Contributors

John Backus
Friedrich L. Bauer
Julian Bigelow
Garrett Birkhoff
Andrew D. Booth
Arthur W. Burks
J. C. Chu
Edsger W. Dijkstra
J. Presper Eckert, Jr.
Andrei P. Ershov
Robert R. Everett
I. J. Good
R. W. Hamming
A. S. Householder
Cuthbert C. Hurd
Harry D. Huskey
Donald E. Knuth
S. H. Lavington
D. H. Lehmer
John W. Mauchly
Kenneth O. May
N. Metropolis
Jan Rajchman
B. Randell
James E. Robertson
Mikhail R. Shura-Bura
Ralph J. Slutz
George R. Stibitz
Ryota Suekane
Antonin Svoboda
Erwin Tomash
Luis Trabb Pardo
Henry S. Tropp
S. M. Ulam
Mark B. Wells
M. V. Wilkes
J. H. Wilkinson
H. Zemanek
Konrad Zuse

A History of Computing in the Twentieth Century

A collection of essays with introductory essay and indexes

Edited by

N. METROPOLIS
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

J. HOWLETT
Oxford University
Oxford, England

GIAN-CARLO ROTA
Massachusetts Institute of Technology
Cambridge, Massachusetts
and
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

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To John R. Pasta

List of Contributors

Numbers in parentheses indicate the pages on which the authors' contributions begin.

JOHN BACKUS (125), IBM Research Laboratory, San Jose, California 96193

FRIEDRICH L. BAUER (505), Institut für Informatik der Technischen Universität, D-8 München 2, Federal Republic of Germany

JULIAN BIGELOW (291), Institute for Advanced Study, Princeton, New Jersey 08540

GARRETT BIRKHOFF (21), Department of Mathematics, Harvard University, Cambridge, Massachusetts 02138

ANDREW D. BOOTH* (551), Lakehead University, Thunder Bay, Ontario P78 5E1, Canada

ARTHUR W. BURKS (311), Department of Computer and Communication Sciences, University of Michigan, Ann Arbor, Michigan 48104

J. C. CHU (345), 10 Baldwin Circle, Weston, Massachusetts 02193

EDSGER W. DIJKSTRA (563), Burroughs, Nuenen, The Netherlands

J. PRESPER ECKERT, JR. (525), Univac Division, Sperry Rand Corporation, Blue Bell, Pennsylvania 19422

ANDREI P. ERSHOV (137), Computing Center, Siberian Branch of the USSR Academy of Sciences, Novosibirsk 630090, USSR

ROBERT R. EVERETT (365), Mitre Corporation, Bedford, Massachusetts 01730

I. J. GOOD (31), Department of Statistics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

* Retired.

R. W. HAMMING (3), Naval Postgraduate School, Monterey, California 93940

A. S. HOUSEHOLDER* (385), Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830

CUTHBERT C. HURD* (389), IBM, New York, New York 10017

HARRY D. HUSKEY (419), Division of Natural Sciences, University of California, Santa Cruz, California 95064

DONALD E. KNUTH (197), Computer Science Department, School of Humanities and Sciences, Stanford University, Stanford, California 94305

S. H. LAVINGTON (433), Department of Computer Science, University of Manchester, Manchester M13 9PL, England

D. H. LEHMER (445), Department of Mathematics, University of California, Berkeley, California 94720

JOHN W. MAUCHLY† (541), Univac Division, Sperry Rand Corporation, Blue Bell, Pennsylvania 19422

KENNETH O. MAY† (11), Department of Mathematics, University of Toronto, Toronto, Ontario, Canada‡

N. METROPOLIS (457), Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544

JAN RAJCHMAN‡ (465), RCA Laboratories, David Sarnoff Research Center, Princeton, New Jersey 08540

B. RANDELL (47, 629), Computing Laboratory, University of Newcastle upon Tyne, Newcastle upon Tyne NE1 7RU, England

JAMES E. ROBERTSON (347), Department of Computer Science, University of Illinois, Urbana, Illinois 61801

MIKHAIL R. SHURA-BURA (137), Institute for Applied Mathematics, The USSR Academy of Sciences, Moscow, USSR

RALPH J. SLUTZ (471), Environmental Research Laboratories, National Oceanic and Atmospheric Administration, Boulder, Colorado 80303

GEORGE R. STIBITZ (479), Department of Physiology, Dartmouth Medical School, Hanover, New Hampshire 03755

RYOTA SUEKANE (575), Faculty of Engineering, Yamanashi University, Takeda-4 Kofu, Japan

ANTONIN SVOBODA (579), Computer Science Department, University of California, Los Angeles, California 90024

ERWIN TOMASH (485), Dataproducts Corporation, Woodland Hills, California 91365

LUIS TRABB PARDO (197), Computer Science Department, School of Humanities and Sciences, Stanford University, Stanford, California 94305

* Retired.

