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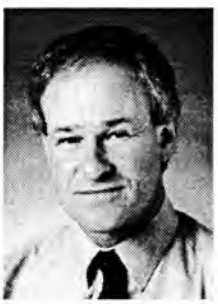
OR NEWSLETTER

Operational Research Society of New Zealand (Inc.), PO Box 904, Wellington, New Zealand **October 1994**

EDITORIAL

Don McNickle



Already already another issue? Yes. Although Hans Daellenbach is just back in New Zealand I thought I had better get this issue out before I give him back control. How many times a year is this thing supposed to come out anyhow?

You may notice a certain Canterbury flavour about many of the articles in this issue. That's because NOBODY ELSE IS SUBMITTING STUFF, and it is easier to brow-beat the locals into writing something. Among the possibilities you might like to consider are: product reviews - write up your favourite piece of software, announcements of visitors, "people" news - job changes, honours, whatever - see your name in print! We will try some of these headings in this issue to see if they provoke responses.

Among the articles in this issue are a comment from Andrew Tobias on educational opportunities for O.R. in the U.K. Andrew visited Canterbury from April to August this year. Jonathan Rosenhead ("A Case for Policy Analysis") was another stimulating visitor in the early part of the year.

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A CASE FOR POLICY ANALYSIS

Jonathan Rosenhead

I'd like to argue that OR has done itself a disservice by its attitude to policy analysis - by which I mean a contribution of analysis to the formulation of public policies. Perhaps I should say attitudes.

In the more bullish period of the 1960s and 70s there were some practitioners (mostly in the USA) who attempted to transfer insights from operational research to this field. They offered (there are exceptions to this as to all generalisations) formulations of policy problems which were over-structured, over-mathematical, or both. This was the first OR attitude. It gave policy analysis a narrow, quantitative, predictive focus. Its thrust was towards the reduction, indeed ideally the elimination, of the need for judgement. It is not too surprising that practising politicians found these representations of their problems unconvincing and unhelpful.

The second OR attitude to policy analysis has been a response to this failure of a generation ago. We've ignored the area. We've stuck to other fields where our methods seem to be more productive and acceptable.

Politics as swamp

I think that this second, and currently dominant, position derives in good part from operational research's natural science heritage. If analysing public policy means getting involved with the power-broking, self-seeking, emotionality and ambiguity of politics, then many OR people would rather cross to the other side of the road. There are seen as two distinct and exclusive modes of decision-making - clinical/analytical, or smoke-filled rooms. Peter Checkland has written of operational research encountering politics as a no-go area where rational thought ends. I will argue below that this OR attitude places an unnecessary restriction on the subject's scope.

Donald Schon (in *Educating the Reflective Practitioner*, Jossey-Bass, 1987) presents a different slant on this dichotomy of both subject matter and approach: "In the swampy lowland, messy, confusing problems defy technical solution. The irony of this situation is that the problems of the high ground tend to be relatively unimportant to individuals or society at large, however great their technical interest may be, while in the swamp lie the problems of greatest human concern. The practitioner must choose. Shall he remain on the high ground where he can solve relatively unimportant problems according to prevailing standards of rigor, or shall he descend to the swamp of important problems and non-rigorous inquiry."

I would take issue with that "non-rigorous". However the quotation does in general capture the dilemma for OR, which is also in principle a dilemma for policy-makers - that analytically-based support which can increase the confidence with which decisions are taken has been on offer only for secondary questions.

Policy-making without policy analysis

It is not only OR which has created or perpetuated this situation. It takes two to tango, and for the past 15 years in many of the countries where OR is strong, government has in any case been a missing partner. Paradoxically this can be turned to advantage: one of the best arguments for (appropriate) policy analysis is to see what happens without it.

Elsewhere (J Rosenhead "Into the swamp: the analysis of social issues", *Journal of the Operational Research Society* 43, 1992) I have recounted the British experience of the Thatcher experiment in policy making without policy analysis. That paper describes in some detail how the public (and often the civil service machine) were 'bounced' into radical (and un-analysed) policies in a number of areas - student loans, the opting out of schools from local government control, the recasting of the health service as an internal market, and the imposition of a flat-rate 'poll tax' for local government taxation.

