Book Review

Proceedings of the International Workshop on Nonlinear Dynamics and Chaos, edited by H.-T. Moon, S. Kim, R. P. Behringer, and Y. Kuramoto, 1997. World Scientific, Singapore. 381 pages. ISBN 9810231431.

This book appears in the publisher's Series on Nonlinear Science, Series B, as vol. 10. It is also published as a special issue in *International Journal of Bifurcation and Chaos.*

This collection of 38 papers is divided into sections as follows: Coupled Oscillations and Neuronal Systems, Bifurcations and Transitions in Various Models, Waves, Patterns and Chaotic Transport, Granular Dynamics and Josephson Junction Arrays, Stochastic Resonance Quantum and Relativistic Systems, Chaos Control and Applications, Applications to Electronic Circuits and Plasmas, Applications to Biological Systems, Applications to Statistical Problems. This is a lushly produced volume in large format on glossy paper with coloured illustrations, apparently type set in LaTeX in double columns. But irritatingly, as is common in conference proceedings, it lacks a subject index.

As usual the life sciences apart from theoretical neurophysiology are thinly represented, but some of the issues raised may be potential metaphors for attacking problems in disciplines outside physics. The style of the mathematics used is typical of physicists but rarely of pure mathematicians. It reflects the strong interest in nonlinear dynamics in Japan and now China and Korea, by workers with some contact with the USA, but there are other welcome international links represented including Russia and Poland.

We have passed, almost thankfully, the stage where every book on nonlinear dynamics described folding baker's dough, and the Logistic, Henon and Rössler attractors, and little else, as the optimal paradigms for any system. Attention is shifting to the genesis of chaos in coupled lattices of oscillators, intermittent chaos through what is called bursting, control by injecting signals into unstable dynamics, and structural criticality. All these are topics with some metatheoretical generality and deserve watching to see where they lead. As the life sciences are frequently faced with modelling large aggregates of loosely coupled semi-autonomous entities,

1090-0578/00/0100-0121$18.00/0

from neurons to decision makers, in an environment with some almost-periodic forcing functions apparently present, some of the developments in this book are worth thought. My view is that they are too tightly linked to specific experiments in the physical sciences, such as the Belousov-Zhabotinsky reaction, to be of immediate use, but they can give a hint of what sort of models we could evolve and what problems of identification and matching to real data will arise. One specific point is seminal; the Hodgkin-Huxley equation for the kinetics of ion transfer in nerve fibres is revisited (Grzywna & Siwy, pp. 331-332) and replaced by equations that allow for the system to have a memory, and exhibit chaotic dynamics. It is nice to be reminded that equations that almost have the status of unquestioned laws can be rewritten and replaced in a style that helps us to gain more insight into ubiquitous processes.

When the various authors write of cell assemblies they pay passing lip service to real biology, but progressively simplify their descriptions in the direction of mathematical tractability. Even so, subtle and intricate patterns emerge, and the bifurcation diagrams take on a form that is much more messy than the tidy pictures which have been reprinted ad nauseam. The graphic presentations in the book are rich and helpful in this regard, and not restricted to cases which are analytically tractable. Kuramoto (pp. 10-18) illustrates that even a relatively simple representation of locally coupled oscillators leads to diagrams which have no tidy description at all scales. One may be thankful that so far in the life sciences no one has created algebra as elaborate as that used for flow between two cylinders (Atobe, pp. 144-147), but we do not yet have the previous formal theory upon which to construct the elaborations of special cases.

As we move from low-dimensional dynamical systems to ones with many attractors and consequent high dimensionality, spatially extended, then what is called the structural criticality of the global system can be defined by a single system coupling parameter. In such systems the path in time from an initial state onto one of the system's many attractors is temporarily periodic, irregular and partly chaotic. Hata and Yabe's paper (pp. 366-375) I find one of the most useful and stimulating, even though it is based on a very idealized case resembling a spin glass network. Some of these results are obtainable without having the dynamics run for 100,000 iterations as is common in physical experiments; therefore they might have psychological relevance.

It is doubtful if in psychology we have strict analogues of physical variables such as force, but at the same time the transitions between different dynamic patterns in a quartic system (that is, fourth order) are such that the forcing functions may drive chaos into periodic motion (Kim & Lee, pp. 234-238). One gets the impression that there is a serious need for the exploration of higher dimensional systems where the forcing functions (the sustained stimulus environment to the individual or to the group) are not the sinusoidal forms used by physicists or motor-skill physiologists, but something better derived from descriptive theory in our own disciplines. The contributors to this volume obviously ignore the sorts of results already appearing in *NDPLS* (Petrov & Nikolov, 1998; Gregson, 1998) to admit those would force a redefinition of the fundamental assumptions which serve as the seed equations for their case studies. Even so, it is clear that we must expect for some years to come a rich creation of oddly configured bifurcation diagrams, attractor trajectories, abrupt jumps in phase spaces, and analytically intractable phenomena even in the supposedly hard sciences. I take this as encouragement to explore problems that are not just paraphrases of physics, yet at the same time profit from the analytical procedures that have been found applicable across a diversity of dynamical theories. As the growth to multi-attractor theory emerges in the literature, it seems to be the most fruitful area to monitor for the future directions of nonlinear dynamics in our disciplines.

Only a few parts of this book are presently relevant unless one is an utterly uncritical reductionist, so I would settle for accessing the library copy of the journal and photocoping the three or four papers which seem interesting.

Robert A. M. Gregson
Division of Psychology
Australian National University

REFERENCES

Gregson, R. A. M. (1998) Effects of Random Noise and Internal Delay in Nonlinear Psychophysics. *Nonlinear Dynamics, Psychology and Life Sciences, 2,* 73-93.

Petrov, V. & Nikolov, S. (1998) Valuation of the Extraocular Effective Elastance on the Base of Dynamic Model. *Nonlinear Dynamics, Psychology and Life Sciences, 2,* 1-20.