Journal of the Operational Research Society (1997) 48, 1144–1150 0160-5682/97 $12.00

Book Selection

Edited by JM Wilson

Four Invited Book Reviews

Following the recent reissue by Productivity Press of the classic text Industrial Dynamics by J W Forrester, which was reviewed and reappraised on pp 1037–1041 of Vol. 48 of the Journal, I have invited reviews of four more reissued texts on System Dynamics

John Wilson

Elements of the System Dynamics Method

J Randers (ed)

Productivity Press, Portland, Oregon, 1994. xxiv + 320 pp. $50.00. ISBN 0 915 299 39 9

Jørgen Randers' collection brings together advanced papers which form an arc from the founding principles of the System Dynamics approach, to the methods used in sketching out and then rigorously constructing computer models and then on to the means of employing such models and some issues relating to implementation. There are numerous tables and figures and also an index.

The collection consists of an introduction and six parts totalling 14 chapters. Part 1—'Paradigm'—has two pieces, dealing with the fundamental epistemological stance of System Dynamics as a method of enquiry and comparing it with that of econometrics. In Part II, on 'Applied Principles', three authors begin to show how these ideas can be applied to understand real world phenomena. The process of 'Conceptualisation' in Part III deals with the difficulties of moving from the complexity of the system under study into the world of System Dynamics ideas in order to begin sketching out a model which uses feedback to probe dynamic behaviour. The next stage, 'Formulation', is covered in two chapters of the fourth part and deals with some of the steps needed to create a fully parametrized computer simulation model which can then be used rigorously to deduce behaviour. Sensitivity analysis and two methods for considering which variables to include in a model are the topics covered in Part V on 'Testing'. The final part on 'Implementation' has three papers describing different experiences of generating contact with client groups in organisations to ensure that they are centrally involved in System Dynamics modelling studies and therefore implement any changes generated by the process.

Hands up, I surrender, I love this book. It is one of the many System Dynamics books reissued by Productivity. It was originally published in 1980 and is drawn from papers at a conference in 1976, no less, but fear not; this is not mutton dressed as lamb. It is true that some of these pieces have been side-lined and some have suffered with age. But the best papers in this collection contain elegant presentations of some of the most powerful ideas in the field of System Dynamics. Randers' piece on how to start out building a model ('Guidelines for model conceptualization') is worth giving to any serious student. Alan Graham is excellent on parameter estimation, gainsaying the distressing and false rumour that system dynamicists are cavalier about parameter values. His description of the range of sources that a System Dynamics modeller will try to use indicates how the catholic tastes of the field regarding good data sources afford excellent triangulation opportunities. Finally, Nat Mass and Peter Senge describe an elegant example which illustrates how the dynamic feedback approach implies that care far beyond the application of naive correlation modelling is needed when choosing variables, describing causal links and exploring the consequences of changing model relationships. These are but

three of the very best and I regret any offence caused to other contributors. Buy it if you want to move beyond fiddling with silly little models to doing some high quality, serious work that matters to you and others. Give readings from it to your undergraduates and Masters students. Tell your Doctoral students to read it all at least once. They will find it all interesting and will pretty quickly decide which ones to re-read. Those outside the System Dynamics field can read Randers' introduction to get a sense of where System Dynamics fits in with the rest of OR. Economists might like to read Dana Meadows' chapter 2 to contrast System Dynamics with their work. Something for everyone and a great deal for the real System Dynamics researcher. A joy.

To summarise, Randers' advanced level book covers a great amount of territory and at a very high quality. The original date should not put off interested readers. Buy if it you claim to do System Dynamics and get it for your library if you are interested in other simulation techniques, GDS approaches or problem structuring methods.

London School of Economics and Political Science DC Lane

Introduction to Computer Simulation—A System Dynamics Modeling Approach

N Roberts, D Anderson, R Deal, M Garet and W Shaffer
Productivity Press, Portland, Oregon, 1994. xv+562 pp. $35.00. ISBN 1 800 394 6868

This is a textbook with lots of examples and exercises (plus some solutions) which introduces the concepts of causal loop diagramming, DYNAMO model building and policy analysis. There are many tables and figures and also an index.