These policies, like many others, were first floated by independent right-wing think tanks. Their advocacy was strong on value assertions and anecdotal evidence. Detailed policy prescriptions followed, with recourse at best to intuitive argumentation. Many of the resulting policies produced administrative or political chaos. Some produced both.

To take just one example, the poll-tax fiasco brought down Mrs Thatcher herself. The policy issue was eminently researchable in advance - on whom would the tax impact? Indeed it was so analysed (by independent researchers) who found that those who would gain most from the change were those who would always vote Conservative, while those who would lose heavily were concentrated in those swing sections of the population vital to Conservative electoral success. The government, sure of the rightness of its policy, failed to listen.

The retreat from reason

Why should the current breed of radical right governments find analysis so uncongenial? The explanation, I believe, lies in a more general retreat from reason. Among its underpinnings are

- an almost mystical belief in market forces as an allocative mechanism
- a current of thought (from Popper, Hayek and others) which is deeply pessimistic about the rational solubility of social problems, and about the limitations of cognitive capacity
- a critique of 'hyper-rationalism' as "an irrational belief in the omnipotence of reason" (Elster).

This is the intellectual climate which has fostered policy-making by hunch, by stealth, by dogma.

In fact it is hyper-irrationalism which is now the pernicious threat to policy-making. Operational research must take some share in the blame for its inadequately opposed spread. First by offering a quite inappropriate form of analysis. Then by offering nothing at all. And still by not caring that big issues were being (inadequately) handled by other means. We need to have the ambition.

Conditions for an OR contribution

There are in fact at least four conditions for OR to make a constructive contribution to policy analysis. They are:

- the ambition
- appropriate methods
- independent platforms
- disseminated analytic capability

Let us assume that the ambition can, as it must, be generated. That will merely open OR to the same disappointments as were experienced twenty years ago unless we have methods more appropriate than were deployed then. However the OR technical repertoire has been broadened and enriched since then by the advent of 'problem structuring methods' (PSMs), as well as by the strengthening of mid-range approaches such as decision analysis and system dynamics. For more detail of PSMs see J Rosenhead (ed) *Rational Analysis for a Problematic World*, Wiley, 1989.

PSMs are designed to assist groups to agree on the nature of their common problem. The process is iterative and participatory, and focused on achieving partial commitment rather than comprehensive solutions. Situations for which they are particularly appropriate are where

- there is no single decision-maker
- there is no clear, unifying objective
- measures, and trade-offs between them, are problematic
- participants hold differing, possibly conflicting, perspectives
- outcomes will be secured by mutual adjustment

These characteristics are more in tune with the conditions and mode of operations of a democratic policy process.

There is no shortage of issues crying out for OR involvement. The design of an alternative electoral system, recently resolved in New Zealand but still under debate in Britain, is one. Public debate on HIV/AIDS continues to throw up questions, most recently in Britain the plausibility of risk of a heterosexual epidemic, from which an OR input has been missed. And so on.

Given the ambition, the methods and the existence of highly relevant problems, what else is needed? Principally, the recognition among policy-makers and the public at large that OR has much to contribute. We need to foster a culture in which analysis is seen as a natural and necessary adjunct of public decision-making. For this OR must shed its image of a subject which reports only to management and in private. One route is to secure its adoption among the disciplines deployed

by independent think tanks - in Britain, for example, there are quite a number of these which would provide an appropriate environment for operational research. Another is to bring about the more direct availability of OR's analytic capabilities to organisations and interest groups at all levels. The British OR Society's community operational research initiative is just one example of how this may be achieved. (See the two articles by Ritchie, Thunhurst and others in *Journal of the Operational Research Society* 43, 1992.)

Operational research already has finely-honed craft skills in the quantitatively-based exploration of complex situations. With the progressive development of these other factors we can help to create an atmosphere in which policy emerges from rational debate among empowered participants. The resulting multiple advocacy is a prerequisite for a better policy process. It is also what is needed for a sanely democratic society.

Jonathan Rosenhead is Professor of Operations Research at The London School of Economics and Political Science

AT THE CONFERENCE

The 30th Annual Conference was held at Massey, on 25 and 26 August. This was a joint affair with the Statistical Association, which resulted in over 160 attendees and 70 papers.

