jonathan**, Dalhousie University, Canada

We classify all measurement models as weak, proper, or strong. This classification has major implications for measurement of subjective variables and, in particular, utility. We will establish connections to one-dimensional measurement, coordinate functions, pairwise comparisons, etc. We will highlight some of the consequences of these results for utility theory.

3) *PFM - a powerful measurement, decision and selection methodology*, **Barzilai, Jonathan**, Dalhousie University, Canada

Preference Function Modeling (PFM) is a new methodology. It is founded on rigorous mathematical foundations and is powerful, easy to use, and more flexible than the AHP. We will review the theory, tools, and the practical application of this methodology.

FD8 **MCDM Preference Formation Systems**

Invited session Venue: AT-3

Organizer: **Springael, Johan**
Vrije Universiteit Brussel, Belgium

Chair: **Brugha, Cathal M.**
University College Dublin, Ireland

1) *Combining Utility and Relative Measurement MCDM Approaches*, **Brugha, Cathal M.**, University College Dublin, Ireland

We propose and describe tests of a two-phase "Direct-Interactive Structured-Criteria" (DISC) approach to MCDM. It is "Direct-Interactive" because it allows for revision of scores and the exclusion of unwanted alternatives during the process. It uses "Structured-Criteria" that are formed using theory that draws from Critical Realism, Personal Construct Theory, and Nomology. The first and easier phase (DISCUS) uses Utility-Satisfaction to discover a group of preferred alternatives. The second and more demanding phase (DISCRIM) uses Relative-Intensity-Measurement to find a best preference by means of directly comparing the top two or three that emerge from the first phase.

2) *A Decision Support System based on a Multi-attribute Utility Model*, **Jimenez, Antonio**, Technical Univ of Madrid, Spain; **Mateos, Alfonso**; **Ríos-Insua, Sixto**

This paper presents a decision support system based on a multi-attribute additive utility model that admits imprecise assignments for weights and utilities and uncertainty in the consequences of the strategies, defined in terms of ranges for each attribute instead of single values. A sensitivity analysis tool is included for testing the robustness of the ranking of the strategies and gaining insight into and confidence about the final solution. An application of the system to the restoration of radionuclide contaminated ecosystem is illustrated throughout the paper.

3) *Quantifying trade-offs between multiple criteria in the formation of preferences*, **Sant'Anna, Annibal Parracho**, UFF, Brazil; **Gomes, Luiz F. Autran M.**

In this article trade-offs between criteria in the formation of preferences are quantified by applying regression analysis. Trade-offs are determined by constant weights and inconsistencies credited to the variability in the forms of measurement applied to each criterion. Ways to measure the value assigned to each option according to each criterion that will allow for the real trade-off weights to be elicited are then discussed. In order to estimate these weights measuring global and partial preferences for a reasonably large set of options and fitting a linear model are proposed. A numerical application example is included in the article.

FD9 **Forecasting II**

Contributed session Venue: MS-3

Chair:

1) *A Hybrid Genetic Algorithm for the Job Shop Problem*, **Goncalves, Jose Fernando**, DEMEGI - Faculdade de Engenharia do Porto, Portugal; **Mendes, Jorge Magalhaes**

This paper presents a hybrid genetic algorithm for the Job Shop problem. The chromosome representation of the problem is based on random keys. The schedules are constructed using a heuristic priority rule in which the priorities are defined by the genetic algorithm. The heuristic generates parameterized active schedules. After a schedule is obtained a local search heuristic is applied to improve the solution. The approach is tested on the basis of a set of standard instances taken from the literature and compared with other approaches. The computation results validate the effectiveness of the proposed algorithm.

2) *Forecasting model for the nodal electric charge in real time* , **Aboun, Nacera**, E N P ALGER, Algeria; **Belmokhtar, Oumhani**

The aim of this work is to elaborate a forecasting model capable of providing the forecasts of the electrical charge at each node (station) of the network every quarter of an hour. The quality of the forecasts is improved by the development of an algorithm for correction of erroneous data acquisitions.

FD10 **Case Studies IV**

Invited session Venue: MS-4

Organizer: **Ranyard, John**
Lancaster University, United Kingdom

Chair: **Ranyard, John**
Lancaster University, United Kingdom

1) *Setting Up A New Team In HM Customs and Excise*, **Turner, Howard**, Government OR Service, United Kingdom

HM Customs & Excise has both an Analysis Division (consisting of economists, statisticians and OR people) and a National Intelligence function. In some cases in the past, these may have provided discordant advice on similar topics. The paper describes the setting-up of an 'Intelligence Team' in Analysis Division specifically concerned with improving collaboration between the two, discusses some of the issues that were encountered, and offers some advice for those who find themselves in a similar situation.

