# NEWSLETTER

**June 2000**

**Operational Research Society of New Zealand (Inc.), PO Box 6544, Wellesley St. Auckland, New Zealand**
**http://www.esc.auckland.ac.nz/Organisations/ORSNZ/**


## GUEST EDITORIAL

This is likely to be the last Newsletter editorial that I write as President, so I would like to depart with some personal views about our role as a Society and the importance to me of the last two letters in ORSNZ. The thoughts expressed here are solely my own opinions and parochial prejudices, offered (under the prerogative of an editorial writer) with no supporting evidence.

I have often found myself asking the hypothetical question: "why do we need to have an Operational Research Society of New Zealand, rather than just a chapter of APORS or subsection of ASOR?"

I suggest that this question is difficult to answer. Of course there are benefits of collaboration with ASOR, and the Council is pursuing some options for closer ties with the Australian Society. But total absorption into ASOR is a bit more problematic. A competent OR/MS practitioner might attack the question on a purely quantitative basis, looking at the potential costs and loss of services to members of ORSNZ incurred by amalgamating with ASOR, compared with the potential savings and benefits of being part of a larger society. Our members (I would hope) could each do the sums for themselves, and be prepared to vote on the result at a future AGM.

However, irrespective of how thorough this analysis might be, I think that it would risk missing an important intangible cost of amalgamating. I have great difficulty in accurately describing this intangible, but it has something to do with nationalism. It is not fashionable to be nationalistic. We live in a post Cold-War world in which nationalism is associated with coups in Fiji, and atrocities in the Balkans. The Zeitgeist is that of a free, global, economically rational society, in which we as New Zealanders seem eager to participate.

**CONTENTS**




**Publication dates: March, June, September, December**
**Deadline for submissions: on the 15th of February, May, August, November (for following month's issue)**
**Send submissions as word attachments by email to Production Manager, Tricia.Lapham@vuw.ac.nz**

Despite our modern pretensions, one often observes in this country a tension between the modern view and the traditional, particularly when the All Blacks lose. (In my opinion, our collective despair when the All Blacks capitulate, though mocked by the highbrow, reflects a nationalistic neurosis about New Zealand's survival in the modern world.) In another sporting arena, the traditional response to the defection of professional sportspeople like Russell Coutts and Brad Butterworth, is one of concern tinged with a sense of betrayal (see e.g. Murray Deaker's column in the NZ Herald); the modern response is to dismiss these events as morally-neutral consequences of being part of a global sports economy (see e.g. Joseph Romanos in the Listener). A similar division of opinion occurs when large New Zealand-owned enterprises are sold to overseas companies.

Should we abandon the traditional for the modern? I think not. Helen Clark posed an open (and largely ignored) question in Germany recently: what is the future for small economies like New Zealand in the global marketplace? It does seem improbable, even if one has some faith in the law of comparative advantage, that such a small remote nation should survive and prosper. One wonders, under such circumstances, how New Zealand has managed to grow to reach its current state. In my view we have survived due to the efforts of a large number of individuals of previous and current generations who have committed themselves to this country. It is this sense of nationalistic commitment that will be the key to our survival and future prosperity. Though the open expression of such commitment is out of fashion, and might be considered by some to be commercially irrational, I believe that such sentiments are widespread in New Zealand, as well as being sustained in many New Zealanders living overseas.

My premise therefore is that New Zealand as a nation will only survive (as an economic entity that is more than a tourist destination) by virtue of the nationalistic commitment of its people. New Zealand is in a remote part of the globe, with relatively few natural resources. With the geography of two slender, sparsely populated islands separated by a body of rough water, the logistic problems of manufacturers meeting our local markets are considerable. Exporting goods and services from our remote islands faces similar problems. Economic forces on their own make long-term survival as an independent economic entity improbable, unless the agents of this economy commit themselves to achieving this.

Let me finish by saying that practitioners of OR/MS have an important role to play in ensuring this survival. By virtue of its remoteness and scale, New Zealand industry and the public sector faces a set of planning problems that cannot be addressed by adopting simple neo-classical economics doctrines, or by purchasing the latest software package from an overseas vendor. Moreover, there is a level of complexity in the problems faced by industries and policy makers in our nation that in general is not well understood. We must engage these problems and develop rigorous models to contribute to their solution.

So what about the problem of determining whether we should have a separate national OR society? This does not require a quantitative model: New Zealand should not cease to be an essential part of ORSNZ.

**ANDY PHILPOTT, University of Auckland, e mail: a.philpott@auckland.ac.nz**

## ORSNZ MEMBER HONOURED

One of the longest serving members of the ORSNZ, Emeritus Professor Bryan Philpott was made a Companion of the Order of New Zealand in the recent Queen's Birthday honours list. Professor Philpott, who is a retired member of the Society, has devoted 50 years of research to the development of economic models of the New Zealand economy. Now aged 79, Professor Philpott has until a recent illness continued to be active in research in the Economics Department at Victoria University. His most recent work is a monograph outlining the research work of the Project on Economic Planning started in 1970. He is the only New Zealand economist to be a Fellow of the Royal Society of New Zealand.

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# 50th ANNIVERSARY PAPER

## A commentary on Ryan, D M (1992): 'The Solution of Massive Generalised Set Partitioning Problems in Aircrew Rostering' J. Opl Res Soc 43(5): 459-467.

**The following article appeared in the Journal of the Operational Research Society, and is one of a series of articles in JORS this year showcasing some of the best papers published in the journal's first 50 years. I thought that ORSNZ members would be interested to read this third party account, and would share with me in congratulating Dave Ryan and his colleagues for this honour. [Editor – Vicky Mabin].**

In an extremely impressive opening plenary session at the IFORS Conference held in Beijing in August 1999, David Ryan, from the University of Auckland, New Zealand spoke on 'Real OR'. What he described was what the OR society would like to think of as OR as we know it. He illustrated his thesis that OR was not real until the model had been verified and validated and the technology transferred to the 'real world' by means of three New Zealand case studies. The third of these concerned the work he had done for Air New Zealand.

The 50th anniversary paper[1] is one from an extensive output of David and his colleagues describing the application and theoretical developments arising from their work with Air New Zealand over many years. This work has been recognised by the Institute of Professional Engineers in New Zealand with the 1999 Engineering Excellence Award in Information Technology, and by INFORMS in being selected as a finalist in this year's prestigious Edelman competition.

