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Preface

Portions of this book are based on a book published in 1968 under the title *Mechanized Assembly* by G. Boothroyd and A.H. Redford. In a later further edition, titled *Automatic Assembly* by G. Boothroyd, C. Poli, and L.E. Murch, the original material developed at the University of Salford in England was updated with work carried out at the University of Massachusetts. In those days, it was felt that manufacturing engineers and designers wished to learn about automatic assembly as it appeared to provide a means of improving productivity and competitiveness. Since 1978, I developed a subject that holds much greater promise for productivity improvement and cost reduction, namely, design for assembly (DFA). The DFA method has become widely used and has helped numerous companies introduce competitive product designs.

This text, therefore, includes detailed discussions of design for assembly, and the subject of assembly automation is considered in parallel with that of product design.

The first step in considering automation of assembly should be careful analysis of the product design for ease of automatic assembly. In addition, analysis of the product for ease of manual assembly should be carried out in order to provide the basis for economic comparisons of automation. Indeed, it is often found that if a product is designed appropriately, manual assembly is so inexpensive that automation cannot be justified. Thus, a whole chapter is devoted to design for manual assembly. Another chapter is devoted to design for high-speed automatic and robot assembly, and a third chapter deals with electronics assembly.

This second edition includes, as an appendix, the popular *Handbook of Feeding and Orienting Techniques for Small Parts* published at the University of Massachusetts. This edition also includes the original data and coding systems for product design for high-speed automatic and robot assembly also developed at the University of Massachusetts. Finally, numerous problems have been added and worked solutions to all the problems are available.

The book is intended to appeal to manufacturing and product engineers as well as to engineering students in colleges and universities.

I wish to thank Dr. A.H. Redford for his kind permission to use material published in our original book, *Mechanized Assembly*, and to Drs. C.R. Poli and L.E. Murch for permission to include much of the material from the *Handbook of Feeding and Orienting Techniques for Small Parts*, which we coauthored.
Finally, thanks go to Dr. P. Dewhurst for his contributions to our work on product design for robot assembly.

Geoffrey Boothroyd
The Author

Geoffrey Boothroyd is Professor Emeritus of Industrial and Manufacturing Engineering at the University of Rhode Island in Kingston. The author or coauthor of more than 100 journal articles, he is also the coauthor or coeditor of several books, including Fundamentals of Machining and Machine Tools, Second Edition (with W.A. Knight), Automatic Assembly (with C. Poli and L.E. Murch), and Applied Engineering Mechanics (with C. Poli) (all titles published by Marcel Dekker.). Additionally, Professor Boothroyd serves as coeditor for the Taylor & Francis series Manufacturing Engineering and Materials Processing. A Fellow of the Society of Manufacturing Engineers, he is a member of the National Academy of Engineering, among other professional societies. Professor Boothroyd received Ph.D. (1962) and D.Sc. (1974) degrees in engineering from the University of London, England. His numerous honors and awards include the National Medal of Technology and the SME/ASME Merchant Medal.
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1 Introduction

Since the beginning of the 19th century, the increasing need for finished goods in large quantities, especially in the armaments industries, has led engineers to search for and to develop new methods of manufacture or production. As a result of developments in the various manufacturing processes, it is now possible to mass-produce high-quality durable goods at low cost. One of the more important manufacturing processes is the assembly process that is required when two or more component parts are to be secured together.

The history of assembly process development is closely related to the history of the development of mass-production methods. The pioneers of mass production are also the pioneers of modern assembly techniques. Their ideas and concepts have brought significant improvements in the assembly methods employed in high-volume production.

However, although many aspects of manufacturing engineering, especially the parts fabrication processes, have been revolutionized by the application of automation, the technology of the basic assembly process has failed to keep pace. Table 1.1 shows that, 35 years ago in the U.S., the percentage of the total labor force involved in the assembly process varied from about 20% for the manufacture of farm machinery to almost 60% for the manufacture of telephone and telegraph equipment. Because of this, assembly costs often accounted for more than 50% of the total manufacturing costs.

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