The Vice-Chancellor of Massey, Dr Neil Waters, gave an interesting and entertaining opening speech which centred around aspects of horse-breeding. This was followed by Bill Henderson of the Teletraffic Research Centre at the University of Adelaide, who gave one of the two keynote addresses. Bill spoke on recent work by members of his group on product form solutions for networks of queues. During his talk he ate some of his customers.

Jonathan Lermit with Megan Thornley

In fact the general standard of presentation of all the talks I went to was very high, with a few brave souls risking incompatible plugs and cantankerous computers to use presentation software like Powerpoint, and almost everyone else having at least readable transparencies. Compared with say the ORSA conferences we are doing rather well.

At the AGM Jonathan Lermit was elected President, with Andy Philpott as Vice President. Mark Pickup and Matthew Hobbs agreed to remain as Secretary and Treasurer respectively. The motion to move the base of the Society to Auckland was passed, along with one that we rejoin the Royal Society provided we can do so on favourable terms. Because Royal Society membership will cost some yet-to-be-determined amount, and also because we are running at a modest deficit, increases in the fees for membership were approved. Ordinary membership is to rise to $45, Corporate membership to $150, and Corporate Sponsorship to $400.

The ORSNZ Young Practitioner's Prize attracted seven papers, all of very high standard. Megan Thornley won First Prize for *Optimisation and column generation techniques for seniority preferential bid rostering.* Second Prize went to Twan Vollebregt for *Experimental design theory for automated simulation studies,* while the judges also decided to award a Highly Commended prize to Geoffrey Gill for *Even packing of containers with fixed charges.*

Bill Henderson's Keynote Address

Conference organisation was first-rate. Jeff Hunter and his team (especially Julie Falkner) did an excellent job, producing a Conference Proceedings the size of the Wellington phone book (apparently not quite what was intended.) The Conference Dinner was held at the Coachman, one of Palmerston North's finest eateries. Need I say more?

News

Tony Vignaux is on leave at Oxford until Christmas.

Hans Daellenbach is back in New Zealand (but still on leave) after six months overseas in Europe and the US. He reports that many O.R. departments are changing their names to Management Science or worse. Hans' book *Systems and Decision Making: A Management Science Approach,* has just been published by Wiley (UK).

Professor **Ralph Disney** (Queueing Theory) will be visiting Canterbury and Massey from January to June next year. Contacts are Don McNickle and Jeff Hunter.

Professor **Michael Jackson** (Soft Systems) is scheduled to return to Canterbury in April 1966 for a five-week visit.

GETTING INTO OPERATIONAL RESEARCH IN THE UK
A Personal View

Andrew Tobias

It's certainly a shame that we in the United Kingdom don't see more applications from "the World's Greatest Travellers" to read Operational Research at our Universities. So what are the prospects for a New Zealander aspiring to read Operational Research at a UK University and perhaps getting a job afterwards? What might he or she expect?

Some undergraduate programmes do exist, but often as part of wider schemes. One of the best of these (in many senses) is the B.Sc. course in Mathematics, Operational Research and Statistics (MORS) at Warwick. But, perhaps unlike in New Zealand, OR is viewed in the UK primarily as a subject to be studied at Master's level. The New Zealander might therefore complete a relevant B.Com or B.Sc. here and then apply for a place on one of the one-year Master's programmes are offered by Lancaster, Southampton, Strathclyde, London School of Economics, Warwick and Birmingham. The first three lie within Departments of Management Science, but OR at LSE is run by their Department of Statistical & Mathematical Sciences, Warwick's M.Sc. is linked to its Business School, and Birmingham's is within its School of Manufacturing & Mechanical Engineering! Each therefore has its own distinctive flavour. Class sizes are small, programmes are mostly fixed rather than modular and there is much emphasis on group work and the development of professional skills through projects.

A limited and decreasing number of student places at each centre are funded by the Physical and Engineering Sciences Research Council (formerly SERC), and the unfortunate reality is that an increasing number of students have to fund themselves from bank loans or personal savings. For example, of the 37 students reading OR at Birmingham in 1993/4, some 23 held SERC grants and the remainder funded themselves paying fees of some £4500 p.a. and requiring a minimum of a further, say, £2500 p.a. to live on. Between four and five applications for places are received for each place. Competition is therefore very keen and entry is restricted to students with a relevant, upper second class degree or better. Standards are high.