Airline crew scheduling involves two distinct phases: planning (involving the construction of tours of duty), and rostering, in which the tours are allocated to specific crew members. I understand that Air New Zealand was the first airline to report the successful use of optimisation methods in the rostering phase of airline crew scheduling. Even today, very few airlines worldwide are using optimisation methods to solve the rostering problem.

The model and solution methods described in the paper have been used continuously in production at Air New Zealand since 1989. Rosters are produced for all international flight attendant ranks (originally five ranks, but crew are now divided into four ranks) every twenty-eight days throughout this period. In the early part of the decade, the system worked well because the higher than necessary levels of manpower (required by the previous heuristic and manual roster construction methods) meant that many feasible rosters existed and the optimisation was easily able to find a high quality feasible roster. As crew productivity increased through increases in scheduled flying without significant increases in crew numbers, it became harder and harder to construct feasible rosters and it was necessary to generate further Lines of Work for some crew members during the solution process.

The optimisation system was revised in 1995 to incorporate full dynamic column generation techniques in place of the original *a priori* generation of Lines of Work for each crew member. The use of dynamic column generation by crew member is particularly effective and is also used throughout the branch and bound process because the constraint branching strategies described in the paper are easily implemented within the shortest path network used in the column generation step.

Since the development of the original rostering system for international flight attendants, three further rostering optimisations based on the same mathematical model described in the paper have been constructed for other crew groups at Air New Zealand. The first of these systems is based on the Preferential Bidding by Seniority (PBS) approach used for flight crews (pilots and first and second officers). The PBS rostering system is widely used in the airline industry but almost all solution methods are based on greedy sequential heuristic solution methods. At Air New Zealand a solution approach based on optimisation (as described in the original paper) has been developed. The major difference in the PBS rostering optimisation, compared to the flight attendant rostering system, is that an optimisation is performed for each crew member in seniority order. The optimisation objective ensures that a roster line of work is constructed for each crew member to maximise bid satisfaction without reducing the bid satisfaction that has already been achieved for more senior crew members in the previous optimisations. Once again, this system has been used continuously in production since 1993.

Two further rostering systems (again based on the mathematical model described in the paper) have been developed for domestic flight attendants and domestic flight crew. These systems are distinctly different from the international rostering systems. This is mainly because the rosters for domestic crews involve daily or at the most two-day Tours of Duty and the optimisation problems have a much higher degree of computational

complexity. Day and Ryan[2] describe the techniques developed to solve these more difficult rostering problems, but the underlying optimisation method is that described in the original *JORS* paper[1].

The benefits to Air New Zealand are both tangible and intangible. Tangible benefits can be identified in increased crew productivity since optimisation methods will definitely find a feasible roster if one exists whereas heuristic methods may well require increased crew numbers just to create a feasible roster. In the original benchmark testing back in the late 1980s, they were able to build a feasible roster for a crew rank of 650 with 30 fewer crew than the heuristic and manual methods used in production at that time. Because of the effectiveness of the optimisation approach, fewer rostering staff are required now to construct rosters. Higher levels of crew satisfaction as measured by the optimisation objective can be achieved using optimisation methods. The most important intangible benefit is that the construction of rosters can be delayed until later in the crew scheduling cycle thus allowing late changes in duties and crew availability to be incorporated so reducing the need for rework. Another intangible benefit is that rostering staff can concentrate now on ensuring that data is correct rather than struggling with a task that is almost impossible for human beings!

The JORS[1] paper described their first contribution to the area of crew rostering. That contribution itself has proved to be particularly effective but more importantly, it has led to further work in other areas of rostering so that now Air New Zealand is totally dependant on optimised crew rostering methods in all areas of aircrew scheduling.

[1]Ryan DM (1992). The Solution of Massive Generalised Set Partitioning Problems in Aircrew Rostering. *J Opl Res Soc* 43 (5): 459-467
[2]Day PR and Ryan DM (1997). Flight Attendant Rostering for Short-haul Airline Operations. *Opns Res* 45: 649-661.

**GRAHAM K RAND, Lancaster University**

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# ORSNZ HANS DAELLENBACH PRIZE

To honour the considerable contributions of Emeritus Professor Hans Daellenbach to OR/MS in New Zealand, the ORSNZ has established the ORSNZ Hans Daellenbach Prize. The purpose of this award is to elicit, recognise and reward outstanding examples of management science and operations research in New Zealand, and to encourage their dissemination in the international literature. Candidates for the prize must be members of ORSNZ. The prize is accompanied by a (NZ)$1,000 honorarium, and winners must give a plenary address on the relevant work at the ORSNZ Conference in the year of the award. The Daellenbach prize is awarded every two years at most. The next Hans Daellenbach Prize is due to be awarded at the 36th Annual ORSNZ Conference in 2001.

**Application Process:**
Applicants should send the ORSNZ Council a one-page or two-page typed summary that describes what they have accomplished, in enough detail to let the selection panel judge the appropriateness of their work for the competition. Entrants will be expected to report on a body of innovative OR/MS work in New Zealand, with international recognition as evidenced by publication. Citations of publications supporting the application should be included in the summary, and copies of the relevant papers should also be forwarded with the application.

Nominations for the award may also be forwarded by members of the ORSNZ, in which case Council will advise the nominees that their names have been put forward, and invite them to consider applying. In order for the nominees to have sufficient time to put together their applications, any such nominations should be sent to Council at least one month before applications close. Any work that has been done in recent years is eligible unless it has already been recognised by a Daellenbach Prize. Anyone is eligible for the competition except members of the judging panel.

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| **Timetable :** | Nomination deadline | March 31, 2001 |
| | Application deadline | April 30, 2001 |
| | Presentation and award announced | June Newsletter, 2001 |
| | Award ceremony and keynote address | ORSNZ Conference, 2001 |

# OPTIMIZATION EARNS ITS WINGS

## The Development of Crew Scheduling Systems for Air New Zealand

While the successful application of optimization methods in solving parts of the crew scheduling problems for major airlines has been well documented in recent years, such was not the case in the early 1980s when I first approached Air New Zealand to inquire about their crewing decisions. At the time, stories circulating in the airline industry suggested that a number of larger airlines had tried and failed to implement optimized crewing systems. A senior manager at Air New Zealand informed me that he was aware of the failures and asked what made me think I could solve crewing problems for his airline. I responded that I didn't know if I could solve the problems, but I wanted to learn more about them, obtain some data and try to solve them.

