

THE INTERNATIONAL CONGRESS ON MODELLING AND SIMULATION, HOBART, TASMANIA, DECEMBER 1997

Michael McAleer

University of Western Australia

Colin McKenzie

Osaka University

Les Oxley

University of Waikato

1. Overview

Every two years, the Modelling and Simulation Society of Australia (MSSA) holds an International Congress on Modelling and Simulation (MODSIM). MSSA is an affiliate of the International Association for Mathematics and Computers in Simulation (IMACS). The aims of the Society are to promote, develop, and assist in the study of all areas of modelling and simulation. Members are from a wide range of professional disciplines, including hydrology, agricultural science, economics, engineering, atmospheric science, ecology, statistics, epidemiology, medical science, oceanography, information science, decision analysis, and many others.

Previous Congresses have been held in Lucas Heights, New South Wales (1974), Melbourne (1976), Canberra (1978), Brisbane (1980), Armidale (1982), Adelaide (1984), Melbourne (1987), Canberra (1989), Gold Coast (1991), Perth (1993), and Newcastle (1995) (see Oxley (1994, 1996) for reviews of MODSIM93 and MODSIM95). The twelfth Congress, organized by David McDonald and a superbly efficient team from the Commonwealth Scientific and Industrial Research Organization (CSIRO), was held at the University of Tasmania in the picturesque State capital of Hobart from 8–11 December 1997, under the theme 'Spatial and Temporal Dynamics in Physical, Biological and Socioeconomic Systems'. Hobart is the second oldest city in Australia and was first settled in 1804, largely by convicts, alongside the deep water of the Derwent River. Constitution Dock is famous for its seafood restaurants and is the final destination of the annual Sydney-to-Hobart yacht race. Overlooking the city is the 1270-metre high Mt. Wellington. The MODSIM conferences have been

increasing in the number of participants and rising steadily in the high quality of the scientific program in recent years. The 300-scientific paper barrier at a MODSIM conference was first broken in 1993, and the number of delegates at MODSIM97 was the largest ever. Participants came from over thirty countries, with Japanese econometricians, economists and engineers being particularly well represented. Many delegates expressed the view that the latest conference was, to paraphrase the words of Tina Turner, 'Simply the best MODSIM conference yet.' At the Annual General Meeting, which was held at the end of the second day and was attended by over fifty members, the name of the Society was expanded to the Modelling and Simulation Society of Australia and New Zealand (MSSANZ). It was also decided to introduce elected Fellowships of the Society, with the inaugural Fellows to be the recipients of the three Medallists from each of MODSIM95 and MODSIM97 (more on this in the Social Programme below). The AGM provided the organisers of MODSIM97, as well as future conferences, with valuable feedback on perceptions of the conference. Some time was devoted to how to produce the conference volumes for the next conference: the current approach of putting all papers in the volumes — the balance between having the volumes prepared on a day-by-day basis, and including very late submissions; a volume of abstracts plus the papers on a CD (which would permit colour graphics), making the papers available on the web; and whether the two-column format was necessary. There was a wide range of accommodation, and corresponding prices, on offer at the conference.

Although registrants were required to make their own accommodation arrangements, this was not particularly difficult given the detailed information for ten hotels that had been provided by the organizers. The information included the advice: 'When making a booking please inform the hotel that you are a MODSIM97 delegate', which proved useful in obtaining the relatively cheaper corporate rate. The accommodation list included Jane Franklin Hall, a bed-and-breakfast style accommodation in a University Residential College (with the potentially frightening words, 'shared bathroom facilities'). Perhaps it is an indication of our ages, but the three authors decided to forego the student accommodation and joined a large number of delegates who had wisely selected the Wrest Point Casino for their accommodation. Not only did the 4.5-star accommodation cost only A\$125 for a double/twin room in the Tower, which had spectacular views of the Derwent River, and A\$82–89 for a double/twin room in the 3.5-star adjoining casino motel, but it also had an incredible seafood smorgasbord for A\$16. Thus, the conference organizers seem to have been very careful in passing the responsibility of obeying Commandment 5 in McAleer (1997), namely to 'Be careful in choosing the conference accommodation', directly to the delegates.

Registration costs of A\$395 for Society members, A\$445 for non-members, and A\$245 for students (before 15 August 1997, after which the costs increased by A\$50 in each category), included the bound Proceedings, conference programme, lunches, morning and afternoon teas, coffees and cakes, the Conference Reception hosted by the Governor of Tasmania, the Congress Dinner, and a delightful keychain made of selected Tasmanian woods such as sassafras

and blackwood (although one of the reviewers did not get the keychain). Hot and cold lunches were available on a daily basis, which showed that the organizers were consistent with Commandment 6 in McAleer, namely to 'Remember to organise conference lunches.' Apart from a conference satchel, perhaps the only thing that was not included in the registration package was a conference T-shirt. However, these could be ordered for a moderate A\$20, for delivery on the last day of the conference.