Typically, applicants come at age 22 straight from first degrees in Mathematics, Business Studies or Computing. Programmes are generally full-time for a period of 12 months, but, for example, Warwick has a significant proportion of part-timers. October to Easter is spent taking lecture courses at the University. At Birmingham, students take courses in optimisation techniques, management accounting, operations management, statistics, computing, information technology, and consultancy practice. There is significant project work in small teams, use of computers and training in consultancy and presentation skills.

The Easter examinations are typically followed by an extended practical project during the Summer. Students work for a commercial or industrial client with a real-world problem, usually in pairs. On the Birmingham programme, four months are spent full-time at the client's premises and this ensures good interaction with the client throughout, as well as providing an excellent introduction to professional life for the students. The project supervisor visits fortnightly to provide tutorial support, and the students produce a joint report which doubles as a thesis. Regular clients include such good blue chip companies as British Airways, British Rail, Nestlé Rowntree, Oxfam and the Royal Automobile Club as well as public sector organisations such as Birmingham City Council, the Ministry of Defence and West Midlands Police.

By the time they leave the University in September, some will have found employment in consultancies, software houses or manufacturing or finance. The most sought-after specialist positions are probably with British Airways. But levels of unemployment remain high in the UK, and even a good Master's in OR no longer guarantees a job. Until say the end of the 1980's, most graduates had no difficulties in getting positions with one of the large companies with specialist OR departments (British Coal, British Steel, etc. etc.). Indeed, so heavily populated were such departments with M.Sc. graduates that the system operated as a slightly incestuous club, where very significant entry was via one of the six M.Sc. courses! Now in the 1990's, however, the trend is for companies with such departments is to close them and buy equivalent services infrequently

from outside if they must. The OR practitioners of brewers Bass in Burton-upon-Trent are just one recent major casualty. Competition for the jobs in the remaining groups is fierce, and most graduates end up having to look further afield.

As for the United Kingdom's professional body, although the OR Society is fairly strong nationally, with a large yearly conference and several strong study groups, most of the regional groups struggle to be effective. Active membership is fairly heavily biased towards academics rather than practitioners, and evening events where invited speakers present new theory or case studies are attended fairly poorly. In the West Midlands, for example, only one of the seven-strong committee is an industrialist, and, but for the support of students studying OR at Birmingham, Warwick, and, now, Wolverhampton, attendance would typically be in single figures each time. Two happy exceptions (again in the West Midlands) are the annual joint meeting in November with the Royal Statistical Society and the joint Christmas lecture at Coventry with the Institute of Mathematics, which typically attract in excess of 100 people each.

In summary, the New Zealander coming to the United Kingdom will therefore find a practical way to complete his or her education; getting a job will be hard but not impossible. The six major programmes in the UK aim to take high quality graduates with relevant but heavily academically-oriented degrees and give them an extra practitioner-oriented qualification to start them on careers in Operational Research. The emphasis on group work, projects and professional skills throughout and the extended projects for real clients during the Summer will give him or her a significant advantage.

Andrew Tobias is Director of the MSc Programme in Operational Research at the University of Birmingham, England, and Chairman of the Midlands Operational Research Society. He has recently been researching Systems Modelling at the Department of Management, University of Canterbury during a six month period of study leave. Readers requiring further information about the M.Sc. programme at Birmingham should write to "The Postgraduate Admissions Secretary, School of Manufacturing & Mechanical Engineering, The University of Birmingham, Birmingham B15 2TT, England".

STABMASTER
A graphical program to optimise ship stability

Kieren Simon

Trimming a commercial fishing vessel is a complex business. The nature of fishing means dragging catches weighing many tonnes onto the deck and transferring the fish into the interior of the ship, all of which can occur during very difficult weather conditions. Apart from the usual consumption of fuel, a large amount of fresh water is used for making ice to pack the fish in.