2) *OR Analyst and Client Partnerships*, **Norman, Michael James**, United Kingdom

Successful OR outcomes depend not just on good analyses leading to solutions to problems, they also depend on the relationship between the client and the OR analytical team. This talk, based on almost forty years of experience of OR, will explore the professional and social relationships that can

provide a more encouraging environment for an OR project. It will also discuss the ethical dimension with reference to situations where an analyst is confronted with a professional dilemma. The talk will be illustrated with examples from the author's own experiences.

3) *Striving to deliver a quality service*, **Sanders, Phil**, United Kingdom

Consignia, the new name for the UK Post Office group, is facing testing times. Rising staff costs and long term under investment have put the organisation in a dire financial position, with estimated losses of #1.5 million per day. Clearly there is a need for business-wide change. This talk looks at some of the ways where OR has helped to inform key business decisions, focusing on the Royal Mail service.

FD11 **Engineering Management**

Contributed session Venue: MS-5

Chair: **Osorio, Maria Auxilio**
Aut University of Puebla , Mexico

1) *Project Termination Decisions by using the improved Hamming Neural Network*, **Guan , Jiancheng** , China; **Liu, Quan**

This paper demonstrates the considerable importance to identify the attributes of an ongoing R&D project. On the basis of the Hamming neural networks, the improved Hamming neural networks used to identify the pattern of an ongoing R&D project are presented, and the convergence of the algorithm used in the networks is proved. The improved Hamming neural networks possess several distinct advantages over present methods. Results of case study verified the feasibility, the simplicity and validity of the improved Hamming neural network in being used for R&D project termination decision. Key words > Research and development, Decision theory, Neural networks, Convergence, Euclidean distance. http://sem.buaa.edu.cn/download/guanjiancheng/IFORS_Guanliu.doc

2) *Reliability and management - Modelling of a personnel recruitment system.* , **Belmokhtar, Oumhani**, ENP ALGER, Algeria; **Lamraoui, Tewfiq**; **Oubdesselam, Abdelaziz**

We first show up to what point reliability can be regarded as a decision making tool in various fields concerning management. Then, by analogy with equipments renewal where reliability intervenes, we carry out a modelling of a personnel recruitment system in human resources management.

3) *A Logic Approach To Semicontinous Flow Variable Formulation*, **Osorio, Maria Auxilio**, Aut University of Puebla , Mexico

Most real problems can involve semicontinuous variables describing the input and output of the model represented. These are variables whose values must lie within certain intervals. Traditional continuous relaxation of a disjunctive constraint may be weak and allow fractional solutions when the original disjunction is satisfied. The reasonable approach we propose for these variables would therefore represent semicontinuity with propositional variables and use a branch and bound scheme, branching directly on the disjunctions that represent discontinuity, instead of branching on the traditional binary variables. Our results show that this procedure may reduce the search for the optimal solution in almost 50%.

FD12 **Outreach Strategies for Development**

Invited session Venue: AT-6

Organizer: **Friend, John Kimball**
University of Lincoln, United Kingdom

Chair: **White, Leroy A.**
South Bank University, United Kingdom

1) *Developing OR in Africa - Initiatives of IFORS and EURO*, **Rand, Graham K.**, Lancaster University Management School, United Kingdom; **Tsoukias, Alexis**

Efforts of IFORS and EURO to encourage the development of OR within Africa will be presented

2) *Discussion Forum on Opportunities for International Networking* , **Floyd, Mike**, City University, United Kingdom

After outlining his early experiences as a volunteer in East Africa, his subsequent career in the UK as a social policy researcher, and his impressions from a recent return visit to East Africa, Mike Floyd will invite another participant in the conference to introduce an African perspective on the issues of two-way outreach between Africa and Europe, before opening a wider discussion of ways of addressing the challenges of trans-continental networking to enhance the role of OR in sustainable development.

FD13 **Large scale optimization in optimal control and molecular dynamics**

Invited session Venue: AT-7

Chair: **Navon, Ionel Michael**
Florida State University, United States

1) *Comparison of advanced large-scale minimization algorithms for solving inverse problems*, **Navon, Ionel Michael**, Florida State University, United States; **Alekseev, Aleksey K.**

We compare the performance of several robust large-scale minimization algorithms applied for the minimization of the cost functional in the solution of inverse problems related to parameter estimation applied to the parabolized Navier-Stokes equations. The methods compared consist of a limited memory

Quasi-Newton (L-BFGS), Truncated Newton (Nash version) and a new hybrid algorithm proposed by Morales and Nocedal that consists of a class of optimization methods that interlace iterations of the limited memory BFGS method (L-BFGS) and a Hessian-free Newton method (HFN) in such a way , that the information collected by one type of iteration improves the performance of the other. CPU and memory requirements of each algorithm will be addressed along with the structure of the spectrum of the Hessian of the cost functional with respect to the control variables obtained by each method .