2. The conference opening

It would generally be neither necessary nor especially interesting to focus on the conference opening. In the case of MODSIM97, however, the quality of the speaker and the speech are such that the opening address deserve to be reproduced in full. The speaker, His Excellency The Honourable Sir Guy Green, AC KBE, Governor of Tasmania, was introduced by David McDonald as follows:

'It is a pleasure for me to welcome you to Hobart and to MODSIM 97. It is also a pleasure for me to introduce to you a man who has had a distinguished career in law, the Chief Justice of Tasmania from 1973 to 1995, the Chancellor of the University of Tasmania from 1985 until 1995, and the man who was appointed as Governor of Tasmania in October 1995, a position that requires performance of the duties of the Head of State. To open the Congress, I introduce to you His Excellency the Governor of Tasmania, Sir Guy Green.'

In spite of the 8:45am opening time, in excess of 200 delegates attended the opening address. If they were expecting the standard homilies about the importance of their craft to the National interest, they were in for a real surprise. The former academic in law demonstrated an outstanding appreciation of and sensitivity to the challenges facing modelling and simulation. For the benefit of those who did not attend the opening, the address by the Governor of Tasmania is reproduced in full below.

'I would like to add my welcome to you all to this congress. I would like to add a special welcome to all our visitors from outside Tasmania. We have with us delegates from all over Australia and from some 32 other countries around the world. We are delighted to see you all and although I know that you are here primarily in order to work I do hope that you find time to see, eat, drink and generally enjoy the large number of diverse attractions and products we have to offer in this island State of ours.

I think that Tasmania can be seen to be an especially appropriate venue for this congress. In common with most other places modelling and simulation are an integral component of hundreds of Tasmanian enterprises. But we are also doing some rather special work in the field.

The Antarctic Cooperative Research Centre located here in Hobart which is one of the largest polar institutes in the world is conducting a major programme in

which atmospheric, ice and ocean processes are being modelled in order to understand their impact on global climate change. That programme has yielded significant results including an indication that the mass of the Antarctic ice sheet is increasing and that the consequential lowering of the sea level may offset the rises predicted as a result of thermal expansion of the ocean through greenhouse warming. Obviously that projection has major policy as well as scientific implications.

Tasmania is also a world leader in predictive microbiology which involves the development of models which provide detailed information about the growth responses of microorganisms under various environmental conditions. The first definitive book about this new field was written by four Tasmanian workers and a computer generated model has been developed by the University of Tasmania which has great potential for the food industry, biotechnology and related fields.

Just to demonstrate our versatility, the University of Tasmania's Department of Anatomy and Physiology recently developed the first yacht sailing simulator in the world. This will not only provide the first accurate information about the physiological demands of sailing but data about sailing techniques and tactics as well.

Your society and congresses of this kind perform a most valuable function. These days some sort of modelling or simulation programme is involved in virtually every area of human activity or intellectual endeavour. But the very ubiquity of your field also presents potential problems. The areas with which you are concerned which range from econometrics, ecology, engineering to epidemiology — to mention just some of those that begin with "e" — are so disparate that there is a risk of modelling and simulation fragmenting into isolated sub-disciplines. That would be detrimental to your field. To begin with, modelling and simulation require close interaction between those who assemble the data which describe that which is to be modelled, those who organise the data into theoretical or mathematical form and those who write the computer programme or construct the entity which will comprise the model. But there are other more general reasons why interdisciplinary understanding is important in modelling.

There is the general point to be made which applies to all science that whilst most advances in science and technology comprise incremental steps building on what is already known, the really significant and original discoveries tend to be made by people who view things from a new point of view and whose perspective transcends the traditional boundaries of disciplines.

Interdisciplinary understanding is also demanded by the increasing complexity and sophistication of your field. The number of aspects of the world which are being modelled is increasing all the time as is the range of the functions which models perform. Each advance in the history of modelling as it has moved from mechanical models to geometric models, to sophisticated mathematical models, to computer models, to models of non-linear systems has demanded a more complex model and a wider and more sophisticated understanding of modelling than its predecessor.

Maintaining a global perspective is also important so as to ensure that a close nexus is maintained between the practical and the technical aspects of the field and the philosophical and scientific concepts which underpin it. That is important for two reasons. First it helps to ensure that modelling techniques are employed with rigour and an understanding of their limitations. Modelling is a powerful tool but it does have its intellectual dangers, especially for the layperson. A model can be presented in such a way as to beguile people into thinking that the thing represented by the model is the thing itself. There is for example a persistent tendency in the media to refer to the output of models being used to test hypotheses about the enhanced greenhouse effect and global warming as if it were data derived from observations of phenomena in the physical world.

