NEWSLETTER

September 1998

Operational Research Society of New Zealand (Inc.), PO Box 6544, Wellesley St. Auckland or PO Box 904, Wellington, New Zealand http://www.esc.auckland.ac.nz/Organisations/ORSNZ/

EDITORIAL

Of Wind, Writing, Weeds and Wellington

Many of you will know I moved from the cosy haven of the University of Canterbury, 40 years of friendships, 30 years of stable work environment, and 8 years as HOD - to the uncertainty of a new career, new friends (I hope!) and a new city. Most of my friends called it "a brave move after all these years"; was this a polite way of saying, "this guy is nuts"? I was gratified by the many statements of warm appreciation from friends and colleagues.

We are starting to become Wellingtonians. We were warned that many people actually like Wellington. I can now see why. The harbour and city have an appeal absent in Christchurch. There is a vibrancy which replaces the smug self-satisfaction of the southern city – which, of course I still love – and is still home!! (Or was it the complacent arrogance of the University that I allowed to colour my view of the city as a whole?) I enjoy working in the heart of the city – even if I now take 15 minutes rather than 5 minutes to get there. But can anyone tell us how to find reliable tradesmen? – and a thousand other little things we just knew how to get done in Christchurch.

And the wind…. It really *is* windy in Wellington. We have managed to find a house "sheltered" from the Southerly and "somewhat sheltered " from the Northerly. That means the house does not shake in the Southerly – the gale passes 10 metres in front of the house and shakes but does not actually rock on its concrete slab in the Northerly. My most memorable moment was walking down Lambton Quay in a northerly storm to find that even if I pressed hard against the shop window – under a wide veranda – I still got totally soaked by the fierce horizontal rain. Well – so it goes!

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Send submissions as word attachments by email to Production Manager, Tricia.Lapham@vuw.ac.nz

As a moderately keen gardener I thought I would still be able to practice my skills in another city – despite being warned otherwise. (At a local garden centre – we eventually discovered that such institutions *do* exist in Wellington – when we said we had come from Christchurch we got that "knowing" look and sigh ….!!) Now I have to learn about container gardening, hillside erosion and the local weeds. I have discovered "onion weed".

I thought Christchurch had pernicious weeds but nothing to compare with onion weed. This stuff has inundated my land with its tiny bulbs thickly matted together making growing space for any other plant impossible. Now here is the problem. Do I dig it out and risk erosion on the steep bank but make way for something more pleasant? Or do I leave it and live with its rampant invasion of what little garden I have? (Do any of you OR types have a suggestion about how to tackle onion weed?)

Now my serious comment to you OR teachers and students is this: the real world of OR is about writing – writing proposals to get work and writing reports to convince your clients that what you have done is good and worth their very real dollars. I have been staggered how much of my time is involved in these activities – far more than anything else. I value Canterbury's approach with its honours class – but I now believe it has not been tough enough. (Hans not tough enough – is that possible?) Project proposals are seriously important documents – without them a consultant starves. Similarly, with project reports. As an employer of OR practitioners we need people who are not only bright, motivated, and hard working but who are articulate. Practical OR is about convincing people they need our services (when they do) and convincing them of the value of the work we have done - as well as doing brilliant analysis.

Finally, let me concur with Hans' article about the value of the seemingly incidental observations and smart alternative solutions. We are about problem solving not technique implementation. So what do I do about my onion weed?

JOHN GEORGE

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For further information please contact: Dr Bob Cavana, Programme Director, School of Business and Public Management, Victoria University of Wellington, PO Box 600, Wellington. Tel: 04 495 5137 Fax: 04 495 5253 email: Bob.cavana@vuw.ac.nz or http://www.vuw.ac.nz/mgmt/courses/mms/

DON'T MISS OUT ON FRINGE BENEFITS OF AN OR PROJECT

In 1960 I attended a graduate seminar with Professor C. West Churchman at the University of California in Berkeley. It was simply entitled 'Operations Research'. In fact, it was the only graduate course in OR, except for the practical project. At that time, there was not the plethora of specialized courses in linear, nonlinear, large-scale mathematical programming, dynamic programming, networks, heuristic search, stochastic optimization, queueing theory, simulation, and so on. It is fair to say that the material covered in the two advanced undergraduate courses on linear programming and operations research techniques came close to what was known in OR at that time.

Those of us who expected that Churchman would transport us to the very edge of OR knowledge were initially disappointed. But our minds were quickly challenged by much more fundamental and philosophical issues: Systems concepts, ethical and professional principles of doing OR, the role of OR and its practitioners, implementation considerations. The two-foot long galley proofs of Churchman's not yet published book *Prediction and Optimal Decision* (Prentice-Hall, 1961) were our text. We were at the forefront of knowledge, but at a different and more fundamental facet. The technique aspect of OR was relegated to its proper place as mere tools, means to much bigger ends.

But I do not really want to reminisce on that aspect. What I want to share with you is a remark Churchman made in the first meeting of that seminar. He was giving us a brief overview of what we (note, not 'he', but 'we') were going to do over the coming 16 weeks. When he talked about systems and why OR needed to take a systems approach, he stressed that unless the analyst sees the problem in its full context, he or she may well do an elegant analytical job, but solve the wrong problem or solve it at the wrong level of resolution and detail. What he was referring to was what now-a-days goes under concepts of 'problems do not occur in isolation, but as part of a rich problem situation'. Then he chuckled and added: "And you may miss to discover the potential for real big savings that you can make at little or no cost." As anecdotal evidence he recounted the Cummings Engine inventory control study (reported in Churchman et al., *Introduction to Operations Research*, Wiley, 1957), where the analysis of the document and information flow revealed easily achievable, huge benefits in term of improving the overall operations of the firm.

What triggered this memory was a small episode in one of our current graduate students' practical research projects. One group is studying packing of various size cable drums into containers. As part of this, the two students not only studied the mathematical problem of container packing, but spent considerable time on the factory floor. They familiarized themselves with the production process and requirements of winding wire on the drums, and watched the stacking of drums of equal and different dimensions into containers. They discussed the process with the people doing it, questioning the 'hows' and 'whys'. For one particular container packed with equal size big-dimension drums, they noticed that the container could only be loaded to about 2/3 of its capacity. A third layer of drums would have exceeded the height dimensions of the container by about 4 cm. Tough luck! One of the students then asked the production supervisor if it were possible to reduce the diameter of the wooden drums by 2 cm, which would allow the container to be used to 100% capacity. A priori, there seemed to be no obstacle to this. In fact, most drums provide enough unfilled space to allow its rims to be reduced without risking transport and handling damage to the cable. It is clear that no container packing algorithm would have been able to achieve such an increase in capacity usage and the resulting decrease in shipping costs as this simple suggestion of fitting the drum sizes to the container dimensions.

I recall another similar event two or three years earlier. Another group was looking at a trim problem for a white-ware manufacturer who experienced off-cut losses on steel sheets of between 15 and 20%. The losses were particularly pronounced for certain sizes of steel sheets. Again, one of the students asked the production planner whether the company could not procure steel sheets that had more favourable dimensions for the sizes of patterns that needed to be cut. The answer was as expected: "No, these are the standard sizes available from our supplier." He also speculated that any other sizes would cost considerably more, and hence it would not be economically attractive to get them. The student did not give up that easily. He asked if the firm would allow them to inquire with the supplier at what cost other sizes could be procured. To their surprise, the supplier said that since that particular customer was one of their major ones, they would be willing to supply a range of other reasonable sizes. Further analysis indicated that getting a different mix of steel sheets would reduce trim losses by 10 to 15% even without any attempt at optimization, simply using the current cutting patterns. Further small reductions could be obtained by complex trim minimization models.

One of my first OR projects involved finding optimal production batch sizes for the manufacture of greases, produced in huge pressure mixers. The grease maker in charge of the operations only took one look at this green fellow right off the production line of the University of California and turned his back to me. "Greases could only be produced properly by filling these mixers completely," he declared with the authority of 30 years of experience. There went my project! However, as you know, I don't give up that easily either. Since the grease maker was not willing to talk to me, I talked to the engineers higher up. Their first answer was: "We don't know if the quality of the greases is affected when the mixer is completely full, but we will study it." A week later, they reported that as long as the mixers were filled to about 40% of capacity, it would not affect the mixing process. My project was back on track. Although the savings in this case were achieved by the use of OR techniques, that project would have died in its diapers, if I had not looked at the wider, richer picture.

