OR Newsletter

Operational Research Society of New Zealand (Inc.)

July 1994

Editorial

Already another issue? Yes, this one almost on time! It is not so much that a new broom is in charge, but that I am going on leave for a few months. Now don't complain about the cushy life of academics! Just think of the hardship of having to miss the skiing season.

The main features of this issue are the articles by Professor Rick Rosenthal from the Naval Postgraduate School in Monterey, California, and Professor Peter Grinyer from the St. Andrews Management Institute in Scotland. Both were visitors at the University of Canterbury earlier this year.

The September issue of the Newsletter will be in the good and efficient hands of Don McNickle, with a little help from ORSNZ members. So send in those articles, quotes, announcements, puzzles, solutions, reports on successful applications, and so on! You can also have a hand at coming up with new definitions for 'What is OR?' I have given one of my versions in this issue. We already have the definition 'OR is the art of giving bad answers to problems to which otherwise worse answers would be given.'

Hans G Daellenbach

What Is Operational Research?

Send in your definition!

Operations Research is a systems approach to analyze complex decision problems that lend themselves to be expressed in quantitative terms. The major aim of OR is to provide the decision maker with insights into the solution space for more rational, more effective, and better informed decision making. To achieve this, OR builds quantitative models that explicitly recognize the systemic content of the problem studied.

Contents

IFORS President - Professor Peter Bell

The 1/1994 IFORS Bulletin profiles Professor Peter Bell, the new IFORS President from January 1995. Professor Bell is a graduate from Oxford University (BA(Hons), MA in Chemistry) and the Graduate School of Business, University of Chicago (MBA, PhD). He has been teaching at the Western Business School, University of Western Ontario, London, Canada since 1977. His research writings include over 50 papers and four books. He is the founder editor-in-chief of 'International Transactions in Operational Research', the latest international OR journal sponsored by IFORS. He is also on the editorial board of INFOR and EJOR, and collects and restores classic British motorcycles.

OR/MS ALERT

A Browsing Service From Elsevier, North-Holland and Pergamon

This quarterly 'newsletter' was first published in March 1994. It contains abstracts of the OR articles in the latest issues of the 19 journals published by these three firms. Each issue will also reprint a full-length paper from one of these journals. If you are interested in receiving a copy, write to:

OR/MS Alert
Elsevier Science, OR/MS Alert
P.O.Box 1991, 1000 BZ Amsterdam,
The Netherlands

Review of Mixed Integer Programming Software

The April 1994 issue of OR/MS TODAY features a comprehensive survey by M J Saltzman of twenty-nine Mixed Integer Programming Software Packages. The article lists publisher, systems platform, pricing, input formats (MPS, spreadsheets, other) and compatible modeling environments, form of problems (binary, pure, mixed, nonlinear), algorithm information, user-controlled features, and comments. Saltzman claims that today the only limit on problem size for most packages is the amount of memory on the PC/mainframe and the user's patience.

1994 ORSNZ / NZSA Conference

This year's ORSNZ Conference is being held jointly with the NZ Statistical Association Conference at Massey University, Palmerston North on 25-26 August. There will be the usual diverse selection of papers, ranging from 'Breeding Plans for Racing Stallions' to 'Spreadsheets for Linear Programming'. As well as sessions on topics such as software, statistical education, and vehicle routing, there will be two keynote addresses from the invited speakers.

Dr Bill Henderson will speak on 'Decomposing Large Telecommunications Systems'. Dr Henderson is currently the Director of the University of Adelaide's Teletraffic Research Centre. His research interests include networks of queues, stochastic Petri nets, and their application to telecommunications networks and protocols.

Bill Henderson

Dr Tom Ryan is a visiting member of the Department of Statistics at the University of Newcastle, and the Director of Newstat, a statistical consulting organisation. For the last nine years he has also been a Vice-President of SQC Systems Inc, a small software company located in Georgia, USA. Dr Ryan's topic will be 'Some Important Control Chart Issues - Applications and Research'.

The Conference will also offer recreational opportunities including a Wednesday afternoon excursion: the Southward Car Museum, one of the largest collections of vehicles in the Southern Hemisphere. So, from mobster cars to optimal solutions, Conference provides something for everyone. See you in Palmerston North!

