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Edited by David Gries

THE ORIGINS OF DIGITAL COMPUTERS

Selected Papers

Edited by Brian Randell

THIRD EDITION



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The Origins of Digital Computers Selected Papers

Third Edition

Edited by Brian Randell

With 126 Figures



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To E. R.

Preface to the Third Edition

Over the eight years since the first edition of this book was published the amount of serious study devoted to the history of computing has increased markedly, as evidenced for example by the launching of a new quarterly journal the *Annals of the History of Computing*, and the holding of two major international conferences.

During this time I have continued the very enjoyable task of searching for published documents and reports relating to the origins of digital computers. I have been aided in this work by many people, far too numerous to name individually, but to all of whom I am pleased to offer my thanks. One result is that in this third edition the annotated bibliography has greatly increased in size, and now consists of over 850 items. Perhaps more importantly two wholly new additions have been made to the set of reprinted papers, covering important early developments of which I was completely unaware until recently, namely the pre-war work by VANNENAR BUSH in connection with his Rapid Arithmetical Machine Project at MIT, and the slightly later work at RCA by JAN RAJCHMAN on digital electronic fire control systems. In addition welcome, albeit partial, relaxation of the security restrictions surrounding the wartime work in Britain on cryptanalysis has enabled me to provide a more detailed account of the Colossus computer. This new edition has also afforded me the chance to make some comparatively modest corrections and additions to the introductory sections given with various chapters.

A considerable and continuing secretarial burden results from my "spare-time" interest in the origins of computers. It is my pleasure to record my thanks to Mrs. BETTY SMITH who, like Miss ANN LAYBOURN before her, has shouldered this burden magnificently.

Newcastle upon Tyne
Spring 1982

BRIAN RANDELL

Preface to the Second Edition

My interest in the history of digital computers became an active one when I had the fortune to come across the almost entirely forgotten work of PERCY LUDGATE, who designed a mechanical program-controlled computer in Ireland in the early 1900's. I undertook an investigation of his life and work, during which I began to realise that a large number of early developments, which we can now see as culminating in the modern digital computer, had been most undeservedly forgotten.

Hopefully, historians of science, some of whom are now taking up the subject of the development of the computer and accumulating valuable data, particularly about the more recent events from the people concerned, will before too long provide us with comprehensive analytical accounts of the invention of the computer. The present book merely aims to bring together some of the more important and interesting written source material for such a history of computers. (Where necessary, papers have been translated into English, but every attempt has been made to retain the flavour of the original, and to avoid possibly misleading use of modern computing terminology. Some papers have had to be type-set from manuscripts and typescripts – the aim has been to do this as faithfully as possible, apart from questions of layout, and errors in the original sources, even of a typographical nature, have not been corrected.) Nearly all of the papers and reports which are collected together in this book are first-hand contemporary accounts, only a comparatively few of which are at all widely known today; indeed several have never before been published. Taken together, however, they provide us with a fascinating series of glimpses into the minds of the pioneers of the computer.

This book therefore is intended for readers, such as computer science students or people employed in the computer field, who are interested in the history of their subject, and particularly in the technical details of the precursors of the modern electronic computer; it is for such a readership that the various introductory passages in the book have been written. The book takes as its basic starting point the Analytical Engine that CHARLES BABBAGE started to design in 1834. It ends with two papers that were presented on the occasion of the inauguration of EDSAC in June 1949. The aim has been to cover each significant milestone on the route from BABBAGE to EDSAC, although the choice of which papers to include in this selection is of course very much a personal one. However there may well be further pioneers whose work has been forgotten more completely than was LUDGATE's. Similarly, there may be further machines which were developed, perhaps like the Colossus series under strict conditions of wartime secrecy, whose existence is even now still unrevealed.

The book also contains, as an appendix, an extensive bibliography on the origins of digital computers which covers a somewhat broader field than the selection of papers. In particular it includes references to earlier inventions such as mechanical adding

and calculating machines, and machines such as automatic draw-loom and musical automata which we would now class as "program-controlled". It also includes references to some of the more interesting electromagnetic calculating devices, and to the earliest digital electronic devices. However the bibliography does not attempt to cover the explosive growth in the literature on electronic computers which occurred in the late 1940's and early 1950's when many computer projects based on the EDVAC and IAS computers were started.

Perhaps the most obvious inadequacy of the bibliography is that the patent literature is almost entirely unrepresented. Some of the difficulties that this literature causes to other than trained patent specialists are well illustrated by the following sentence from the U.K. version of the historic ENIAC patent:

"According to the present invention an electronic computing machine comprises electronic trigger units interconnected to form a plurality of computing devices each responsive to pulses representing quantitative values to perform a predetermined computational operation upon such values and to provide a terminal pulse signal upon the termination of each such operation and electronic programming means arranged to be stimulated by particular ones of said terminal signals to programme the sequence of such computational operations at electronic speeds in any predetermined relationship, whereby the results of any of the operations may be used in other subsequent operations in any of the computing devices to form a programmed routine of operations."

It is to be hoped that the formidable task of surveying and analysing the voluminous patent literature relating to the origins and development of digital computers, and of discussing the extensive patent litigation which commenced after the war, and still continues, will soon be undertaken.

The present book owes much to the help that I have received from many people, including a number of the computer pioneers themselves, namely: Dr. J. V. ATANASOFF, Dr. H. H. GOLDSTINE, Dr. J. W. MAUCHLY, Professor D. MICHIE, Professor G. R. STIBITZ, Professor M. V. WILKES and Professor K. ZUSE. I have been given much assistance by the staff of many libraries and museums, and in particular by Miss S. CRAIG, Computing Laboratory Librarian, University of Newcastle upon Tyne, Mr. W. D. HACKMAN of the Museum of the History of Science, Oxford, Miss J. M. PUGH, Assistant Keeper at the Science Museum, London, Mr. I. J. SELIGSOHN, Manager, Museum and Exhibition Department, IBM Corporation, Dr. H. S. TROPP, Principal Investigator, Computer History Project, Smithsonian Institution, and Mr. H. WOOLFE, Assistant Keeper at the Science Museum Library, London. It is also a pleasure to record my thanks, for all of the assistance and advice that I have received, to Mr. R. BASU, Professor F. L. BAUER, Mr. C. R. COOK, Mr. R. DIERSTEIN, Dr. J. EVE, Lord HALSBURY, Mrs. J. HORNING, Mr. and Mrs. P. JONES, Professor D. E. KNUTH, Dr. P. E. LAUER, Dr. H. P. STADLER, Mr. C. E. STEFFEY, Mr. M. TRASK, and Professor H. ZEMANEK. Finally, my thanks to my secretary, Miss ANN LAYBOURN,

for the unfailing cheerfulness and efficiency with which she has coped with the voluminous correspondence that the assembly of the material for this book has involved.

Newcastle upon Tyne
Spring 1973

BRIAN RANDELL

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D. Gries

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