These are just three examples of 'fringe benefits' that can be obtained from OR projects without even applying any OR techniques. They are a direct result of studying the problem in its full and rich context. Granted, it also means to keep an open mind, not be blinded by the beauty of OR techniques, but see beyond them, and give your creativity freedom for some lateral thinking.

I hear some of you mutter: "These are exceptional cases. Something was wrong with those people if they didn't see these simple remedies themselves." I disagree. They are not exceptional cases. They are there for you to find in many OR projects, provided you keep your mind open, look beyond the technical aspect of the problem. And why is it often the case that people intimately involved in these operations do not see such potential savings themselves? There are a number of reasons: Routine kills imagination; how often have I heard "we always did it that way!"; a fresh pair of eyes sees things differently; an operations researcher's curious mind asks the right questions. One of the basic rules for any operations researcher must be to always ask "Why?" and follow up the answer with another "Why?", not give up until a satisfactory explanation or reason for a given fact has been obtained. This is particularly important for constraints on decision choices, even if they seem of a physical nature.

So, don't miss out on the fringe benefits of doing OR! When you get older (and hopefully wiser), these are the ones that you will remember most fondly!

HANS G. DAELLENBACH, University of Canterbury, Christchurch

JAMDS

The Journal of Applied Mathematics and Decision Sciences (JAMDS) was launched on June 1997 with the aim of providing a platform for applied researchers at the local level and to serve as a vehicle for unifying otherwise disparate areas of research at the global level. An overview of the current mathematical literature clearly shows that the fields of classical applied mathematics, applied statistics and operations research are most often separated, ignoring the fact that the practical problems most often span all three fields. This is not to say that the JAMDS is not interested in research that only employs techniques from one field or problems that necessarily must be modeled as one type. In fact, these types of papers may give an opportunity for the readers to look at those problems from a new prospective.

When we started with the idea of creating JAMDS our focus was directed to New Zealand because of lack of locally produced operations research and applied mathematics journals. We proposed to create a journal that would appeal to practitioners as well as theoreticians with carefully reviewed articles, be inexpensively priced and be published rapidly. We have met all three goals so far and we will strive to do so in the future.

For more information check our Web site at: http://fims-www.massey.ac.nz/maths/jamds/

MAHYAR AMOUZEGAR, Managing Editor, JAMDS

CPLEX ILOG

Dr. GUO Lih Shiew

Hi, I am Lih Shiew from ILOG Singapore. I am in charge of CPLEX Marketing and Sales in Asia Pacific. I am going to be here talking to you in every issue, at least for the coming year.

You may wonder why I am here in a NZ OR newsletter. Well, my company wants to help to promote OR in this region as we believe that there is still tremendous potential for using OR in the industries and organizations in Asia Pacific which has so far been untapped. I found that although New Zealand OR Society is relatively small, it is very dynamic and I look forward to learning more about the ways you are using OR.

Let me tell you a little about what my company is doing. ILOG is a provider of advanced software component for graphics and resource optimization, in the form of C++ and Java libraries. Its optimization engine is based on constraint programming. ILOG and CPLEX merged in August last year. Many of you may have heard of CPLEX, a small company in a remote ski resort in the USA. The product, also called CPLEX, is the large-scale Mathematical Programming software for optimization. CPLEX provides the world's fastest, most robust LP, QP, and MIP algorithms, and has been used in many mission critical applications. Now ILOG offers a suite of optimization tools that includes Mathematical Programming and Constraint Programming. This gives great flexibility for solving complex real-life problems.

For those of you who are already CPLEX users, and those who hesitated because of their concern of remoteness of Incline Village, you will be glad to know that we are now supporting CPLEX from Singapore, a country in a similar time zone to yours. Please feel free to contact me if you have any queries.

I plan to use this column to bring you the latest news in our development, to discuss with you some technical issues and tips of using CPLEX, to describe to you some of our interesting applications developed using CPLEX and constraint programming. I am keen to have your suggestions about the topics that I should discuss in this column that would be of interest to you.

Product news:

CPLEX 6.0 was released on 1st May 1998. CPLEX 6.0 optimizers deliver major improvements in linear programming performance. Technological breakthroughs in both simplex and barrier algorithms have resulted in significant performance gains for large linear programming problems. On ILOG's internal test suite of large problems, CPLEX 6.0 outperformed CPLEX 5.0 by an average of 4.5 times, 2.3 times, and 3.6 times, respectively, for simplex, barrier, and barrier crossover algorithms. Several extremely large problems were solved over 40 times faster with CPLEX 6.0.

For more information, contact Dr. GUO Lih Shiew, email: guo@ilog.com.sg,
phone: (65) 773 0626 http://www.cplex.com http://www.ilog.com.sg

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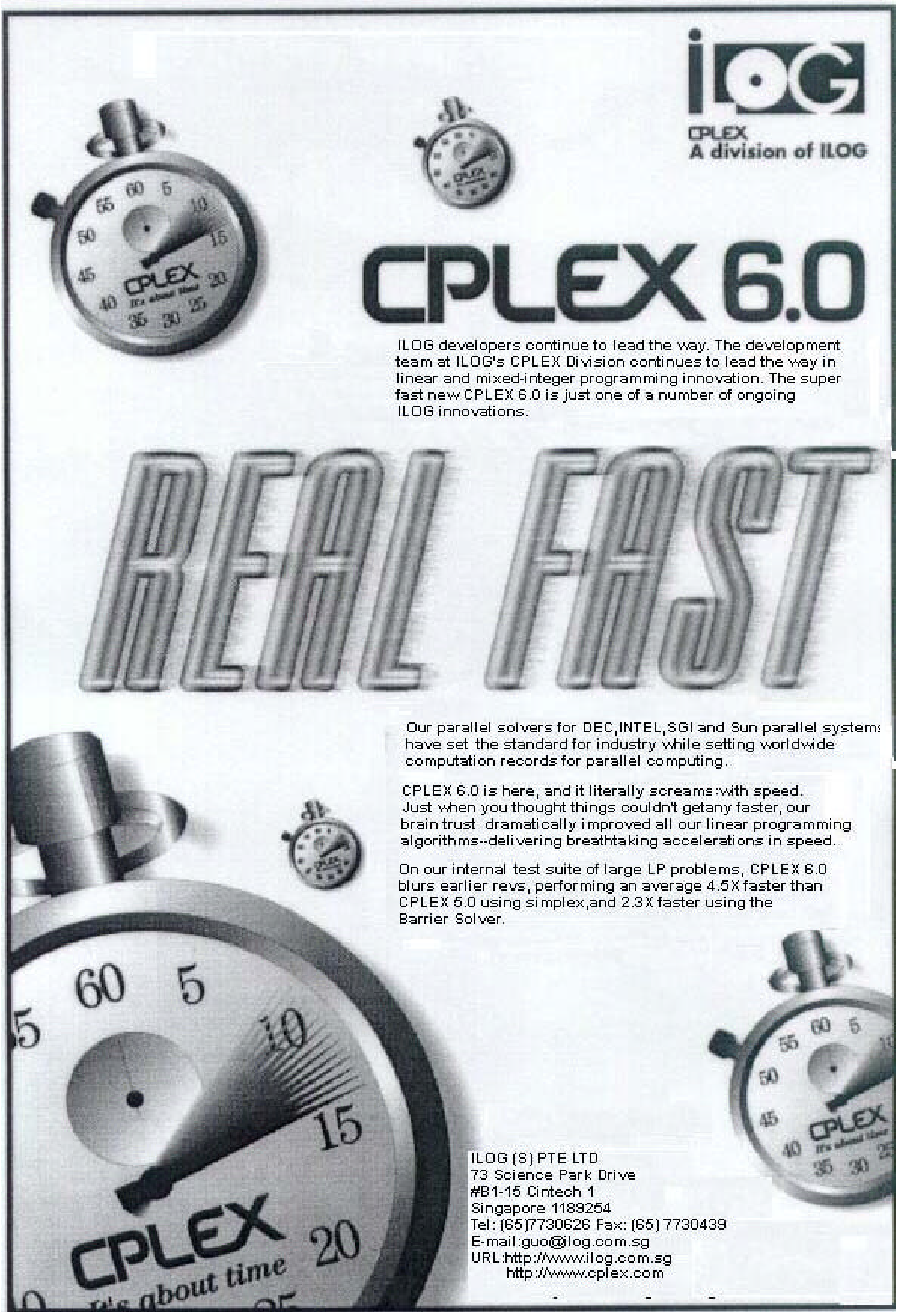
We are pleased to welcome ILOG to ORSNZ as a new corporate member. Many of you will know that ILOG and CPLEX merged and this company has a very real connection with much of the OR work going on in New Zealand. We look forward to regular contributions from ILOG to our newsletter and hope the distance between New Zealand and ILOG's offices in Singapore will not prevent ILOG staff from joining us for future activities.