For further information, please contact:

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Massey University, Private Bag 11222
Palmerston North
Ph: (64) 6 350-5336
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Email: J.C.Falkner@massey.ac.nz

Tom Ryan

Potential Relevance for OR of Perceiving Reality as Socially Constructed

Peter Grinyer[1]

There is currently a development in the areas of social psychology, sociology, and the history and philosophy of science which is called, in a broadly collective way, social construction theory. This in effect argues that most of the world we confront, and regard as real, is socially constructed in the sense that it emerges from social discourse, resultant convergence of belief systems, and then enactment of these by social action. Organisations, conventional patterns of behaviour, the legal system, financial products, even physical artifacts and their use (such as that of cars) are socially constructed in this way. Bodies of thought, or theories, such as scientific disciplines, and the models of operational research are certainly so. The power of such thinking practices resides in the influence they have over action and so their subsequent embodiment in the physical and social world that we navigate.

At first sight, this new school seems to be utterly unsurprising, in that most of us have long recognised the social nature of the processes by which the world is shaped. Managers talk, influence others, perceive new opportunities, develop beliefs on new ways of doing things, negotiate, shape external perceptions of customers and legislators, and so take actions to influence the world in a direction they find desirable. Effective operational researchers have long recognised that they offer models as a means of assisting managers to reframe their understanding of their world in such a way that they can individually and collectively take largely social action to achieve their ends.

However, at a conference in Chicago on the Social Construction of Industries and Markets in mid April organised by the University of Illinois, at which a number of high priests of social constructionism made some powerful arguments, three new perceptions struck me strongly.

Firstly, it was argued that cognitive approaches were no longer of major interest and the focus should now be on language and discourse. This is clearly mistaken if taken to the extreme in that discourse without thinking is garbled nonsense. Use of language, whether verbal, mathematical, or using some other symbolism, clearly is the flip side of the coin of cognition. However, the power of language and discourse, and a focus upon this as a way of viewing the socially enacted drama, clearly deserves enhanced attention.

If we put the practice of operational research under this lens, it magnifies the importance of communication to managers with the power to act in a language which they fully understand and which is comfortable to them. Given the uncertainty surrounding many problems, the quality of the discourse engendered by an operational research study may, then, often be more important than the specific solution proposed. Where problems are deterministic an optimising solution may be appropriate, but even then is unlikely to be adopted unless managers understand the argument by which it is derived. However, frequently where alternative solutions are feasible, and the ambiguity and uncertainty surrounding data relating to the future is such that we cannot be sure that any solution is correct, the important thing is that the operational researcher should structure and participate in a discourse which will allow actions which flexibility, allow a variety of future directions to be pursued under different future conditions, the kind of robust strategies which Jonathan Rosenhead has advocated for so long. It can be argued that the Group Decision Support Systems advocated by management scientists like Jonathan Rosenhead, Colin Eden, and Friend and Hickling, and the St Andrews Management Institute, are basically ways of providing a symbolic language, a basis of discourse between managers and with operational researchers, which are manager friendly and permit managers to surmount the limitations of their own cognitive abilities.

Secondly, the language used in the discourse, including value systems embedded in it, itself will shape the kind of alternatives considered and the outcomes envisioned and created by social action. An individual who in a business meeting might perceive, and suggest, the use of a space in a town centre as ideal for a retail outlet in a church meeting might perceive it as a site for evangelical outreach. The arguments, logics, values, even many of the words used in the two debates would be different and each could be used with utter conviction. One advantage of mathematics as a language is, of course, that it is largely free of such values. This is also a disadvantage in that mathematics consequently lacks rhetorical power. Alone it is an insufficient basis for decision taking (objective functions have to be specified drawing on exogenous values which may be difficult to capture precisely).

Thirdly, the high priests of social constructionism stress that if reality is largely socially constructed, it can be just as easily deconstructed. The structures of the telecommunications industry and electricity industries, for instance, were socially determined. Conventions grew, specific technological solutions were adopted, and these became accepted as almost immutable over time by habituation. In the last decade, throughout the world and in New Zealand, these have been questioned and challenged. Once recognised as socially constructed the foundations of such industries are much more open to question. This gives an enhanced impetus to the forces for challenge and change which must be healthy and such scrutiny should give an enhanced potential role for the operational researcher. However, we need to add a note of caution. If everything is challenged, the whole fabric of our existence would become fluid and uncertain, and the problems of handling real life would become intolerable.