2) *An analysis of the enriched optimization methods for variational data assimilation*, **Daescu, Dacian Nicolae**, IMA, Univ. of Minnesota, United States; **Navon, Ionel Michael**

In four dimensional variational data assimilation (4D-Var) an optimal analysis state is obtained by solving a large-scale minimization problem. Using the adjoint modeling, the gradient of the cost function may be efficiently computed at the expense equivalent to few forward model integrations. Enriched methods aim to provide an improved optimization algorithm by dynamically interlacing inexpensive L-BFGS iterations with fast convergent Hessian-free Newton (HFN) iterations. We present a comparative study of the performance of the L-BFGS, HFN and enriched methods in the 4D-Var context. In particular, it is shown that the lengths of the L-BFGS and HFN cycles as well as the number of inner conjugate gradient iterations during the HFN cycle are problem dependent and must be carefully selected in order to achieve superior performance. Numerical results are presented for a two-dimensional shallow-water model.

3) *Global and local optimization methods for protein systems*, **Das, Bedamati**, University of Pittsburgh, United States; **Ozkan, S. Banu**; **Meirovitch, Hagai**; **Navon, Ionel Michael**

A protein is a long flexible molecule that typically resides in a well-defined three-dimensional compact structure (the native structure). The molecule's energy as a function of structure contains a tremendous number of local minima, where the global minimum corresponds to the native structure. We describe our global optimizer for protein loops - the local torsional deformation (LTD) method. LTD is based on many local energy minimizations that are time consuming. Therefore, We shall also discuss performance studies for protein systems obtained with a new algorithm of Morales and Nocedal (2000) that is a hybrid interlacing iterations of L-BFGS and Hessian-free Newton methods.

4) *Truncated-Newton based Training Algorithm for Neural Networks* , **Al-Haik, Marwan S.**, Florida State University, United States; **Navon, Ionel Michael**

We propose a new second-order learning algorithm for training the multilayer perceptron (MLP) networks. Training in the MLP neural network is generally specified as the minimization of an appropriate error function with respect to parameters of the network (weights and learning rates) corresponding to excitory and inhibitory connections. We propose here a technique for error minimization based on use of Truncated Newton optimization technique. Such technique offers more sophisticated exploitation of gradient information compared to simple gradient descent methods. In this work we specify necessary details for application of Truncated Newton methods to training of the MLP, and provide comparative experimental results from use of these methods to some well-known test problems, to verify superiority of the present approach.

FD16 **System Dynamics Modelling III**

Invited session Venue: WR-11

Organizer: **Lane, David C.**
London School of Economics, United Kingdom

Chair: **Lane, David C.**
London School of Economics, United Kingdom

1) *The Dynamics of Body Weight Management: An agency-structure causal theory*, **Lane, David C.**, London School of Economics, United Kingdom

This paper builds on the author's previous theoretical work on agency/structure effects by providing a practical example of the application of system dynamics simulation modelling. For this first step a social system consisting of only one actor is considered; an individual wishing to control their body weight. The system dynamics model presents the causal mechanisms by which an individual's perceptions of their own need and ability to lose weight by dieting (structural effects) lead to periods of attempted dieting (human actions) which subsequently alter the individual's perception of their own circumstances. This single model offers a formal explanation for various observable phenomena: successful and sustained weight loss, failed dieting attempts; uncontrolled weight gain, recurring periods of weight loss and weight gain, and maintenance of body weight in the face of an uncertain environment.

2) *Group model-building: tackling messy managerial problems*, **Vennix, Jac A. M.**, Nijmegen University, The Netherlands

Many models are constructed of which the results are never implemented. One reason is that a client does not understand the model and its results. Group model building, which is based on system dynamics, aims at maximum client involvement in the process of building a system dynamics model. Client involvement produces client ownership over the model so that the chances increase that results/recommendations will also be implemented. Involving client groups in the process of model building automatically introduces the role of the group facilitator. This is because people have different viewpoints, and effectively communicating these views is not just accomplished by constructing a model. In the presentation the bases of differences in viewpoints will be addressed. Next the basic approach in group model will be outlined and a small example will demonstrate its use and effectiveness in promoting team learning, consensus building and creating a platform for strategic change.

3) *Alternatives to traditional hospitalisation - a system dynamics approach*, **Arnaldos-Garcia, Fuensanta**, Universidad de Murcia, Spain; **Aranda-Gallego, Joaquin**

In the two last decades, hospitals have been staking out positions in two big healthcare growth markets, ambulatory surgery and home care for the chronically ill. In one of the

major hospitals in Murcia (Spain) three different units have been created following that tendency: an independent day surgery unit, a home health care unit, and a day hospital unit. A System Dynamics model has been developed with the aim of gaining understanding of the repercussion in the activity of the hospital of the recent creation of those units. All of them share the characteristic that they avoid the stay of some patients in the hospital, leaving room for patients that need it, what could have consequences for the surgery waiting lists.