Using 25 chapters (organised in seven parts) and two appendices, the authors take students from zero up into the world of System Dynamics. The first chapter describes the contribution that simulation can make to understanding problems, the intellectual antecedents of System Dynamics and the layout of the book. The second chapter introduces the crucial concept of feedback, illustrating the ideas with eight examples (throughout the book examples of the ideas are provided). The second part, 'Structure of Feedback Systems', deals with causal loop diagrams (CLDs), introducing the basic structures that arise and how they might be used to infer time evolutionary behavior. Part III takes these ideas further by providing many examples in which time series data is available or patterns over time can be observed. More detailed examples introduce the concept that system structure influences system behaviour. 'Analyzing Less-structured Problems' is the topic of Part IV; newspaper stories and long descriptions of systems are given so that students can use their knowledge of CLDs to understand the structural sources of undesirable behaviour and to suggest policy changes to improve behaviour. Part V offers an 'Introduction to Simulation' using the DYNAMO language. The System Dynamics concepts of 'level' and 'rate' are described as well as illustrated and the handling of DYNAMO models, namely equation writing, obtaining graphical output etc., are covered. Examples of isolated positive and negative loops are described, models formulated and behaviour rigorously simulated. More complex situations, including those displaying delays, are then treated. 'Formulating and Analyzing Simulation Models' and 'Developing More Complex Models' are the subjects of Parts VI and VII. Seven chapters each describe in detail; a system, the modelling needed to understand its behaviour and the experiments that can be done with the models. Examples range from a flu epidemic to the management of a deer herd via the development of cities. These chapters provide more practice with CLDs as conceptualization tools, with DYNAMO formulation and with the experimental and policy analysis potential of a soundly constructed System Dynamics model. The final chapter encourages students to use feedback thinking in their daily life and describes briefly the benefits of other System Dynamics simulation studies and the potential that exists for the approach. Finally, two appendices contain a 'Glossary of System Dynamics Terms' and 'Answers to Selected Exercises'.

This is a good book. It contains one of the longest treatments of CLDs that is available, some nice 'messy' problems for students to talk around and exercises, exercises, exercises. The text is introductory, however, so there is no appreciable treatment of more advanced areas (sensitivity analysis is an important example). There are two difficulties with this book, one very obvious to all *JORS* readers, one less so. Firstly, the package used throughout this volume is outdated. A newer version of DYNAMO exists and there are other packages on the market that are enormous improvements on what is shown here. For a book published originally in 1983 this is not really a fair criticism but when reviewing the re-issue in 1997 for *JORS* readers the point has to be made. The book is crying out to be updated in this respect, and would be well worth the effort. A second concern that I have is that the amount of space allotted to CLDs might be mis-interpreted. Half of this book is devoted to their treatment. Now CLDs are a good way of getting people to start off thinking about feedback and they can be used to summarise the complex behaviour of simulation models very effectively. However, they present grave problems when one is trying to deduce the dynamic behaviour of a complex structure. The sort of phenomena that System Dynamics concerns itself with, shifts in loop dominance, switches in loop polarity, the basic mechanisms that generates modes of behaviour, cannot be discovered or explored using CLDs. Only a

fully-formulated simulation model can assist in the study of such effects. Yet, regrettably, there has been considerable interest in what we might call 'System Dynamics Lite'. This issue must be emphasised on the pages of *JORS* because 'qualitative System Dynamics'[1] is relatively well known in the UK (though the use of causal loop diagrams and archetypes to give limited but fast insights into dynamic systems only achieved international prominence with the publication of *The Fifth Discipline*[2].) The problem here is that CLDs are known to be problematic in revealing the behaviour of systems[3] and archetypes have their own difficulties.[4] It might well be argued that the whole of the System Dynamics field is predicated on the notion that dynamic, non-linear feedback systems are counter-intuitive in their behaviour and therefore require computer support of some form in order to be understood. Hence, Barry Richmond's observation[5] that, 'using [CLDs] to make inferences about behaviour is a treacherous business' (p. 144). Similarly Forrester[6] holds that, '[CLDs] do not provide the discipline to thinking imposed by level and rate diagrams' and admits only to the occasional use of CLDs, 'for explanation after a model has been created and studied' (both p. 252) (a fine example of such usage may be found in one of Forrester's papers[7]). Work has been done within the System Dynamics field to make more robust the inferences gained from qualitative models[8,9] but the complexity thus introduced is open to the criticism that it approaches the use of a properly formulated simulation model. The authors of *Introduction to Computer Simulation* know all of this; they are giving a good account of CLDs because they see that they have a role to play within the broader System Dynamics approach. However, I think that it is worth emphasising that the use of CLDs in this book is primary pedagogical; in the practical application of System Dynamics ideas CLDs are useful but the much greater emphasis is on a computer simulation model.