ANDREW MASON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It's about time

USING ILOG SOLVER FOR COLUMN GENERATION: A SUCCESSFUL MARRIAGE OF CONSTRAINT PROGRAMMING AND LINEAR PROGRAMMING

Dr. AMAL DE SILVA, ILOG, Asia Pacific

Abstract:

This paper provides details of using constraint programming and Linear programming to successfully develop a Bus driver duty optimization system using column generation. ILOG solver is used for the generation of columns while CPLEX was used to solve the set partitioning LP.

Introduction

In recent years Column Generation (Barnhart et al. 1996) has gained popularity as a technique to solve complex optimization problems in transportation. Column generation is used quite commonly for crew scheduling in the transportation industry (Airplanes, Buses, and Trains). In these problems there are number of activities that start and end at a fixed time. For Aircrew scheduling, an activity represents a flight leg, while for bus scheduling, an activity represents a bus trip. The objective is to assign these activities to crews such that each crew member carries out a number of activities in sequence in manner that it satisfies all the work rules (for example the union rules) and the total cost is minimized. For example, in Aircrew scheduling the objective is to determine an optimal set of pairings. A pairing is a sequence of flight legs that start at a base and ends at a base (See Desrochers and Soumis (1988) and Vance et al. (1997) for details). Similarly, in Bus Crew scheduling, the objective is to develop duties that are a sequence of bus trips that start from a depot and end at a depot. Since we are optimizing bus duties, the terms used will be for Bus crew scheduling. However, the concepts can be applied to airline crew pairings as well.

Column generation is carried out in two phases. In Phase 1 the columns are generated. Each column will represent a legal duty. The constraints that apply to individual duties are considered. For example, there may be a constraint that a person can work only for 8 hours in a duty. In this case it is possible consider an individual duty and figure out that if it breaks this 8 hour rule or not. It is not necessary to consider the complete solution to determine the legality of an individual duty.

In Phase 2, all the columns are brought together to find a feasible and optimal solution to the problem. In phase 1, duties are generated ignoring the requirement that each bus trip has to be covered by only one duty. Thus, this constraint has to be enforced in phase 2. This usually done by using the set partitioning formulation as:

$$\min \quad cx$$

$$s.t$$

$$A\underline{x} = 1$$

$$\underline{x} \text{ is binary}$$

A is a matrix where each row represents a piece of work (bus trip, flight leg). Each column (each element of vector $\underline{x}$) represents a feasible duty. Column j has $a_{i,j} = 1$ if duty j goes through trip i and 0 otherwise.

Also other constraints that apply to the whole solution have to be enforced in this phase. For example, a constraint might require that the total number of duties that start from a given depot have to be less than a given value. This constraint applies to the complete solution and it is not possible to consider an individual duty and conclude whether a duty satisfies the constraint or not. In this case, the constraint has to expressed as a Linear Programming constraint.

One major advantage of this model is that complex constraints that occur in real world crew scheduling problems can be accommodated easily. Columns in crew-scheduling systems for the transportation industry have complex non-linear constraints that cannot be easily included in an LP/MIP formulation. In a column generation framework it is easier to consider them as they have be enforced in the generation phase. That is, only columns that satisfy all the constraints (that apply to individual duties) are generated.

The major drawback of this model is that the number of feasible duties run into millions or billions and it is not possible to generate all possible columns. Column generation handles this by implicitly considering all the columns. As x is binary, the formulation given above need to be solved using the branch and bound algorithm.

However, let us first consider the solution of the relaxed Linear Program. The basic column generation algorithm to solve the relaxed LP is as follows:

1. Generate a reasonable number of columns.
2. Solve the relaxed LP
3. Generate columns that price out, using dual values from the solution of relaxed LP. That is, for minimization problems, columns that have negative reduced cost. The reduced cost of a column is given by :

   $$c_j - \underline{p} \cdot \underline{a}_j$$

   Where, c_j is the cost of duty j, while $\underline{p}$ is the row vector of dual variables of the optimal dual solution in of current relaxed solution and $\underline{a}_j$ is column associated with duty j. If there are no columns that price out (has negative reduced cost) then the current solution is optimal. Thus, stop the algorithm.

4. Go to step 2.

Theoretically, it is possible to add only one column in step 3, but in practice, it may be better to add as many columns as possible.

In this paper we will discuss how ILOG Solver can be used to increase the efficiency of the generation of columns.

Using ILOG Solver for the Generation of columns

A great deal of research has been carried out in solving large set partitioning Linear Programs (Phase 2) (Hoffman and Padberg (1993)). However, less attention has been paid to the generation of columns (Phase 1), although from the author’s experience this can constitute up to 80% of the computation time. The reason for this is possibly because Phase 1 has to deal with complex real world constraints that cannot be easily expressed as LP constraints and these constraints differ from one application to another.

Currently there are two techniques to carry out the generation of columns:

(1) Simple backtracking method. In this method, duties are generated by adding trips and then checking for legality. If it the duty becomes illegal after adding a new trip then this trip is removed from the duty and another trip is added. If the duty can still provide a legal duty, this trip is kept in the duty and a another trip is added. If by adding a trip the duty becomes legal, then the duty is stored and the algorithm continues. This algorithm will provide all the legal duties as it does an exhaustive search. Also in the column generation scheme, if the reduced cost of final column is not negative then it is thrown away. However, since it backtracks each time a trip added to duty triggers a failure, it is generally inefficient. As the complete enumeration of all legal duties would be time consuming, various heuristics have been developed to manage this phase.

Multilabel Shortest Path algorithm: In this method a network is build such that a node represents a trip. If its possible for a duty have trip B after trip A then an arc between the nodes for Trip A and B is added. Thus, a path from a starting Node (a trip that can start a duty) and an ending node (A trip that can end a duty) will be a duty. Labels are kept in this network to store the state of the duty with respect to various constraints. The reader is referred to (Vance et al. (1997)) for more details of the algorithm. This algorithm is complex and it generally has to be used in conjunction with a backtracking algorithm. It is also difficult, if not impossible to implement complex constraints with this technique with out backtracking.

In this project, ILOG Solver was used for the column generation. ILOG Solver is a C++ constraint-programming library. It provides the primitives for declaring decision variables, stating constraints and solving the resulting problem. ILOG Solver's design is based on the following principles

- Problem models are separated from the search algorithms
- All constraints collaborate together to compute solutions
- The user can change the search strategy to generate the targeted solutions

A powerful feature of ILOG Solver is domain reduction through propagation. For each decision variable in ILOG Solver the domain of the feasible values are stored. ILOG Solver reduces the domains on-the fly and thus rapidly reduces the combinatorial explosion and avoids significant computational loads. When you reduce the domain of a decision variable, you refine the information known about this decision variable. ILOG Solver uses this information to deduce new information about the remaining decision variables. This is called propagation.

The advantage of using constraint programming for column generation is propagation. As trips are added to a duty, that is, as elements of the duty are instantiated, the domain of the other elements of the duty is reduced. For example, if the first element of the duty is instantiated to Trip A and Trip A can only connect to Trip B then the domain of the second element is reduced to Trip B. This effect will ripple through. Thus, the propagation will reduce the amount of backtracking required and can make the search algorithm significantly more efficient.

The other advantage of ILOG Solver is that it is very easy to add constraints to the algorithm. Hard coding the constraints can be time consuming and thus not suitable for developing systems in an industrial setting.