FD17 **Client needs in OR II**

Invited session Venue: WR-10

Organizer: **Pidd, Michael**
Lancaster University, United Kingdom

Chair: **Westcombe, Mark**
Lancaster University, United Kingdom

1) *Complementarity - UK Defence Experience*, **Pickburn, George Alfred**, Dstl, United Kingdom

Operational analysis in the UK Ministry of Defence has been characterised by the dominance of objective approaches, often based on simulation. This is now changing, and UK defence analysts are seeking to establish a consensus of approach covering both domains so that a wider range of problems can be tackled. The institutional environment is described and the principles of the debate are examined. Exemplar studies are outlined to illustrate the direction and scale of progress made in adopting and adapting subjective methods

2) *Hard and Soft approaches (INCISM Meeting No. 2)*, **Paterson, George D.**, Shell International, United Kingdom

This paper gives a personal summary of the second INCISM Meeting, which focused on the differences between hard and soft OR approaches, as illustrated by a number of case studies. These case studies, and the ensuing discussion, highlighted the range of different views about the hard/soft distinction, among the participants.

3) *The Status of Models in Systems Engineering*, **Price, Sean**, Cranfield University, United Kingdom; **John, Philip**

Systems approaches inevitably rely heavily on models to develop understanding and aid communication and decisions. In systems engineering these system considerations and modelling lead directly to a design for a purposeful system or process that is implemented in the real world. This paper considers the changing nature of modern systems and their implications on systems engineering, with particular focus on the role of models in the engineering of complex systems and capabilities. The status of models at the various stages of evolution of defence capability, their enduring nature, the fulfilment of stakeholder expectations and the relationship between soft and hard systems methodologies in systems engineering are discussed.

FD19 **Knowledge Management frameworks and models**

Invited session Venue: WR-1

Organizer: **Edwards, John Steven**
Aston Business School, United Kingdom

Chair: **Edwards, John Steven**
Aston Business School, United Kingdom

1) *Towards a Knowledge Management Framework*, **Lehaney, Brian Alexander**, Coventry University, United Kingdom; **Jack, Gillian**

Much effort has been put in to the technology aspects of knowledge management. Attendance at KM events might suggest that there are ready-made, off-the-shelf, KM solutions. This paper suggest that whilst technology is a necessary and important apect of KM, existing technology is not used to anywhere near its potential. A major reason for that is that organiosatuions have not examined their own business processes and needs analytically. The framework proposed was developed during a recent EC-funded project. It includes organisational analysis, issues of commitment, culture, incentives, and clarity. Once these have been addressed, an organisation will be better placed to know what technology it needs.

2) *Towards a Constructivist Model of Knowledge Management*, **Meyer, Edgar**, University of Southampton, United Kingdom; **Klein, Jonathan H.**; **Connell, N. A. D.**

The current models of knowledge and knowledge management (KM) could be described as modernist, control-based concepts, which focus on managing and controlling codified knowledge through IT. This paper presents a more constructivist view of knowledge and KM, and advocates the employment of soft OR approaches to generate more dynamic models of knowledge and KM.

3) *Dynamic Expression of Personal Knowledge and Organizational Capability*, **Gao, Fei**, Japan Advanced Institute of Science and Technology, Japan; **Nakamori , Yoshiteru**

We utilize systems concepts, cybernetic terms, mathematical models, and management ideas, combining the research results got by pioneers on knowledge management to express and interpret personal knowledge, organizational knowledge, knowledge conversion, and knowledge management. In both the individual level and organizational level, according to the characteristics of its nature, function, and utility, knowledge is grouped into different subsystems. Based on the definition and classification of personal knowledge and organizational knowledge, mathematical models of personal knowledge, its dynamic conversion, organizational knowledge, and organizational capability are introduced in the paper.

FD20 **Quality**

Contributed session Venue: WR-2

Chair:

1) *A Comparative Study Between a New Sampling Method and Others Adaptive Sampling Schemes* , **Infante, Paulo de Jesus**, University of Evora, Portugal; **Dias, J. Rodrigues**

A performance study and comparison of a new adaptive sampling method (Rodrigues Dias (1999)) with some adaptive statistical process control procedures is presented. Particularly, using a X bar chart, we provide some interesting analytical expressions to compare the mean time to detection between this new method and some previously developed schemes.

2) *An Integrated Approach for Optimizing the Broadband Tap Coupler Optical Performance*, **Hsu, Chih-Ming**, Taiwan; **Liao, Dirac**; **Su, Chao-Ton**

This study presents an integrated approach using neural networks, exponential desirability functions and genetic algorithms to optimize multi-response problems. The proposed approach aims to identify the settings of the input parameters to maximize the degree of overall minimal level of satisfaction with respect to all the responses. The proposed approach is illustrated through a 1% (1/99) single-window broadband tap coupler and is implemented on a Taiwanese manufacturer of fiber optic passive components. Implementation results demonstrate its practicability, and a comparison also reveals that the proposed approach outperforms the traditional Taguchi method in resolving multi-response problems.