To summarize, the authors offer a good introductory text for undergraduates with many excellent examples. Its handling of CLDs needs to be put into a broader context, however, and the whole volume is begging to be re-written around more modern software. Nevertheless, a book worth adding to most simulation and systems science collections.

London School of Economics and Political Science DC Lane

References

1 Wolstenholme EF and Coyle RG. (1983). The Development of System Dynamics as a Methodology for System Description and Qualitative Analysis. *J Opl Res Soc* **34**: 569–581.
2 Senge P. (1990). *The Fifth Discipline: The Art and Practise of the Learning Organisation*. Doubleday/Currency: New York.
3 Richardson GP. (1986). Problems with causal-loop diagrams. *Syst Dynamics Rev* **2**: 158–170.
4 Lane DC and Smart C. (1996). Reinterpreting 'generic structure': evolution, application and limitations of a concept. *Syst Dynamics Rev* **12**: 87–120.
5 Richmond B. (1994). Systems thinking/system dynamics: Let's just get on with it. *Syst Dynamics Rev* **10**: 135–157.
6 Forrester JW. (1994). System dynamics, systems thinking, and soft OR. Syst Dynamics Rev **10**: 245–256.
7 Forrester JW. (1968). Market growth as influenced by capital investment. *Indust Mgmt Rev* (now the *Sloan Mgmt Rev* **9**: 83–105.
8 Aracil J and Toro M. (1989), Generic qualitative behaviour of elementary system dynamics structures. In: Milling PM and Zahn EOK (eds). *Computer-Based Management of Complex Systems*. Springer, Berlin, pp. 239–245.
9 Dolado JJ. (1992). Qualitative simulation and system dynamics. *Syst Dynamics Rev* ***8***: 55–81.

Introduction to System Dynamics Modeling with DYNAMO

GP Richardson and AL Pugh III

Productivity Press, Portland, Oregon, 1994. xi + 413 pp. $35.00. ISBN 0 915 299 240

This book is a description of the techniques needed to cast problems into a System Dynamics mould and then how to build sound simulation models which can be experimented with to obtain policy insights. The book is written using the iconography and code of DYNAMO and using examples throughout. There are many applications, numerous tables and figures and also an index.

This book consists of seven chapters. Chapter 1 overviews 'The System Dynamics Approach' by introducing feedback thinking and the complex behaviour that feedback systems can generate and by outlining the stages of a System Dynamics modelling study. With chapter 2 we deal with 'Problem Identification and System Conceptualization'. Readers are encouraged to look for patterns of behaviour over time and are shown how to map out assumptions about the underlying system structure using causal loop diagrams and stock and flow diagrams. The importance of having a clear purpose, or focus, for a modelling study is emphasised. The chapter closes by introducing a project management problem (which is then used throughout the book) upon which the previous approaches are used. The computer package DYNAMO is introduced next. Using many examples of feedback systems the authors show how equations are written and what in-built functions exist as well as how output is obtained. Chapter 4 deals with 'Model Formulation', the process of creating a fully specified (structurally, algebraically and parametrically) model. There are extensive treatments of the concepts of rate, level and auxiliary, all with a diverse range of examples. The project example is revisited in order to formulate a complete model. The chapter closes by considering the problems of parameterisation and debugging and by drawing out from all that has gone before some general principles of model construction. 'Model Testing and Further Development' are the concerns of chapter 5, which therefore deals with the need to understand complex model behaviour and the experiments and sensitivity runs

that can be done to achieve this. Again, the project example—along with other smaller models—is revisited. The need to re-work aspects of a model is treated and the concept of validity addressed. The subject of chapter 6 is 'Policy Analysis': the study of the effects of current policies on the general modes of behaviour of a system and the identification of new policies which influence those modes in significant ways. Centred primarily on the project model, the chapter closes with a set of policy conclusions, though it revisits the concept of validity in the context of policy analysis. The final chapter treats advanced functionality in DYNAMO; macros, summary statistics generation and the handling of arrays of variables.