The trick must, then, be to distinguish between what we should and what we had better not challenge. *How should we distinguish between the two categories?* The guiding rule is perhaps that it is pointless to encourage challenge where there is no power to change, since to do so properly invites the criticism of lack of realism. For instance, first our understanding of relationships, like gravity, embedded in physical systems may be an example of such unchallengeable "realities". Second, operational researchers must recognise the value systems of managers and the wider society which are so deeply ingrained that to challenge them will lead to inevitable rejection. Third, political and legal constraints are likely to restrict the freedom of managers to act. Such institutional realities are open to change in the last resort but may be fixed in the foreseeable future for the individual manager and indeed his organisation. To ignore them is to rule the operational researcher out of the debate.

Perhaps all of this is merely to state, in a different way, beliefs which have long been recognised by successful operational researchers. Even so, the different perspective of the social constructionist may usefully refocus our attention on such fundamental issues.

Notes

1. Professor Grinyer teaches strategic management in an MBA programme at the St Andrews Management Institute. His areas of interest are scenario analysis and the use of problem structuring methods for practical decision making.

Aluminium Smelters Scholarship

in

Applied Mathematics - Operations Research - Statistics

This scholarship is sponsored by NZ Aluminium Smelters Ltd to encourage postgraduate research in mathematics and statistics related to the aluminium industry in NZ. It is tenable at Massey University for up to three years and is valued currently at $9500 per annum. Candidates should have completed the requirements for a Bachelor's degree with honours on taking up the scholarship. Masters students or doctoral candidates are encouraged to apply.

Informal enquiries concerning supervision should be addressed to the Heads of Departments - Mathematics or Statistics.

Email:	G.Wake@massey.ac.nz	(Mathematics)
	J.Hunter@massey.ac.nz	(Statistics)
Fax:	(06) 350 5611	

Candidates interested in this award should sent their applications by 1 November to:

The Registrar
Massey University
Private Bag 11-222,
Palmerston North

Algebraic Modeling Languages for Optimization

Richard E. Rosenthal[1]

Algebraic modeling languages are highly specialized computer languages that are used for the rapid formulation of optimization models. Developed experimentally in the 1970s and early 80s and commercialized in the late 80s and 90s, they are based on the premise that the easiest way for a modeler to enter a model into a computer is with the same algebraic notation he or she would use to describe it to a colleague.

Motivation. Optimization models (linear, nonlinear and integer programs) have been used widely and with great success in industry, government and the military. As computers and algorithms for solving these models have become more and more powerful, and as a larger number of people in an ever-widening range of disciplines develop the expertise to pose important decision problems in the optimization modeling framework, there has been a growing awareness that the limiting factor in the application of this technology is often the modeler's ability to provide the necessary inputs to a computer algorithm and to make meaningful analysis of the output.

A complaint that has been made in the past about the viability of optimization modeling by some managers is: "By the time I receive the answer, I have forgotten the question." This complaint is not about computational limitations of the solution algorithms. It refers to the human time expended in converting a modeling idea into a form the computer can process. Before addressing the cause and cure of this bottleneck, it is valuable to review the steps involved in real-world optimization.

The process of building practical optimization models involves several interrelated steps. The first and most important is extensive communication with the client or owner of the decision problem to identify the problem ingredients and to ascertain the extent to which optimization is feasible within the managerial structure of the client organization and the cognitive limitations of the model user. The next step is to formulate the model's decision variables, constraints and objective function and to specify its data requirements. Further steps are computer implementation (generation and solution of instances of the model) and detailed analysis of results. These tasks must be followed by additional communication, which often results in model modifications and data refinements due to invalid assumptions, bad data, programming errors, and, most interestingly, the identification of previously unelucidated policies, constraints and preferences.

The faster the technical steps of model formulation, computer implementation and detailed analysis of results are performed, the smoother the overall process, and the greater the likelihood that the modeling effort will receive sufficient attention from the client in the communication phases. Without extensive client attention and feedback, the model, regardless of its technical brilliance, will never be adopted and supported.

Background. Algebraic modeling languages are highly specialized software packages which enormously reduce the time required for model formulation and analysis. They are based on the premise that modelers using algebraic notation can describe models to other algebraically literate people much more rapidly than they can convey the same information to computers using traditional (non-algebraic) methods. An astute diagnosis of this difficulty was furnished by Fourer (1983), who pointed out that the natural way for a modeler to think about and express models is in direct conflict with the input requirements of solution algorithms. Whereas the modeler's form is symbolic, general, concise, and understandable to other modelers, the solver's form is contrary in every respect: explicit, specific, extensive, and convenient for computation. An algebraic modeling language solves this problem by making the modeler's form acceptable computer input. (See Fourer for historical comments on early modeling languages and for detailed discussion of their advantages over matrix generators, an earlier technology.)