3) *Research on Methods for Studying Storage Reliability*, **Li, Qing**, China; **Lu, Tingjin**; **Yang, Wei**

Study on storage reliability is very important to those products which need storing before being used.Because it is the basis of the decision-making for scientific quality management when products in their storage. The paper studies the storage reliability methods often used at present. Then a new method is presented for studying the storage reliability of new-type products with less test-data and field-data.

FD21 **Finance and Banking V**

Contributed session Venue: WR-3

Chair: **Cowdell, Jane**
Sheffield Hallam Universi, United Kingdom

1) *Modelling Corporate Risk In Emerging Markets*, **Allen, Imogen Mary**, ECGD, United Kingdom

ECGD is a government department whose primary role is to benefit the UK economy by helping exporters to win business. It does this by providing guarantees, insurance and reinsurance against loss. The nature of our portfolio is such that we have significant corporate exposure in emerging markets. This makes modelling the total risk for corporate exposure complex, particularly as we wish to develop an analytical pricing method that is consistent with the credit risk modelling. This paper will address methods used to simulate the total risk on corporate exposure and in corporate pricing.

2) *Estimating Beta Symmetrically*, **Tofallis, Chris**, Univ Of Hertfordhsire, United Kingdom

Conventional least squares estimates of beta (the slope) are based on minimising deviations in only one direction. Yet both variables have uncertainty associated with them. 'Reverse regression' minimises deviations in the other direction and can give very different estimates of beta. We look at ways of incorporating deviations in both directions and propose a symmetric estimator that is not only simpler than least squares, but also has a number of useful properties. We compare rankings based on the new beta with traditional beta.

3) *The dematerialisation of the traditional UK retail banker*, **Cowdell, Jane**, Sheffield Hallam Universi, United Kingdom

This paper explores trends in the dematerialisation of bankers and one possible method of rebuilding relationships without increasing costs. Databases are mined to sell new products, but they are not utilised to their full potential. Customers may prefer the added speed and accessibility given by these IT based delivery channels but many feel that they no longer have a personal relationship with their bank - banking has simply become a commodity item. Banks need to reduce their cost base and to increase their income base. Relationship marketing is one tool that can be used effectively in profitable customer management.

FD22 **Decision Support Systems VI**

Contributed session Venue: WR-4

Chair: **Banga, Julio R.**
IIM-CSIC, Spain

1) *A simulation approach to managing airline disruption*, **Larsen, Allan** , IMM, DTU, Denmark; **Larsen, Jesper**; **Clausen, Jens**; **Saxtorph, Jesper**

Unforeseen events such as bad weather, crew sickness and aircraft un-serviceability disrupt airline schedules every day during the year. The disruptions are extremely costly for airlines as well as for the passengers. The recovery from airline disruptions calls for operation research based methods for assisting controllers in managing the disruptions in an efficient and cost effective manner. During the past two years we have been investigating new methods for handling airline disruptions. In this talk we will present a simulation framework which is being developed as a decision support tool to assist operations control managers when handling disruptions. The emphasis is put on the development of functionality to perform "what-if" analyses and to assess knock-on effects of the various solutions to a disruptive situation.

2) *Through Life Support for Building Services Systems*, **John, Godfaurd Adjaie**, United Kingdom; **Loy, Hsieh-Min**; **Clements-Croome, Derek**; **Fairey, Vic**; **Neale, Keith**

Building services systems creates a comfortable working environment, but needs maintenance throughout its useful life. Building services accounts for about 50% of the capital cost of a building project. Life cycle costs (LCC) were not considered properly for existing systems. Future systems need to identify the cost drivers proactively. Integrated Logistic Support (ILS) is used to identify, minimise LCC. A framework that synthesises existing fragmented efforts and its support is sought. The use of ILS developed specifically for the Building services sector will reduce or eliminate many problems arising from the design and planning processes.

3) *Global Optimization of Non-Linear Dynamic Processes in Chemical and Biochemical Engineering*, **Banga, Julio R.**, IIM-CSIC, Spain; **Moles, Carmen G.**; **Alonso, Antonio A.**; **Pinter, Janos D.**

Nonlinear dynamic optimization problems often arise in the context of chemical and biochemical process engineering. Important classes of such problems are: inverse modeling, optimal control, and simultaneous design and control. Most of these problems can be formulated as nonlinear programming models subject to differential-algebraic constraints. The highly constrained and non-linear nature of such models typically requires the use of proper global optimization tools, to find quality solutions. We shall discuss the application of global solvers to several challenging case studies. References Banga, J.R. et al.(1997) Biotech. Progr. 13(3):326. Esposito, W. R.; Floudas, C. A. (2000) J. Global Optim. 17(1/4):97. Pintér, J.D. (1996) Global Optimization in Action. Kluwer Academic Publishers, Dordrecht Boston London. Pintér, J.D. (2001) Computational Global Optimization in Nonlinear Systems. Lionheart Publishing Inc., Atlanta, GA.