To take another example, I recently read a report of the development of a computerised model of a heart which comprises millions of modules whose interactions simulate the functioning of the heart. The leader of the team which developed the model was reported as saying "because this model is functioning in exactly the same way as a real heart, we can see the consequences of administering a drug and if it could be harmful to humans." I am sure or at least I hope that the Professor, whose field I should say was medicine not modelling, was not suggesting that his model would obviate the need to do any clinical trials at all but even so, if he was accurately reported his suggestion that making observations of the output generated by a computer programme is "exactly" the same as observing the working of a real heart was incautious to say the least.

The other reason why it is important to retain a close linkage between the theoretical and the applied aspects of modelling is that although we do tend to concentrate on the practical applications of modelling, we should not lose sight of the potential which models have to be the vehicles for significant theoretical advances as well. For example, James Clerk Maxwell's equations were developed with the limited objective of providing a more precise mathematical model of electromagnetic phenomena than did Michael Faraday's rather more homely model of elastic lines of force but ended up making one of the greatest and most unexpected predictions in the history of science — the existence of electromagnetic waves.

Your society and this congress will perform a very important function in bringing you up to date with the latest developments in your own particular area of interest. But by fostering interdisciplinary understanding it will also perform the valuable function of encouraging a global perspective and helping to counter any tendency to intellectual insularity.

You are engaged in a field of great intellectual interest and of increasing practical importance as we attempt to cope with the complexity of a rapidly changing world. I am sure that you will find this congress to be informative and rewarding. I congratulate the organisers on their discriminating judgement in choosing Tasmania as the venue for this congress and on putting together such a fine programme and attracting such high calibre speakers.

I also congratulate Hydro-Tasmania on its discriminating judgement and good sense of corporate citizenship in deciding to sponsor the congress.

I have much pleasure in declaring the MODSIM 97 Conference open.'

As mentioned in the Governor's Opening Address, generous sponsorship was provided by the Hydro-Electric Corporation of Tasmania ('Tasmania's clean, green energy source'). A conference pen was also provided to all delegates, which proved useful, among other things, for reporting classic quotes.

3. The academic programme

3.1. *Contributed paper sessions*

There were in excess of 320 contributed papers, all of which appeared in four beautifully bound volumes of Conference Proceedings (with a total of liii + 1901 pages), and eight keynote addresses, seven of which appeared in Volume 4 of the Proceedings volumes. Despite an initial deadline for papers of 15 August, papers that arrived in late-November were still able to be included in the conference proceedings volumes. One of the consequences of this was that the initial draft of the conference program was very late in arriving although it did arrive by EMAIL and fax! Unlike MODSIM93 and MODSIM95, there was no conference satchel in which to carry the four heavy volumes. There were a number of delegates who were prepared for this eventuality by bringing satchels from previous conferences, as well as those who decided they already had too many satchels from earlier conferences.

An interesting innovation for this conference was the large number of special sessions which had been organised by the thirty-two members of the Editorial Board of the Conference. All papers in the four Proceedings volumes were fully refereed by the members of the Editorial Board, and each of the four Proceedings volumes appeared with the appropriate ISBN numbers. Edited selections of papers from the conference will appear in one or more special issues of a wide range of journals, including *Mathematical and Computer Modelling*, *Environment International*, *Mathematics and Computers in Simulation*, *Environmental Modelling and Software*, and *Natural Resource Modelling*, which approaches the special issues of six refereed journals arising from MODSIM93 (see Oxley, 1994).

For those interested in economics, econometrics and finance, there were 29 papers in econometric modelling sessions, 10 papers in time series modelling, 6 papers in economic dynamics and policy, and 5 papers in decision analysis and support systems. There were also numerous sessions in climate change and variability, engineering, computing, earth system sciences, land surface-atmosphere interactions, air pollution and wind flows, distribution networks, ocean outfall, foreshore waters, epidemiology, health and medical research, society-environment interactions, global change impacts, forest and fishery management, systems thinking, atmospheric boundary layers and turbulence, and also many sessions on the mathematical and statistical modelling of natural resources, surface hydrology, ecology, environment, physical structures and

systems, population, groundwater flow, solute transportation, geology and geophysics, agricultural systems, and food technology.

Given the large numbers of papers and the number of concurrent sessions (which ranged from six to nine throughout the conference, with three parallel sessions at the end of the conference), the timing of sessions was very tight and caused a few minor problems. Keynote papers were always followed by a contributed paper session, with little or no time allowed for moving between different sessions. Moving from one lecture theatre to another could take a few minutes, especially as parallel sessions were generally being held in different buildings. If a keynote presentation went over schedule by even a few minutes, all subsequent sessions were affected until the following tea break which, in turn, was shortened. As scones with jam and cream were available for those delegates who had survived until the last day, a shortened tea break was not necessarily optimal. For email junkies, a 5–10 minute walk up a steep hill was necessary to use email facilities in the Economics Building, where around 25 PCs had been set aside for MODSIM97 participants. Towards the end of each lunch hour, most of these were in use. The contributed paper sessions generally started on time. In each contributed paper session, the first paper was generally allocated 25 minutes for presentation and 5 minutes for discussion, while all other papers were allocated 15 minutes for presentation and 5 minutes for discussion. Given the time constraints, it was important for speakers to be very much to the point in their presentations. In several sessions, the chairman was also a paper presenter, which prompted Denzil Fiebig to introduce his paper as: 'The next paper is by me. Who gives the 5 minute warning?' He was a benevolent chairman, giving himself a total of 27 minutes (including discussion). The following interchange made us wonder about the 'voluntary' nature of contributed papers: 'I was volunteered to give this paper' (Ying-Foon Chow, a co-author). The chairman asked: 'Were you railroaded?', to which he replied: 'Yes'.