Adjusting the ship's draught is obviously vital, but the centre of gravity is just as important and this cannot be observed directly, it has to be calculated. The calculations also have to account for the sloshing effect made by the fluid in the tanks which tends to make the ship list, increasing the sloshing effect even further.

Previously, ship stability was done manually using a calculator and a book of tables generated especially for the ship. Sometimes a spreadsheet would be used, but this method remained both tedious and error prone.

StabMaster

The StabMaster program was developed as a tool for the captain of the Sealord ship Thomas Harrison. It has these advantages:

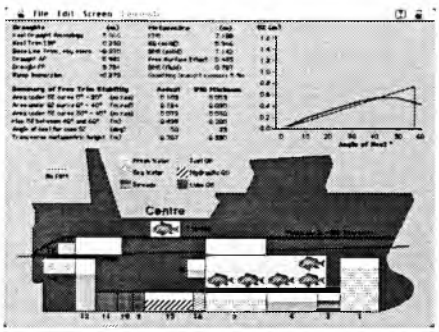
- it is much faster and more accurate than calculating manually
- it does not make mathematical errors
- it can quickly be used to test different combinations of loading

- the graphical display presents information in a far more usable manner
- it can be used to create status reports for management

Currently the operator has to adjust the program manually to correspond the ship's instrumentation. It would possible to have the program constantly monitoring the tank levels to give a real-time readout.

The Interface

The program is intended for non-computer experts, so the interface has been kept extremely simple. The only controls are the tanks which are adjusted using the mouse, and the fish which is adjusted by clicking on the icons. There are three sections on the Thomas Harrison, representing the port, starboard and centre line of the ship. Each section has different tanks in it, but they all look very similar to the centre section shown here. Once the fish and tank levels are adjusted correctly, the program is set to calculate. About 10 seconds later, the numerical output appears and the graph and waterline are redrawn.



The StabMaster Screen Display

Output

At the top-left of the screen is the numerical output which gives a summary of the ship's stability profile. Any value out of range (like the Keel Draught Amidships) is indicated in red. The graph at the top-right of the screen shows the righting moment of the ship. This configuration of tanks and fish means the ship resistance to overturning will increase until to about 50 degrees when the resistance starts to diminish as the vessel starts to overturn. The position of the waterline is drawn along the hull. It is important that the ramp at the back of the ship is immersed or the winches cannot haul the nets up onto the deck. All the output can be printed to give a complete record of the ship's stability profile at any time.

Algorithms

The amount of calculation required is quite considerable. Originally the idea was to have the output change dynamically as the tanks or fish was altered, but this proved to be impractical. The mathematics is not particularly complex. It mainly involves linear interpolation on tabular data read in from external files.

In the program the tanks are displayed as simple rectangles, but in reality the tanks are complex three-dimensional shapes. Calculating the tabular data for these tanks requires highly specialised software and took several hours of computer time.

Development

The program was developed on Apple Macintosh computers using SuperCard. SuperCard is a authoring program and is ideal for creating complex graphical applications. Because it is an interpreted language, numerical calculations are not particularly fast, but it is extremely quick to prototype and modify applications. Once the program was validated, it was converted to Visual BASIC for Windows to run on the ship's IBM computer. This unusual two step process was necessary because all the ship's drawings and calculations were made using Macintosh computers.

The program took about 3 months to develop. John Harrhy, manager of John Harrhy Consulting Ltd., designed the concept and did the mathematics. I did the artwork and wrote the computer programs. Apart from the usual debugging, developing the program went extremely smoothly, which was mainly due to good communication and having a rigorous specification. StabMaster is currently installed on the Thomas Harrison, and will eventually be installed on all ten ships in the Sealord fleet.

Kieren Simon is a software developer based in Nelson, and is an operations research graduate from the University of Canterbury. John Harrhy runs a naval architecture firm, also based in Nelson.

MATLAB
High Performance Numeric Computation and Visualization Software

Reviewed by Tristram Scott

What is Matlab? To quote from the User's Guide:

Matlab is a technical computing environment for high-performance numeric computation and visualization. Matlab integrates numerical analysis, matric computation, signal processing, and graphics in an easy-to-use environment where problems and solutions are expressed just as they are written mathematically – without traditional programming.