In 1984, Air New Zealand agreed to provide information about their planning or tour of duty (pairings) problem for us to use in an honours project for a student in Engineering Science at the University of Auckland. Michelle Kunath undertook this initial project, involving a small part of the domestic (or internal) problem. The results we presented to Air New Zealand at the completion of the six-month project provided the basis of a productive and successful collaboration between the University of Auckland and Air New Zealand. Over the intervening period of more than 16 years, optimization methods have been developed and implemented to solve all aspects of Air New Zealand's crew planning and rostering problems.

In 1984, all crewing decisions were made manually and the airline used no OR/MS techniques. Today, the airline is totally dependent on state-of-the-art, optimization-based computer systems in the areas of crew planning and rostering. The airline now employs more than 10 staff members and contractors with backgrounds in OR/MS. This article will document the transition from dependence on manual methods to dependence on OR/MS methods at New Zealand's national airline.

### Crewing Systems at Air New Zealand

The University of Auckland, in collaboration with Air New Zealand, has undertaken considerable research and development of underlying optimization methods for crew scheduling during the past 16 years. This research has resulted in the development of seven optimization-based computer systems to solve all aspects of both the planning and the rostering processes for both the national and the international airlines. Each business problem is characterized by unique aspects that prevent the development of a single common optimization solver.

These systems incorporate state-of-the-art, mathematical optimization technology and provide Air New Zealand with sophisticated crewing solvers. In 1989, when the International flight attendant rostering system was implemented, Air New Zealand knew of no other airline with an implemented rostering system based on optimization. Even today, few airlines use optimization-based rostering techniques. Further details of each of these systems and their integration are given below.

### National (domestic) planning

The original planning system for the national airline covering both flight attendants and technical crew was developed in 1984 and 1985 and implemented as a mainframe computer system in 1986. The system remained in production essentially in its original form until 1997 when it was replaced by improved optimization methodology implemented on a Unix workstation. The current system generates optimized tours of duty (TODs) for all crew ranks and for crew bases in Auckland, Wellington and Christchurch. It is also able to produce "fully-dated" solutions.

### National (domestic) rostering

While involving relatively small crew ranks (at least compared to the international airline), these problems are probably the most difficult of all the Air New Zealand optimization problems to solve because of their combinatorial complexity. Two previous attempts to solve the problems in the late 1980s were unsuccessful, but the problem for flight attendants was finally solved in 1993 by Dr Paul Day in his Ph.D. research sponsored by Air New Zealand [Day, 1996, and Day and Ryan, 1997]. In 1998, the same solution methodology was adapted to produce technical crew rosters under quite different operating rules. These two unique systems are now fully integrated into the Air New Zealand Genesis Rostering System and produce rosters of excellent quality for all crew ranks and all crew bases in less than four-person days. Previous manual rostering methods involved six roster builders and took two weeks to complete. The actual optimization runs take less than one hour in total.

**International flight attendant rostering**

This problem, involving 1,500 flight attendants in four crew ranks, is the largest problem solved at Air New Zealand. The original system was implemented in 1989 and was revised to incorporate column generation methods in 1996. At the time of its implementation in 1989, the optimized solution demonstrated that it was possible to construct rosters with a 5 percent reduction in the number of flight attendants and significantly improve the quality of the rosters from a crew point of view. The development and implementation involved representatives of the Flight Attendant Union who defined the issues of roster quality that are incorporated in the optimization. The current system also incorporates a language assignment optimization step [Waite, 1995] that ensures that flight attendants with relevant language qualifications are assigned TODs requiring those language skills. This aspect of flight attendant rostering has important commercial benefits to Air New Zealand in that many of its passengers, particularly from Asia and Europe, are non-English speaking.

**International technical crew rostering**

International technical crews at most airlines worldwide are rostered by systems based on preferential bidding by seniority (PBS). The algorithms are generally based on greedy sequential heuristic roster construction methods. PBS involves crew members bidding for work or days off; rosters are then constructed by satisfying as many bids as possible given the constraint that crew members are considered strictly in seniority order within the crew rank. During 1992 and 1993, M.E. Thornley developed a new optimization model and solution method for PBS [Thornley, 1993]. The solution method incorporates a unique "squeeze procedure" that violates the bids of more junior crew members in order to satisfy the bids of more senior crew members. This guarantees that the maximum number of bids can be satisfied in seniority order. Heuristic methods used by other airlines are unable to provide such a guarantee. The PBS system was implemented in 1994 and is now fully integrated into the Genesis Rostering System at Air New Zealand.

**International technical crew planning**

Following the completion of his master's degree research on the topic, Andrew Goldie implemented the technical crew planning system for Air New Zealand International in 1996 [Goldie, 1995]. The system automatically generates "third pilot" TODs that allow duty periods to be extended by including a third pilot on some relevant sectors. This feature is believed to be unique since we understand that planning systems used by other airlines construct such TODs in a subsequent step.

**International flight attendant planning**

The international flight attendant planning problem is a particularly difficult problem in that flight attendants are qualified to operate on more than one aircraft type. The added complexity arises because each aircraft type requires different numbers of crew. For example, a full B747 crew may split after a B747 sector and part of the crew may fly a B767 sector in their next duty period. The remaining part of the B747 crew could fly as passengers or could be combined with other crew members to make up a crew for some other sector. This crew-splitting complication does not occur for technical crew who are qualified to fly just one aircraft type. Chris Wallace developed an optimization solver for international flight attendant planning in his Ph.D. research. This system is again unique in that it automatically permits crew splitting. No other known planning system incorporates this feature.

**Implementation and Integration Issues**

On-site development by a small team of developers, working closely with the users, has been central to the successful implementation of these systems. The complex rules-bound nature of the industry requires detailed understanding, and the optimization solvers must be developed with constant reference to the planners and rosterers.

The optimization solvers are able to find many solutions of similar dollar value, some of which are preferred by the users, and much effort has been spent developing control mechanisms for the users to interact with the solutions and so "shape" the solutions produced. For example, users may wish to fix a particular subset of a solution, or prevent particular undesirable characteristics from being included in a solution. Similar mechanisms have been developed to handle changes to inputs to the problem. For example, if a flight is re-timed in the flight schedule, the optimizer will minimize the changes required from the previous solution to the new solution. The TOD optimizers are integrated into a purpose-built PC-based user interface, also developed as part of the project. The system receives flight schedule data for both proposed and published flight schedules in industry-standard formats from Airflight, the schedules management tool supplied by the Sabre Group. The solutions

produced by the TOD optimizers can be viewed graphically using a tool specifically developed for the purpose. Solutions may be electronically uploaded into the Aircrews System provided by Sabre.