† Deceased.

‡ Present address: Jan Rajchman, Inc., 268 Edgerstone Road, Princeton, New Jersey 08540.

HENRY S. TROPP (115), Department of Mathematics, Humboldt State University, Arcata, California 95521
S. M. ULAM (93), Department of Mathematics, University of Florida, Gainesville, Florida 32611
MARK B. WELLS (275), Los Alamos Scientific Laboratory, Los Alamos, New Mexico 97544
M. V. WILKES (497), Computer Laboratory, University of Cambridge, Cambridge CB2 3QG, England
J. H. WILKINSON (101), National Physical Laboratory, Teddington, Middlesex, England
H. ZEMANEK* (587), IBM, D-7030 Boeblingen, Federal Republic of Germany
KONRAD ZUSE (611), Im Haselgrund 21, 6418 Hünfeld, Federal Republic of Germany

* Present address: IBM Austria, A-1011 Wien, Austria.

Preface

"*Historia magistra vitae, lux veritatis . . . ,*" we repeat to ourselves without conviction, and should like to go on believing. But scientific and technological history seem to belie this saying. The early version of an as yet ill-understood algorithm, the clumsy plan of an early engine, the pristine computer with its huge, superfluous circuits give us little inspiration to face the problems of our day. Technological advances appear as sudden, discontinuous leaps that cover all previous work with an impenetrable cobweb of obsolescence. It is left to the archeologist, not to the historian, to make his way across the tortuous maze of oblivion, and to retrieve at least an appearance of the lost artifact, an obtrusive contraption whose plans and photographs will serve to fill the glossy pages of coffee-table books.

Or so we are tempted to think when we look with secret boredom at the Carrollesque creations of a Babbage, at the megalomaniac plans of Geheimrat Leibniz, at the unconvincing fantasies of Leonardo da Vinci, or at the preposterous wheels of Raimond Lull. There is a point at which the study of the technological past turns into paleontology, and in the history of computation that point is uncomfortably close, and moving closer.

Why, then, a history of computing, no matter how recent the past recaptured? Couldn't it be honorably replaced by a compact commemorative plaque listing in gilded letters the names of the pioneers who made the computer age possible, God bless their souls? Are there any lessons to be learned from retelling and rereading the story of the computer and the rise of computer science?

First, some of the articles in this volume give useful factual information not to be found elsewhere. Randell's account of the COLOSSUS, until now a British top secret, is here made available for the first time; Ershov's, Shura-Bura's, and Svoboda's glimpses beyond the Iron Curtain are a novelty that will provide some exciting reading enjoyment.

The jumping on the bandwagon of the big corporations, belated as always, but done with all the flair and fanfare that would rekindle our wa-

vering faith in the willingness of private enterprise to contribute to scientific research, is here amply documented. The reports of Everett on the MITRE Corporation, Hurd on IBM, Rajchman on RCA, Stibitz on Bell Labs, Tomash on Engineering Research Associates, Eckert and Mauchly on Sperry Rand, should set our capitalistic hearts to rest, at least until the next computer revolution.

The development of programming languages is perhaps the one chapter in this history that displays the dialectical development expected of intellectual history. Each new computer language is motivated by the preceding, and the mistakes of the past shine by their absence in the languages of the present. Backus's nitty-gritty list of early mistakes, Knuth's Olympian survey of early programming languages, Wells's reflections on the possibilities of algorithmic languages, Dijkstra's account of the implementation of ALGOL, Householder's tale of the triumphal stage entry of numerical algebra, are perhaps among the papers in this volume that will bear frequent rereading by all who have to navigate on the high seas of present-day programming. With this edifying objective in mind Hamming and May have written witty exhortations, urging us to preserve the fading records of our computer present.

The chatty, anecdotal accounts of Birkhoff, Good, Ulam, Wilkinson, Tropp, and Bigelow bring to life the pioneers of computing, and center stage is held by the personalities of the logician Alan Turing and mathematician John von Neumann. Few, except these giants, realized in the 1930s that the formalism of mathematical logic, considered by many a sterile exercise for philosophers and for mathematicians in search of a field, was instead the magic key to programming languages as well as to computer design.