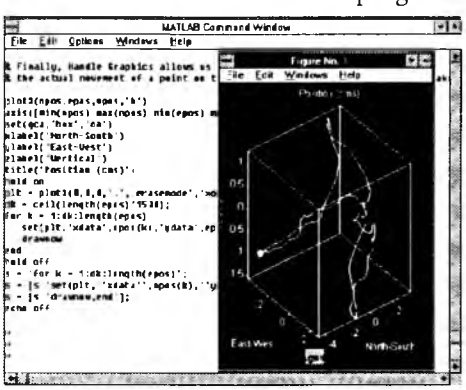
The name Matlab stands for MATrix LABoratory, as that is what it was originally written as, although it now provides much more than just matrix algebra. Matlab provides easy access to the matrix software developed by the LINPACK and EISPACK projects.

The basic data element in Matlab is a matrix which does not require dimensioning. Solving problems using Matlab is easy as the commands are expressed using conventional mathematical notation. For example, to calculate b, the product of matrix A and vector x, simply write **`b = A*x`** . To solve for x in terms of A and b, write **`x = A\b`**. Almost every function and procedure you would learn about in a linear algebra course up to stage three level is available as a built in function with no programming required. Functions include inverse, eigenvalues, QR factorisation, LU decomposition to name but a few.

As well as the hundreds of built in functions, there are optional "toolboxes" of functions for specific purposes such as Optimization, Neural Networks, Signal Processing and Statistics.

Having used Matlab to crunch huge quantities of numbers, you can use its superb graphics to display your results. Plotting functions can be as simple as saying plot(x,y) , but can extend to complicated 3D surface renderings with contours and mesh lines. Axes are automatically labelled in a way which usually doesn't clutter up the image, although if required Matlab gives you almost complete control over the appearance of your plots.

Writing your own functions is as simple as using Matlab itself, and over the past few years I have built up a sizable library of these "m-files". For those die-hard Fortran and C programmers, you can easily call your Fortran and C code, and even, conversely, call Matlab from within your C or Fortran programmes.



Movement of a point in the Santa Cruz (1989) Earthquake

I use Matlab extensively for my research because it enables me to quickly test new ideas and write prototype functions without getting bogged down with the syntax of the programming language. Having left Matlab to churn away at an enormous number of optimisation problems for a few hours, I can plot the results in a few seconds and immediately see what was going on.

The product is well supported, with extensive easy to follow on-line help, excellent technical support from the producers, The Math Works Inc. (TMW), and a newsgroup on the usenet (comp.soft-sys.matlab). TMW have an internet connection at mathworks.com with ftp and world wide web support at **`ftp.mathworks.com`** and **`www.mathworks.com`** respectively.

For those who are still using version 3.5 of Matlab, many new features await you in the latest release, version 4.2. These include sparse matrix support, much improved graphics, including the ability to write GUIs, and commands to help in debugging m-files. On PCs, Matlab now runs under Windows, giving you the ability to have several figure windows open at once, and to cut and paste into other Windows applications, although the best quality output is obtained via the PostScript driver.

Matlab is available on many platforms, including UNIX, VMS, Macintosh, Windows and even Cray! The Windows version does run under OS/2, although there are some bugs apparent in the latest release. The product is available in New Zealand from: Hoare Research Software, P.O. Box 4153, Hamilton East. Ph. 856 2675 or email hoare@midland.co.nz

Tristram Scott is well into his Ph.D. at Canterbury.

Ph.D. Research Summary

THE USE OF OR TECHNIQUES IN SHORT RUN ELECTRICITY MARKET COORDINATION

B. J. Ring

Since 1987 the New Zealand electricity industry has been restructured so as to allow competition from independent buyers and sellers of electricity. OR techniques have been developed to coordinate the resulting market.

A basic tool for determining a half hourly dispatch of a power system is the Optimal Power Flow (OPF) model. This determines efficient values of the complex variables describing the "real" and "imaginary" components of power at each generator or demand node of a transmission network. These variables must satisfy numerous non-linear physical and operational constraints. The criteria for defining an optimal solution vary with situation. The ability to solve the OPF problem is in itself a major triumph of OR techniques.