Of the contributed papers in areas outside economics, econometrics and finance, there were numerous papers which caught the eye. On the basis of their titles, some of the more interesting (at least to the non-specialist) were as follows: *Selection of capacitor for the self-excited single-phase induction generator* [an absolute gem!]; *The North American Pacific salmon wars: Crafting the treaty of peace*; *Modelling the population dynamics of a stock of the green sea turtle (*Chelonia mydas*)*; *Using the negative binomial distribution and risk analysis software to simulate *Bactrocera Papayae* Drew and Hancock (Diptera: Tephritidae) Metapopulations in an eradication context*; *A model of giant clam growth*; *Advances in modelling and prediction of algal blooms in freshwater lakes by artificial neural networks*; *Decadal variability in the Antarctic circumpolar current of a stochastically forced ocean general circulation model*; *Incorporating point basal area, tree dominance, soil type and altitude into the existing taper models for *Eucalyptus pilularis**; *A model of diel vertical migration of zoo plankton and its potential for the redistribution of organic material through the water column*; *Thermonuclear 'bomb' ¹⁴C and its use in modelling soil C dynamics — An assessment of a simple soil C turnover model*; *Spatial*

configuration of a manipulator for laparoscopic telesurgery; Decision support systems for integrated environmental management: Anticipating and interrogating bias; A tree hollow simulation model for forest managers: The dynamics of the absence of wood in trees; Molecular modelling and simulation of deoxyribonucleic acids.

The parallel contributed paper sessions were generally of a very high quality. Such quality was highlighted on the afternoon of the second day when two MSSANZ Medallists were presenting contributed papers in competing sessions.

3.2 Keynote Presentations

There were two one-hour (including questions) keynote presentations on each of the four days of the conference, namely the first sessions in the morning and in the afternoon. Attendance varied from between 150 to in excess of 200 delegates at each keynote talk. It was heartening to see around 150 delegates in attendance at each of the two keynotes on the last day of the conference, especially as the 9:00am starting time was on the morning following the conference dinner. Thus, the organizers were entirely consistent with Commandment 8 in McAleer (1997), namely to 'Select the keynote speakers wisely.' Neville Smith (Bureau of Meteorology Research Centre, Melbourne, Australia) gave the first keynote presentation on 'Modelling and simulation for a global ocean observing system'. Modelling and simulation were argued as being fundamental to the development and evolution of oceanography as a science, and as a long-term, viable operational activity. The role of models was discussed in general terms, focusing on their function as a processor of information, at the heart of the chain of information flow from observations to products, many of which were of significant societal value. The context of the paper was provided by the emergence of a Global Ocean Observing System, the conceptual umbrella for the development of operational oceanography. Models in their role as forecasting tools epitomise the objectives of this system, providing information for decision making and other applications that might otherwise be unavailable. In oceanography there is also a great emphasis on the ability of models to enhance interpretation of data and to integrate and extrapolate information. Data assimilation, either through forcing fields or through direct merging of data and model fields, is also identified as a key activity in oceanography. It is emphasized that models will never be perfect and that, by carefully examining the model errors, it is possible to learn how to improve both the observing network and the model. Several examples were presented of ocean models in action, including forecasts of El Nino, climate change predictions, estimates of global and regional ocean circulations, and short-range ocean forecasts. The Global Ocean Data Assimilation Experiment was introduced and its objectives were discussed. It was argued that this experiment is vital if oceanography were to take the step from a curiosity-driven field, with the consequent necessity for proposal-led support for observing and modelling, to one where real applications motivate and sustain investment in the global ocean observing system and, in turn, provide an even more energetic and vital research effort.

An interesting OHP transparency was presented during the keynote talk, in which various disciplines appeared on a 'Knowledge' and 'Success in predictive ability' graph. Predictably, economics appeared in the lower left-hand corner (that is, low in both knowledge and predictive success). Although economists are used to seeing their discipline treated in this way, especially by natural scientists, they are probably less used to seeing the economics discipline regarded as providing the same amount of knowledge, but lower predictive success, than the 'Stock Market' discipline!