Casting aside any (lingering) aspirations of objectivity, what do I think of this book? Well, I use it as one of the books for my System Dynamics course at LSE. I think that it is super. Originally published in 1981, it suffers from being in an older version of DYNAMO, so that the language allows only short variable names and is a little unfriendly to code. Frankly, this is a limitation. It means that I only use this book with our Operational Research M.Sc. and Decision Science M.Sc. students, since they are sufficiently comfortable with computer languages. When working with students on our M.Sc. for Management I do not use this book. However, with that restriction, what we have here is simply the best treatment of the detailed craft of good System Dynamics model building that I know. Of course, the core ideas are Forrester's[1] and the authors would in no way deny this. But the book bulges with practical tips, cases and examples of how to implement those ideas. It also has two fine sections on validity and the means by which clients develop confidence in a model. The ideas are based on a research paper[2] but are improved in their presentation here and put into context in a better way. The text is very clear and moves in a fluid way from general principle to example, on to another example and then back up to extended principle. It has some lovely touches of humour; for example, the process of discovering errors in a project is parenthetically illustrated with, 'Thorndike, that's the 7th time in the last 10 months you've come in here to report a major boo-boo' (p. 344). It is a comment which amuses the reader but which also draws the learner into thinking about the actual processes being modelled. One last aspect about which I do have mixed feelings is the authors' use of the project problem throughout the book. I accept that this allows the reader to work not only with separate and small examples but also with a substantial model of a substantive issue. The device also provides a narrative arc to the book as we move through all of the stages of a study to final conclusions. However, it does make the book somewhat 'non-dipable'. For example, chapter 5 is heavily dependent on the project model and therefore hard to use simply as a text on model testing. This means that one must either sample from the book with great care, being aware of the textual interdependencies being disrupted and so substitute for them as necessary, or base a course around the whole of the text. I use the first approach.

In conclusion, this is a practical book on good System Dynamics simulation model building. The dated computer language used is an issue but is counter-balanced by the depth of understanding displayed by the authors and by the quality of the materials that they present. If you want to get serious about System Dynamics then you need this on your bookshelf (in which place it will not remain long since you will keep consulting it). I have two copies but *JORS* readers need only buy one!

London School of Economics and Political Science DC Lane

References

1 Forrester JW. (1961). *Industrial Dynamics*. MIT Press: Cambridge, MA (re-issued by Productivity Press, Portland, OR).
2 Forrester JW and Senge PM. (1980). Tests for building confidence in system dynamics models. In: Legasto AA, Forrester JW and Lyneis JM (eds). *System Dynamics: TIMS Studies in the Management Sciences Vol. 14*. North-Holland, Oxford, pp 209–228.

Study Notes in System Dynamics

MR Goodman

Productivity Press, Portland, Oregon, 1994. xiv + 388 pp. $25.00. ISBN 0 262 57051 3

This textbook introduces System Dynamics by treating extensively the basic feedback structures underlying this computer modelling approach. It offers very extensive exercises and solutions for the reader. There are numerous tables and figures but no index.

This book has three parts which may loosely be described as; ideas, simple exercises and harder exercises. Part One deals with 'Simple Structures'. Here are introduced both the concept of feedback and the link between the feedback structure of a system and the dynamic, that is, time evolutionary, behaviour that it displays. Goodman then spends three chapters introducing and exploring positive feedback structures, negative feedback structures and coupled structures. In the last of these he deals with the important concept of a shift in loop dominance. In each case he provides many examples, and models the systems first using causal loop diagrams (CLDs) and then using the DYNAMO software so that the behaviour can be deduced rigorously. Part One closes with a chapter which leads the reader through the processes of model conceptualisation (using CLDs) and simulation model building, analysis and elaboration (using DYNAMO). Part Two provides 'Exercises in Simple Structures'. Intended to support the material of Part One, these are eight exemplifications and elaborations of the ideas first displayed there and are followed by

solutions. Part Three offers 'Exercises in Analysis and Conceptualisation'. Although these also introduce some new material, their essential purpose is to deepen understanding of the Part One material. This is done using seven exercises, with accompanying solutions, which start with a rich statement about the system to be studied. These are then probed using causal loop diagramming, stock and flow diagramming and the building of a fully-specified simulation model. The reader is guided into using the models to investigate the link between system structure and dynamic behaviour. In so doing, the book completes the link back to the simple structures of Part One and to examples of shifts in loop dominance which are of practical importance in a wide range of systems.