In this project, an expression for the reduced cost of a column, using the dual variables from the relaxed LP solved previously, was built and then a constraint was posted that required that all columns generated should have negative reduced cost. Thus, this ensures that the columns generated always had a negative reduced cost.

As the optimal of the relaxed LP can be fractional (that is, the value of x can be fractional), it was necessary to carry out a branch and bound to obtain the optimal integer solution. As the standard branching technique is inefficient in this framework, the branching rule developed by Ryan and Foster (see Vance et 1997, for more details) was used here. In this method, the branching was carried out by selecting two trips on fractional column and then requiring that the two trips should always be together in one branch. And in the other branch the restriction is that these two trips cannot be together. This type of constraints can be easily posted in ILOG Solver.

Conclusion

From this project, it is apparent that the combination of constraint programming and linear programming provide a powerful tool for rapidly building complex crew scheduling systems. In the development of software for the industry, the developers generally face tight deadlines. In such situations, tools like ILOG Solver and CPLEX provide the ability to rapidly prototype and develop applications.

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INTERVIEW: PROFESSOR MICHAEL A. SAUNDERS

Andrew B. Philpott, Department of Engineering Science, University of Auckland
August 1998

Mike Saunders is visiting the University of Auckland during the second semester of 1998. He is teaching the Engineering Science master's course on optimization, and is a keynote speaker at the ORSNZ annual conference. Mike is a Research Professor at SOL (the Systems Optimization Laboratory, Department of EESOR, Stanford University, California). Like his coauthor Bruce Murtagh, Mike grew up in Christchurch and worked several years in Wellington. He received his PhD in Computer Science at Stanford in 1972 while on leave from the DSIR. He is known for his work on large-scale optimization and for his contributions to sparse-matrix methodology. In 1985 he was awarded the Orchard-Hays Prize by the Mathematical Programming Society for excellence in computational mathematical programming.

ABP: *Who or what inspired you to pursue a career in optimization?*

MAS: I imagine that everyone derives satisfaction from watching an iterative method proceed, as long as there's just one line of output per iteration (so you can see what's happening!), and provided a magic number in each line is decreasing steadily. Another dollar saved, another tree spared---we feel a certain joy if we can minimize cost while meeting all relevant needs. Conversely, such output is quite dismaying if the magic number starts wobbling around interminably! Some theory must be lacking, or we're up against an unstable method.

My interest in optimization was sparked by Tony Vignaux at the DSIR Applied Maths Division (though we knew alarmingly little about stability in 1966). At Stanford, numerical analysis was a significant part of computer science (as it still should be!) and Gene Golub was trying to interest OR people in reliable ways to implement the simplex method. Gene taught me about updating matrix factorizations (LU, QR, Cholesky)---the heart of numerical optimization and much else.

A defining moment came in 1970 when Gene arranged for me to visit the National Physical Laboratory in London, where Philip Gill and Walter Murray were busy with their own novel approach to optimization. Stability was a key aim, and tennis proved to be important after work. Our hearts were clearly in the same place! (Oddly, we weren't allowed to use the Lab's courts during lunchtime. Everyone respected the tranquility of the director's neighbouring backyard!)

Stability is a noble aim, but something was missing. Nobody would care about reliable methods unless we could make them work efficiently on large problems. At Stanford I decided to work on a large-scale version of the Gill/Murray approach to the simplex method, based on sparse Cholesky-type factorizations $BB' = LL'$, where $A = (B\ N)$ as usual. Some new updating methods came to light and my interest was awakened in sparse matrices. However, we finally realised it was not the way to do simplex.

Little did we know that years later, Narendra Karmarkar would use sparse Cholesky for linear programming in a far more effective way. We had not been "silly enough" to form BB' explicitly, but here he was forming and factorizing all of AA'. (Perhaps numerical analysis should be abolished after all!)

ABP: *Bruce Murtagh and you developed MINOS together in the 70s. Was there a motivating practical problem? How did you come up with the acronym?*

MAS: Bruce is another important fellow whom I met through Gene. He had just finished his chemical engineering degree at Imperial College, where he and Roger Sargent definitely had practical problems. Chemical equilibrium? Process control? Not necessarily large, but Bruce must have been looking ahead.

In Wellington we wanted to apply sparse simplex techniques to problems with nonlinear objective functions. Quadratic programs are a special case. A young fellow named Andy was a student at Vic then, and his dad Bryan Philpott must have been looking ahead also---he wanted Andy to help us solve an economic model that was formulated as a large quadratic program. I clearly remember this large QP as a motivating influence.

In 1975 I returned to Stanford for two years. SOL had just been formed by Dantzig and Cottle with funding from the Navy and the Dept of Energy. The DOE computing facilities made coding easier, and soon we had to think of a name. Thumbing through an old Webster's dictionary for words containing N and O, I found only one reasonable choice. The pronunciation was allegedly "MY-NOS", but years later I found that Webster's was wrong---the Greeks would say "MIN-OS" (much better for a minimizer).

Alan Manne was in the OR department and like your dad was building nonlinear economic models before solvers existed. To this day, Alan's models have provided strong motivation and excellent test problems.

ABP: *At Stanford, you worked closely with Philip Gill, Walter Murray and Margaret Wright. What special feature of that collaboration made it so successful?*

MAS: That was 1979--1988. The simple answer is that Philip and Margaret are incredibly hard workers, with a vision of what can be achieved. Walter had a way of attracting exceptional students and he too guided us in good directions. We all knew that the theory would evolve better if properly implemented, and that good numerical methods are needed in any scientific software for public consumption (though we have failed to awaken the optimization department of Microsoft Excel!).

At times we were criticized for writing so many papers together, but we know that every one of them was the better for it. At promotion time, coauthorship should be seen as a plus! Far better that papers be raised to new levels by motivated colleagues (to spare the referees).

Not all was plain sailing early on. By 1979 Bruce had implemented a prototype to handle nonlinear constraints, and we worked hard to create MINOS/AUGMENTED while our colleagues slaved over their masterpiece "Practical Optimization". Subsequently I redesigned everything to produce MINOS 5.0, but the continuing years of effort were at great expense to my role in the "Gang of Four" (as the SOL group came to be known). To this day I wish that Bruce had shared the Orchard-Hays prize for his great initiatives earlier, but I think this is how it went.

Meanwhile, Philip was pouring his life into NPSOL, the dense SQP solver that has proved to be so reliable (notably within the NAG Library and the OTIS optimal trajectory system). We had many other projects under way, but Philip was definitely another unsung hero when the lack of faculty positions forced him and Margaret to depart for more secure employment. The saving grace in all this is that Philip has since raised the MINOS design and NPSOL reliability to a splendid new level in the form of SNOPT (our new sparse SQP solver).

ABP: *MINOS has been very widely used as a linear and nonlinear programming system. Why has it eclipsed the others in terms of number of users?*

MAS: Perhaps because it regarded nonlinear problems as an extension of LPs, and because we strove to make the Fortran code portable. VAXes were spreading fast! Arne Drud's CONOPT fits the same description, but number-wise it helps that MINOS is the default solver in the student versions of both GAMS and AMPL! The latter systems have been a tremendous factor in putting optimization to work. MINOS, CONOPT and LANCELOT complement each other nicely as alternative solvers. Arne has been very noble in helping us link GAMS to SNOPT (which probably should become the new default solver).

ABP: *In the late 80s when interior methods were all the rage, Don Goldfarb suggested a Society for the Prevention of Cruelty to MINOS. Did it bother you that so many IP codes were benchmarked against what was never designed to be a dedicated LP code?*

MAS: I guess there were a few depressing moments when the improvement factors were 50 or 100! I always wanted MINOS to be good at LP as well as nonlinear problems, so it was hard to give convincing excuses. There have to be benchmarks somewhere. There's satisfaction in knowing that MINOS is portable and generally reliable for such occasions. Its sparse LU routines (with Bartels-Golub updating!) give stability for linear and nonlinear problems alike. The same is true for SNOPT, which will be no faster for LPs but will converge more reliably when there are nonlinear constraints.