The objects one can formally define with a modeling language are sets (indices), parameters (given or derived data), decision variables, objective functions, constraints, and various collections of the above. Sets may be entered as data or derived using standard set operations such as union, intersection, conditional selection, and Cartesian product. Parameters may be input in a variety of ways or derived using built-in mathematical functions. Primal and dual solutions from previous optimizations are accessible for use in these calculations. Variable and constraint definitions can be conditioned upon the derived sets.

Advantages. In order to accommodate the standard ASCII computer character set, the algebraic modeling language version of the constraint sacrifices some of the clarity of standard mathematical notation, such as the Greek Σ for summation, the use of subscripts for indices, and the symbol £. Once the modeler adjusts to these typographical limitations, the advantages obtained are substantial:

- All the work involved in the encoding of particular instances of the optimization model for input to the solver is automated, sparing the modeler of responsibility for this extemely tedious task
- Model formulation effort is independent of the scale of the problem. Indeed, very large-scale optimization models, with thousands of variables and constraints can be generated easily with an algebraic modeling language
- Modeling languages permit separation of the model and the data, so that changes in input coefficients are easily handled by modifying a data table rather than changing any model equations
- Because of the model/data separation and the model definition's lack of scale-dependency, the modeler can build prototypes very rapidly. Prototypes supply early insights and help determine whether a full-scale modeling effort is justified before substantial resources are committed
- It is just as easy to formulate nonlinear objective functions and constraints with an algebraic modeling language as it is to create linear programs. One simply expresses the nonlinear function in direct terms

Modeling languages automatically generate instructions for the nonlinear programming solver on how to compute derivatives of the nonlinear functions analytically (not by numerical approximation). This is much easier and less error-prone than using the nonlinear programming solver directly, which would require writing FORTRAN subroutines to evaluate the nonlinear functions and their gradients. Further:

- All the modeler's effort is concentrated on modeling-building itself, manipulating objects that are relevant to the problem context, rather than dealing with computational details and far-removed abstractions
- Nearly all algebraic modeling languages offer the modeler a choice of solver. It is easy to switch between them and to change settings that may improve performance. For difficult optimization problems, such as nonlinear and integer programs, it is unlikely that the same solver will always work best. When a model is implemented with an algebraic modeling language, it can readily exploit improvements in solvers as they are released by their developers
- Since algebraic modeling languages use a simple, standard set of characters, any model is readily portable without modification across a wide range of computing platforms and operating systems. Models can be easily shipped by electronic mail. Algebraic modeling languages also have great facility for internal documentation, which helps not only with communication but also long-term maintenance

As noted, in practical applications of optimization, models often require modification as new aspects of the problem being modeled come to light. Another reason to revise a model is for computational performance, particularly with integer programs. The same model can often be formulated in several different ways in the sense that the different formulations, if solved to optimality, would give the same results. However, an important distinction between these seemingly equivalent formulations is that some are much easier to solve than others (see, for example, Barnhart et al 1993; Schrage 1991). Finding the more tractable formulations often calls for experimentation with competing formulations. Whether for this purpose or to respond to newly discovered problem features, modifying a model formulation with an algebraic modeling language takes much less time than traditional modeling tools.

Some algebraic modeling languages contain advanced features that allow efficient implementation of very complex models and of advanced algorithms that involve iterative solution of multiple submodels. For example, it is very easy to implement Dantzig-Wolfe decomposition, Benders decomposition and other large-scale optimization algorithms (Lasdon 1970), which iteratively solve different models, using output of the current model as input to the next. Another convenient use of this capability is on extremely difficult integer programs, where, due to large size or a nonlinear objective function, finding an optimal integer solution is impossible in a reasonable amount of time even after many simplification and reformulation tricks have been tried. An effective approach is to solve two easier optimization submodels in sequence. The first finds a continuous optimal solution. The second finds a feasible integer solution that is "optimally related" in some context-specific sense to the continuous solution. This heuristic approach is not recommended on a blanket basis, but it has been effective on a variety of real-world applications and is easy to implement with an algebraic modeling language (Rosenthal 1994).

Caveats. One should be aware that there are some circumstances when algebraic modeling languages may not be appropriate. These circumstrances tend to cluster at two extremes. For casual users of optimisation, whose models are not very complex, an algebraic modeling language may be an overly specialised tool and perhaps of less value than spreadsheets, which have some (but not as much) embedded optimisation modeling capability.