The Genesis Rostering System, which has been developed independently of this project, is used by rostering staff to manage the construction of rosters for aircrew. It has replaced mainframe and PC-based systems and manual methods. Genesis accesses the Aircrews database for roster data and provides a common user interface for managing crew pre-assignments, training and crew requests. Genesis passes data to the rostering optimizers where the roster is constructed before it uploads and displays the optimized rosters in the graphical interface. The final rosters are then uploaded into the Aircrews system.

There are two important aspects associated with the implementation of sophisticated crewing systems. The first is concerned with the effects of new technology; the second is concerned with issues of technology transfer.

The introduction of high-technology mathematical optimizers has changed the nature of the jobs and the key competencies of staff in the planning and rostering areas. Staff now manage data and processes associated with the construction of TODs and rosters, rather than simply constructing TODs or rosters. The optimizers allow staff to concentrate on meeting specific business requirements, which might include training or absences, meeting special requirements of management or crew, or incorporating last-minute changes.

Because of the sophisticated nature of the mathematical optimization models and methods, it is important that management, the crew and the planning and rostering staff develop trust and confidence in the solution methods and the quality of the solutions. This can only be achieved through close collaboration with these affected groups. The development of trust and confidence has been a major objective of this project since it is an essential requirement of successful technology transfer from a research and development environment to a production environment. We believe that this objective has been fully achieved in this project.

**Keys to the project's success**:

Each application is built to solve a particular business problem, with further domain-specific customizations exploiting facets of Air New Zealand's business problem. These customized solvers produce better results in less time than a general-purpose solver. Since the solutions are developed in close liaison with the users, the systems have a natural fit, both in supporting Air New Zealand's business practices and integrating into the existing computer systems infrastructure.

Each optimization application has reduced the costs of operating a flight schedule. Over the past 10 years, Air New Zealand's aircraft fleet and route structure has increased significantly in size, but the number of staff required to manage the crew scheduling process has been reduced significantly.

Solution quality is maintained, even after staff changes, as the optimizers incorporate the complex business rules. This has the additional benefit of complying with legislative and contract limitations, as required by the Civil Aviation Authority.

Solutions are developed in significantly less time than manual solutions. This has different business benefits in the two different areas: in planning, this results in more scenarios being evaluated leading to improvements in the value of the flight schedule; in rostering, the roster-build can commence later, therefore incorporating late changes and reducing rework.

The definition of the "best-quality roster" is predominantly a concern of the crew since many feasible rosters exist for the same work and number of people. Optimized crew rostering based on a crew-defined quality measure provides a win-win opportunity for crew and management. Any complaints with rosters are directed to crew representatives for evaluation and comment. Many "soft rules" have been agreed to, leading to improved roster quality. These non-contractual "soft rules" can usually be stepped back from in order to find a feasible roster, and they therefore have no significant impact on crew productivity.

As optimization methods have been improved, harder problems have been solved and better implementations of existing solvers have been completed. Redevelopment has yielded additional savings, in both planning and rostering, as the newer optimization technology is able to examine larger and larger parts of the possible solution spaces.

Use of mathematical optimization solvers provides a robust solution method that is guaranteed to identify infeasibilities when a solution cannot be found. Manual or heuristic methods can never provide such a guarantee because there is always a doubt that infeasiblity might be due to the less effective solution method.

**Economic Benefits**

The TOD optimizers provide real dollar cost savings to Air New Zealand by reducing the cost of crewing in areas such as the total number of crew required, the number of hotel bed-nights, meals and other expenses which must be paid to support crew away overseas. Air New Zealand's flight schedule has considerable variation from week to week, as the airline responds to market opportunities. These minor changes in the flight schedule may significantly impact the costs of the solution, due to the complex inter-related nature of the rules. Solutions created at the time of publishing a schedule may not "survive" a schedule change, or may now be significantly more costly than alternative solutions. The TOD optimizers can be used to re-confirm a solution after changes have been made to the published flight schedule, ensuring that the schedule is crewed as efficiently as possible.

Using the TOD optimizers, a solution can be produced in a matter of minutes, compared with two or more days, to create a manual solution. For example, a B767 pilot TOD problem can be optimally solved in approximately 60 minutes, while the B747-400 pilot TOD problem can be solved in less than five minutes on a standard Sun workstation. These fast solution times have made it possible to provide valuable feedback to the schedules creation process with more proposed schedules now comprehensively evaluated prior to the publication of a new flight schedule. This is a significant intangible benefit to Air New Zealand in that it facilitates the development of robust and profitable flight schedules.

The TOD optimizers reduce Air New Zealand's dependence on a small number of highly skilled staff who must be conversant with the relevant rules and awards, and have sufficient experience to create consistently high-quality manual solutions. These staff now use the TOD optimizers as their core tool to create TOD solutions, which they then analyze, tune and modify using the optimizers to generate the preferred solutions.

The rostering optimizers are "production systems." By the time they are used, the number of crew, the flight schedule and tours of duty are already well defined and specified. The rostering objective is, therefore, to build the best-quality roster possible, where "roster quality" is a concept that is defined from the crews' perspective. The rostering optimizers have improved the quality of the "fair-and-equitable" rosters, and allowed the introduction of a properly optimized "seniority preferential bidding" rostering method for international pilots.

Rosters now take less time to build, with far less manual input, resulting in a reduction in the number of rostering staff from 18 in 1987 to eight today. Roster construction is begun much later and closer to the roster publication date with the result that last-minute changes can be more easily incorporated.

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# ORSNZ 2000 – CALL FOR PAPERS

## The 35th Annual Conference of the Operational Research Society of New Zealand

**VENUE**

The conference will be held at Victoria University of Wellington on December 1 and 2, 2000 and will be hosted jointly by the School of Business and Public Management and the School of Mathematical and Computing Sciences.

**TOPICS**

The conference committee welcomes papers in OR and decision modelling. In addition to papers of general interest, the conference will have theme sessions on *OR in Competitive Markets* and *Logistics and Transportation*. The committee particularly welcomes papers on practical applications.

**SUBMISSIONS**

Submissions of abstract in plain text, LaTeX or Microsoft Words format may be emailed to
Orsnz2000@mcs.vuw.ac.nz
and hard copies may be sent to
ORSNZ
School of Mathematical and Computing Sciences
Victoria University of Wellington
PO Box 600, Wellington, New Zealand

The closing date for acceptance of abstracts is 29 September, 2000. Authors of papers will be notified regarding acceptance of their abstracts by 3 October, 2000. Authors of accepted abstracts will be required to submit a full-length paper (up to 10 single-space typed pages) for publication in the Conference Proceedings which is issued to all participants and to all ORSNZ members. Authors are also encouraged to submit postscript (.ps) or Adobe Acrobat (.pdf) versions of their papers for inclusion in the conference archive. The deadline for submission of full papers is 27 October, 2000. Guidelines for style and format of the full paper will be sent at the time of acceptance.

