PREFACE

Many information processing problems are conveniently treated by networks that exhibit a repeated structure of identical subnetworks. While such an iterative structure has long been used in the design of switching circuits, it has been restricted primarily to simple one-dimensional networks without memory capabilities. In recent years, interest has arisen in a number of problems that require two-dimensional iterative networks, or one-dimensional iterative networks with memory capabilities. As a result, it has become important to determine some of the basic characteristics of these more complex types of iterative arrays. While some work has been done on a number of special iterative phenomena, such as "growing" automata and "self-reproducing" machines, there is also a need for a better understanding of the fundamental types of behavior that systems with repeated structures can exhibit.

This book represents an attempt to formulate and answer a few simple questions about the analysis and synthesis of the more general types of iterative arrays. It is the result of work conducted by the author while a member of the Research Laboratory of Electronics at the Massachusetts Institute of Technology and while at the General Electric Research Laboratory in Schenectady, New York. A small part of the work reported here is drawn from the author's Master's thesis; the remainder forms the basis for a Doctoral thesis submitted to the Department of Electrical Engineering at the Massachusetts Institute of Technology in May, 1961.

Although it is far from being a complete treatment of iterative systems, there are several reasons for making this material available in its present form. First, it contains several techniques which those interested in data processing, computer design, and switching theory may find useful in the design of iterative networks. Second, it demonstrates that there can be no general procedures for the analysis and synthesis of even relatively simple types of iterative systems. An understanding of the precise nature of this result should serve as a guide for future work in the area. Finally, an appreciation of the capabilities and limitations of the methods presented here may facilitate the development of other, more powerful, approaches.

This monograph will have served its purpose if it stimulates some of its readers to apply their ingenuity to the important and fascinating problems as yet unsolved.

While this is not a textbook, I have attempted to present the available analysis and synthesis techniques with sufficient detail to enable the reader to make practical use of them. Even so, the major emphasis is not on design techniques, but rather on a logical development of the properties of the various classes of iterative systems and the tests that are available for answering certain simple questions about them. Those who wish to concentrate on practical analysis and synthesis aspects may prefer to skip Section 2.4 and Chapters 3, 4, and 5 on the first reading.

My own interest in this subject was first aroused in 1956 by Professor David A. Huffman, who has provided encouragement and guidance throughout the course of this work. His suggestions and constructive criticism have contributed to the effectiveness of the finished product. I am also indebted to Dr. Richard L. Shuey of the General Electric Research Laboratory for making available an ideal research environment during two summers, and to Dr. Philip M. Lewis, II, for his continued interest and valuable suggestions. Thanks are also due Professor Dean N. Arden and Mr. Lester A. Gimpelson, both of the Massachusetts Institute of Technology, for their critical reading of the manuscript.

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F. C. Hennie