The advantages of modeling languages over spreadsheet optimisers are data/model separation, scale independence, documentability, and ease of revision, all features noted above. Another advantage is dimension-independence, which means that it is extremely easy in a modeling language to define a variable with many indices or to convert a variable with one or two indices into a variable with three or more indices. In a spreadsheet, this conversion may be extremely difficult if not impossible.

On the other hand, spreadsheet optimizers have some significant advantages over modeling languages. They are currently more advanced in terms of integrating with database management systems, graphical user interfaces, and other components of corporate software systems. (Modeling languages are starting to improve in these areas. For example, MPL can tie directly into databases and AIMMS has very good graphics.) Spreadsheets are also a more familiar and comfortable computing environment for most people, particularly those who started using computers in the personal-computer era.

The other extreme where algebraic modeling languages are not the best choice for implementation (although they can be of great value for prototyping) are problems of such great size or difficulty or time-criticality that they require special-purpose model generators and solvers. A common example is in the airline industry, where scheduling problems are often formulated as integer programs with so many columns they cannot be generated apriori. Between the extremes of simple models for which modeling languages may be too sophisticated, and exceptionally challenging models for which they may not be powerful enough, there is a vast middle range of optimization applications where algebraic modeling languages serve as an excellent implementation tool.

Notes

1. At the Operations Research Department, Naval Postgraduate School Monterey, California. This article will appear in *The Encyclopedia of Operations Research and Management Science, edited by Saul Glass and Carl Harris.* For reasons of space, this article has been shortened slightly.

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MENTOR: Multimedia Educational Technology for OR

Summary of a paper presented at the UK OR Society, York 1993 by Valerie Belton, Mark Elder, Helyn Thornbury, and Emma Candy

In August 1992, the UK Universities Funding Council awarded a £500,000 grant to a three-year project called 'MENTOR'. This project, to develop a multimedia teaching support system for an introductory OR course, will ultimately consist of 17 modules, covering a wide range of specific subject areas in OR. Each module corresponds to an equivalent of about 10 hours of traditional lectures/tutorials/computing labs. The objective is to improve the effectiveness of teaching OR and enhance the students' learning experience, by engaging them in an interactive multimedia learning system. It will consist of:

- *Hypertext:* presentation of theory and concepts allowing the student to explore to the depth they judge appropriate for their own knowledge and level of interest
- *Video and animation:* to give a better feel for the context of the problem
- *Interactive graphics:* to involve the student in active learning about the technique or problem
- *Software:* the integration of commercial or teaching software packages for the solution of problems

The system will allow instructors to insert their own material, using standard word processing systems. Video, graphics, and animation can also be incorporated.

The objectives for year 1 of the MENTOR project were to research the process of producing modules, the content and design of modules, and ensuring their use across the UK academic OR community. Licensing arrangement to foreign users are currently being worked out. The five modules developed in 1993/4 cover:

Linear Programming: problem formulation, graphical solution, simplex, sensitivity analysis

Stock Control: functions, costs, EOQ, Pareto concepts, service level concepts

Simulation: events/activities, queues, random numbers, experimentation, simple modelling

Forecasting: overview, moving averages, Arima models, seasonal decomposition, errors, etc

Introduction to OR: methodology, models, uncertainty, multiple criteria, decision support

If you are interested in receiving more information, write to:

Helyn Thornbury
MENTOR coordinator
Department of Management Science, Strathclyde University
26 Richmond Street, Glasgow G1 1XH, UK
Email: mentor@uk.strath.vaxa

The Wagro Rugby Federation Problem

Tim Robinson

There are 16 teams in the Wagro Rugby Federation. Traditionally, the Federation has held a round-robin tournament, with every team playing every other team exactly once in a 15 week rugby season. By Federation rules:

- Games may be played only on Saturday
- Each team plays exactly one game per week
- The draw for each Saturday must be published on the preceding Monday at the latest

The tourrnament organiser has noticed that for any three teams A, B, C, if in any one season A beats B and B beats C, then A beats C. So in any season it has been possible to number the teams in order of ability, from 1 (the best) to 16 (the worst) such that team P beats team Q only if $P < Q$. Curiously, there seems to be little similarity between one season's rankings and the next.

This year the season has been reduced to 10 weeks because of flooding. A round-robin tournament is therefore impossible. Assuming that a consistent ranking exists, and that no game ends in a draw:

- Show how to rank the 16 teams in the 10 weeks available
- Show that nine weeks is not enough
- Determine the maximum number of teams that can be reliably ranked in a 15 week season

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From the Guardian Weekly...Over the past 2500 years, some of the best brains that mankind has produced have studied the problems of philosophy. What problems of relevance to everyday life have they solved?