In introducing Kazuo Nishimura (Institute of Economic Research, Kyoto U.) prior to the second keynote address, Michael McAleer described the speaker's best-selling book as follows: 'Professor Nishimura's Principles of Economics in Manga (that is, cartoon-style) is a best seller in Japan — not for primary school students, but for university students.' Kazuo Nishimura gave the second keynote on 'Non-linear dynamics and economic cycles', based in part on a paper entitled 'On the existence of chaotic solutions in dynamic linear programming'. The presentation discussed the result, which demonstrates that chaos may emerge as a solution to a dynamic linear programming problem. It is well known that dynamic programming can be treated in the standard linear programming framework by adding a time structure. In order to demonstrate the existence of chaotic solutions to such a problem, it is necessary to focus on the case in which the solutions to a linear programming problem can be described by an autonomous system, as chaos is a phenomenon that appears in an autonomous system. For this reason, it is necessary to work with an infinite-time horizon linear programming model. The problem is to maximise an objective function under recursive constraints and the initial condition. The solution to the problem can be described by a binary relation, which is called an optimal program. Owing to its linear structure, the maximization problem generally has multiple solutions, so that the binary relation describing the solutions is a set-valued function. The question to be asked is whether or not such an optimal program can be a chaotic dynamical system. In order to deal with this issue, it is necessary to answer the following two specific questions: (1) Under what conditions is the optimal program a dynamical system in the standard sense, described by a single-valued function instead of the set-valued function? (2) Under what conditions is the resulting dynamical system chaotic? In order to deal with these questions, a simple linear programming problem with an infinite-time horizon was constructed. The conditions under which the solutions are described by a chaotic dynamical system were then derived. Some concluding remarks regarding the direction of future research were also presented including one possible consequence of chaos being 'There may be too many optimum paths ... everything might be optimum.'

David Lam (National Water Research Institute, Environment Canada) gave the first keynote address on the morning of the second day, with a talk entitled 'Decision support systems for water resources problems'. Environmental problems are complex. Their solutions require information on physical, chemical and biological processes, as well as considerations for socio-economic factors. A new approach was proposed for the development of decision support systems for

environmental water resources problems by integrating the quantitative and qualitative knowledge on these scientific processes and socio-economic constraints. It was found that knowledge-based systems tools, such as expert systems and neural networks, facilitated greatly the application of numerical models and data by using the associated descriptive knowledge and enabled better understanding between scientists and managers. Also, as a result of the recent paradigm shift on information technology towards microcomputers and the Internet, it was now possible to customize the decision support system for a given problem by assembling the necessary knowledge-based tools and by accessing a variety of databases including real-time data, Geographical Information System maps. This generic tool-kit approach of constructing decision support systems helped highlight the visualization of the spatial and temporal dynamics in the combined knowledge-bases. Several case studies, including watershed management, acid rain and other water resources applications, were used to illustrate the approach. Lam suggested that 'Managers do not want detailed advice ... You can give all kinds of advice, but managers want intelligent advice', there is a strong potential for data bias when 'Guys measuring water quality do not like going out in the rain', and he described one human-based system with 'I captured his brain in this computer.'

Les Oxley in introducing Adrian Pagan (Economics Programme, Research School of Social Sciences, Australian National U.) for his key note address answered the rhetorical question: 'How do you describe Adrian Pagan', as follows: 'As a giant, and I am talking about his intellect.' Pagan's presentation on 'Uses of simulation-based econometrics' was based on a paper entitled 'On some uses of simulation in econometrics'. Simulation methods are now widely used in econometrics, having been firmly established within the set of activities engaged in by modellers and in econometric work more generally. It is almost impossible to write about econometrics today without acknowledging the importance of simulation methods. Yet in this continuity there has been change. In previous years, simulation methods were used as a way of learning about a model and the interactions within it, such as tackling questions regarding large scale and mildly non-linear systems that could not be readily answered analytically. An alternative introduction to simulation methods was when it was desired to know something more about the properties of estimators and tests that econometricians either developed or imported from the statistics literature. The second path was heavily involved in stochastic simulations, learning how to do it efficiently with the aid of techniques such as anti-thetic and control variables. In fact, the two streams were not mutually exclusive, with everyone recognising the desirability of stochastically simulating econometric models. Lowered computational costs, the advent of powerful matrix languages, and the development of stochastic programming methods meant that one could explicitly allow for the influence of uncertainty upon decisions. Expectations about events now became a powerful factor in determining the dynamics of such models. The idea that unpredictable stochastic elements, 'shocks', are the driving forces of economic systems came to be treated as the standard view, a fact that is evident today in almost any academic and much

policy discussion. The ability to stochastically simulate models became an important element in this transition. The keynote presentation discussed how simulation methods could be used to investigate some issues that have proven extremely difficult to handle analytically. Specifically, consideration was given to the questions of how to measure the business cycle characteristics associated with macroeconomic models, and the estimation of the parameters of a popular latent variable model. Pagan suggested that explaining the business cycle is 'simpler than people think ... Everyone knows what causes business cycles ... even my doctor', and 'simulation has democratized research.'

