PREFACE

The collection of these reports, which appeared over the considerable span of years that I spent at Los Alamos, concerns a great variety of topics. Its very heterogeneous nature illustrates the diversity of the programs and of the areas of research that interested the laboratory.

Before World War II it was almost exclusively in the universities, in the graduate schools of the larger institutions that scientific research used to take place. The Bureau of Standards and a very few large industrial companies such as Bell Telephone, General Electric, and some pharmaceutical firms were the exception to the rule.

This little collection may bear witness, in a very modest way, to the wide-ranging changes, which are still going on in the organization and practice of research in this country and abroad. Because of the novel problems which confronted its scientists during the wartime establishment of Los Alamos, the need arose for research and ideas in domains contiguous to its central purpose. This trend continues unabated to the present.

Problems of a complexity surpassing anything that had ever existed in technology rendered imperative the development of electronic computing machines and the invention of new theoretical computing methods. There, consultants like von Neumann played an important role in helping enlarge the horizon of the innovations, which required the most abstract ideas derived from the foundations of mathematics as well as from theoretical physics. They were and still are invested in new, fruitful ways.

An enormous number of technological and theoretical innovations were initiated at this laboratory during these forty years. To mention but a few, besides the advances in computing, one can name research on nuclear propulsion of rockets and space vehicles, in molecular biology, and on the technology of separating cells.

The growing importance of research laboratories such as this one became a not exclusively American phenomenon. For instance the aspect of academic research has changed almost beyond recognition in France. What used to be, before World War II, almost exclusively the province of universities, has now shifted to the French National Center of Research (Centre National de Recherche.)

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This collection of Los Alamos Reports ranges over almost four decades and may illustrate, I hope, how a mathematical turn of mind, a mathematical habit of thinking, a way of looking at problems in different subfields of physics, astronomy, or biology can suggest general insights and not just offer the mere use of techniques. Ideas derived from even very pure mathematical fields can provide more than mere "service work," they may help provide true conceptual contributions from the very beginning.

The period in question has seen the origin and development of the art of computing on a scale which vastly surpasses the breadth and depth of the numerical work of the past. In at least two different and separate ways the availability of computing machines has enlarged the scope of mathematical research. It has enabled us to attempt to gather, through heuristic experiments, impressions of the morphological nature of various mathematical concepts such as the behavior of solutions of certain nonlinear transformations, the properties of some combinatorial systems, and some topological curiosities of seemingly general behaviors. It has also enabled us to throw light on the behavior of solutions of many problems concerning complicated systems, by allowing numerical computations of very elaborate special physical problems, using both Monte Carlo type experiments and extensive but "intelligently chosen" brute force approaches, in hydrodynamics for example.

A number of such experiments have revealed, surprisingly, a non-classical ergodic behavior of several dynamical systems. They have showed unexpected regularities in certain flows of dynamical systems, in the mechanics of many-body problems, and in continuum mechanics. Recently they have been applied to the study of elementary particle physics set-ups and interactions.

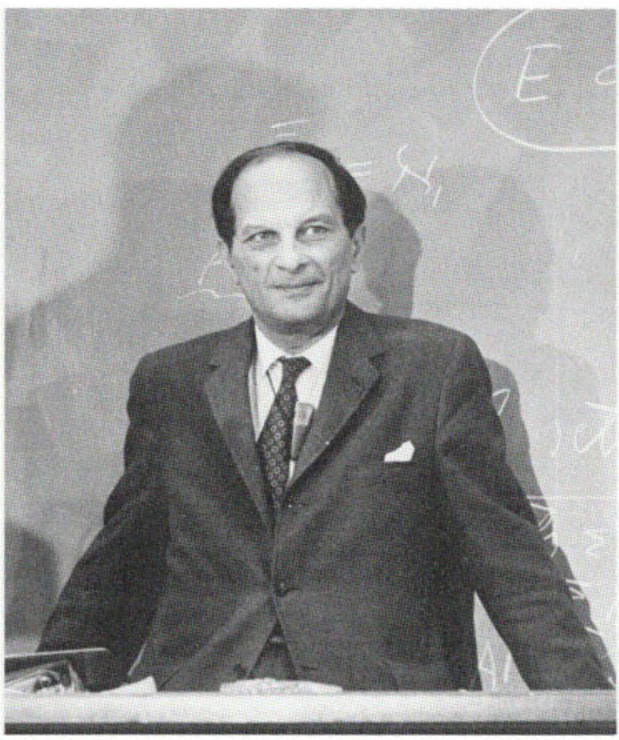
And now there appear some most exciting vistas in the applications of mathematics to biology that deal with both the construction and the evolution of living systems, including problems of the codes, which seem to define the basic properties of organisms and ultimately may provide us with a partial understanding of the working and evolution of the nervous system and some of the powers of the brain itself.

In addition these reports show the varying involvments of my collaborators and myself. I particularly want to stress the importance of

the role of collaborators. An ever increasing number of publications of mathematical research is proof of the advantages derived when two or more authors share ideas and techniques. The nature of this exchange varies from case to case, depending on the personality and experience of the individuals.

These few very sketchy remarks are merely intended to emphasize how the necessity of defense work at the frontiers of science has continued to this day to stimulate research in a multitude of directions.

S. M. Ulam
Santa Fe,
February 1984



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This report contains 22 pages

THEORY OF MULTIPLICATIVE PROCESSES. I.

WORK DONE BY

D. Hawkins

S. Ulam

REPORT WRITTEN BY

D. Hawkins

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