**CONTACT**

All enquiries to either orsnz200@mcs.vuw.ac.nz or the ORSNZ 2000 address above.
Website: http://www.mcs.vuw.ac.nz/orsnz2000/

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**IMPORTANT DATES**

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| Abstract Submission | 29 September 2000 |
| Notification of Abstract Acceptance | 3 October 2000 |
| Full paper submission | 27 October 2000 |
| Registration | 27 October 2000 |

# INTERNATIONAL CONFERENCE ON SYSTEMS THINKING IN MANAGEMENT (ICSTM2000) - 8-10 November 2000

## hosted by Deakin University, Australia

With rapid advancement of holistic concepts, with associated development of information systems and technologies, the management of business and organisation is taking new directions. The managers and decision-makers are confronted with enormous challenges in understanding the new developments and preparing for their massive impacts to work places and societal infrastructure. The ICSTM2000, which is the result of close co-operation of many leading experts around the world, will show us the ways to tackle such challenges. This conference aims to provide an emphasis to systems thinking and knowledge management as the future alternative, to expose delegates to leading experts in the field, and to generate active discussion in an area of rapid changes.

The ICSTM2000 theme is "Dynamics of Theory and Practice". The conference theme will be addressed from a number of perspectives, which include:

- action learning and research
- adaptive and strategic planning
- chaos and complexity
- cognitive processes in systems thinking and learning
- community and soft operational research
- cybernetics
- hard, soft and critical systems
- information systems implementation and management
- management science methodologies
- management strategy for information technology
- organisational learning and knowledge management
- philosophy of systems thinking
- project management systems
- quality management systems
- sustainability
- system dynamics modelling
- systems in education and
- systems methodologies.

**Conference details:**

Web site: http://www.ICSTM.deakin.edu.au/2000/
E-mail: icstm@deakin.edu.au
Tel: 61-3-5227 8121 fax: 61-3-5227 8188

**Conference Chair:** Dr Purnendu Mandal; Tel: 61-3-5227 1245

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# VICTORIA NEWS

This month we welcome Dr Linda Angell from Pennsylvania State University to our Operations Management staff. Linda's specialities are quality and environmental issues and how these interrelate with OM. Steve Balderstone left at the start of the year to take up an appointment as Manager of Andersen Consulting's Systems and Simulation Modelling team in Melbourne.

John Davies, Bob Cavana, Urs Daellenbach and I have been among the vanguard of VUW staff who recently moved downtown. We are now located in the old ECNZ building, Rutherford House, next to Parliament. This is familiar territory to us, having attended many ORSNZ Wellington Branch meetings hosted by ECNZ, as well as ORSNZ Council meetings held in the ECNZ Boardroom!

One of the good things about moving is having a clear-out, or more appropriately in my case, rediscovering all sorts of treasures and hanging on to them. Amongst such treasures were some old OR Quarterly and NZOR issues, donated to me by former ORSNZ member Kevin Hall, when he departed for overseas many years ago. For the younger members, ORQ is the old name for the UK OR Society's journal, and NZOR was our very own journal.

The first issue of the OR Quarterly dated March 1950 set itself the task of "justifying burdening the scientific world with yet another journal." (I wonder what they would think today about the number of journals!) It also contained this definition of OR:
"The application of the scientific method to the provision of bases for executive action, in particular when the behaviour of people, either by themselves or in relation to their environment and equipment, is involved. Within this, there appear to be four main headings under which OR work may be grouped:

1. Studies of human behaviour by itself, … social problems, social science, economics.
2. Man and his machines … eg industrial efficiency, providing rational decisions based on the statistical analysis of the behaviour of the men, machines and environment concerned. This large group covers the majority of the applications of OR in industry and much of the military field.
3. Traffic and Flow: the example being given here was one on "Open Hearth Furnace Charging", and
4. General papers, those concerned with the organisation and purposes of OR itself."

In this editorial, and in the paper by Blackett which follows, there is no mention of "mathematics". There is mention of numerical deduction and induction, statistical analysis; there is a definition by Kittell of OR as a "scientific method for providing executives with a quantitative basis for decision," and about "analysing quantitatively the effects of (alternative) actions".

The status and role of OR people is discussed at length: and the need for them to be in close contact with the executives if they are to understand their thinking and convince them to adopt a new course of action in place of an old one.

Blackett stresses the need for OR people to be alert to problems rather than waiting for executives to seek their help: stating that if the executives realise the problem exists, it will already be under study, whereas the OR person is in a better position to spot problems that are amenable to scientific study.

Clearly the writers were very much influenced by wartime experiences, and math programming was hardly on the scene, but there seem to be some gems here that are useful for us to remember in particular the importance of including people and their behaviour in our systems models.

**VICKY MABIN, Victoria University of Wellington, e mail: Vicky.Mabin@vuw.ac.nz**

# FROM THE WAIKATO: TWO PUZZLES

A glass rod is dropped on the floor and it breaks in two places - at random. (These are perfectly clean breaks.)

What is the probability that a triangle can be made from the three resulting pieces?

Those adventurous people might like to try and extend it to the general situation of a rod which breaks into n-1 pieces and therefore the probability of constructing a n-sided polygon.

## Puzzle page

**JOHN BUCHANAN, Waikato University, e mail: jtb@mngt.waikato.ac.nz**

# NEWS FROM AUCKLAND

The last three months has seen a resurgence of interest in the Auckland Branch of ORSNZ. A social function to welcome students to the ORSNZ was held at the University of Auckland in March, and after listening to a stirring pep talk from Kevin Broad (Auckland Branch chair) a considerable proportion of the students were moved to join up on the spot. We are planning to offer students a web presence on the ORSNZ site, that prospective employers can access. This is a service that other branches might consider.

The OR Group at Auckland University has been featuring in a number of awards. Dave Ryan and his collaborators at Air New Zealand were named finalists in the 2000 Franz Edelman Prize. Being the first New Zealand paper to ever feature in this competition is a huge honour for Dave and his group. By all accounts Dave and Rod Butchers of Air New Zealand gave a flawless presentation at INFORMS in Salt Lake City, but were just pipped at the post by Jeppesen Sanderson, Inc. Dave's work at Air New Zealand is featured in the April issue of OR/MS Today. Two articles on this work also appear in this Newsletter.