Achim Sydow (GMD Research Institute for Computer Architecture and Software Technology, Berlin) gave a keynote presentation on 'Simulation models for air quality management.' Air quality models are extremely valuable for environmental planning and management, as they may be used to study complex source/receptor relationships. During the past decade, atmospheric modelling and air quality analysis have been significantly improved by developing comprehensive 3D simulation models describing the transport and chemical transformation of air pollutants, taking into account complex flow and dispersion characteristics. The model domain ranges from microscale (street canyon, flow around buildings) over mesoscale (urban and industrial areas) to macroscale applications (continental pollutant transport, global climate research). In recent years, increasing computing capacity (and its use by parallel programming) made it possible to run realistic scenario analyses in an acceptable time and to enable smog predictions. Two developments in atmospheric research that have been observed are efforts in building air quality management systems, and efforts in building forecast systems connected with monitoring networks for meteorological data and emission and background concentrations. The keynote talk presented a survey of atmospheric simulation models and applications for air quality management in different model scales. To provide an example for the usability of an air pollution simulation system, the DYMOS system was described. Air quality management systems based on DYMOS permit an integrated quantitative and qualitative analysis of the air pollution in urban and industrial areas. In particular, it supports historical investigations, prediction of trends and planning issues. Applications were presented of the DYMOS system as a basic module of different management decision support systems for different purposes. These applications were primarily performed in the framework of European cooperation projects.

Steven Gorelick (Department of Geological and Environmental Sciences, Stanford U.) presented a keynote presentation on 'Approaches to represent aquifer heterogeneity: Structure and process imitation'. Among the most important problems in hydrogeology is understanding and mapping spatially variable aquifer properties. Heterogeneity in hydraulic conductivity is particularly important in modelling contaminant transport. The two most useful approaches to represent aquifer heterogeneity are structure imitation and process imitation. In structure imitation, sparse local measurements are used to create images of subsurface properties that exhibit the observed spatial statistics, but these may give spatial patterns that are geologically implausible. Process imitating accounts

for physical processes that have occurred over geologic time such as sedimentation, erosion, compaction, subsidence, and faulting. Maps produced tend to make sense geologically and provide insight into the nature of an aquifer system.

Kenneth Lindsay (Department of Mathematics, U. of Glasgow) presented the keynote talk at 9:00am on the morning after the Conference Dinner, which is a daunting task in itself. The title of his presentation was 'Numerical methods for stochastic differential equations', and was based on a paper entitled 'Estimating the parameters of stochastic differential equations'. The notion of a stochastic system of differential equations, defined as a deterministic system of differential equations perturbed by random variables that are not necessarily small, has been used profitably in a variety of disciplines, including engineering, environmetrics, physics, population dynamics and medicine. While the analysis of stochastic processes has received extensive treatment over a long period, the estimation of the parameters of such processes has until recently received less attention. Indeed, it has recently been argued with some force that the difficulty in obtaining consistent estimates of the parameters of non-linear stochastic differential equations is one of the most pressing difficulties in statistical inference of continuous-time processes with discretely sampled data. Two maximum likelihood methods for estimating the parameters of stochastic differential equations from time series data were proposed. The first is that of simulated maximum in which a nonparametric kernel is used to construct the transitional density of a stochastic differential equation from a series of simulated trials. The second approach uses a spectral technique to solve the Kolmogorov equation satisfied by the transitional probability density. The exact likelihood function for a geometric random walk is used as a benchmark against which the performance of each method is measured. Both methods perform well, with the spectral method returning results, which are practically identical to those derived from the exact likelihood. The technique is illustrated by modelling interest rates in the UK gilts market using a fundamental one-factor term-structure equation for the instantaneous rate of interest.

It must be a disconcerting feeling to be asked to present the last of eight keynote talks on the last day of the conference. Peter Young (Centre for Research on Environmental Systems and Statistics, Lancaster U.) presented a talk on 'Data-based mechanistic modelling of environmental, ecological, economic and engineering systems', all of which are areas in which he has excelled. It was argued that mathematical modelling in the natural and engineering sciences is most often dominated by a philosophy of deterministic reductionism. Moreover, many of the 'simulation' models that emerge from this approach to modelling are very large and difficult to identify, estimate (i.e. calibrate) and validate in rigorous statistical terms. In this situation, it seems sensible to consider alternative modelling strategies, which overtly acknowledge these data-based modelling difficulties, and address the very real problems of calibration and validation associated with the dynamic modelling of complex systems. The paper outlined a Data-Based Mechanistic (DBM) modelling philosophy and its associated methodological approaches to the analysis and modelling of data from environ-