ABP: *The debate of simplex versus interior methods has died down. Who won the contest?*

MAS: As we know, both approaches have advanced remarkably and they work side-by-side in commercial systems. It took us a while to believe this would happen! The three issues are storage, time per iteration, and number of (very different) iterations. Simplex is surely best for restarting slightly modified problems (e.g., within branch-and-bound), but for cold starts it may need millions of iterations on truly large problems. Interior methods need incredibly few iterations almost regardless of problem size. In many applications, Karmarkar's vision has proved right: the factorization $AA' = LL'$ is sufficiently stable and sparse to emerge way ahead.

Of course there are times when L is hopelessly dense. I have spent much of the last decade seeking alternative ways to solve the same system of equations (purely a sparse-matrix question). Sometimes we can factorize a much larger "KKT" system, as in Bob Vanderbei's LOQO. I have helped John Tomlin implement a more stable form of this for IBM's OSL. If A is enormous and dense (as in signal analysis), conjugate-gradient methods are the only option. This interest is partly why I haven't managed to update MINOS more regularly. (I still wish we could pursue the convergence theory for MINOS with nonlinear constraints, even though SNOPT fills the void at last.)

ABP: *Applications involving nonlinear programming have become very widespread. What single factor has contributed most to this growth?*

MAS: As mentioned, GAMS and AMPL have played a major role (especially for economics modeling and OR models in general, where the nonlinearities are algebraic functions). If you check the Web pages or receive email from the GAMS-L listserver, you'll find a vibrant discussion of modeling techniques and useful auxiliary software. Fortunately there is more on "How do I formulate my model" than "What's wrong with the solver"! Though the latter certainly occurs.

Semidefinite Optimization seems to be another leap forward. At Stanford, Stephen Boyd and Lieven Vandenberghe have collected a remarkable array of engineering applications that fit the SDO framework.

ABP: *Some might say in the late 90s that nonlinear programming has run its course. What new challenges do you see in the subject?*

MAS: I'm sure you feel as I do that optimization is increasingly relevant, not less so. CFD people have learned how to compute cheaper gradients for optimizing aircraft (and yacht!) design. Exact second derivatives are increasingly available from the algebraic languages, and interior methods may be the best way to use them (requiring new theory for nonconvex problems). Combinatorial problems and stochastic LPs are being tackled by SDO, so new implementation methods are needed for large cases.

"Planning Under Uncertainty" is the George Dantzig/Gerd Infanger name for stochastic programming, and it's what most companies and governments really want from optimization. From the recent Vancouver meeting you know that the field is flourishing. Stochastic additions to the modeling languages will help linear and nonlinear models alike. And it's marvellous news that plans are under way to create George and Gerd's dream of the 90s: an Institute for Planning Under Uncertainty.

ABP: *Anything else for the future? How are we looking in NZ?*

MAS: Well, it's wonderful to be back here with friends in a department where OR is put to work so well. To give a personal perspective, I feel lucky to have a VMS system on my desk (the same as at Stanford) while PC and Mac software is crashing all around me. Knowing that DEC machines run for a year on end ("non-numerical stability"), we can only feel dismay at their demise. In past visits to New Zealand I did my best to promote reliable Optimal Power Flow software (a tiny part of a full Energy Control System). I believe that OPF is now implemented within Transpower's control centres, by a company with at least one virtue: they use DEC systems! Perhaps it's a far cry from reliable computer hardware and software to the Auckland blackout, but with Microsoft taking over (and SOL's funding very scarce), I can't suppress my sense of unease.

It's a much brighter fact that FRST is awarding 5-year grants to trusty people like your group here. Keep up the great work! We'll help down in the engine room as best we can.

MATHEMATICS IN NEW ZEALAND: PAST, PRESENT AND FUTURE

On July 14, 1998, Dr James Buwalda, the Chief Executive of the Ministry of Research Science and Technology approved the general release of the report "Mathematics in New Zealand: Past, Present and Future", commissioned by MRST in June 1997. The compilation of this report has taken over a year, and has been a major undertaking by the mathematical sciences community of New Zealand. As President of ORSNZ, I have participated in the preparation of the report by providing a point of view from the perspective of OR/MS. Although it is not hard to find one or two omissions or inaccurate generalisations in the report, it is gratifying to see the positive picture that it paints of OR/MS in New Zealand, and the opportunities which exist for its application. (One of the recommendations of the executive summary is for government support of the promotion of OR/MS.)

Inasmuch as mathematics underpins much activity in Operations Research and Management Science, members of ORSNZ should take the opportunity of reading the report. The executive summary is reproduced below. The full text of the report is available on the web site http://www.mcs.vuw.ac.nz/~edith/front.html

Executive Summary

1. This report presents a foresight perspective on mathematics in New Zealand. It describes the potential role of mathematics in our future knowledge-based society, notes current trends in mathematics, and outlines opportunities for strengthening the role of mathematics in New Zealand. The report also provides information about the current state of the mathematical sciences in New Zealand, both outside and inside the educational institutions, their contributions to the economy, and the factors likely to affect their role in the future.

2. The most important role of mathematics is in underpinning almost all activities in a modern society. It operates at many levels and extends across all socio-economic sectors.

3. Within a knowledge-based society, one would expect to find a high general level of quantitative literacy; care for data quality and integrity in both public and private sectors; adequate mathematical expertise available for proper advice and interpretation of quantitative software, and the development, interpretation, and application of quantitative models; recognition that proper uses of computer software and packages for complex or high-consequence analyses requires sound professional knowledge of mathematics and statistics; an active core of research mathematicians linking universities, research organisations and research sections of large companies and industries; a strong professional role for mathematical scientists; effective use of quantitative techniques in policy analysis and decision-making; school and university programmes which supported and enhanced the development of quantitative and logical skills.

4. Within New Zealand, the mathematical sciences directly underpin a significant proportion (often over 50%) of total business, industry and government activity; have been major contributors to research, particularly in the agricultural sector, worth many billions of dollars to New Zealand's annual income; continue to provide direct contributions of many millions of dollars through profits or savings achieved by operations research and related methods; are vital to continued efforts to model, monitor, and forecast environment, climate, population, and many other variables of basic economic importance; are generally undervalued and underutilised in New Zealand business and government; face peculiar difficulties in their adoption by small scale business and industry; underpin all socioeconomic sectors and so are not easily placed in any one sector.

5. On the basis of current trends the future is likely to show a continued role for mathematics as an underpinning science; computing power as an essential component of mathematics research; an increased demand for statistical skills, including operations research, and process and quality control; continued and increased demand for mathematical modelling applications and research; an increased professionalisation of mathematics, especially statistics; significant impacts arising from advances in technological data management, including acquisition, coding, storage, retrieval, interrogation, and analysis of large data sets.

6. Within universities, current trends for mathematics suggest the future is likely to see: development of specialised research areas, research institutes and study groups; closer links with international researchers by

electronic communication; strengthening of the computing component in both undergraduate and graduate mathematics courses; closer links with computer science departments and quantitative groups in commerce; collaboration with user departments to extend the quantitative training given to students outside the mathematical sciences beyond first year service courses.

7. The mathematical sciences outside the universities currently face the following difficulties: most individual research groups are now below the critical mass required for effective operation, particularly in regard to library facilities and "apprenticeship training" for young graduates; there is no natural funding route for methodological research in the present sector-oriented structure; the mathematical component underpinning FRST proposals is liable to be underestimated, inadequately reviewed, or treated as expendable if budget cuts are required; overall, the reduction in the number of mathematical scientists employed outside the universities is near the stage where it brings into question New Zealand's capacity to undertake effective applied mathematical research (including statistics and operations research);

8. Difficulties faced by the mathematical sciences within the universities include departments are inadequately resourced (especially for computer-intensive methods), precariously dependent on large introductory service courses to maintain staff numbers, over-weighted towards the upper age brackets, and thinly spread over a wide range of research areas and special fields; apart from first-year courses, current student enrolments are not high, with a perception that career prospects in the mathematical sciences are limited; opportunities for research grants are largely limited to the Marsden Fund, which is intensively competitive, and particularly difficult to access by younger staff without established track records; heavy teaching loads and internal bureaucracy limit opportunities for consulting and contract research activities which would allow staff's expertise to be made more widely available.