Leading the reader from disease-carrying mosquitoes, via cycles in commodity prices and on to the growing strategy of a start-up company, one might expect this to be a somewhat dizzying read. Instead, Mike Goodman's book takes its time in slowly laying out and exploring some of the basic ideas of System Dynamics. Clearly building on the seminal ideas of Forrester, and also acknowledging the contribution of subsequent system dynamicists, he is offering a narrower but less dense account than the founding work[1] whilst also introducing readers to some of the most interesting applications that have arisen to date. That date, it must be said, is 1974, for this is another of Productivity Press's re-issues of books in the System Dynamics field (though, once more, no new publication date is to be found). It therefore suffers for being written in an old version of DYNAMO which has an unforgiving equation structure and lacks a graphical user interface (GUI). However, rejecting the book on these grounds would be to allow form to triumph over content and this would be unfortunate since the content is very good. When it was written, this material had been used with students at three universities and had been put together very carefully. At every point in its pages the reader is aware of the educational purpose of the section being worked on. The exercises present building blocks of understanding, laying them squarely and firmly before progressing. The CLDs are developed slowly and presented well. The stock and flow diagrams use the same conventions developed by Forrester,[1] ones that are still used, with slight variations, by modern software packages which do have GUIs. Finally, the range of applications accumulates to demonstrates the generality of the approach and to validate the power of the abstract ideas being employed. Of course, many ideas are not covered and this book by no means conveys all that is System Dynamics today or even in 1974 (readers must look elsewhere for work on validation approaches and techniques for using System Dynamics in a GDS mode). But Goodman offers an excellent set of examples for introducing the fundamentals of the structure-behaviour perspective at the heart of System Dynamics. A final observation: the stock and flow diagram on page 371 has a causal link missing. Finding this printing error is left as an exercise to the interested *JORS* reader. . .

To conclude, this book is old but not too dated. Its presentation and examination of the basic loop structures and associated behaviours of System Dynamics and its layout using multiple exercises makes it an excellent source book for teachers.

London School of Economics and Political Science DC Lane

References

1 Forrester JW. (1961). *Industrial Dynamics*. MIT Press: Cambridge, MA (re-issued by Productivity Press, Portland, OR).

Book Reviews

Lean Thinking—Banish Waste and Create Wealth in your Corporation

JP Womack and DT Jones

Simon and Schuster, London, 1996. 350 pp. £16.99. ISBN 0 684 81035 2

In *The machine that changed the world*,[1] Womack and Jones with their co-author, presented the results of a major benchmarking study on the automobile industry. The results of the study showed that Japanese plants in Japan were far ahead of other plants on all major measures of performance. The book had a profound effect on manufacturing executives in general, and not just those in the automobile industry. It will have also caused a good deal of frustration because no cure was provided along with the diagnosis. In this book they seek to remedy that situation.

The lean thinking prescription for the elimination of waste, *muda* in Japanese, is a five stage process. First, there is the need to specify *value*. Value, it is argued, should be defined by the customer, in terms of specific products with specific capabilities at specific prices. Second, the *value stream* should be identified. The value stream incorporates all the actions required to bring the product to the customer: including detailed design, engineering, production, order-taking, production scheduling and delivery. This stage should identify activities that add value, that do not add value but are unavoidable in current circumstances and those that do not add value and are avoidable. Those activities in the third category should be eliminated. The third stage is to create *flow*. Here the authors argue that a radical change from traditional batch processes is required. They expect such a change to reduce product development time by a half, order processing time by 75% and physical production time by 90%. Then the fourth stage is to let the customer *pull* the product as needed. The fifth stage is called *perfection*.

No doubt such a description of lean thinking will create a good deal of scepticism. However, many detailed recent

examples are given, from North America, Japan and Germany and involving both small firms and large corporations, which show that these ideas do work. Here you can read about the dramatic changes at Pratt and Whitney, what the authors call the acid test for lean thinking, in which a £1m swing in operating results from 1991–1992 was the catalyst for a complete overhaul of their production process, involving *inter alia* the movement of all 7000 machines at least once, so that throughput time fell from 18 months to 6 months, inventories fell by 70%, the massive central warehouse was closed, and unit costs fell by 20% during a period when production volume declined by 50%.

Or consider the revolutionary changes at Porsche, which in 1994 resulted in the first defect-free car ever rolling off the production line. In 1991 the concept to launch time for a new car was 7 y. In 1997 it is expected to be 3 y. In 1991 the time from welding to the finished car was 6 weeks. In 1997 it is down to 3 d. Over the same period the inventories have fallen from 17 d supply to 3 d, and the effort to build a 911 model and its successor has fallen from 120–45 h. It is difficult to gainsay these achievements.