mental, ecological, economic and engineering systems. The model structure is first identified and estimated; as objectively as possible, from the available data, and the resulting model is only then interpreted in a scientifically acceptable and physically meaningful manner. This can be contrasted with the more conventional approach to model building in which the model structure is first defined on the basis of the scientist's perception of the system, and then this model structure is used as the basis for estimation and validation exercises. The paper discussed a number of interesting and practical examples, including: extracting simplicity out of complexity in a large, non-linear simulation model of the global carbon cycle used in climate change research; nonlinear rainfall-flow modelling; modelling the nonlinear feedback mechanism between blowflies and eggs in the Nicholson blowfly data; evaluating the possible causes of unemployment in the USA over the period 1948–1988; and the modelling and automatic control of the Harrier VSTOL Aircraft. Young provided the following illustration of non-linear dynamic systems with the aid of blowfly reproduction: 'When there are few blowflies, life is a luxury and there's a lot of food around, so they get on with it. When there are too many blowflies, they spend their time looking for food, so the amount of sex falls.'

4. The social programme

It would be almost self-indulgent to ask for better weather than that available during the week of the conference. It was simply perfect, even when it was predicted to hit a high of only 18 degrees Celsius. The blue skies and cool breezes made it a pleasure to have a stroll around Hobart and the attractive campus of the University of Tasmania. Owing to pressing engagements, the Governor was unable to attend the first keynote address after the conclusion of his opening remarks. However, the delegates had the opportunity to meet with the Governor that same evening at his residence, when he and Lady Green hosted the first social event of the conference, the Conference Reception (Dress code: lounge suit/day dress) at Government House from 6:00pm (sharp) to 7:00pm. The closing time was not strictly adhered to, and the 250 or so attendees had an amazingly pleasant evening (more on this in the Social Programme below). As the reception was by personal invitation from the Governor to delegates and their partners, delegates received an invitation to the function as part of their registration package. As might be expected, Governor and Lady Green were superb hosts, greeting each of the 300 or so in attendance personally as they were introduced. The food was plentiful and the drinks flowed for over an hour. There were many photo opportunities, both inside Government House as well as in the beautiful surrounding gardens. Even though the scheduled finishing time of 7:00pm was extended to around 7:15pm, the reception finished all too soon for most of the delegates and their partners. Buses were available at several designated pick-up points to ferry the delegates and their partners to Government House. The buses arrived exactly on time and also returned their passengers to various locations, including popular restaurants in Hobart and the wharf area, after the reception.

In every way, the Conference reception was consistent with a variation of Commandment 7 in McAleer (1997), namely 'The conference reception must be excellent.'

On the third evening of the conference, the Conference Dinner was held on the campus of the University of Tasmania. In excess of 300 delegates and their partners attended the dinner, which involved salad/entree, self-serve main meal (choice of any or all of pork, rack of lamb, chicken and fish), dessert and tea/coffee. Long queues were generally the order of the evening for the main meal. As the first author was suffering from a severe case of food poisoning from a previous dinner, and was thereby restricted to a regimen of bread and water, he is unfortunately not in a position to comment on the dinner. For accompanying persons the dinner cost \$A55 which was considered by some to be a little expensive.

At the commencement of the dinner, student presentations were made in the three MSSANZ categories. Student Prize Committees had been established before the conference, and at least two nominated assessors (and up to four) had attended each student presentation. The Prize Winners and the Runners-up in the three categories were as follows: Natural Systems (Winner: Margriet Nakken, (Macquarie U.), Runner-up: John Gallant (Australian National U.)); Socio-economic Systems (Winner: Christine Lim (U. of Western Australia), Runner-up: Lee Kian Lim (U. of Western Australia)); General Systems (Winner: Fayen Wong (Australian National U.); Runner-up: John Ndivitu, (U. of Adelaide)). Both Christine Lim and Fayen Wong had received commendations for their excellent student presentations at MODSIM95 in Newcastle. Overall, the quality of the student presentations was excellent, which augurs well for the future of the Society. There were also presentations to the Medallists in the three MSSANZ categories: Tom Chapman (U. of New South Wales) for Natural Systems, Adrian Pagan (Australian National U.) for Socio-economic Systems, and Paul Sullivan (U. of Western Ontario) for General Systems. Pagan's short acceptance speech included the following gem: 'In my keynote address on simulation-based methods in econometrics, I said: "Simulate early, and simulate often". A secretary, reading my notes, typed this as: "Stimulate early, and stimulate often". This might sound a little risqué, so I had better leave it at that.' The President thanked the outgoing Secretary of the Society, Fred Ghassemi, who had worked tirelessly for the Society in the previous four years. The organizer of the conference, David McDonald, and his many helpers were also explicitly acknowledged during the presentations.