9. Despite a tradition of innovation and some outstanding individual teachers, mathematics also faces serious problems within the schools and polytechnics. Some of the main difficulties are within the secondary schools, there is an acute shortage of well-qualified mathematics teachers, a situation that has persisted for decades and effects students' perceptions of mathematics;< within the primary schools, there is a shortage of teachers with sufficient depth of mathematics training to act as advisors and support persons for their colleagues; school teachers at all levels are under stress from repeated restructuring, excessive emphasis on assessment, and delays and uncertainties in the implementation of new curriculum and examination structures; within the polytechnics, the quantitative subjects also face declining enrolments and inadequate resourcing; existing programmes are often outdated, and there is continuing pressure to reduce the quantitative component in trade-related courses. Teachers have little time to address these problems, or to develop personal research programmes.

10. To deal with these issues, the review team suggests the development of a national strategy for the mathematical sciences. Different aspects would need to be tackled in a coordinated manner by MoRST, by the universities and polytechnics, by the discipline groups and associated professional associations, and by the schools and Ministry of Education.

11. The Ministry of Research, Science and Technology might consider sponsoring a follow-up report to identify, within each socio-economic sector, major research tasks requiring a significant component of quantitative analysis; assisting the discipline groups and the CRI's in developing organisational structures, whether in the form of inter-institutional centres or otherwise, to strengthen the role of the mathematical sciences within the CRI's, and prevent the continued erosion of New Zealand's applied mathematics capacity; promoting the use of operations research and statistics within New Zealand industry, and especially exploring ways of bringing some of the benefits of such methods to small scale enterprises; working with FRST to examine possibilities of addressing the concerns of mathematical scientists over the operation of the current funding regime. Initial suggestions are a.improved quality control over the mathematical components of PGSF bids; b.development of a new output class for "underpinning methodology"; c.funding mathematical services from overheads; d.in appropriate cases expanding the allocation for mathematical science in the Marsden Fund.

12.The university departments in the mathematical sciences should consider broadening the focus of their activities to include closer links with external research organisations and a greater role for consulting and contract research; extending the service teaching role beyond introductory first-year courses, and investigating opportunities for joint appointments with user departments; encouraging inter-university and inter-institutional research programmes, including the possibility of setting up specialised research centres; rationalising the research and graduate programmes between the universities, to allow for greater specialisation and concentration of expertise in particular institutions.

13. Support should be given to the efforts of university and polytechnic mathematics departments to secure greater resources for teaching and research in computer-intensive aspects of the mathematical sciences.
14. The discipline groups and professional associations should consider ways of strengthening the professional role of the mathematical sciences, through encouraging their members to offer advisory and consultancy services; establishing professional guidelines and codes of conduct for their members; publishing lists of qualified associates or consulting firms who may be contacted for professional advice in different mathematical fields, including especially statistics and operations research.

15. The university departments in the mathematical sciences, the associated discipline groups and professional associations, and MoRST, should examine ways of cooperating with the Ministry of Education to combat continuing difficulties in the school mathematics programme, especially the chronic shortage of qualified mathematics teachers at all levels.

ANDREW PHILPOTT, University of Auckland

NEWS FROM AUCKLAND

Early in the year we farewelled Golbon Zakeri, who has taken up a position in the Mathematics and Computer Science group of the Argonne National Laboratory in Chicago. As well as continuing her research in stochastic programming, Golbon will be working on the Meta-NEOS project, an initiative set up to solve large optimisation problems in parallel by distributing pieces of them to idle computers via the internet. We wish her well.

Also departing Auckland for overseas was Megan Thornley, the ORSNZ acting secretary. In her place the Council have appointed Diane Bischak, of the MSIS department at Auckland. Nominations for elections to all Council positions are expected for the 1998 AGM which to be held at the conference on August 31.

Visitors to the Engineering Science Department this semester include Professor Michael Saunders from the Department of Engineering and Economic Systems and Operations Research at Stanford, and Professor Azim Houshyar from the University of Western Michigan.

Andy Philpott returned from leave in Sydney, where he had been working with John Kaye and Eddie Anderson on electricity markets, only to leave again after only three week's teaching for a week's "holiday" at the Stochastic Programming Symposium in Vancouver.

The Department of Engineering Science is currently seeking to appoint two people in OR. The first position is a lecturing position, and the second is a FRST postdoctoral fellowship. Formal advertisements will appear in the next month; in the meantime interested persons should contact Dave Ryan at d.ryan@auckland.ac.nz.

The lead up to the ORSNZ conference in Auckland has seen a frenzy of activity as the organizing committee, running smoothly like a well-oiled machine, give a lie to the conjecture that Management Scientists are the most disorganized profession. This promises to be an excellent conference with a full complement of good papers. This is the first year that the Conference Proceedings Volume is disseminated to all in the Society, and with a bound of 10 pages per paper, we expect this to represent excellent value.

ANDREW MASON, University of Auckland

WAIKATO BRANCH

John Buchanan and Jim Corner recently returned from the INFORMS Israel Conference which was held in Tel Aviv from 28 June to 01 July. There were about 600 attendees and a high quality of presentations. John and Jim stayed on to continue some research with Professor Mordecai Henig on problem structuring in decision making. This is also the topic for the thesis of one of our doctoral students, Stuart Dillon. The weather in Tel Aviv was almost the same each day and it became, among locals especially, a cause for celebration if for one day the temperature dropped 2 degrees to around 30 degrees [C]. In fact, it is only more recently that the summer weather forecast has been included in the Israeli TV news - there has been little point since it is always the same. A far cry, perhaps, from a South African newspaper which made this statement some years ago, "Since weather conditions are becoming increasingly unpredictable, you should be sure to obtain a weather forecast before setting out." There are similarities, however - in both this case and that of the Tel Aviv weather - forecasts are unnecessary or useless, yet there remains an (almost superstitious) craving for prediction. Astrological "forecasts" or horoscopes exemplify the individual demand. Arie de Geus in the Living Company (Harvard Business Press, 1997) observes that managers often use forecasting as the basis of planning - that is, reducing uncertainty through prediction. Consequently, the future is viewed in a fatalistic way, as a given. Instead, de Geus argues, one should seek to anticipate possible futures and prepare for them. Here it is the concept of being prepared which is the issue; that of being mentally prepared for different futures. Thus with respect to the South African weather situation, one would ignore the forecasts and take an umbrella everywhere. And in Tel Aviv, just put on a clean short sleeved shirt and go and face the day. John also took a three day trip through Jordan - so if you want any information about renting cars in Jordan, walking across borders or applying multi-objective shortest route problems (maximize sights while minimizing stress and distance), he will be glad to help.

A recent book by Edward Tenner, “Why Things Bite Back - Technology and the Revenge Effect”, discusses systems thinking from the journalistic perspective of “bite back.” Everything that we do has an effect - perhaps it will take a long will to bite us, or maybe the next generation is affected. Sometimes the bite back is positive, but this is usually not the case. One nice example provided by Tenner is of the use of home alarms. This is a good idea, improve security and reduce crime. Date from the state of Philadelphia shows that of 157,000 home alarm call outs, only 3,000 were genuine. The others were false alarms, diverting the equivalent of 58 full-time police officers from the very purpose that the home alarms were originally put in for - that of preventing crime. Hans Daellenbach discusses some other nice examples in his 1994 book, “Systems and Decision Making” (Chapter 2).

Jim Corner is working very hard since his co-chairperson, John Buchanan, has just begun sabbatical leave. John Scott continues his work on Modelling in Sport and maybe next issue he will fill in some of the details. Les Foulds and Chuda Basnet uphold the Operations Management arm of our departmental activities.

JOHN BUCHANAN, Waikato University

MAINLAND NEWS

In the Mainland the tide has turned on the number of Management Science staff manning the fort with the arrival of several new appointees and the return of others from study leave.

On June 1st we welcomed the arrival of Shane Dye in the department. Shane will be lecturing in the mathematical programming courses. Shane obtained his PhD from Massey University under John Giffin. His thesis looked at hydro-thermal electricity generation modelling in New Zealand After completing his PhD, Shane worked for the last three years as a postdoctoral researcher at the Norwegian University of Science and Technology in Trondheim. His research work there involved looking at intelligent telecommunication service provision using stochastic programming. Shane can be contacted at s.dye@mang.canterbury.ac.nz.