The classic example is, of course, Toyota. Here you can read a blow by blow account of the experiences of Taiichi Ohno as he pushed what became known as the Toyota Production System through Toyota itself in the 50s and 60s, and then through Toyota's supply base, and after his retirement from Toyota, through Showa Manufacturing, a traditional manufacturer of radiators and boilers.

In my view, this is a book that should be read by everyone in OR who is interested in Operations Management. The principles delineated, and the examples given, cover manufacturing, the supply chain and logistics. The stories told are fascinating in the historical detail and description of the actions of individual managers. It certainly is not a textbook, but I was interested to read a review in a Sunday newspaper, which said that 'much of the text, not to mention the charts, comes over like a manual for production and operations engineers.'[2] If that is the view of a management journalist then I suspect there is enough in the book to keep the typical OR person interested.

Lancaster University G Rand

References

1 Womack JP, Jones DT and Roos D. (1990). *The Machine that Changed the World*. Rawson: New York.
2 Trapp R. (1996). How to be a lean machine. *The Independent on Sunday*. 20 October.

Self-Producing Systems—Implications and Applications of Autopoiesis

J Mingers

Plenum Press, London, 1995. xvii + 246 pp. $59.40.
ISBN 0 306 44797 5

The intention of this book is to bring together in one volume an introduction to Maturana and Varela's concept of autopoieses and related ideas, and to illustrate their applications across a spectrum of subjects. A primary aim is to re-present the ideas of autopoiesis in a more transparent language than the original. The book also attempts to examine the connections of these ideas to other bodies of work, and in particular to explore the philosophical stance of the work.

After a short introductory chapter, the book divides into four parts. The first, 'Autopoiesis in the Physical Domain' develops the essential idea of autopoiesis as an explanation of living systems, then explores the implications of this on biology in particular, but also more generally. The first part finishes with a chapter dealing with various aspects of the mathematics of autopoieses and a computer model of autopoiesis. Part two then deals with theories of cognition, exploring first the organization of the nervous system, then the evolution of such systems to yield language, description and the observer. The last chapter in this section explores the philosophical implications of autopoiesis, both the original work, and Maturana's more recent development of radical constructivism.[1,2] Here Mingers argues that this later work is compatible with a critical realist position, along the lines expounded by Bhaskar.[3,4]

The third part is concerned with the application of autopoieses in various disciplines; there are four different chapters. The first covers sociology and organisation theory and includes discussion of Maturana's own social theory,[1,5] Luhmann's analysis of society as autopoietic communication,[6] and finishes by considering Morgan's work[7] as an example of using autopoiesis as a metaphor for viewing social systems. The second chapter looks at law as an autopoietic system, starting from Luhmann's work[8,9] and then moving on to the debates this has stimulated. The third chapter looks at the impact on family therapy of Maturana's later theories, focusing on the constructivist family therapy[10] that is based on Maturana's general cognitive theories, epistemology, and theory of social systems. Here the argument is that although constructivist family therapy brings some benefits to family therapy, it has major weaknesses, arising out of its epistemological assumptions, and leading to the criticism that social and political contexts are ignored. The fourth chapter deals with Varela's later work on cognition[11] and its relationship to information systems, cognitive science and artificial intelligence. Here Mingers argues that Varela's work on 'enactive cognition'[12] may well provide a framework for future research, something that he argues is needed in view of the perceived failure of the representational paradigm to produce results.

The fourth and final section in the book includes a single chapter which provides a review of the major ideas of autopoiesis and the debates it has stimulated, followed by a short section which explores two potentially new debates, the political implications of Maturana's position, and possible 'resonances' between autopoiesis and postmodernism.

In summary, an interesting and stimulating book, with a wide agenda, which it succeeds in addressing to varying degrees. To explain what I mean, I suspect many readers will come to the book wanting to address only a subset of the total agenda on offer, and thus dipping into only parts of the book. Because of the breadth of material covered, the depth in some aspects is perhaps less than desirable. To display my own preferences, I came to the book interested primarily in autopoieses in terms of its relevance to working within social systems such as specific organisations, and with a secondary interest in the philosophical stance of autopoiesis. My attention was thus particularly directed to some of the material in parts III and II. An example of where I found the arguments less than convincing in all its aspects (quite possibly because of the brevity of the treatment) was in terms of Mingers' 'reconciliation' of Maturana's more recent work with a critical realist position. The debate in the last chapter on politics and postmodernism was also frustratingly short, and, out of deference to the requested length of this review, I will forgo the temptation to open some debate here. But, that caveat aside, the book does succeed in opening up Maturana and Varela's work to a wider audience, in a largely accessible fashion. As such it will be a useful addition to many an individual library, as well as being arguably essential for any institutional library.