For if there is a message that comes across in these essays, it is that the spark of life was given to computer science by a few men who displayed the vision gained elsewhere from a broad cultural background, and who were immune to the stupefying demands of some presumed relevance. The improbable symbolism of Peano, Russell, and Whitehead, the analysis of proofs by flowcharts spearheaded by Gentzen, the definition of computability by Church and Turing, all inventions motivated by the purest of mathematics, mark the beginning of the computer revolution.

Once more, we find a confirmation of the sentence Leonardo jotted despondently on one of those rambling sheets where he confided his innermost thoughts: "Theory is the captain, and application the soldier."

On a more practical plane, another unmistakable message emerges from these essays. Over the years, the constant and most reliable support of computer science—and of science generally—has been the defense establishment. While old men in congresses and parliaments would debate the allocation of a few thousand dollars, farsighted generals and admirals would not hesitate to divert substantial sums to help the oddballs in Princeton, Cambridge, and Los Alamos. Ever since Einstein wrote a letter to President

Roosevelt, our best friends have been in the branch of government concerned with defense. And now that the processing of intelligence data is rapidly reaching Byzantine complexity, we can learn from the past to appreciate another possible source of support that may be coming along.

"*Historia magistra vitae, lux veritatis. . . .*"

Los Alamos, New Mexico
27 April 1979

N. METROPOLIS
GIAN-CARLO ROTA

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Introductory Essay

All revolutions, like the computer revolution, are described and recorded before they happen. While computers were still inconspicuous adding machines, star-gazers and senior scientists took turns at providing unsolicited accounts of the New Age. But as soon as the revolution began to affect our lives, predictions on the shape of science and society in the age of the computer became cautious and rare.

The art of prediction, whether practiced by professionals or by amateurs, deals with the discontinuity of change. In the face of a staggering jump never before encountered, the lessons of yesterday are only logarithmically significant, and the achievements of the past are no longer the source of inspired guesswork. Today's accomplishments in computing beat those of our immediate predecessors by several orders of magnitude.

Yet, now more than ever the time calls for a cool assessment of the effects of the computer revolution. One need not wait for the next major change, for the advent of massive parallel systems now at the planning stage, in a world race so feverish as to call into question the work ethics of East and West. Even the media are now broadcasting the opinion that the future of civilization no longer depends as much on armies and weapons as on arrays of supercomputers, and on the inspired software that the best minds of each nation will devise for them. The stakes are high. As in old science fiction novels, the reward will go to whoever is first to program in the four dimensions of space and time.

Every corner of science will then be revamped. The predictive powers of quantum mechanics — now limited to small atoms — and those of mathematical economics — now limited to past events — will be triumphantly verified or definitively refuted. Statistical mechanics will explain why water boils at 100°, and biologists will be experts in combinatorics. Artificial intelligence will be pushed to its natural limits, and the uneasy boundary between mind and matter will be drawn. The mathematician, far from being thrown into the dustbin of history, as some mistakenly fear and others secretly expect, will again be called upon to explain extraordinary phenomena to be revealed by experimentation with the computer.

In fact, the demands on the powers of the intellect, far from being taken over by computers, as some simplistically predict, will be greater than ever. All trite and routine work removed, the scientist will be forced to face those tasks that call for the exercise of his creative faculties, those he does not share with machines. Even scholars in the humanities, freed from the trivia of erudition, will return to their calling as men of letters, and the new music may well surpass that of the Baroque age, as composers experiment on their terminals with heretofore unheard permutations of sound.

As economic planning is made effective by computing, the world will benefit from the demise of political ideologies based on wishful thinking. And not a minute too soon, as the depletion of natural resources will threaten a famine that only computer-aided foresight will avert. Similarly, only a swift pharmacology that will bypass lengthy experimentation shall prevent mankind from falling victim to the new diseases that are already darkening the horizon.

The coming generations will at first rejoice, as every child acquires analytic skills that are now a privilege of the technological elite. Instruction by computer will weed out incompetent teachers and old educational shibboleths. But minds that will be largely trained in analysis will be made aware of their deficiencies in synthetic and speculative thought. Will a new kind of teacher come along who will meet these unexpected educational needs?

We shall live in a society of poverty amid plenty. Communication on the computer's display will make ordinary conversation rare and difficult, but no less coveted, and the flood of impersonal information will stress the lack of genuine human contacts. As everyone becomes skillful at dealing with abstract entities, society will suffer from clumsier human relations. The survivors of our age will then be sought-after wise old men, and our time may then be admiringly studied for clues to a lost happiness. *Historia* will then again, with a vengeance, be regarded as *magistra vitae.*

Los Alamos
August, 1983

N. METROPOLIS
GIAN-CARLO ROTA