Also in June, Don McNickle returned back from 12 months study leave at Brown University in Providence, R.I. U.S.A. He writes: "During my leave I went to the INFORMS meetings at Dallas and at Montreal. Dallas was a little disappointing - most of the interesting papers in my area (queueing theory) had been poached by an Applied Probability conference in Boston a few weeks before. The turnout at Montreal was much better, with something like fifteen sessions of direct interest to me. This problem of people now wanting more specialised conferences was raised at the Membership Meeting at Montreal. INFORMS intends to change the format of the meetings to one general meeting per year, along with a much more tightly focused specialist conference which they also hope will attract people from industry. (Although attendance at INFORMS conferences has remained pretty constant over the years, almost all the attendees now come from academia)".

"Generally what I found most interesting was to watch the U.S. economy recover and pick up speed (at least until I left Providence in June!) About November last year "Staff Wanted" signs started appearing in the windows of all of the fast food outlets - their managers knew that their existing staff would be the first to move up to better jobs as they became available. By February about half the stores in our local mall had similar signs. Unemployment in Rhode Island (previously a rather depressed rust-belt state) had dropped to below 4% for the first time since the 1970's. All this without much government intervention."

Don takes over as Head of the Department of Management from Hans Daellenbach on 1st October.

With the impending retirement of Hans on 31st January some of you will have also noticed we are now advertising for a chair in Management Science. Applications close at the end of October for this position.

At the University level, the new Vice Chancellor, Professor Le Grew, took over the reins from 1st July. We now wait to see what changes he will bring....

ROSS JAMES, University of Canterbury

NEWS FROM VICTORIA, School of Business & Public Management, Decision Sciences Group

Visiting us this August was Professor Hervè Mathe. Hervè (pronounced Errrrvay Mat, if you have a French accent) has joint positions at the University of Lausanne, where he is chairman of the Faculty of Management, and ESSEC in Paris, where he is Head of the Department of Production Management. Herve was here for a month and was teaching Operations & Services Management in the DBA and CertMS all through August. He has held visiting positions at Harvard, Wharton, Cranfield and Bocconi and now Victoria! He has a PhD in Tech Management from Cranfield and doctorates in Management Science and Political Science from the Uni de Paris and the Institute for Political Studies in Paris. He has published extensively, writing in English, French and German. He's enjoyed our winter - getting sunburnt in the Wellington sunshine, I might say. We hope he'll return same time next year.

John Davies and I are off to the UK after the ORSNZ conference to the 40th Annual Conference of the UK OR Society. We will be presenting papers in the inaugural "OR Downunder" stream being organised by Miles Nicholls whom some of you will have met at APORS last year. The OR40 conference is being chaired by Professor Alan Mercer, long-standing Professor in OR at Lancaster, who is retiring this year. Alan supervised John's MA Project and my PhD thesis, so we are both attending his retirement dinner. We were interested to read the following note that appeared in the Skein newsletter, (Lancaster Management School's newsletter.)

Alan Mercer's attention was recently drawn to a paper entitled "Survival in Dynamic Environments", published in 1995 in Statistical Science by N.D. Singpurwalla, who is totally unknown to Alan. The papers contains the following two sentences.

"It appears that Mercer (1961) may have been the first to consider the idea of describing item state by a stochastic process, and Gaver (1963) the first to propose modelling the item failure rate as such. Failure models based on covariate processes also appear to have been first envisioned by Mercer (1961) in his remarkably far-sighted paper".

If recognition of Alan's recent publications in marketing and logistics is as long in coming, then it will be posthumous, which is a very sobering thought!

Michelle Baron popped home in July to California to see family and friends, and is back refreshed and into second trimester teaching. She will be attending INFORM and DSI conferences later this year.

Bob Cavana went to the International Systems Dynamics conference in Quebec at the start of this month. This conference is being held here in Wellington next year. We hope many of you will attend that.

20 students started our Master of Management Studies programme this year, 16 on the Technology side and 4 doing the Decision Sciences specialisation. One of the projects from our 2nd year MMS students is being presented at this year's OR conference, and hopefully there'll be more in years to come.

We too, have a new VC – perhaps it's catching: you other Uni's had better watch out!

That's it for now.

VICKY MABIN, Victoria University of Wellington

A SIMULATION GAME FOR TEACHING MATERIAL REQUIREMENTS PLANNING

Simulation games are activities designed to mimic the reality of the external world, within the classroom, with the goal of instruction. The learning is intended to be experiential - the student experiences the studied phenomenon and learning proceeds inductively. The unique characteristic of simulation games is the incorporation of the time element - simulations imitate the passage of time and the students have to live with the results of their past decisions. Another characteristic of simulation games is their strong sense of make-believe. A study of the literature on simulation gaming shows that the effectiveness of games in teaching / learning management topics is still unclear. But it is fair to say, from the numerous studies done, that a well conducted simulation game can provide an excellent experiential learning atmosphere for the student of operations management.

I spent some time during my sabbatical in the first half of 1998 building a simulation game for the explicit purpose of teaching / learning material requirements planning (MRP) concepts such as bill of materials, routing, order review and release, priority setting, queuing, forecasting, master production scheduling, and capacity requirements planning. In this note, I would like to present this game and to offer Operations Management academics an option to use this game in their classes.

THE GAME

In the game the students play the role of the production planner of the "Greek Manufacturing Company", and develop decision support systems (DSS) to help them in that role. They manage two products, for which customer orders are placed in variable quantities throughout the week. These products are made up of components, some of which are produced within the company, and others are sourced from vendors. In carrying out the production, the parts are routed through processing machines within the company where processing time is spent. The production planning is done on a weekly basis. At the beginning of the week, inventories are checked and orders are released both within the company and to the vendors. The cycle repeats week by week. This scenario is simulated by a simulator incorporated in an EXCEL spreadsheet.

The main screen is shown in Figure 1. The upper left corner shows the products currently being processed by the machines and their queues. It also shows orders placed with the vendor. The lower part of the screen shows the current inventory position. Current pending customer orders are also shown.