FD23 **Data Envelopment Analysis VI**

Contributed session Venue: AF-10

Chair: **Tam, Fai Keung**
University of Toronto, Canada

1) *Technical Allocative and Scale Efficiency of Health Centres Human Resources in Zambia*, **Masiye, Felix** , Zambia; **Kirigia, Joses M.** ; **Emrouznejad, Ali** ; **Sambo , Luis G.** ; **Chimfwembe, Davis**

In this paper we study the possibility of improving quality and coverage of health services through enhanced efficiency in the production/acquisition using DEA. The analysis is based on a cross-sectional sample survey of 40 health centres in Zambia. Our findings suggest that if all health centres human resources had been operating efficiently, they would have provided health care to a considerably greater number of Zambians at no extra cost. Given the limited sample used in this study and dearth of such studies in the WHO African Region, there is urgent need to replicate the study among all other health centres and hospitals in the country. Such studies should be undertaken in all health facilities, irrespective of their proprietorship.

2) *Business application of efficiency benchmarking in banking*, **Fecker, Lukas**, Accenture, Switzerland; **Schlamp, Stefan**

Since its development, academia has applied Data Envelopment Analysis (DEA) to a wide variety of industries, while management response has been limited due to the technique's complexity. We present an easy-to-follow methodology for DEA in a business setting providing guidelines for the choice of input/output variables, data issues, and stability and interpretation of the results. The approach ensures that the results are sound mathematically as well as business-wise, yielding applicable management insights. DEA is used to identify potential synergy effects through mergers and acquisitions. The benchmarking of European commercial banks and different merger scenarios of Swiss regional banks are used as examples.

3) *Relative Stock Market Pricing Efficiency Evaluation using DEA*, **Tam, Fai Keung**, University of Toronto, Canada; **Paradi, Joseph C.**

This research examines whether a Data Envelopment Analysis (DEA) model based on risk-return considerations can identify stocks which are mispriced relative to other stocks in the same industry. The risk variables employed had previously been found to help explain covariance in investment returns. Four technology industries were considered in each of 1997 and 1998. Of these industries, the Software industry had the lowest level of overall pricing efficiency, and the Telecom industry the highest. Equally-weighted portfolios of efficiently priced stocks in the Software industry outperformed portfolios of inefficiently priced and randomly chosen stocks. Results in the other industries were mixed.

FD24 **Military OR VI**

Contributed session Venue: AF-13

Chair:

1) *The DIAMOND Model of Peace Support Operations*, **Bailey, Peter William**, Dstl, United Kingdom; **Vernon, Sue**

DIAMOND (DIplomatic And Military Operations in a Non-warfighting Domain) is a high-level stochastic simulation developed at Dstl Analysis as a key centrepiece within the Peace Support Operations (PSO) 'modelling jigsaw'. It is designed to examine the utility of military force elements and equipments, the effectiveness of future force structures, and possible outcomes of different operational strategies within PSO. It represents the differing parties in a PSO, which may include military organisations, non-combatants, Non-Governmental Organisations (NGOs) and civilians, together with their relationships.

2) *A hierarchical modelling approach to Theatre Ballistic Missile Defence*, **Boddington, Sally**, Dstl Analysis, United Kingdom; **Christley, James**; **Moffat, James**; **Petrusma, Mark**

A hierarchical modelling approach has been developed to assess the balance of capabilities for theatre ballistic missile defence. A Mission Oriented Analysis approach is used to link high level Measures of Policy Effectiveness back down through the Measures of Merit chain to lower level Measures of Effectiveness. The Measures of Effectiveness are assessed using a mix of closed form analytic modelling and simulation, drawing on existing detailed technical work. Using this mix of methods it was possible to provide high level advice to decision makers in a short timescale, and to inform on the balance of future technology investment.

3) *Tracking Zombies - When OR Just Isn't Enough*, **Loe, Richard Gustav**, United Kingdom

Modern naval sensor and command systems provide command teams with more information than ever before; to many it seems obvious that more information will give better situational awareness and hence better decision making. However, trials results suggest that giving command teams more information may not achieve this. This paper discusses the progress made to date in developing methods to assess the operational benefits of improving command team situational awareness.

FD26 **Applications**

Contributed session Venue: AF-18

Chair: **Marin Gracia, Angel**
Univ Politecnica Madrid, Spain

1) *Towards a fuzzy Delphi method*, **Raquel, Caro-Carretero** , U Pontificia Comillas, Spain; **Angel, Sarabia Viejo**

Fuzzy models may provide an alternative to the Delphi technique as a means for decision-making through the use of expert judgement. The stated purpose of this study will be the definition of a fuzzy coefficient based on the Spearman´s coefficient of rank correlation for achieving consensus among experts.