Philosophers to do not solve problems, but (re-)create them in forms ever more difficult to solve, thus perpetuating philosophy. This is not unique; economists, sociologists, and politicians behave in exactly the same way with corresponding consequences. (Prof Sir James Beaument, Queens' College, Cambridge)

As the last lecture of my moral philosophy course, our professor said: "Don't think you're no further forward. The value of studying philosophy is that you've reached a more informed state of ignorance." (Alan Brown, Glasgow)

NZSA/ORSNZ Joint Conference

Massey University 25-26 August 1994

Wed 24: (Optional) Excursion and Registration

Thurs 25: Conference Day 1, including Registration and Dinner

Fri 25: Conference Day 2.

Contact: Julie Falkner or John Griffin
Department of Mathematics, Massey University
Private Bag 11-222 Palmerston North
Ph: (+64 6) 350-5336
Fax: (+64 6) 350-5611
Email: J.C.Falkner@massey.ac.nz

Local and International Events

TIMS/ORSA '94 Joint National Meeting

Detroit, USA, 23-26 October 1994

Global Manufacturing in the 21st Century

Contact: Kenneth Chelst, General Chair
Dept of Industrial &Manufacturing Engineering
College of Engineering
Wayne State University
Detroit, MI 48202 USA
Ph: (313) 577-3857
Fax: (313) 577-8833
Email: chelst@mie.eng.wayne.edu

TIMS XXXIII

Singapore, 25-28 June 1995

Excellence in Global Services: Competitive Technologies

Call for papers: Mail three copies of abstact plus submission fee of $100 US to TIMS XXXIII (as below) by 10 November 1994

Contact: TIMS XXXIII - Singapore
The Institute of Management Sciences
290 Westminster Street
Providence, RI 02903 USA
Ph: (401) 274-2525
Fax: (401) 274-3819

TIMS/ORSA Joint National Meeting

Los Angeles, California, 23-26 April 1995

There will be a special stream of sessions on OR in the Pacific Rim. Dr Bruce Lamar and Dr John George, University of Canterbury, are the co-chairs for the two Sessions devoted to New Zealand. There is still room for one or two papers. If you have any interesting or novel OR implementation in NZ, please contact them to participate in this session.

General Chair:
Richard D. McBride
University of Southern California,
Los Angeles, CA 90090-1421

IFORS SPC 3 Special Conference

Santa Monica, California, 15 -18 January 1995

Digital Technologies/Multimedia: OR/MS in Strategy, Operations and Decision Support

Contact: IFORS SPC 3 c/o
Dean William Pierskalla
Anderson School of Management
University of California
405 Hilgard Ave, Los Angeles
Ph: (310) 825 7982
Fax: (310) 206 2002
Email: spc3@agsm.ucla.edu

Symposium on Modelling and Control of National and Regional Economies

Gold Coast, Queensland, Australia 2-5 July 1995

Call for Papers: Submission of extended abstracts 15 September 1994

Contact: Convention Manager (IFAC 95)
AE Conventions Pty Limited
P.O.Box E181
Queen Victoria Terrace, ACT 2600
Australia

ANZAM '94 Conference

Wellington, New Zealand 7-10 December 1994

Vanishing Borders :The Managerial Challenges

Contact: ANZAM '94 Conference,
The Management Group,
Graduate School of Business
and Government Management,
Victoria University of Wellington
PO Box 600
Wellington, New Zealand

WHAT IS OPERATIONAL RESEARCH?

Operational Research is the scientific approach to solving management problems. Using observation, data and analysis, the OR practitioner builds up quantitative relationships, called models. Models that take an overall system view help management make informed decisions.

The Secretary
Operational Research Society of New Zealand
PO. Box 904
WELLINGTON

Please enrol me as a member of the Operational Research Society of New Zealand, at the membership grade indicated below. I enclose the appropriate fees*.

I agree to be governed by the constitution of the ORSNZ, and to remain liable for subscriptions until I notify the Secretary in writing of my intent to withdraw from the Society.

Signature :______________________ Date :_________________

Individual members in
Auckland, Wellington, Christchurch and overseas $35.00
Individual members in other areas $31.50
Student members † $15.00
Corporate members $100.00
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Special interest areas : ____________________________________
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* Current fees for 1993
† Student certification : ______________________________________
(Signature of Instructor and Institution)
†† Corporate sponsors may specify up to 4 additional addresses.