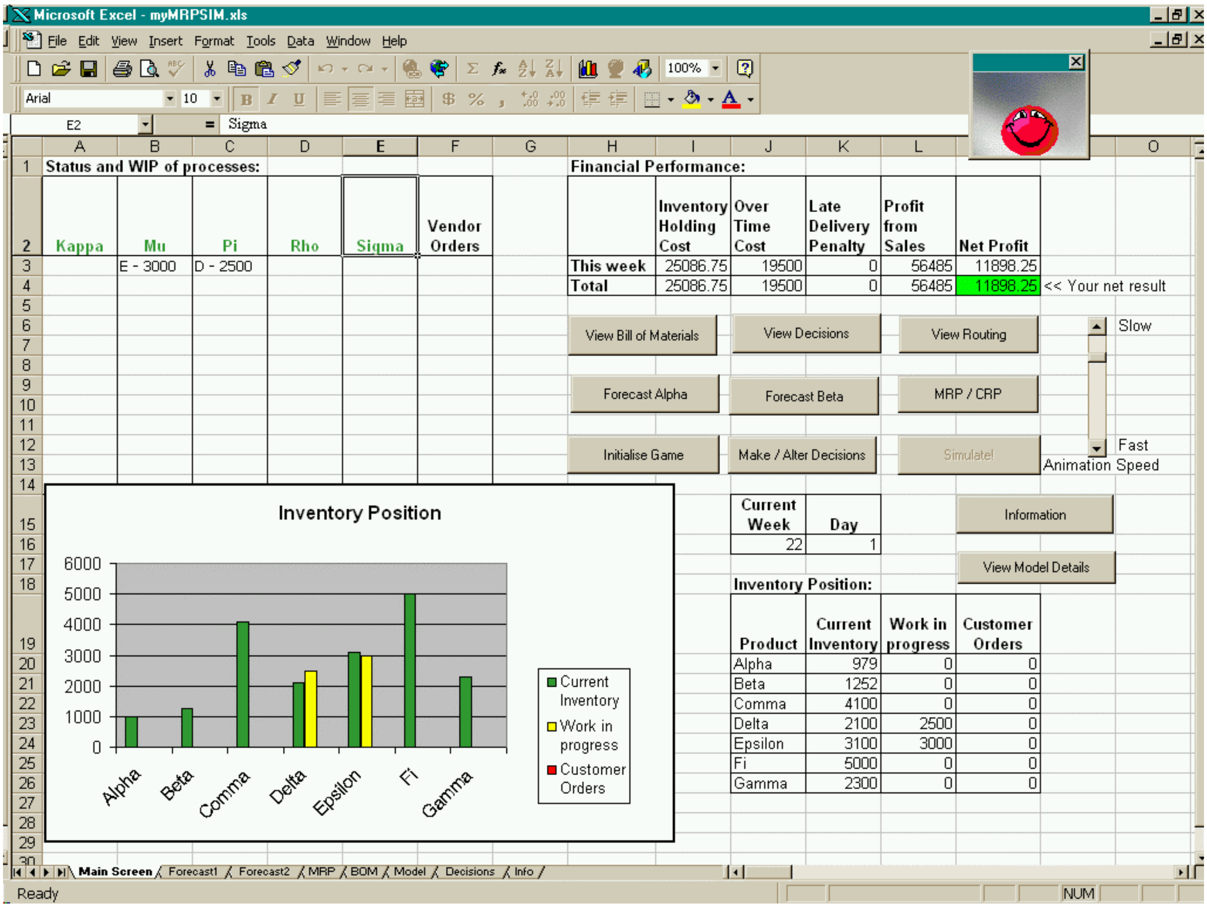

Figure 1. The Main Screen

To play the game, the button Initialise Game is used to initialise. This causes a history of demand to be created up until week 20. The students can view the current inventory, work in progress, and vendor orders at this time. Next they need to decide on orders to place for next week, their priorities, and overtime to authorise for the next week. Once they have made the decisions, they communicate it to the simulator by clicking on the Make / Alter Decisions button. Once the decisions are entered, they press the Simulate! button to let the production for the week begin, and to let the time advance to the next week. The queues of the machines, the finishing of the work, the inventory position, the arrival of orders, and the filling of the orders are animated on the screen. Profits are accumulated for every item in customer orders that is filled. For every late item in customer orders, a penalty is charged per day. There are also costs associated with holding inventory and with overtime work. These and other details of the model may be viewed by pressing the View Model Details button. At the end of the week the current and cumulative financial performance is shown at the top right of the screen. The students then make decisions for the next week and repeat the cycle.

THE ASSIGNMENT

I used this game in our Part V Semester B course "Advanced Operations Management". I asked the students to play the game and to come up with a DSS consisting of a forecasting module and an MRP module to help them play the game. Generally, the students found the assignment quite challenging. But they felt that they learnt the MRP concepts pretty well. Since the students usually have some familiarity with spreadsheets, it helps that the game is in a spreadsheet format, and they are required to do the assignment within the spreadsheet. I offer this game for you to use in your classes. Send me an email, and I will send you the spreadsheet, and the assignment to be given to the students. You can customise the game by altering the parameters. All I ask is some feedback on your experience using this game.

CHUDA BASNET, University of Waikato
Email: chuda@waikato.ac.nz

PUZZLE CORNER

SKEIN newsletter is renowned for its devilish crosswords compiled by Cliff Wilkinson (Lancaster Uni, Dept MS). In the last issue this contribution appeared in lieu of a crossword.

Amazing Anagrams!

Dormitory – Dirty Room
The Morse Code – Here Come Dots
Animosity – Is No Amity
Snooze Alarms – Alas! No More Z's
Semolina – Is No Meal
A Decimal Point – I'm A Dot in Place
Eleven Plus Two – Twelve Plus One

Desperation – A Rope Ends It
Slot Machines – Cash Lost in 'em
Mother-in-law – Woman Hitler
Alec Guinness – Genuine Class
Public Art Galleries – Large Picture Halls, I Bet
The Earthquakes – That Queer Shake
Contradiction – Accord Not In It

To be or not to be: that is the question, whether tis nobler in the mind to suffer the slings and arrows of outrageous fortune. Becomes………
In one of the Bard's best-thought-of tragedies, our insistent hero, Hamlet, queries on two fronts about how life turns rotten.

"That's one small step for man, one giant leap for mankind: Neil A Armstrong. Becomes…….
A thin man ran: makes a large stride; left planet, pins flag on moon! On to Mars!

Philip Sutton, the organiser of the '65 reunion had a problem. How to encourage interaction at the dinner by asking people to shift places at the end of each course? This is his account of the problem.

The shrewd observer will notice the botch I have made of the plan of seating changes during successive courses. It got me thinking about a more elegant solution to the problem. This may be summarised as – How do you move *n* people around *m* tables so that everyone meets each other person once, but only once? You may imagine as many courses as you wish.

I think I have cracked it (says Philip) - for *n* people moving around *n* tables (though only when *n* is prime) and for 2*n* people moving around *n* tables.

But asks Philip…..

Q1. Is there an algorithm for the general case?

Q2. Are there any other more useful applications for such an algorithm?

VICKY MABIN

MEETINGS CALENDAR FOR 1998 AND BEYOND

4h Annual Australia New Zealand Systems Conference: 7-10 October 1998, Hawkesbury, NSW, Australia
email:g.wallace@uws.edu.au

INFORMS Seattle Fall 1998 Meeting: 25-28 October 1998, Seattle, Washington
Chair: Marisa Altchuler, Boeing Computer Services, PO Box 24346 M/S 7A TH, Seattle WA 98124-0346
Marisa.altschul@boeing.com

SEAL'98 Second Asia-Pacific Conference on Simulated Evolution and Learning: 24-27 November 1998, ADFA, Canberra, Australia
Email:seal98@cs.adfa.oz.au or http://www.cs.adfa.oz.au/

7th International Applied Statistics in Industry and Manufacturing Conference: 14-16 December 1998, Melbourne, Australia
Programme Chairman: Mali Abdollahian, RMIT University, Melbourne
Email:RSTMA@laplace.ma.rmit.edu.au or http://www.isai.org/7th-int.shtml

International Conference on System Dynamics: 15-18 December 1998, Indian Institute of Technology, Kharagpur, India. Organising Secretary: Dr. Biswajit Mahanty
email:bm@hijli.iitkgp.ernet.in

International Conference on Nonlinear Programming and Variational Inequalities: 15-18 December 1998, Hong Kong
Contact: maopt@cityu.edu.hk or http://www.cityu.edu.hk/ma

4th Pacific Symposium on Biocomputing: 4-9 January 1999, Mauni Lani, Hawaii.
Track Organisers: David Dowe and Klaus Prank
Email:dld@cs.monash.edu.au or http://www.cs.monash.edu.au/~dld/PSB99/PSB99.Info.CFPs.html

Western Decision Sciences Institute, 28th Annual Meeting: 6-10 April 1999, Puerto Vallarta, Mexico
Email:mnicholls@swin.edu.au or http://faculty.mckenna.edu/wdsi

INFORMS Cincinatti Spring 1999 Meeting: 2-5 May 1999
Chair: David F. Rogers, University of Cincinnati, Ohio, 45221-0210, USA
David.rogers@uc.edu

3rd International ICSC Symposia on Intelligent Industrial Automation: 1-4 June 1999, Genova, Italy
Conference Organiser: operating@icsc.ab.ca

5th International Conference of the Decision Sciences Institute: 4-7 July 1999, Athens, Greece
Contact: http://www.dsi99.athens.aueb.gr

ASOR National Conference: 4–7 July 1999, Gold Coast, Queensland, Australia
Email:asor@fsc.qut.edu.au or http://www.math.fsc.qut.edu.au/asor

17th Conference of the International System Dynamics Society and 5th Australia New Zealand Systems Conference: 20-23 July 1999
Conference Manager: Margaret Stevenson-Wright, Graduate School of Business and Government Management, Victoria University of Wellington
Tel: 64 4 496 5453 Facsimile 64 4 496 5454 email: Margaret.Stevenson-Wright@vuw.ac.nz

IFORS '99 Beijing: 16- 20 August 1999, Friendship Hotel, Beijing, China
Contact: Ms Loretta Peregrina, IFORS Secretariat, Richard Ivey School of Business, University of Western Ontario, London, Canada N6A 2K7
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