

## Book Review

### **Sociodynamics – A Systematic Approach to Mathematical Modelling in the Social Sciences**, By Wolfgang Weidlich

*“Quantitative models never comprise the full richness of qualitatively different properties in a social system. On the contrary: Only models which are parsimoniously designed with respect to the number of variables and trendparameters are sufficiently transparent to yield possible insights into the structure and dynamics of a social system”*. These words of Wolfgang Weidlich underline one of the basic ideas behind the development of the framework of Sociodynamics.

The observation that many systems composed by large number of subsystems behave quite similar on the macro level even if the interactions among their subsystems are completely different on the micro level has encouraged researchers to look for unifying concepts. In Synergetics a conceptual framework for the mathematical treatment of closed or open multi-component systems with “co-operative” interactions occurring between the units of the systems was developed since the 1970th mainly by H. Haken. The interdisciplinary relevance of some concepts of synergetics have been successfully demonstrated. However, the application of synergetic concepts or more general of mathematical and physical principles to social sciences bear some fundamental problems:

- In contrast to physical, chemical and several physiological systems no equations of motion on the micro level, this means on the level of agents (*i.e.*, human individuals) are available for social systems. Therefore an alternative formalism has to be developed which gets along without micro-equations but nevertheless takes into account the decisions and actions of individuals and derives from them dynamic equations for the relevant macro-variables of the social system.
- General motivations and patterns of behaviour which are interpretable in sociological terms and therefore characterise the members of social systems must emerge in the framework.

In this direction Weidlich and Haag and their co-workers have developed a framework over the last decades for the modelling of social systems referring to their special character from the very beginning.

The excellent book of Wolfgang Weidlich, the founder of the field of Sociodynamics, gives an account of the “state of the art” of this interdisciplinary project named “Sociodynamics”.

The framework is based on the master equation approach and belongs to the mathematical theory of stochastic systems with non-linear interactions.

There is no direct similarity between physical and social systems used in Sociodynamics, instead due to the universal applicability of certain mathematical concepts to statistical multi-component systems, an indirect similarity on the macro level can be found.

The main focus of the book consists in the introduction to the framework, in other words to the general strategies of model building in Sociodynamics, and its demonstration by means of several well selected nontrivial socio-economic problems.

The book consists of three parts divided into twelve chapters:

Part I (3 chapters) provides the foundation of the conceptual framework of Sociodynamics and its general interdisciplinary relation to other sciences of complex systems such as General Systems Theory (GST) and Synergetics. The scope and limitations of quantitative models and critical arguments about quantitative modelling in social science are also discussed.

Part II (6 chapters) demonstrates the applicability of Sociodynamics in four sectors of the society:

- *Population dynamics*  
Migration of interacting populations (chapter 4)
- *Sociology*  
The rise and fall of interacting social groups (chapter 5)  
Opinion formation on the verge of political phase-transitions (chapter 6)
- *Economics*  
Quality Competition between high-tech firms (chapter 7)  
Dynamics of conventional and fashion demand (chapter 8)
- *Regional Science*  
Urban evolution and population pressure (chapter 9)

It is very helpful for the reader that all these chapters 4 to 9 begin with an adequate qualitative consideration of the social structures, socio-

economic problems and motivations behind the quantitative model. This leads in a straightforward way to the relevant variables that can be chosen and to plausible assumptions about the form of the motivation potentials and transition rates. Numerous simulations of characteristic scenarios, together with their sociological interpretation, underline the power of the framework and illustrate by means of well selected figures the dynamic behaviour of the different models.

The mathematical framework is sometimes a little bit too short for a newcomer in this field. However, references to original publications are always given. The solution and the interpretation of the outcome of the different mathematical models of the chapters 4 to 9 are always very clearly presented and exciting for further research activities. The estimation of model parameters from empirical data is demonstrated in the case of interregional migration. The reader of the book, who is interested in applications of the framework to real world data may find this chapter too short. It should be mentioned, that the question of parameter estimation is not the main target of the book.

Part III (3 chapters) gives a very nice self-contained introduction to the mathematical methods utilised in this book for the quantitative modelling of social processes. The master equation formalism is derived and the main features of the master equation are proved and discussed. All mathematical tools needed for the understanding of the framework are introduced in a smart way. Especially the derivation of meanvalue- and variance-equations from the master equation is clearly demonstrated. Furthermore, the concept of stochastic trajectories, quasi meanvalue equations and their relation to the probability distribution is explained. These concepts are also very helpful for the interpretation of mathematical results in an socio-economic context.

This book gives a short view over the comprehensive interdisciplinary work of Wolfgang Weidlich during the last three decades. It is not just a

book, it describes his scientific life and political and social interests. Therefore, it is a must for all those who are interested and working in this field of tension between the blurred social and political interactions and the precise formulation of mathematical models.

It is not only a book presenting the “state of the art” in the field of Sociodynamics for insiders but

can be used by graduate students with a mathematical background in order to get an overview of this interesting field of interdisciplinary research.

Prof. Dr. Günter Haag,  
Steinbeis Transfer Centre,  
Rotwiesenstrasse 22,  
70599 Stuttgart.



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