Preface to the 1980 Edition

As I review these pages, the last of them written in summer 1978, some thoughts come to mind that put the whole business into better perspective for me and might aid the prospective reader in choosing how to approach this volume.

The most conspicuous thought in my mind at present is the diversity of wholly independent explorations that came upon phase singularities, in one guise or another, during the past decade. My efforts to gather the published literature during the last phases of actually writing a whole book about them were almost equally divided between libraries of Biology, Chemistry, Engineering, Mathematics, Medicine, and Physics.

A lot of what I call "gathering" was done somewhat in anticipation in the form of conjecture, query, and prediction based on analogy between developments in "different fields." The consequence throughout 1979 was that our long-suffering publisher repeatedly had to replace such material by citation of unexpected flurries of papers giving substantive demonstration. I trust that the authors of these many excellent reports, and especially of those I only found too late, will forgive the brevity of allusion I felt compelled to observe in these substitutions.

It is clear to me already that the materials I began to gather several years ago represented only the first flickering of what turns out to be a substantial conflagration. Accordingly, I took a liberty with the 1978 reference list. You will notice that about 20% of its entries are not to be found in the page index of publications cited. That is because they are not explicitly cited. Readers who like to browse will easily find these extra papers: they lie among papers on similar topics by much-cited authors. They lead in the directions of significant expansion.

► Indeed they did, so they are less interesting today: I have accordingly deleted them. The new and shortened old reference lists, each now with about 900 items, are alphabetized together. ◄

And what comes next? Well, one never knows; that is half the fun of doing science. But one inevitable development is especially conspicuous by its absence here. In fact, the original 30 chapters came down to 23 by purging 7 to ripen further into a later volume[1]. You will find here almost ***no mention*** of rhythmic driving of

[1] This became *The Timing of Biological Clocks* Freeman, 1986 and *When Time Breaks Down: The Three-Dimensional Dynamics of Electrochemical Waves and Cardiac Arrhythmias*, Princeton Univ. Press, 1987.

biological dynamics. Plainly that must contain the essence of any practical application, be it in hormonal gating of cell division, in cardiac or gastric pacemaking, or in agricultural photoperiodism. Many surprises await discovery in connection with alternative modes of entrainment, the consequences of synchronization, and evolution in periodic environments. This topic is the natural successor to the present volume on autonomous periodicity. It is now undergoing rapid development, mainly at the hands of neurobiologists, mathematicians, and engineers, and will be riper for harvest a few years hence.[2]

A residue of loose ends (questions for research) is largely collected in the index under "***Queries***."

► Survivors and replacements are instead flagged in the margins for the Y2K Edition. ◄

It has been my good fortune to visit lively investigators in many laboratories. I have been stimulated by early exposure to their discoveries (which fill out so much of the following chapters), and their critical attention to my own seminars has refined into presentable form most of what is presented here. But I have never found an opportunity to teach on these subjects, as you can see by the lack of problem sets in this presentation. I suspect that substantial improvements of content and clarity as well as significant new directions would inevitably emerge through contact with students who are eager and ready to study living systems in a mathematical spirit. That is a hard clientele to locate; I could use some help.

I wish you good reading and wish you to send me marginal notations to collect on my copy. Who knows? There **might** even be a second edition.[3]

Acknowledgments

I wrote this book but its authors live all over the world. In a broad sense the list of authors is the bibliography. But in a more precise sense this gathering of facts and ideas was shaped by about twenty-five individuals whose conversation and correspondence molded every topic represented here. Many others also will recognize in these pages the distorted reflection of their own imagination and skepticism. Rather than belabor the apologies and disclaimers usual in books of this sort, let me just remark that without the impact of Ralph Abraham, Arthur Brill, Robert DeHaan, Wolfgang Engelmann, Brian Goodwin, Herman Gordon, Joseph Higgins, Walter Kaufman-Bühler, Stuart Kauffman, Richard Levins, Robert MacArthur, Graeme Mitchison, Jay Mittenthal, George Oster, Theodosios Pavlidis, Colin Pittendrigh, John Platt, Kendall Pye, John Rinzel, Frank Rosenblatt, Otto Rössler, René Thom, John Tyson, and Trisha Woollcott, my explorations into the dynamics of evolved life would have lacked the special richness and color that I here seek to share.

[2] See Glass, L. and Mackey, M.C. *From Clocks & Chaos: The Rhythms of Life* Princeton Univ. Press, 1988.

[3] After a second printing in 1990 that fixed many typos, this is it.

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Finally, I wish to acknowledge the frequent restoration of my sanity by the turquoise waters, white sands, and blinding sunlight of the Isle of Palms, South Carolina, where most of these pages were first drafted in 1977.

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