Traditionally, the New Zealand system has been operated by a central dispatcher. In a market situation the coordinative role must be played by prices. The correct set of prices are those which would be implied by a price decomposition of a welfare maximising OPF problem. In practice the market will still be centrally dispatched, but the dispatch must be consistent with previously announced offers from generators and bids from wholesale customers. Consequently, the prices need to be determined after the event so as to ensure that all parties have the appropriate incentives to optimise their actual behaviour, rather than just their announced intentions. Consistent prices can be found by forming a welfare maximising OPF which has been linearised about the observed solution, and solving the dual of the resulting linear programming problem. Spot prices for power at each network node result, with the marginal cost of transmission between two nodes being defined by the differences in these prices.

A fundamental assumption of ex post pricing is that the observed power system dispatch is optimal. In practice if this assumption is violated goal programming techniques may be used to determine the best compromise spot prices, and the compensation payments which need to be made to incorrectly dispatched market participants.

An ex post pricing program has been developed by Trans Power New Zealand Limited which can determine prices for all 600 nodes in the NewZealand system within about 90 seconds using a 386 PC. This model calculates both active and reactive power prices which reflect the costs of losses, system security requirements, and transmission constraints (Further details are given by M. Rosevear and B. Ring in "Implementation of Transmission Pricing Using a GAMS model", *Proceedings of the 28th Annual ORSNZ Conference, 159-165, 1992*).

This use of OR techniques contrasts with traditional approaches in that rather than optimising a primal problem assuming that the solution will be imposed by central control, we are evaluating a dual problem so as to provide appropriate incentives for optimal competitive behaviour. This competitive approach allows for innovations and efficiency gains to be made.

Brendan Ring is completing his Ph.D. at Canterbury, under the supervision of Grant Read.

MEETINGS

TIMS/ORSA Joint National Meeting

23-26 April 1995
Los Angeles, California, Bonaventure Hotel
General Chair: Richard D. McBride, University of Southern California, Los Angeles, CA 90090-1421.
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 Session devoted to New Zealand.

TIMS XXXIII International Meeting

25-28 June 1995
Singapore
Conference theme: Excellence in Global Services: Competitive Technologies
General Chair: Juzar Motiwalla, Institute of Systems Science, National University of Singapore, Heng Muikeng Terrace, Kent Ridge, Singapore 0511
Call for papers: Mail three copies of typed abstract (50 words non-technical) plus submission fee of US$100 to TIMS XXXIII - Singapore, TIMS, 290 Westminster Street, Providence RI 02903 USA, by 10 November 1994.
Selected full-length papers presented at the conference will be considered for publication in a special issue of the *Asia-Pacific Journal of O.R.*

1996 IFORS Conference in Vancouver, B.C.

Theme: Operational Research: Bridging the Theory and Practice of Decision Making
Venue: HYATT REGENCY
July 8-12, 1996
Chairman: Theodor J. Stewart, Department of Statistical Sciences, University of Cape Town, Private Bag, Rondebosch 7700, South Africa
Abstracts are due by October 1995

IFAC 95/IFIP/IFORS/SEDC
Symposium on Modelling and Control of National and Regional Economies

Gold Coast, Queensland, Australia
2-7 July 1995
Contact Elizabeth Hutchinson, Convention Manager (IFAC 95)
AE Conventions Pty Limited, PO Box E181, Queen Victoria Terrace, ACT 2600, Australia.

17th IFIP TC7 Conference on System Modelling and Optimization

Prague, Czech Republic,
10-14 July 1995
Secretariat: Institute of Information Theory and Automation,
Academy of Sciences of the Czech Republic, P.O.B. 18, Pod vodarenskou vezi 4, CZ-18208, Prague, Czech Republic.

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
P.O. 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*.

Individual members in Auckland, Wellington, Christchurch and overseas $45.00
Individual members in other areas $40.50
Student members † $15.00
Corporate members $150.00

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 _____

Name _____
(block letters please)

Address _____

_____

Telephone number _____ Occupation _____

Organisation _____

Special interest areas _____

_____

Payment enclosed _____ Please charge my VISA card _____

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* Current fees for 1995

† Student certification _____
(Signature of Instructor and Institution)