South Bank University A Taket

References

1 Maturana H. (1988). Reality: the search for objectivity or the search for a compelling argument. *Irish J Psych* **9**: 25–82.
2 Maturana H . (1990). Science and daily life: the ontology of scientific explanations. In: Krohn W, Kuppers G and Nowotny H (Eds). *Selforganziation: Portrait of a Scientific Revolution*. Kluwer Academic Publishers: Dordrecht, pp 12–35.
3 Bhaskar R. (1978). *A Realist Theory of Science*. (2nd edn). Harvester Press: Sussex.
4 Bhaskar R. (1979). *The Possibility of Naturalism*. Harvester Press: Sussex.
5 Maturana H. (1981). Autopoiesis. In: Zeleny M (Ed). *Autopoiesis: a Theory of Living Organization*. Elsevier-North Holland: New York, pp 21–33.
6 Luhmann N. (1986). The autopoiesis of social systems. In: Geyer F and van der Zouwen (Eds.) *Sociocybernetic paradoxes*. Sage: London.
7 Morgan G. (1986). *Images of Organization*. Sage: California.
8 Luhmann N. (1987). The unity of the legal system. In: Teubner G (Ed). *Autopoiesis and the Law*. de Gruyter: Berlin, pp 335–348.
9 Luhmann N. (1992). Operational closure and structural coupling: the differentiation of the legal system. *Cardozo Law Rev* **3**: (5): 1419–1441.
10 Mendez C, Coodou F and Maturana H. (1988).The bringing forth of pathology. *Irish J Psych* **9**: 144–172.
11 Varela F. (1992). Whence perceptual meaning? A cartography of current ideas. In: Varela F and Dupuy J (Eds). *Understanding Origins: Contemporary Views on the Origin of Life, Mind and Society*. Kluwer Academic Press: Dordrecht, pp 235–263.
12 Varela F. (1991). Making it concrete: before, during and after breakdowns. *Rev Int Psychopathologie* **4**: 435–450.

Tools for Thinking—Modelling in Management Science

M Pidd

John Wiley and Sons, Chichester, 1996. x + 350 pp. £22.50. ISBN 0 471 96455 7

This is an excellent book, and it is ideal for students entering a masters course in management science, operational research, or business modelling. It would be particularly useful as a pre-course reader, and as a companion to subject-specific texts. The style makes it an enjoyable read, and could even fool the reader into thinking that management science modelling can and should be fun! It may even appeal to practising managers.

The book is split into four parts: Modelling in Management Science; Interpretive Modelling: Soft Management Science; Mathematical and Logical Modelling; Model Assessment and Validation. The difficulty that Mike Pidd has struggled with, with a good deal of success, is how to portray what he sees clearly as intertwined processes in a book which, by the nature of the medium, must be laid out sequentially. The trick is achieved to a certain extent by the overview of modelling provided in the first part. By addressing modelling in general, the book provides a platform from which the more specific aspects of modelling can be viewed in the subsequent parts.

Part II considers soft methods or problem structuring methods in general, and then looks specifically at Soft Systems Methodology, Cognitive Mapping, and System Dynamics. One criticism here is that although the use of System Dynamics is advocated as an interpretive tool, this message may be lost, as it may appear to be a rather 'hard' approach.

Part III considers Linear Programming, Discrete Event Simulation, and Heuristics, with examples on Excel Solver being used for LP. This is a nice approach, as many readers will be interested in using LP with computers, and utilising a standard package is helpful.

Case examples are provided throughout, but helpful as this is my main criticism is that I feel that the hard/soft sections remain separate, and that the cases could have been used to link them—not an easy trick. There is a short paragraph on complementarism on page 123, but this does little justice to the debates in the area. All of this having been said, for a masters/management audience, the text is probably about right. Too much on complementarism could be an immediate turn-off, and for those interested in the area there are plenty of references to follow up.

University of Luton B Lehaney and S Clarke