2) *Scheduling aircraft landings*, **Pinol, H. L.**, Imperial College, United Kingdom; **Beasley, J. E.**

In this presentation we discuss the application of the bionomic and scatter search algorithms to the problem of scheduling aircraft landings.

3) *The role of technical sophistication in repatriation success*, **Young, Scott T.**, University of Utah, United States; **Morgan, Leslie O.**; **Nie, Winter**

Problems with repatriation, including dissatisfaction of employees and companies losing top employees after their expatriate assignments,have motivated a growing focus on repatriation as a part of the overall expatriation process that must be managed by the firm. In this research we study factors that influence satisfaction with both expatriation and repatriation. The factors considered in our analyses go beyond the cultural and demographic issues to look at issues related to technical sophistication of both the individual employee and the organization.

FD27 **New Technologies**

Invited session Venue: AF-19

Organizer: **Yeoman, Ian Seymour**
Napier University, United Kingdom
Organizer: **McMahon-Beattie, Una Sinead**
University of Ulster, Northern Ireland

Chair: **Blair, Montgomery**
PROS Revenue Management, United States

1) *Electronic Commerce and Price Competition*, **Kocas, Cenk**, Michigan State University, United States

We examine price competition in on-line markets. Homogenous goods, lower search costs, possible customer loyalty, multi item purchases, various search methods and specific retailer strategies characterize these on-line markets. We analyze the competitive pricing dynamics in these markets.

2) *Optimal Bidding in Online Auctions with Frictional Costs*, **Savin, Sergei**, Columbia Business School , United States

We look at the problem faced by a consumer participating in a name-your-own-price online auction in an environment where multiple bids are allowed. We analyze properties of the optimal bidding strategies under the assumption that every additional bid consumer makes generates “frictional cost” associated with the preparation and submission of a bid.

FD28 **Scheduling and Timetable V**

Contributed session Venue: DH-C

Chair: **Lin, Bertrand M. T.**
Natioal Chi Nan Universit, Taiwan

1) *Solving the nurse-scheduling problem with a general scheduling solver*, **Horio, Masanori**, AichiWomenJuniorCollege, Japan; **Suzuki, Atsuo**

In this paper, we consider to solve the nurse-scheduling problem with our general scheduling solver. We have developed the solver based on the resource constrained project scheduling problem, and have applied to a school timetable problem and PSPLIB for its usefulness and capability verification. We need to consider additional new methods for expressing several constraints of the nurse-scheduling problem. The result as expected is obtained by the carried-out test, and the important information to realize the system become clear.

2) *Selection and Sequencing jobs with tardiness penalities on a single machine environment*, **Yugma, Claude Galliam**, GILCO, France; **Dupont, Lionel** ; **Rapine, Christophe**

We are concerned with a decision problem of a company producing to orders. Commands are sent by clients with some required delivery dates. The company has the ability to accept or reject a command. Each accepted command inccurs a benefit to the company, which may be disminuished by a penalty in case of late delivery. We study the static case of a portefolio of commands in a single ressource environment. The objective is to find a subset of the commands and a schedule of them to maximize the total profit of the company. We present both exact and approximate solutions.

3) *Algorithms for the Minimization of Maximum Lateness under Linear*, **Lin, Bertrand M. T.**, Natioal Chi Nan Universit, Taiwan; **Hsu, Y.H.**

This paper considers a single-machine scheduling problem to minimize the maximum lateness. The processing time of each job is a linear function of the time when the job starts processing. This problem is known as NP-hard in the literature. In this paper, we design a branch-and-bound algorithm for deriving exact solutions by incorporating several properties concerning dominance and lower bounds. The algorithm can solve problems of 60 jobs in less than one second. To compose approximate solutions, we revise a heuristic algorithm available in the literature. Numerical results of computational experiments show that the proposed algorithm is very effective. It successfully reports optimal solutions for most of the test cases.

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Schedule:

#	Code	MA 9:30 - 11:00	MC 2:00 - 3:30	MD 4:00 - 5:30	TA 9:00 - 10:30	TB 11:00 - 12:30	TC 1:30 - 3:00	TD 3:30 - 5:00
1	DHL-B	Health Services						
2	DHL-C	Transportation						
3	DH-N	Practice of OR I	Weight Estimation	Dec. Making Model	Vehicle Routing			
4	DH-S		Cutting and Packing (SICUP workshop)					
5	MS-1	Tutorial: Strat Choice	Tutorial: Max-Plus	Tut. :Measurement	Network Design IV	Tutorial: Applied NLP	Tutorial: Web Courses	
6	AT-1	Project Mgmt	Data Envelopment Analysis					
7	AT-2	Decision Making under Uncertainty I & II			Military Applications			
8	AT-3	Financial Applications and Operations Research					Modeling languages	
9	MS-3	Electricity Markets						Software Tools for OR
10	MS-4	Stoch. and FD Prog	Q'ing Models and An.	Q'ing Thr & Apps IV	Maintenance Replacement and Reliability			
11	MS-5	Metaheuristics						
12	AT-6	OR for Development Prize Competition			OR in Development			
13	AT-7	E-Commerce I		E-Commerce II	Electronic Commerce and e-Business			Env. Mgmt II
14	AT-8	OR and the Global Automotive Industry			Panel: Branding OR	Transportation I, II & III		
15	AT-2B	Management Information Systems I & II		Supply Chain Management				Q'ing Thr & Apps I
16	WR-11	Simulation I & II		MCDA V	Semi-Plenary: Max-	Max-Plus - Approach to Dynamic Event Systems		
17	WR-10	Decision Making in Banking and Finance			Multicriteria Decision Analysis			Internet Optimization
18	WR-9	Graph Theory I & II			Group Decision and Negotiation Support			
19	WR-1	Large Scale Optimization I & II		Marketing	Integer Programming and Discrete Optimization			
20	WR-2	Telecommunications					Reliability I & II	
21	WR-3	GIS Apps and OR	Quadratic Assignment	Integer and Combinatorial Optimization				
22	WR-4	AI, Expert Systems and Neural Networks I, II & III			Simulation III	Modeling Science	Education	DSS I
23	AF-10		DEA II	Decision Analysis I, II, III, IV & V				
24	AF-13	Fuzzy Sets	MCDA II	Location Analysis I & II		Practice of OR II	Location Analysis III	
25	AF-14	Mathematical Programming-General I, II & III			Mathematical Programming-Combinatoric I, II & III			
26	AF-18	Stochastic models I	Mathematical Programming-Integer I, II, & III			MCDA I	Mathematical Prog-Integer IV & V	
27	AF-19	Production Management & Manufacturing I, II, & III			Supply Chain Management IV, V, VI & VII			
28	DH-C	Game theory I & II		Sched. and Tim VI	Scheduling and Timetabling			
29	GS							

#	Code	RA 9:00 - 10:30	RB 11:00 - 12:30	RC 1:30 - 3:00	RD 3:30 - 5:00	FA 9:00 - 10:30	FB 11:00 - 12:30	FD 2:40 - 4:10
1	DHL-B	Health Services		Fin & Banking I	Health Services			
2	DHL-C	Transportation						
3	DH-N	Vehicle Routing						
4	DH-S	Cutting and Packing (SICUP workshop)					Electrical Power Systems I & II	
5	MS-1	Tutorial: E-Business	Tutorial: Dialog Map.	Tutorial: Global Opt		Data Mining		
6	AT-1	Data Envelopment Analysis				Environmental Management		
7	AT-2	Decision Analysis						
8	AT-3	IP Algorithms	Multicriteria Decision Aid					
9	MS-3	Complex Societal Problems					Forecasting I & II	
10	MS-4	Case studies and OR consultancy			Case studies and OR consultancy			
11	MS-5	Economics II, III & IV			Edu Innovation	OR in Government	Economics I	Engin. Mgmt
12	AT-6	Community Development and Capacity Building				Managing International Development		
13	AT-7	Education					Env. Mgmt I	Large Scale Opt
14	AT-8	Replace and Maint.	OR in Forestry					
15	AT-2B	OR in Process Industries		SCM	Queuing Theory and Apps II & III			
16	WR-11	The History of Operational Research		Tech Foresight	The History of OR	System Dynamics		
17	WR-10	Complementarity in Systems Modelling		Strategic Planning	Complementarity in Systems Modelling			
18	WR-9	OR and Strategy		Sys Methodology	OR and Strategy			
19	WR-1	Routing I & II		Ren. and Nat Res	Knowledge Mgmt	Knowledge Management and Intellectual Capital		
20	WR-2	MP Applications		Telecom	MP Applications	MP Models	Airline Apps II	Quality
21	WR-3	Military OR I, II & III			Finance and Banking II, III, IV & V			
22	WR-4	Production Mgmt & Manufacturing IV & V		Decision Support Systems II, III, IV, V & VI				
23	AF-10	Risk Mgmt & An.	Practice of OR III	Data Envelopment Analysis III, IV, V, I & VI				
24	AF-13	Multi-Criteria Decision Analysis III & VI		Inventory II	Analytic Hierarchy Process I & II		Military OR V	Military OR VI
25	AF-14	Inventory I	Mathematical Programming-Linear I & II		Prize Competition	NLP	Stochastic models II	
26	AF-18	Metaheuristics and Tabu search I, II & III			Military OR IV	Sched & Time. VII	Airline Apps I	Applications
27	AF-19		Revenue Mgmt	Database Modeling	Revenue Management			
28	DH-C	DEA VII	Scheduling and Timetable VIII, I, II, III, IV & V					
29	GS			ORS Pres. Med				