

FOREWORD

Over a hundred engineers and managers from academic, research, and industrial organizations came to The First European Conference on Computer Control in Fermentation in Dijon, France in 1973 at the invitation of Professor Blachere. For some it was the culmination of three years of intensive effort to bring modern process computing know-how into fermentation technology. For others it was a decision point for extensive capital investment. But for all it was an acknowledgment that biochemical research and production has at last entered the age of automation. With this came two realizations, first, that computer technology must be adapted before it would fit the needs of microbiologists and, secondly, that instrumentation would have to be developed before the measurement of biological variables could be put on an objective basis. As could be expected, the adaptation of computer technology has progressed much more rapidly than has the science of measurement.

At the conclusion of the Dijon conference it was agreed that a second conference should be held at the Gesellschaft für Biotechnologische Forschung in Stöckheim immediately following the V IFS in Berlin. In the time intervening the GBF has installed and operates an advanced computer-coupled pilot plant for biological process development under the direction of Professor F. Wagner. This installation, which was funded by grants from the Volkswagen Foundation and the Bundesministerium für Forschung und Technologie, was conceived and constructed as a unique facility for accelerated development of biochemical processes through the coupling of a computer hierarchy to fermentation and recovery equipment in the newly built Biotechnikum. In fact the data from as many as six fermentation and two recovery processes can now be gathered on-line by the process computer, analyzed, and transmitted over a data link to a time-sharing computer for modelling and optimization studies. There is, indeed, much in Stöckheim to see. However, in view of the week long IFS it seemed preferable to assemble a monograph of invited chapters, representing a report on the state-of-the-art on computer applications to fermentation technology. The individual contributions have been solicited to give a broad coverage of the goals of computer-coupled fermentation, the problems encountered, and the solutions available today. The Directors of the GBF have kindly agreed to underwrite the publication of this report as an item in the GBF Monograph Series published by Verlag Chemie. We all sincerely hope that it will fulfill the need for a state-of-the-art report on this field in the year 1976.

With regard to the preparation of this manuscript, I most sincerely thank all of my colleagues who have contributed their timely ideas to this monograph: Messrs. Armiger, Bach, Blachere, Corrieu, Hampel, Humphrey, Lehmann, Meskanen, Nyiri, Peringer, Reuß, Ribot, Röhr, Selva, Taguchi, Vogelmann, Winter, Yoshida, Zabriskie, and Zerbetto. I thank Prof. Dr. F. Wagner for his encouragement of this effort, the Directors of the GBF for their direct support of the monograph, and Verlag Chemie for agreeing to bring it to print as rapidly as possible. I acknowledge with gratitude the

helpful service of Dr. J.-H. Walsdorff for publishing and editorial assistance. The financial support of the Bundesministerium für Forschung und Technologie of the German Federal Republic and the Fulbright Commission, both of which sponsored my work and leave of absence in Germany, are hereby most gratefully acknowledged.

Braunschweig-Stöckheim, 5 July 1976 R. P. Jefferis III

CONTENTS

H. T. BLACHERE, P. PERINGER, and G. V. CORRIEU Optimization of fermentation plants.	1
G. SELVA and P. ZERBETTO Software engineering: experience in a consulting agency.	11
R. P. JEFFERIS Software and file structures for computer-coupled pilot fermentation plants.	21
L. K. NYIRI, G. M. TOTH C. S. KRISHNASWAMI, and D. V. PARMENTER On-line analysis and control of fermentation processes.	37
W. HAMPEL, H. P. BACH, and M. RÖHR Low cost data acquisition and analysis with on-line desk calculators.	47
D. W. ZABRISKIE, W. B. ARMIGER, and A. E. HUMPHREY Applications of computers to the indirect measurement of biomass concentration and growth rate by component balancing.	59
A. MESKANEN Design of the man-machine interface for computer coupled fermentation.	73
T. YOSHIDA and H. TAGUCHI The use of models in fermentation control.	93
M. REUB, R. P. JEFFERIS, and J. LEHMANN Application of an on-line system of coupled computers to fermentation modelling.	107
D. RIBOT Polynomial identification methods.	125
R. P. JEFFERIS, H. WINTER, and H. VOGELMANN Digital filtering for automatic analysis of cell density and productivity.	141