The other award to be made was to David Teirney, who won a FiRST award for the best FRST funded graduate project in the North Island in 1999. David's work on yacht match race simulation was sponsored by a GRIF in conjunction with Team New Zealand. Readers might remember his presentation as a Young Practitioner Prize entry at the 1998 ORSNZ Conference.

**ANDY PHILPOTT, University of Auckland, email: a.philpott@auckland.ac.nz**

# MAINLAND NEWS

Snow on the Southern Alps has raised hopes for an early start to the 2000 ski season. Great news for skiers and, with some help from an honours MS/OR project this year, future ski seasons at one of New Zealand's biggest ski fields may run even more efficiently in the future.

The search continues for a new chair in Management Science. Applications have closed and we are again assessing potential applicants. Hopefully we will be able to announce a new Professor in Management Science in the not too distant future. We are also in the process of interviewing for a new Lecturer/Senior Lecturer in Operations Management. Again an appointment to this position will hopefully be made in the next few months. Watch this space.

Our first year course, MSCI 101 Systems and Decision Making, is going to be replaced by two new semester length courses MSCI 102 Systems and Decision Making and MSCI 112 Introduction to MS/OR Tools. Essentially the two new courses cover the same material as the old MSCI 101, but the semesterisation provides a little more flexibility for students by allowing mid-year entry to a programme in management science.

The 10 students we had on our Management Science honours programme last year all found jobs quickly. These graduates are now employed in the UK, Hong Kong, Australia and of course New Zealand. Several have been employed in the electricity sector, others in telecommunications, forestry, banking, consulting and IT companies. This year we have six full time students and one part time student on the programme. The current crop of students are doing their major projects for Meridian Energy, Transfund NZ, Mount Hutt Ski Field and the Christchurch Hospital Emergency Department.

For those who are Canterbury MSCI BCom(Hons)/BSc(Hons)/MCom Graduates you may have heard of the MSCI Graduates Alumni Web Page. Basically it is a page where graduates can submit their current contact address so others can get in touch with them. Anyone who has graduated from Canterbury with an honours or higher degree is eligible for a free entry on the page. We hope that this initiative will help to keep our graduates in touch with each other as well as allow us to keep in touch with them. If you would like to get your name added to the page e-mail me with your name and contact details along with the year you completed the degree. If you wish to look up the page the URL is: http://www.mang.canterbury.ac.nz/alumni/msci. Although the page currently only covers the 1990's, there is no restriction on when you graduated. All those graduates of the 70's and 80's get in touch! If you know of the whereabouts of other graduates which have not signed up then please let them know about the page and encourage them to do so.

Also on the Alumni front we are hoping to have a reunion of all MSCI graduates, probably in conjunction with the ORSNZ Conference in Christchurch, 2001. Again watch this space.

**ROSS JAMES, University of Canterbury, e mail: r.james@mang.canterbury.ac.nz**

# THEORY OF CONSTRAINTS: A TOP TEN BOOK LIST

Quite often people ask me to recommend books on the Theory of Constraints (TOC), and I normally find it a hard ask with so many books available now, and given that the field is pretty wide. I've been making the most of my sabbatical to review some of the more recent offerings, and thought I could put together a Top Ten books on TOC. For those of you with kids, I imagine you're fully aware that the 4th Harry Potter book is due out soon, and while the kids are lost in another world/argue over who gets to read it first, you're sure to need a good book yourself, so here goes:

1. **Eli Goldratt: The Goal, 2nd revised Edition, North River Press, 1992** : A novel – the seminal popular work, first published in 1984, set in a manufacturing environment, providing a fictitious application of TOC, its performance measures, 5 focusing steps method, and the kernels of the TOC Drum-Buffer-Rope Scheduling method. This novel has been responsible for a remarkable number of business turnarounds! And it's an enjoyable read too.

2. **Cox and Spencer: The Constraints Management Handbook, St Lucie Press, Boca Raton, 1998.** A detailed look at the Constraints Management side of TOC – ie basically the material from the Goal. (mostly with a manufacturing focus), with a couple of chapters at the end on the Thinking Processes, including a treatment of the product mix problem. More of a traditional text-book treatment.

3. **Eli Goldratt: It's Not Luck, North River Press, 1994** – the second novel. Introduces the Thinking Processes (TPs), Goldratt's systems method containing a suite of tools for diagnosing problems in any arena and developing solutions and implementing them. Applies these methods to marketing, sales, and distribution problems, as well as personal problems.

4. **Bill (HW) Dettmer: Breaking the Constraints to World Class Performance, ASQ Quality Press, Milwaukee, 1998**. Excellent guide to TOC, especially the TP's. heaps of examples. Good explanations of the methods. While Bill's earlier book: "Goldratt's Theory of Constraints", ASQ Quality Press, 1997 is probably still the most definitive work on TOC, I find this one an easier read, yet still with enough detail on the finer points.

5. **Eli Schragenheim: Management Dilemmas, St Lucie Press, 1999.** A case study approach showing how to use the TOC methods and performance measures, including the 5 focusing steps, and the TP's. Using the Socratic approach, Schragenheim poses problems based on common managerial situations, and encourages readers to develop his/her own thinking before providing ***an*** answer using TOC. An excellent book on many aspects of TOC that will get you thinking. Eli Schragenheim has a long association with Eli Goldratt and has made many other contributions to TOC, including the MICSS Simulator computer package based on TOC principles, and a new book out co-authored with Carol Ptak on Enterprise Resource Planning, called ERP Tools, Techniques and Applications for Integrating the Supply Chain, St Lucie Press, 2000.

6. **Lisa Scheinkopf: Thinking for a change: Putting the thinking processes to use, St Lucie Press, 1999.** A step by step guide to the building blocks behind the thinking processes. Not many business examples, but a very low-key approach which I've seen people with little TOC experience use to map out a full strategy for solving their problems.

7. **Eli Goldratt: Critical Chain, North River Press, 1997**. This is the novel about project management, set in academia. A must for all involved with projects, business or academia!

8. **Larry Leach: Critical Chain Project Management, Artech House, Norwood, 2000**. In depth description and application of Goldratt's project management method, Critical Chain.

9. **Debra Smith: The Measurement Nightmare: How the Theory of Constraints can resolve conflicting strategies, policies and measures, St Lucie Press, 2000**. A treatise on TOC and accounting, with some fascinating accounts of real consulting stories (read, disasters). Other related books here: Noreen, Smith and Mackey, The TOC and its Implications for Management Accounting, 1995, and Goldratt's Haystack Syndrome, 1990.