In addition to a silent movie which played throughout the dinner, there was also a Movie Quiz (no, we are not making this up!). Since collusion was not only permitted, but actually encouraged, there was a lot of movement in between the tables for assistance with the answers. Included in the instructions was the following: 'In the event of a tie for 1st place, extra marks will be awarded for additional or creative information and neatness of writing.' Unfortunately, the 'creativity' did not extend to highly imaginative (though incorrect) answers. For trivia buffs, a selection of the 19 questions, as well as the answers, are attached

[the correct answers are given in brackets]: (1) How old was Alfred Hitchcock when he died? 76, 80, 81? [80: born 13 August 1899, died 28 April 1980]; (2) What was Groucho Marx's real name? Julius, Leonard, Adolph, Milton or Herbert? [Julius Henry Marx]; (3) Name the five Marx Brothers. [Chico, Harpo, Groucho, Gummo and Zeppo]; (4) Where was Errol Flynn born? [Hobart, Tasmania, 20 June, 1909]; (5) At what age did Judy Garland make her stage debut? [age 3]; (6) What was the real name of the dog that played Lassie in the 1943 movie 'Lassie Come Home'? Pal, Furs, Bill or Roddy? [Pal, a male collie]; (7) Name the Robots in the 1997 science fiction movie 'Star Wars'. [R2D2 and C-3PO (a missing hyphen resulted in a loss of points!)]. We never found out if anyone won.

Unlike MODSIM95 in Newcastle, there was no singing and no playing of a didgeridoo by a bush band (together with an improvised rendition by Tony Jakeman on the didgeridoo), and no improvised karaoke performances by members of the audience (a singularly amazing performance of 'My Way' in Japanese by Toshio Nakanishi from Seikei U. comes to mind). During the conference dinner at MODSIM95, Kazumitsu Nawata from the U. of Tokyo had promised (threatened?) to sing 'When you wish upon a star' in both English and Japanese at MODSIM97 (see Oxley (1996, 231)). Unfortunately, he was unwell on the evening of the conference dinner in Hobart (that's his story!), so his performance has had to be postponed until MODSIM99. The members of the Society are waiting with bated breath!

Paper aeroplane flying was not only not on the program, it also did not occur at the conference dinner at MODSIM97. This was a real pity. Given the large number of practising engineers in attendance, as well as the large number of amateur flyers from various disciplines who had demonstrated their capabilities in 1995 (see Oxley (1996, 231)), it would have been interesting to measure the overall improvement in aerial skills over the last two years.

In the unofficial social programme, many followed the request in the Governor's opening address request in sampling the seafood delights at Hobart's restaurants washed down with plentiful amounts of Australian wines. At one of these occasions, Tony Jakeman, the President of MSSANZ and a noted winebuff, recommended as 'gutsy' a particular red wine that was described by some who drank it as a 'pleasant, well-priced wine', to which he replied: 'If you don't think that's gutsy, you should be drinking orange juice!' At the same dinner, an unnamed speaker was heard to say 'These guys have drunk too much white wine, so their brains are not working properly'.

5. Classic quotes

In what follows, the names of some of the classic quoters have, for obvious reasons, been omitted.

'This simulation is set to run on forever, so you'd better stop it, Rod!' (Ric Herbert, to his co-author on a practical simulation experiment).

'Only one out of ten authors in the 1995 Journal of Finance have read Adrian Pagan's classic 1984 paper, and they get it wrong anyway!' (Colin McKenzie).

'The problem with econometrics is that it is all regression-based.' (An unnamed critic of econometrics).

'None of the theory has anything to do with the data.' (Unnamed).

On getting subjects for experiments in economics: 'We use students because they are there.' (Peter Moffatt).

'Large follows large, small follows small'. Most people thought this was a description of data generated by an ARCH process until the speaker said: '... try it in the Casino but you would probably not win a lot of money.' (Unnamed).

On investing in the Chinese stock market: 'Don't invest on Monday and Tuesday, but try and invest on Friday.' (Unnamed).

'I want to collect the standard remuneration for academics.' (Cornelis Los, at the completion of chairing his session — he was, of course, referring to applause).

When Adrian Pagan asked Clinton Watkins the difficult question: 'How do I decide which categories to use?' in an empirical critique, someone in the audience turned to Pagan and asked: 'Let's reverse this question? What's the answer?'

'Why did you estimate an AR(1) model?', to which the answer was: 'That was all I could deal with.' (Unnamed).

A warning about diagnostic tests: 'Because you have done so many tests, you do not know which one you are talking about.' (David Lam).

'The way physicists talk about cycles is fine for physics, but not fine for economics.' (Adrian Pagan).

'I once worked for a company where the managers never saw the raw data. They just saw three-month moving averages of the data.' (Unnamed).

6. Epilogue

Approval was given at the annual General Meeting at MODSIM97 to hold the next Congress to be organized by Les Oxley and Frank Scrimgeour, scheduled for December 1999, at the University of Waikato, Hamilton, New Zealand (details from <http://www.mngt.waikato.ac.nz/depts/econ/modsim99.html>). This is the first time that a MODSIM conference of MSSANZ will be held in New Zealand, and there are great expectations regarding the conference.

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