MATHEMATICAL MODELLING

Edited by J.G. Andrews, R.R. McLone

Butterworth, London-Boston

The book is adressed to the students in Mathematics and to those of other disciplines who have to study the object called: Mathematical Modelling. Having also chapters with an advanced mathematical content, the book can be successfully used by those who work in Univercities or in productive domains conected to mathematical applications.

The essential scope of this book is to point out how a practising mathematician has to do his approach to the real-life situations, the volume assembling case studies from many and different fields. Let us note here that it is not essential to follow the book chapter by chapter, but only those parts considered to be interesting to the studied field, parts which are self-consistent applications. The question which is the central point of the book is: "What is Mathematical Modelling?". The simple answer is given by the well-known definition which says that mathematical modelling is the art of applying mathematics to a real-life situation. A good model recognises the relevant features of a problem by means of a judicious choice of assumptions and has a well-defined mathematical structure from which the quantities of practical interest can be derived.

The traditional academic course in mathematics provides instruction in formal techniques for developing existing models, but usually fails to help in devising new models for problems facing the practising mathematician in the real world. To give the readers an insight into the process by which mathematicians adapt their mathematics to real-life situations, the Editors have assembled case-studies from the fields of: engineering, chemistry, biology, medicine, operations research, business planning and social studies. Each case study written by an expert in the particular subject, demonstrates the particular elements and style of mathematical structure required for the practical situation. At the begining of each chapter is inserted a note in which are specified the mathematic inserts necessary for understanding the discussed problem. So, in chapters as: "Steering Problems", "Why Build Three Stage Rockets?", "Population Models", "A Differential Model of Diabetes Mellitus", "A Business Planning Model" , "Urban Structure", a.s.o., is offered an illustration of the various domains in which applied mathematics can formalise and solve problems.

For example, we shall briefly present a very interesting chapter entitled: "Population Models", by C. Murdie from Imperial College, London. The necessary mathematic inserts are ordinary differential equations. The concern of this chapter is the strategic models which provide a framework of basic biological processes such as: birth and death in formal terms.

The first paragraph deals with simple-species populations.

This unlimited geometric population increase is constrainted by the limit of natural resources such as: food, space, water, a.s.o. These constraints impose an upper limit, K say, for population size to which the population tends and on reaching or overshooting it, falls again as (for instance) food shortage leads to starvation, increased mortality and descreased fertility. The outcome of such processes is that populations do not maintain a steady state but fluctuate, sometimes very wildly around a mean level. The study of the stabilization mechanism of this oscillation pleads for the development of the population models which leads to the logistic equation Verhulst-Pearl. However, one serious criticism of this model is the use of the instantaneous rates which suppose a perfect temporal dependence on the population at that instant. On the other hand is adequate for species with discrete generations (when breeding occurs only at certain times of the year). For elliminating these inconvenients one consideres the age-structured population methods, leading to more complex models.

The next paragraph deals with the two species models, starting from the obvious fact that no organisms can live in complete isolation from others and in living together in the same habitat, organisms often compete for limited resources such as: food, space, etc. More specialized competitions are vizible in host-parasite systems.

At host-parasites systems the interactions are more complex and the development of the attacking species depends absolutely on the available food. Due to the ambiant factor the competitions appear not only between host and parasite, but also between hosts. The effect of these interactions is transformed in mathematical relations using simplifying hypothesis as the assumption that, although some hosts receive more that one parasite egg, only one parasite develops from each host attacked. For illustrating these phenomena are used the Lotka-Volterra equations, obtaining complex models, the last being Hussel-May Model (1973), in which is also introduced the space variable. The conclusion of that chapter is that the problems of the biological populations are far to be solved, the domain remaining opened to the future researches.

The concept of the book, as well as its transposition, contribute in making the book an efficient and clear instrument for students and research-workers from various fields. The competent contribution of the experts who prepared the book adds to the reasons for which we believe that the volume should be consulted by all those interested in mathematical modelling.

Rodica Costake