10. **Domenico Lepore and Oded Cohen: Deming and Goldratt, North River Press, 1999.** Combines Deming's teachings with Goldratt's and presents a combined methodology as a 10-step Decalogue.

Well, that's 10 already: and I haven't mentioned Thomas Corbett (Throughput Accounting, North River Press, 1998), or Gerry Kendall ("Securing the Future: Strategies for Exponential Growth using the TOC", St Lucie Press, 1998) or Bob Stein's books, nor all of Eli Goldratt's books, all of which are highly recommended.

Eli Goldratt's new book, co-authored by Carol Ptak and Eli Schragenheim, and titled "Necessary but not Sufficient" is due out shortly. This moves into the supply chain Enterprise Resource Planning (ERP) and e-business arenas. Will his compare with Harry Potter? We'll see! Happy reading!

PS If you want more bibliographic details, do contact me or look in our book.

**VICKY MABIN, Victoria University of Wellington, e mail:Vicky.Mabin@vuw.ac.nz**

# RESEARCH SCIENTIST - OPERATIONS RESEARCH

## CSIRO MATHEMATICAL AND INFORMATION SCIENCES

## Location: Melbourne

$52K-$70K plus Superannuation (Exceptional candidates may be appointed at a higher level).

You will be a member of a highly successful team of nine operations research professionals working on challenging industrial applications of optimisation and simulation technology. The objective of the group is to improve the effective use of resources in Australian industry. This is achieved by developing models, algorithms and functional software for decision support.

You will undertake research-backed consulting activities, which will involve the development of optimisation models, algorithms and functional software in areas such as supply chain optimisation, electronic service delivery, scheduling, logistics, rostering and yield management.

Your responsibilities will also involve undertaking research into generic models and methods.

You will have a PhD in operations research or applied mathematics, or equivalent research experience. You will have a strong background in optimisation together with demonstrated problem-solving skills. You will have strong experience in developing efficient algorithms and implementing them using C/C++. Sound oral and written communication skills are essential.

Further information about the position is available from:
Dr Mohan Krishnamoorthy Tel: (03) 9545 8042, e mail: Mohan.Krishnamoorthy@cmis.csiro.au

Copies of the job description and selection criteria are available from:
Yvonne Craig Tel: (03) 9545 8009 e mail: Yvonne.Craig@cmis.csiro.au

Applications should quote reference number 00M22 and should include details of your skills, qualifications, work achievements and the names of two professional referees. Applications should include your response to the selection criteria and be sent by 30 June, 2000 to:

The Personnel Manager,
CSIRO Mathematical and Information Sciences,
Private Bag No. 10,
South Clayton MDC 3169,
Australia

# RESEARCH FELLOWSHIP IN OPERATIONS RESEARCH FOR COMPUTER GRAPHICS

## SCHOOL OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING MONASH UNIVERSITY

The Optimisation and Constraint Solving Research Group at Monash University is seeking a research fellow in the field of constraint-based graphics and its application to the Internet. Current projects include interactive graph and diagram layout, constraint-based authoring tools, and the development of efficient constraint solving techniques for interactive graphical applications.

The research fellow will be responsible for extending QOCA, a Java/C++ toolkit for incrementally solving constrained arithmetic optimization problems which arise in computer graphics applications. QOCA currently employs simplex based approaches.

The position is funded by a large ARC grant. The research fellow will work closely with the principal investigators of the grant, Associate Professor Kim Marriott and Associate Professor Peter Stuckey of the University of Melbourne, as well as other members of the research group. The position is available immediately and is for two years, although renewal for the second year will depend on satisfactory performance.

Applicants must hold a relevant degree and should preferably have a Masters or PhD in Computer Science or Operations Research. Programming experience in an object-oriented language and knowledge of mathematical programming techniques is a requirement.

The salary will be within the range $37,750 to $52,027 AUD per annum according to qualifications and relevant experience.

Applicants should send a curriculum vitae, a list of publications, names of three referees, and a statement of research interests to:

Associate Professor Kim Marriott, Monash University, Clayton 3168 Australia
Tel: (+61 3) 9905 5525 Fax: (+61 3) 9905 5146 e mail: marriott@csse.monash.edu.au

# WESTERN DECISION SCIENCES INSTITUTE

## THIRTIETH ANNUAL MEETING APRIL 3-7, 2001

## THE WESTIN BAYSHORE HOTEL, VANCOUVER, CANADA

## CALL FOR PAPERS

Competitive papers (including detailed abstracts) are invited in, but not limited to, the topic areas listed. Papers submitted will be double-blind reviewed by qualified individuals. Accepted papers will be published in the Proceedings. Although comprehensive abstracts will be reviewed, preference will be given to complete papers. Abstracts are generally scheduled for presentation in table topic sessions and should provide sufficient details to indicate the research objectives, methodology, and expected outcome.

Paper submission acknowledges that the author(s) will register for and attend the conference, and personally present the accepted paper at the time specified in the conference program. Publication in the program proceedings of multiple papers by the same author will be subject to extra page charges.

**Submission Deadline:** October 1, 2000

**Contact:**
Professor Miles G Nicholls, Director of Research, School of Business, Swinburne University of Technology,
e mail: mnicholls@swin.edu.au

# VISITOR WITH EXPERTISE IN GLOBAL OPTIMIZATION

Professor Janos Pinter, an internationally known expert in Global Optimization is interested in visiting OR related institutions and organisations in Australia sometime in the very near future (second half of July 2000).

Interested persons may wish to contact him directly (jdpinter@is.dal.ca) to co-ordinate possible site visits, in-house seminars, etc.

The following details will give you an idea of his plan.

Time period suggested: July 14-31, 2001 (directly following the conferences "OPTIMIZATION AND INDUSTRY", Great Keppel Island, Queensland, Australia, 1-6 July, 2001 and SGO.NZ.01, Hanmer Springs, South Island, New Zealand, July 9-13)

I will be glad to offer research/educational copies of my LGO software (an integrated model development and solver environment for nonlinear - specifically including global - optimization), and global optimization tutorial or lecture presentations. In return, I would like to ask for travel support (airfare to/from Canada) and accommodation support during my stay with these institutions. (Most likely, I will be arriving via Europe, from Amsterdam.)

Ideally, it would be mutually advantageous, if the host institution(s) would have some funded industrial R&D project(s) in which LGO - or possibly a customized version of the software - can be put to good use. Then I can effectively contribute to the project(s), by donating a copy of LGO to the project, and providing assistance regarding its use to solve practically important models. Other suggestions are also most welcome.

For further information, please e mail me at jdpinter@is.dal.ca; and/or visit http://is.dal.ca/~jdpinter.

**M. SNIEDOVICH, University of Melbourne, e mail: m.sniedovich@ms.unimelb.edu.au**

# FIRST WORLD SYMPOSIUM ON LOGISTICS IN THE FOREST SECTOR

## HELSINKI, MAY 15-16, 2000

The first symposium on logistics in the forest sector was hosted by the University of Helsinki and the Industrial Insurance Company in the city of Helsinki. Kim Sjostrom, chief technologist, was the main organizer who was responsible for the program and the editing of the proceedings. A group of about 45 scientists and practitioners came together to exchange ideas and identify future opportunities for research and development.
http://honeybee.helsinki.fi/logistics/sympos.htm

The main goal of a firm is to maintain competitive performance in an increasing turbulent environment. For a long time, competitive practices focused on production technology and management, assuming that production cost is the decisive factor. Economic research demonstrated that transaction cost (cost of making exchange or indirect production expenses) has become more and more important. A shift in orientation has taken place, partly as a consequence of M. Porter's theoretical framework concerning the value chain, going along with a shift of management from the firm level to the industry level. Logistics aims to improve the flow of goods from the source of origin to the customer in order to reduce cost and improve customer's value.

Sixteen papers were accepted for presentation, covering research in decision systems and tools (4 papers), performance monitoring (5 papers), exchange activities (1 paper), transport and distribution (5 papers), and logistics as a scientific discipline (1 paper). The technical sessions combined with a workshop, an excursion to the port of Helsinki and a business meeting. The discussions showed that understanding the performance and cost is a precondition to improve a specific supply chain. Contributions on decision systems which were mainly based on Operations Research tools demonstrated that optimization of decision and control problems still offers a big potential for improvement. Presentations on transport and materials handling covered practical aspects of land and maritime transportation, as well as the management of spatial information using Geographical Information Systems and real-time data gathering. Finally, a conceptual framework for logistics as a scientific discipline was proposed. All the papers were published in a proceedings volume (Logistics in the Forest Sector, Kim Sjostrom (Ed.), Econpap, Espoo, Finland,
http://honeybee.helsinki.fi/logistics/order.htm ).

During the business meeting participants decided to establish a formal " WOOD LOGISTICS Club"
(http://www.egroups.com/group/logistics-forest/) which will try to develop collaborations with the International Society of Logistics (founded in 1966 as Society of Logistics Engineers SOLE), and the International Union of Forest Research Organizations (IUFRO). Kim Sjostrom was elected for president for the next 3 year period. The second Symposium on Logistics in the Forest Sector will cover the topic "Supply Chain Management" (http://honeybee.helsinki.fi/logistics/second.htm ) and will take place in Vaxjo, Sweden; hosted by Institute of Forest and Wood of the University of Vaxjo, August 12-15, 2001.

**HANS HEINIMANN, Switzerland, e mail: heinimann@fowi.ethz.ch**

# CONSTRAINTS MANAGEMENT CONFERENCE

With this newsletter you will find a brochure on a Constraints Management conference to be held in Auckland on August 29 and 30. We have arranged with the organisers, the Institute for International Research, for our members to receive a 20% discount for their registration.

**VICKY MABIN, Victoria University of Wellington, e mail: Vicky.Mabin@vuw.ac.nz**

## CPLEX ad

# MEETINGS CALENDAR FOR 2000 AND BEYOND

**International DEA Symposium, 2-4 July, 2000, Brisbane, Australia**
**Symposium Convenor: Dr Necmi Avkiran. Department of Hospitality, Tourism and Property Management, University of Queensland, Gatton Campus, Queensland 4345, Australia.**
**Registration fee: AUD300.00**
**Email: n.avkiran@mailbox.uq.edu.au Web: www.uq.edu.au/financesite**

**APORS 2000, Fifth Conference of the Asian-Pacific Operations Research Societies within IFORS, 5 – 7 July, 2000, Singapore.**
**Details on http:www.comp.nus.edu.sg/~phuakh/apors**
**Contact Programme chair, Pual KH Phua, email:phuakh@comp.nus.edu.sg**

**MCDM XV International Conference on Multiple Criteria Decision Making, 10-14 July, 2000, Ankara, Turkey.**
**Details: http://mcdm2000.ie.metu.edu.tr**

**Matrix Analytic Methods Conference, 12-14 July 2000, Leuven, Belgium.**
**Contact: Peter Taylor, email:ptaylor@maths.adelaide.edu.au or Malcolm Faddy, email: M.Faddy@math.canterbury.ac.nz**

**EURO Conference, 16-19 July, 2000, Budapest, Hungary.**
**Details http://www.sztaki.hu/conferences/euro17/**

**Knowledge Management Conference, 17-18 July 2000, Birmingham, United Kingdom.**
**Contact www.orsoc.org.uk**

**International Conference on Production Research Special ICPR-2000, 2-4 August, Bangkok.**
**Contact: Dr Nagen Nagarur, email:nagarur@ait.ac.th website http://www.ise.ait.ac.th/icpr-2000**

**OR42, 42nd Annual Conference of the Operational Research Society, 12-14 September, 2000, Swansea, Wales.**
**Contact www.orsoc.org.uk**

**Decision Science Institute, 18-21 November, 2000, Orlando, Florida, USA.**
**Contact by email: dsi2000@bus.msu.edu**

**ORSNZ 35th Annual Conference, 1-2 December, 2000, Victoria University, Wellington, New Zealand.**
**Abstract submission –29 September, 2000**
**Contact by email:Yu.Hayakawa@vuw.ac.nz for further details**

**ANZAM Conference, 6-9 December, 2000, McQuarie University, Sydney, Australia.**
**Contact by email: Dai.gilbertson@vuw.ac.nz**

**First International Congress on Intelligent Systems and Applications (ISA 2000), 12-15 December 2000, University of Wollongong, near Sydney, Australia.**
**Details on http://www.icsc.ab.ca/isa2000.htm**

**Western Decision Sciences Institute, 30th Annual Meeting, 3-7 April, 2001, Westlin Bayshore Hotel, Vancouver, Canada.**
**Call for papers, submission deadline: 1 October 2000**
**Contact: Professor Miles Nicholls, email: mnicholls@swin.edu.au**